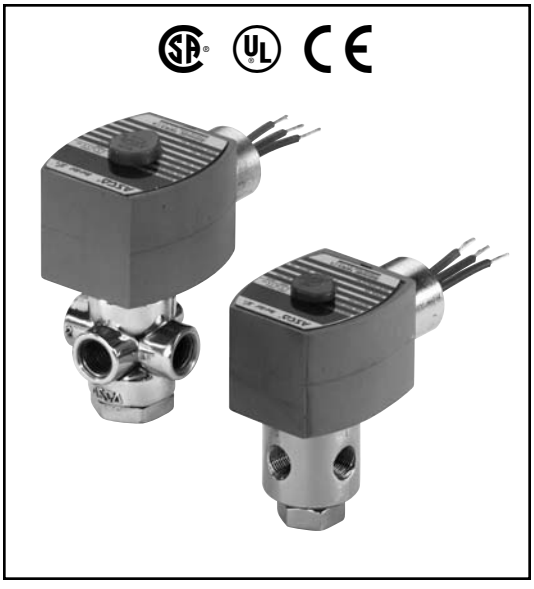
MAJOR INSTRUMENTATION MANUALS INDEX

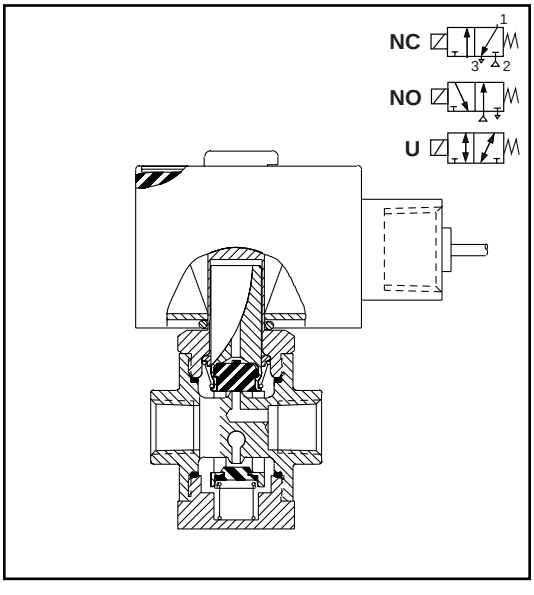
TAB	MANUFACTURER	MANUAL	INSTRUMENT
1	ASCO	8320	FCV, LCV, PCV, SDV
2	Ashcroft	50EI	TI
3		600B	TI
4		1279	PI
5		Thermowells	TW
6	Brooks	Ar-Mite	ME
7	Chromalox	Circulation Heater	H
8	Emerson - FieldQ	Valve Actuator	SDV
9	Emerson - Fisher	67CFR	FCV, LCV, PCV, TCV, SDV
10		299H	LT
11		627	PCV
12		657	FCV, PCV
13		667	FCV, LCV, PCV
14		846	LCV
15		2052	TCV
16		D4	LCV
17		DLC3010	LT
18		DVC6200	FCV, LCV, PCV, TCV
19		ET, EAT	FCV, PCV
20		EZ	LCV, PCV
21		EZ-C, ET-C, EWT-C	FCV
22		HP, HPA, HPT	LCV
23		Micro-Form	LCV
24		V150, V200, V300	TCV
25		Whisper III	PCV
26	Emerson - Rosemount	3051	FE, FT
27	Farris	2600 Series	PSV
28		2700 Series	PSV
29		3800 Series	PSV
30		IOM	PSV
31	Grove	B5 Ball Valve	SDV
32	Honeywell	ST 700 Series	FT, LT, PDT, PT
33		ST 800 Series	TT

TAB	MANUFACTURER	MANUAL	INSTRUMENT
34	JMS Southeast	3ESBNK	TE
35	Midwest	120 Series	PDI
36	Pentair	Keystone	SDV
37		Morin	SDV, XV
38		Vanessa	SDV, XV
39		Westlock	SDV, XV
40	PGI	2, 3, & 5 Valve Manifold	FT, PDT
41	Phymetrix	Moisture Analyzer	ME
42	PLT	MG	LI
43	Quality Products	Orifice Plate	FE
44		Restriction Union	RO
45	Quest-Tec	1S, RL, TL, TM	LG
46	S.O.R.	700 Series	LSHH
47	Topworx	DXP	FCV, PCV, SDV
48	Versa	VSG	SDV
49	WKM	370D6	SDV

Features

- All NPT connections are in the valve body to allow in-line piping
- No Minimum Operating Pressure Differential required
- Broadest range of applications
- Mountable in any position





Construction

Valve Parts in Contact with Fluids		
Body	Brass	303 Stainless Steel
Seals and Disc	NBR or Cast UR, as Listed	
Core Tube	305 Stainless Steel	
Core and Plugnut	430F Stainless Steel	
Core Springs	302 Stainless Steel	
Shading Coil	Copper	Silver
Disc-Holder	CA	
Core Guide	CA (10.1 and 17.1 Watt only)	

Electrical

Standard Coil and Class of Insulation	Watt Rating and Power Consumption				Spare Coil Part Number			
		AC			General Purpose		Explosionproof	
	DC Watts	Watts	VA Holding	VA Inrush	AC	DC	AC	DC
F	10.6	6.1	16	30	238210	238310	238214	238314
F	-	9.1	25	40	238210	-	238214	-
F	11.6	10.1	25	50	238610	238710	238614	238714
F	22.6	17.1	40	70	238610	238710	238614	238714

Standard Voltages: 24, 120, 240, 480 volts AC, 60 Hz (or 110, 220 volts AC, 50 Hz). 6, 12, 24, 120, 240 volts DC. Must be specified when ordering. Other voltages are available when required.

Solenoid Enclosures

Standard: Watertight, Types 1, 2, 3, 3S, 4, and 4X.

Optional: Explosionproof and Watertight, Types 3, 3S, 4, 4X, 6, 6P, 7, and 9. (To order, add prefix "EF" to the catalog number.)

See Optional Features Section for other available options.

Nominal Ambient Temp. Ranges

AC: 32˚F to 125˚F (0˚C to 52˚C)
DC: 32˚F to 104˚F (0˚C to 40˚C)

Note: Some stainless steel constructions are rated -40˚F (-40˚C). See note ④ in specifications table.

Refer to Engineering Section for details.

Approvals

CSA certified. UL listed General Purpose Valves.
Meets applicable CE directives.

SIL 3 capable per IEC 61508 on normally closed const. Third party certification provided by EXIDA.

Refer to Engineering Section for details.

Specifications (English units)

Pipe Size (ins.)	Orifice Size (ins.)	Cv Flow Factor	Operating Pressure Differential (psi) Max. AC Air-Inert Gas	Max. AC Water	Max. AC Lt. Oil @ 300 SSU	Max. DC Air-Inert Gas	Max. DC Water	Max. DC Lt. Oil @ 300 SSU	Max. Fluid Temp. ˚F AC	Max. Fluid Temp. ˚F DC	Brass Body Catalog Number	Brass Body Const. Ref.	Stainless Steel Body Catalog Number	Stainless Steel Body Const. Ref.	Watt Rating/ Class of Coil Insulation ② AC	Watt Rating/ Class of Coil Insulation ② DC
UNIVERSAL OPERATION (Pressure at any port)																
1/8	3/64	0.06	175	175	175	125	125	125	140	120	8320G130 ①	1	8320G140 ①	1	9.1F	10.6F
1/8	1/16	0.09	100	100	100	65	65	65	180	120	8320G001	1	8320G041 ③	1	9.1F	10.6F
1/8	1/16	0.09	175	175	175	125	125	125	200	150	8320G212	4	8320G221 ④	4	17.1/F	22.6/F
1/8	3/32	0.12	50	50	50	50	50	50	180	120	8320G083	1	8320G087 ③	1	6.1/F	10.6/F
1/8	3/32	0.12	100	100	100	60	60	60	200	150	8320G213	4	8320G222 ④	4	17.1/F	11.6/F
1/8	1/8	0.21	30	30	30	20	20	20	180	120	8320G003	1	8320G043 ③	1	9.1/F	10.6/F
1/8	1/8	0.21	50	50	50	25	25	25	200	150	8320G214	4	8320G223 ④	4	17.1/F	11.6/F
1/4	1/16	0.09	125	130	130	75	75	75	200	150	8320G172	2	-	-	10.1/F	11.6/F
1/4	1/16	0.09	175	175	175	125	125	125	200	150	-	-	8320G230 ④	3	17.1/F	22.6/F
1/4	3/32	0.12	100	100	100	60	60	60	200	150	8320G174	2	8320G200 ③④	3	17.1/F	11.6/F
1/4	1/8	0.25	50	50	50	25	25	25	200	150	8320G176	2	8320G201 ③④	3	17.1/F	11.6/F
1/4	11/64	0.35	20	20	20	12	12	12	200	150	8320G178	2	-	-	10.1/F	11.6/F
NORMALLY CLOSED (Closed when de-energized) – PFD_{AVG} = 6.81 x 10^{-4}																
1/8	3/64	0.06	200	200	200	200	200	200	180	120	8320G132	1	8320G142 ③	1	6.1F	10.6/F
1/8	1/16	0.09	150	125	125	125	125	125	180	120	8230G013	1	8320G045 ③	1	6.1F	10.6/F
1/8	1/16	0.09	210	225	225	160	160	160	200	150	8320G215	4	8320G224 ④	4	17.1/F	11.6/F
1/8	3/32	0.12	100	100	100	100	100	100	180	120	8320G015	1	8320G047 ③	1	6.1F	10.6/F
1/8	3/32	0.12	150	150	150	115	115	115	200	150	8320G216	4	8320G225 ④	4	10.1/F	11.6/F
1/8	1/8	0.21	40	40	40	40	40	40	180	120	8320G017	1	8320G049 ③	1	6.1F	10.6/F
1/8	1/8	0.21	85	85	85	60	60	60	200	150	8320G217	4	8320G226 ④	4	10.1/F	11.6/F
1/4	1/16	0.09	210	225	225	160	160	160	200	150	8320G182	2	8320G231 ④	3	17.1/F	11.6/F
1/4	3/32	0.12	150	150	150	115	115	115	200	150	8320G184	2	8320G202 ③④	3	10.1/F	11.6/F
1/4	1/8	0.25	85	85	85	60	60	60	200	150	8320G186	2	8320G203 ③④	3	10.1/F	11.6/F
1/4	11/64	0.35	45	45	45	25	25	25	200	150	8320G188	2	-	-	10.1/F	11.6/F
NORMALLY OPEN (Open when de-energized)																
1/8	3/64	0.06	200	200	200	200	200	200	180	120	8320G136	1	8320G146 ③	1	6.1F	10.6/F
1/8	1/16	0.09	150	125	125	125	125	125	180	120	8320G027	1	8320G051 ③	1	6.1F	10.6/F
1/8	1/16	0.09	235	250	250	160	160	160	200	150	8320G218	4	8320G227 ④	4	17.1/F	11.6/F
1/8	3/32	0.12	100	100	100	100	100	100	180	120	8320G029	1	8320G053 ③	1	6.1F	10.6/F
1/8	3/32	0.12	150	140	140	100	100	100	200	150	8320G219	4	8320G228 ④	4	10.1/F	11.6/F
1/8	1/8	0.21	40	40	40	40	40	40	180	120	8320G031	1	8320G055 ③	1	6.1F	10.6/F
1/8	1/8	0.21	70	70	70	55	55	55	200	150	8320G220	4	8320G229 ④	4	10.1/F	11.6/F
1/4	1/16	0.09	235	250	250	160	160	160	200	150	8320G192	2	8320G232 ④	3	17.1/F	11.6/F
1/4	3/32	0.12	150	140	140	100	100	100	200	150	8320G194	2	8320G204 ③④	3	10.1/F	11.6/F
1/4	1/8	0.25	70	70	70	55	55	55	200	150	8320G196	2	8320G205 ③④	3	10.1/F	11.6/F
1/4	11/64	0.35	40	40	40	30	30	30	200	150	8320G198	2	-	-	10.1/F	11.6/F

① Supplied with cast UR disc.
② On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts; the watt rating for the 9.1/F solenoid is 11.1 watts.
③ Can be used for ***dry*** natural gas service with the EF prefix.
④ Constructions standard rated -40˚F (-40˚C) ambient temperature. EFX prefix and TPL # not required.

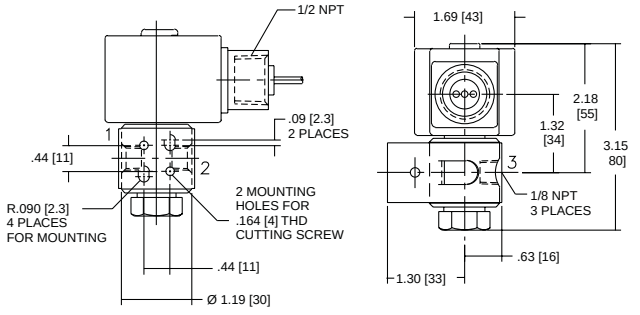
Specifications (Metric units)

Pipe Size (ins.)	Orifice Size (mm)	Kv Flow Factor (m3/h)	Operating Pressure Differential (bar) Max. AC Air-Inert Gas	Max. AC Water	Max. AC Lt. Oil @ 300 SSU	Max. DC Air-Inert Gas	Max. DC Water	Max. DC Lt. Oil @ 300 SSU	Max. Fluid Temp. °C AC	Max. Fluid Temp. °C DC	Brass Body Catalog Number	Brass Body Const. Ref.	Stainless Steel Body Catalog Number	Stainless Steel Body Const. Ref.	Watt Rating/ Class of Coil Insulation② AC	Watt Rating/ Class of Coil Insulation② DC
UNIVERSAL OPERATION (Pressure at any port)																
1/8	1.2	0.05	12	12	12	9	9	9	60	49	8320G130 ①	1	8320G140 ①	1	9.1F	10.6F
1/8	1.6	0.08	7	7	7	4	4	4	82	49	8320G001	1	8320G041 ③	1	9.1F	10.6F
1/8	1.6	0.08	12	12	12	9	9	9	93	66	8320G212	4	8320G221 ④	4	17.1/F	22.6/F
1/8	2.4	0.10	3	3	3	3	3	3	82	49	8320G083	1	8320G087 ③	1	6.1/F	10.6/F
1/8	2.4	0.10	7	7	7	4	4	4	93	66	8320G213	4	8320G222 ④	4	17.1/F	11.6/F
1/8	3.2	0.18	2	2	2	1	1	1	82	49	8320G003	1	8320G043 ③	1	9.1/F	10.6/F
1/8	3.2	0.18	3	3	3	2	2	2	93	66	8320G214	4	8320G223 ④	4	17.1/F	11.6/F
1/4	1.6	0.08	9	9	9	5	5	5	93	66	8320G172	2	-	-	10.1/F	11.6/F
1/4	1.6	0.08	12	12	12	9	9	9	93	66	-	-	8320G230 ④	3	17.1/F	22.6/F
1/4	2.4	0.10	7	7	7	4	4	4	93	66	8320G174	2	8320G200 ③④	3	17.1/F	11.6/F
1/4	3.2	0.21	3	3	3	2	2	2	93	66	8320G176	2	8320G201 ③④	3	17.1/F	11.6/F
1/4	4.4	0.30	1	1	1	1	1	1	93	66	8320G178	2	-	-	10.1/F	11.6/F
NORMALLY CLOSED (Closed when de-energized) – PFD_{AVG} = 6.81 x 10^{-4}																
1/8	1.2	0.05	14	14	14	14	14	14	82	49	8320G132	1	8320G142 ③	1	6.1F	10.6/F
1/8	1.6	0.08	10	9	9	9	9	9	82	49	8230G013	1	8320G045 ③	1	6.1F	10.6/F
1/8	1.6	0.08	14	15	15	11	11	11	93	66	8320G215	4	8320G224 ④	4	17.1/F	11.6/F
1/8	2.4	0.10	7	7	7	7	7	7	82	49	8320G015	1	8320G047 ③	1	6.1F	10.6/F
1/8	2.4	0.10	10	10	10	8	8	8	93	66	8320G216	4	8320G225 ④	4	10.1/F	11.6/F
1/8	3.2	0.18	3	3	3	3	3	3	82	49	8320G017	1	8320G049 ③	1	6.1F	10.6/F
1/8	3.2	0.18	6	6	6	4	4	4	93	66	8320G217	4	8320G226 ④	4	10.1/F	11.6/F
1/4	1.6	0.08	14	15	15	11	11	11	93	66	8320G182	2	8320G231 ④	3	17.1/F	11.6/F
1/4	2.4	0.10	10	10	10	8	8	8	93	66	8320G184	2	8320G202 ③④	3	10.1/F	11.6/F
1/4	3.2	0.21	6	6	6	4	4	4	93	66	8320G186	2	8320G203 ③④	3	10.1/F	11.6/F
1/4	4.4	0.30	3	3	3	2	2	2	93	66	8320G188	2	-	-	10.1/F	11.6/F
NORMALLY OPEN (Open when de-energized)																
1/8	1.2	0.05	14	14	14	14	14	14	82	49	8320G136	1	8320G146 ③	1	6.1F	10.6/F
1/8	1.6	0.08	10	9	9	9	9	9	82	49	8320G027	1	8320G051 ③	1	6.1F	10.6/F
1/8	1.6	0.08	16	17	17	11	11	11	93	66	8320G218	4	8320G227 ④	4	17.1/F	11.6/F
1/8	2.4	0.10	7	7	7	7	7	7	82	49	8320G029	1	8320G053 ③	1	6.1F	10.6/F
1/8	2.4	0.10	10	10	10	7	7	7	93	66	8320G219	4	8320G228 ④	4	10.1/F	11.6/F
1/8	3.2	0.18	3	3	3	3	3	3	82	49	8320G031	1	8320G055 ③	1	6.1F	10.6/F
1/8	3.2	0.18	5	5	5	4	4	4	93	66	8320G220	4	8320G229 ④	4	10.1/F	11.6/F
1/4	1.6	0.08	16	17	17	11	11	11	93	66	8320G192	2	8320G232 ④	3	17.1/F	11.6/F
1/4	2.4	0.10	10	10	10	7	7	7	93	66	8320G194	2	8320G204 ③④	3	10.1/F	11.6/F
1/4	3.2	0.21	5	5	5	4	4	4	93	66	8320G196	2	8320G205 ③④	3	10.1/F	11.6/F
1/4	4.4	0.30	3	3	3	2	2	2	93	66	8320G198	2	-	-	10.1/F	11.6/F

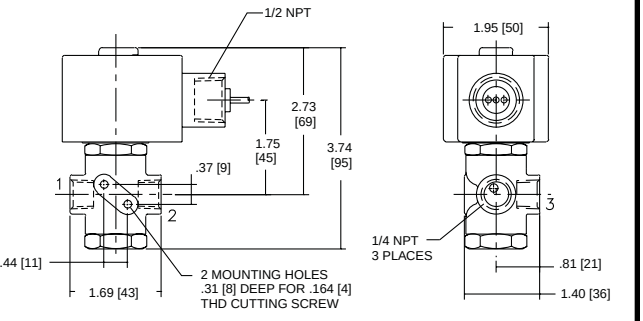
① Supplied with cast UR disc.
② On 50 hertz service, the watt rating for the 6.1/F solenoid is 8.1 watts; the watt rating for the 9.1/F solenoid is 11.1 watts.
③ Can be used for ***dry*** natural gas service with the EF prefix.
④ Constructions standard rated -40˚F (-40˚C) ambient temperature. EFX prefix and TPL # not required.

Dimensions: inches (mm)

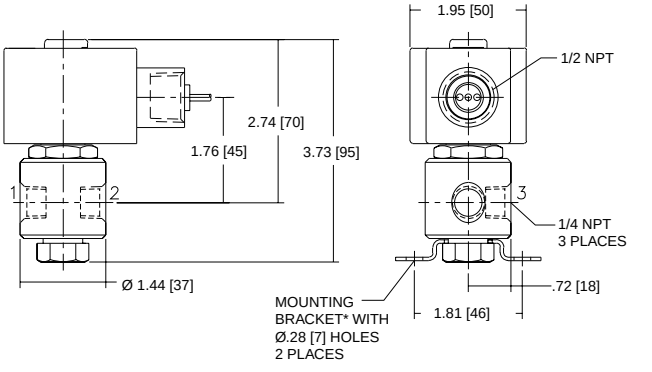
Const. Ref. 1



Const. Ref. 2

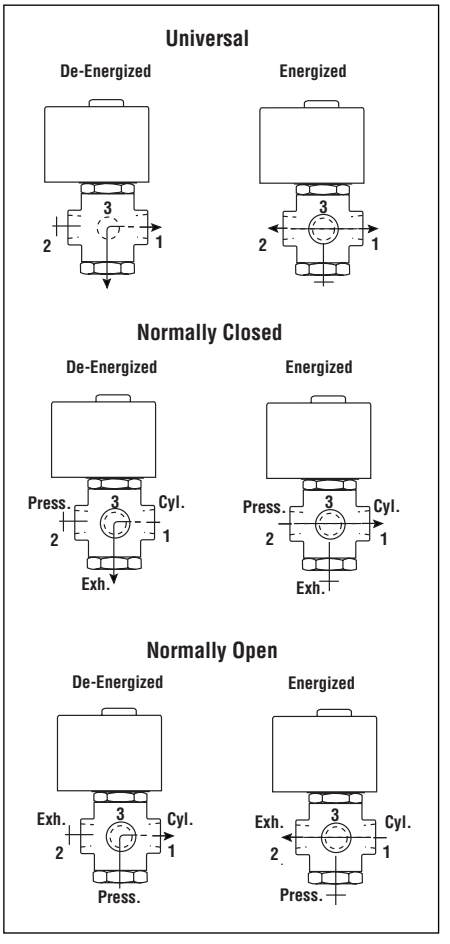


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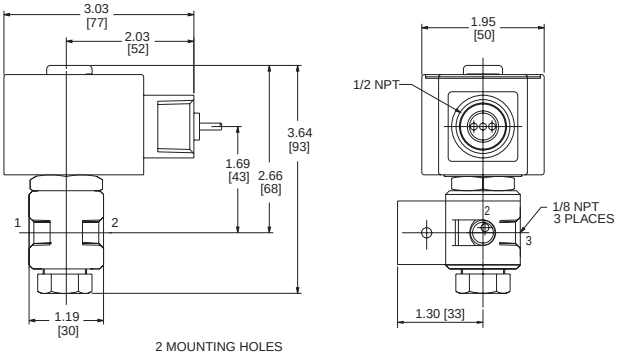


* MOUNTING BRACKET
IS STANDARD ON THIS
CONSTRUCTION

FLOW DIAGRAMS



Const. Ref. 4



SHOWING MOUNTING BRACKET ONLY
212299-001

Installation & Maintenance Instructions

3–WAY MINIATURE SIZED SOLENOID VALVES
NORMALLY CLOSED, NORMALLY OPEN AND UNIVERSAL OPERATION
1/8 NPT – 3/64, 1/16, 3/32 AND 1/8 ORIFICE
BRASS AND STAINLESS STEEL CONSTRUCTION

SERIES

8320

I&M No.V6055R3

NOTICE: See separate solenoid installation and maintenance instructions for information on: Wiring, Solenoid Temperature, Cause of Improper Operation and Coil Replacement.

DESCRIPTION

Series 8320 valves are 3–way, direct–acting, miniature sized solenoid valves with all three pipe connections located in the valve body. Valves are of rugged brass or stainless steel construction. Standard valves have a General Purpose NEMA Type 1 Solenoid Enclosure. Valves may also be equipped with a solenoid enclosure which is designed to meet NEMA Type 4 – Watertight, NEMA Type 7 (C or D) Hazardous Locations – Class II, Groups E, F or G. See Installation and Maintenance Instructions, V9531 for Explosionproof/Watertight Solenoid Enclosures.

OPERATION

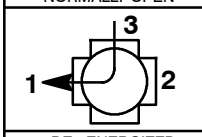
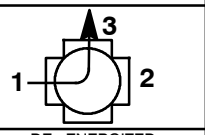
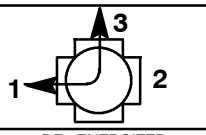
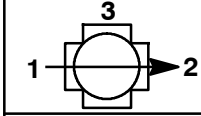
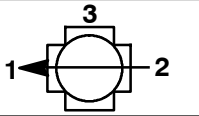
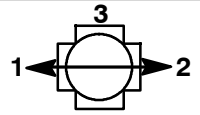
Normally Closed: Applies pressure when solenoid is energized; exhausts pressure when solenoid is de–energized. Flow is Connection "2" to "1" when solenoid is energized. Connection "3" is closed. Flow is from Connection "1" to "3" when solenoid is de–energized. Connection "2" is closed. Pressure is applied at Connection "2".

Normally Open: Applies pressure when solenoid is de–energized; exhausts pressure when solenoid is energized. Flow is Connection "1" to "2" when solenoid is energized. Connection "3" is closed. Flow is from Connection "3" to "1" when solenoid is de–energized. Connection "2" is closed. Pressure is applied at Connection "3".

Universal: For normally closed or normally open operation, selection or diversion of pressure can be applied at Connections "1", "2" or "3". Flow is between Connection "1" to "2" when solenoid is energized. Connection "3" is closed. Flow is between Connection "1" to "3" when solenoid is de–energized. Connection "2" is closed. Pressure may be applied at Connection "1", "2" or "3".

Manual Operation (Valves with Suffix MS): Manual operator allows manual operation when desired or during an electrical power outage. The screw type manual operator is in the "off position" when screwdriver slot is in the horizontal position. To engage manual operator, rotate stem on the side of the body clockwise 90°. Valve will now be in the same position as when the solenoid is energized. To disengage, rotate the stem counterclockwise back to 0° in its original horizontal position.

Flow Diagram

NORMALLY OPEN	NORMALLY CLOSED	UNIVERSAL
		
DE–ENERGIZED PRESSURE AT 3	DE–ENERGIZED PRESSURE AT 2	DE–ENERGIZED PRESSURE AT ANY ORIFICE
		
ENERGIZED PRESSURE AT 3	ENERGIZED PRESSURE AT 2	ENERGIZED PRESSURE AT ANY ORIFICE

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage, frequency, and service. Never apply incompatible fluids or exceed pressure rating of the valve. Installation and valve maintenance to be performed by qualified personnel.

Temperature Limitations

For maximum valve ambient and fluid temperatures, refer to the following table. For higher ambient and fluid temperatures, consult factory. Check catalog number prefix and watt rating on nameplate to determine the maximum temperatures.

Construction	Watt Rating	Prefix	Coil Class	Max Ambient Temp		Max Fluid Temp	
				°C	°F	°C	°F
AC	6	None, DA or S	A	25	77	82	180
		DB, LB, SB, DF, FT or SF	H or F	50	122	93	200
		HT	H	60	140	93	200
	9 †	None, DP or SP	F	25	77	82	180
DC	9.7	None, FT, HT, LB, S or SF	A, F or H	25	77	49	120

† Catalog Numbers 8320B130, 8320B131, 8320B134, 8320B135, 8320B138, 8320B139, 8320A140, 8320A141, 8320A144, 8320A145, 8320A148 and 8320A149 are limited to a fluid temperature of 60°C (140°F).

Positioning

This solenoid is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertically and upright to reduce the possibility of foreign matter accumulating in the cartridge assembly area.

Mounting

For mounting dimensions of mounting bracket, refer to Figure 1.

Piping

Connect piping or tubing to valve according to markings on valve body. Apply pipe compound sparingly to male pipe threads only. If applied to valve threads, the compound may enter the valve and cause operational difficulty. Avoid pipe strain by properly supporting and aligning piping. When tightening the pipe, do not use valve or solenoid as a lever. Locate wrenches applied to valve body or piping as close as possible to connection point.

IMPORTANT: To protect the solenoid valve, install a strainer or filter, suitable for the service involved, in the inlet side as close to the valve as possible. Clean periodically depending on service conditions. See ASCO Series 8600, 8601 and 8602 for strainers.

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Wiring

Wiring must comply with local codes and the National Electrical Code. Housings for all solenoids are provided with accommodations or connections for 1/2 inch conduit. The general purpose solenoid enclosure may be rotated to facilitate wiring by removing the retaining cap or clip.

CAUTION: When metal retaining clip disengages, it will spring upward. Rotate coil to desired position. Replace retaining clip before operating.

NOTE: AC and DC solenoids are built differently. To convert from one to the other, it is necessary to change the complete solenoid, including the plugnut/core tube sub−assembly and core assembly.

Solenoid Temperature

Standard catalog valves are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched with the hand only for an instant. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of a burning coil insulation.

MAINTENANCE

⚠ WARNING: To prevent the possibility of death, personal injury or property damage, turn off electrical power, depressurize valve, and vent fluid to a safe area before servicing the valve.

NOTE: It is not necessary to remove the valve from the pipeline for repairs.

Cleaning

All solenoid valves should be cleaned periodically. The time between cleanings will vary depending on the medium and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive noise or leakage will indicate that cleaning is required. In the extreme case, faulty valve operation will occur and the valve may fail to open or close. Clean valve strainer or filter when cleaning the valve.

Preventive Maintenance

- Keep medium flowing through the valve as free from dirt and foreign material as possible.
- Periodic exercise of the valve should be considered if ambient or fluid conditions are such that corrosion, elastomer degradation, fluid contamination build up, or other conditions that could impede solenoid valve shifting are possible. The actual frequency of exercise necessary will depend on specific operating conditions. A successful operating history is the best indication of a proper interval between exercise cycles.
- Depending on the medium and service conditions, periodic inspection of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. If parts are worn or damaged, install a complete rebuild kit.

Causes Of Improper Operation

- **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic click signifies that the solenoid is operating. Absence of the click indicates the loss of power supply. Check for loose or blown fuses, open−circuited or grounded solenoid, broken lead wires or splice connections.
- **Burned−Out Solenoid:** Check for open−circuited solenoid. Replace if necessary. Check supply voltage; it must be the same as specified on nameplate/retainer and marked on the solenoid.
- **Low Voltage:** Check voltage across the solenoid leads. Voltage must be at least 85% of rated voltage.
- **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within range specified on nameplate.
- **Excessive Leakage:** Disassemble valve and clean all parts. If parts are worn or damaged, install a complete ASCO Rebuild Kit.

Coil Replacement (Refer to Figure 1)

Turn off electrical power supply and disconnect coil lead wires then proceed in the following manner:

1. Remove retaining cap or clip, nameplate and cover.

CAUTION: When the metal retaining clip disengages, it will spring upward.

2. Slip the yokes containing the coil, sleeves and insulating washers off the plugnut/core tube sub−assembly. Insulating washers (2) are omitted when a molded coil is used.
3. Slip coil, sleeves and insulating washers from the yoke.
4. Reassemble in reverse order of disassembly paying careful attention to the exploded view provided for identification and placement of parts.

CAUTION: The solenoid must be fully reassembled as the housing and internal parts are part of and complete the magnetic circuit. Place an insulating washer at each end of the coil, if required.

Valve Disassembly

Depressurize valve and turn off electrical power supply. Proceed in the following manner:

1. Remove retaining cap or clip and slip the entire solenoid enclosure off the plugnut/core tube sub−assembly.

CAUTION: When metal retaining clip disengages, it will spring upward.

NOTE: For valves with an Explosionproof/Watertight Solenoid enclosure, the solenoid may be removed as a complete unit by unscrewing the solenoid base sub−assembly.

2. Unscrew the valve bonnet with a special wrench adapter provided in the Spare Parts Kit (special wrench adapter Order No. 158−477−1).
3. Remove plugnut/core tube sub−assembly with valve bonnet and bonnet gasket attached.
4. Remove core spring, core assembly and body gasket.
5. Unscrew end cap or manual operator assembly and remove disc spring, disc, disc holder and body gasket.
6. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete Spare Parts Kit for best results.

Valve Reassembly

1. Reassemble in reverse order of diassembly using exploded views for identification and placement of parts.
2. Lubricate all gaskets with DOW CORNING® 111 Compound lubricant or an equivalent high−grade silicone grease.
3. Replace disc holder, disc, disc spring, body gasket and end cap.

IMPORTANT: Some valves have a disc with a conical point on one side. Be sure that the conical point on the disc faces the orifice in the valve body. Torque end cap (or manual operator assembly) to 90±10 inch−lbs (10,2±1,1 N−m).

4. Replace body gasket and install core spring into the core assembly. Install wide end of core spring into core assembly first, closed end protrudes from top of core assembly.

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5. Position core assembly and core spring into plugnut/core tube sub−assembly. Install plugnut/core tube sub−assembly with core assembly and core spring in valve body. Torque valve bonnet to 90±10 inch−lbs (10,2±1,1 N−m).
6. Replace solenoid enclosure and retaining cap or clip.

NOTE: For valves with an Explosionproof/Watertight Solenoid enclosure, the solenoid may be assembled as a complete unit.

7. After maintenance, operate the valve a few times to be sure of proper operation.

ORDERING INFORMATION FOR ASCO REBUILD KITS

Parts marked with an asterisk (*) in the exploded view are supplied in Rebuild Kits. When Ordering Rebuild Kits for ASCO valves, order the Rebuild Kit number stamped on the valve nameplate. If the number of the kit is not visible, order by indicating the number of kits required, and the Catalog Number and Serial Number of the valve(s) for which they are intended.

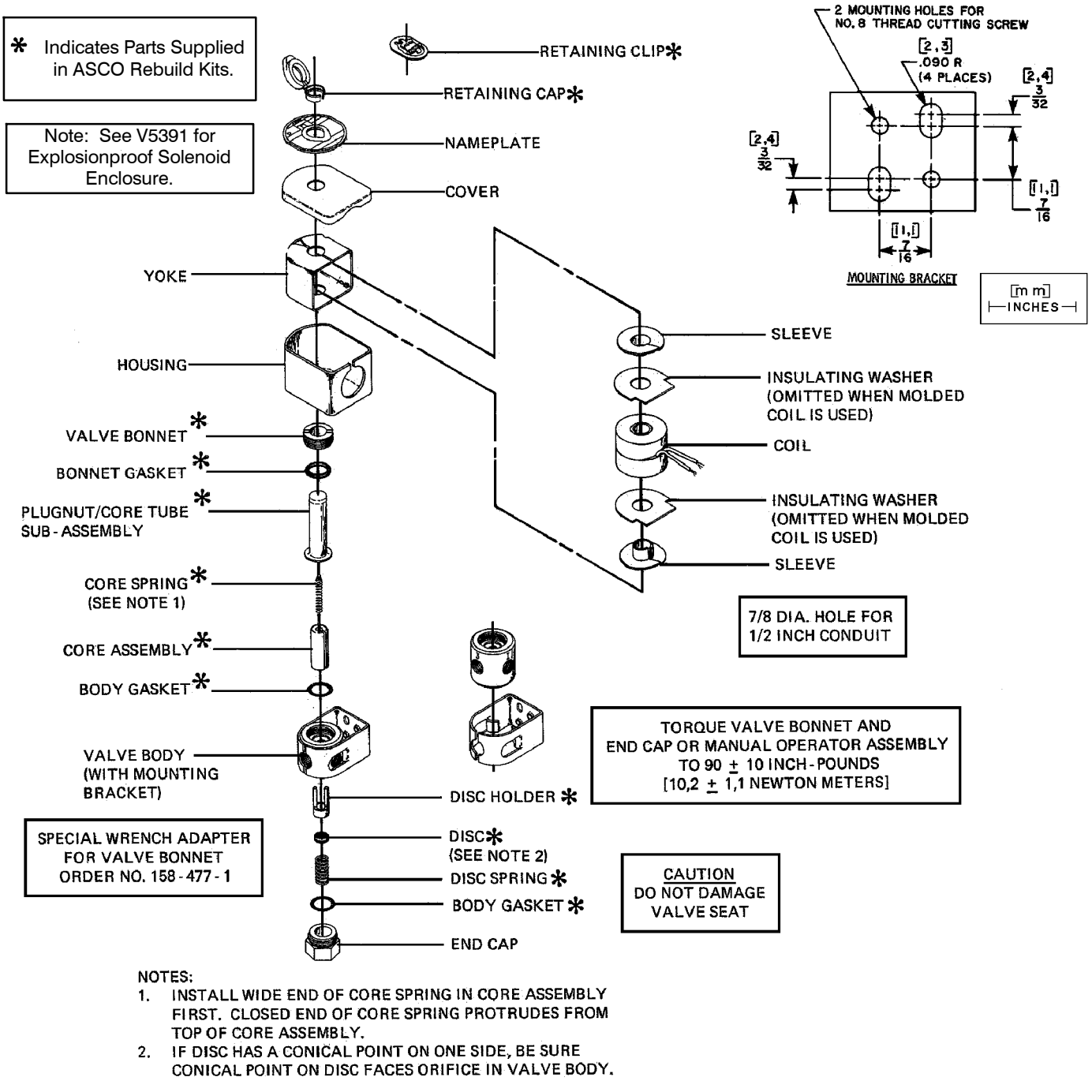


Figure 1. General Purpose Solenoid Enclosure.

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EI Series Bimetal Thermometers



FEATURES

- *1% full span accuracy ASME B40.200 (ASME B40.3 Grade A)*
- *Maximum ambient temp. is 200°F (94°C)*
- *Hermetically sealed case to prevent entry of moisture, interior corrosion and coil freeze-up.*
- *External adjustment permits zero reset from outside the case.*
- *Maxivison® dial allows readability from any angle without parallax error.*
- *Silicone coil dampening (up to 400°F) provides vibration dampening and improves response time.*
- *All-welded stainless steel construction*
- *Heavy-Duty glass lens*
- *Protection NEMA 4X/IP66*
- *Five year limited warranty*

NEW OPTIONAL 316SS HOUSING & STEM AVAILABLE ON 5″ EVERYANGLE

SPECIFICATIONS

Ashcroft® Series:	EI
Dial Sizes:	2,″ 3,″ 5″
Stem Length:	2½″-60″ (1)
Case & Stem:	304 stainless steel, hermetically sealed
Stem Dia:	.250″
Window:	Heavy-duty glass, plastic or shatter-proof glass optional
Dial:	Maxivision®, black figures on white background
Pointer:	Black
Connection:	Plain, pointed plain, ¼ NPT, ½ NPT, ½ NPT union
Connection Location:	Everyangle™, Lower, Rear
Ranges:	–80/120°F-200/1000°F –50/50°C-100/500°C

Options:

Code	Description
C4	Individual calibration cert.
XCS	Dual scale(2)
XDM	Dial marking
XNH	Stainless steel tag
XNN	Paper tag
XPD	Plastic window
XSG	Shatter proof glass
X3B	⅜″ stem dia. with ½ NPT
X02	¼ NPT when ½ NPT is standard(3)
XS1	Silicone free
XYW	316SS Housing(4) and stem

(1) 25″-60″ lengths available, consult factory
(2) Dual scale available with 3″ and 5″ case only
(3) Only available on rear connection
(4) Only available on 5″ Everyangle™

Thermowells must be used on all pressure or velocity applications, to protect the stem of thermometer from corrosion and physical damage, and to facilitate removal of the thermometer without disturbing the process. Maximum ambient temperature is 200°F (95°C).

HOW TO ORDER

30 EI 60 R 040 0/250°F XNH

- **Dial Size:** 3″ Code 30
- **Case Style:** EI
- **Stem Connection:** ½ NPT Code 60
- **Stem Location:** Rear Code R
- **Stem Length:** 4″ Code 040
- **Range:** Code 0/250°F
- **Options:** Stainless steel tag

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EI Series Bimetal Thermometers

EI Series selection table

Case Dial	Size Code	Style Code	Stem Conn.	Stem Code	Stem Location	Stem Lengths Available Code	"S" Length (inches)	Code	Temperature Range °F* Fahrenheit	°/Div.	Fig. Inter.	°C Celsius	°/Div.	Fig. Inter.
2″	20		Plain	40	Rear	R	2½	025	–80/120	2	20	–50/50	1	10
			Pointed	50					–20/120††			–10/110	2	10
			¼ NPT	60					–40/120	1	10	–20/120	2	20
3″	30		½ NPT Union	42	Everyangle	E	4	040	30/130††	2	20	0/50††	1	5
			½ NPT	60			6	060	0/200			0/100	1	10
			½ NPT	60	Rear	R	9	090	20/120		50	10/150	2	20
					Lower	L	12	120	0/250			0/200	2	20
5″	50		½ NPT Union	42	Everyangle	E	15	150	50/300	5	50	0/300††	5	50
			½ NPT	60			18	180	50/400			0/400	5	50
			½ NPT	60	Rear	R	24	240	50/550			50/450**†	5	50
					Lower	L			200/700†			100/500**†	5	50
									100/800†					
									200/1000†	10	100			

CONTACT FACTORY FOR ADDITIONAL STEM LENGTHS AND RANGES NOT LISTED

EI Dimensions

Case Series	Dial Size	Connection Location	A	B	C	D	E	G	H	S	NPT	Hex	Weight in ounces[3] S – 2½″
EI	2″	Rear (Plain)	2 3/32 (53)	3/8 (10)	3/8 (8)	–	–	–	–	–[2]	–	11/16	4½
EI	2″	Rear (Plain, pointed stem)	2 3/32 (53)	3/8 (10)	5/16 (8)	–	–	–	–	–[2]	–	11/16	4½
EI	2″	Rear (Threaded)	2 3/32 (53)	3/8 (10)	3/8 (8)	–	–	–	–	–[2]	¼	11/16	4½
EI	3″	Rear	3 3/32 (80)	19/32 (15)	3/8 (8)	–	–	–	–	–[2]	½	7/8	7
EI	3″	Lower	3 3/32 (80)	1 27/32 (47)	–	2 5/8 (67)	¼ (6)	–	–	–[2]	½	7/8	11
EI	3″	Everyangle	3 3/32 (80)	19/32 (15)	–	–	–	1 21/32 (42)	3 1/32 (89)	–[2]	½	7/8	10
EI	5″	Rear	5 1/32 (128)	23/32 (18)	3/8 (8)	–	–	–	–	–[2]	½	7/8	16
EI	5″	Lower	5 1/32 (128)	1 15/16 (49)	–	3 5/8 (92)	¼ (6)	–	–	–[2]	½	7/8	26
EI	5″	Everyangle	5 1/16 (128)	23/32 (18)	–	–	–	1 7/8 (48)	3 21/32 (93)	–[2]	½	7/8	25

NOTES:
1. Figures in parenthesis ( ) are in millimeters. All other dimensions are in inches.
2. Standard "S" dimensions are 2½, 4, 6, 9, 12, 15, 18 and 24 inches. Standard stem diameter is ¼ inch.
3. Add 1 oz. for every 2 inches of stem length.

EI Series dual scale ranges

Dual scales are available in 3″ and 5″ dial sizes in the following ranges:

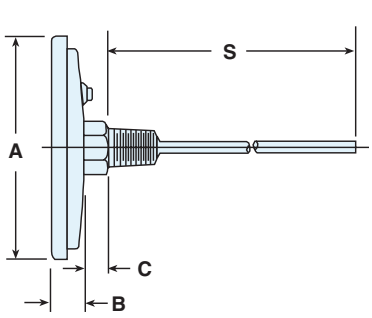
Inner		Outer
–80/120°F	and	–60/50°C
–40/120°F	and	–40/50°C
–40/160°F	and	–40/70°C
–20/120°F	and	–30/50°C††
0/200°F	and	–20/90°C
0/250°F	and	–20/120°C
30/130°F	and	0/55°C††
50/300°F	and	10/150°C
50/400°F	and	10/200°C
50/550°F	and	10/290°C
100/800°F	and	50/400°C†
200/700°F	and	100/370°C†
200/1000°F	and	100/550°C**†

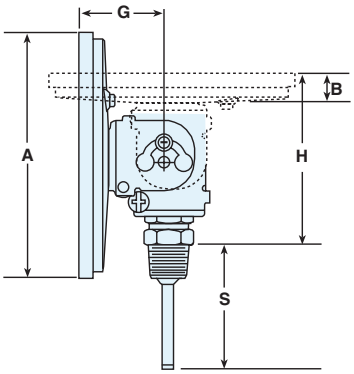
Overtemperature limits

Top of Range °F	Maximum Over Temperature
up to 250	100% of span
251/550	50% of span
551/1000	800°F **

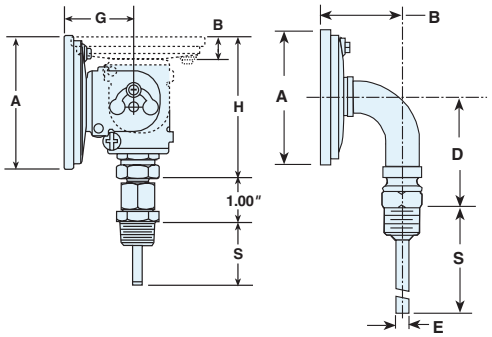
*Dual scale ranges available for all standard °F ranges (3″ and 5″ case only)
**Satisfactory for continuous service up to 800°F or 425°C. Can be used for intermittent service from 800 to 1000°F, or 425 to 500°C. Use Ashcroft Duratemp® thermometers for ranges above and below those listed above.
†Minimum stem length for these ranges is 4″.
††Minimum stem length for lower connection and Everyangle is 4″.

DIMENSIONS





30EI60E
50EI60E
50EL60E



30EI42E
50EI42E
50EL42E

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INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR ALL ASHCROFT® BIMETAL DIAL THERMOMETERS

ASHCROFT®

GENERAL

In removing the thermometer out of the packing box, handle it by the case or case outlet. Avoid handling it by the stem.

INSTALLATION OF THERMOMETERS

The thermometer should be mounted at any convenient location where it will be subjected to the average temperature variations to be indicated.

For an EVERYANGLE CONNECTION PLEASE REFER TO THE REVERSE SIDE OF THIS DOCUMENT before beginning the installation.

Avoid bending the stem as this will cause misalignment of the internal parts, resulting in undue frictional errors.

To tighten the thermometer to the apparatus, use a wrench applied to the hexagon head of the threaded connection located just outside of the case.

INSTALLATION

Locate the stem so that at least two inches will be subjected to the average temperature to be measured.

Exposing the stem to a temperature in excess of the highest dial reading should be avoided.

The thermometer is normally provided with a threaded connection. To tighten the thermometer to the apparatus or into the well, use an open-end wrench applied to the hexagon head of the threaded connection.Turn until reasonably tight, then tighten still further in the same manner as a pipe elbow or similar pipe fitting until the scale is in the desired position for reading. DO NOT TIGHTEN BY TURNING THE THERMOMETER CASE. *Install the dry type thermometer so that the maximum case temperature is kept below 200°F at all times. Install the liquid filled type thermometer so that the maximum case temperature is kept below 150°F at all times.*

When a thermometer is equipped with a well, the well should be installed onto the apparatus first. The stem of the thermometer should then be coated with a heat conducting medium (a mixture of glycerin and graphite or vaseline or any other heavy lubricant may be used), after which the thermometer stem is inserted, and tightened into the well.

CAUTION:
Thermowells should be used on all pressurized applications, to protect the thermometer from corrosion or physical damage, and to facilitate removal of the thermometer without disturbing the process.

TESTING

Ashcroft Bimetal Dial Thermometers are carefully calibrated at the factory and under most operating conditions will retain their accuracy indefinitely. However, as in the case of all instruments, it is well to make periodic checks for accuracy against known standards.

ADJUSTMENT

If it is necessary to make an adjustment to the thermometer proceed as follows:

On thermometers fitted with an “External Adjustment” – Use a small wrench, small screwdriver or a coin to turn the slotted hexagon head in the back of the case until the pointer indicates the proper temperature on the dial.

MAINTENANCE OF DIAL THERMOMETERS

Aside from occasional testing, little or no maintenance is required.

Be sure that the gasketed glass cover is on the case at all times, as moisture and dirt inside the case will eventually cause the thermometer to lose its accuracy. (See caution note below.)

If the thermometer is used for measuring the temperature of a material that may harden and build up an insulating layer on the stem, the thermometer should be removed from the apparatus occasionally, and the stem cleaned. Observe this precaution to ensure the sensitivity of the instrument.

CAUTION:
Bimetal Thermometers operating below freezing must have a perfectly tight case to prevent entrance of moisture which eventually will condense and freeze inside the stem. This condition shows up as a failure of the thermometer to read accurately below 32°F or 0°C. For this reason it is important to avoid damage to the glass front while the stem temperature is at freezing or below. All thermometers are hermetically sealed in a dry atmosphere at the factory and require no further maintenance.

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INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR ASHCROFT® BIMETAL THERMOMETERS WITH EVERYANGLE™ CONN.

ASHCROFT®

This thermometer was designed to be positioned to face the direction of easiest reading.

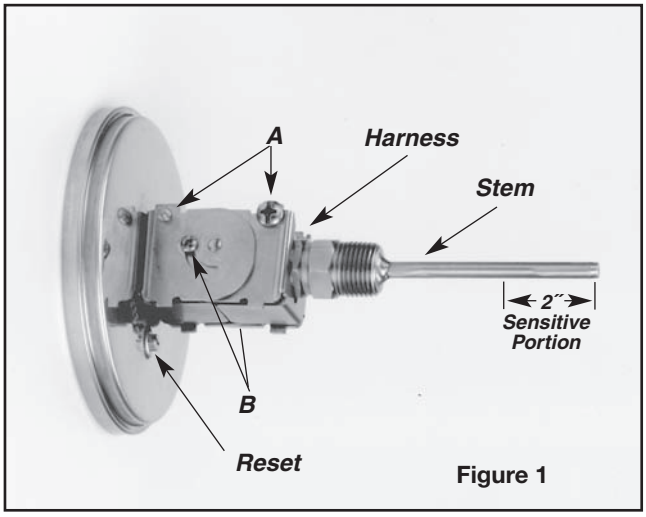


Figure 1

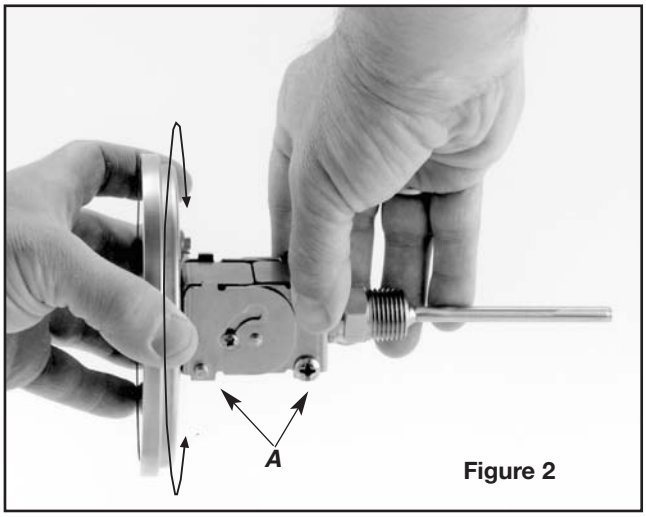


Figure 2

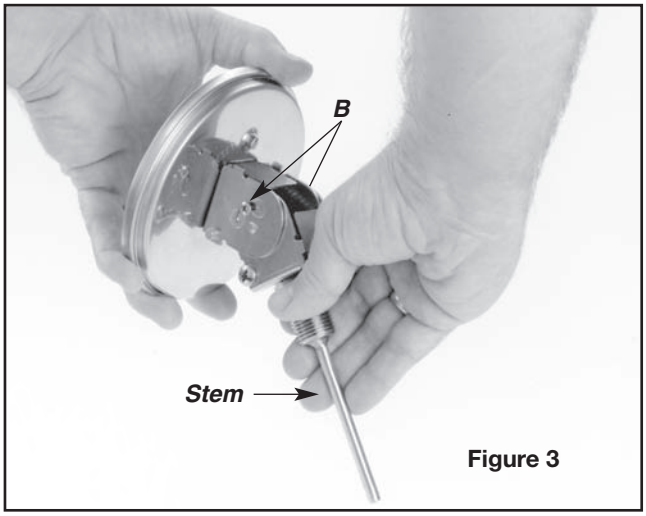


Figure 3

CAUTION: *To assure longest life, the "EVERY- ANGLE" joint should be operated only when necessary during installation or removal of the thermometer.*

POSITIONING THE STEM

Before installation, the stem should be set to the desired angle as follows:

Figure 1: Loosen the four screws labeled "A" and "B" in Figure 1, until the harness revolves freely without twisting the flexible housing.

Figure 2: While holding the case, revolve the harness clockwise or counterclockwise, as indicated by arrows in Figure 2, to place the harness in a position that will permit flexing the stem in the desired direction with respect to the case. Then lock the two screws labeled "A."

Figure 3: Flex the stem to the desired angle with respect to the face of the thermometer, as shown in Figure 3, then lock the two screws labeled "B."

INSTALLATION

The lower 2″ of the stem is the sensitive portion. Be sure this part of the stem is exposed to the temperature to be measured.

Tighten the thermometer to the apparatus or into the thermometer well, using an open-end wrench applied to the hexagon head of the connection bushing. Turn until reasonably tight, then tighten further (in the same manner as a pipe fitting) until the scale is in the desired position for reading.

DO NOT TIGHTEN BY TURNING THE THERMOMETER CASE OR THE HARNESS. INSTALL THE DRY TYPE EVERYANGLE THERMOMETER SO THAT THE MAXIMUM CASE TEMPERATURE IS KEPT BELOW 200°F. INSTALL THE LIQUID-FILLED TYPE EVERYANGLE THERMOMETER, SO THAT THE MAXIMUM CASE TEMPERATURE IS KEPT BELOW 150°F.

THERMOMETER WELLS

When the thermometer is equipped with a well, the well should first be removed from the thermometer and screwed into the apparatus.

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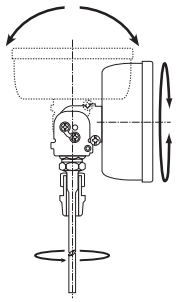
Model C-600B Duratemp® Thermometer



FEATURES

- *Exclusive movementless design resists shock and vibration – no gears to wear out – or misalign resulting in increased instrument life*
- *Gas-operated molecular sieve*
- *Mercury free*
- *1% full-span accuracy*
- *Everyangle Duratemp® thermometer can be rotated 360° and can be angled 180°, ensuring readability in any installation*
- *Maxivision® dial*
- *Limited five-year warranty*

The direct-reading thermometer (stainless steel case only) offers the same unique features of the Ashcroft® Duratemp® remote-reading thermometer for those critical applications where only a direct-connected instrument can be used. Available in 4½″ dial size.



The Everyangle™ Duratemp® thermometer may be rotated 360° for readability and the stem turned 180° for the most challenging installations.

PRODUCT SPECIFICATIONS

Model: C-600B-01
Accuracy: ±1% of span
Case Style: Stainless steel
Dial Size: 4½″ Maxivision linear anti-parallax dial black markings on a white dial
Window: Glass, shatterproof glass and plastic are optional.
Mounting and Connection: Direct mount, fixed ½ union connection
Ambient Temperature: 160°F/71°C
Stem Material: 316 Stainless steel
Stem Lenth: 6″, 9″,12″, 15″, 18″, 24″, 30″ and 36″
Ranges: –320/200°C-400/1200°F
–200/100°C-200/650°C
Dual scale ranges available
Over Range: 125% of span
Product Options:
Dial Markings **XDM**
Externally adjustable red set hand **XEO**
Externally adjustable **XEP**
Externally adjustable min. pointer **XEQ**
Non-glare glass **XNG**
Paper Tag **XNN**
Stainless steel tag **XNH**
Plastic Window **XPD**
Shatterproof glass **XSG**
Stationary Red Hand Set **XSH**

Note: Thermowells must be used on any application where the bulb of the thermometer may be exposed to pressure, corrosive fluids, or velocity. Additionally, the use of a thermowell permits instrument interchangeability or recalibration without shutting down the process.

HOW TO ORDER

C-600B – 01 – AB

Type	Table 1		Table 2			
C-600B	CODE	STEM LENGTH	CODE	SINGLE RANGES	CODE	DUAL RANGES
DIRECT MOUNTED	01	Semirigid Stainless Steel 6″	AB	–320/200°F	CE	0/120°C 20/240°F
	02	Semirigid Stainless Steel 9″	AE	–100/100°F		
	03	Semirigid Stainless Steel 12″	AG	–40/180°F	CF	0/300°C 50/550°F
	04	Semirigid Stainless Steel 15″	AK	20/240°F		
	05	Semirigid Stainless Steel 18″	AL	50/300°F	DR	10/150°C 50/300°F
	06	Semirigid Stainless Steel 24″	AN	50/550°F		
	07	Semirigid Stainless Steel 30″	AR	50/750°F*	DT	–40/80°C –40/180°F
	08	Semirigid Stainless Steel 36″	AT	400/1200°F*		
			AY	–200/100°C		
			BL	–80/40°C		
			BN	–40/80°C		
			BS	0/120°C		
			BT	10/150°C		
			BU	0/300°C		
			BW	0/400°C*		
			BJ	200/650°C*		

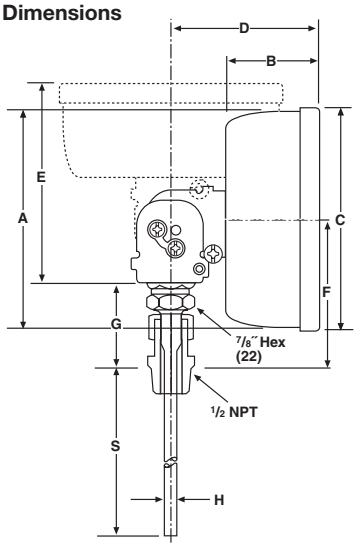
*For these ranges a minimum "S" dimension (stem length) of 9 inches is required. This removes case from exposure to high temperature which may damage the instrument.

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Model C-600B Duratemp® Thermometer

Case Dimensions



Dial Size	A	B	C	D	E	F	G	H
4½	4²³⁄₃₂ (120)	2¹⁄₁₆ (52)	5¹⁄₃₂ (128)	3¹¹⁄₁₆ (81)	4¹³⁄₁₆ (122)	3 (76)	1 (25)	⅜ (10)

NOTE: Dimensions in inches, ( ) are millimeters.

FOR TEMPERATURES 750°F AND ABOVE USE WELL WITH 3″ LAG		
S	Well Lag	U-Dimension (Insertion Length)
9 (229)	3	4½ (114)
12 (305)	3	7½ (191)
15 (381)	3	10½ (268)

FOR TEMPERATURES BELOW 750°F	
S	U-Dimension (Insertion Length)
6 (152)	4½ (114)
9 (229)	7½ (191)
12 (305)	10½ (268)

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DURATEMP® GAS ACTUATED THERMOMETERS, INSTALLATION AND USE INFORMATION

ASHCROFT®

INSTALLATION OF REMOTE READING THERMOMETERS

The case of the thermometer should be mounted at a location where it can be read conveniently. The maximum case temperature should not exceed 160°F (70°C). The capillary line also should be laid so that it will not be exposed to extreme temperatures, such as alongside steam pipes, ovens or other heated surfaces.

The minimum capillary line radius is 1″. Place it so that it will be protected from damage. Should the capillary line be too long, coil the surplus neatly at a convenient point but **"DO NOT CUT IT."**

The thermometer system (Bourdon spring, capillary line and temperature sensing bulb) must not, under any circumstances be taken apart, or the capillary line cut.

INSTALLATION OF TEMPERATURE SENSING BULB IN THERMOWELL— (note: a 3/8″ bore thermowell is required— adapters are available to permit installation in larger bore thermowells.)

1. Install thermowell.
2. Assemble union connection to temperature sensing bulb finger tight.
3. Apply heat conducting medium to temperature sensing bulb of thermometer (50/50 mix of glycerin and graphite, or Vaseline.)
4. Insert temperature sensing bulb into thermowell and hold against bottom of thermowell.
5. Assemble union connection to thermowell.
6. Tighten jam nut to union to lock temperature sensing bulb in position, normal tightening is 3/4 to 1 turn from finger tight.

Where service temperatures exceed 350°F (177°C) the heat conducting medium may smoke when first subjected to a high temperature. This is caused by the vehicle, in the heat conducting medium, vaporizing and leaving the dry solids behind. This should not be cause for alarm. The dry solids will act equally well as a heat conducting medium for temperatures up to 1200°F (650°C).

TESTING

Every ASHCROFT DURATEMP thermometer is carefully calibrated at the factory and under normal operating conditions it will remain accurate. If it is necessary to test the thermometer the following procedure should be used:

Immerse the entire sensitive part of the temperature sensing bulb side by side with a test thermometer of known accuracy in a liquid bath which is being stirred vigorously and in which the temperature is maintained constant for several minutes before readings are taken.

Never attempt to test thermometers in air. Air is a poor conductor of heat and there is always the danger of cold currents influencing the thermometer reading.

TO CHANGE THE INDICATED TEMPERATURE READING

1. Remove the window.
2. Hold the hub of the pointer stationary. Use a slotted screwdriver for 4 1/2″ and 8 1/2″ cases, grasp the knurl of the 6″ pointer hub.
3. Hold pointer in other hand between thumb and forefinger so that torque can be applied to move pointer.
4. Establish reference temperature and rotate pointer required amount for most accurate reading.
5. Replace the window.

INSTALLATION OF DIRECT READING THERMOMETERS

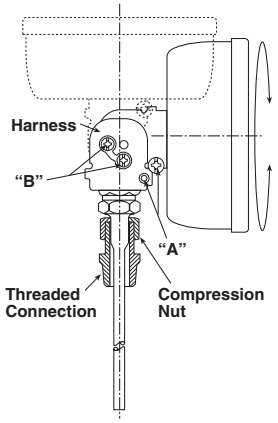
POSITIONING THE SYSTEM

Before installation, the stem should be set to the desired angle as follows:

1. Loosen the four screws labeled "A" and "B" in Figure until the harness revolves freely without twisting the flexible housing.
2. While holding the case, revolve the harness clockwise or counterclockwise as indicated by the arrows in Figure to place the harness in a position that will permit flexing the stem in the desired direction with respect to the case, then lock the two screws labeled "A."
3. Flex the stem to the desired angle with respect to the face of the thermometer as shown in Figure, then lock the screws labeled "B."

INSTALLATION

1. The thermometer is normally provided with a threaded connection. To tighten the thermometer to the apparatus or into a thermowell, use an open end wrench applied to the hexagon head of the threaded connection. Turn until reasonably tight, then tighten still further in the same manner as a pipe fitting until the scale is in the desired position for reading. **"DO NOT TIGHTEN BY TURNING THE THERMOMETER CASE."**
2. Insert the thermometer into the threaded connection and turn the compression nut until reasonably tight, then tighten still further in the same manner as a pipe fitting.



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Type 1279 Duragauge® Pressure Gauge Available With *PLUS!™* Performance Option



- *Solid front case design, field convertible to hermetically sealed or liquid filled style*
- *Pressure ranges from vacuum — 30,000 psi*
- *Select from various socket and Bourdon tube materials*
- *Micrometer adjustable pointer*
- *400 Series stainless steel movement wears better for longer life*
- *Teflon-coated pinion for longer life*
- *Patented Duratube™ with as-welded tube construction controls stresses for longer life*
- ***PLUS!™** Performance Option:*
  - *Liquid-filled performance in a dry gauge*
  - *Fights vibration and pulsations without liquid-filled headaches*
  - *Order as option XLL*

The Ashcroft® Duragauge® pressure gauge is the finest production gauge on the market for industrial use where precise indications are required. The product line offers a wide variety of case styles, Bourdon tubes and pressure ranges to meet your application needs.

With the component combinations available in the Duragauge gauge line, over ten million variations are possible to serve the needs of all types of industries, including process, power, nuclear, aerospace and cryogenics.

TEMPERATURE LIMITS

	Ambient	Process	Storage
Dry	–20/200°F(1) (–29/93°C)	–20/250°F(1) (–29/121°C)	–40/250°F (–40/121°C)
LF (glycerin)	20/150°F (7/66°C)	20/150°F (7/93°C)	0/150°F (–18/66°C)
(silicone)	–40/150°F (–40/66°C)	–40/200°F (–40/93°C)	–40/150°F (–40/66°C)
(halocarbon)	–40/150°F (–40/66°C)	–40/200°F (–40/93°C)	–40/150°F (–40/66°C)

Note: Other than discoloration of the dial and hardening of the gasketing that may occur as ambient or process temperatures exceeds 150°F, non-liquid-filled gauges with standard glass windows, can withstand continuous operating temperatures up to 250°F (121°C). Liquid-filled gauges can withstand 200°F (93°C) but glycerin fill and acrylic window will tend to yellow. Accuracy at temperatures above or below the reference ambient temperature of 68°F (20°C) will be affected by approximately .4% per 25°F. Gauges with welded joints will withstand 750°F (450°F (232°C) with silver brazed joints) for short times without rupture, although other parts of the gauge will be destroyed and calibration will be lost. For continuous use and for process or ambient temperatures above 250°F (121°C), a diaphragm seal or capillary or siphon is recommended.

(1) Available for temperatures below –20°F, see Product Information page ASH/PI-21B for details.

PRODUCT SPECIFICATIONS

Model Number:	1279
Accuracy:	½% full scale (Grade 2A, ASME B40.100)
Ranges:	Vac., compound to 30,000 psi
Dial Size:	4½″ diameter
Case Material:	Black phenolic, solid front
Weather Protection:	Dry Case: IP54 Liquid filled or hermetically sealed case: IP 66
Ring:	Threaded reinforced black polypropylene
Window:	Glass
Dial:	Aluminum, white background, black figures and intervals
Pointer:	Micrometer adjustable
Movement:	Rotary, 400 SS, Teflon® coated pinion gear and segment
Bourdon Tube and Socket:	C510 Phos. bronze/brass (A)(1) 316L SS/steel (R)(2) 316L SS/316L SS (S)(2) K Monel/ Monel (P)(2)
Conn. Size:	¼″, ½″ NPT
Conn. Location:	Lower or back

OPTIONAL FEATURES

Fill:	L-Glycerin-Standard XGV-Silicone-Optional XGX-Halocarbon-Optional
***PLUS!™* Performance:**	XLL(3)
Hermetically Sealed, IP65:	H
Flush Mounting Ring:	X56
Receiver Gauge:	XPR
Shatter Proof Glass Window:	XSG
Acrylic Window:	XPD
Red Set Hand:	XSH
Maximum Pointer:	XEP

(1) Joints silver brazed
(2) Joints welded
(3) Not available with silicone filled case (XGV option)

STANDARD RANGE TABLE*

Pressure – psi		
Range	**Figure interval**	**Minor Graduation**
0/15	1	0.1
0/30	5	0.2
0/60	5	0.5
0/100	10	1
0/160	20	2
0/200	20	2
0/300	50	2
0/400	50	5
0/600	50	5
0/800	100	10
0/1000	100	10
0/1500	200	20
0/2000	200	20
0/3000	500	20
0/5000	500	50
0/6000	500	50
0/10,000	1000	100
0/20,000	2000	200
0/30,000	5000	200

* Full standard and metric equivalent range table available on our web site.

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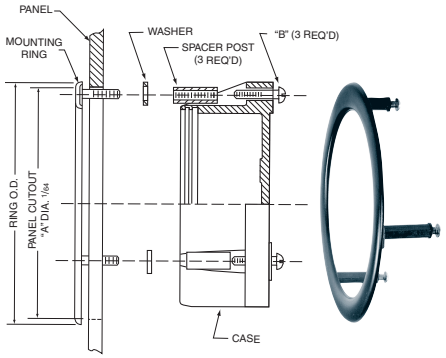
Type 1279 Duragauge® Pressure Gauge Available With *PLUS!™* Performance Option

Compound				
Range	Figure Interval		Minor Grads	
	in Hg	psi	in Hg	psi
30˝ Hg/15 psi	5	3	0.5	0.2
30˝ Hg/30 psi	10	5	1	0.5
30˝ Hg/60 psi	10	10	1	1
30˝ Hg/100 psi	10	10	2	1
30˝ Hg/150 psi	10	20	5	2
30˝ Hg/200 psi	30	20	5	2
30˝ Hg/300 psi	30	50	5	2

Vacuum		
Range	Figure Interval	Minor Grads
30/0 in. Hg 34/0 ft H_2O	5 in 5 ft	0.2 in 0.5 ft

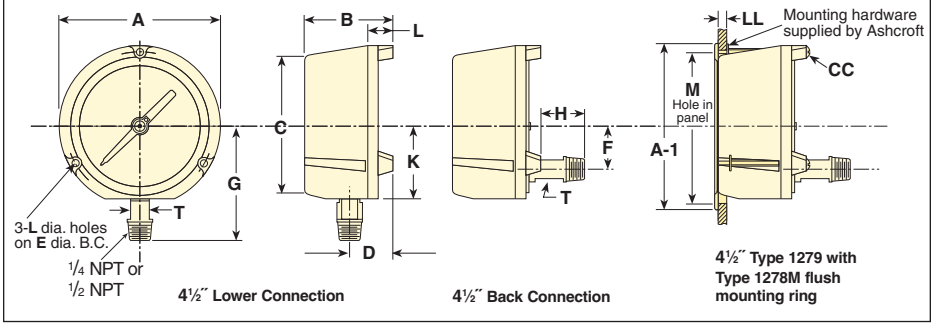
TYPE 1278M SERIES FLUSH MOUNTING RING

Used to flush mount gauge case Type 1279(*)S. Standard finish is black; optional polished stainless steel finish is available.



GAUGE SIZE	RING O.D.	"A" DIA.	"B" Size of 3 Screws	"C" Size of Washers
4½	6.000 (152)	5⅝ (148)	#10-24 x 1⅝	7/16 x 17/64 x ⅝

Dimensions



Dial Size Inches	A	B	C	D	E	F	G	H	K	L	T	V	Weight (lbs)
4½	5.81 (147.6)	3.36 (85.3)	5.07 (128.7)	1.06 (40.6)	5.375 (137)	1.62 (41.2)	4.08 (103.7)	.73 (18.4)	2.62 (66.6)	.22 (5.5)	.62 (15.7)	2.625 (67)	2.5 (Dry) 3.5 (L.F.)

Order Coding Example

45	1279	S	S	04	L	XEPNH	100	#

SIZE	TYPE	SYSTEM (TUBE & SOCKET)	CASE DESIGN SOLID FRONT	PROCESS CONNECTION SIZE	CONNECTION LOCATION	OPTIONS (X VARIATIONS)[1]	RANGE	ENGINEERING UNITS[1]
(45) 4½	**1279**	**(A)** Bronze tube, Brass socket[1] **(P)** K-Monel 500 tube, Monel 400 socket[2] **(R)** 316L st st tube, steel socket **(S)** 316L[2] [1] Max pressure 1000psi [2] Max pressure 30,000psi	**(S)** Dry(IP54) **(SH)** Dry, Hermetically Sealed, Field Fillable (IP65) **(SL)** Liquid filled (glycerin standard) (IP65)	**(02)** ¼ NPT male[1] **(04)** ½ NPT male[1] **(09)** 9/16-18 UNF-2B Aminco (standard for high pressure >20,000psi) [1] Max pressure 20,000psi	**(B)** Back **(D)** Side (3:00) **(E)** Side (9:00) **(L)** Lower **(T)** Top (12:00)	**(GV)** Silicone case fill **(GX)** Halocarbon case fill **(NH)** St. St. Wired Tag **(TS)** Throttle screw[2] **(6B)** Oxygen service **(PD)** Acrylic window[2] **(SG)** Safety glass **(EP)** Maximum pointer, adjustable **(SH)** Red set hand, stationary **(LL)** ***PLUS!*** Performance **(56)** Flush mounting ring **(C4)** Individual calibration chart [1] Others on request [2] Standard with hermetically sealed or liquid filled gauge	See website for most common ranges offered	**(#)** PSI **(BR)**) Bar **(KG)** Kilograms/CM2 **(KP)** Kilopascal **(IMV)** Inches of Mercury Vacuum [1] See website for more units of measure

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ASHCROFT®

PRESSURE GAUGE INSTALLATION, OPERATION AND MAINTENANCE



I&M008-10098-5/02 (250-1353-L) Rev. 12/15

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Cover photo courtesy of Johnson/Yokogawa Co.

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1.0 SELECTION & APPLICATION

Users should become familiar with ASME B40.100 (Gauges – Pressure Indicating Dial Type – Elastic Element) before specifying pressure measuring gauges. That document – containing valuable information regarding gauge construction, accuracy, safety, selection and testing – may be ordered from:

ASME International
Three Park Avenue
New York, N.Y. 10016-5990
800-843-2763 (US/Canada)
001-800-843-2763 (Mexico)
973-882-1170 outside North America
email: infocentral@asme.org
www.asme.org

WARNING: To prevent misapplication, pressure gauges should be selected considering media and ambient operating conditions. Improper application can be detrimental to the gauge, causing failure and possible personal injury, property damage or death. The information contained in this manual is offered as a guide in making the proper selection of a pressure gauge. Additional information is available from Ashcroft Inc.

The following is a highlight of some of the more important considerations:

1.1 Range – The range of the instrument should be approximately twice the maximum operating pressure. Too low a range may result in (a) low fatigue life of the elastic element due to high operating stress and (b) susceptibility to overpressure set due to pressure transients that exceed the normal operating pressure. Too high a range may yield insufficient resolution for the application.

1.2 Temperature – Refer to Section 2 of this manual for important information concerning temperature related limitations of pressure gauges, both dry and liquid filled.

1.3 Media – The material of the process sensing element must be compatible with the process media. Use of a diaphragm seal with the gauge is recommended for process media that (a) is corrosive to the process sensing element; (b) contain heavy particulates (slurries) or (c) are very viscous including those that harden at room temperature.

1.4 Oxidizing media – Gauges for direct use on oxidizing media should be specially cleaned. Gauges for oxygen service should be ordered to variation X6B and will carry the ASME required dial marking "USE NO OIL" in red letters. Gauges for direct use on other oxidizing media may be ordered to variation X6W. They will be cleaned but carry no dial marking. *PLUS!*™ Performance gauges or Halocarbon filled gauge or diaphragm fill is required for use with oxidizing media; order variation XCF.

1.5 Pulsation/Vibration – Pressure pulsation can be dampened by several mechanisms; the patented *PLUS! Performance* gauge will handle the vast majority of applications. One exception to this is high frequency pulsation which is difficult to detect. The only indication may be an upscale zero shift due to movement wear. These applications should be addressed with a liquid filled gauge, or in extreme cases, a remotely mounted liquid filled gauge connected with a length of capillary line. The small diameter of the capillary provides excellent dampening, but can be plugged. The Ashcroft 1106 pulsation dampener and 1112 snubber are auxiliary devices which dampen pulsation with less tendency to plug.

1.6 Gauge fills. – Once it has been determined that a liquid filled gauge is in order, the next step is selecting the type of fill. **Glycerin** satisfies most applications. While being the least expensive fill, its usable temperature range is 20/180°F. **Silicone** filled gauges have a broader service range: –40/250°F. Oxidizing media require the use of **Halocarbon,** with a service range of –40/250°F. Pointer motion will be slowed at the low end of the low end of these temperature ranges.

1.7 Mounting – Users should predetermine how the gauge will be mounted in service: stem (pipe), wall (surface) or panel (flush). Ashcroft wall or panel mounting kits should be ordered with the gauge. See Section 3.

2.0 TEMPERATURE

2.1 Ambient Temperature – To ensure long life and accuracy, pressure gauges should preferably be used at an ambient temperature between –20 and +150°F (–30 to +65°C). At very low temperatures, standard gauges may exhibit slow pointer response. Above 150°F, the accuracy will be affected by approximately 1.5% per 100°F. Other than discoloration of the dial and hardening of the gasketing and degradation of accuracy, non-liquid filled Type 1279 (phenolic case) and 1379 (aluminum case) Duragauge® gauge, with standard glass windows, can withstand continuous operating temperatures up to 250°F. Unigauge models 2½˝ and 3½˝ 1009 and 1008S liquid filled gauges can withstand 200°F but glycerin fill and the acrylic window of Duragauge® gauges will tend to yellow. Silicone fill will have much less tendency to yellow. Low pressure, liquid filled Types 1008 and 1009 gauges may have some downscale errors caused by liquid fill expansion. This can be alleviated by venting the gauge at the top plug (pullout the blue plug insert). To do this the gauge must be installed in the vertical position.

Although the gauge may be destroyed and calibration lost, gauges can withstand short times at the following temperatures: gauges with all welded pressure boundary joints, 750°F (400°C); gauges with silver brazed joints, 450°F (232°C) and gauges with soft soldered joints, 250°F (121°C). For expected long term service below –20°F (–30°C) Duragauge® and 4½˝ 1009 gauges should be hermetically sealed and specially lubricated; add "H" to the product code for hermetic sealing. Add variation XVY for special lubricant. Standard Duralife® gauges may be used to –50°F (–45°C) without modification.

2.2 Accuracy – Heat and cold affect accuracy of indication. A general rule of thumb for **dry gauges** is 0.5% of full scale change for every 40°F change from 75°F. Double that allowance for gauges with hermetically sealed or liquid filled cases, except for Duragauge® gauges where no extra allowance is required due to the elastomeric, compensating back. Above 250°F there may exist very significant errors in indication.

2.3 Steam service – In order to prevent live steam from entering the Bourdon tube, a siphon filled with water should be installed between the gauge and the process line. Siphons can be supplied with ratings up to 4,000 psi. If freezing of the condensate in the loop of the siphon is a possibility, a diaphragm seal should be used to isolate the gauge from the process steam. Siphons should also be used whenever condensing, hot vapors (not just steam) are present. Super heated steam should have enough piping or capillary line ahead of the siphon to maintain liquid water in the siphon loop.

2.4 Hot or very cold media – A five foot capillary line assembly will bring most hot or cold process media within the recommended gauge ambient temperature range. For media above

750°F (400°C) the customers should use their own small diameter piping to avoid possible corrosion of the stainless steel. The five foot capillary will protect the gauges used on the common cryogenic (less than –300°F (200°C) gases, liquid argon, nitrogen, and oxygen.) The capillary and gauge must be cleaned for oxygen service. The media must not be corrosive to stainless steel, and must not plug the small bore of the capillary.

2.5 Diaphragm seals – A diaphragm seal should be used to protect gauges from corrosive media, or media that will plug the instrument. Diaphragm seals are offered in a wide variety of designs and corrosion resistant materials to accommodate almost any application and most connections. Visit www.ashcroft.com for details.

2.6 Autoclaving – Sanitary gauges with clamp type connections are frequently steam sterilized in an autoclave. Gauges equipped with polysulfone windows will withstand more autoclave cycles than those equipped with polycarbonate windows. Gauges equipped with plain glass or laminated safety glass **should not be autoclaved.** Gauge cases should be vented to atmosphere (removing the rubber fill/safety plug if necessary) **before** autoclaving to prevent the plastic window from cracking or excessively distorting. If the gauge is liquid filled, the fill should be drained from the case and the front ring loosened before autoclaving.

3.0 INSTALLATION

3.1 Location – Whenever possible, gauges should be located to minimize the effects of vibration, extreme ambient temperatures and moisture. Dry locations away from very high thermal sources (ovens, boilers etc.) are preferred. If the mechanical vibration level is extreme, the gauge should be remotely located (usually on a wall) and connected to the pressure source via flexible tubing.

3.2 Gauge reuse – ASME B40.100 recommends that gauges not be moved indiscriminately from one application to another. The cumulative number of pressure cycles on an in-service or previously used gauge is generally unknown, so it is generally safer to install a new gauge whenever and wherever possible. This will also minimize the possibility of a reaction with previous media.

3.3 Tightening of gauge – Torque should never be applied to the gauge case. Instead, an open end or adjustable wrench should always be used on the wrench flats of the gauge socket to tighten the gauge into the fitting or pipe. NPT threads require the use of a suitable thread sealant, such as pipe dope or teflon tape, and must be tightened very securely to ensure a leak tight seal.

CAUTION: Torque applied to a diaphragm seal or its attached gauge, that tends to loosen one relative to the other, can cause loss of fill and subsequent inaccurate readings. Always apply torque **only** to the wrench flats on the lower seal housing when installing filled, diaphragm seal assemblies or removing same from process lines.

3.4 Process isolation – A shut-off valve should be installed between the gauge and the process in order to be able to isolate the gauge for inspection or replacement without shutting down the process.

3.5 Surface mounting – Also known as wall mounting. Gauges should be kept free of piping strains. The gauge case mounting feet, if applicable, will ensure clearance between the pressure relieving back and the mounting surface.

3.6 Flush mounting – Also known as panel mounting. The applicable panel mounting cutout dimensions can be found at www.ashcroft.com

4.0 OPERATION

4.1 Frequency of inspection – This is quite subjective and depends upon the severity of the service and how critical the accuracy of the indicated pressure is. For example, a monthly inspection frequency may be in order for critical, severe service applications. Annual inspections, or even less frequent schedules, are often employed in non-critical applications.

4.2 In-service inspection – If the accuracy of the gauge cannot be checked in place, the user can at least look for (a) erratic or random pointer motion; (b) readings that are suspect – especially indications of pressure when the user believes the true pressure is 0 psig. Any gauge which is obviously not working or indicating erroneously, should be immediately valved-off or removed from service to avoid a possible pressure boundary failure.

4.3 When to check accuracy – Any suspicious behavior of the gauge pointer warrants that a full accuracy check be performed. Even if the gauge is not showing any symptoms of abnormal performance, the user may want to establish a frequency of bench type inspection.

4.4 When to recalibrate – This depends on the criticality of the application. If the accuracy of a 3-2-3% commercial type gauge is only 0.5% beyond specification, the user must decide whether it's worth the time and expense to bring the gauge back into specification. Conversely if the accuracy of a 0.25% test gauge is found to be 0.1% out of specification then the gauge should be recalibrated.

4.5 Other considerations – These include (a) bent or unattached pointers due to extreme pressure pulsation; (b) broken windows which should be replaced to keep dirt out of the internals; (c) leakage of gauge fill; (d) case damage – dents and/or cracks; (e) any signs of service media leakage through the gauge including its connection; (f) discoloration of gauge fill that impedes readability.

4.6 Spare parts – As a general rule it is recommended that the user maintain in inventory one complete Ashcroft® instrument for every ten (or fraction thereof) of that instrument type in service.

5.0 GAUGE REPLACEMENT

It is recommended that the user stock one complete Ashcroft® instrument for every ten (or fraction thereof) of that instrument type in service. With regard to gauges having a service history, consideration should be given to discarding rather than repairing them. Gauges in this category include the following:

a. Gauges that exhibit a span shift greater than 10%. It is possible the Bourdon tube has suffered thinning of its walls by corrosion.

b. Gauges that exhibit a zero shift greater than 25%. It is likely the Bourdon tube has seen significant overpressure leaving residual stresses that may be detrimental to the application.

c. Gauges which have accumulated over 1,000,000 pressure cycles with significant pointer excursion.

d. Gauges showing any signs of corrosion and/or leakage of the pressure system.

e. Gauges which have been exposed to high temperature or exhibit signs of having been exposed to high temperature – specifically 250°F or greater for soft soldered systems; 450°F or greater for brazed systems; and 750°F or greater for welded systems.

f. Gauges showing significant friction error and/or wear of the movement and linkage.

g. Gauges having damaged sockets, especially damaged threads.

h. Liquid filled gauges showing loss of case fill.

NOTE: ASME B40.100 does not recommend moving gauges from one application to another. This policy is prudent in that it encourages the user to procure a new gauge, properly tailored by specification, to each application that arises.

6.0 ACCURACY: PROCEDURES/DEFINITIONS

Accuracy inspection – Readings at approximately five points equally spaced over the dial should be taken, both upscale and downscale, before and after lightly rapping the gauge to remove friction. **A pressure standard with accuracy at least four times greater than the accuracy of the gauge being tested is recommended.**

Equipment – A finely regulated pressure supply will be required. It is critical that the piping system associated with the test setup be leaktight. The gauge under test should be positioned as it will be in service to eliminate positional errors due to gravity.

Method – ASME B40.100 recommends that **known** pressure (based on the reading from the pressure standard used) be applied to the gauge under test. Readings including any error from the nominal input pressure, are then taken from the gauge under test. The practice of aligning the pointer of the gauge under test with a dial graduation and then reading the error from the master gauge ("reverse reading") can result in inconsistent and misleading data and should NOT be used.

Calibration chart – After recording all of the readings it is necessary to calculate the errors associated with each test point using the following formula: ERROR in percent = 100 times (TRUE VALUE minus READING) ÷ RANGE. Plotting the individual errors (Figure 1) makes it possible to visualize the total gauge characteristic. The plot should contain all four curves: upscale – before rap; upscale – after rap; downscale – before rap; downscale – after rap. "*Rap*" means lightly tapping the gauge **before** reading to remove friction as described in ASME B40.100.

Referring to Figure 1, several classes of error may be seen:

Zero – An error which is approximately equal over the entire scale. This error can be manifested when either the gauge is

FIG. 1

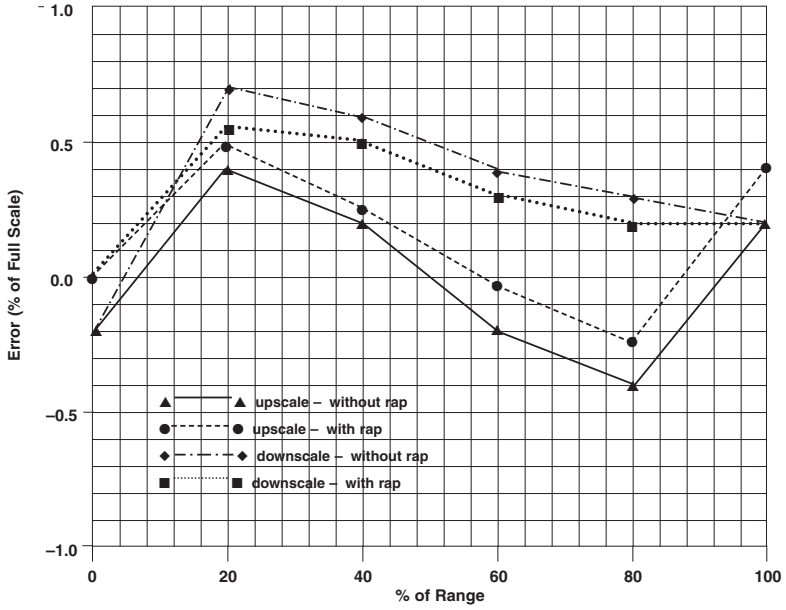
TYPICAL CALIBRATION CHART

INDICATED VALUE (PSI)

True Value – PSI	Increasing – Without RAP	Increasing – With RAP	Decreasing – Without RAP	Decreasing – With RAP
0	–.4	0	–.4	0
40	+.8	+1.0	+1.4	+1.1
80	+.4	+.5	+1.2	+1.0
120	–.4	–1.0	+.8	+.6
160	–.8	–.5	+.6	+.4
200	+.4	+.8	+.4	+.4

ERROR (% OF FULL SCALE)

True Value – % of Range	Increasing – Without RAP	Increasing – With RAP	Decreasing – Without RAP	Decreasing – With RAP
0	–.20	0	–.20	0
20	+.40	+.50	+.70	+.55
40	+.20	+.25	+.60	+.50
60	–.20	–.05	+.40	+.30
80	–.40	–.25	+.30	+.20
100	+.20	+.40	+.20	+.20



dropped or overpressured and the Bourdon tube takes a permanent set. This error may often be corrected by simply repositioning the pointer. Except for test gauges, it is recommended that the pointer be set at midscale pressure to "split" the errors.

Span – A span error exists when the error at full scale pressure is different from the error at zero pressure. This error is often proportional to the applied pressure. Most Ashcroft gauges are equipped with an internal, adjusting mechanism with which the user can correct any span errors which have developed in service.

Linearity – A gauge that has been properly spanned can still be out of specification at intermediate points if the response of the gauge as seen in Figure 1 (Typical Calibration Chart) is not linear. The Ashcroft Duragauge® pressure gauge is equipped with a rotary movement feature which permits the user to minimize this class of error. Other Ashcroft gauge designs (e.g., 1009 Duralife®) require that the dial be moved left or right prior to tightening the dial screws.

Hysteresis – Some Bourdon tubes have a material property known as hysteresis. This material characteristic results in differences between the upscale and downscale curves. This class of error can **not** be eliminated by adjusting the gauge movement or dial position.

Friction – This error is defined as the difference in readings before and after lightly tapping the gauge case at a check point. Possible causes of friction are burrs or foreign material in the movement gearing, "bound" linkages between the movement and the bourdon tube, or an improperly tensioned hairspring. If correcting these potential causes of friction does not eliminate excessive friction error, the movement should be replaced.

6.1 Calibration – Rotary Movement Gauges and Type 1259 Gauges – Inspect gauge for accuracy. Many times gauges are simply "off zero" and a simple pointer adjustment using the micrometer pointer is adequate. If inspection shows the gauge warrants recalibration to correct span and/or linearity errors, proceed as follows:

a. Remove ring, window and, if solid front case, the rear closure assembly.

b. Pressurize the gauge **once** to full scale and back to zero.

c. Refer to Figure 2 (Ashcroft System Assembly w/Rotary Gear Movement) for a view of a typical Ashcroft rotary system assembly with component parts identified. Refer to Figure 2A for link configuration of Type 1259 gauge.

FIG. 2 ASHCROFT SYSTEM ASSEMBLY W/ROTARY GEAR MOVEMENT

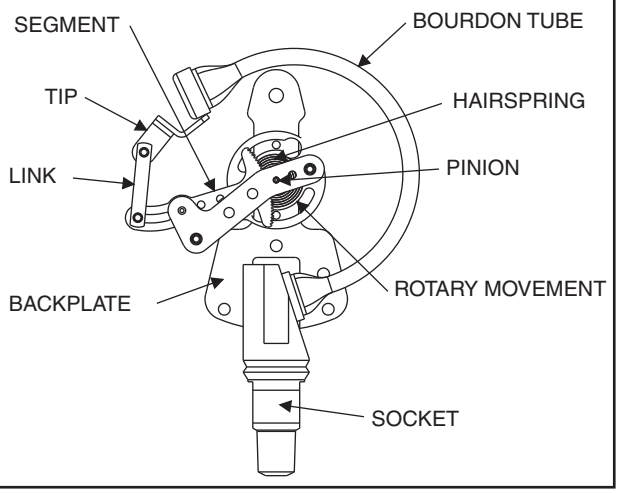
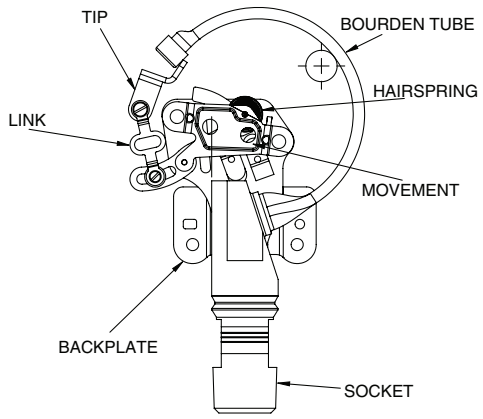


FIG. 2A ASHCROFT TYPE 1259 SYSTEM ASSEMBLY



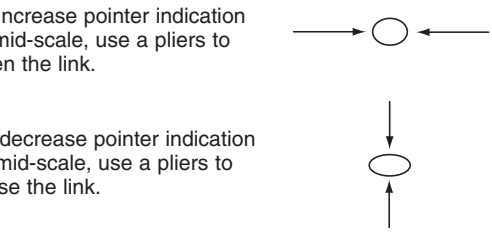
d. Adjust the micrometer pointer so that it rests at the true zero position. For open front gauges the pointer and dial must also be disassembled and the pointer should then be lightly pressed onto the pinion at the 9:00 o'clock position.

e. Apply full scale pressure and note the magnitude of the span error. With open front gauges, ideal span (270 degrees) will exist when at full scale pressure the pointer rests exactly at the 6:00 o'clock position.

f. If the span has shifted significantly (span error greater than 10%), the gauge should be replaced because there may be some partial corrosion inside the Bourdon tube which could lead to ultimate failure. If the span error exceeds 0.25%, loosen the lower link screw and move the lower end of the link toward the movement to increase span or away to decrease span. An adjustment of 0.004 inch will change the span by approximately 1%. This is a repetitive procedure which often requires more than one adjustment of the link position and the subsequent rechecking of the errors at zero and full scale pressure.

g. Apply midscale pressure and note error in reading. Even though the gauge is accurate at zero and full scale, it may be inaccurate at the midpoint. This is called linearity error. For corrections to linearity with the Type 1259 gauges refer to Figure 2B. For rotary movement gauges, note the following: if the error is positive, the movement should be rotated counter clockwise. Rotating the movement one degree will change this error by approximately 0.25%. Rotating the movement often affects span and it should be subsequently rechecked and readjusted if necessary according to step 6.1e and 6.1f.

FIG. 2B LINEARITY ADJUSTMENT & LINK CONFIGURATION FOR ASHCROFT TYPE 1259



h. While recalibrating the gauge, the friction error – difference in readings taken with and without rap – should be

noted. This error should not exceed the basic accuracy of the gauge. If the friction error is excessive, the movement should be replaced. One possible cause of excessive friction is improper adjustment of the hairspring. The hairspring torque,or tension, must be adequate without being excessive. The hairspring should also be level, unwind evenly (no turns rubbing) and it should never tangle.

NOTES:

1 For operation of test gauge external zero reset, refer to page 17.

2 For test gauge calibration procedure, refer to Figure 2 on page 18.

7.0 DIAPHRAGM SEALS

7.1 General – A diaphragm seal (isolator) is a device which is attached to the inlet connection of a pressure instrument to isolate its measuring element from the process media. The space between the diaphragm and the instrument's pressure sensing element is solidly filled with a suitable liquid. Displacement of the liquid fill in the pressure element, through movement of the diaphragm, transmits process pressure changes directly to a gauge, switch or any other pressure instrument. When diaphragm seals are used with pressure gauges, an additional 0.5% tolerance must be added to the gauge accuracy because of the diaphragm spring rate.

Used in a variety of process applications where corrosives, slurries or viscous fluids may be encountered, the diaphragm seal affords protection to the instrument where:

- The process fluid being measured would normally clog the pressure element.
- Pressure element materials capable of withstanding corrosive effects of certain fluids are not available.
- The process fluid might freeze due to changes in ambient temperature and damage the element.

7.2 Installation – Refer to bulletin OH-1 for information regarding (a) seal configurations; (b) filling fluids; (c) temperature range of filling fluids; (d) diaphragm material pressure and temperature limits; (e) bottom housing material pressure and temperature limits; (f) pressure rating of seal assembly; (g) accuracy/temperature errors of seal assembly; (h) diaphragm seal displacement. The volumetric displacement of the diaphragm must at least equal the volumetric displacement of the measuring element in the pressure instrument to which the seal is to be attached.

It is imperative that the pressure instrument/diaphragm seal assembly be **properly** filled prior to being placed in service. Ashcroft diaphragm seal assemblies should only be filled by a seal assembler certified by Ashcroft Inc. Refer to section 3.3 for a cautionary note about not applying torque on either the instrument or seal relative to the other.

7.3 Operation – All Ashcroft® diaphragm seals, with the exception of Type 310 mini-seals, are continuous duty. Should the pressure instrument fail, or be removed accidentally or deliberately, the diaphragm will seat against a matching surface preventing damage to the diaphragm or leakage of the process fluid.

7.4 Maintenance – Clamp type diaphragm seals – Types 100, 200 and 300 – allow for replacement of the diaphragm or diaphragm capsule, if that ever becomes necessary. The Type 200 top housing must also be replaced with the diaphragm. With all three types the clamping arrangement allows field disassembly to permit cleaning of the seal interior.

7.5 Failures – Diaphragm failures are generally caused by either corrosion, high temperatures or fill leakage. Process media build-up on the process side of the diaphragm can also require seal cleaning or replacement. Consult Customer Service, Stratford CT for advice on seal failures and/or replacement.

WARNING: All seal components should be selected considering process and ambient operating conditions to prevent misapplication. Improper application could result in failure, possible personal injury, property damage or death.

8.0 DAMPENING DEVICES

8.1 General – Some type of dampening device should be used whenever the pressure gauge may be exposed to repetitive pressure fluctuations that are fairly rapid, high in magnitude and especially when transitory pressure spikes exceeding the gauge range are present (as with starting and stopping action of valves and pumps). A restricted orifice of some kind is employed through which pressure fluctuations must pass before they reach the Bourdon tube. The dampener reduces the magnitude of the pressure pulse thus extending the life of the Bourdon tube and movement. This reduction of the pressure pulsation as "seen" by the pressure gauge is generally evidenced by a reduction in the pointer travel. If the orifice is very small the pointer may indicate the average service pressure, with little or no indication of the time varying component of the process pressure.

Commonly encountered media (e.g. – water and hydraulic oil) often carry impurities which can plug the orifice over time thus rendering the gauge inoperative until the dampener is cleaned or replaced.

Highly viscous media and media that tend to periodically harden (e.g., asphalt) require a diaphragm seal be fitted to the gauge. The seal contains an internal orifice which dampens the pressure fluctuation within the fill fluid.

8.2 Throttle Screws & Plugs – These accessories provide dampening for the least cost. They have the advantage of fitting completely within the gauge socket and come in three types: (a) a screwed-in type which permits easy removal for cleaning or replacement; (b) a pressed in, non-threaded design and (c) a pressed in, threaded design which provides a highly restrictive, helical flow path. Not all styles are available on all gauge types.

8.3 Ashcroft Pulsation Dampener – Type 1106 Ashcroft pulsation dampener is a moving pin type in which the restricted orifice is the clearance between the pin and any one of five preselected hole diameters. Unlike a simple throttle screw/plug, this device has a self-cleaning action in that the pin moves up and down under the influence of pressure fluctuations.

8.4 Ashcroft Pressure Snubber – The heart of the Type 1112 pressure snubber is a thick porous metal filter disc. The disc is available in four standard porosity grades.

8.5 Ashcroft Needle Valves – Type 7001 thru 7004 steel needle valves provide varying degrees of dampening. These devices, in the event of plugging, can easily be opened to allow the pressure fluid to clear away the obstruction.

8.6 Chemiquip® Pressure Limiting Valves – Model PLV-255, PLV-2550, PLV-5460, PLV-5500 and PLV-6430, available with and without built-in snubbers, automatically "shut off" at adjustable preset values of pressure to protect the gauge from damage to overpressure. They are especially useful on hydraulic systems wherein hydraulic transients

(spikes) are common.

9.0 TEST EQUIPMENT & TOOL KITS

See our website www.ashcroft.com for more details

9.1 Pressure Instrument Testing Equipment

Type 1305D Deadweight Tester

Type 1327D Pressure Gauge Comparator

Type 1327CM “Precision” Gauge Comparator

9.2 Tools & Tool Kits For Recalibration of 4½˝ and Larger Gauges

Type 2505 universal carrying case for 1082 test gauge

Type 266A132-01 span wrench for 1082 test gauge

Type 1281 socket O-Ring kit for 1279/1379 lower connect

Type 1285 4½˝ ring wrench for 1279/1379 lower & back connect

Type 1286 6˝ ring wrench for 1379 lower & back connect

Type 3220 pointer puller (all gauges except 1009 Duralife®)

Type 3530 pinion back-up tool for 1009 Duralife®

Type 3220 Handjack set

Type 1105 Tool Kit

9.3 Kits to Convert a Dry Gauge to a Liquid Filled or Weather Proof Case Gauge

Type 1280 conversion kit for 4½˝ lower connect 1279/1379

Type 1283 conversion kit for 4½˝ back connect 1279/1379

Type 1284 conversion kit for 6˝ lower & back connect



TYPE 1105
TOOL KIT

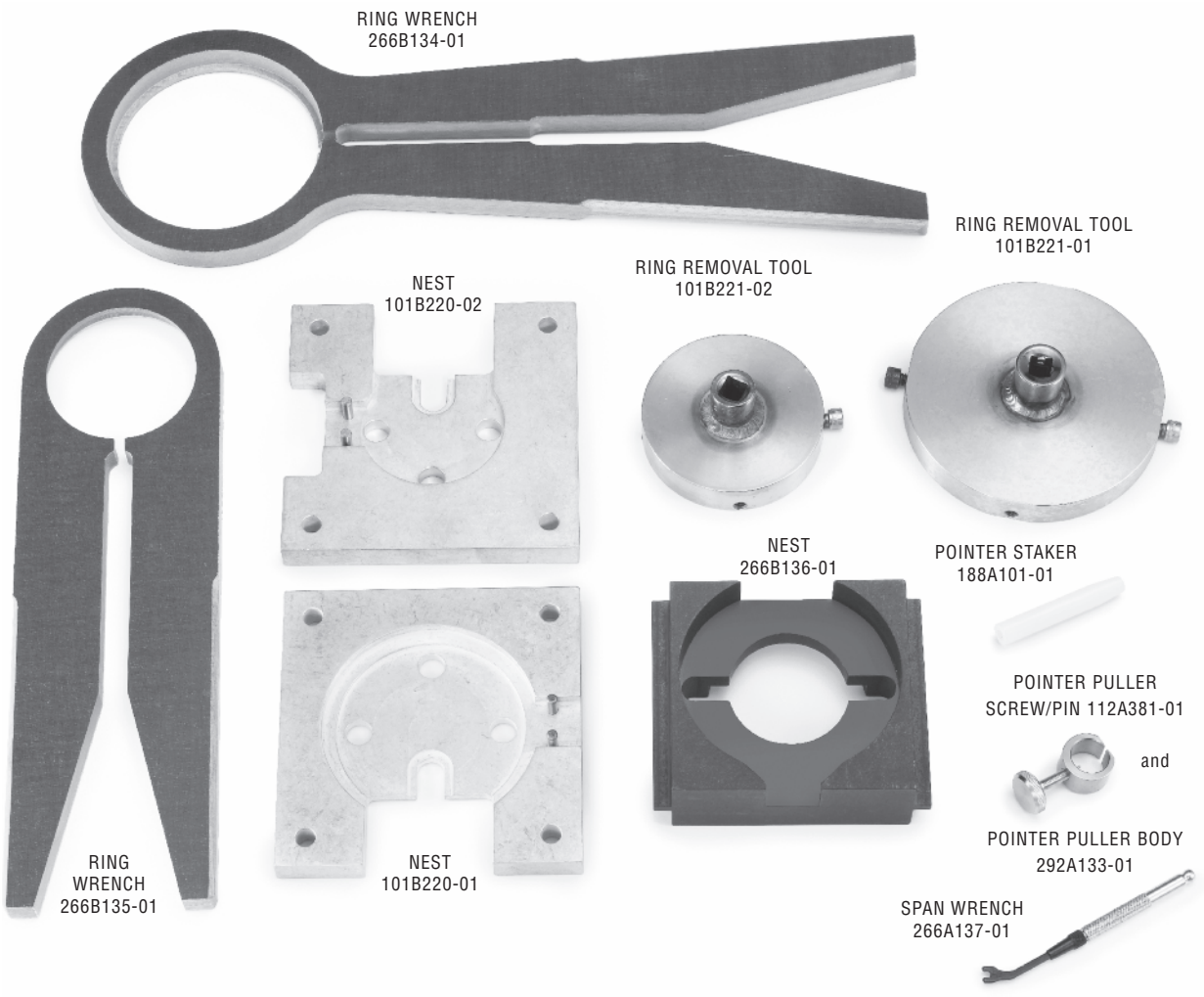


TYPE 3220
HAND JACK SET

9.4 2½ & 3½ 1009 Duralife® Gauge Tools

Description	Part No.
Pointer Puller Screw/Pin[2][3][4]	112A381-01
Pointer Puller Body[2][3][4]	292A133-01
Pointer Staker[2][4]	188A101-01
Span Wrench[2][5] (to adjust span)	266A137-01
Ring Wrench 3½″[1][5] (for ring removal) (35 1009)	266B134-01
Ring Wrench 2½″[1][5] (for ring removal) (25 1009)	266B135-01
Nest 2½″ & 3½″[1][5] (to hold gauge for ring removal) (25/35 1009)	266B136-01
Ring Removal Tool[6] (25 1009)	101B221-02
Ring Removal Tool[6] (35 1009)	101B221-01
Nest 2½″[6] (to hold gauge for ring removal) (25 1009)	101B220-02
Nest 3½″[6] (to hold gauge for ring removal) (35 1009)	101B220-01
Type 1230 throttle plug insertion (¼ NPT) for 1009 Duralife®)	1230
Type 1231 throttle plug insertion (½ NPT) for 1009 Duralife® (body only)	1231
Tool to open orifice on push-in throttle plug	101A206-01

(1) Formerly 1206T Tool Kit.
(2) Formerly some parts in 1205T Tool Kit.
(3) Both parts must be purchased together.
(4) Previous and current design.
(5) Previous design only.
(6) Current design only.



ASHCROFT® Type 1188 Bellows Gauge Calibration Procedure

CALIBRATION & TROUBLE CORRECTION DIAGRAM

RANGE SPAN ADJUSTMENT

- **RANGE TOO SHORT** — Adjust slide "S" inward
- **RANGE TOO LONG** — Adjust slide "S" outward

POINTER JUMPING

- **STICKY PARTS** — Clean all bearings and gear teeth
- **LOOSE HAIRSPRING** — Remove backlash by disengaging pinion & rotate to tighten
- **COUNTER BALANCE RUBBING** — Bend if necessary to clear socket in travel

NOTE: After adjusting range span, set both movement stops. Set the underload stop so that the pointer will stop at zero. Set the overload stop so that the pointer will pass the maximum range approximately 5˝.

After adjusting span re-zero pointer by removing from pinion and re-assembling at the proper dial mark.

SLUGGISH MOVEMENT

TIGHT HAIRSPRING — Loosen by disengaging pinion & rotate

NON LINEAR

- **NON LINEAR FIRST 3RD.** → **ADJ. ANGLE OF PULL BY INCREASING ANGLE "A"**
- **NON LINEAR LAST 3RD.** → **ADJ. ANGLE OF PULL BY DECREASING ANGLE "A"**

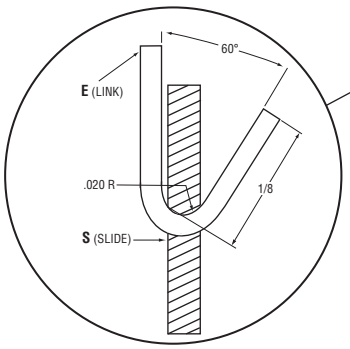
NOTE: To increase or decrease angle "A," bend tip inward or outward as required. Doing this may run the movement segment off the pinion. This can be corrected by cutting off one end off the link "E" decreasing its length, or makin a new length from .032 dia. phos. bronze wire.

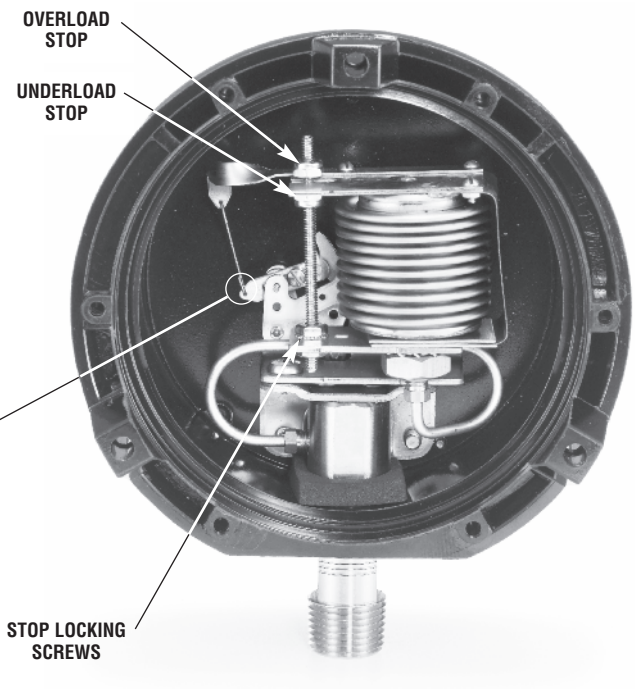
Caution: When reproducing link end, follow figure 44 very closely. this will prevent too much play, or, binding in operation.

REF: Replacing System Bellows

After assembling bellows to the gauge socket securely, subject system to 30 psi for five minutes, allowing bellows to travel approximately 1/8˝ against the overload stop. After this, heat treat system for 15 hours at 250°F, this procedure is necssary to prevent gauge drift.

SLIDE AND LINK (angle "A")
Enlarged view of slide and link





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ASHCROFT® Previous Type 1009 Duralife® Calibration Procedure – Vacuum Range

1. Remove ring, window and gasket pointer.

2. Using a pencil, refer to dial and mark the 0 and 25˝ Hg positions on the case flange.

3. Remove dial.

4. Apply 25˝ Hg vac.

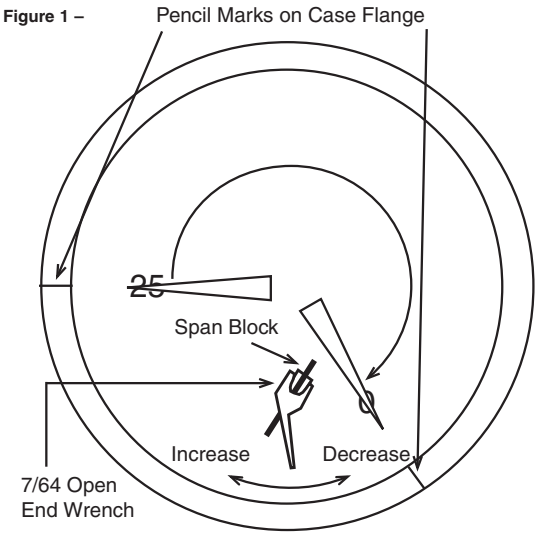
5. Lightly press pointer onto pinion carefully aligning it with the 25˝ Hg vac. mark on the flange.

6. Release vacuum fully.

7. Note agreement of pointer to zero mark on flange.

8. If span is high or low, turn span block as shown in Figure 1.

Figure 1 –



9. Repeat steps 4 through 8 until span is correct.

10. Remove pointer.

11. With 25˝ Hg vac applied, reassemble dial, dial screws (finger tight) and point.

12. Apply 15˝ Hg vac. and note accuracy of indication. If required, slide dial left or right to reduce error to 1% maximum.

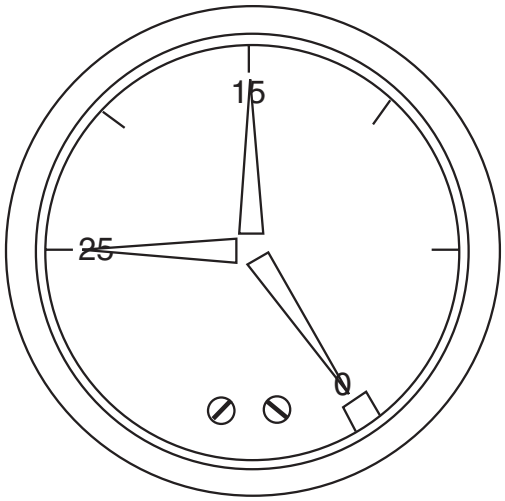
13. Firmly tighten dial screws.

14. Firmly tap pointer onto pinion.

15. recheck accuracy at 15 and 25˝ Hg vac. (Figure 2).

16. Reassemble window, gasket and ring.

Figure 2 –



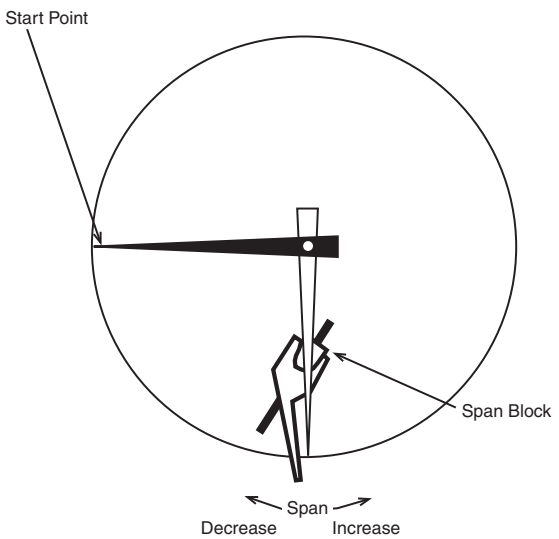
Notes: See page 10 for any tools required to calibrate.

For models produced prior to September 2008 for 2½˝ version and December 2008 for 3½˝ version.
Back of gauge will have a date code sticker.

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Step 1. With the dial off, install pointer at 9 o'clock "lightly," Figure 3.

Figure 3 –

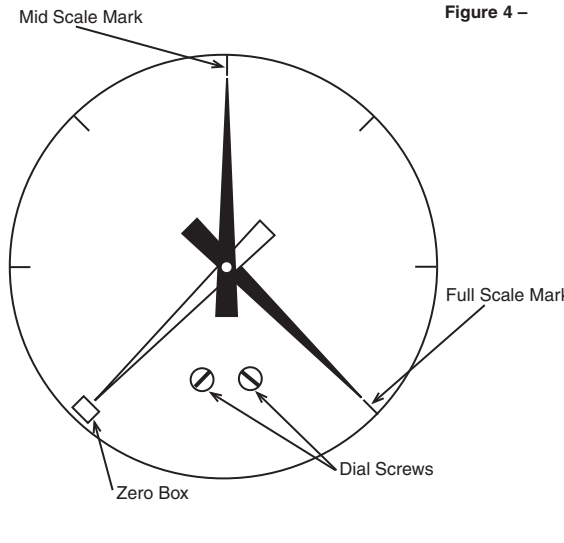


Step 2. Go to full scale pressure…rotate span block with tool until pointer rests at 6 o'clock.

Step 3. Go to zero pressure (9 o'clock)…if pointer has not moved away from start point, go to Step 4. If pointer has moved, repeat Step 1 until span is correct.

Step 4. Install dial with screws snug.

Figure 4 –



Step 5. Install pointer centered in zero box, Figure 4.

Step 6. Go to full scale pressure…check that pointer is within 1% of full scale mark. If not, remove pointer and dial and return to step 1, Figure 4.

Step 7. Go to mid-scale pressure…rotate dial until mid-scale mark is aligned with pointer, Figure 4.

Step 8. Tighten dials screws and stake on pointer.

Step 9. Check zero and full scale. Reassemble window, gasket and ring.

Notes: See page 10 for any tools required to calibrate.

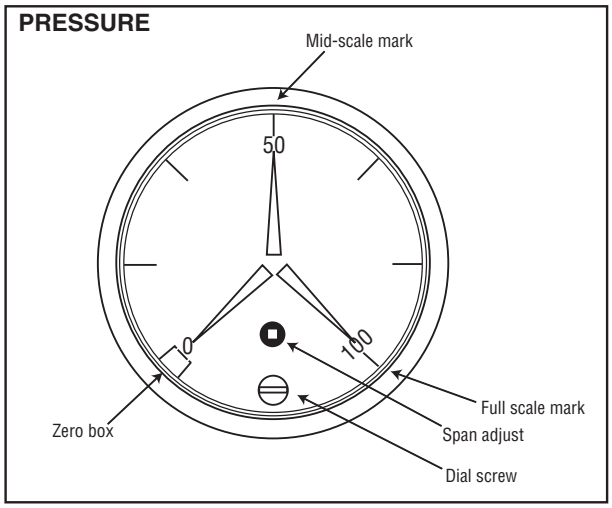
For models produced prior to September 2008 for 2½˝ version and December 2008 for 3½˝ version.
Back of gauge will have a date code sticker.

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ASHCROFT® Current Type 1009 Duralife® Calibration Procedure – Pressure and Vacuum Range

Calibration – 1009 Duralife® Gauge –
Inspect gauge for accuracy. At times gauges are simply "off zero" and opening the ventable plug at the top of the gauge will relieve internal gauge pressure and correct the offset. If this is not adequate and inspection shows that the gauge warrants recalibration to correct zero, span and/or linearity errors, proceed as follows:

Remove ring, window, and gasket using Ashcroft Ring Removal Tools P/N 101B220-02 and 101B221-02 for 2½" gauges and 101B220-01 and 101B221-01 for 3½" gauges.



Positive Pressure Ranges –

1. Adjust pointer with a slotted screwdriver until it is in the center of the zero box. This is often all that is required it correct calibration issues.

2. Apply full scale pressure. If error exceeds 1% rotate the black span adjustment device with a #0 square drive bit. Clockwise increases span, counterclockwise decrease span.

3. Fully exhaust pressure and check that pointer still is still in the zero box. If not, repeat step 1 and 2

4. Once 0 and full scale are within tolerance, pressurize gauge to mid-scale.

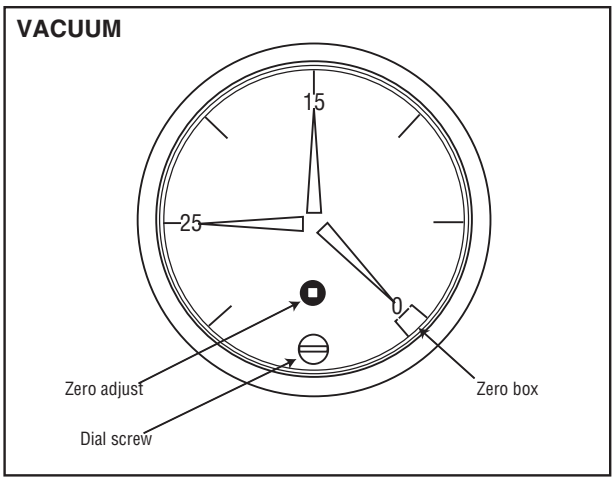
5. If gauge is within 1%, calibration is complete. If not loosen the dial screw and rotate dial left or right to adjust midpoint. Retighten dial screw.

6. If an adjustment was made in step 5, recheck the gauge at zero and full scale, adjust accordingly until zero, mid and full scale points are in tolerance.

Vacuum Range –

1. Adjust pointer with a slotted screwdriver until it is in the center of the zero box. This is often all that is required it correct calibration issues.

2. Apply 25 inches Hg vacuum. If the error exceeds 1% adjust pointer with a slotted screwdriver until gauge is within tolerance.



3. Vent to 0 pressure and check pointer position in the zero box. If error exceeds 1% rotate the black span adjustment device with a #0 square drive bit. Clockwise rotation moves pointer clockwise, counterclockwise rotation moves the pointer counterclockwise.

4. Repeat step 1 and 2 until 0 and 25 inches of Hg are within gauge tolerance.

5. Apply 15 inches Hg vacuum. If gauge is within 1%, calibration is complete. If not loosen the dial screw and rotate dial left or right to adjust midpoint. Retighten dial screw.

6. If an adjustment was made in step 4, recheck the gauge at zero and 25 inches of Hg vacuum, adjust accordingly until zero, 15 and 25 inches Hg are in tolerance.

7. Continue below.

Re-assemble window and ring to gauge:

a. If plastic window is used, push window back into front of gauge, ensure the o-ring does not roll out of window groove (lubricate if necessary). Align the tabs of the window with the tabs of the case front. Once window is in place, install ring and tighten with tools referenced above and shown on page 10.

b If safety glass is used, reinstall window, gasket, and ring. Ensure that the gasket is seated properly under all four tabs of the ring and does not wrinkle when ring is tightened.

Note: Tighten ring: Apply 120-200inlb of torque. Rotate ring clockwise to tighten. Warning: over tightening of safety glass may induce cracking.

Notes: See page 10 for any tools required to calibrate.

For models produced after September 2008 for 2½˝ version and December 2008 for 3½˝ version.
Back of gauge will have a date code sticker.

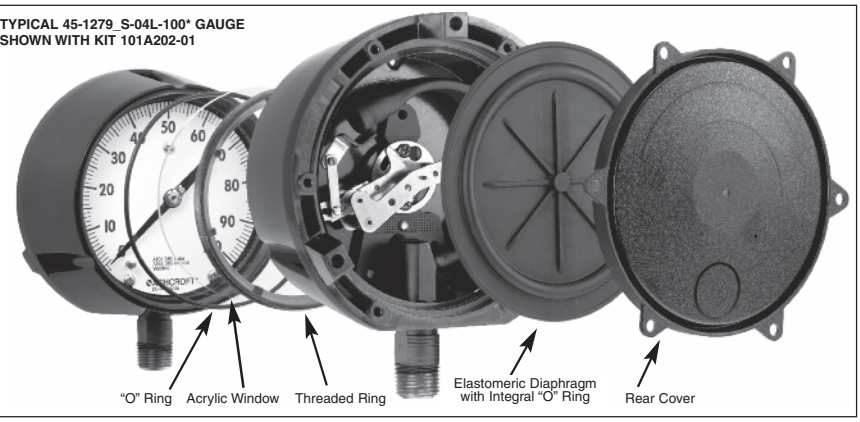
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TYPE 1279 & 1379 SOLID FRONT DURAGAUGE® PRESSURE GAUGE CONVERSION INSTRUCTIONS TO:

- **Convert A Standard Dry Gauge To A Liquid Filled Gauge**
- **Convert A Standard Dry Gauge To A Dry, Weatherproof IP66 Gauge**

ASHCROFT®

TYPICAL 45-1279_S-04L-100* GAUGE SHOWN WITH KIT 101A202-01



	1279		1379		
	4½˝ LOWER	4½˝ BACK	4½˝ LOWER	4½˝ BACK	6˝ LOWER & BACK
KIT PART NO.	101A202-01	101A203-01	1280	1283	1284
	QUANTITY INCLUDED				
ACRYLIC WINDOW	1	1	1	1	1
FRONT O-RING	1	1	1	1	1
DIAPHRAGM(1)	1	1	1	1	2(1-LC:1-BC)
REAR COVER	1	1	1	1	2(1-LC:1-BC)
COVER SCREWS	4	4	-	-	-
THROTTLE SCREWS	2	2	2	2	2
GARTER SPRING	–	1	1	1	1
FILL IDENTIFICATION	1	1	1	1	1
THREADED RING	–	–	1	1	1
TOP FILL PLUG	–	–	1	1	–

1. When Halocarbon fill is a requirement, rear case diaphragm bladder material is Viton instead of the standard Buna diaphragm bladder. Consult factory for part number.

TEMPERATURE LIMITS[1]				60 psi and Under Down Scale Zero Shift Required
	Ambient	Process	Storage	
Dry (IP66)	–20/200°F (–29/93°C)	–20/250°F(1) (–29/121°C)	–40/250°F (–40/121°C)	NONE
LF (glycerin)	20/150°F (7/66°C)	20/200°F (7/93°C)	0/150°F (–18/66°C)	NONE
(silicone)	–40/150°F (–40/66°C)	–40/200°F (–40/93°C)	–40/150°F (–40/66°C)	.12 psi
(halocarbon)	–40/150°F (–40/66°C)	–40/200°F (–40/93°C)	–40/150°F (–40/66°C)	.12 psi

Note: Other than discoloration of the dial and hardening of the gasketing that may occur as ambient or process temperatures exceeds 150°F, non-liquid-filled gauges with standard glass windows, can withstand continuous operating temperatures up to 250°F (121°C). Liquid-filled gauges can withstand 200°F (93°C) but glycerin fill and acrylic window will tend to yellow. Accuracy at temperatures above or below the reference ambient temperature of 68°F will be affected by approximately .4% per 25°F. Gauges with welded joints will withstand 750°F (450°F (232°C) with silver brazed joints) for short times without rupture, although other parts of the gauge will be destroyed and calibration will be lost. For continuous use and for process or ambient temperatures above 250°F (121°C), a diaphragm seal or capillary or siphon is recommended.
(1) Available for temperature below –20°F, see Production Information page ASH-PI-21B for details

1. Unscrew front threaded ring (turn CCW). Remove and discard glass window. For range spans 60 psi and under, shift pointer down scale by the amount shown in the table. With either the glass or plastic window, replace the O-ring with one furnished in the kit.
2. Remove protective paper from acrylic plastic window taking care not to scratch window. Assemble window in gauge.
3. Moisten face of threaded ring with silicone oil or silicone grease where ring bears up against window. Replace front threaded ring and tighten firmly hand tight. See instructions on reverse side for applying proper torque to ring to establish desired squeeze on O-ring seal. **(Fig. 4).**
It is important to hold gauge **rigidly,** otherwise ring lugs may be damaged during removal or assembly process.
4. From rear of gauge, remove and discard these parts: rear cover and cover gaskets from case.
Note: Disregard Step Nos. 5a and 5b if converting to hermetically sealed version.
When converting a 45-1379 with the top fill hole configuration, p/n 256A176-01 fill plug is required and must be ordered separately.
5. Filling Procedures:
a. Manual Filling Procedure: Place gauge face down on bench and **tip gauge** by blocking up front with a ⅜ inch block at the 12 o'clock dial position. Tipping of the gauge is necessary so fluid will flow into front cavity of the case. Pour in fill liquid to within about 1⁄16 inch of rear seal lip. When bubbles stop rising, front cavity is filled. Remove ⅜ inch block and pour in liquid until level is about 1⁄16 inch below rear sealing lip.
Note: An alternative method of filling is to fill the front dial cavity, adding the front window, etc., as in Step No. 3. Then fill the rear of the gauge. This method eliminates the need to tip the gauge.
b. Vacuum Pump Fill Procedure: (This procedure is recommended when filling a large number of gauges.) Place gauge face down and insert a ⅛ inch diameter tube, connected to a vacuum pump, through the 12 o'clock position hole in the rear, solid front portion of the case **(see Fig. 5).** Evacuate the air from the front dial cavity while pouring in the fill fluid through the case back. The vacuum will displace the air with fluid. When the dial cavity is solidly filled, remove the tubing and continue to pour the fill fluid to within 1⁄16 inch BELOW the O-ring channel lip.
Pre-measuring fill amount is not necessary with above methods. For reference, amount of fill is approximately 400 ml. or 14 fluid oz. (4½˝ GA.) and 455 ml. or 16 fluid oz. (6˝ GA.).
c. Note: The liquid fill level should be ⅜˝ (±⅛) as measured from the inside of the ring at the 12:00 o'clock position.
6. On lower connection gauges, assemble rear seal diaphragm to case.
For back connection gauges see instructions on reverse side. **(Fig. 2/4).**
7. For 1279:
Assemble rear cover and six self tapping screws in a criss-cross pattern and torque to 12 in lbs. (±2 in lbs.)
For 1379:
- Thread rear ring and torque to 200 in lbs
- Install stainless steel back cover using two screws. Torque screws to 14 in lbs. (±2 in lbs.)

8. Assemble throttle screw to threaded hole in socket.
Note: If system is monel (socket wrench flat stamped "PHS" or "PH") use monel throttle screw.
9. Check appropriate box on fill identification label, and peel off label back, and attach fill label to gauge case.
10. If gauge is to be repackaged:
a. Include enclosed instruction sheet inside carton.
b. Change type number on carton label to:
(1) Hermetically Sealed – 1279(*)SH.
(2) Liquid Filled – 1279(*)SL.
*Bourdon Tube System Code

Glycerin or silicone should not be used in applications involving Oxygen, Chlorine, Nitric Acid, Hydrogen Peroxide or other strong oxidizing agents, because of danger of spontaneous chemical reaction, ignition or explosion. Halocarbon should be specified. Products with this fill can be ordered from factory.

The use of fluids other than those listed in the table above (for example, Hydrocarbon-based oils) may result in leakage caused by a reaction between the fluid and the elastomeric seals. Consult the factory before filling with any other fluid.

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TYPE 1279 & 1379 SOLID FRONT DURAGAUGE®
PRESSURE GAUGE CONVERSION INSTRUCTIONS TO:

- **Convert A Standard Dry Gauge To A Liquid Filled Gauge**
- **Convert A Standard Dry Gauge To A Dry, Weatherproof IP66 Gauge**

ASHCROFT®

INSTRUCTIONS FOR USING CONE TOOL AND RING WRENCH

Garter Spring & Diaphragm Assembly (Back Connection Gauge Only)

A. Place cone tool over socket shank as shown.

B. Moisten lip of socket and outer O-ring surface with silicone oil or grease.

C. Place diaphragm with rib side facing upward over cone into case grove.
Diaphragm O-ring must be completely in socket-shank grove.

D. Place garter spring over cone as shown and slide onto diaphragm in socket grove

E. Assemble rear cover with screws per step 7.

Front Ring Assembly (All Gauges)

A. Assemble ring to case by hand to start.

B. Place ring on wrench as shown

C. Use ½˝ drive extension and torque ring to 200 in. lb

Alternate Method

A. Tighten ring snugly by hand

B. Mark case and ring.

C. Turn ring another 100 to 120 degrees (slightly less than ½ turn) using the ring wrench and ½˝ drive socket wrench or place the blunt end of a wooden or plastic dowel against a ring lug and tap with a hammer.

BACK CONNECTION ASSEMBLED GAUGE

Fig. 2

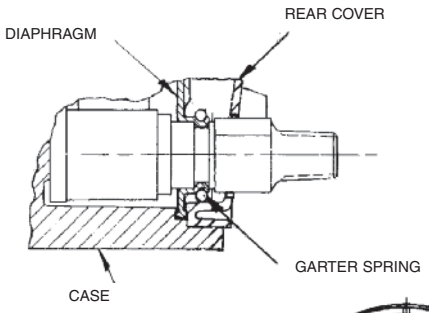


Fig. 3

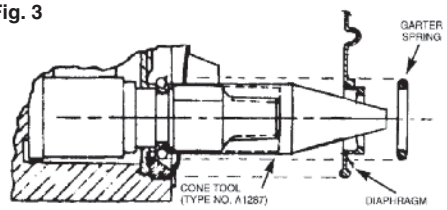
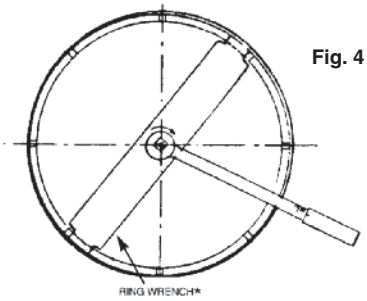


Fig. 4



INSTRUCTIONS FOR LIQUID FILLING ASHCROFT® TYPE 1279 AND 1379 SOLID FRONT DURAGAUGE® PRESSURE GAUGES USING A VACUUM PUMP

A. Insert a length of ⅛ ˝ diameter tubing through the 12 o'clock position hole in the rear, solid front portion of the case, as shown.

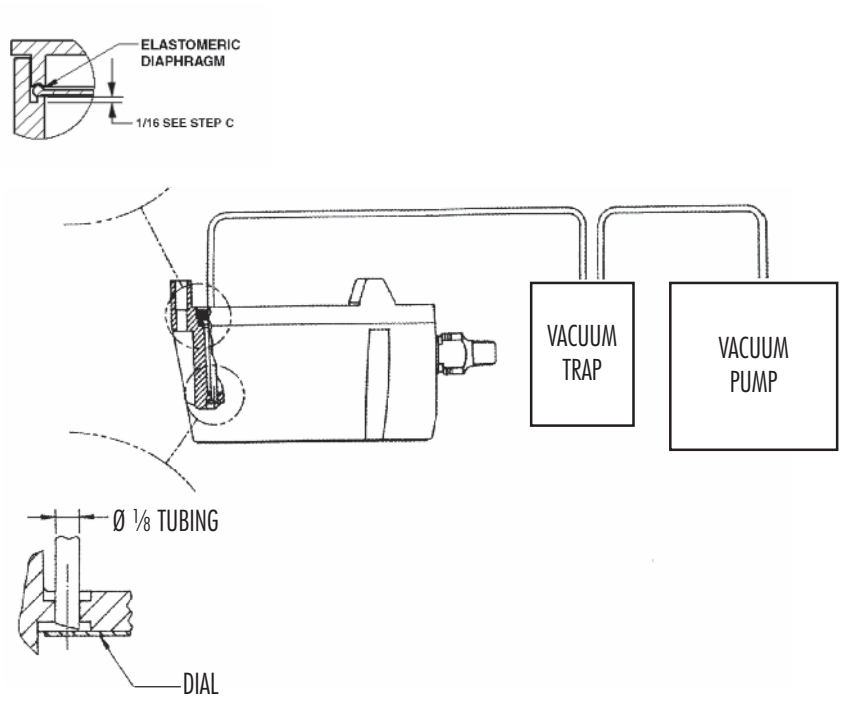
B. Evacuate the air from the front dial cavity while pouring in the fill fluid through the case back. The vacuum will displace the air with fluid.*

C. When the dial cavity is solidly filled, remove the tubing and continue to pour the fill fluid to within 1/16 ˝ below the o-ring channel lip, as shown.

D. When converting a 45-1379 with the top fill hole configuration, p/n 256A176-01 fill plug is required and must be ordered separately.

*To prevent breakage, reduce vacuum to 15 in. Hg for plain glass and safety glass.

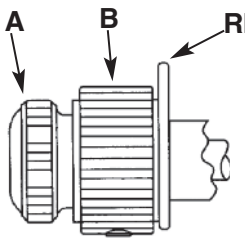
Fig. 5



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INSTRUCTIONS FOR USE OF EXTERNAL EASY ZERO™ ADJUST FEATURE*

Fig. 1



1. LOOSEN RING-LOCKING SCREW **A**.
2. OBTAIN REQUIRED ADJUSTMENT BY ROTATING KNOB **B** CLOCKWISE OR COUNTER-CLOCKWISE.
3. TIGHTEN SCREW **A** DOWN ON KNOB **B**.

*Applicable only for test gauge with hinged ring design.

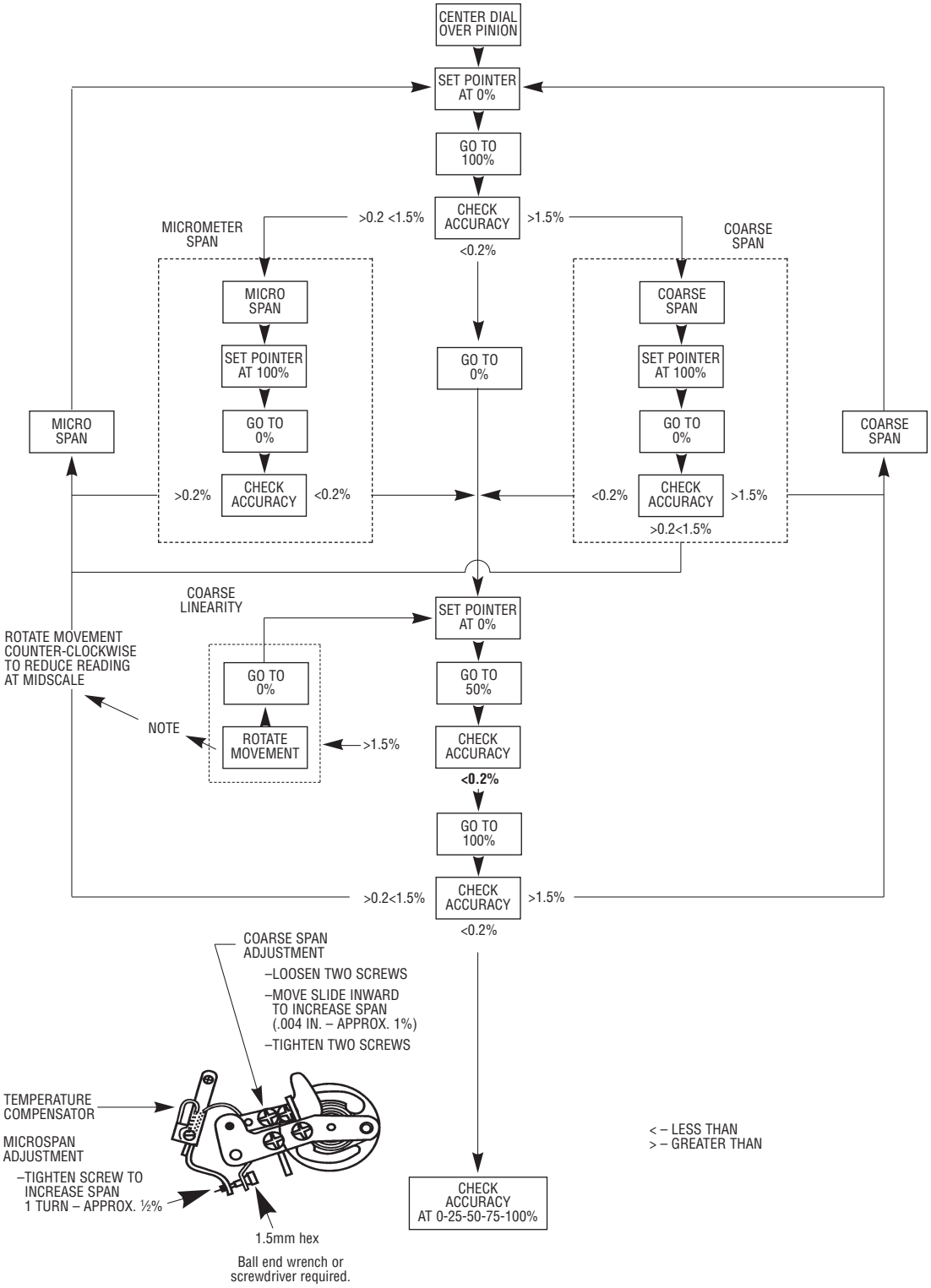
ADDITIONAL CALIBRATION INSTRUCTIONS

1) "Standards shall have nominal errors no greater than ¼ of these permitted for the gauge being tested." *(Ref: ASME B40=100-1998)*
2) The instrument used as the calibration standard should have a maximum range no greater than 2x that of the gauge being tested. (i.e. Do not use a 400psi standard to test a 15psi gauge.)
3) "Known pressure shall be applied at each test point on increasing pressure (or vacuum) from one end to the other end of the scale. At each test point the gauge shall be . . .
lightly tapped, and then read . . ."
(*Ref: ASME B40.1 ¶ 6.2.4.1*)
4) To read gauge indication, move eye over red pointer tip at OD of printed dial until red reflection in mirror band is no longer visible, and then read the pointer position in reference to the dial.

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Fig. 2

THIS TEST GAUGE IS PROVIDED WITH A MICROSPAN™ ADJUSTMENT TO SIMPLIFY CALIBRATION. THE FLOW CHART BELOW OUTLINES THE RECOMMENDED CALIBRATION PROCEDURE



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Threaded Thermowells



A thermowell provides invaluable triple duty service, by protecting your delicate temperature sensing instrumentation.

- Protects your instrument against corrosive effects and resulting physical damage caused by media flow.
- Permits instrument interchange or calibration check without disturbing or closing down the process.
- Helps to contain dangerous or costly process fluids, when properly installed as an integral part of the vessel or piping.

Basic thermowell types are threaded, flanged, socket weld, weld-in, sanitary and van stone.

Shank configurations are available in straight, stepped or tapered styles.

Extensive selection of materials are available to meet the demanding applications.

Ashcroft's wide variety of thermowells are available for light duty, high pressures, high temperatures, or high velocity applications as well as meeting many general service industry needs.

- ***One piece bar stock construction***
- ***Large selection of mill traceable materials***
- ***Stamped with material, heat number and date code***
- ***Various test reports and certifications***
- ***Wake Frequency Calculations per ASME PTC 19.3 -2010***

PRODUCT SPECIFICATIONS

Type:	Threaded
Shank Style:	Straight, Tapered, Stepped
Bore Size:	.260, .385
Process Connection:	1⁄2, 3⁄4, 1 NPT
Materials:	304 SS, 316 SS with many others available on application
Instrument Connection:	1⁄2 NPSM standard, NPT or others optional

PRODUCT OPTIONS

- Special bore diameters
- Additional process connections
- NPT threads for instrument connections
- Stamp tag numbers on thermowell
- SS tag
- Cap and chain
- Material test reports
- Wake frequency calculations

TYPICAL CODE

75	W	0750			H	T	260	C			
SIZE		U-DIMENSION	THREAD	LAGGING	SHANK	TYPE	BORE	MATERIAL	CAP & CHAIN	VARIATION	SPECIAL LAGGING LENGTH

CODE	INCHES
50	½
75	¾
10	1

CODE	INCHES
0162	1⅝
0250	2½
0450	4½
0750	7½
1050	10½
1350	13½
1650	16½
1950	19½
2250	22½

CODE	LAGGING
–	Without
L	With

CODE	TYPE
T	NPT Thd.

CODE	TYPE
AA	Brass
B	Carbon Steel
C	304
S	316

CODE	INTERNAL THD.
–	½ NPSM
2	½ NPT

CODE	SHANK
H	Tapered
S	Straight
R	Stepped

CODE	DIAMETER
260	.260
385	.385

CODE	MATERIAL
1	Brass
2	SS

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Flanged Thermowells



A thermowell provides invaluable triple duty service, by protecting your delicate temperature sensing instrumentation.

- Protects your instrument against corrosive effects and resulting physical damage caused by media flow.
- Permits instrument interchange or calibration check without disturbing or closing down the process.
- Helps to contain dangerous or costly process fluids, when properly installed as an integral part of the vessel or piping.

Flanged thermowells are appropriate for high pressure applications, typically larger pipe sizes and are designed to mate up to an existing flange. Serving to isolate and protect your temperature instrumentation.

- ***One piece bar stock construction***
- ***Large selection of mill traceable materials***
- ***Stamped with material, heat number and date code***
- ***Full penetration welds on flanged wells***
- ***Various test reports and certifications***
- ***Wake Frequency Calculations per ASME PTC 19.3 -2010***

PRODUCT SPECIFICATIONS

Type:	Flanged
Shank Style:	Straight, Tapered, Stepped
Bore Size:	.260, .385
Process Connection:	1″, 1½″, 2″ flange sizes
Flange Facing:	Raised, flat, ring joint
Rating/Class:	150#, 300#, 600# flanges
Materials:	304 SS, 316 SS with many others available on application
Instrument Connection:	½ NPSM standard, NPT or others optional

PRODUCT OPTIONS

- Special bore diameters
- Additional flange sizes
- NPT threads for instrument connections
- Stamp tag numbers on thermowell
- SS tag
- Cap and chain
- Material test reports
- Wake frequency calculations

TYPICAL CODE

15	W	0700			H	F	260	C			R	150	
SIZE		U-DIMENSION	THREAD	LAGGING	SHANK	TYPE	BORE	MATERIAL	CAP & CHAIN	VARIATION	FACING	RATING	SPECIAL LAGGING LENGTH

CODE	INCHES
10	1
15	1½
20	2

CODE	INCHES
0200	2
0400	4
0700	7
1000	10
1300	13
1600	16
2200	22

CODE	LAGGING
–	Without
L	With

CODE	TYPE
F	Flanged

CODE	TYPE
C	304
S	316

CODE	RATING #
150	150
300	300
600	600
1500	1500
2500	2500

CODE	INTERNAL THD.
–	½ NPSM
2	½ NPT

CODE	SHANK
H	Tapered
S	Straight
R	Stepped

CODE	DIAMETER
260	.260
385	.385

CODE	MATERIAL
1	Brass
2	SS

CODE	FACING
F	Flat
R	Raised
J	Ring-Joint

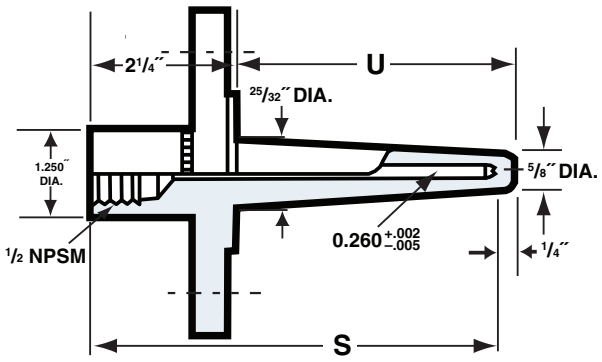
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Flanged Thermowells

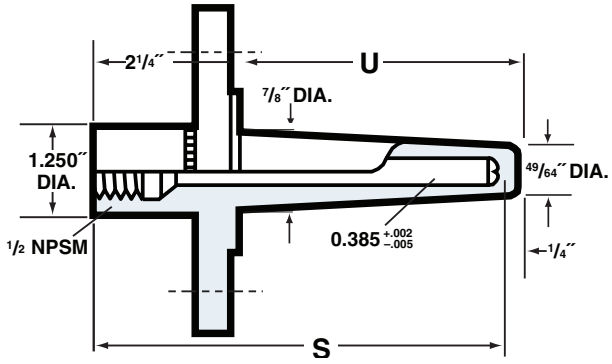
Raised Face

¼″ Nominal Bore



Raised Face

⅜″ Nominal Bore



Standard U Insertion Depth	Standard "S" Element Length
2	4
4	6
7	9
10	12
13	15
16	18
22	24

Legend:
U = Shank length under threads
S = Bore depth = instrument element lengthincluding threads

All specifications are subject to change without notice.
All sales subject to standard terms and conditions.
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email: info@ashcroft.com • www.ashcroft.com

ASHCROFT®

Thermowells

75	W	0750	____	____	H	T	260	C	____	____	____	____
Size		U-Dimesion	Thread	Lagging	Shank	Type	Bore	Material	Cap & Chain	Facing	Rating	Special Lagging Length

Code	Inches
50	½
75	¾
10	1
12	1¼
15	1½
20	2
30	3
40	4

Code	Inches
0162	1⅝
0250	2½
0450	4½
0750	7½
1050	10½
1350	13½
1650	16½
1950	19½
2250	22½

Code	Inches
–	Without
L	With

Code	Type
T	NPT Thd.
W	Weld-in
F	Flanged
V	Van Stone
S	Socket Weld
M	Limited Space Threaded
G	Ground Joint
C	Sanitary

Code	Type
AA	Brass
B	Carbon Steel
C	AISI 304
S	AISI 316

Code	Rating #
150	150
300	300
600	600
1500	1500
2500	2500

Code	Internal Thread
–	½ NPSM

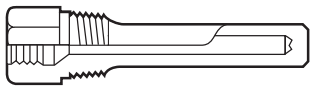
Code	Shank
H	Tapered
S	Straight
R	Stepped
B	Built-up

Code	Diameter
260	.260″
385	.385″

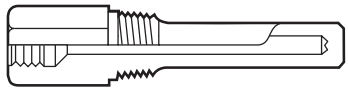
Code	Material
1	Brass
2	Stainless Steel

Code	Facing
F	Flat Face
R	Raised Face
J	Ring Joint
L	Lap Joint

Type: Straight (Uniform) Shank, Threaded
Bore Size: .385
Process Conn.: ½, ¾, 1 NPT, Wed-In
Materials: Brass, Carbon Steel
304 Stainless Steel, 316 Stainless Steel

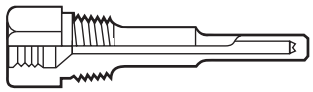


Standard Configuration

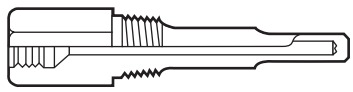


Lagging Configuration

Type: Stepped Shank, Threaded
Bore Size: .260
Process Conn.: ½, ¾, 1 NPT
Materials: Brass, Carbon Steel
304 Stainless Steel, 316 Stainless Steel

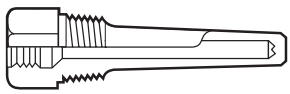


Standard Configuration

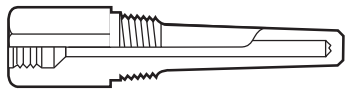


Lagging Configuration

Type: Tapered Shank, Threaded
Bore Size: .260, .385
Process Conn.: ½, ¾, 1 NPT
Materials: Brass, Carbon Steel
304 Stainless Steel, 316 Stainless Steel

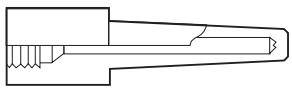


Standard Configuration

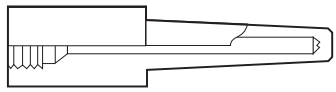


Lagging Configuration

Type: Socket Weld
Bore Size: .260, .385
Process Conn.: ¾″, 1″ Pipe Size
Materials: 304 Stainless Steel, 316 Stainless Steel, Carbon Steel

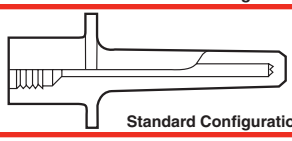


Standard Configuration



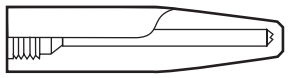
Lagging Configuration

Type: Van Stone
Bore Size: .260, .385
Process Conn.: 1,″ 1½″ Pipe Size
Materials: 304 Stainless Steel, 316 Stainless Steel



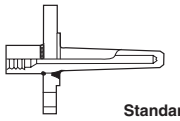
Standard Configuration

Type: Weld-in
Bore Size: .260, .385
Process Conn.: 1½″ Dia.
Materials: 304 Stainless Steel, 316 Stainless Steel



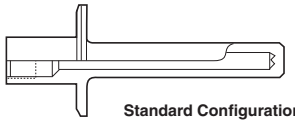
Standard Configuration

Type: Flanged
Bore Size: 260, .385
Process Conn.: 1″, 1½″, 2″ Pipe Size
Materials: 304 Stainless Steel, 316 Stainless Steel

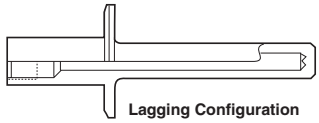


Standard Configuration

Type: Sanitary
Bore Size: .260, .385
Process Conn.: Tri-Clamp connection® 1″, 1½″, 2″
Materials: 304 Stainless Steel, 316 Stainless Steel



Standard Configuration



Lagging Configuration

Consult factory for guidance in product selection
Phone (203) 378-8281, Fax (203) 385-0499 or
visit our web site at www.ashcroft.com

Installation and Operation Manual
X-VA-MT3750C-eng
Part Number: 541B063AAG
October, 2016

Ar-Mite™ Low Flow Armored Flowmeter



Ar-Mite™ Model MT3750
Metal Tube Flowmeter
with Transmitter or Inductive Alarm



Ar-Mite™ Model MT3750
Metal Tube Flowmeter

BROOKS® INSTRUMENT

Brooks® Ar-Mite™ MT3750C

Essential Instructions
Read before proceeding!

Brooks Instrument designs, manufactures and tests its products to meet many national and international standards. These products must be properly installed, operated and maintained to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, operating and maintaining Brooks Instrument products.

- To ensure proper performance, use qualified personnel to install, operate, update, program and maintain the product.
- Read all instructions prior to installing, operating and servicing the product. If this instruction manual is not the correct manual, please see back cover for local sales office contact information. Save this instruction manual for future reference.

⚠ **WARNING: Do not operate this instrument in excess of the specifications listed in the Instruction and Operation Manual. Failure to heed this warning can result in serious personal injury and / or damage to the equipment.**

- If you do not understand any of the instructions, contact your Brooks Instrument representative for clarification.
- Follow all warnings, cautions and instructions marked on and supplied with the product.

⚠ **WARNING: Prior to installation ensure this instrument has the required approval ratings to meet local and national codes. Failure to heed this warning can result in serious personal injury and / or damage to the equipment.**

- Install your equipment as specified in the installation instructions of the appropriate instruction manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- Operation: (1) Slowly initiate flow into the system. Open process valves slowly to avoid flow surges. (2) Check for leaks around the flow meter inlet and outlet connections. If no leaks are present, bring the system up to the operating pressure.
- Please make sure that the process line pressure is removed prior to service. When replacement parts are required, ensure that qualified people use replacement parts specified by Brooks Instrument. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look-alike substitutions may result in fire, electrical hazards or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place to prevent electrical shock and personal injury, except when maintenance is being performed by qualified persons.

⚠ **WARNING: For liquid flow devices, if the inlet and outlet valves adjacent to the devices are to be closed for any reason, the devices must be completely drained. Failure to do so may result in thermal expansion of the liquid that can rupture the device and may cause personal injury.**

European Pressure Equipment Directive (PED)

All pressure equipment with an internal pressure greater than 0.5 bar (g) and a size larger than 25mm or 1" (inch) falls under the Pressure Equipment Directive (PED).

- The Specifications Section of this manual contains instructions related to the PED directive.
- Products described in this manual are in compliance with EN directive 2014/34/EU.
- All Brooks Instrument Flowmeters fall under fluid group 1.
- Products larger than 25mm or 1" (inch) are in compliance with PED category I, II or III.
- Products of 25mm or 1" (inch) or smaller are Sound Engineering Practice (SEP).

European Electromagnetic Compatibility (EMC)

The Brooks Instrument (electric/electronic) equipment bearing the CE mark has been successfully tested to the regulations of the Electro Magnetic Compatibility (EMC directive 2014/30/EU).
Special attention however is required when selecting the signal cable to be used with CE marked equipment.

Quality of the signal cable, cable glands and connectors:

Brooks Instrument supplies high quality cable(s) which meets the specifications for CE certification.
If you provide your own signal cable you should use a cable which is overall completely screened with a 100% shield.
"D" or "Circular" type connectors used should be shielded with a metal shield. If applicable, metal cable glands must be used providing cable screen clamping.
The cable screen should be connected to the metal shell or gland and shielded at both ends over 360 Degrees.
The shield should be terminated to an earth ground.
Card Edge Connectors are standard non-metallic. The cables used must be screened with 100% shield to comply with CE certification.
The shield should be terminated to an earth ground.
For pin configuration : Please refer to the enclosed Instruction Manual.

ESD (Electrostatic Discharge)

⚠ **CAUTION: This instrument contains electronic components that are susceptible to damage by static electricity. Proper handling procedures must be observed during the removal, installation or other handling of internal circuit boards or devices.**

Handling Procedure:

1. Power to unit must be removed.
2. Personnel must be grounded, via a wrist strap or other safe, suitable means before any printed circuit card or other internal device is installed, removed or adjusted.
3. Printed circuit cards must be transported in a conductive container. Boards must not be removed from protective enclosure until immediately before installation. Removed boards must immediately be placed in protective container for transport, storage or return to factory.

Comments

This instrument is not unique in its content of ESD (electrostatic discharge) sensitive components. Most modern electronic designs contain components that utilize metal oxide technology (NMOS, SMOS, etc.). Experience has proven that even small amounts of static electricity can damage or destroy these devices. Damaged components, even though they appear to function properly, exhibit early failure.

Dear Customer,

We appreciate this opportunity to service your flow measurement and control requirements with a Brooks Instrument device. Every day, flow customers all over the world turn to Brooks Instrument for solutions to their gas and liquid low-flow applications. Brooks provides an array of flow measurement and control products for various industries from biopharmaceuticals, oil and gas, fuel cell research and chemicals, to medical devices, analytical instrumentation, semiconductor manufacturing, and more.

The Brooks product you have just received is of the highest quality available, offering superior performance, reliability and value to the user. It is designed with the ever changing process conditions, accuracy requirements and hostile process environments in mind to provide you with a lifetime of dependable service.

We recommend that you read this manual in its entirety. Should you require any additional information concerning Brooks products and services, please contact your local Brooks Sales and Service Office listed on the back cover of this manual or visit www.BrooksInstrument.com

Yours sincerely,

Brooks Instrument

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1-1 Description

The Brooks® Ar-Mite™ is a reliable, low flow metal tube flowmeter with 316L stainless steel wetted parts. The magnetically coupled indicator provides a highly reliable method of indication. This model is a practical and economical approach to low flow rate indication for high pressure and difficult to handle fluids. Optional accessories include 4-20 mA output, Needle Valve, Flow Controllers and Alarms.

1-2 Specifications

⚠ WARNING

Do not operate this instrument in excess of the specifications listed below. Failure to heed this warning can result in serious personal injury and/or damage to the equipment.

⚠ CAUTION

It is the user's responsibility to select and approve all materials of construction. Careful attention to metallurgy, engineered materials and elastomeric materials is critical to safe operation.

Pressure Equipment Directive (PED) 97/23/EC
Flowmeters metnioned in this instruction manual are Sound Engineering Practice (SEP).

- Pressurized materials are manufactured in compliance with material standard ASTM.
- Applied welding method is in accordance with ASME IX / EN 287-288.
- Flowmeters are designed in accordance with ASME B31.3 and ASME B31.1
- Admissable maximum temperatures and pressure are stated further in this manual.

Table 1-1 MT3750C Specifications

Specifications	MT3750C
Measuring Range	See Capacities Table 1-2
Rangeability	10:1 (most sizes)
Metering Tube	316L (stainless steel) Monel K-500
End Fittings	316L (stainless steel) Monel K-500
Accuracy	5%, 3%, VDI/VDE class 4, 2.5
Repeatability	1% Full Scale
Scale	Silver increments with black background - Aluminum Material (52 mm long), single or dual
Connections	1/4" to 3/4"NPT Female 1/4", 6 mm tube compression
Floats	316L stainless steel Titanium Gr. II
O-rings	Viton® fluoroelastomers PTFE Teflon®, Buna-N, Kalrez® 4079 perfluoroelastomers, Ethylene Propylene
Protection Category	(Indicator only) IP64/NEMA 4X, (Alarms) IP65/NEMA 4X, (Transmitter) IP66/67/NEMA 4X
Indicator Housing & Cover	Die cast Aluminum (Alloy 380), epoxy paint, glass window
Maximum Fluid Temperature	204°C/400°F (Refer to Tables 1-4 & 1-5)
Maximum Fluid Pressure	1500 PSIG (100 Bar) 4000 PSIG (276 Bar) (No valve, 1/4" NPT only)
Meter Dimensions	Refer to Figures on Pages 1-8 thru 1-11
Pressure Equipment Directive (PED) 97/23/EC	Flowmeter complies under Sound Engineering Practices (SEP)
Inductive Alarm Switches	1 or 2 inductive switches
Reed Switches	1 or 2 switches
Transmitter	4-20 mA output
Agency Approvals	Refer to Tables 1-6 thru 1-9
Optional Equipment	Cartridge or NRS™ valves Integrally mounted flow controllers

Table 1-2 MT3750C Capacities

Meter Size	Flow Range					Viscosity Limit (3)	Pressure Drop	
	Water		Air (1, 2)					
	gph	l/h	ln/h	scfh	m^3n/h	CP	mBar	Inches WC
0	0.021-0.21	0.08-0.8	3.9-39	0.15-1.5	-	5	12	4.8
1	0.034-0.34	0.13-1.3	5.6-56	0.21-2.1	-	10	12	4.8
2	0.95-0.95	0.36-3.6	13.0-120	0.5-4.9	-	20	12	4.8
3	0.29-2.8	1.0-10	-	1.2-12	0.033-0.33	35	12	4.8
4	0.55-5.5	2.1-21	-	2.5-23	0.063-0.62	70	32	12.8
5	1.1-11	4.2-42	-	5.4-53	0.15-1.3	100	38	15.3
6	2.8-26	11-100	-	12-110	0.31-3.1	130	44	17.7

Notes:
1. Air flows in scfh converted to 70°F and 14.7 psia when the meter is operated at 70°F and 14.7 psia.
2. Air flows in m^3n/h (converted to normal conditions: 0° and 1.013 bar abs) when the meter is operated at 1.013 bar abs and 20°C.
3. When the viscosity of the fluid exceeds the viscosity immunity ceiling (VIC), a calculated correction is applied to account for the difference between factory calibration fluid and process fluid.

Table 1-3 MT3750C Pressure Ratings in PSIG (BarG)

Meter Type	Pressure Rating -58°F to 400°F / -50°C to 204°C
Standard Meter	1500 (100)
High Pressure Meter	4000 (276)

Table 1-4 MT3750C Fluid Temperature at Ambient Temperature

Max. Ambient Temperature		Max. Fluid Temperature per Option					
		Indicator		Alarm		Transmitter	
°F	°C	°F	°C	°F	°C	°F	°C
-58	-50	-58 to 400	-50 to 204	N/A	N/A	N/A	N/A
-20	-29	400	204	-20 to 250	-29 to 120	-20 to 180	-29 to 82
104	40	400	204	250	120	180	82
110	43	390	199	250	120	175	79
120	49	380	193	250	120	170	76
130	54	370	187	250	120	165	74
140	60	360	182	240	115	155	68
150	65	350	176	235	112	150	65

Notes:

1. Ambient temperature is limited to 150°F (65°C) maximum. Contact factory for ambient temperature > 150°F (65°C)

Table 1-5 MT3750C Temperature Ratings for Elastomer Materials

Elastomer Materials	Minimum Temperature		Maximum Temperature	
	°F	°C	°F	°C
Kalrez 4079	-58	-50	400	204
Viton A	5	-15	400	204
Teflon PTFE	-58	-50	400	204
Buna	-22	-30	250	120
Ethylene Propylene	-58	-50	250	120

Table 1-6 Certifications - MT3750C
(Reference Tables 1-7, 1-8 & 1-9 for Certifications with Transmitter, Reed Switch Alarm and Inductive Alarm)

Mark	Certification	Applicable Standard	Details
CE	EMC Directive 2004/108/EC	EN:61326-1:2006	EMC
	All Canadian Provinces - CRN	ASME B31.3	
PA	Pattern Approval Certificate for Measuring Instruments- Peoples Republic of China		2012-F233

1-3 Optional Equipment



Figure 1-1 Model MT3750C with Transmitter

Transmitter

The transmitter provides accurate magnet angle detection and conversion to a 4 - 20 mA industry standard output signal, based on the position of a float assembly in the flowmeter. This rugged, compact, microprocessor-driven device is capable of providing accurate flow information to your external support systems. The patented magnetic sensor with automatic gain control enables an extremely high dynamic capture range without sacrificing accuracy.

Reference Transmitter Wiring Diagram Figure 1-3

Table 1-7 Certifications - MT3750C with Transmitter

Flameproof/ Explosion-proof

Mark	Agency	Certification	Applicable Standard	Details
	ATEX	Zone 1, Zone 21 II 2 G Ex d IIC T6 II 2 D Ex tD A 21 IP66 T 85°C	EN 60079-0:2006 EN 60079-1:2004 EN 61241-0:2006 EN 61241:2004	KEMA 01ATEX2174
	IECEx	Zone 1 EX d IIC T6	IEC 60079-0:2004 IEC 60079-1:2003	KEM 06.0049
	UL	Class I, Div.1, Groups A, B, C, and D,T6 Class II, Div.1, Groups E, F, and G Class I, Zone 1 AEx d IIC T6 Ex d IIC T6	UL & CSA Standards	File E73889
	NEPSI (China)	Ex d IIC T6 Gb	GB3836.1-2010 GB3836.2-2010	GYJ11.1638X

Intrinsically Safe

	ATEX	Zone 1, Zone 21 II 2 G Ex ia IIC T6 II 2 D Ex iaD 21 IP66/IP67 T70°C II 2 D Ex tD A21 IP66/IP67 T70°C	EN 60079-0:2006 EN 60079-11:2007 EN 61241-0:2006 EN 61241-11:2006	KEMA 01ATEX1033
	IECEx	Zone 1 EX ia IIC T6	IEC 60079-0:2004 IEC 60079-11:1999	KEM 06.0037
	CSA	Class I, II, III, Div.1, Groups A, thru G, T6 Class I, Zone 1 AEx ia IIC T6 Ex ia IIC T6	UL & CSA Standards	1292059
	NEPSI (China)	Ex ia IIC T6 Gb Ex iaD 21 T70°C	GB3836.1/4-2010, IEC 61241-0:2004, GB 12476.4-2010	GYJ11.1637

Non-Incendive

	IECEx	Zone 2 Ex nA II T6	IEC 60079-0:2004 IEC 60079-15:2005	KEM 06.0037
	CSA	Class I, Div.2, Grps A, B, C, and D; Class II Grps F and G, T6 Class I, Zone 2 AEx nA II T6 Ex nA II T6	UL & CSA Standards	1292059

Flameproof, Intrinsically Safe & Non-Incendive

		Custom Union including Russia “On safety of the equipment operating under excessive pressure”	TR CU 032/2013	TC N RU Д-U.АУ04.В.05988
		Custom Union including Russia "On safety of the equipment for work in explosive environments"	TR CU 012/2011 (TR CU Ex)	RU C-HU.ГБ08.В.00741

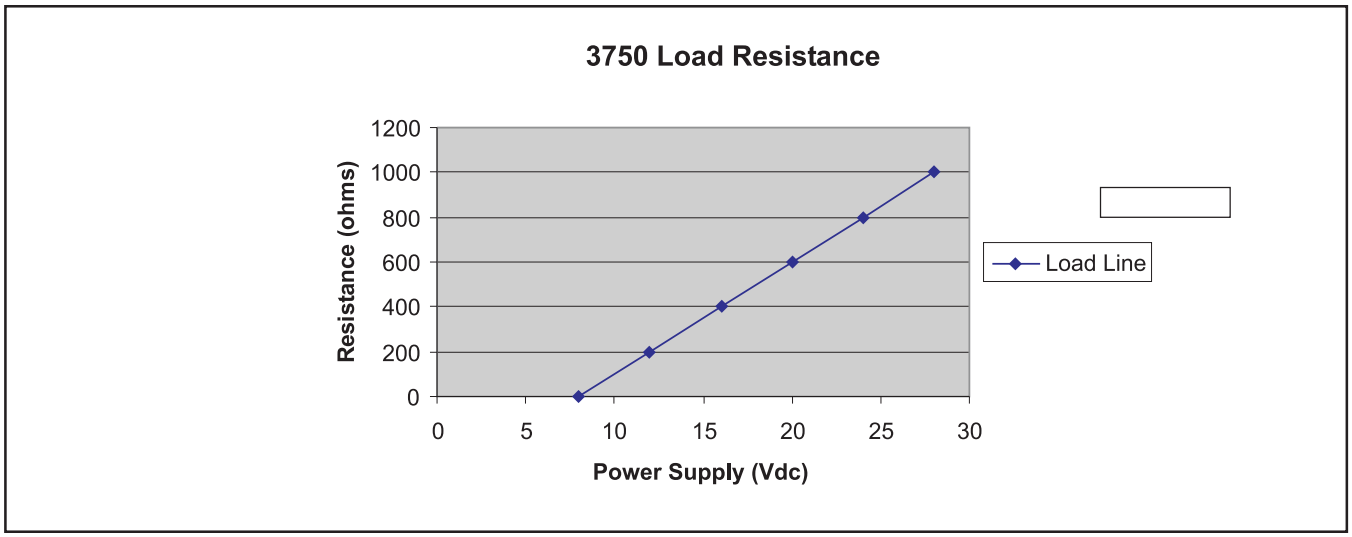


Figure 1-2 Power Supply vs. Maximum Load Resistance

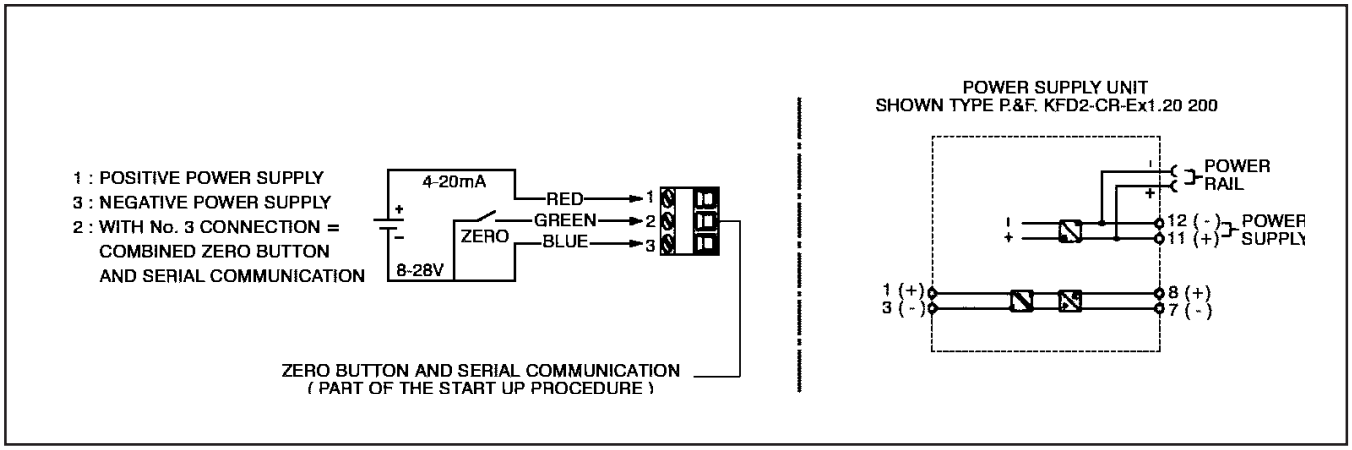


Figure 1-3 Transmitter Wiring Diagram

⚠ CAUTION

The transmitter is typically used with a 2 wire loop analog signal. Under normal conditions, the transmitter must always sense a static magnetic field. Failure to do this will produce an output independent of arbitrary fields like the earth's magnetic field.



Figure 1-4 Model MT3750C with Reed Switch Alarm

Reed Switch Alarm

Two reed switches are installed in the alarm housing to provide signaling or switching functions when a preset flow value has been reached. The reed switches provide high, low or dual setpoints and latched output over the full range. The switches are normally adjusted to the desired flow range in the factory. Modifications to the switch settings can be made in the field. Minimum setting distance between two switches is approximately 40% of the scale. (Reference Reed Switch Wiring Diagram Figure 1-5)

Data Reed Switch

Maximum Voltage*	175 Vdc, 124 Vac
Maximum Current*	250 mA
Maximum Contact Rating*	3 Watts

(*Maximum Switch Specifications)

Electrical Classification

Non Incendive:

Maximum Voltage	30 Vdc
Maximum Current	100 mA
Maximum Contact Rating	3 Watts

Table 1-8 Certifications - MT3750C With Reed Switch Alarm

Mark	Agency	Certification	Applicable Standard	Details
C SP US	CSA	Intrinsically Safe Class I, Div 1, Groups A, B, C and D; Class II, Groups E, F and G; Class III; Encl Type 4X	UL & CSA Standards	1788748
		Non-Incendive Class I, Div 2, Groups A, B, C and D; Class II, Groups E, F and G; Class III; Encl Type 4X	UL & CSA Standards	1788748

Intrinsically Safe: Entity Parameters, Vmax=30Vdc, Imax=100mA, Ci=0, Li=0

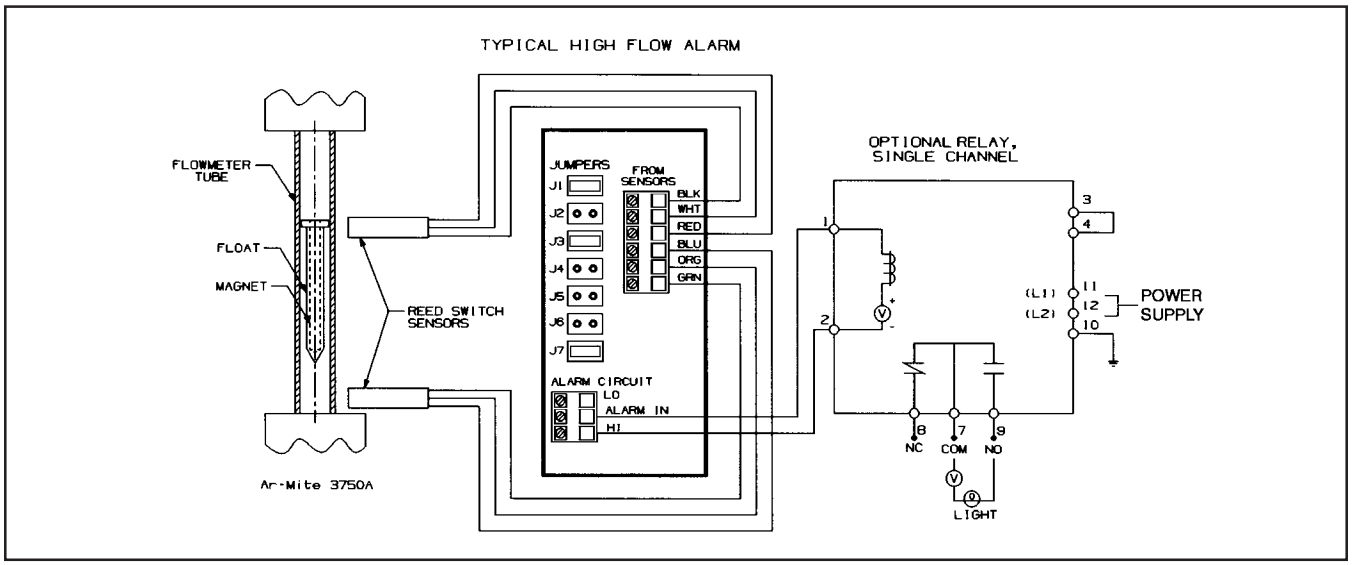


Figure 1-5 Reed Switch Wiring Diagram



Figure 1-6 Model MT3750C with Inductive Alarm

Limit Switches - Inductive Alarm Switch

One or two electronic limit switches type SJ2-N can be installed in the indicator housing to allow initiation of signaling or switching functions on a preset flow value being reached. The SJ2-N limit switch operates as a slot initiator that is inductively actuated by a cam mounted to the pointer. Any flow value can be used for setting the limit value by sliding the switch along the slot in the mounting plate for the initiators. Minimum setting distance between two limit switches is approximately 50% of the scale range.

Power supply	**8 Vdc (Max. 15.5 Vdc)**
Current consumption	active area clear: > 3 mA
Current consumption	active area obscured: < 1 mA
Self inductance	29 µH
Self capacitance	20 nF
Max Temp	158°F (70°C)

The flow valve can be used for setting the limit value by sliding the switch along the slot in the mounting plate for the initiators. Minimum setting distance between two limit switches is approximately 50% of the scale range.

Table 1-9 Certifications - MT3750C With Inductive Alarm

Intrinsically Safe

Mark	Agency	Certification	Applicable Standard	Details
	ATEX	Zone 1, Zone 21 II 2 G Ex ia IIC T6 II 2 D Ex ia D 21 IP65 T75°C	EN 60079-0:2006 EN 60079-11:2007 EN 61241-0:2006 EN 61241-11:2006	KEMA 02ATEX1126
	IECEx	Zone 1, Zone 21 Ex ia IIC T6 Gb Ex ia IIIC T 75°C Db IP65	IEC 60079-0:2007-10 IEC 60079-11:2006 IEC 61241-11:2005	IECEx KEM 09.0046
	CSA	Class I, II, III, Div.1, Groups A thru G, T6 Class I, Zone 0, Zone 1 AEx ia IIC, T6 Ex ia IIC T6	UL & CSA Standards	1379260
	NEPSI (China)	Ex ia IIC T6 Gb	GB3836.1-2010 GB3836.4-2010	GYJ11.1639

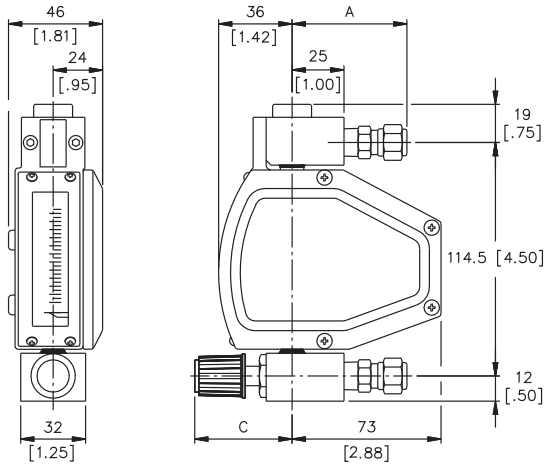
Non-Incendive

	CSA	Class I, II, III, Div. 2, Groups A thru G, T6 Class I, Zone 2 AEx nA II, T6 Ex nA II T6	UL & CSA Standards	1379260
	NEPSI (China)	Ex nA IIC T6 Gc	GB3836.1:2010; GB3836.8:2003	GYJ13.1315

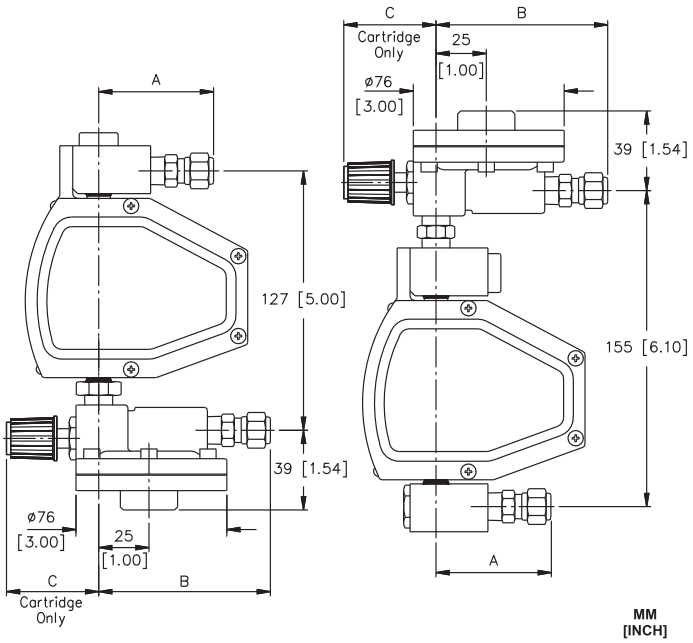
Intrinsically Safe & Non-Incendive

		Custom Union including Russia “On safety of the equipment operating under excessive pressure”	TR CU 032/2013	TC N RU Д-U.АУ04.В.05988
		Custom Union including Russia "On safety of the equipment for work in explosive environments"	TR CU 012/2011 (TR CU Ex)	RU C-HU.ГБ08.В.00741

MT3750 STANDARD CONNECTION



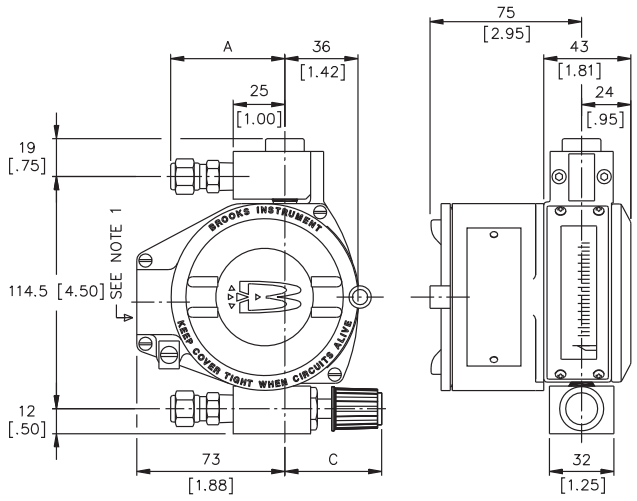
MT3750 WITH 8800 SERIES **MT3750 WITH 8900 SERIES**



	1/4" NPT–F	1/4" Rc–F	1/4" TB CPR.	6mm TB CPR.	1/2" NPT–F	3/4" NPT–F	DIM. C valve open
DIM. A	25 [1,00]	52 [2,05]	56 [2,20]	56 [2,20]	71 [2.79]	73 [2.87]	Cartridge II 46 [1,81]
DIM. B	53 [2,09]	80 [3,15]	84 [3,30]	84 [3,30]	99 [3.89]	101 [3.97]	N.R.S. 59 [2,32]

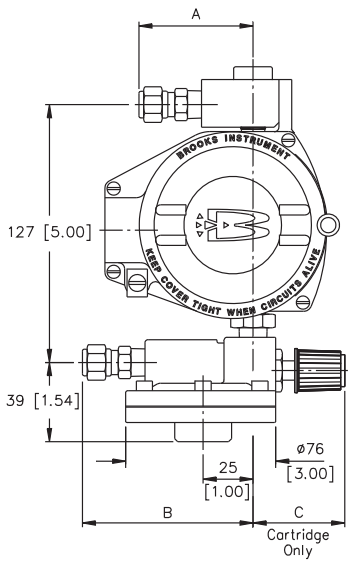
Figure 1-7 Dimensions for MT3750C Threaded Connections Metal Tube Flowmeter with Indicator

MT3750 STANDARD CONNECTION

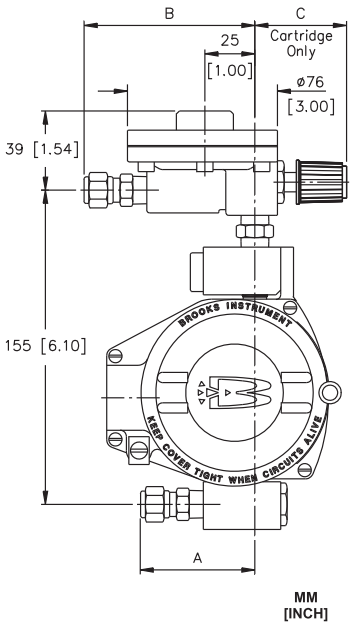


NOTE 1:
CONDUIT CONNECTION M20x1,5 ISO
OR ½"NPT F

MT3750 WITH 8800 SERIES



MT3750 WITH 8900 SERIES

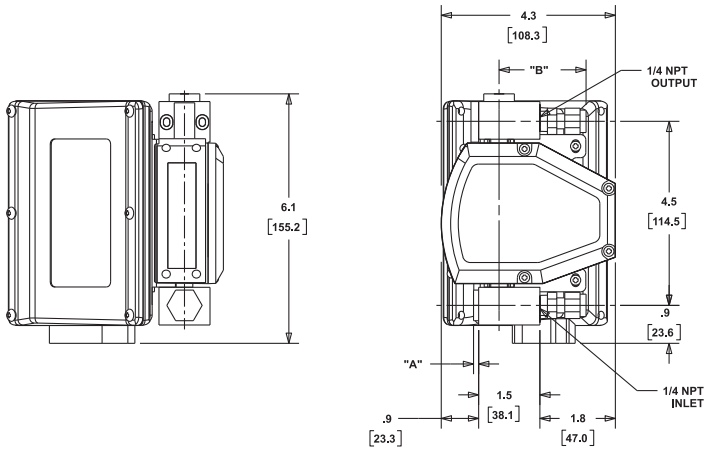


MM
[INCH]

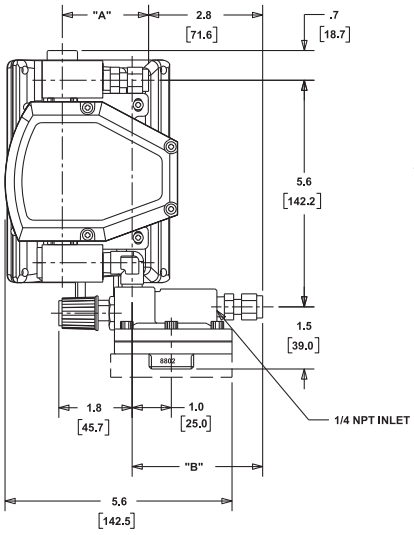
	1/4" NPT-F	1/4" Rc-F	1/4" TB CPR.	6mm TB CPR.	1/2" NPT-F	3/4" NPT-F	DIM. C valve open	Dimension D
DIM. A	25 [1,00]	52 [2,05]	56 [2,20]	56 [2,20]	71 [2.79]	73 [2.87]	Cartridge II 46 [1,81]	8800 series 125 [4,92]
DIM. B	53 [2,09]	80 [3,15]	84 [3,30]	84 [3,30]	99 [3.89]	101 [3.97]	N.R.S. 59 [2,32]	8900 series 150 [5,90]

Figure 1-8 Dimensions for MT3750C Threaded Connections with Transmitter or Inductive Alarm

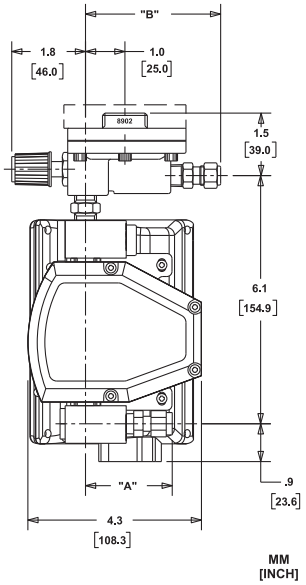
MT3750 STANDARD CONNECTION



MT3750 WITH 8800 SERIES



MT3750 WITH 8900 SERIES



	1/4"NPT-F	1/4" Rc-F	1/4" TB CMPR.	1/2" NPT-F	3/4" NPT-F	6mm TB CMPRS.	DIM C Valve open	
DIM A	1.0 [25.0]	2.0 [50.8]	2.2 [55.9]	2.8 [71.1]	2.9 [73.7]	2.2 [55.9]	CARTRIDGE 1.3 [3.3]	PLUG .1 [3.0]
DIM B	2.1 [53.3]	3.2 [81.3]	3.3 [83.8]	3.9 [99.1]	4.0 [101.6]	3.3 [83.8]	NRS 2.2 [55.9]	

 Figure 1-9 Dimensions for MT3750C Threaded Connections with Reed Switch Alarm

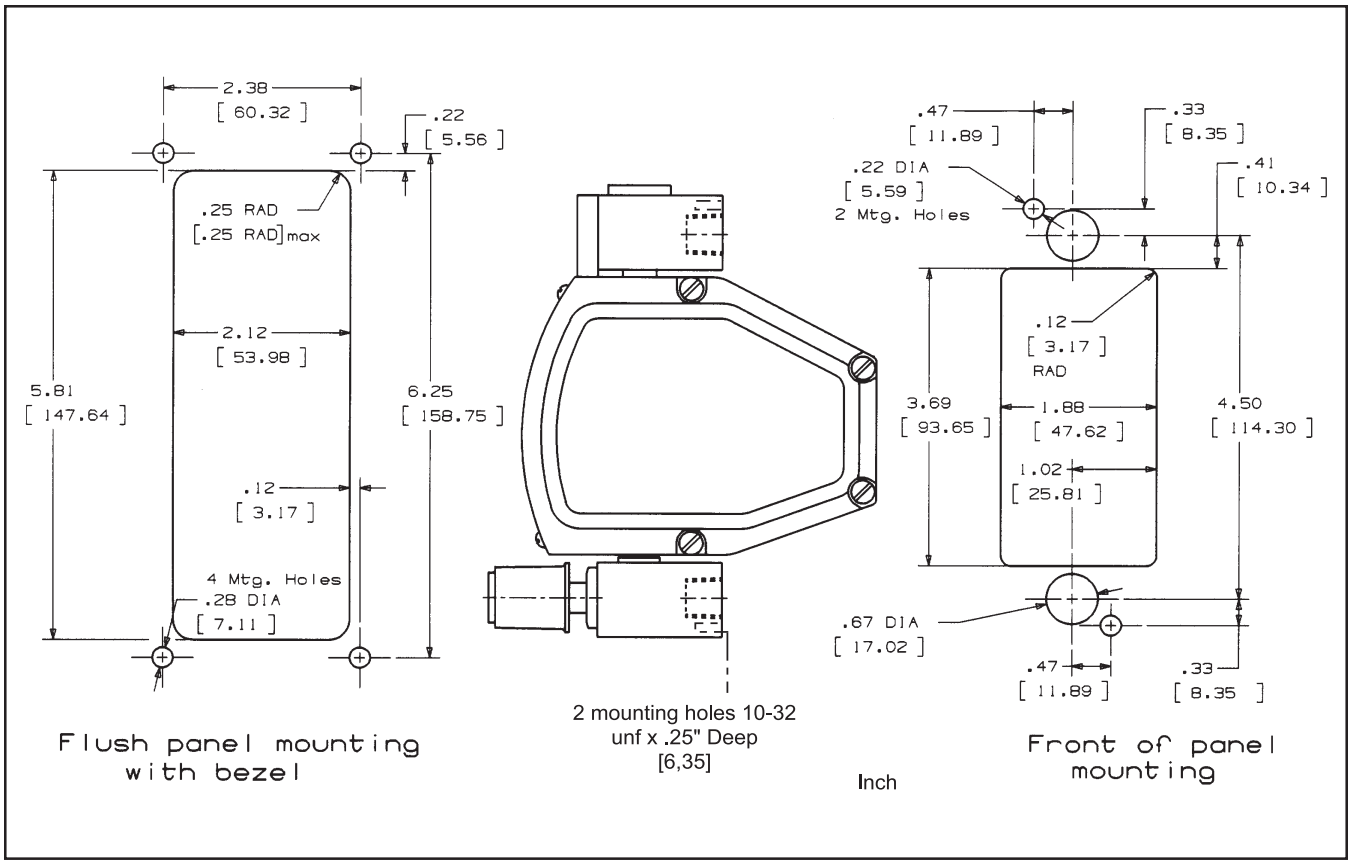


Figure 1-10 Dimensions for MT3750C Panel Mounting

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2-1 General

This section contains the procedures for the receipt and installation of the instrument. Do not attempt to start the system until the instrument has been permanently installed. It is extremely important that the start-up procedures be followed in the exact sequence presented.

2-2 Receipt of Equipment

When the instrument is received, the outside packing case should be checked for damage incurred during shipment. If the packing case is damaged, the local carrier should be notified at once regarding his liability. A report should be submitted to your nearest Product Service Department.

Brooks Instrument
407 W. Vine Street
P.O. Box 903
Hatfield, PA 19440 USA
Toll Free (888) 554 FLOW (3569)
Tel (215) 362 3700
Fax (215) 362 3745
E-mail: BrooksAm@BrooksInstrument.com
www.BrooksInstrument.com

Brooks Instrument
Neonstraat 3
6718 WX Ede, Netherlands
P.O. Box 428
6710 BK Ede, Netherlands
Tel +31 (0) 318 549 300
Fax +31 (0) 318 549 309
E-mail: BrooksEu@BrooksInstrument.com

Brooks Instrument
ITW Japan Ltd.
1-4-4 Kitasuna Koto-Ku
Tokyo, 136-0073 Japan
Tel +81 (0) 3 5633 7100
Fax +81 (0) 3 5633 7101
Email: Sales-Japan@BrooksInstrument.com

Remove the envelope containing the packing list. Carefully remove the instrument from the packing case. Make sure spare parts are not discarded with the packing materials. Inspect for damaged or missing parts.

2-3 Recommended Storage Practice

If intermediate or long-term storage of equipment is required, it is recommended that the equipment be stored in accordance with the following:

a. Within the original shipping container.
b. Stored in a sheltered area, preferably a warm, dry, heated warehouse.
c. Ambient temperature of 70° F (21° C) nominal, 109° F (43° C) maximum, 45° F (7° C) minimum.
d. Relative humidity 45% nominal, 60% maximum, 25% minimum. Upon removal from storage a visual inspection should be conducted to verify the condition of equipment is "as received".

2-4 Return Shipment

Prior to returning any instrument to the factory, contact your nearest Brooks location for a Return Materials Authorization Number (RMA#). This can be obtained from one of the following locations:

Brooks Instrument
407 W. Vine Street
P.O. Box 903
Hatfield, PA 19440 USA
Toll Free (888) 554 FLOW (3569)
Tel (215) 362 3700
Fax (215) 362 3745
E-mail: BrooksAm@BrooksInstrument.com
www.BrooksInstrument.com

Brooks Instrument
Neonstraat 3
6718 WX Ede, Netherlands
P.O. Box 428
6710 BK Ede, Netherlands
Tel +31 (0) 318 549 300
Fax +31 (0) 318 549 309
E-mail: BrooksEu@BrooksInstrument.com

Brooks Instrument
ITW Japan Ltd.
1-4-4 Kitasuna Koto-Ku
Tokyo, 136-0073 Japan
Tel +81 (0) 3 5633 7100
Fax +81 (0) 3 5633 7101
Email: Sales-Japan@BrooksInstrument.com

Instrument must have been purged in accordance with the following:

⚠ WARNING

If the inlet and outlet valves adjacent to the indicator are to be closed for any reason, the indicator must be completely drained. Failure to do so may result in thermal expansion of the liquid which can rupture the meter and cause possible personal injury.

All flow instruments returned to Brooks requires completion of Form RPR003-1, Brooks Instrument Decontamination Statement, along with a Material Safety Data Sheet (MSDS) for the fluid(s) used in the instrument. Failure to provide this information will delay processing by Brooks personnel. Copies of these forms can be downloaded from the Brooks website www.BrooksInstrument.com or are available from any Brooks Instrument location listed above.

2-5 Transit Precautions

To safeguard against damage during transit, transport the instrument to the installation site in the same container used for transportation from the factory if circumstances permit.

2-6 Removal From Storage

Upon removal of the instrument from storage, a visual inspection should be conducted to verify its "as-received" condition. If the instrument has been subject to storage conditions in excess of those recommended (See Section 2-3), it should be subjected to a pneumatic pressure test in accordance with applicable vessel codes.

2-7 Installation of Flowmeter

⚠WARNING

If the inlet and outlet valves adjacent to the indicator are to be closed for any reason, the indicator must be completely drained. Failure to do so may result in thermal expansion of the liquid which can rupture the meter and cause possible personal injury.

Recommended installation for Model MT 3750C is as follows:

A. Carefully remove the covers from each end of the flowmeter.
B. Install the flowmeter with the inlet at the bottom and the outlet at the top.
C. When installing the flowmeter in the process line, follow accepted plumbing practices for flanged or threaded fittings.
D. Install the flowmeter within 5° of true vertical. Use of a level is recommended to determine the proper alignment.
E. Installation of a bypass piping arrangement is recommended, Refer to Figure 2-1. Bypass piping permits the meter to be isolated from the flow line for servicing and cleaning.

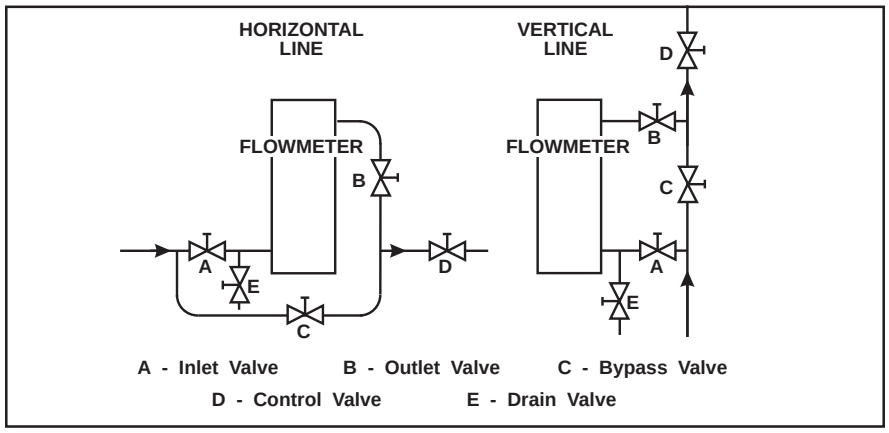


Figure 2-1 Typical Installation

GENERAL NOTE FOR ELECTRONICS:

The Electrical connections shall be made in such a way that the degree of ingress protection is maintaintained and is suitable for the installed environment. See UL 50, NEMA 250 and EN 60529. Most installations will require Type 4X or IP54 as a minimum installation.

2-8 Installation of Inductive Alarm

⚠WARNING

Proper grounding of the instrument is required to avoid shock or personal injury. A terminal for grounding is provided inside the instrument identified with the symbol ⏚ .

A. For intrinsically safe operation (recognized by a BLUE COVER), intrinsic safety barrier selection, cable parameters and power supply limits must be in accordance with the entity parameters shown on drawing.

B. If the area classification is a Division 2 or Zone 2, a barrier is not required. Note however when intrinsic safe apparatus is used without barrier, this apparatus may **NOT** be considered as intrinsically safe. This is because input protection diodes may be damaged without affecting normal operation. It is the customers' responsibility to clearly mark the apparatus when intrinsic safety is no longer valid.

C. Connect the IS Alarm as shown in Figures 2-2 and 2-3.

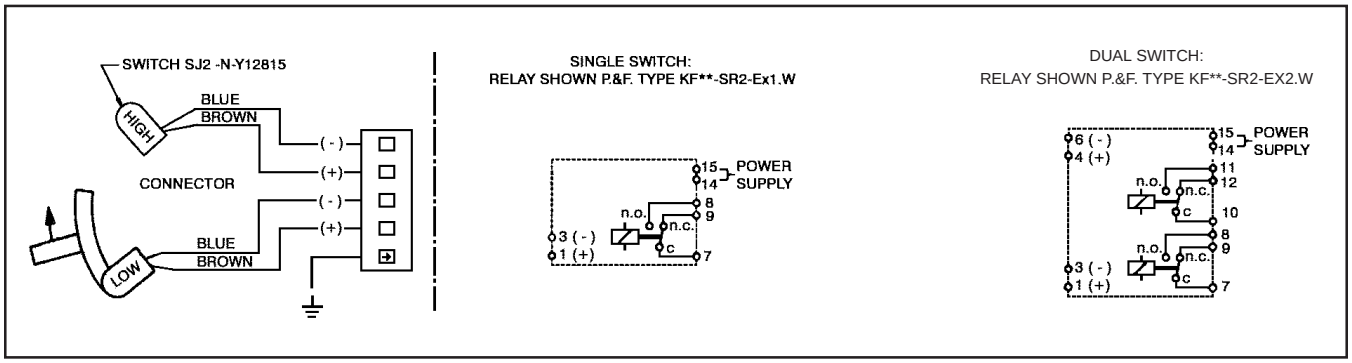


Figure 2-2 Inductive Switch Wiring Diagram

2-9 Installation of Reed Switch Alarm

⚠WARNING

Proper grounding of the instrument is required to avoid shock or personal injury. A terminal for grounding is provided inside the instrument identified with the symbol ⏚ .

⚠NOTICE

Class III Equipment: The dc main input shall be supplied from a SELV (Separated Extra-Low Voltage) source.

A. Install meter as described in Section 2-4.

⚠WARNING

High voltages may be present within the intergral alarm housing. Make no adjustments to the system while power is applied. Failure to heed warning can result in serious personal injury.

B. For Factory Mutual Approved installations and for CSA/NRTL/C Certified installations, refer to Figures 2-4 and 2-5. On the system printed circuit board is a three terminal block marked "Alarm Circuit". The middle terminal is marked "Alarm In". This terminal is common for

both high alarm and low alarm applications. A circuit is completed by connecting wires to “Alarm In” and to either “HI” for high flow alarm or “LO” for low flow alarm. Wires used should be in the range from 12 to 20 AWG. Remove 0.3 inches of insulation before inserting the wire into the terminal block and tightening the screw.
For electrical hook-up of units requiring intrinsically safe power connections, use Brooks optional power supply and relay connected as in Figure 2-6 for the integral alarm.

2-10 Installation of Transmitter

A. For intrinsically safe operation (recognized by a BLUE COVER), intrinsic safety barrier selection, cable parameters and power supply limits must be in accordance with the entity parameters shown in Figure

⚠ WARNING

Proper grounding of the instrument is required to avoid shock or personal injury. A terminal for grounding is provided inside the instrument identified with the symbol ⏚ **.**

⚠ CAUTION

Since this is a magnetically activated device, strong magnetic fields and materials with magnetic properties may cause faulty operation when in close proximity to the flowmeter. This includes steel pipes, steel conduit, motors and transformers

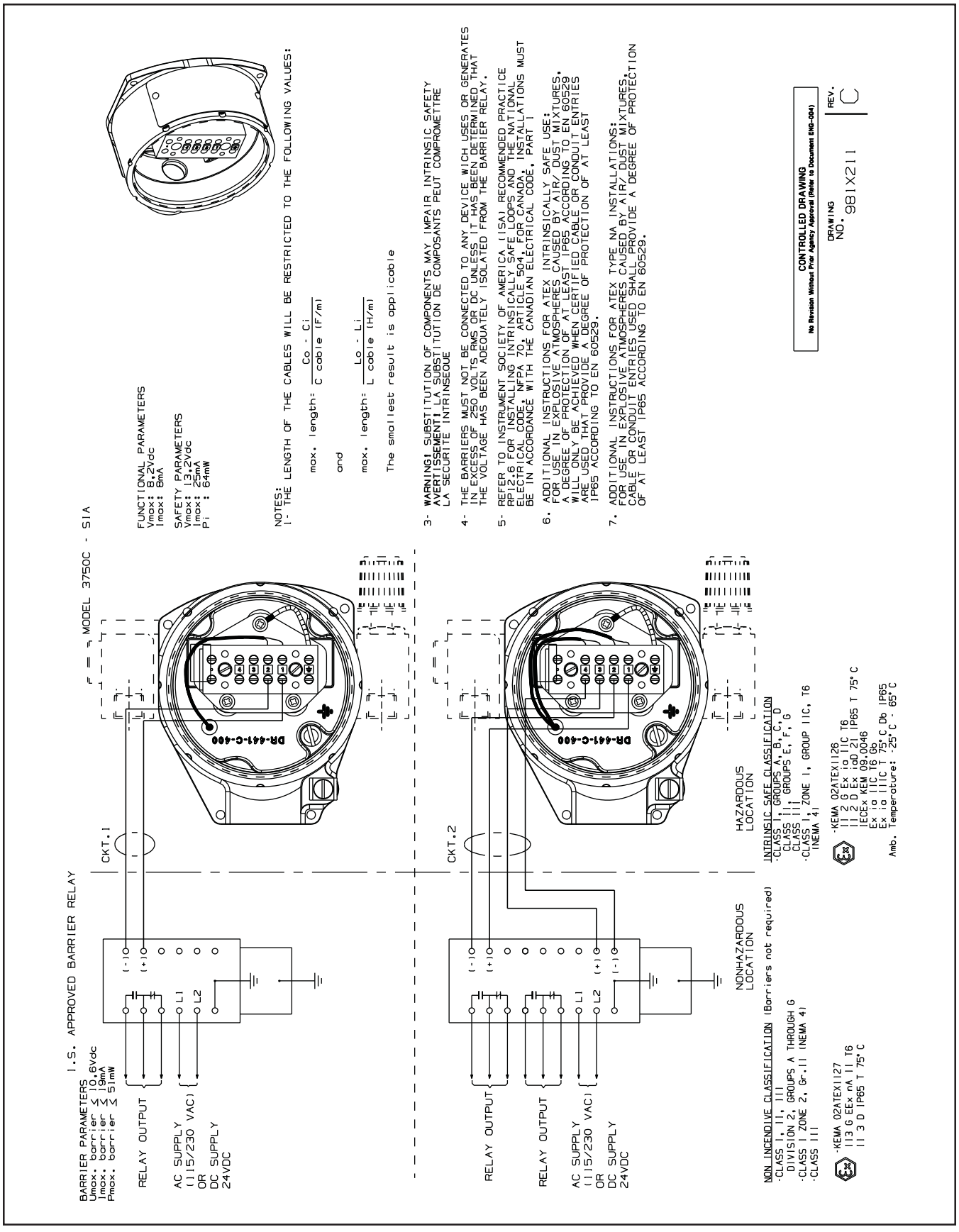
2-6. Do not connect the zero wire (keep it floating) when the transmitter is in normal operation. The zero wire is not meant to be extended as zeroing must be done locally.

B. If the area classification is Division 2 and Zone 2, a barrier is not required and cable parameters are not applicable. The electrical code will require the use of conduit for wire protection. Refer to Figure 2-7.

C. If the installation is to be protected by Division 1 and Zone 1 explosion-proof methods, explosion-proof installation methods must be followed. Refer to Figure 2-8.

D. The power supply voltage determines the maximum resistance of the loop, the associated cable and the barrier. Always be sure that the voltage on the transmitter is within the specifications.

E. After installation and powering of the loop, the transmitter must be zeroed to compensate for any stray magnetic effects in the vicinity of the transmitter. The zero function may be activated as part of a periodical maintenance check. The zero function is activated by momentary (>2 seconds) shorting the zero wire to the ground wire while power is on. Connect the transmitter as shown in Figure 2-9.



2-6 *Figure 2-3 Inductive Switch Wiring*

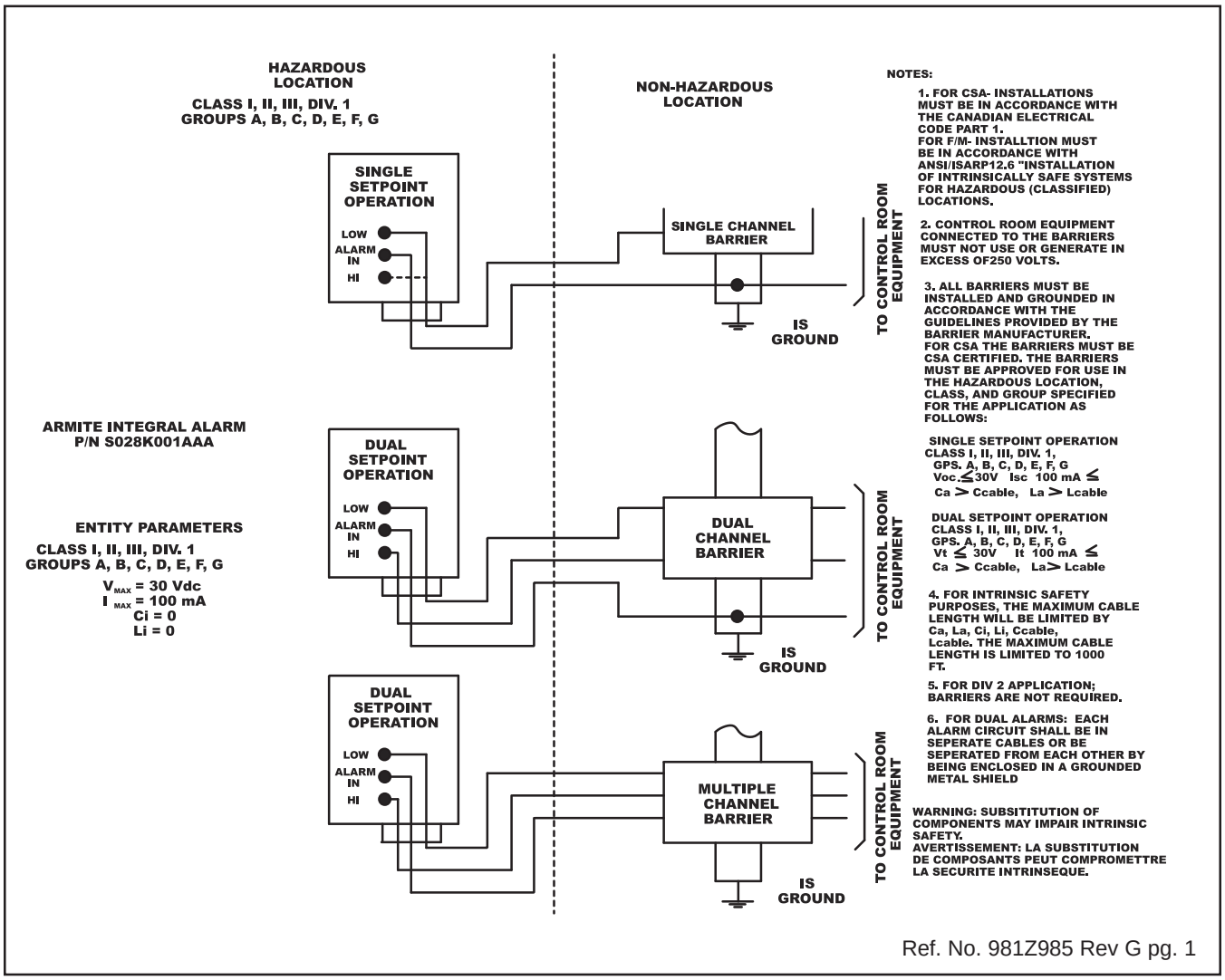


Figure 2-4 Reed Switch Alarm Installation Using IS Barriers.

⚠ NOTICE

The Brooks (electric/electronic) equipment bearing the CE mark has been successfully tested to the regulations of the Electro Magnetic Compatibility (EMC directive 2004/108/EC). Special attention is required when selecting the signal cable to be used with CE marked equipment.

Brooks supplies high quality cables which meet the specifications for CE certification. If you provide your own signal cable you should use a cable which is completely screened with a 100% shield.
D-Connectors should also be shielded using a metal cable screen clamping. The cable screen should be connected to the metal shell or gland and shielded at both ends over 360 degrees. The shield should be terminated to an earth ground.

See Essential Instructions for additional CE information.

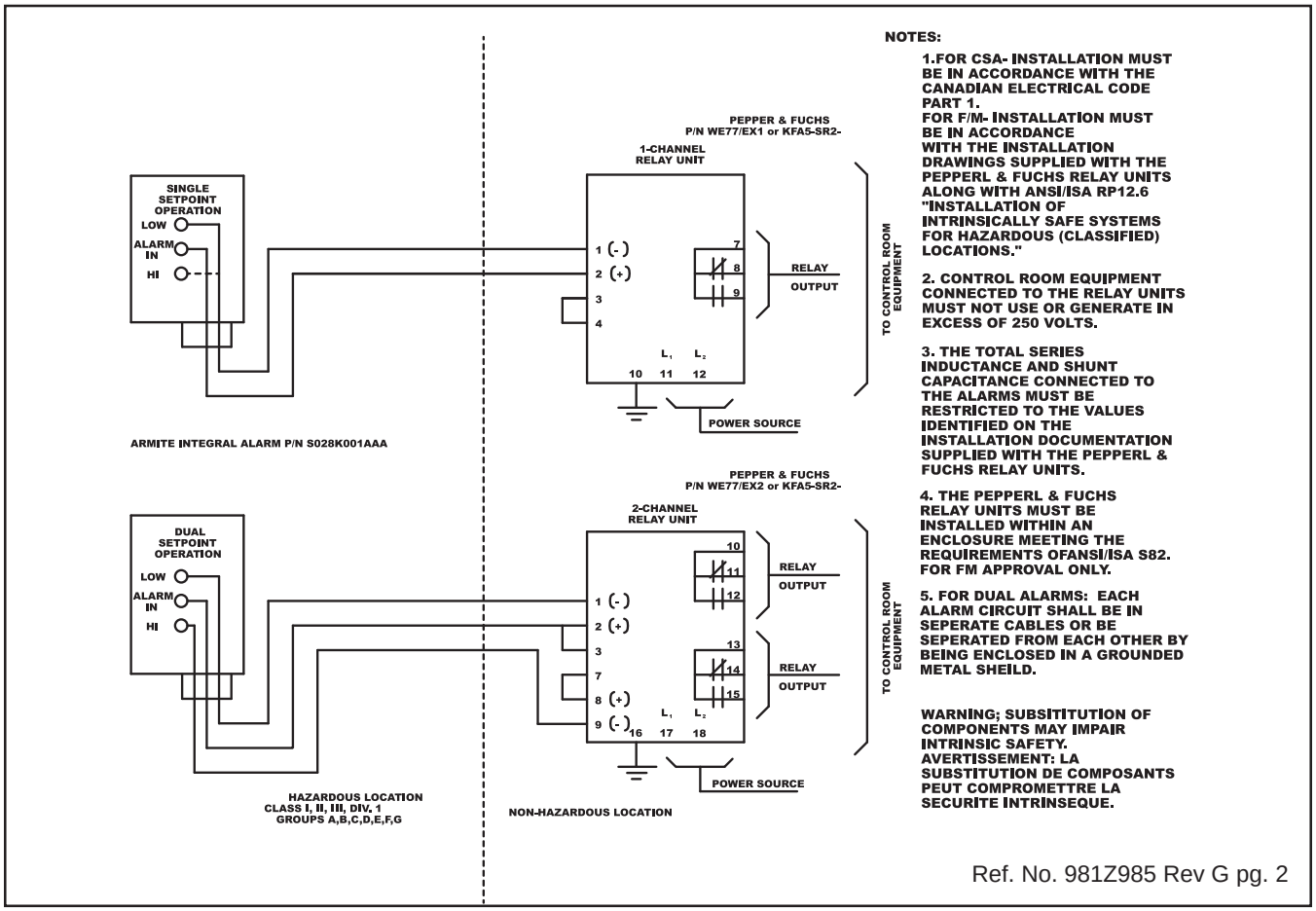


Figure 2-5 Reed Switch Alarm Installation Using P&F Relay Unit.

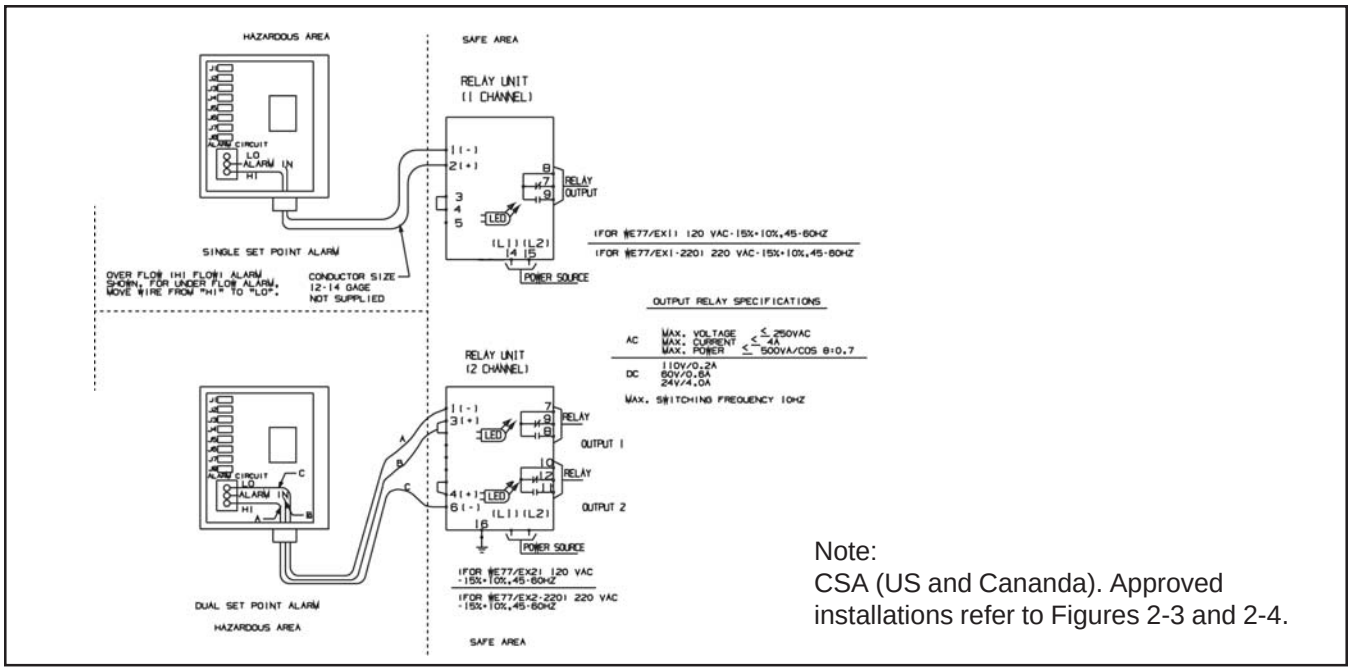


Figure 2-6 Reed Switch Alarm Wiring Using P & F Relay Unit.

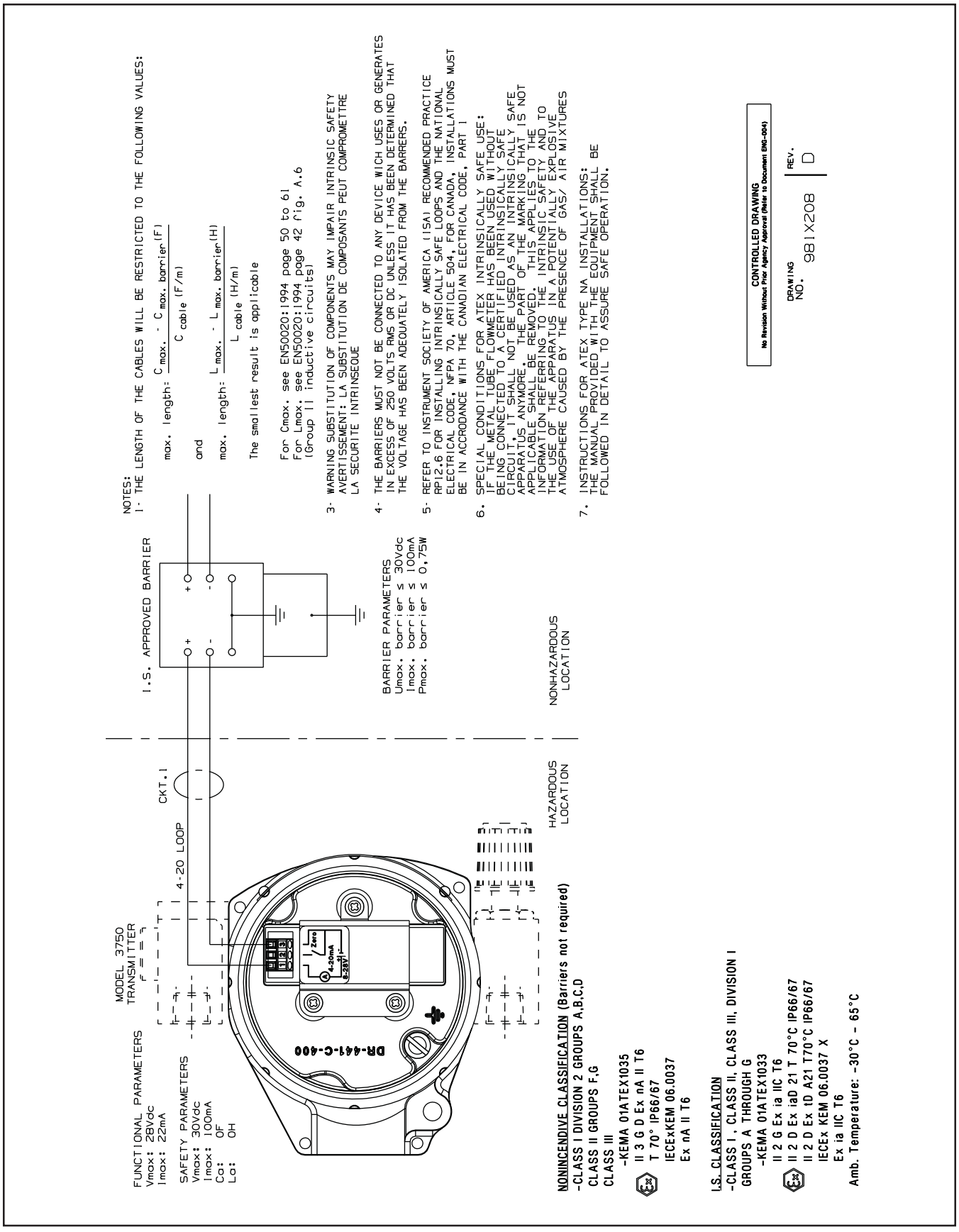


Figure 2-7 Transmitter Wiring Diagram for I.S. Systems

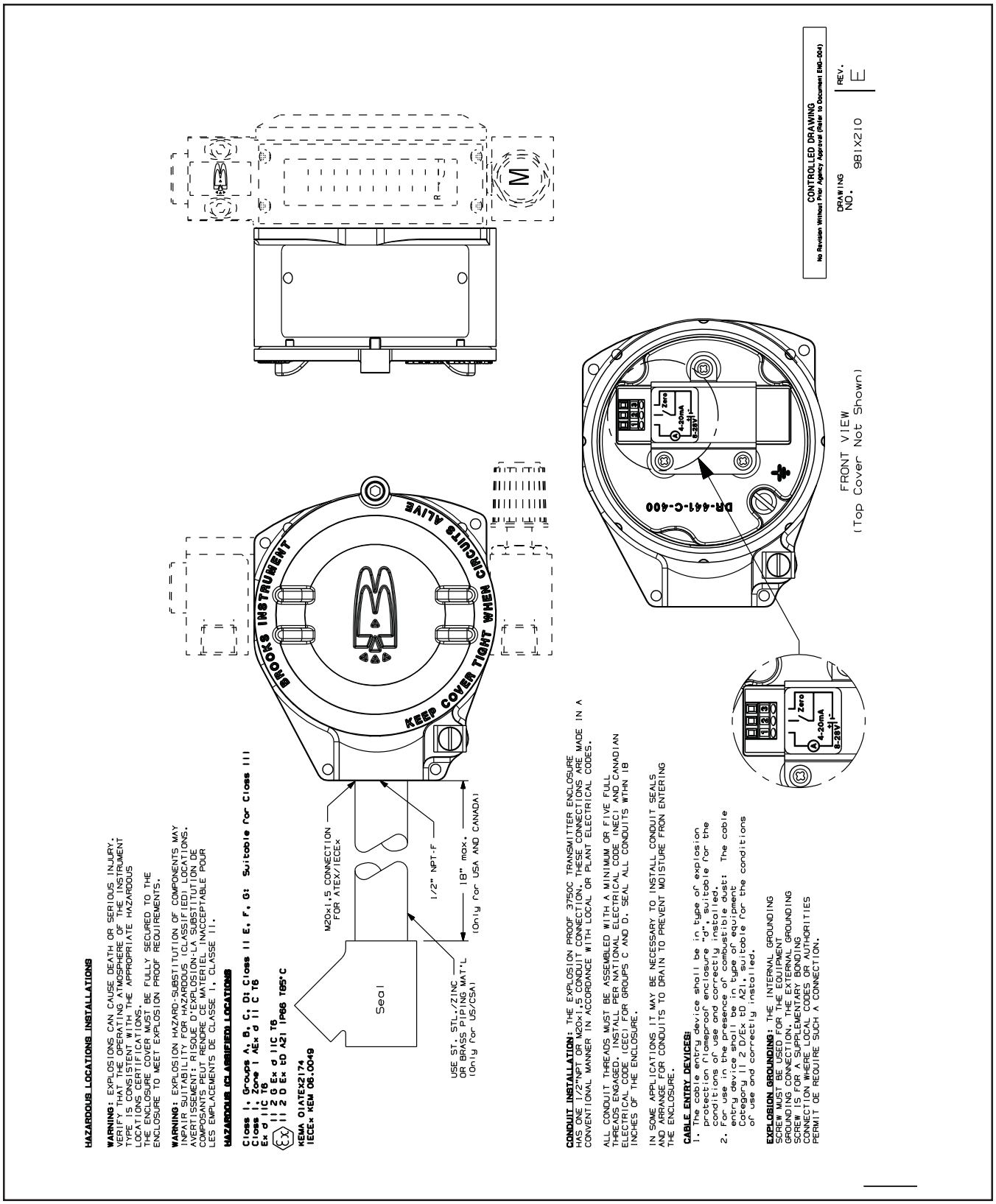


Figure 2-8 Transmitter Wiring Diagram for XP Systems

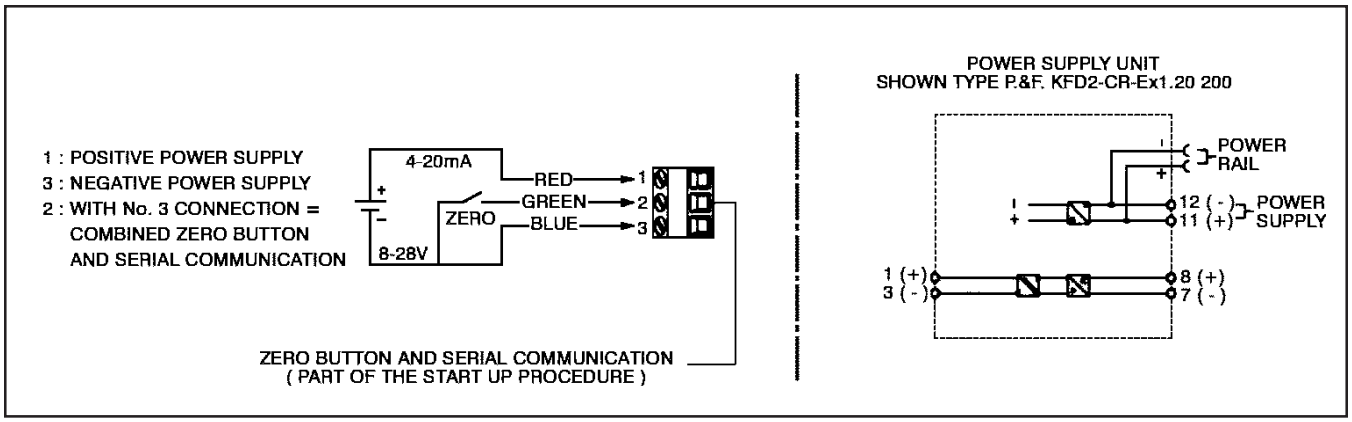


Figure 2-9 Transmitter Wiring Diagram

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3-1 Operating Procedure

After the flowmeter has been properly installed in the process, it is ready for operation. When initiating flow, slowly open the valve to avoid a flow surge.Bypass is a help in bringing the flow on smoothly. Avoid starting a pump to supply the flowmeter without the use of a valve upstream of the flowmeter.

⚠WARNING

Before operating the flowmeter, ensure all fluid connections have been properly tightened and, where applicable, all electrical connections have been properly terminated.

⚠ CAUTION

Any sudden change in system pressure may cause mechanical damage to elastomer materials. Damage can occur when there is a rapid expansion of fluid that has permeated elastomer materials. The user must take the necessary precautions to avoid such conditions.

3-2 Operation of Inductive Alarm

A. Start-up the meter as described in Section 3-1
B. To modify the alarm set points, remove the side cover of the indicator housing by removing the four screws.
C. Set the alarm position by loosening the screw mounting the switch to the plate.
D. Hold the pointer to the desired alarm flow rate.
E. Move switch assembly until the metal initiator, attached to the pointer, is not inserted into the switch.
F. Tighten the screw mounting the switch to the plate.
G. Replace the indicator housing cover and gasket and secure with the four screws.

3-3 Operation of Transmitter

A. Start-up meter as described in Section 3-1.
B. Programming is performed prior to shipment. The transmitter is preprogrammed prior to shipment for the following parameters based on the order information, meter configuration and application. If parameters are not specified in the customer purchase order, the defaults inherent to the electronics will be as shown in (parenthesis).

Pre-Programmed Parameters

Serial Number
Flow Rate units of measure (gpm)
Low Flow cutoff (5% FS flow)
Analog Output LoRange
(4 mA @ 0% flow)
Analog Output HiRange
(20 mA @ 100% flow)

3-4 Operation of Reed Switch Alarm

⚠ WARNING

High voltages may be present within the intergral alarm housing. Make no adjustments to the system while power is applied. Failure to heed warning can result in serious personal injury.

A. Start-up meter as described in Section 3-1

B. Note: The alarm flow ranges specified in Table 3-1 are for reference only. Normal variations in sensors and meter scales may cause these values to shift. If the desired performance is not achieved, adjust alarm for the next nearest flow range and repeat the operation procedure. Setting the flow rate at which the alarm activates requires placing three jumpers on the system circuit board and positioning the two sensors. These combinations are listed in Table 3-1 and in the same table inside the alarm enclosure. The letters “A” and “B” in the table refer to a scale imprinted on the sensor bracket. To accurately set the alarm, it is necessary to establish flow through the meter at a rate corresponding to the desired set-point.

As an example, set the alarm for switch closure at flow rates below 50% of rated maximum flow. Disconnect any wires which are connected to the “Alarm Circuit” terminal strip. Connect an ohmmeter or continuity tester across the printed circuit board terminals marked “Alarm In” and “LO”. Find, in the table, the row marked “Low Flow 40 - 70%”. Follow the row across to the column marked “Jumpers”. In this case, the jumpers required are J1, J4, and J6. Simply pull the jumpers out from their current positions and place them in the correct three places. Apply flow to the flow meter and adjust for 50% of rated maximum flow. Loosen the adjustment screw on the lower sensor holder and move the sensor until it reaches the lowest position possible on the sensor bracket. On the sensor holders is a white index line. Loosen the adjustment screw on the upper sensor holder and move the sensor until the index line is within the region marked “A”. Watching the ohmmeter, slowly move the upper sensor within this region until a change in continuity takes place (switch closes or opens). Tighten the adjustment screw.

Fine adjustment of the set point may be required. Adjust the flow rate and observe the behavior of the system. Adjust the upper sensor up or down slightly as required to meet your requirements for accuracy. **After establishing setpoint, operate system over entire flow range to verify desired alarm performance.**

The position of the sensors along the flow tube is the only required sensor adjustment. **Adjustment of the distance between the sensor and the wall of the flow tube is made at the factory. This setting should not be altered.**

C. Two jumper configurations allow simultaneous use of both the high and low alarm circuits. In the first of these configurations, an alarm is always active. If the flow rate is under the set point, the low alarm circuit is closed. If the flow exceeds the set point, the low alarm circuit opens and the hi alarm circuit closes. There is hysteresis associated with reed switches, so the flow rates at which the alarm switches between HI and LO will be slightly different depending on whether the flow rate is increasing or decreasing.

The second “Dual” alarm option allows separately adjusting the set points for low flow alarm and high flow alarm within a limited range of the maximum flow rate of the meter.

The dual setpoint alarm is set in the same manner as described in Section 3-4. Simply use two ohmmeters to observe the behavior of both circuits.

Table 3-1 Interior Label MT 3750 Ar-Mite Alarm.

Alarm Programming Table

Alarm Flow Range	Jumper Positions	Adjust Upper Sensor in Region (2)	Lower Sensor Position
High, 60-100%	J-2,5,7	B	Bottom of Slot
High, 40-75%	J-1,4,6	A	Bottom of Slot
High, 0-40%	J-1,3,5	B	Bottom of Slot
Low, 55-100%	J-2,3,7	B	Bottom of Slot
Low, 40-75%	J-1,4,6	A	Bottom of Slot
Low, 0-40%	J-1,5,7	B	Bottom of Slot
Dual: High, 40-75% Low, 30-60%	J-1,4,6	A	Bottom of Slot
Dual: High, 40-75% Low, 10-45%	J-1,6,8	A (High Set)	Region B (Low Set)

(1) These ranges for reference only.
(2) Final sensor position may be slightly outside of these ranges.

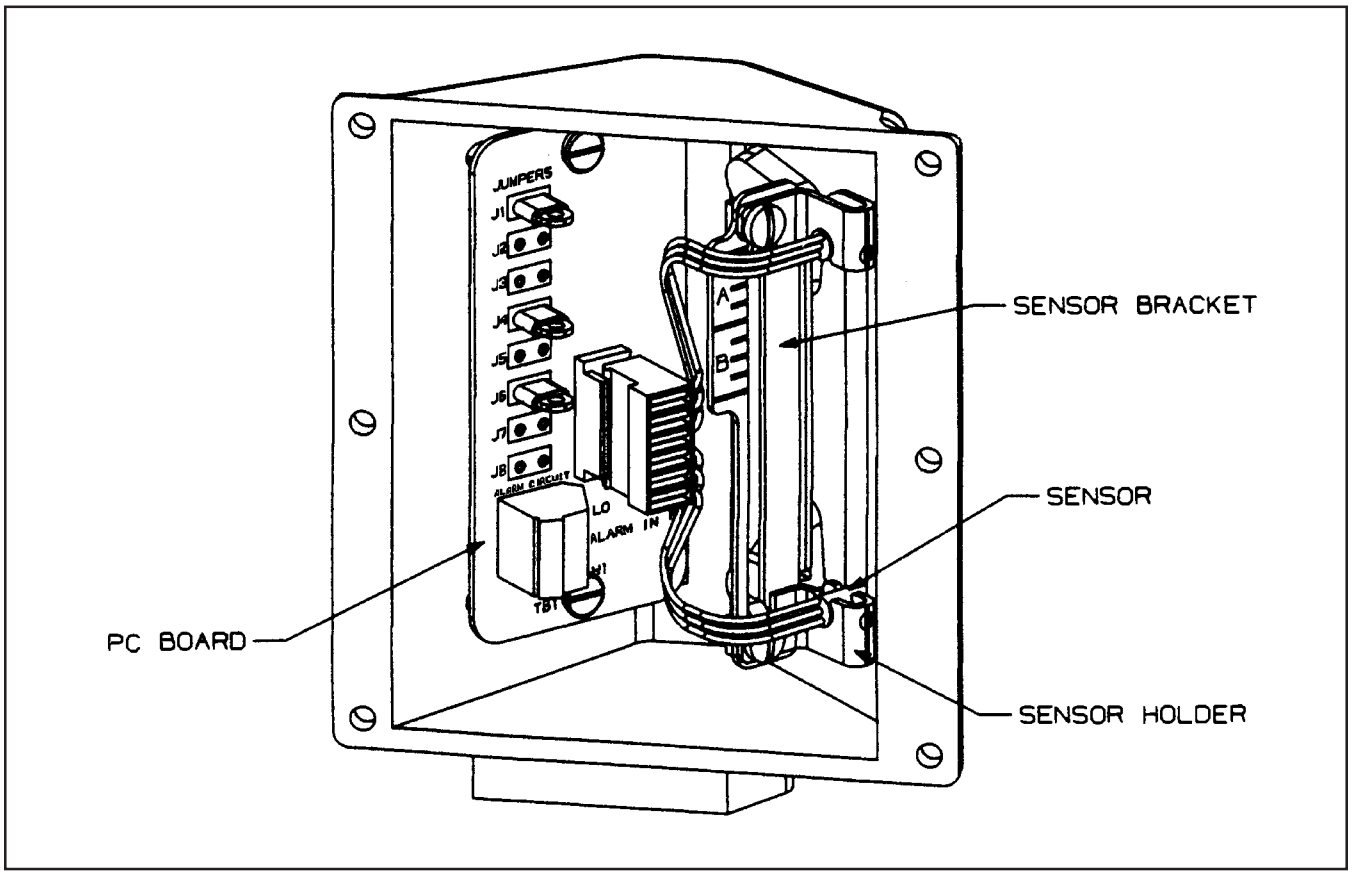


Figure 3-1 Reed Switch Alarm.

4-1 General



⚠ WARNING

METER/CONTROLLER SEAL COMPATIBILITY

Products in this manual may contain metal or elastomeric seals, gaskets, O-rings or valve seats. It is the "user's" responsibility to select materials that are compatible with their process and process conditions. Using materials that are not compatible with the process or process conditions could result in the Meter or Controller leaking process fluid outside the pressure boundary of the device, resulting in personnel injury or death.

It is recommended that the user check the Meter or Controller on a regular schedule to ensure that it is leak free as both metal and elastomeric seals, gaskets, O-rings and valve seats may change with age, exposure to process fluid, temperature, and /or pressure.

⚠ WARNING

If it becomes necessary to remove the instrument from the system, power to the device must be disconnected.

⚠ WARNING

If it becomes necessary to remove the flowmeter from the system after exposure to toxic, pyrophoric, flammable or corrosive gas, purge the flowmeter thoroughly with a dry inert gas such as Nitrogen before disconnecting the gas connections. Failure to correctly purge the flowmeter could result in fire, explosion or death. Corrosion or contamination of the flowmeter upon exposure to air, may also occur.

⚠ CAUTION

It is important that this device only be serviced by properly trained and qualified personel.

4-2 Service Information

⚠ WARNING

Should the equipment require repair, contact the nearest Brooks Sales/Service office. It is important that servicing is performed only by trained and qualified service personnel. If equipment is not properly serviced, serious personal injury and/or damage to the equipment could result.

4-3 On Site Adjustment/Calibration

The transmitter can be adjusted and/or calibrated with the help of a Windows 95/98 calibration program in combination with an applicable interface that can be plugged into any RS232 serial PC-port. The calibration data is stored in the non-volatile memory in the transmitter. After calibration the transmitter functions as a stand alone device (consult factory for more details).

PC interface is needed to calibrate the transmitter. With this interface the transmitter can be connected to the serial RS232 port of a computer. At power/start-up the transmitter is waiting (~2 seconds) for serial communication before entering normal operation. When a serial communication is established, the transmitter is instructed to sustain its low-power mode (typically 2.6 mA). In this low-power mode the transmitter is directly powered from the RS232 port without the need of an external power supply.

Software Kit (Calibration CD-ROM and RS232 Interface): partnumber: F535Y001ZZZ

5-1 General

When ordering parts, please specify:

Brooks Serial Number
Model Number
Part Description
Quantity

(Refer to Figure 5-1,and Tables 5-1, 5-2).

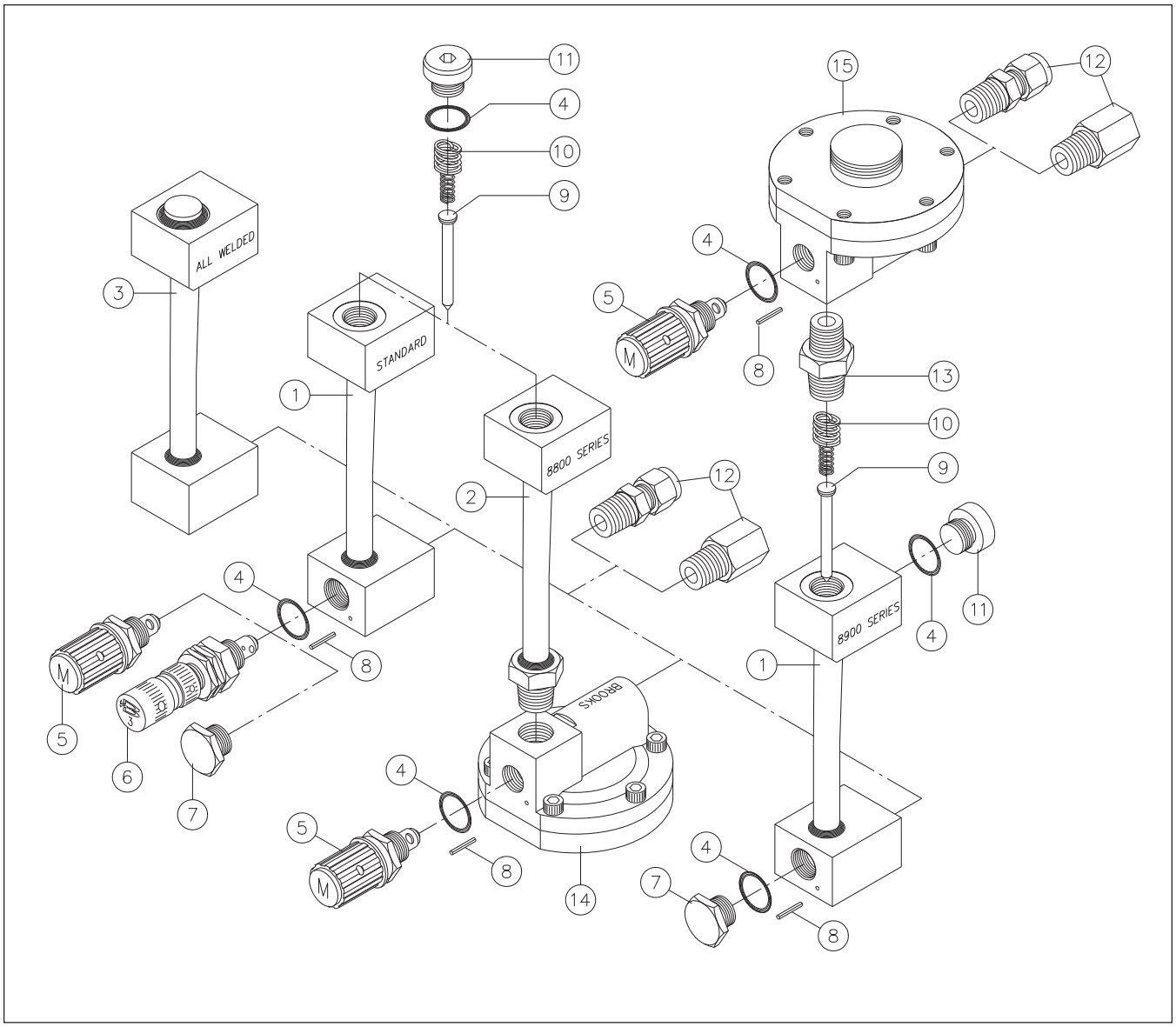


Figure 5-1 Model MT3750 Exploded View

Table 5-1 Model MT 3750 Recommended Spare Parts List (Refer to Figure 5-1)

POS.	QTY.	Description
4	2	O-ring size 015 Viton
4	2	O-ring size 015 Buna
4	2	O-ring size 015 EPDM
4	2	O-ring size 015 Teflon
5	1	Cartridge valve low flow, Viton O-rings
5	1	Cartridge valve medium flow, Viton O-rings
5	1	Cartridge valve high flow, Viton O-rings
5	1	Cartridge valve low flow, Buna O-rings
5	1	Cartridge valve medium flow, Buna O-rings
5	1	Cartridge valve high flow, Buna O-rings
5	1	Cartridge valve low flow, EPR O-rings
5	1	Cartridge valve medium flow EPR O-rings
5	1	Cartridge valve high flow EPR O-rings
5	1	Cartridge valve low flow Telfon/Kalrez O-rings
5	1	Cartridge valve medium flow Teflon/Kalrez O-rings
5	1	Cartridge valve high flow Teflon/Kalrez O-rings
6	1	NRS #3 valve, Viton O-rings
6	1	NRS #4 valve, Viton O-rings
6	1	NRS #5 valve, Viton O-rings
6	1	NRS #6 valve, Viton O-rings
6	1	NRS #7 valve, Viton O-rings
6	1	NRS #3 valve, Buna O-rings
6	1	NRS #4 valve, Buna O-rings
6	1	NRS #5 valve, Buna O-rings
6	1	NRS #6 valve, Buna O-rings
6	1	NRS #7 valve, Buna O-rings
6	1	NRS #3 valve, EPR O-rings
6	1	NRS #4 valve, EPR O-rings
6	1	NRS #5 valve, EPR O-rings
6	1	NRS #6 valve, EPR O-rings
6	1	NRS #7 valve, EPR O-rings
6	1	NRS #3 valve, Teflon/Kalrez O-rings
6	1	NRS #4 valve, Teflon/Kalrez O-rings
6	1	NRS #5 valve, Teflon/Kalrez O-rings
6	1	NRS #6 valve, Teflon/Kalrez O-rings
6	1	NRS #7 valve, Teflon/Kalrez O-rings
7	1	Inlet O-rings seal plug
8	1	Lock pin for valve/plug
9	1	Float assy Model MT 3750; #0
9	1	Float assy Model MT 3750; #1 thru 6
10	1	Outlet float stop spring
11	1	Outlet O-ring seal plug

Table 5-2 Model MT 3750 Indicator, Alarm and Transmitter Spare Parts List

QTY.	Description
1	Scale Model MT3750
1	Indicator Cover MT3750
1	KFA relay Ex 1W, 220V/50Hz Intrinsically safe
1	KFA relay Ex 2W, 220V/50Hz Intrinsically safe
1	KFA relay Ex 1W, 110V/60Hz Intrinsically safe
1	KFA relay Ex 2W, 110V/60Hz Intrinsically safe
1	KFD 2 CR Ex 1.20 200, 24 Vdc Intrinsically safe
1	KFA 6-STR-1.24.500 *****
1	Pointer assy standard indicator
1	Pointer assy for alarm
1	Sleeve Initiator
1	Indicator Cover Gasket
4	Indicator Cover Mounting screws
1	Alarm, Transmitter Cover O-ring
1	Transmitter assembly
1	Alarm, Transmitter Fixation screw
1	Reed Switch Alarm assembly

*** Note:**

Power Supply Unit 110/220 AC input to 24 Vdc output to feed KFD 2 CR Ex 1.20 200

Bulgarian

Основни инструкции
Прочетете преди работа!

Brooks Instrument проектира, произвежда и тества продуктите си по такъв начин, че те да отговарят на многобройни национални и международни стандарти. Тези оборудвания трябва правилно да се инсталират, експлоатират и поддържат за да се гарантира, че ще могат да работят съответно на техните нормални спецификации. Следващите инструкции трябва да се спазват и трябва да се включат в програмата за безопасност на труда при инсталирането, експлоатацията и поддръжката на продуктите на Brooks Instrument.

- За да се гарантира характерната производителност, инсталирането, експлоатацията, актуализирането, програмирането и поддръжката на продукта трябва да се извършват само от квалифициран персонал.
- Прочетете всички инструкции преди инсталирането, експлоатацията и поддръжката на продукта. Ако това ръководство не е съответстващото издание, вижте на задната обложка информацията за контакт с местния търговски офис. Запазете това ръководство за по-късно информиране.

⚠ ВНИМАНИЕ: Не работете с оборудването извън диапазоните, указани в инструкцията и ръководството по експлоатация. Неизпълнението на това може да доведе до сериозни телесни повреди и / или повреждане на оборудването.

- Ако не разбирате някои инструкциите, свържете се с представителя на Brooks Instrument за изясняване на проблема.
- Спазвайте всички предупреждения, призови и инструкции означени върху оборудването или доставени заедно с него.

⚠ ПРЕДУПРЕЖДЕНИЕ: Преди инсталацията се убедете, че този инструмент притежава необходимите одобрения за съответствие на местните и националните кодове. Неспазването на това предупреждение може да доведе до сериозни травми и/или повреда на оборудването.

- Инсталирайте оборудването съответно на указанията в инструкцията за инсталиране и на действащите на местни и национални предписания. Свързвайте продуктите само към подходящи източници на електричество и налягане.
- Ход: (1) Бавно въведете системата под налягане. Бавно отворете работните клапани за да се избегнат колебанията на потока. (2) Проверете дали няма изтичане при входното и изходното съединение на разходомера. Ако няма изтичане, напълнете системата до работно налягане.
- Преди извършване на поддръжката непременно проверете дали работният тръбопровод не се намира под налягане. Ако са необходими резервни части, с определените от Brooks Instrument резервни части трябва да борави само квалифициран персонал. Неразрешените части и процедури могат да окажат влияние върху работата на продукта, и също да застрашат безопасността на експлоатацията. Заместването с неоригинални части може да доведе до пожар, опасност от токов удар или неправилна работа.
- Всички врати на оборудването непременно да бъдат затворени, а защитните покрития да бъдат на мястото си, за да се избегнат токовите удари и телесните повреди, освен ако квалифицирани специалисти извършват работи по неговото поддържане.

⚠ ВНИМАНИЕ: При оборудванията с протичащи течности, ако по някаква причина е необходимо да се затворят намиращите се до оборудването изходни и входни клапани, оборудването трябва напълно да се изпразни. Неизпълнението на това може да причини топлинно разширение на течността, което може до спука оборудването и да доведе до телесни повреди.

Европейска директива за уреди под налягане (PED)

Всички съоръжения под налягане с вътрешно налягане над 0,5 bar (g) и с размер по-голям от 25 mm или 1" (inch), попадат под действието на европейската директива за уреди под налягане (PED).

- Глава „Технически данни" на настоящото ръководство съдържа свързаните с директивата PED инструкции.
- Указаните в настоящото ръководство продукти съответстват на европейската директива 2014/34/EU.
- Всички разходомери на Brooks Instrument се отнасят към флуиди от група 1.
- Продуктите по-големи от 25 mm или 1" (inch) съответстват на I, II или III категория според PED.
- Продуктите с размери 25 mm или 1" (inch), или по-малки, следват добрата инженерна практика (SEP).

Европейска директива за електромагнитна съвместимост (EMC)

Носещото знака CE (електрическо/електронно) оборудване на Brooks Instrument е изпълнило успешно тестовете за проверка на изискванията за електромагнитна съвместимост (директива EMC 2014/30/EU).
Особено внимание трябва да се обръща обаче на избирането на сигналните кабели, използвани с оборудването, носещо знака CE.
Качество на сигналните кабели, кабелните салници и съединители:
Brooks Insturment предлага висококачествени кабели, отговарящи на изискванията на CE сертификацията.
Ако използвате собствен сигнален кабел, трябва да изберете такъв, който е напълно защитен със 100%-ово екраниране.
Съединителите тип „D" или „кръгов" трябва да бъдат екранирани с метален щит. При необходимост за фиксирането на щита на кабела трябва да се използват метални кабелни салници.
Щитът на кабела трябва да се свърже с металното покритие или металния салник и в двата края да се екранира в 360°. Щитът трябва да бъде заземен.
Съединителите за печатни платки са стандартно неметални. Използваните кабели трябва да бъдат защитени със 100%-ово екраниране, за да отговарят на CE сертификацията.
Щитът трябва да бъде заземен.
Конфигурация на контактите: Виж приложената инструкция за експлоатация.

Електростатичен разряд (ESD)

⚠ ВНИМАНИЕ: Приборът съдържа електронни компоненти, които са чувствителни към статичното електричество и могат да се повредят от него. Трябва да се спазват съответните процедури по време на изваждане, слагане или друго боравене с вътрешните монтажни платки и устройства.

Процедура за работа:

1. Изключете оборудването.
2. Персоналът трябва да се заземи с гривна или друго безопасно и подходящо за целта средство, преди да инсталира, изважда или регулира монтажна платка или друго вътрешно устройство.
3. Печатните монтажни платки трябва да се транспортират в проводяща опаковка. Печатните платки могат да се изваждат от защитното покритие само непосредствено преди инсталирането. Отстранените печатни платки незабавно трябва да се сложат в защитна опаковка, служеща за транспортиране, складиране или връщане на производителя.

Забележки:
Не е уникално явление, че този прибор съдържа чувствителни към електростатичния заряд (ESD) компоненти. Болшинството от съвременните електронни прибори съдържат компоненти, изготвени по технология метал-окис (NMOS, SMOS и т.н.). Опитът доказва, че даже и малко количество статическо електричество може да повреди или съсипе тези прибори. Повредените компоненти даже ако привидно работят правилно, проявяват начални неизправности.

Czech

Základní instrukce

Před instalací si přečtěte následující instrukce!

Společnost Brooks Instrument konstruuje, vyrábí a testuje tento produkt tak, aby splnil mnoho národních a mezinárodních standardů. Přístroje musí být řádně nainstalovány, používány a udržovány tak, aby byl zajištěn jejich nepřetržitý provoz v rámci normálních technických specifikací. Musíte dodržovat následující pokyny a integrovat jejich obsah do svého bezpečnostního programu při instalování, používání a udržování produktů společnosti Brooks.

- Pro zajištění správné funkce zařízení mohou jeho instalaci, obsluhu, programování, údržbu a aktualizace firmwaru provádět výhradně kvalifikované osoby.
- Před instalací, provozem a údržbou produktu si prostudujte všechny pokyny. Pokud tato příručka není tou správnou příručkou pro dané zařízení, informujte se na zadní straně obálky o kontaktu na místní prodejní kancelář. Uchovejte si tuto příručku pro pozdější potřebu.

⚠UPOZORNĚNÍ: Neprovozujte zařízení v rozsahu mimo daný rozsah v provozní příručce. Porušení tohoto upozornění může mít za následek vážné újmy na zdraví a vést k poškození zařízení.

- Pokud některým pokynům nerozumíte, kontaktujte svého prodejního zástupce společnosti Brooks a vyžádejte si objasnění.
- Dodržujte všechny výstrahy, upozornění a pokyny, uvedené a vyznačené na produktu, nebo s ním dodané.

⚠VAROVÁNÍ: Před instalací prověřte, zda má tento přístroj požadované schválené parametry splňující místní a národní předpisy. Nedodržení tohoto varování může způsobit vážnou újmu na zdraví osob a/nebo poškození zařízení.

- Namontujte zařízení specifikovaným způsobem podle správné montážní příručky a podle platných místních a národních předpisů. Připojte všechny produkty ke správným zdrojům elektrické energie a stlačených médií.
- Postup: (1) Pomalu do systému přivádějte médium. Pro zabránění vzniku rázů v systému otvírejte procesní ventily postupně. (2) Překontrolujte těsnost vstupního a výstupního připojení průtokoměru. Pokud nezjistíte žádné netěsnosti, postupně zvedejte tlak na provozní hodnotu.
- Před prováděním servisních prací zkontrolujte, zda systém není pod tlakem. V případě potřeby výměny dílů zajistěte, aby byly použity náhradní součásti specifikované společností Brooks Instrument a výměnu prováděla kvalifikovaná osoba. Použití neschválených dílů a postupů může negativně ovlivnit efektivitu a bezpečnost procesu. Použití náhrad za originální díly může způsobit požár, úraz elektrickým proudem nebo nesprávnou funkci.
- Pokud není zrovna prováděna údržba kvalifikovanou osobou, ujistěte se, že zařízení je opatřeno všemi předepsanými kryty.

⚠UPOZORNĚNÍ: Pokud je u zařízení s průtokem kapalin nutno z jakéhokoli důvodu uzavřít vstupní a výstupní ventily, je nutné zařízení kompletně vyprázdnit. Pokud tak neučiníte, může z důvodu teplotní roztažnosti zbytků média v zařízení dojít k jeho poškození nebo k ohrožení zdraví osob.

Evropská směrnice pro tlakové zařízení (PED)

Na veškerá tlaková zařízení s vnitřním tlakem vyšším než 0,5 baru (g) a velikosti větší než 25 mm nebo 1" (palec) se vztahuje platnost směrnice o tlakovém zařízení (PED).
Kapitola „Technické údaje“ v této příručce obsahuje důležité bezpečnostní a provozní pokyny související se směrnicí PED.

- Produkty popsané v této příručce jsou v souladu se směrnicí EN 2014/34/EU.
- Všechny průtokoměry společnosti Brooks Instrument spadají do rámce Kapaliny, skupina I.
- Produkty větší než 25 mm nebo 1" (palec) jsou v souladu se směrnicí PED, kategorii I, II nebo III
- Produkty s velikostí 25 mm nebo 1" (palec) a menší spadají do rámce Správných technických postupů (SEP).

Evropská směrnice pro elektromagnetickou kompatibilitu (EMC)

Elektrické/elektronické zařízení Brooks Instrument nesoucí značku CE bylo úspěšně testováno dle předpisů pro elektromagnetickou kompatibilitu (směrnice EMC č. 2014/30/EU).
Výběru signálních kabelů pro použití se zařízením označeném CE je nutné věnovat zvláštní pozornost.
Kvalita signálních kabelů, kabelových průchodek a konektorů:
Brooks Instrument dodává vysoce jakostní kabely splňující požadavky kvalitativního zařazení CE. Pokud chcete použít vlastní signální kabely, zvolte typy s kvalitním stíněním všech žil a v celé délce trasy.
V případě použití konektorů kruhových nebo tvaru „D“, musí mít tyto kovové stínění. V případě jejich použití, musí kovové kabelové průchodky být propojeny se stíněním kabelu.
Stínění by mělo být připojené ke kovovému tělesu přístroje nebo krytu, na obou koncích kabelu a po celém jeho obvodu.
Stínění by mělo být uzemněno.
Přípojky vedoucí ke kartám podle norem jsou nekovová. Pro splnění požadavků předpisů CE musí být použité kabely kompletně stíněny.
Stínění by mělo být uzemněno.
Konfigurace kontaktů je uvedena v přiloženém návodu k obsluze.

Elektrostatický výboj (ESD)

⚠UPOZORNĚNÍ: Tento přístroj obsahuje komponenty citlivé na poškození statickou elektřinou. Při montáži, demontáži či jiné manipulaci s vnitřními elektronickými obvody je potřeba dodržovat příslušné postupy.
Postup ošetřování:

1. Odpojte přístroj od napájení.
2. Osoba provádějící údržbu má být při instalaci, vyjímání či práci na desce plošných spojů nebo jiné vnitřní elektronice uzemněna zemnícím náramkem, nebo jiným vyhovujícím způsobem.
3. Desky plošných spojů je nutné přepravovat v elektricky vodivém obalu. Plošné spoje vyjímejte z vodivého obalu až bezprostředně před instalací do přístroje! Plošné spoje vyjmuté z přístroje a určené pro další využití, opět neprodleně umístěte do ochranného obalu.

Poznámky:
Existence prvků, citlivé na elektrostatické výboje (ESD) v přístrojích je častým jevem. Prvky s technologií oxidu kovů (NMOS,SMOS) jsou používány u většiny moderních elektronických zařízení. Zkušenosti dokazují, že i jen malé elektrostatické výboje mohou poškodit nebo zničit tyto zařízení. U poškozených součástek, jakkoli zdánlivě pracujících bezchybně, dochází brzy k poruše.

Dansk

Grundlæggende vejledninger Læs disse før anvendelse!

Brooks Instruments designer, fremstiller og afprøver sine produkter således, at de tilpasser sig både de indenrigs og internationale standarder. Disse udstyr bør installeres, bruges og repareres omhyggeligt, så at de kan virke tilsvarende deres normale anvendelsesperiode. De følgende regler skal overholdes og implementeres under installeringen samt ved brug og reparation.

- For at garantere den passende kapacitet, er udstyrets installation, anvendelse, opdatering, programmering kun tilladt for kvalificeret personale. Alle vejledninger skal læses før produktets installation, anvendelse og reparation.
- Hvis denne manual ikke er den passende udgave, kontakt venligst jeres leverandør for yderligere information.
- Det anbefales at gemme denne manual for senere brug.

⚠ OBS.: Udstyret må ikke anvendes til andet end det er angivet i brugsanvisningen. Hvis denne regel brydes, kan der forekomme alvorlige personskader eller brist på udstyret.

Hvis vejledningerne ikke er forståelig, kontakt venligst Deres Brooks repræsentant for at afklare problemet som er opstået.

- Overhold alle regler, som er markeret eller leveret sammen med udstyret.

⚠ ADVARSEL! Før ibrugtagning/installation skal det kontrolleres, at det ihåndenværende instrument opfylder de lokale og nationale sikkerhedskrav. Hvis denne advarsel ignoreres, kan det resultere i alvorlig personskade og/eller skader på instrumentet.

- Installer udstyret efter den angivne installationsvejledning og gældende lovgivning for anvendelsesområde. Udstyret må kun tilsluttes med kabler og stik som overholder kravspecifikationerne i vejledningen.
- Ibrugtagning: (1) Åbn langsomt for trykket i systemet.. Åbn langsomt for alle procesventiler for at forhindre ustabil gas flow. (2) Tjek systemet for lækage ved tilsluttet måleinstrumenter, samlinger og andet tilsluttet udstyr. Derefter øg trykket i systemet indtil arbejdstrykket er opnået.
- Før reparation tjek altid at procesledningen ikke står under tryk. Hvis der er brug for at udskifte defekte dele må kun kvalificeret personale udføre arbejdet og af sikkerhedsmæssige årsager må der kun anvendes originale Brooks reservedele. Det er ikke tilladt at anvende reservedele eller udføre arbejde der på nogen måde kan ændre produktet fra dens oprindelige specifikationer. Manglende overholdelse af de foreskrevne procedurer kan resultere i brænd, og fare for elektrisk stød eller kortslutning.
- Af sikkerhedsmæssige årsager sørg for at alle sikkerhedsforanstaltninger er overholdt. Eksempelvis at alle afskærmninger eller anden form for installationsbeskyttelse er lukket eller installeret ved normal drift.

⚠ Advarsel.: Ved brug af udstyr som anvendes til væske skal det sikres at indgangsventilen og udgangsventilen ikke bliver lukket på samme tid i forbindelse med aftapning. Såfremt dette ikke overholdes, er der risiko for at væsken på grund af varmeudvikling ekspanderer og dette kan forårsage skade på udstyr og personer.

Det Europæiske direktiv for trykudstyr (PED)

På alt udstyr hvis indgangstryk er større end 0,5bar (g) og større end 25 mm eller en tomme, gælder det europæiske direktiv for trykapparater. Manualens afsnit "tekniske data" indeholder anvisninger om PED direktivet.

- I manualen angives instrumenter der er tilpasset direktiv 2014/34/EU.
- Alle Brooks gennemstrømningsmålere tilhører væskegruppe nr. 1.
- Alle instrumenter som er større end 25 mm eller en tomme beskrives i direktivet PED´s kategorier I, II eller III.
- Alle instrumenter som er på 25 mm eller en tomme, eller mindre, beskrives i Sound Engineering Practice (SEP).

Det europæiske direktiv for elektromagnetisk kompatibilitet (EMC)

Alle Brooks instrumenter (elektrisk/elektronisk) som har CE markering er godkendt og testet ifølge om elektromagnetiske kompatibilitets forskrifter (EMC direktiv 2014/30/EU).
OBS: Man skal være opmærksom på hvilken type kabler der bruges til CE mærket udstyr..

Om kvalitet af signalkabler, kabeltilslutninger og koblinger:
Brooks tilbyder kabler af højest kvalitet, som er tilpasset CEE kvalificeringens forskrifter. Hvis man vælger at bruge egne kabler, skal man vælge et kabel som har den nødvendige afskærmning for at sikre 100 % mod udefra kommende støj.
Tilslutningerne "D" eller rundformede tilslutninger skal være afskærmet med skal af metal.
Stikket skal være afskærmet på alle sider. Al afskærmning skal jordes..
Card Edge tilslutninger er ifølge standarden ikke metalliske.. De anvendte kabler og stik skal være 100 % afskærmet for at opfylde CE kravene.. De skal ligeledes jordes.
For stik konfigurationen se vedlagte brugsvejledning.

Elektrostatisk afladning (ESD)

⚠ OBS.: Udstyret indeholder tilbehør som kan skades ved elektrostatisk elektricitet. Alle forskrifter skal overholdes ved kontakt med alle elektriske komponenter både under drift og vedligeholdelse..

Behandlingsproceduren:

1. Sluk for al strømtilførsel til udstyret.
2. Personer som skal i kontakt med udstyret skal være jordet eller bære anden form for elektrisk beskyttende udstyr. Manglende overholdelse af dette kan medføre skader på alle elektriske komponenter.
3. Alle elektriske komponenter skal opbevares eller transporteres i deres originale indpakning for at sikre komponenter mod statiske elektriske skader. Emballagen må ikke åbnes før komponenten skal installeres i udstyret. Ved afslutning af vedligeholdelse/reparation af udstyret, skal udstyret installeres med det samme eller pakkes forsvarligt hvis det skal på lager eller transporteres.

Bemærkninger:
Dette udstyr er ikke unik i den hensigt, at det indeholder for elektrostatisk afladning (ESD) sensitive reservedel. I de fleste elektronisk udstyr findes der metaloxyd teknologiske reservedel (NMOS, SMOS m.m.). Erfaringerne viser at selv den mindste statiske elektricitet kan skade, eller ødelægge disse instrumenter. Selv en fungerende elektrisk del kan have levetiden markant reduceret på grund af statisk elektricitet..

Dutch

Essentiële instructies Lees ze voordat u verder gaat!

Brooks Instrument ontwerpt, produceert en test haar producten zodanig dat ze voldoen aan vele nationale en internationale normen. Deze producten moeten correct worden geïnstalleerd, bediend en onderhouden zodat ze binnen hun normale specificaties blijven werken. De volgende instructies moeten worden toegevoegd aan en geïntegreerd in uw veiligheidsprogramma als u producten van Brooks Instrument installeert, bedient en onderhoudt.

- Om de juiste prestaties te kunnen garanderen mag alleen gekwalificeerd personeel het product installeren, bedienen, updaten, programmeren en onderhouden.
- Lees alle instructies voordat u het product gaat installeren, bedienen en onderhouden. Als dit niet de juiste handleiding is, kijk dan op de achterzijde voor contactinformatie van uw vertegenwoordiger. Bewaar deze handleiding voor later.

⚠WAARSCHUWING: gebruik dit instrument niet als niet is voldaan aan de specificaties in de handleiding. Het niet naleven van deze waarschuwing kan ernstig letsel en/of schade aan de apparatuur tot gevolg hebben.

- Als u één of meer instructies niet begrijpt, vraag dan om uitleg aan uw vertegenwoordiger van Brooks Instrument.
- Neem alle waarschuwingen, voorschriften en instructies in acht die op het product zijn aangebracht of bij het product zijn geleverd.

⚠ WAARSCHUWING: Zorg ervoor dat dit instrument de vereiste goedkeurings-classificatie heeft om te voldoen aan de lokale en nationale standaarden, voordat u het gaat installeren. Het niet naleven van deze waarschuwing kan ernstig letsel en/of schade aan de apparatuur tot gevolg hebben.

- Installeer uw apparatuur volgens de instructies in de bijgeleverde handleiding en in overeenstemming met de geldende lokale en nationale voorschriften. Sluit alle producten aan op de juiste elektrische voedings- en drukbronnen.
- Bediening: (1) Laat het systeem langzaam volstromen. Open de procesafsluiters langzaam om drukstoten te voorkomen. (2) Controleer op lekkages rondom de inlaat- en uitlaataansluitingen van de stromingsmeter. Als er geen lekkages zijn, kan het systeem op de bedrijfsdruk worden gebracht.
- Zorg ervoor dat de procesleiding drukvrij is gemaakt voordat u servicewerkzaamheden gaat uitvoeren. Als vervangingsonderdelen nodig zijn, zorg er dan voor dat gekwalificeerd personeel de door Brooks Instrument gespecificeerde vervangingsonderdelen gebruikt. Niet goedgekeurde onderdelen en procedures kunnen de prestaties van het product en de veilige werking van uw proces in gevaar brengen. Niet goedgekeurde vervangingsonderdelen kunnen brand, elektrische schokken of een onjuiste werking tot gevolg hebben.
- Zorg ervoor dat alle deksels van de apparatuur gesloten zijn en de afdekkingen gemonteerd zijn om elektrische schokken en lichamelijk letsel te voorkomen, behalve als gekwalificeerd personeel de onderhoudswerkzaamheden uitvoert.

⚠WAARSCHUWING: bij vloeistofstroomapparaten waarvan de inlaat- en uitlaatkleppen om welke reden dan ook gesloten zijn, moet de vloeistof volledig worden afgetapt. Als dat wordt nagelaten, kan dit leiden tot thermische expansie van de vloeistof waardoor het apparaat kan barsten en lichamelijk letsel kan veroorzaken.

PED (Pressure Equipment Directive)

Alle drukapparatuur met een interne druk van meer dan 0,5 barg en een diameter van meer dan 25 mm valt onder de PED-richtlijn.

- In het hoofdstuk Specificaties van deze handleiding staan aanwijzingen die verband houden met de PED-richtlijn.
- De producten die in deze handleiding worden beschreven, voldoen aan de Europese richtlijn 2014/34/EU.
- Alle stromingsmeters van Brooks Instrument vallen in groep 1.
- Producten met een diameter van meer dan 25 mm voldoen aan de categorieën I, II of III van de PED-richtlijn.
- Producten met een diameter van 25 mm of kleiner voldoen aan de regels van goed vakmanschap.

Elektromagnetische compatibiliteit (EMC)

De elektronische apparatuur van Brooks Instrument met de CE-markering is succesvol getest in overeenstemming met de EMC-voorschriften (richtlijn EMC 2014/30/EU).
De keuze van de signaalkabel voor gebruik in combinatie met apparatuur met CE-markering verdient speciale aandacht.
Kwaliteit van de signaalkabel, kabelafdichtingen en stekkers:
Brooks Instrument levert hoogwaardige kabels die voldoen aan de specificaties voor de CE-markering.
Als u zelf voor signaalkabel zorgt, moet u altijd een volledig afgeschermde kabel gebruiken.
Stekkers van het type “D” of ronde stekkers moeten zijn voorzien van een metalen afscherming. Indien nodig moeten metalen kabelafdichtingen worden gebruikt waarvan de afscherming voor het klemmen van de kabel kan worden gebruikt.
Het kabelscherm moet met het metalen omhulsel of de metalen afdichting worden verbonden en aan beide uiteinden rondom volledig worden afgeschermd.
De afscherming moet aan de aardpotentiaal worden aangesloten.
Card Edge Connectors zijn standaard niet van metaal. De gebruikte kabels moeten volledig zijn afgeschermd om te voldoen aan de CE-markering.
De afscherming moet aan de aardpotentiaal worden aangesloten.
Voor de pinconfiguratie: Raadpleeg de bijgevoegde handleiding.

Elektrostatische ontlading

⚠ VOORZICHTIG: Dit instrument bevat elektronische componenten die gevoelig zijn voor statische elektriciteit. Neem de juiste procedures in acht bij het verwijderen en installeren of bij andere werkzaamheden aan de interne printplaten of apparaten.

Procedure:
1. Schakel de voeding van de eenheid uit.
2. Het personeel moet zich met een polsbandje of ander veilig en geschikt hulpmiddel aarden voordat een printplaat of ander intern apparaat mag worden geïnstalleerd, verwijderd of aangepast.
3. Printplaten moeten in een geleidende verpakking worden vervoerd. De platen mogen pas vlak voor de eigenlijke installatie uit de beschermende verpakking worden gehaald. Verwijderde printplaten moeten onmiddellijk in de beschermende verpakking worden geplaatst om te worden getransporteerd, opgeslagen of teruggestuurd naar de fabriek.

Opmerkingen
Dit instrument is niet uniek als het gaat om componenten die gevoelig zijn voor elektrostatische ontlading. De meeste moderne elektronische apparaten bevatten componenten die gebruik maken van de metaaloxidetechnologie (NMOS, SMOS, enz.). Uit ervaring blijkt dat zelfs kleine hoeveelheden statische elektriciteit deze apparaten al dan niet onherstelbaar kunnen beschadigen. Beschadigde componenten, zelfs als ze goed lijken te functioneren, raken eerder defect.

Estonian

Olulised juhised

Enne kasutamist lugege hoolikalt läbi!

Brooks Instrument konstrueerib, valmistab ja katsetab oma tooteid selliselt, et need vastaksid paljudele riiklikele ja rahvusvahelistele standarditele. Ainult nõuetekohane paigaldamine, kasutamine ja hooldamine tagab toodete katkematu talitluse tavaspetsifikatsiooni raames. Brooks Instrumenti toodete paigaldamisel, kasutamisel ja hooldamisel tuleb täita alljärgnevaid juhiseid ja integreerida need asjakohasesse ohutusprogrammi.

- Nõuetekohase talitluse tagamiseks tohib toodet paigaldada, kasutada, täiustada, programmeerida ja hooldada ainult kvalifitseeritud personal.
- Enne toote paigaldamist, kasutamist ja hooldamist lugege kõik kasutusjuhised hoolikalt läbi. Kui see kasutusjuhend ei vasta teie tootele, pöörduge kohaliku edasimüüja poole, kelle kontaktandmed leiate kasutusjuhendi tagakaanelt. Hoidke see kasutusjuhend edaspidiseks alles.
  ⚠ **HOIATUS. Ärge kasutage seda instrumenti väljaspool kasutusjuhendis spetsifitseeritud piirväärtusi. Hoiatuse eiramine võib kaasa tuua raske kehavigastuse ja/või kahjustada seadet.**
- Kui te saa mõne juhise mõttest aru, pöörduge selgituste saamiseks kohaliku Brooks Instrumenti edasimüüja poole.
- Järgige kõiki hoiatusi, tähelepanule manitsusi ja juhiseid, mis on tootele peale kantud või tootega kaasa antud.
  ⚠ **HOIATUS. Enne paigaldamist veenduge, et see instrument vastaks kohalike ja riiklike määrustega kehtestatud nimiandmetele. Hoiatuse eiramine võib kaasa tuua raske kehavigastuse ja/või kahjustada seadet.**
- Seadme paigaldamisel järgige vastavas kasutusjuhendis toodud paigaldusjuhiseid ning asjakohaseid kohalikke ja riiklikke eeskirju. Ühendage tooted nõuetekohaste toite- ja surveallikatega.
- Talitlus. (1) Avage aeglaselt vool süsteemi. Vooluimpulsside vältimiseks avage tööventiilid aeglaselt. (2) Kontrollige, et voolukulumõõturi sisend- või väljundühenduste ümber ei oleks lekkeid. Kui lekkeid ei ole, laske süsteemil saavutada töösurve.
- Enne seadme hooldamist veenduge, et kogu süsteem oleks surve alt vabastatud. Varuosasid tohib vahetada ainult kvalifitseeritud personal, kasutades selleks Brooks Instrumenti heakskiidetud varuosi. Mitteoriginaalvaruosade kasutamine ja ebapädev toimingute tegemine võivad kahjustada toote tööomadusi ja põhjustada riski tootmistegevuse ohutuse tagamisel. Originaalvaruosadele sarnaste osade kasutamine võib põhjustada tule- või elektrilöögiohtu või seadme väärtalitlust.
- Elektrilöögi- ja vigastuseohu vältimiseks peavad seadme luugid olema alati suletud ja kaitsekatted oma kohal, v.a seadme hooldamisel kvalifitseeritud isikute poolt.
  ⚠ **HOIATUS. Voolava vedelikuga seadmete kasutamisel – kui seadmega külgnevad sisend- ja väljundklapid on vaja mingil põhjusel sulgeda, tuleb seadmed vedelikust täiesti tühjaks lasta. Vastasel korral võib vedelik soojuse mõjul paisuda niivõrd, et seade puruneb. See võib põhjustada raskeid kehavigastusi.**

Euroopa surveseadmete direktiiv (PED)

Euroopa surveseadmete direktiiv kohaldub kõikidele surveseadmetele, mille sisesurve on üle 0,5 baari (g) ja läbimõõt üle 25 mm või 1 tolli.

- Selle kasutusjuhendi spetsifikatsiooniosa sisaldab surveseadmete direktiiviga seonduvaid juhiseid.
- Kasutusjuhendis kirjeldatud tooted vastavad EL direktiivi 2014/34/EÜ nõuetele.
- Brooks Instrumenti voolukulumõõturid kuuluvad vedelike 1. gruppi.
- Tooted läbimõõduga üle 25 mm või 1 tolli vastavad surveseadmete direktiivi kategooriale I, II või III.
- Toodetele läbimõõduga alla 25 mm või 1 tolli kohaldatakse häid inseneritavasid.

Euroopa elektromagnetilise ühilduvuse direktiiv (EMÜ)

Brooks Instrumenti (elektrilised/elektroonilised) seadmed, millele on omistatud CE-tähis, on edukalt läbinud asjakohased katsed ja vastavad elektromagnetilise ühilduvuse nõuetele (EMÜ direktiiv 2014/30/EÜ).
Kuid signaalkaabli valimisel on vaja pöörata suurt tähelepanu CE-tähisega seadmetele.

Signaalkaabli, läbiviigutihendite ja konnektorite kvaliteet

Brooks Instrument turustab kõrgekvaliteedilisi kaableid, mis vastavad CE-sertifikaadi nõuetele.
Olemasoleva kaabli kasutamisel jälgige, et kaabel oleks täielikult ümbritsetud varjestusega.
„D"- või „Ring"-tüüpi konnektorid peavad olema varustatud metallvarjestusega. Võimaluse korral tuleb kasutada metallist läbiviike, mis tagavad kaabli varjestuse ühenduse.
Kaabli varjestus ühendatakse metallkesta või läbiviigutihendiga ja on mõlemast otsast kaitstud 360° ulatuses.
Varjestus peab olema maandatud.
Mikroskeemide servaühendused on üldjuhul mittemetallist. Vastavuse tagamiseks CE-sertifikaadi nõuetele peavad kasutatud kaablid olema 100% varjestatud.
Varjestus peab olema maandatud.
Klemmide konfigureerimine: vt komplekti kuuluvat kasutusjuhendit.

Elektrostaatiline laeng

⚠ **TÄHELEPANU! Seade sisaldab staatilise elektri suhtes tundlikke elektroonikakomponente. Seadmesse paigaldatud trükkplaatide eemaldamisel ja paigaldamisel, samuti trükkplaadi või seadmega muude toimingute teostamisel järgige nõuetekohase käsitsemise juhiseid.**

Käsitsemisjuhised

1. Lahutage seade toiteallikast.
2. Enne trükkplaadi või mõne muu siseelemendi paigaldamist, eemaldamist või konfigureerimist peab personal olema maandatud läbi randmepaela või mõne muu sobiva vahendi.
3. Trükkplaate transporditakse voolujuhtivas konteineris. Võtke trükkplaat kaitsvast konteinerist välja vahetult enne selle paigaldamist. Seadmest eemaldatud trükkplaadid tuleb viivitamatult asetada kaitsvasse konteinerisse, kas siis edasiseks transportimiseks, hoiustamiseks või tehasesse tagasisaatmiseks.

Kommentaarid

See seade ei ole ainus, mis sisaldab staatilise elektri suhtes tundlikke elemente. Enamik kaasaegsetest elektroonikaseadmetest sisaldavad komponente, mille valmistamiseks on kasutatud metalloksiidtehnoloogiat (NMOS, SMOS jne). Kogemused näitavad, et isegi väike kogus staatilist elektrit võib neid seadmeid kahjustada või isegi hävitada. Kuigi võib näida, et kahjustatud komponendid töötavad nõuetekohaselt, hakkavad talitlushäired ilmnema juba varakult.

Finnish

Perusohjeet
Lue ensin ohjeet huolellisesti!

Brooks Instrument suunnittelee, valmistaa ja testaa laitteensa vastaamaan useimpien kotimaisten ja kansainvälisten standardien vaatimuksia. Tuotteet tulee asentaa, käyttää ja huoltaa käyttöohjeiden mukaan jotta niiden toimivuus taataan. Brooks Instrumentin laitteiden asennuksessa, käytössä ja huollossa on noudatettava soveltuvia määräyksiä ja ohjeita, lisäksi mainitut ohjeet on huomioitava työsuojelun ohjeistuksessa.

Oikean toiminnan varmistamiseksi vain valtuutettu huoltohenkilö saa asentaa, käynnistää, päivittää, ohjelmoida ja huoltaa laitteita.
Lue kaikki käyttöohjeet koskien tuotteen asennusta, käyttöä ja huoltoa. Jos käyttöohje on puutteellinen, lisätietoja saa paikalliselta jälleenmyyjältä. Yhteystiedot löytyvät oppaan kansilehdestä. Säilytä ohjeet.

⚠ **VAROITUS!: Käyttöohjeessa ilmoitettujen standardien mukaisia ohjeita ja raja-arvoja ei saa ylittää. Rajoitusten laiminlyönti voi aiheuttaa tuotteen rikkoutumisen ja/tai vakavan henkilövahingon vaaran.**

- Jos ohjeissa on epäselvyyttä, ota yhteyttä Brooks Instrumentin edustajaan ongelman selvittämiseksi.
- Noudata kaikkia laitteessa olevia tai siihen liittyviä ohjeita, määräyksia ja varoituksia.

⚠ **VAROITUS: Tarkista ennen asennusta, että tällä laitteella on paikallisten ja maasi koodien mukaiset hyväksyntäluokitukset. Tämän varoituksen laiminlyönnistä saattaa aiheutua vakava vamma ja/tai laitevaurio.**

- Laittteen asennuksessa on noudatettava erityisiä asennusohjeita sekä voimassa olevia paikallisia ja kansainvälisiä määräyksiä. Laitteet saa yhdistää vain sopivaan sähkö- ja paineverkkoon.
- Asennusohjeita: (1) Päästä virtaus hitaasti järjestelmään. Avaa venttiilit hitaasti, jotta virtaus pysyy tasaisena. (2) Tarkista, ettei virtausmittarin sisään- ja ulosmenon liitoksissa ole vuotoa. Jos järjestelmässä ei ole vuotoa, aseta oikea käyttöpaine.
- Tarkista, että laitteeseen menevä paine on katkaistu ennen laitteen korjaamista välttääksesi loukkaantumisriskin. Mahdollisten varaosien tulee olla Brooks Instrumentin hyväksymiä. Vain valtuutettu huoltohenkilö saa asentaa varaosat. Ei-hyväksyttyjen varaosien käyttö voi vahingoittaa tuotteen toimintaa ja aiheuttaa turvallisuusriskin. Samoin ei-hyväksyttyjen varaosien käyttö voi aiheuttaa tulipalon, sähköiskun tai virhetoiminnan riskin.
- Varmista että kaikki kaikki laitteen ovet/luukut ovat suljettuina ja tarkista että suojakannet ovat paikoillaan estääksesi mahdollisen sähköisku- ja loukkaantumisvaaran.

⚠ **VAROITUS!: Jos järjestelmässä virtaa neste ja laitteen sisään- ja ulosmenoventtiilit pitää sulkea, laite on ensin tyhjennettävä kokonaan. Tyhjentämisen laiminlyönti aiheuttaa nesteen lämpölaajenemista, joka saattaa johtaa laitteen rikkoutumiseen ja henkilövahingon vaaraan.**

Eurooppalainen painelaitedirektiivi (PED)

Painelaitteet, joiden paine on suurempi kuin 0,5 bar (g) ja joiden koko on suurempi kuin 25 mm tai 1 tuuma , kuuluvat eurooppalaiseen painelaitedirektiiviin (PED).

- PED direktiiviä koskevat määräykset löytyvät käyttöoppaan ’’Tekniset tiedot” -luvusta.
- Käyttöoppaassa kuvatut tuotteet ovat 2014/34/EU EU-direktiivin mukaisia.
- Kaikki Brooks Instrumentin virtausmittarit kuuluvat ryhmään 1. Laitteet, jotka ovat suurempia, kuin 25 mm tai 1 tuuma, ovat PED I, II, III kategorien mukaisia.
- Mittarit joiden koko on alle 25 mm tai 1 tuuma ovat hyvän konepajakäytännön (SEP) mukaisia.

Eurooppalainen direktiivi sähkömagneettisesta yhteensopivuudesta (EMC)

Brooks Instrumentin CE-merkin saaneet (sähkö/sähköiset) laitteet täyttävät EMC direktiivin vaatimukset ja testit sähkömagneettisesta yhteensopivuudesta (2014/30/EU EMC direktiivi).
Erityistä huomioita on kiinnitettävä CE-merkittyjen laitteiden käytössä olevien kaapelien valintaan.

Kaapelien, kiinnikkeiden ja liittimien laatu:

Brooks Insturmentin kaapelit ovat korkealaatuisia ja täyttävät CE-merkintä direktiivin vaatimukset.
Muun valmistajan kaapelia käytettäessä on käytettävä 100% suojattua kaapelia.
Liittimien tulee olla häiriösuojattua tyyppiä. Tarvittaessa käytetään metallisia kiinnikkeitä kaapelin suojuksen kiinnittämiseen. Kaapelin suojakuoren pitää olla yhdistettynä metallisuojukseen tai laippaan ja sen pitää olla molemmista päistä suojattuna 360°. Suojaus päättyy maadoitukseen.
Standardin mukaan korttien liittimet eivät ole metallisia. Käytettyjen kaapelien suojaus on oltava 100%, jotta se täyttäisi CE-merkinnän direktiivin vaatimukset.
Suojaus päättyy maadoitukseen.
Napojen järjestys: Katso liitteenä oleva käyttöopas.

Elektrostaattinen purkaus (ESD)

⚠ **VAROITUS!: Tuote sisältää elektroniikkakomponentteja jotka voivat vahingoittua staattisesta sähköstä. Sisäisten piirilevyjen purkamisessa,asennuksessa ja käsittelyssä tulee noudattaa kaikkia määräyksiä ja ohjeita.**

Asennusohjeet:

1. Järjestelmän sähköt katkaistaan.
2. Laitteen kanssa työskentelevä henkilö on suojattava sähköiskuilta rannehihnalla tai muulla suojavarustuksella ennen piirilevyn tai muun sisäosan asennusta, poistamista tai korjaamista.
3. Piirilevyt kuljetetaan antistaattisessa pakkauksessa. Piirilevyt puretaan paketista juuri ennen asennusta. Poistettu piirilevy on heti pakattava soveltuvaan suojapakkaukseen kuljettamista, varastoimista tai palautusta varten.

Huomautukset:

Tuotteen herkkyys elektrostaattiselle purkaukselle (ESD) ei ole epätavallista. Suurin osa elektroniikkatuotteista sisältää komponentteja jotka hyödyntävät metallioksiditekniikkaa (NMOS, SMOS jne.) Kokemusten mukaan pienikin elektrostaattinen purkaus voi aiheuttaa laitteiden virhetoiminnan tai vahingoittumisen. Vahingoittuneet komponentit saattavat aiheuttaa laitteen ennenaikaisen rikkoutumisen vaikka laite näyttäisi toimivan normaalisti.

French

Instructions essentielles
A lire avant de commencer !

Brooks Instrument conçoit, fabrique et teste ses produits pour répondre à de nombreuses normes nationales et internationales. Ces produits doivent être correctement installés, utilisés et entretenus pour pouvoir fonctionner dans le cadre de leurs spécifications normales. Les instructions qui suivent doivent être respectées et intégrées à votre programme de sécurité lors de l'installation, l'utilisation et l'entretien des produits Brooks Instrument.

- Afin d'assurer un fonctionnement correct, faites appel à du personnel qualifié pour l'installation, l'utilisation, la mise à jour, la programmation et l'entretien du produit.
- Lisez toutes les instructions avant l'installation, l'utilisation et l'entretien du produit. Si le présent manuel d'utilisation n'est pas le bon, consultez la dernière page de la couverture pour connaître le point de vente le plus proche. Conservez ce manuel d'utilisation pour pouvoir vous y reporter par la suite.

⚠ AVERTISSEMENT: n'utilisez pas cet instrument au-delà des spécifications énumérées dans le manuel d'utilisation.
Le non-respect de cet avertissement peut entraîner de graves blessures et / ou endommager l'équipement.

- Si vous ne comprenez pas l'une des instructions, prenez contact avec un représentant de Brooks Instrument pour obtenir des explications.
- Tenez compte de tous les avertissements, précautions et instructions marquées sur le produit et fournies avec celui-ci.

⚠ AVERTISSEMENT: Avant toute installation, vérifier que cet instrument est conformes aux normes locales et nationales.
Le non-respect de cet avertissement peut entrainer des blessures graves et/ou endommager l'équipement.

- Installez votre équipement de la façon indiquée dans les instructions d'installation du manuel d'utilisation et conformément à la législation en vigueur au niveau local et national. Branchez tous les produits aux sources d'électricité et de pression agréées.
- Utilisation : (1) Faites lentement entrer le débit dans le système. Ouvrez progressivement les vannes de procédé pour éviter des pics de débits. (2) Vérifiez qu'il n'y a pas de fuite au niveau des branchements d'entrée et de sortie du débitmètre. S'il n'y a pas de fuite, amenez le système à sa pression d'utilisation.
- Avant de procéder à l'entretien, assurez-vous que la conduite de procédé n'est plus sous pression. Lorsqu'il faut remplacer une pièce, assurez-vous que les pièces de rechange sont celles indiquées par Brooks Instrument et que des personnes qualifiées effectuent le remplacement. Les pièces et procédures non autorisées peuvent porter atteinte au fonctionnement du produit et mettre en péril la sécurité de votre procédé. Les remplacements par des pièces d'apparence similaire peuvent entraîner des incendies, des risques électriques ou un mauvais fonctionnement.
- Vérifiez que toutes les trappes de l'équipement sont fermées et que les couvercles de protection sont en place pour éviter les chocs électriques et les blessures, sauf lorsque l'entretien est réalisé par des personnes qualifiées.

⚠ AVERTISSEMENT: dans le cas d'appareils à écoulement liquide, si les vannes d'entrée et de sortie adjacentes aux appareils doivent être fermées pour une raison quelconque, les appareils doivent être complètement vidangés. Si cela n'est pas fait, une éventuelle dilatation thermique du fluide peut casser l'appareil et provoquer des blessures.

Directive européenne « équipements sous pression » (PED)

- Tous les équipements sous pression dont la pression interne est supérieure à 0,5 bar (pression relative) et dont la taille dépasse 25 mm ou un pouce entrent dans le cadre de la directive PED.
- La section « Spécifications » de ce manuel contient les instructions relatives à la directive PED.
- Les appareils de mesure de ce manuel sont conformes à la directive EN 2014/34/EU.
- Tous les débitmètres Brooks Instrument fonctionnent avec des fluides de groupe 1.
- Les appareils de mesure d'une taille supérieure à 25 mm ou un pouce entrent dans la catégorie PED I, II ou III.
- Les appareils de mesure d'une taille inférieure ou égale à 25 mm ou un pouce relèvent des « bonnes pratiques d'ingénierie » (SEP).

Compatibilité électromagnétique européenne (CEM)

L'équipement Brooks Instrument (électrique / électronique) portant le marquage CE répond à la réglementation en matière de compatibilité électromagnétique (directive CEM 2014/30/EU).
Il faut cependant prêter une grande attention au choix du câble d'interconnexion à utiliser avec l'équipement marqué CE.
Qualité du câble d'interconnexion, des presse-étoupes et connecteurs :
Brooks Instrument fournit un ou des câbles de qualité supérieure qui répondent aux spécifications exigées pour la certification CE.
Si vous utilisez votre propre câble d'interconnexion, ce câble doit être protégé par un blindage intégral.
Les connecteurs rectangulaires ou circulaires utilisés doivent avoir un blindage métallique. S'il y a lieu, des presse-étoupes métalliques doivent faire office de serre-écran de câble.
L'écran du câble doit être raccordé à l'enveloppe métallique ou au presse-étoupe et blindé aux deux extrémités sur 360 degrés.
Le blindage doit s'achever sur une prise de terre.
Les connecteurs de carte standards sont non métalliques. Les câbles utilisés doivent être protégés par un blindage intégral pour se conformer à la certification CE.
Le blindage doit s'achever sur une prise de terre.
En ce qui concerne la configuration des broches, veuillez vous reporter au manuel d'utilisation joint.

ESD (décharge électrostatique)

⚠ ATTENTION : cet instrument contient des composants électroniques sensibles à l'électricité statique. Des procédures de manipulation adéquates doivent être respectées pendant le retrait, l'installation ou la manipulation des cartes de circuits imprimés ou des dispositifs internes.

Procédure de manipulation :
1. L'alimentation électrique de l'appareil doit être coupée.
2. Le personnel doit être mis à la terre, au moyen d'une bande de poignet ou d'un autre moyen sûr et adéquat, avant l'installation, le retrait ou le réglage de toutes les cartes de circuits imprimés ou autres dispositifs internes.
3. Les cartes de circuits imprimés doivent être transportées dans un récipient conducteur. Les cartes ne doivent enlevées de cette enveloppe protectrice qu'au dernier moment, juste avant l'installation. Les cartes retirées doivent être immédiatement placées dans un récipient de protection pour le transport, le stockage ou le retour à l'usine.

Observations
Brooks Instrument n'est pas le seul à proposer des produits comportant des composants sensibles aux décharges électrostatiques. La plupart des produits électroniques modernes contiennent des composants qui utilisent des technologies à oxydes métalliques (NMOS, SMOS, etc.). L'expérience démontre que d'infimes quantités d'électricité statique suffisent à endommager ou détruire ces appareils. Les composants endommagés, même s'ils semblent fonctionner correctement, tombent rapidement en panne.

German

Wichtige Anweisungen
Bitte zuerst lesen!

Brooks Instrument entwickelt, produziert und testet seine Produkte derart, dass sie viele nationale und internationale Standards erfüllen. Nur bei korrektem Einbau sowie richtiger Bedienung und Wartung dieser Produkte ist ein Betrieb unter Einhaltung der Standardvorgaben sichergestellt. Die folgenden Anweisungen müssen eingehalten werden und in Ihr Sicherheitsprogramm integriert werden, wenn Sie Brooks Produkte installieren, bedienen und warten.

- Um die entsprechende Leistung zu gewährleisten, setzen Sie qualifiziertes Personal für die Installation, den Betrieb, die Aktualisierung, Programmierung und Wartung des Produkts ein.
- Lesen Sie alle Anweisungen, bevor Sie das Produkt installieren, in Betrieb nehmen und warten. Falls es sich bei diesem Handbuch nicht um das richtige Handbuch handelt, schauen Sie bitte auf der Rückseite nach den Kontaktdaten Ihres Vertriebsbüros vor Ort. Bewahren Sie dieses Handbuch auf, falls Sie später etwas nachschauen möchten.

⚠ WARNUNG: Dieses Gerät nicht außerhalb der in Bedienungsanleitung und Handbuch angegebenen Grenzen betreiben. Wird diese Warnung nicht beachtet, kann dies zu schweren Personenschäden bzw. Schäden des Gerätes führen.

- Falls Sie Anweisungen nicht verstehen, wenden Sie sich zur Klärung an Ihren Brooks Instrument Vertreter.
- Befolgen Sie alle Warnhinweise und Anweisungen, die auf dem Produkt markiert sind oder zusammen mit diesem geliefert werden.

⚠ ACHTUNG: Vor der Installation sicherstellen, dass dieses Instrument den nationalen und lokalen Vorschriften endspricht. Die Nichtbeachtung kann zu schweren Verletzungen und/oder Schäden am Gerät führen.

- Installieren Sie Ihr Gerät, wie in den Installationsanweisungen des entsprechenden Handbuchs angegeben und gemäß der gültigen regionalen und nationalen Gesetze. Schließen Sie alle Produkte an eine geeignete Strom- und Druckluftversorgung an.
- Bedienung: (1) Langsam den Zufluss zum System starten. Die Ventile langsam öffnen, um einen sprunghaften Anstieg der Durchflussmenge zu verhindern. (2) Bereich der Anschlüsse (Zufluss und Ausfluss) des Durchflussmessers auf Undichtigkeiten überprüfen. Wenn das System dicht ist, auf Betriebsdruck hochfahren.
- Sicherstellen, dass der Leitungsdruck vor Wartungsarbeiten heruntergefahren wird. Wenn Ersatzteile benötigt werden, stellen Sie sicher, dass qualifizierte Personen Ersatzteile verwenden, die von Brooks Instrument vorgegeben sind. Nicht genehmigte Teile und Verfahren können die Leistungsfähigkeit des Produkts beeinträchtigen und den sicheren Betrieb Ihres Prozesses gefährden. Ähnlich aussehende Austauschteile können zu Bränden, elektrischen Gefahren oder nicht sachgerechtem Betrieb führen.
- Stellen Sie sicher, dass alle Türen der Anlage geschlossen sind und dass alle Schutzabdeckungen angebracht sind, um Stromschläge und Personenschäden zu vermeiden, es sei denn die Wartungsaufgaben werden von qualifizierten Personen durchgeführt.

⚠ WARNUNG: Werden die Ein- und Auslassventile neben Durchflussmessgeräten aus irgendwelchen Gründen geschlossen, so müssen die Geräte komplett entleert werden.

Durchflussmessgeraete muessen vor dem Schliessen von Ein- und Auslassventilen komplett entleert werden,

anderenfalls kann es zu einer thermischen Ausdehnung der Flüssigkeit und damit zum Bruch des Gerätes kommen; Personenschäden können die Folge sein.

Europäische Druckgeräterichtlinie (PED)

Alle Druckgeräte mit einem internen Druck von mehr als 0,5 bar (g) und einer Größe von mehr als 1in (1 in = 25,4 mm) unterliegen der Druckgeräterichtlinie.

- Das Kapitel zu den technischen Daten in dieser Anleitung enthält wichtige Sicherheits- und Betriebsanweisungen in Bezug auf die Druckgeräterichtlinie.
- Produkte die in diesem Handbuch beschrieben sind, erfüllen die europäische Richtlinie 2014/34/EU.
- Alle Durchflussmesser von Brooks Instrument fallen unter die Fluidgruppe 1.
- Produkte die größer als 25 mm oder 1“ (inch) sind, erfüllen die Kategorien I, II oder III der Druckgeräterichtlinie (PED).
- Produkte mit einer Größe von 25 mm oder 1“ (inch) oder kleiner sind Sound Engineering Practice (SEP).

Europäische Verordnung zur elektromagnetischen Verträglichkeit (EMV)

Geräte von Brooks Instrument (elektrischer und elektronischer Art) mit CE-Zeichen haben den Test auf Einhaltung der Verordnung zur elektromagnetischen Verträglichkeit (EMV Richtlinie 2014/30/EU) erfolgreich bestanden.
Dennoch muss bei der Wahl des Signalkabels für das Gerät mit CE-Zeichen auf folgende Dinge geachtet werden.
Qualität von Signalkabel, Kabeldurchführung und Anschlüsse:
Brooks Instrument liefert qualitativ hochwertige Kabel, die den Anforderungen für eine CE-Zertifizierung entsprechen.
Sollten Sie eigene Kabel einsetzen, so sollte das Kabel überall mit einer 100%-Abschirmung versehen sein.
D- oder Rundstecker sollten eine Metallabschirmung aufweisen. Wenn möglich, müssen Kabeldurchführungen aus Metall mit Kabelschirmgeflechts-Klemmen verwendet werden.
Der Kabelschirm sollte an die Metallhülle oder -durchführung angeschlossen werden und an beiden Enden rundherum (360°) abgeschirmt werden.
Die Abschirmung sollte geerdet werden.
Randstecker auf Platinen sind standardmäßig nicht aus Metall. Die verwendeten Kabel müssen mit einer 100 % Abschirmung versehen werden, um die CE-Vorgaben zu erfüllen.
Die Abschirmung sollte geerdet werden.
Klemmenbelegung: Siehe beigefügtes Handbuch.

ESD (Elektrostatische Entladung)

⚠ ACHTUNG: Dieses Gerät enthält elektronische Komponenten, die durch elektrostatische Entladungen beschädigt werden können. Ordnungsgemäße Verfahrensanweisungen müssen während des Ausbaus, der Installation oder anderer Handhabung der eingebauten Platinen oder Geräte eingehalten werden.

Verfahrensanweisung:

1. Trennen Sie das Gerät von der Stromversorgung.
2. Das Personal ist vor dem Einbau, Ausbau oder der Einstellung von Platinen oder anderen internen Komponenten durch ein entsprechendes Armband mit dem Erdpotential zu verbinden.
3. Platinen sind in speziellen Behältern mit Schutz gegen elektrostatische Spannungen zu transportieren oder zu lagern. Platinen dürfen erst kurz vor dem Einbau aus der Schutzhülle entfernt werden. Ausgebaute Platinen müssen umgehend in Schutzbehälter zum Transport, zur Lagerung oder Rücksendung an das Werk gelegt werden.

Anmerkung
Dieses Gerät ist wie viele andere elektronische Geräte auch mit Komponenten bestückt, die anfällig für elektrostatische Entladung sind. Die meisten modernen, elektronischen Geräte enthalten Komponenten, die die Metalloxidtechnologie (NMOS, SMOS etc.) verwenden. Die Erfahrung hat gezeigt, dass schon geringe Mengen elektrostatischer Energie ausreichen, um diese Geräte zu beschädigen oder zu zerstören. Beschädigte Teile fallen früh aus, obwohl sie funktionsfähig zu sein scheinen.

Greek

Βασικές οδηγίες Διαβάστε πριν συνεχίσετε!

Η Brooks Instrument σχεδιάζει, παράγει και δοκιμάζει τα προϊόντα της σε συμμόρφωση με πλήθος εθνικών και διεθνών προτύπων. Η σωστή εγκατάσταση, χρήση και συντήρησή τους αποτελεί απαραίτητη προϋπόθεση της λειτουργίας εντός των κανονικών ορίων. Οι παρακάτω οδηγίες πρέπει να τηρούνται και πρέπει να ενσωματωθούν στο πρόγραμμα ασφάλειας της εργασίας σας κατά την εγκατάσταση, χρήση και συντήρηση προϊόντων της Brooks Instrument.

- Για σωστό αποτέλεσμα η εγκατάσταση, λειτουργία, ενημέρωση, προγραμματισμός και συντήρηση πρέπει να γίνεται από ειδικευμένο προσωπικό.
- Διαβάστε όλες τις οδηγίες πριν εγκαταστήσετε, λειτουργήσετε και συντηρήσετε το προϊόν. Εάν το παρόν εγχειρίδιο δεν είναι το σωστό εγχειρίδιο, συμβουλευθείτε το πίσω εξώφυλλο για τα στοιχεία επικοινωνίας του τοπικού αντιπροσώπου. Φυλάξτε το εγχειρίδιο αυτό για μελλοντική αναφορά.

⚠ ΠΡΟΕΙΔΟΠΟΙΗΣΗ: Μη λειτουργείτε τη συσκευή αυτή καθ' υπέρβαση των ορίων που αναγράφονται στο Εγχειρίδιο Οδηγιών και Λειτουργίας. Η μη συμμόρφωση με την προειδοποίηση αυτή μπορεί να οδηγήσει σε σοβαρό προσωπικό τραυματισμό ή/και ζημιά στον εξοπλισμό.

- Σε περίπτωση μη κατανόησης κάποιας από τις οδηγίες ζητήστε διευκρινίσεις από τον τοπικό αντιπρόσωπο της Brooks Instrument.
- Τηρείτε όλες τις προειδοποιήσεις, προφυλάξεις και οδηγίες που αναγράφονται ή συνοδεύουν το προϊόν.`

⚠ ΠΡΟΕΙΔΟΠΟΙΗΣΗ: Πριν από την εγκατάσταση βεβαιωθείτε ότι αυτό το εργαλείο διαθέτει τις απαιτούμενες εγκεκριμένες προδιαγραφές ώστε να συμμορφώνεται με τους τοπικούς και εθνικούς κανονισμούς. Η αποτυχία τήρησης της παρούσας προειδοποίησης μπορεί να οδηγήσει σε σοβαρό τραυματισμό και/ή ζημιά στον εξοπλισμό

- Εγκαταστήστε τη συσκευή όπως προβλέπεται στις οδηγίες εγκατάστασης του σωστού εγχειριδίου οδηγιών και στις κείμενες τοπικές και εθνικές διατάξεις. Συνδέστε τα προϊόντα στις εκάστοτε σωστές παροχές ρεύματος και πίεσης.
- Διαδικασία: (1) Αφήστε να ξεκινήσει αργά η ροή στο σύστημα. Ανοίξτε αργά τις βαλβίδες λειτουργίας για να αποφύγετε τις απότομες αυξομειώσεις ροής. (2) Ελέγξτε για διαρροές τις συνδέσεις εισόδου και εξόδου του ροόμετρου. Αν δεν υπάρχουν διαρροές, γεμίστε το σύστημα μέχρι η πίεση να φτάσει την κανονική πίεση εργασίας.
- Πριν από τη συντήρηση βεβαιωθείτε ότι γραμμή εργασίας έχει τεθεί εκτός πιέσεως. Σε περίπτωση αντικατάστασης ανταλλακτικών βεβαιωθείτε ότι το προσωπικό είναι ειδικευμένο και χρησιμοποιεί ανταλλακτικά που προβλέπει η Brooks Instrument. Μη εγκεκριμένα ανταλλακτικά και επεμβάσεις ενδέχεται να επηρεάσουν τις επιδόσεις του προϊόντος και να προκαλέσουν κίνδυνο για την ασφαλή λειτουργία. Αντικαταστάσεις με φαινομενικά όμοια ανταλλακτικά ενδέχεται να προκαλέσουν πυρκαγιά, κίνδυνο ηλεκτροπληξίας ή ανεπαρκή λειτουργία.
- Βεβαιωθείτε ότι όλα τα ανοίγματα του εξοπλισμού είναι κλειστά και τα προστατευτικά καλύμματα είναι στη θέση τους προκειμένου να αποφευχθεί ο κίνδυνος ηλεκτροπληξίας και προσωπικών τραυματισμών, εκτός εάν εκτελούνται εργασίες συντήρησης από ειδικευμένο προσωπικό.

⚠ ΠΡΟΕΙΔΟΠΟΙΗΣΗ: Προκειμένου για συσκευές με ροή ρευστού, όταν για οποιονδήποτε λόγο πρόκειται να κλείσουν οι βαλβίδες εισαγωγής και εξαγωγής κοντά στις συσκευές, οι συσκευές πρέπει να αποστραγγιστούν εντελώς. Η μη συμμόρφωση μπορεί να προκαλέσει θερμική διαστολή του υγρού που περιέχουν, με αποτέλεσμα να ραγίσει η συσκευή και να προκληθούν προσωπικοί τραυματισμοί.

Ευρωπαϊκή Οδηγία για τον εξοπλισμό υπό πίεση (PED)

Κάθε εξοπλισμός υπό πίεση με εσωτερική πίεση άνω του 0,5 bar (g) και μεγέθους μεγαλύτερου των 25 mm ή της 1 ίντσας εμπίπτει στις διατάξεις της ευρωπαϊκής Οδηγίας για τον εξοπλισμό υπό πίεση (PED).

- Το κεφάλαιο Προδιαγραφές του παρόντος εγχειριδίου περιλαμβάνει οδηγίες σχετικά με την Οδηγία PED.
- Τα προϊόντα που περιγράφονται στο παρόν εγχειρίδιο συμμορφώνονται με την ευρωπαϊκή Οδηγία 2014/34/EU.
- Όλα τα ροόμετρα της Brooks Instrument ανήκουν στην ομάδα ρευστών 1.
- Προϊόντα μεγαλύτερα από 25 mm ή 1 ίντσα συμμορφώνονται με τις κατηγορίες I, II και III της Οδηγίας PED.
- Προϊόντα μεγέθους 25 mm ή 1 ίντσας ή και μικρότερα κατασκευάζονται σύμφωνα με ορθές τεχνικές πρακτικές (SEP).

Ευρωπαϊκή Οδηγία για την ηλεκτρομαγνητική συμβατότητα (EMC)

Ο (ηλεκτρικός/ηλεκτρονικός) εξοπλισμός της Brooks Instrument που φέρει το σήμα CE έχει υποστεί επιτυχώς τις δοκιμές που προβλέπουν οι διατάξεις της Οδηγίας για την ηλεκτρομαγνητική συμβατότητα (Οδηγία 2014/30/EU για την EMC).
Πάντως χρειάζεται ιδιαίτερη προσοχή στην επιλογή του καλωδίου σήματος για τον εξοπλισμό που φέρει το σήμα CE.
Ποιότητα των καλωδίων σήματος, στυπιοθλιπτών και βυσμάτων καλωδίων:
Η Brooks Instrument προσφέρει υψηλής ποιότητας καλώδια τα οποία πληρούν τις προδιαγραφές CE.
Σε περίπτωση παροχής δικού σας καλωδίου σήματος, χρησιμοποιείτε καλώδιο με πλήρη θωράκιση 100% σε όλα τα σημεία.
Βύσματα τύπου «D» ή κυκλικά πρέπει να έχουν μεταλλική θωράκιση. Να χρησιμοποιηθούν κατά προτίμηση μεταλλικοί στυπιοθλίπτες καλωδίων για τη στερέωση της θωράκισης.
Να συνδεθεί η θωράκιση του καλωδίου στο μεταλλικό κέλυφος ή στυπιοθλίπτη και να θωρακιστεί και στα δύο άκρα κατά 360 μοίρες. Η θωράκιση πρέπει να τερματίζει σε γείωση εδάφους.
Τα βύσματα άκρου της πλακέτας είναι εκ κατασκευής μη μεταλλικά. Τα χρησιμοποιούμενα καλώδια πρέπει να έχουν 100% θωράκιση για συμμόρφωση με την πιστοποίηση CE. Η θωράκιση πρέπει να τερματίζει σε γείωση εδάφους.
Για τη διάταξη των ακίδων: Συμβουλευθείτε το συνημμένο εγχειρίδιο οδηγιών.

Ηλεκτροστατική εκκένωση (ESD)

⚠ ΠΡΟΦΥΛΑΞΗ: Η συσκευή αυτή περιέχει ηλεκτρονικά εξαρτήματα τα οποία μπορούν να υποστούν εύκολα βλάβες από τον στατικό ηλεκτρισμό. Πρέπει να ακολουθούνται οι ορθές διαδικασίες χειρισμού κατά την αφαίρεση, τοποθέτηση ή άλλο χειρισμό των εσωτερικών πλακετών και διατάξεων.
Διαδικασία χειρισμού:

1. Θέστε τη συσκευή εκτός τάσεως.
2. Φροντίστε για τη γείωση του προσωπικού με περικάρπιο ή άλλο ασφαλές και κατάλληλο μέσο πριν τοποθετήσετε, αφαιρέσετε ή ρυθμίσετε κάρτες τυπωμένων κυκλωμάτων ή άλλη εσωτερική διάταξη.
3. Οι κάρτες τυπωμένων κυκλωμάτων πρέπει να μεταφέρονται σε συσκευασία από αγώγιμο υλικό. Οι κάρτες δεν πρέπει να αφαιρεθούν από το προστατευτικό περίβλημα παρά μόνο αμέσως πριν από την τοποθέτηση. Οι κάρτες που αφαιρέθηκαν πρέπει να τοποθετηθούν αμέσως σε προστατευτική συσκευασία για μεταφορά, αποθήκευση ή επιστροφή στο εργοστάσιο.

Παρατηρήσεις:
Η ύπαρξη εξαρτημάτων ευαίσθητων στα φαινόμενα ESD (ηλεκτροστατικής εκκένωσης) δεν είναι μοναδικό χαρακτηριστικό της συσκευής αυτής. Οι περισσότερες σύγχρονες ηλεκτρονικές συσκευές περιέχουν εξαρτήματα τεχνολογίας μεταλλικών οξειδίων (NMOS, SMOS κά.). Η πείρα έχει αποδείξει ότι μια μικρή ποσότητα στατικού ηλεκτρισμού αρκεί για να προκαλέσει βλάβες ή να καταστρέψει τις συσκευές αυτές. Εξαρτήματα που υπέστησαν βλάβη, ακόμη και αν μοιάζουν να λειτουργούν σωστά, κινδυνεύουν από πρώιμη αστοχία.

Hungarian

Alapvető utasítások Először olvassa el ezeket!

A Brooks Instrument olyan módon tervezi, gyártja és teszteli termékeit, hogy azok megfeleljenek számos belföldi és nemzetközi szabványnak. Ezeket a berendezéseket megfelelően kell telepíteni, üzemeltetni és karbantartani ahhoz, hogy mindenképpen a normál működési tartományuknak megfelelően üzemelhessenek. Az alábbi utasításokat be kell tartani, és be kell építeni a munkavédelmi programba a Brooks Instrument termékeinek telepítése, üzemeltetése és karbantartása során.
A megfelelő teljesítmény garantálása érdekében kizárólag szakképzett személyzet végezze a termék telepítését, üzemeltetését, frissítését, programozását és karbantartását.
Valamennyi utasítást el kell olvasni a termék telepítése, üzemeltetése és szervizelése előtt. Amennyiben ez a kézikönyv nem a megfelelő kiadvány, a hátsó borítón keresse meg a helyi forgalmazót, és további tájékoztatásért lépjen kapcsolatba vele. Őrizze meg ezt a kézikönyvet későbbi tájékoztatásként.

⚠ FIGYELEM: Ne működtesse a berendezést az üzemeltetési utasításban megadott üzemi tartományokon túl. Ennek megsértése súlyos személyi sérüléshez vagy a berendezés meghibásodásához vezethet.

- Amennyiben a kezikönyv utasításai nem egyértelműek, lépjen kapcsolatba Brooks Instrument képviselőjével, hogy tisztázzák a problémát.
- Tartsa be a berendezésen feltüntetett vagy azzal együtt szállított összes figyelmeztetést, felhívást és utasítás.

⚠ FIGYELEM: Üzembe helyezés előtt győződjön meg arról, hogy a műszer rendelkezik-e a helyi és nemzeti szabványoknak megfelelő jóváhagyásokkal. Ennek elmulasztása súlyos személyi sérülést és / vagy az eszköz károsodását okozhatja!

- A megfelelő telepítési utasításban megadott utasítások valamint a hatályos helyi és nemzeti előírások szerint telepítse a berendezést. A termékeket kizárólag a megfelelő elektromos és nyomásellátó forrásra kösse.
- Menete: (1) Lassan helyezze nyomás alá a rendszert. Lassanként nyissa ki az üzemi szelepeket az áramlásingadozás elkerülése érdekében. (2) Ellenőrizze, nincs-e szivárgás az áramlásmérő be-, és kimeneti bekötéseinél. Ha nincs szivárgás, töltse fel a rendszert az üzemi nyomásra.
- Szervizelés előtt mindenképpen ellenőrizze, hogy az üzemi vezeték nincs-e nyomás alatt. Amennyiben cserealkatrészekre van szükség, mindenképpen szakképzett személynek kell kezelnie a Brooks Instrument által meghatározott cserealkatrészeket. A nem engedélyezett alkatrészek és tevékenységek befolyásolhatják a termék teljesítményét, illetve veszélyeztethetik a biztonságos üzemeltetést. A pusztán hasonló alkatrészekkel történő helyettesítés tüzet, áramütésveszélyt vagy elégtelen működést eredményezhet.
- A berendezés összes ajtaja mindenképpen legyen zárva, a védőburkolatok pedig legyenek a helyükön az áramütés és a személyi sérülések elkerülése érdekében, kivéve, ha szakképzett szakember végez rajta karbantartási munkákat.

⚠ FIGYELEM: Folyadékot áramoltató berendezések esetében, ha bármilyen okból el kell zárni a berendezés melletti ki-, és belépő szelepeket, a berendezést teljesen le kell üríteni. Ennek elmulasztása a folyadék hőtágulását okozhatja, ami károsíthatja a berendezést, és személyi sérüléshez vezethet.

Nyomástartó berendezésekre vonatkozó európai irányelv (PED)

Minden 0,5 bar-nál (g) magasabb belső nyomású és 25 mm-nél vagy 1 hüvelyknél nagyobb nyomástartó berendezés a nyomástartó berendezésekre vonatkozó európai irányelv (PED) hatálya alá tartozik.

- A használati utasítás „Műszaki adatok” fejezete tartalmaz a PED irányelvre vonatkozó utasításokat.
- A használati utasításban megadott termékek megfelelnek a 2014/34/EU EU irányelvnek.
- Minden Brooks átfolyásmérő az 1-es folyadékcsoportba tartozik.
- A 25 mm-nél vagy 1 hüvelyknél nagyobb termékek megfelelnek a PED I, II, vagy III kategóriának.
- A 25 mm-es illetve 1 hüvelykes vagy kisebb termékek az elfogadott mérnöki gyakorlatot (SEP) követik.

Elektromágneses kompatibilitásra vonatkozó európai irányelv (EMC)

A Brooks Instrument CE jelölést kiérdemelt (elektromos/elektronikus) berendezései sikeresen teljesítették az elektromágneses kompatibilitási követelményeket (2014/30/EU sz. EMC irányelv) vizsgáló teszteket.
Ugyanakkor különös figyelmet kell fordítani a CE jelölésű berendezésekhez felhasznált jelkábelek kiválasztására.
A jelkábelek, kábelösszekötők, csatlakozók minősége:
A Brooks Insturment magas minőségű kábeleket kínál, melyek megfelelnek a CE minősítés követelményeinek.
Amennyiben saját jelkábelt alkalmaznak, olyat kell választani, amely 100%-os árnyékolással, teljes mértékben szűrt.
A „D” vagy „kör alakú” csatlakozóknak fémárnyékolóval árnyékoltnak kell lennie. Szükség esetén fém kábelösszekötőket kell alkalmazni a kábelszűrő rögzítésére.
A kábelszűrőt a fém házhoz vagy hüvelyhez kell csatlakoztatni és mindkét felén 360°-ban le kell árnyékolni. Az árnyékolásnak földelésben kell végződnie.
A kártyákhoz tartozó csatlakozók szabványosan nem fémesek. Az alkalmazott kábeleknek 100%-és árnyékolással szűrteknek kell lenniük, hogy megfeleljenek a CE minősítésnek.
Az árnyékolásnak földelésben kell végződnie.
Érintkező konfiguráció: Lásd a mellékelt kezelési utasítást.

Elektrosztatikus kisülés (ESD)

⚠ VIGYÁZAT: A készülék olyan alkatrészeket tartalmaz, melyek hajlamosak a sztatikus elektromosság okozta károsodásra. Be kell tartani a megfelelő eljárásokat a belső áramköri kártyák és eszközök eltávolítása, behelyezése vagy egyéb kezelése során.
Kezelési eljárás:

1. A berendezést áramtalanítani kell.
2. A személyt földelni kell csuklópánttal vagy egyéb biztonságos és a célra alkalmas eszközzel, mielőtt áramköri kártyát vagy egyéb belső eszközt telepítene, venne ki, vagy állítana be.
3. A nyomtatott áramköri kártyákat vezetőképes csomagolásban kell szállítani. A kártyák kizárólag közvetlenül a behelyezés előtt vehetők ki a védőburkolatból. A kiszerelt kártyát haladéktalanul el kell helyezni a mozgatásra, raktározásra vagy a gyári visszaszállításra szolgáló védőcsomagolásba.

Megjegyzések:
Nem egyedi jelenség, hogy a készülékben elektrosztatikus kisülésre (ESD) érzékeny alkatrészek találhatók. A legtöbb korszerű elektronikus eszközben fémoxid technológiás alkatrészek (NMOS, SMOS stb.) találhatók. A tapasztalatok azt igazolják, hogy még kis mértékű sztatikus elektromosság is károsíthatja, vagy tönkreteheti ezeket az eszközöket. A károsodott alkatrészek, még ha látszólag megfelelően működnek is, kezdődő hibára utalnak.

Italian

Istruzioni fondamentali Leggerle subito!

La Brooks Instrument progetta, fabbrica e collauda i propri prodotti in maniera tale che siano conformi ai vari standard nazionali ed internazionali. Tali apparecchiature devono essere installate, messe in esercizio e tenute in manutenzione in maniera adeguata affinché operino in conformità alle loro normali specifiche di funzionamento. Le seguenti istruzioni devono essere rispettate ed inserite nel programma di tutela sul lavoro durante l'installazione, il funzionamento e la manutenzione dei prodotti Brooks Instrument.

- Per garantire un adeguato rendimento l'installazione, il funzionamento, l'aggiornamento, la programmazione e la manutenzione del prodotto devono essere eseguiti esclusivamente da personale specializzato.
- Leggere tutte le istruzioni prima dell'installazione, utilizzo e manutenzione del prodotto. Se questo manuale non è quello relativo al Vostro prodotto, cercare sul retro della copertina il distributore locale e contattarlo per ulteriori informazioni. Conservare il presente manuale per future consultazioni.

⚠ ATTENZIONE: Non utilizzare questo strumento in condizioni che eccedono le specifiche riportate nel Manuale d'Uso. L'inosservanza può causare gravi lesioni alle persone e/o danni all'apparecchiatura.

- Qualora le istruzioni del manuale non siano chiare, contattare un rappresentante della Brooks Instrument per chiarire il problema.
- Rispettare tutti gli avvisi, le istruzioni e gli avvertimenti riportati sull'apparecchiatura o forniti insieme ad essa.

⚠ ATTENZIONE: prima di installare questo strumento, assicurarsi che sia in regola rispetto alle normative di sicurezza locali e nazionali. La non osservanza di questo avvertimento può procurare seri danni a persone e/o danneggiare sia lo strumento che le cose circostanti.

- Installare l'apparecchiatura in base alle istruzioni riportate nel Manuale d'Uso e alle prescrizioni locali e nazionali in vigore. Collegare i prodotti esclusivamente ad un'adeguata sorgente di pressione ed alimentazione elettrica.
- Procedimento: (1) mettere lentamente sotto pressione il sistema. Aprire lentamente le valvole di servizio per evitare l'oscillazione del flusso. (2) Controllare che non ci siano perdite nei punti di connessione in entrata e in uscita del misuratore di flusso. Se non ci sono perdite, caricare il sistema alla pressione d'esercizio.
- Prima di effettuare manutenzione controllare che la linea di processo non sia sotto pressione. Se avete bisogno di pezzi di ricambio, il personale specializzato deve usare i pezzi di ricambio definiti dalla Brooks Instrument. Attività e pezzi di ricambio non autorizzati possono influire sul rendimento del prodotto e comprometterne il funzionamento in sicurezza. La sostituzione con pezzi di ricambio non originali può causare incendi, pericolo di scosse elettriche o funzionamento improprio.
- Tutti gli sportelli dell'impianto devono essere chiusi, le cappe di protezione devono essere al loro posto per evitare scosse elettriche e lesioni personali, tranne quando il personale specializzato esegue lavori di manutenzione.

⚠ ATTENZIONE: In caso di apparecchiature in cui scorre un liquido, se per qualsiasi motivo bisogna chiudere le valvole d'entrata e d'uscita accanto all'apparecchiatura, allora si deve svuotare completamente l'apparecchiatura. L'inosservanza può causare la dilatazione termica del liquido che può danneggiare l'apparecchiatura e provocare lesioni alle persone.

Direttiva europea relativa alle apparecchiature a pressione (PED)

Ogni apparecchiatura a pressione con pressione interna maggiore di 0,5 bar (g) e più grande di 25 mm o di 1 pollice ricade nell'ambito della Direttiva Europea relativa alle apparecchiature a pressione (PED).

- Il capitolo „Dati tecnici" del manuale contiene le disposizioni relative alla direttiva PED.
- I prodotti di misura descritti nel presente manuale sono conformi alla Direttiva UE 2014/34/EU.
- Ogni flussimetro Brooks appartiene al gruppo di fluidi 1.
- I prodotti di misura maggiori di 25 mm o di 1 pollice sono conformi alla categoria I, II o III della PED.
- I prodotti di misurazione minori di 25 mm o di 1 pollice rientrano nella categoria SEP (Sound Engineering Practice).

Direttiva europea relativa alla compatibilità elettromagnetica (EMC)

Le apparecchiature (elettriche/elettroniche) Brooks Instrument dispongono del marchio CE ed hanno superato positivamente i test per i requisiti di compatibilità elettromagnetica (Direttiva EMC 2014/30/EU).

In ogni caso bisogna prestare particolare attenzione alla scelta dei cavi di segnale utilizzati per le apparecchiature con marchio CE.

Qualità dei cavi di segnale, dei pressacavi e dei connettori:

La Brooks Instrument offre cavi d'alta qualità conformi ai requisiti della certificazione CE.

Qualora vengano utilizzati cavi di segnale propri, devono essere scelti con schermatura al 100% e interamente filtrati.

I connettori „D" o „rotondi" devono essere schermati con schermatura metallica. In caso di necessità bisogna utilizzare pressacavi metallici di collegamento per fissare la schermatura del cavo.

La schermatura del cavo deve far contatto col guscio metallico o col pressacavo; il cavo deve essere schermato su entrambi i lati a 360°. La schermatura deve essere effettuata con messa a terra.

I connettori Card Edge normalmente non sono di metallo. I cavi utilizzati devono essere filtrati con schermatura al 100% per essere conformi alla marcatura CE.

La schermatura deve essere effettuata con messa a terra.

Configurazione pin: Vedi Manuale d'uso allegato.

Scarica elettrostatica (ESD)

⚠ ATTENZIONE: Il dispositivo contiene componenti elettronici che possono essere danneggiati da elettricità statica. Bisogna rispettare le adeguate procedure durante la rimozione, l'installazione o altra manovra delle schede del circuito elettrico interno.

Procedura di manovra:

1. Togliere alimentazione elettrica all'apparecchiatura.
2. La persona deve essere collegata a terra con una cerniera o con altri strumenti di sicurezza e adeguati allo scopo prima di installare, togliere o impostare la scheda del circuito elettrico o altri dispositivi interni.
3. Le schede del circuito stampato devono essere spedite in contenitori conduttivi. Le schede devono essere tolte dal rivestimento protettivo esclusivamente prima dell'installazione. Le schede confezionate devono essere collocate immediatamente nell'imballaggio protettivo per la movimentazione, l'immagazzinamento o resa alla fabbrica.

Note:

È un fenomeno comune che nei dispositivi di questo tipo si trovino componenti sensibili alla scarica elettrostatica (ESD). Nella maggior parte degli strumenti elettronici moderni si trovano componenti tecnologici metallo-ossido (NMOS, SMOS, ecc.). Le esperienze dimostrano che l'elettrostaticità anche in piccola misura può danneggiare o rovinare gli strumenti. I componenti danneggiati, anche se all'apparenza funzionano correttamente, potrebbero manifestare il difetto rapidamente.

Latvian

Svarīga instrukcija

Pirms turpināt izlasiet!

„Brooks Instrument" projektē, ražo un pārbauda savus izstrādājumus atbilstoši daudziem nacionālajiem un starptautiskajiem standartiem. Lai nodrošinātu šo izstrādājumu turpmāku darbību atbilstoši noteiktajiem parametriem, tie ir pareizi jāuzstāda, jālieto un jāapkopj. Uzstādot, lietojot „Brooks Instrument" izstrādājumus un veicot to apkopi, ir jāievēro šie norādījumi un jāiekļauj tie jūsu drošības programmā.

- Lai nodrošinātu pienācīgu izstrādājuma sniegumu, izstrādājuma uzstādīšanu, lietošanu, atjaunināšanu, programmēšanu un apkopi uzticiet veikt tikai kvalificētam personālam.
- Pirms izstrādājuma uzstādīšanas, lietošanas un apkalpošanas izlasiet visus norādījumus. Ja šī instrukciju rokasgrāmata nav pareizā, izstrādājumam atbilstošā rokasgrāmata, lūdzu skat. aizmugurējo vāku, kur ir sniegta vietējā tirdzniecības biroja kontaktinformācija.
  ⚠ **BRĪDINĀJUMS! Nelietot instrumentu ārpus Instrukciju un lietošanas rokasgrāmatā norādītajiem parametriem. Šī brīdinājuma neievērošanas rezultātā var rasties traumas un/vai aprīkojuma bojājumi.**
- Ja jūs nesaprotat kādu no instrukcijām, sazinieties ar „Brooks Instrument" pārstāvi un lūdziet izskaidrot to.
- Ievērojiet visus brīdinājumus, piesardzības mērus un instrukcijas, kas norādīti uz izstrādājuma vai piegādāti kopā ar to.
  ⚠ **BRĪDINĀJUMS. Pirms uzstādīšanas pārliecinieties, ka šim instrumentam ir nepieciešamie apstiprinājuma novērtējumi, lai atbilstu vietējiem un valsts kodeksiem. Šī brīdinājuma neizlasīšanas rezultātā var rasties nopietni personas savainojumi un/vai aprīkojuma bojājumi.**
- Uzstādiet aprīkojumu tā, kā tas norādīts attiecīgajā instrukciju rokasgrāmatā iekļautajā uzstādīšanas instrukcijā un atbilstoši piemērojamajām vietējām un nacionālajām normām. Pievienojiet visus izstrādājumus pareiziem elektriskajiem un spiediena avotiem.
- Lietošana: (1) Lēnām uzsāciet plūsmu sistēmā. Lai izvairītos no straujiem plūsmas kāpumiem, lēnām atveriet procesa vārstus. (2) Pārbaudiet, vai nav noplūdes ap plūsmas mērītāja ieplūdes un izplūdes savienojumiem. Ja noplūdes nav, uzstādiet sistēmā darba spiedienu.
- Pārliecinieties par to, lai pirms instrumenta tehniskās apkopes būtu likvidēts procesa līnijas spiediens. Ja ir nepieciešams veikt kādu daļu nomaiņu, nodrošiniet, lai tiktu izmantotas „Brooks Instrument" norādītās daļas un daļu nomaiņu veiktu kvalificēts personāls. Neatļautu daļu un procedūru izmantošana var ietekmēs izstrādājuma sniegumu un samazināt procesa drošību. Līdzīgu, bet ne identisku daļu nomaiņas lietošana var izraisīt ugunsgrēka, elektrisko traucējumu riskus un nepareizu izstrādājuma darbību.
- Nodrošiniet, lai būtu aizvērtas visas durvis un būtu pareizi uzstādīti visi aizsargpārsegumi, tādējādi novēršot elektrošoka un traumu risku. Izņēmums ir gadījumi, kad kvalificēts personāls veic ražojuma apkopi.
  ⚠ **BRĪDINĀJUMS! Ja šķidrās plūsmas ierīču tuvumā esošos ieplūdes un izplūdes vārstus kāda iemesla dēļ ir jāaizver, no ierīcēm ir jāizlaiž viss šķidrums. Pretējā gadījumā šķidrums var termiski izplesties, pārraut ierīci un radīt traumas.**

Eiropas spiedieniekārtu direktīva (PED)

Uz visām spiedieniekārtām, kuru iekšējais spriegums pārsniedz 0,5 bar (g) un ir lielākas par 25 mm jeb 1" (collu), attiecas Eiropas spiedieniekārtu direktīva (PED).

- Šīs rokasgrāmatas tehnisko parametru nodaļā ir sniegtas a PED Direktīvu saistītās instrukcijas.
- Šajā rokasgrāmatā aprakstītie izstrādājumi atbilst EN Direktīvas 2014/34/EU prasībām.
- Visi „Brooks Instrument" plūsmas mērītāji ietilpst 1. šķidrumu grupā.
- Uz 25 mm jeb 1" (collu) maziem un mazākiem izstrādājumiem attiecas labas inženierijas prakse (SEP).
- 25 mm jeb 1" (collu) mazi vai mazāki izstrādājumi atbilst PED kategorijai I, II vai III.

Eiropas elektromagnētiskās savietojamības direktīva (EMS)

„Brooks Instrument" (elektriskās/elektroniskās) iekārtas ar CE zīmi ir izturējušas pārbaudi un atzītas par atbilstošām Eiropas elektromagnētiskās savietojamības direktīvas (EMS) prasībām (EMS 2014/30/EU)
Tomēr, izvēloties signālkabeli, kas tiks lietots kopā ar CE marķējuma iekārtu, ir jāievēro īpaša uzmanība.
Signālkabeļa, kabeļa blīvslēgu un savienotāju kvalitāte:
„Brooks Instrument" piegādā augstas kvalitātes kabeļus, kas atbilst CE sertifikācijas tehniskajiem parametriem.
Ja jūs lietojat pats savu signālkabeli, tam ir jābūt pilnībā, 100% ekranizētam.
„D" un „apaļā" tipa savienotājiem ir jābūt aprīkotiem ar metāla ekranizējumu. Ja nepieciešams, ir jāizmanto metāla blīvslēgi ar kabeļa ekranizējuma skavojumu.
Kabeļa ekranizējumam ir jābūt savienotam ar metāla apvalku un abās pusēs aizsargātam 360 grādu diapazonā.
Ekranizējumam ir jābeidzas pie iezemējuma.
„Card Edge" savienotāji standarta izpildījumā ir nemetāla. Kabeļiem ir jābūt pārklātiem ar 100% ekranizējumu, lai tie atbilstu CE sertifikācijas prasībām.
Ekranizējumam ir jābeidzas pie iezemējuma.
Attiecībā uz tapu konfigurāciju: skat. pievienoto instrukciju rokasgrāmatu.

ESD (elektrostatiskā izlāde)

⚠ **IEVĒROT PIESARDZĪBU! Šis instruments satur elektriskos komponentus, kas ir jutīgi pret statisko elektrību. Izņemot un uzstādot iekšējās ķēdes plates un ierīces vai kā citādi darbojoties ar tām, ir jāievēro noteikta darba kārtība.**
Darba kārtība:

1. Iekārta jāatslēdz no barošanas.
2. Pirms jebkādas drukātas shēmas kartes vai citas iekšējās ierīces uzstādīšanas, izņemšanas vai regulēšanas personālam, kas veiks šos darbus, ir jābūt iezemētam, piem., izmantojot aproces vai citus drošus, piemērotus līdzekļus.
3. Drukātās shēmas kartes ir jātransportē vadošā iepakojumā. Plāksnes no aizsargkorpusa drīkst izņemt tikai tieši pirms uzstādīšanas. Transportējot, uzglabājot vai atgriežot rūpnīcā, izņemtās plāksnes ir nekavējoties jāievieto aizsargiepakojumā.

Komentāri
Instruments nav unikāls tajā aspektā, ka tas satur pret ESD (elektrostatisko izlādi) jutīgus komponentus. Vairākums mūsdienu elektroiekārtu satur komponentus, kuru ražošanā izmantota metāla oksīdu tehnoloģijas (NMOS, SMOS u.c.). Pieredze rāda, ka pat neliels daudzums statiskās elektrības var nodarīt bojājumus šādām ierīcēm vai pilnībā sabojāt tās. Bojātie komponenti pat tad, ja tie šķietami darbojas pareizi, ir pakļauti ātrākai atteicei.

Lithuanian

Pagrindinės instrukcijos

Perskaitykite prieš tęsdami!

„Brooks Instrument“ projektuoja, gamina ir išbando savo gaminius, kad jie atitiktų įvairius nacionalinius ir tarptautinius standartus. Šie gaminiai turi būti tinkamai montuojami, eksploatuojami ir prižiūrimi, kad ir toliau veiktų pagal jiems būdingus techninius parametrus. Toliau pateiktų nurodymų reikia laikytis ir įtraukti juos į saugos programą montuojant, eksploatuojant ir prižiūrint „Brooks Instrument“ gaminius.

- Siekiant užtikrinti tinkamą veikimą, montuoti, eksploatuoti, naujinti, programuoti ir prižiūrėti gaminį turi tik kvalifikuoti darbuotojai.
- Perskaitykite visus nurodymus prieš montuodami, eksploatuodami ir prižiūrėdami gaminį. Jei gavote netinkamą instrukciją, galiniame jos viršelyje ieškokite vietinės prekybos atstovybės kontaktinės informacijos. Neišmeskite šios instrukcijos, jos gali prireikti ateityje.

⚠ **ĮSPĖJIMAS: nenaudokite šio prietaiso viršydami instrukcijoje ir eksploatacijos vadove nurodytus techninius duomenis. Nesilaikydami šio įspėjimo galite sunkiai susižeisti ir (arba) sugadinti įrangą.**

- Jei nesuprantate kokių nors nurodymų, kreipkitės į „Brooks Instrument“ atstovą, kad paaiškintų.
- Paisykite visų įspėjimų, perspėjimų ir nurodymų, pažymėtų ant gaminio arba pateiktų su juo.

⚠ **ĮSPĖJIMAS: prieš montuodami įsitikinkite, kad ši įranga atitinka vietinius ir nacionalinius teisės aktus. Nepaisant šio įspėjimo gali būti sužeisti žmonės ir (arba) pažeista įranga.**

- Įrangą montuokite taip, kaip nurodyta atitinkamos instrukcijos montavimo nurodymuose arba taikomuose vietiniuose ar nacionaliniuose teisės aktuose. Visus gaminius junkite prie tinkamų elektros ir slėgio šaltinių.
- Naudojimas: (1) lėtai įjunkite srautą į sistemą. Lėtai atidarykite proceso vožtuvus, kad išvengtumėte srauto antplūdžių. (2) Patikrinkite, ar nėra nuotėkių aplink srauto matuoklio įleidimo ir išleidimo jungtis. Jei nuotėkių nėra, sukurkite sistemoje darbinį slėgį.
- Prieš atlikdami priežiūros darbus būtinai pašalinkite slėgį proceso linijoje. Jei reikia pakeisti dalis, užtikrinkite, kad kvalifikuoti darbuotojai naudotų „Brooks Instrument“ nurodytas pakaitines dalis. Naudojant netinkamas dalis ir netinkamai atliekant procedūras, gali pablogėti gaminio veikimas ir gali kilti pavojus naudojimo proceso saugai. Naudojant tik panašiai atrodančius pakaitalus gali kilti gaisro ar elektros smūgio pavojus arba gaminys gali veikti netinkamai.
- Užtikrinkite, kad visos įrangos durelės būtų uždarytos, o apsauginiai dangčiai uždėti, kad išvengtumėte elektros smūgio ir sužeidimų, išskyrus, kai kvalifikuoti darbuotojai atlieka priežiūros darbus.

⚠ **ĮSPĖJIMAS: naudojant skysto srauto įrenginius, jei dėl kokios nors priežasties prireikia uždaryti šalia įrenginio esančius įleidimo ir išleidimo vožtuvus, iš įrenginio reikia išleisti visą skystį. To nepadarius galimas šiluminis skysčio plėtimasis, galintis sugadinti įrenginį ir sužeisti žmonės.**

Europos slėginės įrangos direktyva (PED)

Visa slėginė įranga, kurios vidinis slėgis didesnis nei 0,5 bar (g), o dydis didesnis nei 25 mm arba 1 col., yra reglamentuojama Slėginės įrangos direktyvos (PED).

- Šios instrukcijos dalyje „Techniniai duomenys“ pateikiami nurodymai, susiję su PED direktyva.
- Šioje instrukcijoje aprašyti gaminiai atitinka Europos Sąjungos direktyvą 2014/34/EU.
- Visi „Brooks Instrument“ srauto matuokliai priklauso 1 skysčių grupei.
- Didesni nei 25 mm arba 1 col. gaminiai atitinka PED I, II arba III kategoriją.
- 25 mm arba 1 col. ar mažesni gaminiai atitinka tinkamą inžinerijos praktiką (SEP).

Europoje taikomi elektromagnetinio suderinamumo (EMS) reikalavimai

CE ženklu pažymėta „Brooks Instrument“ (elektrinė / elektroninė) įranga buvo sėkmingai išbandyta pagal elektromagnetinio suderinamumo reikalavimus (EMS direktyvą 2014/30/EU).
Tačiau ypač atidžiai reikia rinktis signalizavimo kabelį, kuris bus naudojamas su CE ženklu pažymėta įranga.
Signalizavimo kabelio, kabelių riebokšlių ir jungčių kokybė:
„Brooks Instrument“ tiekia kokybiškus kabelius, kurie atitinka CE sertifikavimo specifikacijas.
Jei naudojate savo signalizavimo kabelį, jis turi būti visiškai ir visas ekranuotas 100 % ekranu.
Naudojamos „D“ arba „apskrito“ tipo jungtys turi būti ekranuotos metaliniu ekranu. Jei taikoma, reikia naudoti metalinius kabelių riebokšlius, užtikrinančius kabelio ekrano suspaudimą.
Kabelio ekraną reikia jungti prie metalinio apvalkalo ar riebokšlio ir ekranuoti abiejuose galuose 360 laipsnių.
Ekranas turi užsibaigti įžeminimu.
Standartinės kraštinės jungtys yra nemetalinės. Naudojami kabeliai turi būti ekranuoti 100 % ekranu, kad atitiktų CE sertifikavimą.
Ekranas turi užsibaigti įžeminimu.
Keturių kontaktų konfigūracija: žr. pridėtą instrukciją.

ESD (elektrostatinis išlydis)

⚠ **PERSPĖJIMAS: šiame prietaise yra elektroninių komponentų, kuriuos gali sugadinti statinė elektra. Išimant ar įdedant vidines spausdintines plokštes ar įrenginius, arba atliekant su jomis kitus darbus, reikia laikytis tinkamų darbo procedūrų.**
Darbo procedūra:

1. Atjunkite įrenginio maitinimą.
2. Darbuotojai turi pasirūpinti įžeminimu naudodami riešo juostelę ar kitas saugias tinkamas priemones prieš įdėdami, išimdami ar reguliuodami bet kokią spausdintinės plokštės kortelę ar kitą vidinį komponentą.
3. Spausdintinės plokštės korteles reikia transportuoti laidžiame konteineryje. Neleidžiama išimti plokštės iš apsauginio dėklo, nebent prieš pat įdėjimą. Išimtas plokštes reikia nedelsiant įdėti į apsauginį konteinerį, kuriame jos bus transportuojamos ar saugomos, arba grąžinti į gamyklą.

Pastabos
Šis instrumentas nėra unikalus dėl jame esančių ESD (elektrostatiniam išlydžiui) jautrių komponentų. Daugelyje šiuolaikinių elektroninių gaminių yra komponentų, kuriuose naudojama metalo oksidų technologija (NMOS, SMOS ir pan.). Patirtis rodo, kad net ir mažas statinės elektros kiekis gali pakenkti tokiems gaminiams ar juos sugadinti. Sugadinti komponentai, net jei atrodo, kad jie veikia tinkamai, greitai sugenda.

Polish

Niezbędne zalecenia

Prosimy przeczytać przed rozpoczęciem użytkowania!

Brooks Instrument projektuje, wytwarza i testuje swoje produkty tak, aby spełniały wymagania licznych norm krajowych i międzynarodowych. Produkty te muszą być poprawnie instalowane, obsługiwane oraz konserwowane, aby zapewnić ich prawidłowe działanie zgodnie ze specyfikacją techniczną. Podczas instalowania, obsługiwania i konserwowania produktów firmy Brooks Instrument należy przestrzegać następujących zaleceń:

- Aby zapewnić właściwe działanie sprzętu, instalacja, obsługa, aktualizacje, programowanie i konserwacja powinny być wykonywane przez przeszkolony personel.
- Przed instalacją, obsługą i czynnościami serwisowymi należy zapoznać się ze wszystkimi zaleceniami producenta. Aby uzyskać instrukcję obsługi odpowiednią dla danego sprzętu, należy skontaktować się z lokalnym przedstawicielem handlowym producenta. Instrukcję obsługi należy zachować do późniejszego użycia.

⚠ **OSTRZEŻENIE: Nie wolno przekraczać podanych w instrukcji zakresów działania urządzenia. Nieprzestrzeganie tego zalecenia może doprowadzić do poważnego zagrożenia życia lub zdrowia personelu i / lub uszkodzenia sprzętu.**

- Jeżeli jakieś zalecenia w instrukcji obsługi urządzenia są niezrozumiałe, prosimy o skontaktowanie się z przedstawicielem firmy Brooks Instrument, aby wyjaśnić problem.
- Należy przestrzegać wszystkich ostrzeżeń, uwag i zaleceń umieszczonych na produkcie lub do niego dołączonych

⚠ **OSTRZEŻENIE: Przed rozpoczęciem instalacji należy sprawdzić, czy wymagana specyfikacja niniejszego urządzenia zgodna jest z miejscowymi i krajowymi normami.**
Zignorowanie tego ostrzeżenia może spowodować poważne obrażenia ciała i/lub uszkodzenie sprzętu.

- Instalację urządzenia należy przeprowadzić zgodnie z zaleceniami zawartymi w instrukcji instalacji oraz z obowiązującymi lokalnymi i narodowymi oznaczeniami. Wszystkie urządzenia można podłączać wyłącznie do odpowiednich źródeł energii elektrycznej oraz ciśnienia.
- Pierwsze czynności obsługowe: (1) Należy powoli włączyć przepływ w instalacji. Następnie powoli otworzyć zawory robocze tak, aby uniknąć wahań przepływu. (2) Należy teraz sprawdzić, czy nie występują nieszczelności przy podłączeniach wejściowym i wyjściowym miernika przepływu. Jeżeli nie ma żadnych nieszczelności, można zwiększyć ciśnienie w instalacji do wartości ciśnienia roboczego.
- Przed przystąpieniem do czynności serwisowych należy upewnić się, że ciśnienie robocze jest odłączone. Jeżeli konieczna jest wymiana części zamiennych, należy zawsze stosować części zamienne specyfikowane przez firmę Brooks Instrument a czynności ich wymiany powinien w każdym przypadku dokonywać przeszkolony personel. Stosowanie nieautoryzowanych części i procedur serwisowych może niekorzystnie wpłynąć na działanie produktu oraz zagrozić bezpieczeństwu instalacji. Korzystanie z podobnie wyglądających zamienników może doprowadzić do pożaru, porażenia prądem lub nieprawidłowego działania urządzenia.
- Należy upewnić się, że wszystkie otwory urządzenia są zamknięte a osłony umocowane na swoich miejscach, aby zapobiec obrażeniom ciała lub porażeniu prądem personelu. Zalecenie to nie dotyczy przeszkolonego pracownika wykonującego prace serwisowe lub konserwacyjne.

⚠ **OSTRZEŻENIE: W przypadku mierników przepływu cieczy, jeżeli znajdujące się na nich zawory wejściowe i wyjściowe mają być z jakiegoś powodu zamknięte, to urządzenie musi zostać całkowicie opróżnione z ciekłego medium. Niedopełnienie tego zalecenia może doprowadzić do termicznego zwiększenia objętości cieczy, co z kolei może spowodować uszkodzenie urządzenia i obrażenia personelu.**

Europejska dyrektywa dotycząca urządzeń ciśnieniowych (PED)

Wszystkie urządzenia ciśnieniowe pracujące przy ciśnieniu wewnętrznym względnym większym niż 0,5 bara i wielkości powyżej 25 mm lub 1 cala podlegają dyrektywie europejskiej dotyczącej urządzeń ciśnieniowych (PED).

- Rozdział „Specyfikacja techniczna" niniejszej instrukcji zawiera zalecenia dotyczące dyrektywy PED.
- Produkty opisane w tej instrukcji są zgodne z dyrektywą EN 2014/34/EU.
- Wszystkie mierniki przepływu firmy Brooks Instrument należą do 1. grupy cieczy.
- Produkty o wielkości powyżej 25 mm lub 1 cala należą do kategorii I, II lub III dyrektywy PED.
- Produkty o wielkości 25 mm lub 1 cala lub mniejsze podlegają zaleceniom „Uznanej Praktyki Inżynierskiej" (SEP).

Europejska dyrektywa dotycząca kompatybilności elektromagnetycznej (EMC)

Urządzenia elektryczne / elektroniczne firmy Brooks Instrument posiadające oznaczenie CE, przeszły pozytywnie testy pod kątem spełniania przez nich wymogów kompatybilności elektromagnetycznej (Dyrektywa EMC 2014/30/EU).
Jednakże szczególną uwagę należy poświęcić przy doborze przewodów sygnałowych, które mają być stosowane z urządzeniami ze znakiem CE.
Jakość przewodu sygnałowego, dławic oraz złączy przewodu:
Firma Brooks Instrument dostarcza wysokiej jakości przewody, które spełniają wymagania zawarte w specyfikacji dla certyfikatu CE.
Jeżeli stosuje się własne przewody sygnałowe, to powinny one być w całości w pełni ekranowane.
Złącza typu „D" lub okrągłe powinny zawierać metalowy ekran. Jeśli to możliwe, należy stosować metalowe dławice przewodu zapewniające mocowanie jego ekranu.
Ekran przewodu powinien być połączony z metalową osłoną lub dławicą zapewniając całkowite, dookólne ekranowanie na obu końcach przewodu.
Ekran przewodu powinien być uziemiony.
Złącza krawędziowe są standardowo niemetaliczne. Stosowane przewody muszą być w pełni ekranowane zgodnie z certyfikatem CE.
Ekran przewodu powinien być uziemiony.
Konfiguracja styków jest podana w niniejszej instrukcji obsługi.

Wyładowania elektrostatyczne (ESD)

⚠ **UWAGA: Urządzenie zawiera części elektroniczne podatne na uszkodzenia spowodowane ładunkami elektrostatycznymi. Przy obchodzeniu się z wewnętrznymi podzespołami i częściami elektronicznymi należy przestrzegać następujących zasad postępowania:**

1. Należy odłączyć zasilanie od urządzenia.
2. Osoba wykonująca czynności musi zostać uziemiona za pomocą opaski na przegubie dłoni lub w inny, bezpieczny sposób, zanim przystąpi do instalacji, wyjęcia lub regulacji obwodów drukowanych lub innych wewnętrznych podzespołów elektronicznych urządzenia.
3. Obwody drukowane należy transportować w przewodzącym pojemniku. Płytki drukowane należy wyjmować z opakowania ochronnego bezpośrednio przed ich montażem. Wymontowane płytki należy niezwłocznie umieścić w opakowaniu ochronnym służącym do transportowania, składowania lub odsyłania do producenta.

Uwagi:
Fakt, że urządzenie zawiera części nieodporne na wyładowania elektrostatyczne (ESD) jest rzeczą normalną. Większość nowoczesnych urządzeń elektronicznych zawiera komponenty wykonane w technologii tlenków metali (NMOS, SMOS itp.). Jak pokazuje praktyka, nawet niewielkie wyładowanie elektrostatyczne może uszkodzić lub zniszczyć takie urządzenie. Uszkodzone części, nawet jeżeli na pozór działają poprawnie, szybko doprowadzają do nieprawidłowej pracy urządzenia.

Portuguese

Instruções Básicas
Ler antes de proceder!

A Brooks Instrument projecta, fabrica e testa os seus produtos de forma a satisfazer numerosas normas nacionais e internacionais. Estes equipamentos devem ser instalados, utilizados e mantidos de forma adequada, e devem funcionar dentro da sua gama de utilização. As instruções seguintes devem ser, durante a instalação, uso e/ou manutenção dos equipamentos da Brooks Instrument, apreendidas e integradas no plano de protecção e segurança no trabalho.

- Para assegurar o desempenho adequado, a instalação, exploração, actualização e/ou manutenção do equipamento deve ser realizada, exclusivamente, por pessoal qualificado.
- Antes de instalar, utilizar e/ou executar operações de manutenção devem ser lidas todas as instruções do equipamento. No caso do presente manual não ser apropriado procure, na capa traseira, o distribuidor mais próximo e contacte-o para obter informações adicionais. Guarde este manual para futura referência.

⚠ ATENÇÃO: não sujeite o equipamento a condições fora das gamas de serviços indicadas. Ao não respeitar esta advertência poderá provocar avarias no equipamento e/ou danos pessoais.

- Se as instruções deste manual não estiverem suficientemente claras, contacte o representante Brooks Instrument para esclarecer as suas dúvidas.
- Tenha sempre presente todas as advertências, apelos e instruções indicadas no equipamento e/ou fornecidas junto com o mesmo.

⚠ AVISO: Antes de proceder à instalação, certifique-se de que este instrumento está em conformidade com as categorias de homologação exigidas pelas regulamentações locais e nacionais. O incumprimento pode resultar em lesões pessoais graves e/ou danos no equipamento.

- A instalação do equipamento deverá ser efectuada cumprindo todas as instruções indicadas no manual assim como as normas e regulamentos locais e nacionais vigentes. Ligue o equipamento exclusivamente a fontes de energia eléctrica e/ou pneumática adequadas.
- Procedimento: (1) Pressurize lentamente o sistema. Abra lentamente as válvulas para evitar variações bruscas de caudal. (2) Verifique se há fugas nas ligações de entrada e saída do medidor de caudal. Se não detectar fugas, poderá colocar o sistema à pressão de trabalho.
- Antes de efectuar qualquer operação de manutenção verifique sempre a possibilidade do equipamento estar sob pressão. No caso de ser preciso substituir peças, estas devem ser as recomendadas pela Brooks Instrument e o trabalho de substituição deverá ser efectuado por técnicos qualificados. Procedimentos e peças não conformes poderão alterar o desempenho do equipamento, danificá-lo ou colocar em risco a sua segurança ou de outros. Substituir peças por outras não originais, meramente semelhantes, poderá originar choques eléctricos, fogo ou em funcionamento inadequado.
- Deverá manter o equipamento intacto e fechado, verificando se as coberturas de protecção estão nos seus lugares devidos, de forma a evitar choques eléctricos e/ou danos pessoais, excepto no caso de se tratar de um técnico qualificado e se estiver a executar trabalhos de manutenção.

⚠ ATENÇÃO: Se por qualquer razão for necessário fechar as válvulas a montante e jusante do equipamento, tenha em atenção que o mesmo deverá ser previamente esvaziado do fluído que o atravessa. Esta obrigação surge do facto de existir a possibilidade de ocorrer dilatação térmica do líquido, no interior do aparelho, podendo provocar danos pessoais ou materiais graves.

Directiva Europeia para equipamentos sob pressão (PED)

Todos os equipamentos sujeitos a pressão interior superior a 0,5 bar (g) e com calibre superior a 25 mm (1 polegada) estão sob a vigência da directiva europeia de equipamentos sob pressão (PED).

- O capítulo "Dados técnicos" do manual contém instruções relativas à Directiva PED.
- O produto objecto deste manual satisfaz a directiva 2014/34/EU da UE.
- Os caudalímetros Brooks pertencem ao grupo 1 de fluidos.
- Os produtos com calibre superior a 25 mm (1 polegada) pertencem às categorias PED I, II, ou III.
- Os produtos de 25 mm (1 polegada) ou menores seguem as “Boas regras de engenharia” (SEP).

Directiva Europeia sobre Compatibilidade electromagnética (EMC)

Os equipamentos (eléctricos/electrónicos) da Brooks Instrument que têm a marcação CE passaram os testes comprovativos dos requisitos de compatibilidade electromagnética (Directiva EMC número 2014/30/EU).
Todavia, ao utilizar os aparelhos compete-lhe a escolha dos cabos de sinal adequados para os equipamentos com marcação CE.

Qualidade dos cabos de sinal, bucins e conectores:

A Brooks Instrument fornece cabos de alta qualidade que cumprem todos os requisitos da marcação CE.
No caso de utilizar os seus próprios cabos de sinal, assegure uma blindagem a 100%.
Os conectores do tipo “D” ou "circular" têm que ser blindados por uma malha metálica. Se precisar de usar bucins, estes têm que permitir a crimpagem da malha/blindagem do cabo.
A blindagem do cabo deve ser ligada ao corpo metálico ou bocal e assegurando a blindagem em 360°. A blindagem deve terminar numa ligação à terra.
Os conectores ligados a cartões serão, em geral, não-metálicos. Os cabos utilizados devem ter fita de blindagem a 100% para satisfazer a marcação CE.
A blindagem, deverá terminar numa ligação à terra.
Atribuição de pinos: Veja as instruções de operação anexas.

Descarga Electrostática (ESD)

⚠ ATENÇÃO: Alguns componentes deste equipamento são susceptíveis à acção da electricidade estática, podendo ficar danificados. Ao remover, colocar ou manipular placas de circuitos electrónicos deverá ter em atenção os seguintes procedimentos:

1. Desligar o equipamento da rede.
2. O utilizador, antes de qualquer intervenção que envolva os cartões de circuitos ou outros dispositivos internos, terá que se ligar à terra por meio duma bracelete de pulso ou outro dispositivo adequado.
3. Os circuitos impressos deverão ser transportados numa embalagem condutiva. Os cartões só deverão ser retirados da embalagem protectora imediatamente antes da sua inserção. O cartão retirado deverá ser recolocado imediatamente na embalagem protectora que servirá para o seu transporte, armazenagem ou retorno a fábrica.

Observações:

Tenha presente que este equipamento poderá não ser o único objecto capaz de ser portador de peças sensíveis a descargas electrostáticas (ESD).
Na maioria dos dispositivos electrónicos Brooks encontram-se peças de tecnologia de óxidos metálicos (NMOS, SMOS, etc.). A experiência mostra que até pequenas quantidades de electricidade estática são capazes de danificar ou destruir esses dispositivos. Os componentes danificados, embora inicialmente funcionem aparentemente bem, acabam por ter falhas prematuramente.

Romanian

Indicaţii de referinţă

Citiţi-le întâi pe acestea!

Brooks Instrument îşi proiectează, produce şi testează produsele într-un mod ce respectă un mare număr de standarde autohtone şi internaţionale. Aceste instalaţii trebuie amplasate, exploatate şi întreţinute corespunzător, pentru ca în toate situaţiile, domeniul lor de lucru să corespundă operării normale. În ceea ce priveşte instalarea, operarea şi întreţinerea produselor Brooks Instrument, indicaţiile de mai jos trebuie respectate şi trebuie introduse in programul de protecţia muncii.

- Pentru garantarea prestaţiei corecte, instalarea, operarea, actualizarea, programarea şi întreţinerea produsului poate fi realizată doar de către personal calificat.
- Instrucţiunile de instalare ale produsului trebuie citite integral, înainte de punerea în serviciu şi exploatarea sa. În măsura în care ediţia acestui manual nu este cea adecvată, identificaţi pe ultima copertă coordonatele distribuitorului local şi pentru lămuriri suplimentare adresaţi-vă acestuia. Păstraţi acest manual pentru referinţe ulterioare.

⚠ ATENŢIE: Nu utilizaţi instalaţia în afara intervalului de funcţionare indicat în instrucţiunile de operare. Nerespectarea acestui lucru se poate solda cu răniri grave de persoane sau defectarea instalaţiei.

- În măsura în care indicaţiile cărţii maşinii nu sunt suficient de lămuritoare, luaţi legătura cu reprezentantul Brooks Instrument pentru clarificarea problemei.
- Păstraţi toate avertismentele, avizele şi instrucţiunile livrate odată cu instalaţia sau inscripţionate pe aceasta.

⚠ AVERTISMENT: Înainte de instalare, asiguraţi-vă că valorile nominale ale acestui instrument respectă codurile naţionale. Nerespectarea acestui avertisment poate avea drept rezultat răniri personale grave şi/sau defectarea echipamentelor.

- Efectuaţi instalarea echipamentului în conformitate cu indicaţiile de instalare corespunzătoare, respectiv cu respectarea prevederilor naţionale. Echipamentul se conectează exclusiv la surse de energie electrică şi de presiune corespunzătoare.
- Succesiune: (1) Presurizaţi lent instalaţia. Deschideţi încetul cu încetul supapa de funcţionare pentru evitarea fluctuaţiilor de flux. (2) Controlaţi dacă nu sunt prelingeri la intrarea sau ieşirea debitmetrului de branşare. Dacă nu sunt scurgeri, presurizaţi instalaţia la presiunea de lucru.
- Înaintea exploatării/ întreţinerii, verificaţi neapărat dacă conducta uzinală nu este sub presiune. În măsura în care este nevoie de piese de schimb, este neapărat necesar ca manevrarea pieselor de schimb să fie făcută de personal cu calificare profesională agreat de Brooks Instrument. Utilizarea altor piese de schimb decât cele originale şi licenţiate poate avea efecte asupra performanţelor instalaţiei şi asupra siguranţei sale în exploatare. Utilizarea de piese asemănătoare de substituire poate avea ca rezultat pericol de incendiu şi electrocutare.
- În toate cazurile toate uşile instalaţiei trebuie să fie închise, cuştile de protecţie să fie puse la locurile lor, pentru evitarea electrocutării şi rănirii de persoane, exceptând situaţiile când un specialist efectuează lucrări de întreţinere.

⚠ ATENŢIE: În cazul instalaţiilor cu flux de fluide, dacă din orice motiv este necesară închiderea valvelor de intrare şi ieşire, limitrofe instalaţiei, instalaţia trebuie complet golită. Neglijarea acestui lucru poate avea ca efect dilatarea termică a fluidului, care poate defecta instalaţia şi poate produce răniri de persoane.

Directiva europeană pentru instalaţiile sub presiune (PED)

Toate instalaţiile şi sistemele presurizate ce se află sub presiuni interne ce depăşesc 0,5 mbar (g) şi au mai mult de 25 mm sau 1 ţol, cad sub incidenţa normei europene corespunzătoare (PED).

- La capitolul "Date tehnice" din cartea maşinii se găsesc indicaţiile corespunzătoare directivei PED.
- Produsele menţionate în cartea maşinii corespund directivei 2014/34/EU EU.
- Toate debitmetrele Brooks corespund clasei 1 de fluide.
- Produsele mai mari de 25 mm sau 1 ţol corespund categoriei PED I, II sau III.
- Produsele mai mici de 25 mm sau 1 ţol se conformează practicii inginereşti acceptate (SEP).

Directiva europeană privitoare la compatibilitatea electromagnetică (EMC).

Instalaţiile (electrice /electronice) ce poartă marca Brooks Instrument CE îndeplinesc cu succes cerinţele testelor de verificare ale compatibilităţii electromagnetice (Cf. directivelor europene EMC cu nr. 2014/30/EU).
În acelaşi timp trebuie acordată o atenţie deosebită la alegerea cablurilor de semnalizare utilizate pentru instalaţiile ce poartă marcajul CE.
Calitatea cablurilor de semnalizare, a legăturilor prin cablu şi a conectoarelor:
Brooks Instrument oferă cabluri de calitate ridicată, care corespund cerinţelor calitative ale CE.
În măsura în care folosiţi cabluri proprii, trebuie alese acelea care sunt 100% ecranate şi prevăzute cu filtre.
Conectoarele „D" sau cele „circulare" trebuie sa dispună de ecrane metalice. În caz de nevoie trebuie folosite conectoare metalice pentru montarea filtrelor de cablu.
Filtrul de cablu trebuie conectat la carcasa metalică sau manşon şi în ambele cazuri trebuie asigurată ecranarea la 360°. Ecranarea trebuie terminată cu o legare la pământ.
Conform standardului, conectoarele aparţinând plăcilor electronice nu sunt metalice. Cablurile folosite trebuie să fie 100% ecranate şi prevăzute cu filtre pentru a corespunde clasificării CE.
Ecranarea trebuie terminată cu o legare la pământ.
Configuraţie de contact: Vezi instrucţiunile de operare ataşate.

Descărcare electrostatică (ESD)

⚠ ATENŢIE: Instalaţia include piese care sunt predispuse la defectare sub influenţa electricităţii statice. Trebuie respectate metodele corespunzătoare de extragere, instalare sau alte manipulări ale circuitelor electronice.

Procedură de manipulare:

1. Instalaţia trebuie scoasă de sub tensiune.
2. Înaintea de inserarea, scoaterea sau reglarea vreunei cartele electronice, sau a altui dispozitiv intern, persoana trebuie să se lege la pământ cu banda pentru articulaţia mâinii sau alte dispozitive de siguranţă disponibile pentru acest scop.
3. Cartelele cu cablaje electronice imprimate trebuie transportate în ambalaje anti-electrostatice (conductoare). Cartelele se pot scoate din ambalaj, doar nemijlocit înaintea amplasării lor. Cartela demontată trebuie pusă neîntârziat în ambalajul de protecţie în vederea transportării, a depozitării sau returnării la producător.

Observaţii:
În echipamente se găsesc adesea componente sensibile la descărcare electrostatică (ESD). Majoritatea echipamentelor moderne includ componente electronice realizate în tehnologie metal-oxid semiconductor (NMOS, SMOS, etc.) Experienţa a dovedit că acestea pot fi afectate sau deteriorate chiar de energii electrostatice de slabă intensitate. Componentele defectate, cu toate că în aparenţă sunt funcţionale, duc în timp la defecţiuni incipiente.

Slovak

Základné príkazy

Prečítať pred inštaláciou!

Brooks Instrument svoje výrobky projektuje, vyrába a testuje takým spôsobom, aby tieto vyhoveli domácim aj medzinárodným normám. Tieto zariadenia je potrebné predpísaným spôsobom inštalovať, prevádzkovať a udržiavať, na zabezpečenie ich spoľahlivej a normálnej prevádzky v celom pracovnom rozsahu. Nižšie uvedené príkazy je potrebné dodržiavať a začleniť do programu bezpečnostných predpisov v priebehu inštalácie, prevádzky a údržby výrobkov Brooks Instruments.

- V záujme zabezpečenia vyhovujúceho výkonu inštaláciu, prevádzku, programovanie, aktualizáciu a údržbu zariadení má vykonávať výlučne odborne kvalifikovaný personál.
- Pred inštaláciou, prevádzkou a servisu zariadení je potrebné prečítať všetky príkazy. Ak táto príručka nie je správna, tak na zadnej strane treba nájsť miestneho distribútora, kontaktovať ho pre ďalšie informácie. Pre neskoršie informácie uschovajte príručku.

⚠ UPOZORNENIE: Neprevádzkovať zariadenie v rozsahu mimo rozsahu uvedenom v prevádzkovej príručke. Porušenie tohto oznámenia môže mať za následok ťažkú ujmu na zdraví a vedie k poškodeniu zariadenia.

- Ak príkazy v návode nie sú jednoznačné, kontaktujte zástupcu Brooks Instrument na objasnenie problémov.
- Dodržujte všetky upozornenia, príkazy a usmernenia uvedené na zariadení, alebo s ním dodané.

⚠ VAROVANIE: pred montážou sa uistite, že toto zariadenie disponuje potrebnými klasifikáciami povolení, ktoré spĺňajú miestne a národné predpisy. Nedodržanie tohto varovania môže mať za následok vážne zranenia osôb alebo poškodenie zariadenia.

- Zariadenia inštalujte podľa návodu uvedeného v príkaze na inštaláciu, v súlade s miestnymi a národnými predpismi. Zariadenie pripojte výlučne len na vyhovujúci elektrický a tlakový zdroj
- Postup: (1) Pomaly natlakujte systém. Prevádzkový ventil otvorte pomaly na zamedzenie kolísania prietoku. (2) Prekontrolujte tesnosť vstupného a výstupného zapojenia prietokomeru. Keď nie je presakovanie, spoje sú tesné, naplniť systém na prevádzkový tlak.
- Pred vykonávaním servisných prác kontrolovať, či systém nie je pod tlakom. V prípade, že je potrebná výmena súčiastky, výmenu dielov, určených Brooks Instrument musí vykonať kvalifikovaná osoba. Použitie nepovolených dielov a vykonávanie nepovolených aktivít ohrozujú bezpečnosť prevádzvky a majú negatívny vplyv na výkon zariadenia. Nahradenie súčiastok len podobnými komponentmi môže mať za následok požiar, úraz elektrickým prúdom alebo nedostatočnú funkciu zariadenia
- Všetky ochranné kryty, dvierka zariadenia majú byť zatvorené na zabezpečenie ochrany proti úrazu elektrickým prúdom a proti poraneniam obsluhy. Výnimku tvorí vykonávanie údržby kvalifikovaným odborníkom.

⚠ UPOZORNENIE: Pri zariadeniach s prietokom kvapalín, keď z akéhokoľvek dôvodu je nutné uzavrieť vstupné a výstupné ventily, zariadenie je potrebné úplne vyprázdniť. Zanedbanie vypúšťania má za následok poškodenie zariadenia s možnosťou zranenia obsluhy z dôvodu tepelnej rozťažnosti náplne.

Európska smernica vzťahujúca sa na tlakové zariadenia (PED)

- Všetky zariadenia s vyšším vnútorným pretlakom ako 0,5 bar (g), a väčšieho rozmeru ako 25 mm alebo 1 anglický palec, podliehajú pod Európsku smernicu vzťahujúcu sa na tlakové nádoby (PED).
- Kapitola "Technické údaje" návodu na obsluhu obsahuje príkazy vzťahujúce sa na smernicu PED.
- Produkty uvedené v návode na obsluhu vyhovujú smernici 2014/34/EU EÚ.
- Všetky prietokomery Brooks patria do 1. skupiny kvapalín.
- Produkty presahujúce rozmery 25 mm alebo 1 " spĺňajú I., II., alebo III. kategóriu PED.
- Produkty menšie alebo rovné ako 25 mm alebo 1 " zodpovedajú zaužívanej meracej praxi (SEP).

Európska smernica vzťahujúca sa na elektromagnetickú kompatibilitu (EMC)

Elektrické / elektronické zariadenia Brooks Instrument, ktoré si zaslúžili značku CE, úspešne splnili skúšobné testy požiadaviek elektromagnetickej kompatibility (smernica EMC č. 2014/30/EU).
Pritom treba venovať zvláštnu starostlivosť na výber signálnych káblov zariadenia, s označením CE.

Kvalita signálnych káblov, káblových spojov a prípojov:

Brooks Instrument ponúka vysoko kvalitné káble, ktoré spĺňajú požiadavky kvalitatívneho zaradenia CE.
Ak použijete vlastné signálne káble, majú mať 100%-né tienenie, s plným filtrovaním.
Prípojky "kruhové" alebo tvaru "D" majú mať kovové tienenie. V prípade potreby treba použiť kovové káblové spojky k upevneniu káblového filtra.
Káblový filter treba pripojiť ku kovovému telesu alebo k puzdru, na oboch stranách zabezpečiť tienenie v kruhu 360 °. Tienenie má byť ukončené uzemnením.
Prípojky vedúce ku kartám podľa noriem sú nekovové. Použité káble, pre vyhovenie predpisom CE musia mať 100%-né filtrovanie tienením.
Tienenie má byť ukončené uzemnením.
Konfigurácia kontaktov: Viď priložený návod na obsluhu. .

Elektrostatický výboj (ESD)

⚠ UPOZORNENIE: Prístroj obsahuje súčiastky, ktoré môžu byť poškodené od elektrostatických nábojov. Pri montáži, odstraňovaní alebo inej údržby vnútorných obvodových kariet je potrebné dodržiavať príslušné postupy.

Postup ošetrovania:

1. Zariadenie odpojiť od napájania.
2. Osoba vykonávajúca údržbu má byť uzemnená uzemňujúcim náramkom, alebo iným, na túto prácu vyhovujúcim spôsobom pred vykonávaním inštalácie, demontáže a nastavenia obvodových kariet alebo iného vnútorného prostriedku.
3. Karty obvodov sa musia prepravovať v elektricky vodivom balení. Karty sa môžu vyberať z ochranného obalu výlučne len tesne pred montážou, zasunutím! Vybranú kartu okamžite treba umiestniť do ochranného obalu, určeného pre dopravu, skladovanie, alebo pre spätnú prepravu do výrobného závodu.

Poznámky:

Existencia prvkov, ktoré sú citlivé na elektrostatické výboje (ESD) v prístroji je častým javom. U väčšiny moderných elektronických prostriedkov sú použité prvky s technológiou oxidu kovov (NMOS, SMOS, atď.). Skúsenosti dokazujú, že aj nepatrné elektrostatické výboje poškodzujú, zničia tieto prostriedky. Poškodené súčiastky, aj keď zdanlivo pracujú bez chyby, odkazujú na vznikajúce poruchy.

Slovene

Osnovna navodila

Preberite jih pred nadaljevanjem.

Brooks Instrument oblikuje, proizvaja in preskuša svoje izdelke tako, da ustrezajo številnim nacionalnim in mednarodnim standardom. Te izdelke je treba ustrezno namestiti, jih uporabljati in vzdrževati, saj bodo le tako še naprej delovali v skladu s svojimi običajnimi tehničnimi podatki. Upoštevajte spodnja navodila in jih vključite v svoj varnostni program pri namestitvi, uporabi in vzdržavanju izdelkov družbe Brooks Instrument.

- Če želite zagotoviti ustrezno delovanje, zagotovite, da bo izdelek namestilo, uporabljalo, posodabljalo, programiralo in vzdrževalo usposobljeno osebje.
- Pred namestitvijo, uporabo in servisiranjem izdelka preberite vsa navodila. Če ta priročnik ni ustrezen priročnik, na hrbtni strani poiščite podatke za stik z lokalnim prodajnim mestom. Ta priročnik shranite za poznejšo uporabo.

⚠ OPOMBA: To napravo lahko uporabljate samo v okviru tehničnih podatkov, ki so navedeni v priročniku z navodili za uporabo. Če tega opozorila ne upoštevate, lahko pride do hudih telesnih poškodb in/ali poškodb opreme.

- Če katerih koli navodil ne razumete, se za pojasnilo obrnite na svojega zastopnika družbe Brooks Instrument.
- Upoštevajte vsa opozorila, svarila in navodila, ki so navedena na izdelku ali so mu priložena.

⚠ OPOZORILO: Pred namestitvijo se prepričajte, da ima ta naprava zahtevane ocene odobritve, ki izpolnjujejo lokalne in nacionalne zakone. Če tega opozorila ne upoštevate, lahko pride do hudih telesnih poškodb in/ali poškodb opreme.

- Opremo namestite v skladu z navodili za namestitev, ki so navedena v ustreznem uporabniškem priročniku, ter v skladu z veljavnimi lokalnimi in nacionalnimi zakoni Vse izdelke priključite na ustrezne električne vire in vire tlaka.
- Postopek: (1) V sistemu počasi zaženite pretok. Počasi odprite procesne ventile, da preprečite nihanja pretoka. (2) Preverite, ali prihaja do puščanj okrog vhodnih in izhodnih priključkov merilnika pretoka. Če ne prihaja do puščanj, vzpostavite delovni tlak v sistemu.
- Pred servisom morate odstraniti tlak v obdelovalni liniji. Če potrebujete rezervne dele, zagotovite, da usposobljeno osebje uporablja rezervne dele, ki jih je odobrila družba Brooks Instrument. Neodobreni deli in postopki lahko vplivajo na učinkovitost delovanja izdelka ali ogrozijo varno upravljanje postopka. Rezervni deli, ki so podobni samo na videz, lahko povzročijo požar, nevarnost električnega udara ali nepravilno delovanje.
- Prepričajte se, da so vrata vrata naprave zaprta in da so zaščitni pokrovi nameščeni, da preprečite električni udar in telesne poškodbe, razen kadar usposobljeno osebje izvaja vzdrževalna dela.

⚠ OPOMBA: Če je pri napravah za pretok tekočine vhodne in izhodne ventile ob napravi treba iz kakršnega koli razloga zapreti, je treba naprave popolnoma izprazniti. Če tega ne naredite, lahko pride do toplotnega raztezanja tekočine, zaradi katerega se lahko naprava prelomi in povrzoči telesne poškodbe.

Evropska direktiva o tlačni opreni (PED)

Vsa tlačna oprema z notranjim tlakom, ki je večji od 0,5 bara (g), in velikostjo, ki je večja od od 25 mm ali 1 palca, spada v direktivo o tlačni opremi (PED).

- V poglavju »Tehnični podatki« v tem priročniku najdete navodila, ki se nanašajo na direktivo PED.
- Izdelki, opisani v tem priročniku, so skladni z direktivo EN 2014/34/EU.
- Vsi merilniki pretoka družbe Brooks Instrument spadajo v skupino tekočin 1.
- Izdelki, večji od 25 mm ali 1 palca, so skladni s kategrijo I, II, ali III direktive PED.
- Izdelki, katerih velikost je 25 mm ali 1 palec ali manjši izdelki, so skladni z dobro inženirsko prakso (SEP).

Evropska direktiva o elektromagnetni združljivosti (EMC)

Naprave družbe Brooks Instrument (električne/elektronske) z oznako CE so bile uspešno preskušene v sklčadu s predpisi direktive o elektromangnetni združljivosti (Direktiva o elektromagnetni združljivosti 2014/30/EU).
Posebno pozornost morate nameniti izbiri signalnega kabla, ki jih uporabljate za naprave z oznako CE.
Kakaovost signalnih kablov, kabelskih tesnilk in priključkov:
Brooks Insturment ponuja kable visoke kakovosti, ki ustrezajo tehničnim podatkov za pridobitev oznake CE.
Če uporabljate svoj signalni kabel, morate uporabiti kabel, ki je na splošno popolnoma oklopljen s 100 % zaščito.
Priključki tipa »D« ali »krožni« priključki morajo biti zaščiteni s kovinskim ščitom. Po potrebi je treba uporabiti kovinske kabelske tesnilke, ki zagotavljajo vpenjala za zaslon kabla.
Zaslon kabla je treba priključiti na kovinsko ohišje ali tesnilko in ga na obeh koncih popolnoma zaščititi.
Zaščito je treba prekiniti pri ozemljitvi.
Robni priključki običajno niso kovinski. Kable je treba zaščititi s 100 % zaščito, da ustrezajo oznaki CE.
Zaščito je treba prekiniti pri ozemljitvi.
Navodila z konfiguraciju nožic najdete v priloženem uporabniškem priročniku.

Elektrostatična razelektritev (ESD)

⚠ OPOZORILO: Naprava vsebuje elektronske komponente, ki so občutljive na poškodbe zaradi statične elektrike. Pri odstranitvi, namestitvi ali drugih postopkih uporabe notranjega tiskanega vezja ali naprav morate upoštevati ustrezne postopke.

Postopek ravnanja:

1. Izklopite napravo.
2. Osebje je treba pred namestitvijo, odstranitvijo ali prilagajanjem katare koli kartice tiskanega vezja ali druge notranje naprave ozemljiti z zapestnim paščkom ali drugimi varnostnimi in primernimi sredstvi.
3. Kartice s tiskanim vezjem je treba prevažati v prevodnem vsebniku. Plošče lahko iz zaščitne embalaže odstranite šele tik pred namestitvijo. Odstranjene plošče je treba takoj shraniti v zaščitno embalažo za prevoz, shranjevanje ali vračilo v tovarno.

Opombe:
Ta naprava ni edinstvena z vidika komponent, ki so občutljive na elektrostatično razelektritev. Večina sodobnih elektronskih naprav vsebuje komponente, ki uporabljajo oksidno tehnologijo (NMOS, SMOS itd.). Izkušnje dokazujejo, da lahko celo majhne količine statične elektrike poškodujejo ali uničijo te naprave. Poškodovane komponente se predčasno okvarijo, čeprav navidez delujejo pravilno.

Spanish

Instrucciones básicas ¡Léalos primero!

El Brooks Instrument proyecta, fabrica y prueba sus productos de manera que éstos respondan a numerosas normas nacionales e internacionales. Dichas instalaciones deben ser emplazadas, operadas y mantenidas adecuadamente, para que puedan marchar de todas formas en conformidad con el alcance normal de funcionamiento. Las siguientes instrucciones deben cumplirse y incorporadas en su programa de seguridad cuando instalando, operando y mantenimiento los productos Brooks Instrument.

- Para asegurar el adecuado rendimiento, para instalar, operar, actualizar, programar y mantener tiene que realizarse exclusivamente por una persona calificada.
- Antes de la instalación, operación y servicio del producto leer todas las respectivas instrucciones. Si el presente manual no es la adecuada publicación, busque al distribuidor local que figura en la contraportada y póngase en contacto con él para obtener informaciones. Guarde el presente manual para tener informaciones también en el futuro.

⚠ ATENCIÓN: No haga funcionar los equipos fuera del rango indicado en las instrucciones de funcionamiento. El incumplimiento de estas últimas puede conducir a graves daños personales o a la avería del equipo.

- Si las instrucciones del manual no son evidentes, póngase en contacto con el representante de Brooks Instrument para aclarar el problema
- Observar todas las alertas, advertencias e instrucciones indicadas en el equipo o suministradas con el mismo.

⚠ ADVERTENCIA: Antes de la instalación, asegúrese de que el instrumento ofrece las características de aprobación necesarias para satisfacer los requisitos normativos locales y nacionales. En caso contrario, se pueden producir lesiones personales y/o daños en el equipo.

- Instale su equipo en conformidad con las recomendaciones indicadas en las respectivas instrucciones de instalación y con las pautas de las normas vigentes locales e internacionales. Conectar el producto exclusivamente a la adecuada fuente eléctrica y presión.
- Proceso: (1) Colocar lentamente flujo en el sistema. Abrir lentamente las válvulas de proceso para evitar oscilación del flujo. (2) Verificar si hay fuga alrededor de las conexiones de entrada y salida del flujómetro, Si no hay, llenar el sistema con la presión de operación.
- Antes de efectuar el servicio, verificar si hay presión o no en la tubería de la red. Si se requiere realizar un recambio de piezas, solamente el personal calificado puede manipular las piezas de repuesto determinadas por Brooks Instrument Las piezas y operaciones no autorizadas pueden afectar el rendimiento del producto o arriesgar el funcionamiento seguro. El recambio realizado con piezas sólo similares pueden traer como consecuencias incendios, choques eléctricos o funcionamiento bajo.
- Todas las puertas de la instalación deben estar cerradas, las cubiertas de protección tienen que hallarse en el debido sitio con el fin de evitar los daños personales y los choques eléctricos, salvo cuando un especialista efectúa el mantenimiento.

⚠ ADVERTENCIA: En caso de instalaciones que circulen líquido, si por cualquier razón se hubiera de cerrar las válvulas de entrada y salida situadas al lado del equipo, dichas instalaciones deberán ser completamente vaciadas. La omisión de esto último puede provocar la dilatación térmica del líquido, lo que puede dañar al equipo y conducir a daños personales.

Directriz Europea de los Equipos de Presión (PED)

Todos los equipos de presión, con una presión interna que supere a 0,5 bar (g) con tamaño mayor a 25 mm o 1 pulgada entran el ámbito de la Directriz Europea de los Equipos de Presión (PED).

- El capítulo Datos Técnicos del manual incluye las instrucciones respecto a las directivas de PED
- Los instrumentos de medición indicados en el Manual responden a las EN directivas 2014/34/EU.
- Todos los caudalímetros Brooks pertenecen a la categoría 1 del grupo de fluidos.
- Los instrumentos de medición más grandes que 25 mm o 1 pulgada están en conformidad con las categorías I, II o III de PED
- Los instrumentos de medición más pequeños que 25 mm o 1 pulgada siguen la Práctica Aceptada de Ingeniería (SEP).

Directriz Europea respecto a la Compatibilidad Electromagnética (EMC)

Las instalaciones de Brooks Instrument (eléctricas/electrónicas) merecedores de la categoría CE cumplieron con éxito las pruebas que verifican las exigencias de la compatibilidad electromagnética (directiva de EMC 2014/30/EU).
Al mismo tiempo se ha de prestar una especial atención en la selección de los cables de señal, utilizados con los equipos marcados con CE.

Calidad de los cables de señal, piezas de unión de cable y conectores:

El Brooks Instrument ofrece cables de alta calidad, que responden a los requerimientos de calificación CE.
Si se utiliza cable propio de la firma, se ha de elegir uno que sea completamente filtrado con blindaje de 100%.
Las piezas de unión de forma „D" o „circular" deben ser blindadas mediante blindaje metálica. Si es necesario, aplicar piezas de unión de metal para sujetar el filtro de cable.
Conectar el filtro de cable a la caja o manguito de metal blindándolo en ambas caras en 360°.
El blindaje debe terminar en tierra.
Los conectores que pertenecen a las tarjetas normalmente no son metalizados. Los cables utilizados deben ser filtrados con una blindaje de 100% para responder a la calificación CE.
El blindaje debe terminarse en tierra.
Configuración de contacto: Véase Instrucciones de operación adjuntas.

Descarga Electroestática (ESD)

⚠ PRECAUCIÓN: El aparato incluye piezas electrónicas que son susceptibles a los daños provocados por la electricidad estática. Observar los adecuados procesos para remover, instalar o manipular las tareas y medios de circuitos eléctricos internos

Proceso de operación:

1. Desconectar la fuente eléctrica de la unidad.
2. La persona debe ponerse a tierra mediante una palanca acodada o por otro medio seguro y apropiado para dicho fin antes de instalar, sacar o ajustar el circuito impreso eléctrico u otro medio interno.
3. El circuito impreso debe ser transportado en embalaje conductivo. Las tarjetas no pueden sacarse de la cubierta protectora exclusivamente directamente antes de la instalación. Las tarjetas desmontadas deben colocarse sin tardar en el embalaje protector utilizado para manipulación, almacenamiento o devolución a la fábrica.

Notas:

Esto equipo no es el único contenido de piezas susceptibles a la descarga electroestática (ESD). En la mayoría de los medios electrónicos modernos se encuentran piezas fabricadas por tecnología de óxido metálico. (NMOS, SMOS etc.). Las experiencias confirman que incluso una mínima electricidad estática puede dañar o destruir dichos medios. Las piezas averiadas, aunque funcionen aparentemente bien, indican una falla inicial.

Swedish

Väsentliga anvisningar. Läs detta innan du fortsätter!

Brooks Instrument konstruerar, tillverkar och testar sina produkter med syfte att uppfylla alla nationella och internationella standarder. Dessa produkter måste installeras på rätt sätt, handhas och underhållas för att de skall fungera kontinuerligt enligt deras normala specifikation. De följande anvisningarna bör följas och integreras till Ert säkerhetsprogram varje gång när Brooks Instruments produkter installeras, handhas och underhålls.

- För att garantera angiven funktion, använd kvalificerad personal till att installera, handha, uppgradera, programmera och serva produkten.
- Läs alla instruktioner innan produkten installeras, startas upp och underhålls. Om du finner att denna instruktionshandbok inte är den rätta instruktionsboken, titta på i slutet av pärmen för information om hur man kan kontakta lokala representanter. Spara denna instruktions manual för senare behov.

⚠ VARNING: Kör inte detta instrument utanför dess specifikationer som är angiven i Instruktionsboken. Undvikande att ta denna varning kan leda till allvarliga personliga skador och / eller skada utrustningen.

- Om du inte förstår någon av dessa instruktioner, kontakta din representant för Brooks Instrument för klarläggande.
- Följ alla varningar och instruktioner som följer med leveransen av denna produkt.

⚠ VARNING: Säkerställ före installation att detta instrument har alla nödvändiga godkännanden för att uppfylla lokala och nationella regler. Underlåtenhet att följa denna varning kan leda till personskador och/eller skador på utrustningen.

- Installera din utrustning på sättet som anges i den gällande handbokens installationsanvisningar och enligt tillämpliga lokala och nationella föreskrifter. Koppla varje produkt till föreskriven ström- och tryckkällan.
- Igångsättning: (1) Koppla långsamt på flöde i systemet. Öppna processventiler sakta för att undvika för höga flöden. (2) Kontrollera läckor vid mätarens anslutningar för in- och utlopp. Om inget läckage förekommer, kör systemet upp till drifttrycket.
- Kontrollera att processledningens tryck är bortkopplat före service. I fall det behöves kompletteras med nya delar, se till att komponenter föreskrivna av Brooks Instrument används. Samt att kvalificerad personal utför arbetet. Ej rekommenderade komponenter och åtgärder kan påverka produktens prestanda och sätta din driftsäkerhet på spel. ”Felaktiga” ersättningar kan orsaka eld, elektriska skador samt felaktig funktion.
- Se till att anordningens kåpor och skyddslock ligger på sin plats med syfte att förebygga elektriska kontakt och personliga skador; det enda undantag gäller när underhållsarbete utförs av kvalificerad personal.

⚠ VARNING: I fall av - flödesmätare / regulatorer för vätskor: Ifall ventiler före och efter skall stängas av, måste alla ledningar tömmas på all vätska. Att ej tömma ledningar alt koppla bort trycket kan göra så att vätskans värmeutvidgning kan spräcka / skada utrustningen och orsaka personliga skador.

European Pressure Equipment Directive (PED) - (Rådets Direktiv 99/36/EG av den 29 april 1999[1] om transportabla tryckbärande anordningar)

Alla utrustning för tryck med ett tryck över 0.5 Bar(g) bar och större demensioner än 25 mm eller 1" (inch) faller under Tryck direktiv 99/36/EG av den 29 april 1999[1] om transportabla tryckbärande anordningar - PED.

- Den här Instruktionsbokens Sektion ” Specifikation” innehåller anvisningar gällande PED Direktivet.
- Mätare som beskrivs i denna Instruktionsbok är i överensstämmelse med EN Direktivet 2014/34/EU.
- Brooks Instruments alla flödesmätare faller under flödesgrupp nr. I.
- Mätare som är större än 25 mm eller 1" (inch) överensstämmer med PED kategorier I, II eller III.
- Mätare på 25mm eller 1" (inch) eller mindre faller under Sound Engineering Practice (SEP) (God Teknisk Praxis).

European Electromagnetic Compatibility (EMC) - Elektromagnetisk kompatibilitet

Brooks Instrument (elektriska/elektroniska) CE-märkta anordningar har redan genomgått ett framgångsrikt prov enligt regleringar under Electromagnetic Compatibility (EMC directive 2014/30/EU). Man måstre dock ägna särskild uppmärksamhet till valet av signalkabeln som skall används för CE-märkta anordningar.

Signalkablars, packboxars och kontakdons kvalitet:

Brooks Instrument levererar högkvalitativa kablar som överensstämmer med specifikation för CE-intygade produkter.
Om man använder sin egen signalkabel, då bör man använda en kabel som är fullständigt skärmad med en 100% avskärmning.
“D” eller “Cirkelformiga” kontakdon skall vara skärmade med metalliska avskärmningar. Om det är användbart, bör metallpackboxar som ger en bra fastspänning för kabelskärmar användas.
Kabelavsärmningen måste kopplas till den metalliska skärmande anordningen eller packboxen och skärmas vid båda ändar runt omkring.
Avskärmningens avspänning måste jordas.
Card Edge Kontaktdon är icke metalliska. För att överensstämma med krav på CE-intyg, skall de kablarna som används vara skärmade med 100% skärmning.
Skärmningen måste jordas.
Vad gäller stiftkonfigurationen: Se den bifogade Instruktionshandboken.

ESD (Elektrostatiska urladdningar)

⚠ OBS: Denna utrustning innehåller elektroniska komponenter som är lättpåverkade av skada orsakad av statisk elektricitet. Lämplig hanteringsprocedur måste följas när man tar bort, installerar eller på något annat sätt hanterar inre kretskort eller andra anordningar.

1. Ström till enheten måste kopplas från.
2. Personalen måste jordas med hjälp av ett armband eller något annat säkert medel innan något kretskort eller andra inre anordningar installerras, tas bort eller justeras.
3. Kretskort måste transporteras i en speciell förpackning för elektronik. Kort skall ej tas bort från deras skydsskåpa innan man skall installera dem. De borttagna korten bör omedelbart läggas i speciell förpackning för transport, lagring eller återlämnande till fabriken.

Anmärkningar:

Dessa instrument är ej unika vad gäller dess ESD **(**Elektrostatiska urladdningar) - känsliga komponenter. De flesta samtida konstruktioner innehåller komponenter som utnyttjar metalloxid teknologi (NMOS, SMOS, o.s.v.). Erfarenhet har visat att även små mängder av statisk elektricitet kan skada eller förstöra dess komponenter. Skadade komponenter - även om de annars verkar fungera ordentligt – har ofta en kortare livslängd.

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Brooks® Ar-Mite™ MT3750C

LIMITED WARRANTY
Visit www.BrooksInstrument.com for the terms and conditions of our limited warranty.

BROOKS SERVICE AND SUPPORT

Brooks is committed to assuring all of our customers receive the ideal flow solution for their application, along with outstanding service and support to back it up. We operate first class repair facilities located around the world to provide rapid response and support. Each location utilizes primary standard calibration equipment to ensure accuracy and reliability for repairs and recalibration and is certified by our local Weights and Measures Authorities and traceable to the relevant International Standards.

Visit www.BrooksInstrument.com to locate the service location nearest to you.

START-UP SERVICE AND IN-SITU CALIBRATION

Brooks Instrument can provide start-up service prior to operation when required.
For some process applications, where ISO-9001 Quality Certification is important, it is mandatory to verify and/or (re)calibrate the products periodically. In many cases this service can be provided under in-situ conditions, and the results will be traceable to the relevant international quality standards.

CUSTOMER SEMINARS AND TRAINING
Brooks Instrument can provide customer seminars and dedicated training to engineers, end users and maintenance persons.

Please contact your nearest sales representative for more details.

HELP DESK
In case you need technical assistance:
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Due to Brooks Instrument's commitment to continuous improvement of our products, all specifications are subject to change without notice.

TRADEMARKS

Ar-Mite	Brooks Instrument, LLC	NRS	Brooks Instrument, LLC
Brooks	Brooks Instrument, LLC	Locquic	Loctite Corporation
Inconel	Inco Alloys International, Inc.	Loctite	Loctite Corporation
Kalrez	DuPont Dow Elastomers	Teflon	E.I. DuPont de Nemours & Co.
Monel	Inco Alloys International, Inc.	Viton	DuPont Performance Elastomers

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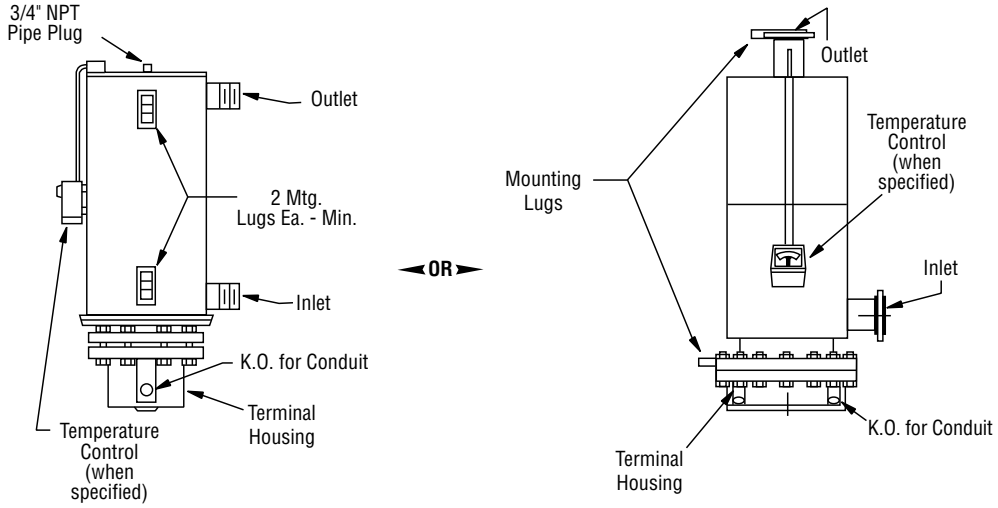
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Chromalox®

Installation, Operation
and
RENEWAL PARTS IDENTIFICATION

SERVICE REFERENCE	
DIVISION 4	SECTION GCH
SALES REFERENCE (Supersedes PE417-2)	PE417-3
	161-025752-001
DATE FEBRUARY, 1999	

Type GCH/GCHIS Circulation Heater (for Steam, Gas and Air Heating)



Specifications – Design is dependent upon size of heater and customer's specifications.

GENERAL

WARNING: ***Safe operating conditions depend on operating pressure, mass velocity of gas and discharge temperature of the gas. At a given discharge gas temperature, heater element sheath temperature and pipe body temperature will increase as gas flow (mass velocity) decreases. The standard GCH has a 750˚F limitation on the carbon steel body and 1500˚F limit on the INCOLOY® sheath elements. Pressure limits vary as the temperature of the vessel increases. If the vessel temperatures exceed 250˚F or operating pressure is greater than 100psi, the vessel limits must be evaluated at the specific pressures and temperatures expected during operation. Contact Chromalox if any doubt exists as to temperatures that will be encountered in your specific application. At pipe body temperatures above 750˚F, a stainless steel body is required (Model GCHIS).***

WARNING: ***Do not exceed the Pressure-Temperature rating of the flange as listed in ANSI B16.5. Before installing, local codes must be reviewed to verify ASME Certification of the pressure vessel is not a requirement. If required, contact Chromalox.***

WARNING: ***This heater is not intended for use in hazardous atmospheres where flammable vapors, gases, liquids or other combustible atmospheres are present as defined in the National Electrical Code. Failure to comply can result in explosion or fire.***

The GCH/GCHIS series is a general purpose gas or steam circulation heater intended for indoor use. This heater can be used in an outdoor environment, if ordered with an E4 moisture-resistant terminal enclosure and a weatherproof insulation jacket. Also available is an E3 explosion-resistant terminal enclosure. Consult with Chromalox for operating restrictions in hazardous locations. **Note:** The GCHIS is intended for use in corrosive or high temperature applications.

The INCOLOY® sheathed tubular elements are centered in a steel/stainless steel heating chamber and welded to a removable steel/stainless steel flange. The number of elements will vary, depending upon the flange size used. Some units are fitted with baffles to increase the flow. They are designated as GCHB. The assembly is surrounded by insulation and a sheet metal jacket.

Depending upon the order specifications, the GCH/GCHIS may or may not be factory equipped with an AR or other Chromalox thermostat. Such thermostats function to control outlet temperatures and to limit internal temperatures under abnormal flow conditions. These controls are not fail-safe.

WARNING: ***Users should install adequate back-up controls and safety devices with their electric heating equipment. When heating in closed vessels where the consequences of failure may be severe, controls and back-up controls must be used to prevent buildup of temperature and/or pressure. Although the safety of the installation is the responsibility of the user, Chromalox will be glad to make equipment recommendations.***

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INSTALLATION

WARNING: ***Hazard of Electric Shock. Disconnect all power before installing heater.***

1. Before installing, check your GCH/GCHIS circulation heater for any damage that may have occured during shipment.
2. Check to insure that the line voltage is the same as that stamped on the nameplate.
3. Vertical mounting (axis of chamber vertical as in Figures on previous page) is preferred.
4. To avoid excess temperatures at electrical wiring, mount heater with terminal enclosure at bottom, and use lower nozzle as inlet to the circulating steam, air or gas.
5. The GCH/GCHIS series of circulation heaters is provided with mounting lugs to support the heater chamber. Refer to figures on previous page for location of these mounting lugs.
6. Mount heaters to permit unrestrained expansion of chamber due to temperature. This can be accomplished by using a slotted mounting assembly on either of the lugs.
7. Provide adequate space at terminal end to permit withdrawal of the heater from chamber should servicing be required.
8. **DANGER:** ***Hazard of Fire.*** Provide a minimum of 6" spacing from chamber and related piping to nearest combustible material. Avoid operation of heater near combustible fluids or in combustible vapor or gas laden atmosphere.
9. If two or more heaters are required to provide the needed heating capacity, arrange them for series gas or vapor flow.
10. **DANGER:** ***Possible Explosion.*** A pressure relief valve should be provided by customer at outlet of vessel. There should be no valving between vessel and relief valve.
11. In a forced circulation system, use pump on the inlet side.

WIRING

WARNING: ***Hazard of Electric Shock. Any installation involving electric heaters must be effectively grounded in accordance with the National Electrical Code to eliminate shock hazard.***

1. Be sure line voltage matches heater voltage (on nameplate).
2. All wiring should be done in accordance with local codes and the National Electrical Code by a qualified person as defined in the NEC.
3. Because of the high operating temperatures expected, 250°C wire should be used.
4. Power controls must be used when heaters are rated 3 phase and when the heater amperage exceeds the rating of the thermostat.
5. Refer to Wiring Diagrams for the typical wiring used for connecting the GCH series heater.
6. Other circuit arrangements are often supplied depending upon customer specifications or amperage rating.

OPERATION

WARNING: ***Do not heat materials that are corrosive to the heating element sheath or chamber.***

It is the responsibility of the user to know the chemical composition of the corrosive solution and the character of the materials entering the solution as well as the corrosive effect of the solution upon entering the heating elements and chamber. Chromalox cannot warrant any electric circulation heater against failure by sheath corrosion if such failure is the result of operating beyond our control.

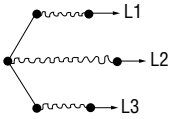
1. Terminal ends of heater must be protected from drippings, condensation, spray or direct spill-over of material whose presence at the terminals may damage heater electrical insulation. Liquid-tight terminal enclosures are available to protect heater. Consult your Local Chromalox Sales office.
2. If foreign material is carried by the gaseous flow, install suitable filters in the inlet pipe line to the heater.
3. Do not allow heater to operate when steam, air or gas flow is interrupted as dry operation of the heater can cause failure.

MAINTENANCE

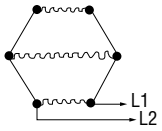
1. **WARNING:** ***Hazard of Electric Shock. Disconnect all power before wiring or servicing heater.***
2. Remove heating element assembly periodically to check heater sheath for corrosion or excessive oxidation. Correct operating conditions to minimize sheath deterioration.
3. Periodically check temperature control and pressure-temperature safety limit control operation to insure accurate and safe process operation.
4. Check all electrical connections periodically and retighten connections which may have loosened in service. Replace wire and wire terminals which show signs of oxidation which would interfere with establishment of reliable electrical connections.
5. Clean any filters in the inlet pipeline to avoid reduced flow, which can cause element overheating and premature failure.

TYPICAL WIRING DIAGRAMS

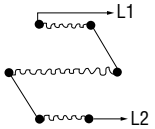
3 Series



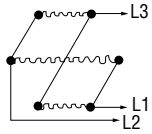
208-600V, 3Ø Y



208-600V, 1Ø

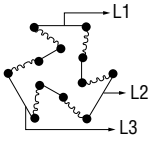


380-600V, 1Ø, SERIES

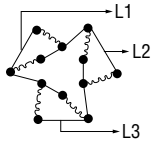


208-600V, 3ØΔ

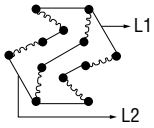
6 SERIES



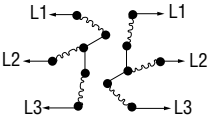
380-600V, 3Ø, SERIES Δ



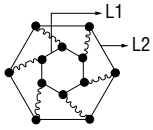
208-240V, 3Ø, PARALLEL Δ



380-600V, 1Ø, SERIES

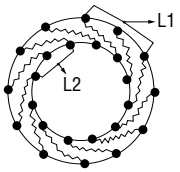


208-600V, 3Ø Y
2 CIRCUITS

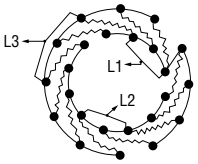


240V, 1Ø (15 kW Max)
208-230V, 1Ø (12 kW Max)

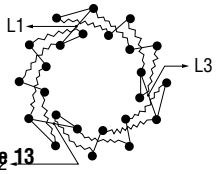
12 Series



380-600V, 1Ø PARALLEL



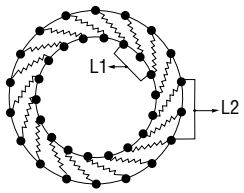
208-600V, 3Ø, PARALLEL Δ



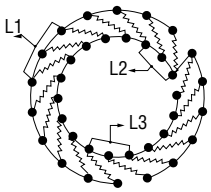
380-600V, 3Ø, SERIES Δ

Figure 13

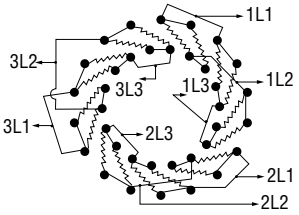
18 Series



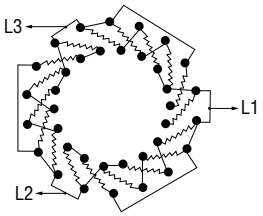
380-600V, 1Ø, PARALLEL



208-600V, 3Ø, PARALLEL Δ

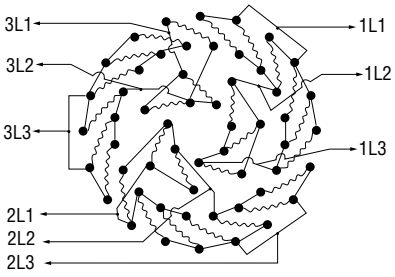


208-600V, 3Ø, PARALLEL Δ, 3 CIRCUITS



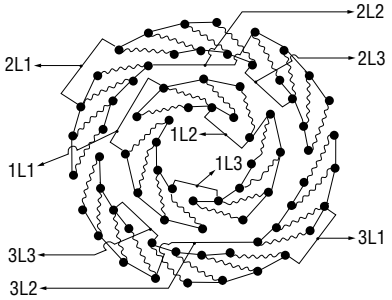
380-600V, 3Ø, SERIES Δ

27 Series



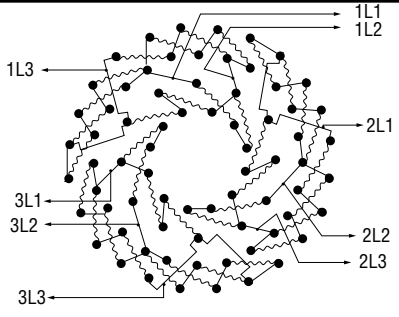
208-600V, 3ØΔ, 3 CIRCUITS

36 Series



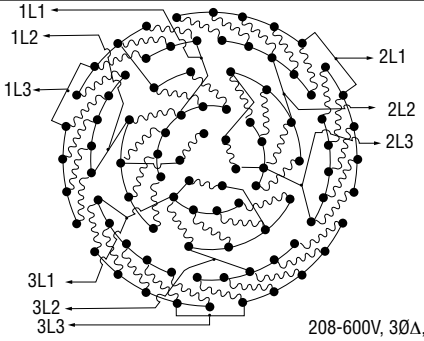
208-600V, 3ØΔ, 3 CIRCUITS

36 Series



380-600V, 3Ø, 3 CIRCUITS, SERIES Δ

45 Series



208-600V, 3ØΔ, 3 CIRCUITS

RENEWAL PARTS IDENTIFICATION

Contact Chromalox Product Service for a list of the necessary replacement parts of your specific heater.

Limited Warranty:
Please refer to the Chromalox limited warranty applicable to this product at
http://www.chromalox.com/customer-service/policies/termsofsale.aspx.

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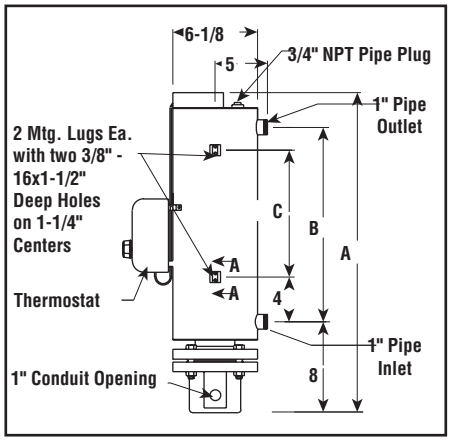
GCHI & GCHIB

Steam, Air & Gas Applications to 750°F[1]

- **3 - 18" ANSI Blind Flange Design**
- **3 - 18" Carbon Steel Pipe Body, 150 Lb Construction (750°F Max. Vessel and 1600°F Max. Sheath Temp.)[1] For Stainless Steel Pipe Body Construction, Refer to GCHIS Series Circulation Heaters.**
- **3 - 350kW**
- **240 and 480V, 1 & 3 Phase**
- **General Purpose, Moisture Resistant Terminal, Moisture Resistant/Explosion Proof Enclosure**
- **0.475" Dia. INCOLOY® Sheath Elements (15 - 23 W/In²)**
- **3 and 5" with Side Mounted Thermostat (200 - 550°F), 8, 10, 14 and 16" without Thermostat**
- **CSA and Other Third Party Approval, Listing or Certification Available**



Dimensions (Inches) GCHI-03



Applications

Steam, Air and Gas — Higher kW ratings for larger industrial and commercial gas heating applications.

Features

Terminal Enclosure — E1 General Purpose is standard. E2 Moisture Resistant/Explosion Proof or E4 Moisture Resistant available.

Elements — 0.475" diameter INCOLOY® sheath elements.

Flange — 3 -10" ANSI B-16.5 flange with 1/2" thermowell for thermostat bulb and a 1/8" NPT threaded opening for a thermocouple or RTD.

Vessel — Pipe body and nozzles are ASTM A53B carbon steel pipe. The end disk is ASTM A516 Grade 70 carbon steel plate. Provided with thermal insulation and painted sheet metal jacket.

Baffle Assembly — Internal baffle assemblies are provided on GCHIB-18 models. Baffles reduce the internal cross sectional area thereby increasing the velocity of the gas. Increasing the gas velocity reduces the operating temperature of the elements and the shell of the vessel.

Wiring — Convenient field wiring terminals are provided for easy installation.

Controls — Series 03 and 06 stock and assembly stock heaters come equipped with side mounted thermostat. Series 18, 27, 45 and 108 are furnished without thermostat.

Specifications and Ordering Information

kW	Volts	Ckt & Phase	Dimensions (In.) A	B	C	Model	Stock	PCN	Wt. (Lbs.)
Series 03 — 3 inch, 150 lb carbon steel vessel — 3 INCOLOY® elements[1] (23 W/In²) with thermostat									
3	240	1-1	32-15/16	22-1/2	16-1/2	GCHI-03-003P-E1	NS	013240	62
3	240	1-3	32-15/16	22-1/2	16-1/2	**GCHI-03-003P-E1**	**S**	**103915**	62
3	480	1-1	32-15/16	22-1/2	16-1/2	GCHI-03-003P-E1	NS	013258	62
3	480	1-3	32-15/16	22-1/2	16-1/2	**GCHI-03-003P-E1**	**S**	**103958**	62
4.5	240	1-1	42-15/16	32-1/2	26-1/2	GCHI-03-04P5-E1	NS	013266	72
4.5	240	1-3	42-15/16	32-1/2	26-1/2	GCHI-03-04P5-E1	NS	104070	72
4.5	480	1-1	42-15/16	32-1/2	26-1/2	GCHI-03-04P5-E1	NS	013274	72
4.5	480	1-3	42-15/16	32-1/2	26-1/2	**GCHI-03-04P5-E1**	**S**	**104117**	72
6	240	1-1	55-7/16	45	39	GCHI-03-006P-E1	NS	013282	94
6	240	1-3	55-7/16	45	39	**GCHI-03-006P-E1**	**S**	**104230**	94
6	480	1-1	55-7/16	45	39	GCHI-03-006P-E1	NS	013290	94
6	480	1-3	55-7/16	45	39	**GCHI-03-006P-E1**	**S**	**104272**	94

Stock Status: **S** = stock NS = non-stock
To Order—Specify model, volts, phase, kW, PCN and quantity.

1. Outlet gas temperature must be kept below both maximum sheath and vessel temperature or element and heater damage may occur. Contact your Local Chromalox Sales office for application assistance.

GCHI & GCHIB

Steam, Air & Gas Applications to 750°F[1] *(cont'd.)*

Specifications and Ordering Information

kW	Volts	Ckt & Phase	Dimensions (In.) A	B	C	Model	Stock	PCN	Wt. (Lbs.)
Series 06 — 5 inch, 150 lb carbon steel vessel — 6 INCOLOY® elements[1] (23 W/In²) with thermostat									
9	240	1-1	41-3/4	30	11-3/8	GCHI-06-009P-E1	NS	013303	135
9	240	1-3	41-3/4	30	11-3/8	GCHI-06-009P-E1	NS	104715	135
9	480	1-1	41-3/4	30	11-3/8	GCHI-06-009P-E1	NS	013311	135
9	480	1-3	41-3/4	30	11-3/8	GCHI-06-009P-E1	NS	013320	135
12	240	1-1	48-3/4	37	14-7/8	GCHI-06-012P-E1	NS	013338	164
12	240	1-3	48-3/4	37	14-7/8	**GCHI-06-012P-E1**	**S**	**104870**	164
12	480	1-1	48-3/4	37	14-7/8	GCHI-06-012P-E1	NS	013346	164
12	480	1-3	48-3/4	37	14-7/8	**GCHI-06-012P-E1**	**S**	**104598**	164
20	240	1-1	60-1/4	48-1/2	20-5/8	GCHI-06-020P-E1	NS	013354	195
20	240	1-3	60-1/4	48-1/2	20-5/8	GCHI-06-020P-E1	NS	013362	195
20	480	1-1	60-1/4	48-1/2	20-5/8	GCHI-06-020P-E1	NS	013370	195
20	480	1-3	60-1/4	48-1/2	20-5/8	**GCHI-06-020P-E1**	**S**	**105478**	195
25	240	1-1	73-5/8	61-7/8	27-5/16	GCHI-06-025P-E1	NS	013389	212
25	480	1-3	73-5/8	61-7/8	27-5/16	GCHI-06-025P-E1	NS	013397	212
25	240	1-1	73-5/8	61-7/8	27-5/16	GCHI-06-025P-E1	NS	013400	212
25	480	1-3	73-5/8	61-7/8	27-5/16	GCHI-06-025P-E1	NS	013418	212
30	240	1-3	86-5/8	74-7/8	33-7/8	GCHI-06-030P-E1	NS	013434	240
30	480	1-3	86-5/8	74-7/8	33-7/8	GCHI-06-030P-E1	NS	013450	240
Series 18 — 8 inch, 150 lb carbon steel vessel — 18 baffled INCOLOY® elements[1] (20 W/In²)									
30	240	3-3	54-5/16	32-11/16	29-3/16	GCHIB-18-030P-E1	NS	080768	350
30	480	3-3	54-5/16	32-11/16	29-3/16	GCHIB-18-030P-E1	NS	080776	350
40	240	3-3	61-5/16	39-11/16	36-3/16	GCHIB-18-040P-E1	NS	080784	420
40	480	3-3	61-5/16	39-11/16	36-3/16	GCHIB-18-040P-E1	NS	080792	420
50	240	3-3	68-15/16	47-5/16	43-13/16	GCHIB-18-050P-E1	NS	080805	480
50	480	3-3	68-15/16	47-5/16	43-13/16	GCHIB-18-050P-E1	NS	080813	480
Series 27 — 10 inch, 150 lb carbon steel vessel — 27 INCOLOY® elements[1] (15 W/In²)									
50	240	3-3	68-9/16	43	39-1/2	GCHI-27-050P-E1	NS	020212	400
50	480	3-3	68-9/16	43	39-1/2	GCHI-27-050P-E1	NS	020220	400
60	240	3-3	75-9/16	50	46-1/2	GCHI-27-060P-E1	NS	020239	440
60	480	3-3	75-9/16	50	46-1/2	GCHI-27-060P-E1	NS	020247	440
70	240	3-3	81-9/16	56	52-1/2	GCHI-27-070P-E1	NS	020255	480
70	480	3-3	81-9/16	56	52-1/2	GCHI-27-070P-E1	NS	020263	480
80	240	3-3	91-9/16	66	62-1/2	GCHI-27-080P-E1	NS	020271	520
80	480	3-3	91-9/16	66	62-1/2	GCHI-27-080P-E1	NS	020280	520
90	240	3-3	100-9/16	75	71-1/2	GCHI-27-090P-E1	NS	020298	560
90	480	3-3	100-9/16	75	71-1/2	GCHI-27-090P-E1	NS	020300	560

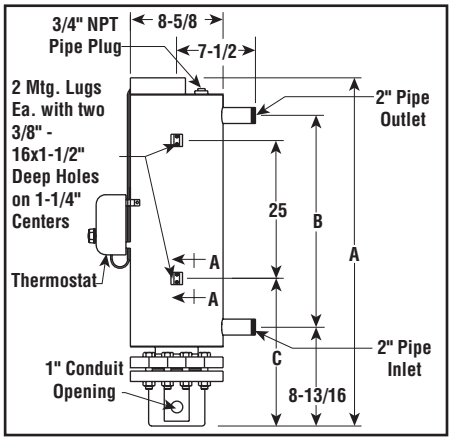
Stock Status: **S** = stock NS = non-stock
To Order—Specify model, volts, phase, kW, PCN and quantity.

1. Outlet gas temperature must be kept below both maximum sheath and vessel temperature or element and heater damage may occur. Contact your Local Chromalox Sales office for application assistance.

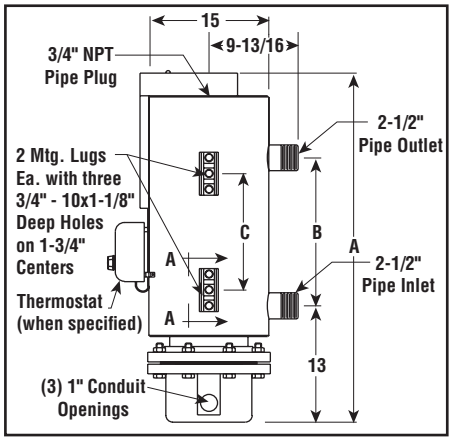
Other Note — Refer to the Controls section for control panels.

Dimensions (Inches)

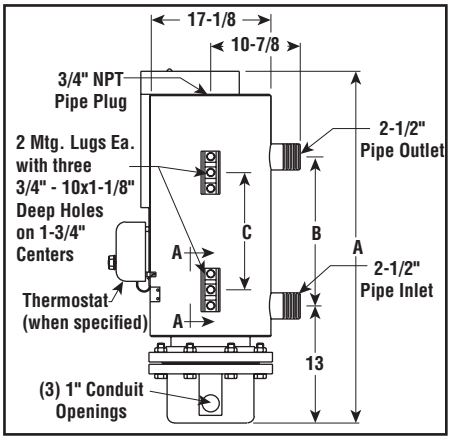
GCHI-06



GCHIB-18



GCHI-27



GCHI & GCHIB

Steam, Air & Gas Applications to 750°F[1] *(cont'd.)*

Specifications and Ordering Information

kW	Volts	Ckt & Phase	Dimensions (In.) A	B	C	D	E	Model	Stock	PCN	Wt. (Lbs.)
Series 45 — 14 inch, 150 lb carbon steel vessel — 45 INCOLOY® elements[1] (15 W/In²)											
75	480	3-3	76	57-3/16	66-11/16	15	11-1/2	GCHI-45-075P-E1	NS	086238	835
90	480	3-3	76	57-3/16	66-11/16	15	11-1/2	GCHI-45-090P-E1	NS	086254	925
125	480	3-3	91	72-3/16	81-11/16	15	11-1/2	GCHI-45-125P-E1	NS	086270	1,025
150	480	3-3	106	87-3/16	96-11/16	15	11-1/2	GCHI-45-150P-E1	NS	086297	1,125
175	480	3-3	121	102-3/16	111-11/16	15	11-1/2	GCHI-45-175P-E1	NS	086318	1,225
Series 72 — 16 inch, 150 lb carbon steel vessel — 72 INCOLOY® elements[1] (15 W/In²)											
200	480	3-3	93	74-5/8	84-1/8	16	12-3/4	GCHI-72-200P-E1	NS	086393	1,265
225	480	3-3	101	82-5/8	92-1/8	16	12-3/4	GCHI-72-225P-E1	NS	086369	1,310
250	480	3-3	109	90-5/8	100-1/8	16	12-3/4	GCHI-72-250P-E1	NS	086334	1,355
Series 108 — 18 inch, 150 lb carbon steel vessel — 108 INCOLOY® elements[1] (15 W/In²)											
300	480	6-3	94	75-1/2	85	17	13-1/2	GCHI-108-300P-E1	NS	086422	1,400
325	480	6-3	100	81-1/2	91	17	13-1/2	GCHI-108-325P-E1	NS	086457	1,450
350	480	6-3	106	87-1/2	97	17	13-1/2	GCHI-108-350P-E1	NS	086481	1,500

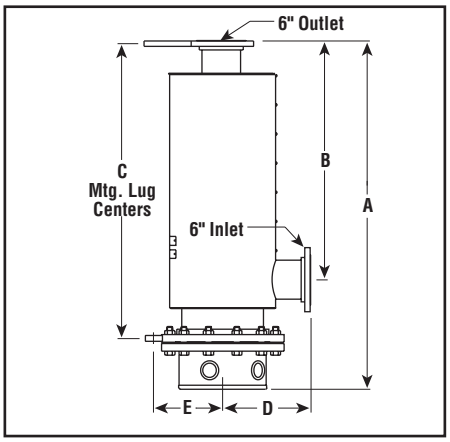
Stock Status: **S** = stock NS = non-stock
To Order—Specify model, volts, phase, kW, PCN and quantity.

1. Recommended temperature limits for all GCH heaters with carbon steel vessels and INCOLOY® elements are 1600°F maximum for the sheath temperature and 750°F maximum for the vessel temperature at 5 psi pressure maximum. Exceeding these recommendations will void the factory warranty. Outlet gas temperatures must be kept below both the maximum sheath and vessel temperature or element and vessel damage may occur. Contact your Local Chromalox Sales office for assistance in determining the gas flow characteristics and proper heater selection. Heaters supplied without controls.

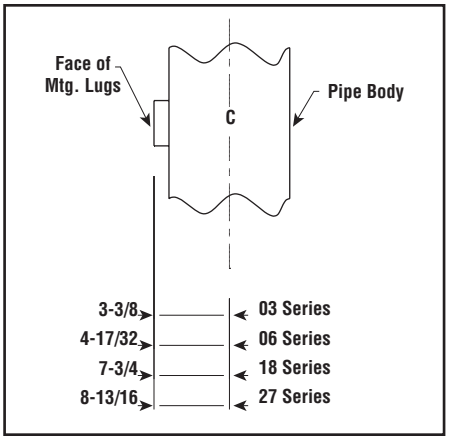
Other Note — Refer to the Controls section for control panels.

Dimensions (Inches)

GCHI-45, 72, 108



GCHI-AA



Ordering Information

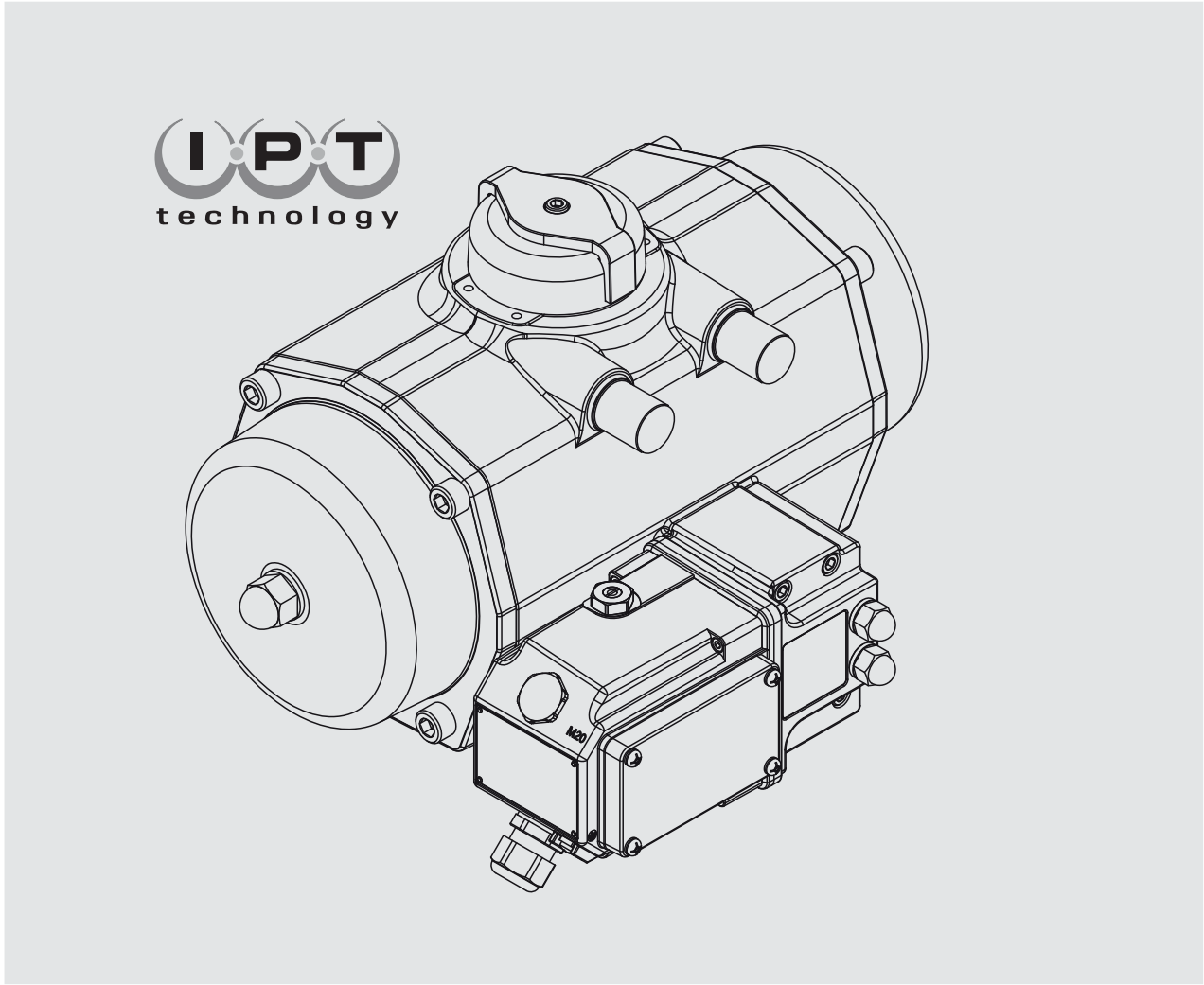
To Order — Complete the Model Number using the Matrix provided.

Model	Steam, Air and Gas to 750°F[1]				
GCHI	Gas Circulation Heater — INCOLOY® Elements — Steel Vessel				
B	Internal Baffles				
Code	**Number of Elements**				
03	Three	**45**	Forty Five		
06	Six	**72**	Seventy Two		
18	Eighteen	**108**	One Hundred Eight		
27	Twenty Seven				
Code	**kW**				
003P	3	**040P**	40	**150P**	150
04P5	4.5	**050P**	50	**200P**	200
006P	6	**060P**	60	**225P**	225
009P	9	**070P**	70	**250P**	250
012P	12	**075P**	75	**300P**	300
020P	20	**080P**	80	**325P**	325
025P	25	**090P**	90	**350P**	350
030P	30	**125P**	125		
Code	**Terminal Enclosure**				
E1	General Purpose				
E2	Moisture Resistant/Explosion Resistant				
E4	Moisture Resistant				

GCHI	45	072P	E1	Typical Model Number

Installation Operation & Maintenance Manual
DOC.IOM.Q.E Rev: B
May, 2010

FieldQ Valve Actuator



www.FieldQ.com

EMERSON
Process Management

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A Before you start

- FieldQ pneumatic actuators must be isolated both pneumatically and electrically before (dis)assembly.
- It is not permitted to connect a pressure vessel with unreduced media to the FieldQ pneumatic actuator.
- FieldQ actuators must not be connected to an air supply greater than 8 bar g or 120 psig
- This manual does not provide instructions for installations in hazardous areas.
- Installation, adjustment, putting into service, use, assembly, disassembly and maintenance of the pneumatic actuator must be done by qualified personnel.

A1 Orientation (see fig. A1)

The FieldQ actuator is an integrated concept for the automation of quarter turn valves, dampers or other quarter turn applications. It consists of three basic parts:
1. Pneumatic actuator
2. Pneumatic Module or NAMUR Plate
3. Control Module

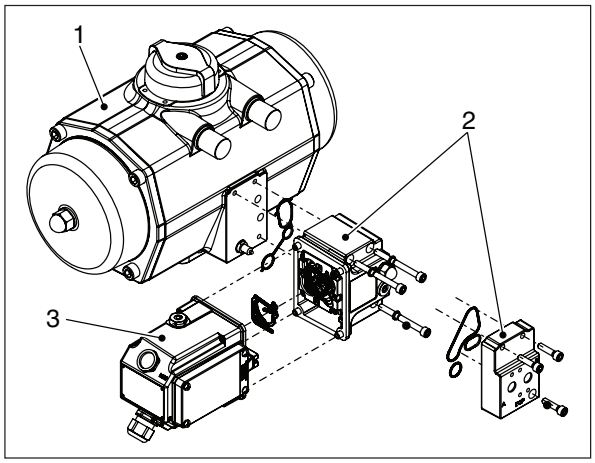


Fig A1 Orientation

A2 Installation, operation and maintenance reference documents

Before mounting, installing, commissioning or (dis)assembling the actuator consult the following documents:
- All chapters of this manual and
- Installation Guide of the supplied Control Module.
- For installation in hazardous area's: The applicable section of the Installation Guide, as shipped with the Control Module.
- For Control Modules with bus communication there may be an additional Reference Manual with more detailed information.

(available from www.FieldQ.com).

A3 Operating medium

- Air or inert gasses:
  - Filtered to 50 micron.
  - Intrinsically safe modules (QC03, QC04 & QC34: filtered at 5 micron.
  - Check the Installation Guide as shipped with the module for the applicable air quality.
- Maximum pressure, 8 bar g / 120 psig
- Dew point 10 K below operating temperature.
- For subzero applications take appropriate measures.

A4 Product integrity

- Assembly or disassembly is only allowed for replacing seals and guide bands (soft parts).

A5 Hazardous areas

Improper installation in a hazardous area can cause an explosion.

- Assembly, disassembly and maintenance must be done in safe area's without a potential explosion hazard.
- For information about installation in a hazardous area, refer to the appropriate sections of the Installation Guide, as shipped with the control module.

A6 Warning ; Moving parts

Applying pressure to the actuator or Applying a control signal to the Control Module, may cause the actuator/valve assembly to operate.

A7 Prevent moisture entering the actuator

Condensation or moisture that enters the actuator, the Pneumatic Module or the Control Module can damage these components and can result in failures. Therefore:

- Try not to mount the actuator with the conduit openings or the air entries, pointing upward.
- Ensure integrity of gaskets and o-rings.
- Install drip loops in conduit or cable.
- Seal all conduit openings whether used or not.

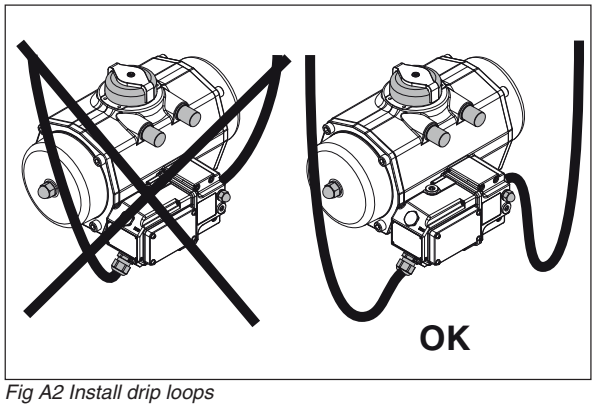


Fig A2 Install drip loops

A8 Warehouse storage

- FieldQ Actuators, Pneumatic Modules and Control Modules should be stored in a clean, dry warehouse, free from excessive vibration and rapid temperature changes.
- Actuators should not be stored on any floor surface.

A9 On site storage

- FieldQ Actuators, Pneumatic Modules and Control Modules should be stored in a clean, dry warehouse, free from excessive vibration and rapid temperature changes.
- Ensure all actuator covers are in place and securely fastened.
- Replace plastic conduit plugs with appropriate pipe plugs.

Failure to follow proper storage guidelines will void warranty.

1 Introduction

1.1 Orientation (see fig. 1.1)

The FieldQ actuator is an integrated concept for the automation of quarter turn valves, dampers or other quarter turn applications.

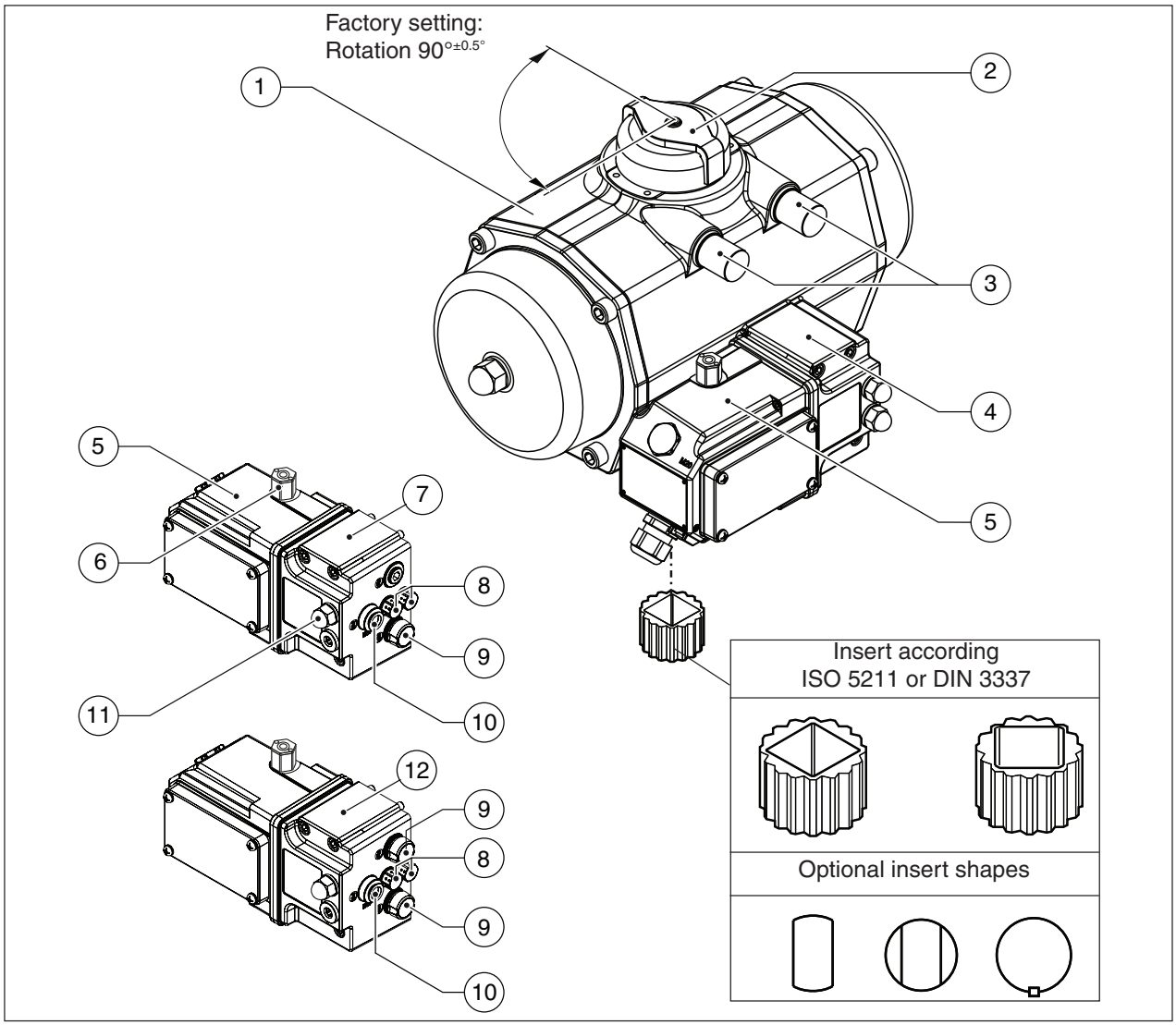


Fig 1.1 Introduction

1. Pneumatic actuator
2. Visual Position Indication
3. Stroke adjustment bolts
4. Pneumatic Module
5. Control Module
6. Pneumatic Manual Override
7. Single acting Pneumatic Module
8. Vents
9. Exhausts
10. Supply air entry
11. Speed Control
12. Double acting Pneumatic Module

2 Installation

2.1 Before you start

In case of an air or electrical failure, it is important to know the behavior of the actuator.
Before mounting the actuator on a valve consult the following paragraph's.

2.2 Failure modes

2.2.1 Valve rotation

Valves are normally manufactured so that:
- the valve is closed after a clock wise rotation (viewed from above).

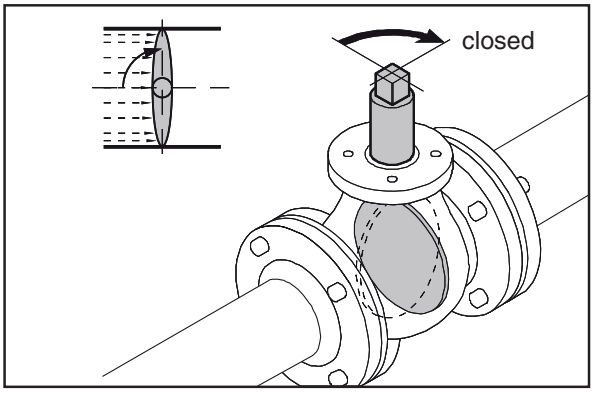


Fig. 2.2.1

- the valve is open after a counter clock wise rotation (viewed from above).

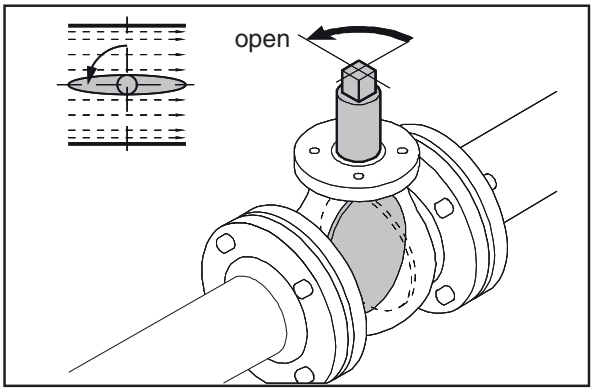


Fig. 2.2.2

2.2.2 Position after a failure

The position of the actuator after a failure depends on the:
- Operating principles (see §2.3)
- Assembly code (see §2.4)
- Kind of failure

Table 2.1 Position after a failure

Principle of operation	Assembly code :	Kind of failure :	Position :
Double acting actuator	CW	Pressure	not defined
		Signal	Closed
		Supply voltage	Closed
	CC	Pressure	not defined
		Signal	Open
		Supply voltage	Open
Single acting actuator (Spring Return)	CW	Pressure	Closed
		Signal	Closed
		Supply voltage	Closed
	CC	Pressure	Open
		Signal	Open
		Supply voltage	Open

2.3 Operating principle

2.3.1 Double acting actuators

IMPORTANT

The operating principle, as explained here, is applicable for actuators with assembly code CW (direct acting).

- The outward stroke will move the valve to the "Open" position.
- The inward stroke will move the valve to the "Closed" position.

For assembly codes CC the operating principle is reversed (reverse acting):

See paragraph 2.4 for more information about actuator assembly codes

* Electric control signals can be connected in the Control Module (QC; see documentation supplied with the Control Module). The Control Module is equipped with a pilot valve which controls the Pneumatic Module (QP).
* Connect air supply to air inlet (Ps).

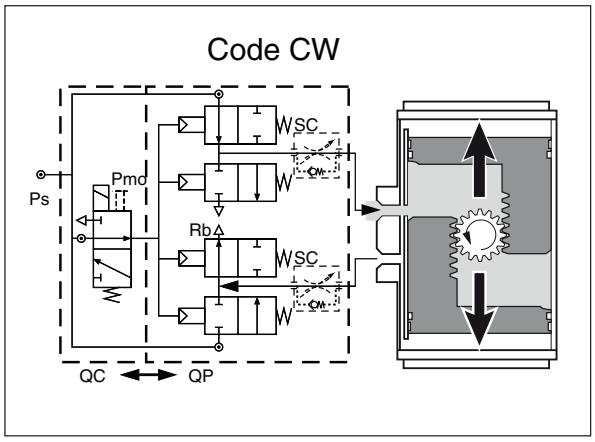


Fig. 2.3.1

Outward stroke

1 Send control signal "Open" to the Control Module.
2 The pilot valve will be activated and the Pneumatic Module will pressurize the central air chamber.
3 The piston will move outwards to the "Open" position.
4 The Control Module indicates the "Open" position and activates feedback signal "Open".

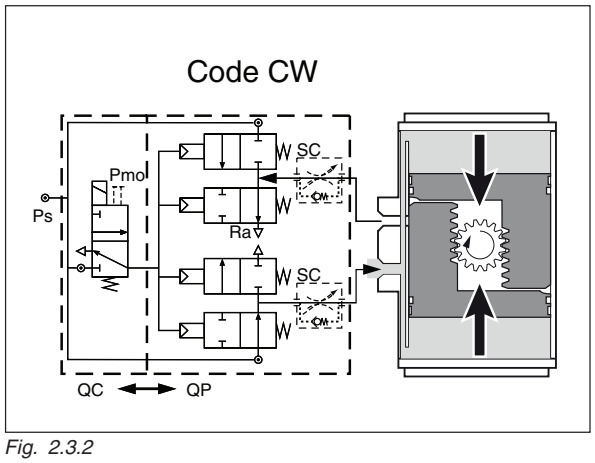


Fig. 2.3.2

Inward stroke

1 Send control signal "Close" to the Control Module.
2 The pilot valve will be deactivated and the Pneumatic Module will pressurize the end cap air chambers.
3 The piston will move inwards to the "Closed" position.
4 The Control Module indicates the "Closed" position and activates feedback signal "Closed".

Optional controls:

Pmo	Pneumatic Manual Override
SC	Speed Control

2.3.2 Single acting (spring return) actuators

IMPORTANT

The operating principle, as explained here, is applicable for actuators with assembly code CW (direct acting).
- The outward stroke will move the valve to the "Open" position.
- The inward stroke will move the valve to the "Closed" position.

For assembly code CC the operating principle is reversed (reverse acting):

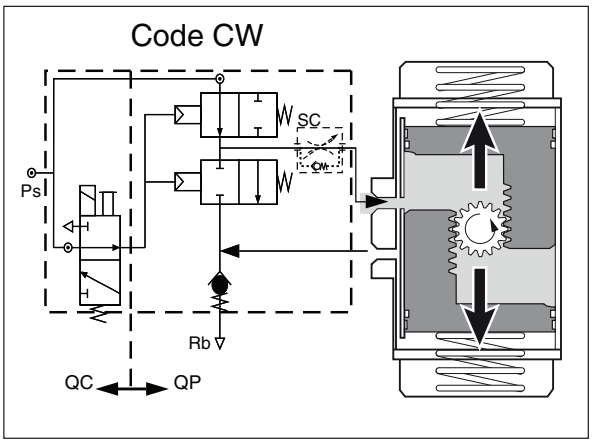


Fig. 2.3.3

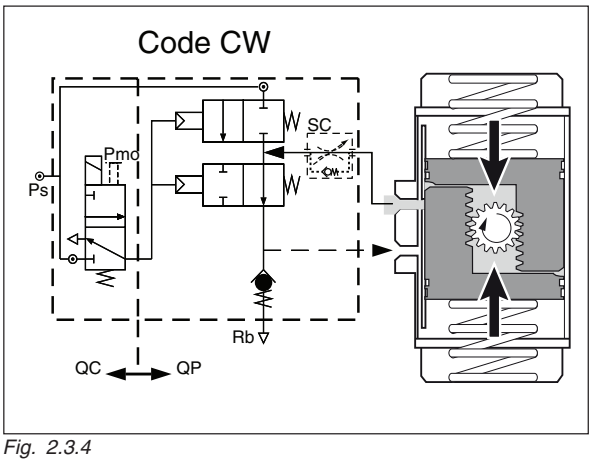


Fig. 2.3.4

See paragraph 2.4 for more information about actuator assembly codes

* Electric control signals can be connected in the Control Module (QC; see documentation supplied with the Control Module). The Control Module is equipped with a pilot valve which controls the Pneumatic Module (QP).
* Connect air supply to air inlet (Ps).

Outward stroke

1 Send control signal "Open" to the Control Module.
2 The pilot valve will be activated and the Pneumatic Module will pressurize the central air chamber.
3 The piston will move outwards to the "Open" position
4 The Control Module indicates the "Open" position and activates feedback signal "Open".

Inward stroke

1 Send control signal "Close" to the Control Module.
2 The pilot valve will be deactivated and the Pneumatic Module will vent the central air chamber
3 The springs will move the pistons inwards to the "Closed" position
4 The Control Module indicates the "Closed" position and activates feedback signal "Closed".

Optional controls:

Pmo	Pneumatic Manual Override
SC	Speed Control

2.3.3 Position feedback

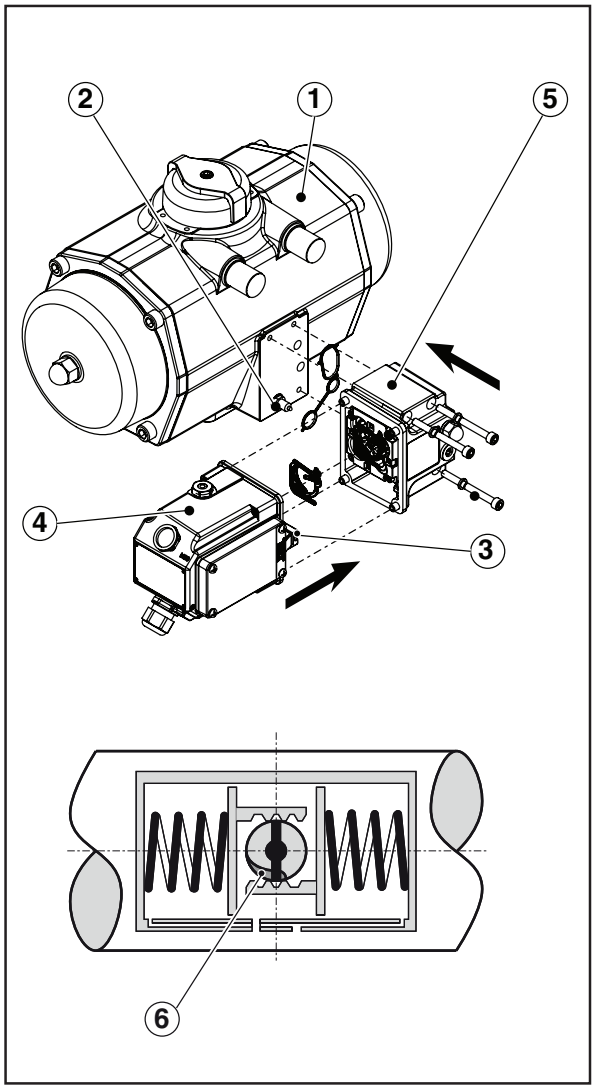


Fig. 2.3.5

FieldQ patented, position sensing system

The FieldQ actuator (1) has a patented, contactless position sensing system. This system consists of a position probe (2) which is rides on a special curve (6) in the pinion bottom.

The curve is shaped in such a way that the position probe moves linearly and proportionally to the rotation of the actuator pinion.

The linear movement of the position probe is tracked by a GMR sensor. This GMR sensor is placed in the protruding part (3) of the Control module (4), which slots in the Pneumatic Module (5).

Control Modules

The electronics in the Control Modules converts the signal of the GMR sensor and controls the switch outputs in the terminal compartment of the Control Module.

For the Control modules with a bus communication protocol the electronics convert the signal of the GMR sensor to a digital output signal, also positioned in the terminal compartment.

WARNING:
Do not put the Control module and the Pneumatic module in direct contact with magnetic material. This can cause damage or malfunction of the position feedback.

Mechanical installation of the FieldQ modules

For mechanical installation of the modules see chapter 4.

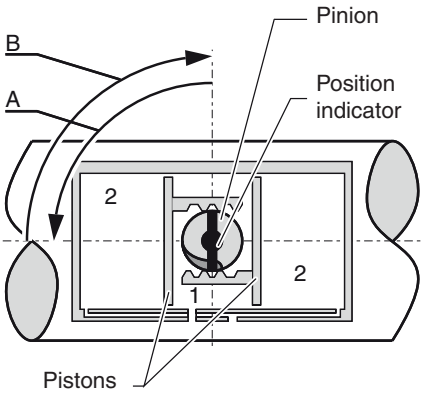
Installation Guides - Control modules

Each Control Module is shipped with an Installation Guide, which contains more information on the pneumatic and electrical installation and operation of the Module. Additionally, these Installation Guides can be downloaded from **www.FieldQ.com**

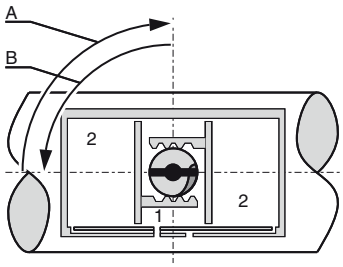
2.4 Actuator assembly codes

2.4.1 Double acting assembly codes

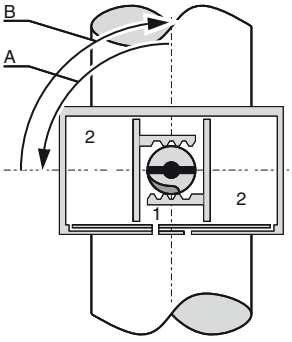
Standard assembly code: (= **Clock Wise** Rotation) **CW**
Visual indicator mounted: (= for **I**n line position indication **I**



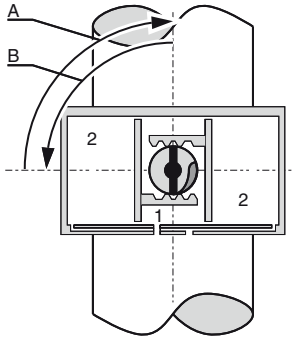
Optional assembly code: (= **Counter Clock Wise** Rotation) **CC**
Visual indicator mounted: (= for **I**n line position indication **I**



Optional assembly code: (= **Clock Wise** Rotation) **CW**
Visual indicator mounted: (= for **C**ross line position indication) **C**



Optional assembly code: (= **Counter Clock Wise** Rotation) **CC**
Visual indicator mounted: (= for **C**ross line position indication) **C**

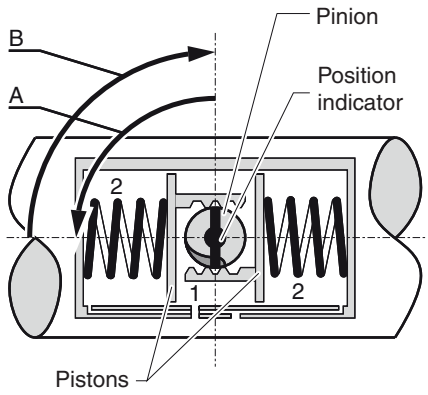


A = Pilot valve operated in Control Module - Central air chamber (1) pressurized
B = Pilot valve not operated in Control Module - End cap air chambers (2) pressurized

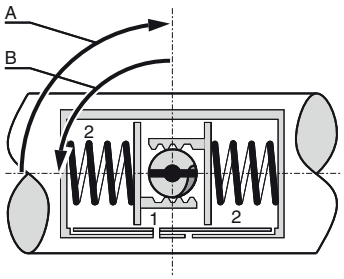
All views are from above. Pistons are shown in inner position

2.4.2 Single acting (Spring Return) assembly codes

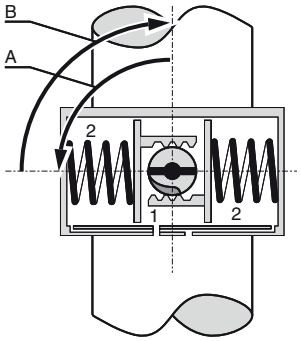
Standard assembly code:
(= **Clock Wise** Rotation / Spring to Close) **CW**
Visual indicator mounted:
(= for **I**n line position indication **I**



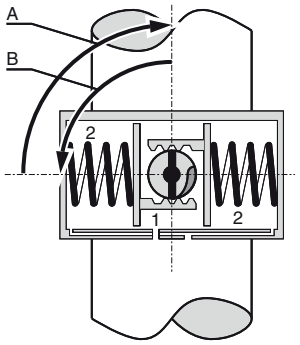
Optional assembly code:
(= **Counter Clock Wise** Rotation / Spring to Open) **CC**
Visual indicator mounted:
(= for **I**n line position indication **I**



Optional assembly code:
(= **Clock Wise** Rotation / Spring to Close) **CW**
Visual indicator mounted:
(= for **C**ross line position indication **C**



Optional assembly code:
(= **Counter Clock Wise** Rotation / Spring to Open) **CC**
Visual indicator mounted:
(= for **C**ross line position indication **C**



A = Pilot valve operated in Control Module - Central air chamber (1) pressurized
B = Pilot valve not operated in Control Module - **Spring stroke (2)**

All views are from above. Pistons are shown in inner position

2.5 Valve Installation

WARNING!
Actuator must be isolated both pneumatically and electrically before (dis)assembly. Before mounting or (dis)assembling the actuator consult the relevant sections of this manual.

Remove handle nut, handle, lock washer, etc. from valve if required.

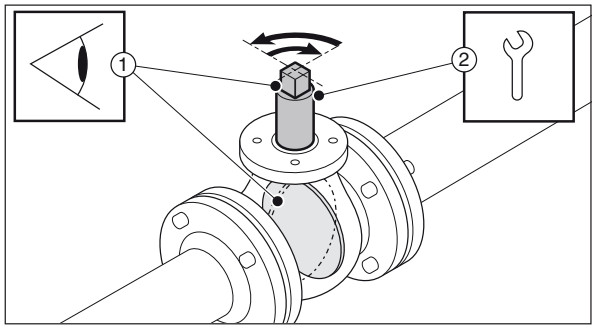


Fig. 2.5.1

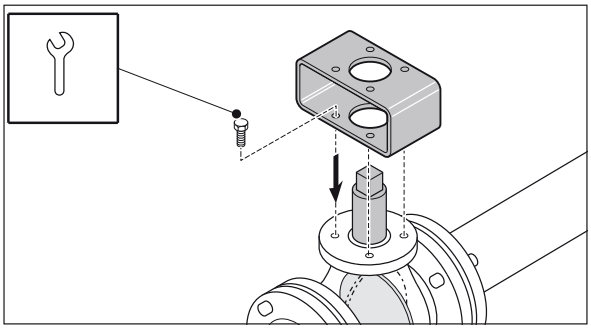


Fig. 2.5.2

CAUTION!
Be sure that the insert is mounted at 90° or 45°.
It is possible to mount the insert turned 22.5°. This way the valve will not open or close the right way.

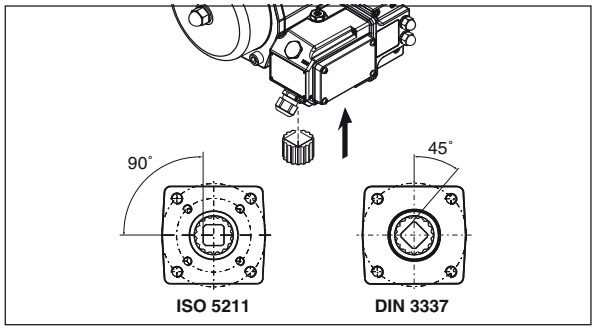


Fig. 2.5.3

CAUTION!
- Before mounting the actuator on the valve be sure that both the actuator and the valve have the same position.
- When mounting do not hit with hammer on pinion top.

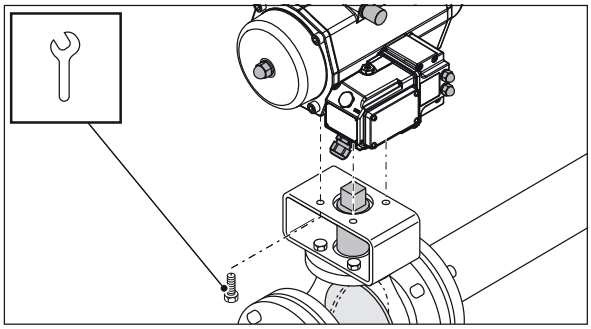


Fig. 2.5.4

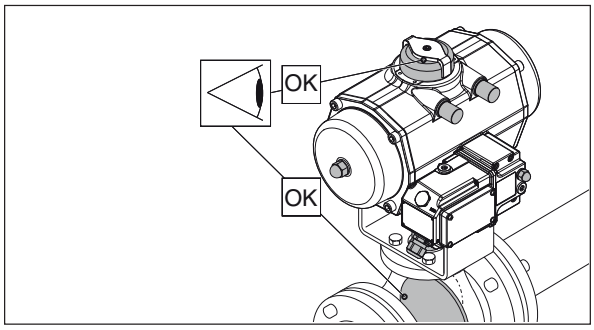


Fig. 2.5.5

IMPORTANT!
- When mounting the actuator across the pipeline, the NAMUR slot at the pinion top is turned 90° and does not reflect the position of the valve blade.
- When mounting NAMUR (VDI/VDE3845) switch boxes or positioners take care that these devices can be and will be set to reflect the actual limit positions.

2.6 Recommended tubing sizes

Actuator Model no.	Runs up to 1.2 mtr / 4 ft.	Runs over 1.2 mtr. / 4 ft.
Q-40, 65	6 mm / 1/4”	6 mm / 1/4”
Q-100, 150, 200, 350	6 mm / 1/4”	8 mm ~ 5/16”
600, 950, Q1600	8 mm / 1/4”	10 mm ~ 3/8”

2.7 Air consumption per stroke at atmospheric pressure

Air chamber	Model								
- at 1 atm (litres)	Q40	Q65	Q100	Q150	Q200	Q350	Q600	Q950	Q1600
Central air chamber	0.16	0.33	0.35	0.84	0.8	1.8	2.9	4.7	7.3
End cap air chambers	0.22	0.36	0.49	0.78	1	1.9	3.1	4.9	8.0
- at 1 atm (cu./in.)									
Central air chamber	10	20	21	51	49	110	177	287	445
End cap air chambers	13	22	30	48	61	116	189	299	488

3 Mechanical stroke adjustment

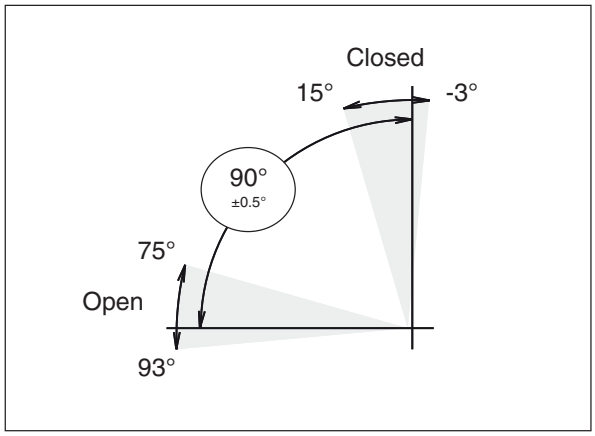


Fig. 3.1

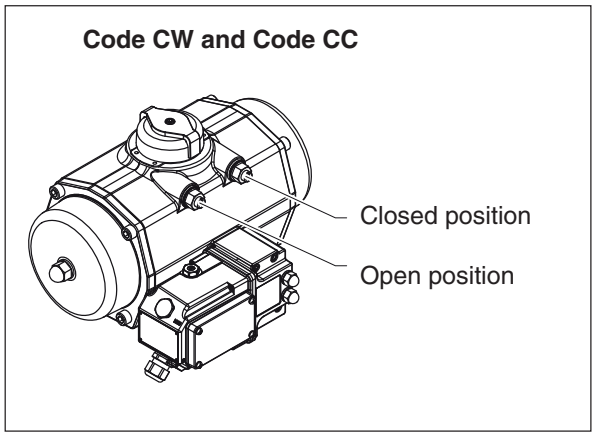


Fig. 3.2

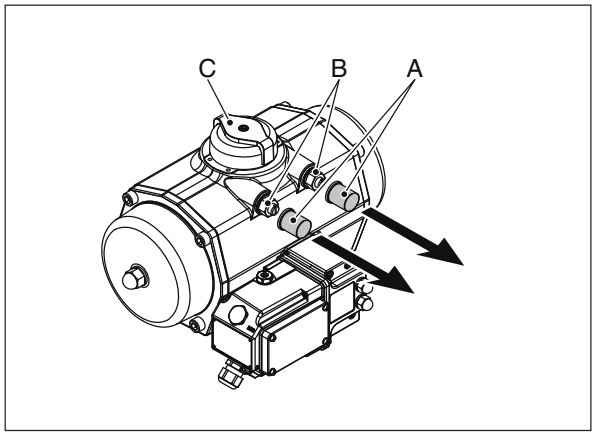


Fig. 3.3

The factory setting of the stroke is 90° ±0.5°

If required the stroke can be adjusted by means of two stroke adjustment bolts.

3.1 Adjusting the "Open" position

1. Connect supply pressure and control wiring according the instructions shipped with the Control Module.
2. Remove the nut caps (A).
3. Loosen nuts (B). See table 3.1.

Repeat next steps 4 to 8 until desired setting is achieved:

4. Send the actuator/valve assembly to the "Open" position (see instructions shipped with the Control Module).
5. Check whether the position of the valve is correct. The position indication knob (C) indicates the valve position

If the position is not correct, proceed with the following steps:

6. Send the actuator/valve assembly to the "Closed" (opposite) position (see instructions shipped with the Control Module).
7. Turn the limit stop bolts (see table 3.1):
   Turning in reduces the stroke:
   Turning out increase the stroke:
8. Send the actuator/valve assembly to the "Open" position (see instructions shipped with the Control Module).
9. Check whether the position of the valve is correct..

When the "Open" position is correct proceed with adjusting the "Closed" Position.

3.2 Adjusting the "Closed" position

1. Execute steps 4 to 8 of §3.1 but now for the "Closed" position.
2. Mount the nut caps (A).

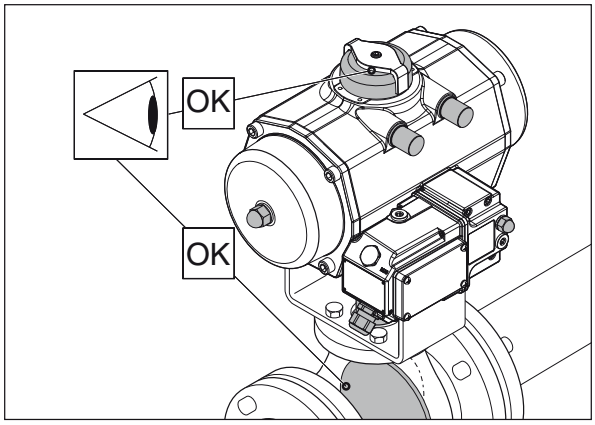


Fig. 3.1.2

Table 3.1 Angular Displacment & Tools

Actuator Size	Angular displacement	Tools	
		Nut	Bolt
Q40	3.0 °	W10 mm	SD1.2 mm
Q65	3.6 °	W13 mm	SD1.2 mm
Q100	2.7 °	W13 mm	SD1.2 mm
Q150	2.7 °	W17 mm	SD1.5 mm
Q200	2.3 °	W17 mm	SD1.5 mm
Q350	2.7 °	W19 mm	SD1.5 mm
Q600	2.7 °	W24 mm	W10 mm
Q950	2.5 °	W24 mm	W10 mm
Q1600	2.7 °	W30 mm	W10 mm

W = Wrench
SD = Screwdriver

3.3 Adjusting the end position with no electrical wiring connected.

If the Control Module is equipped with the optional Pneumatic Manual Override (A), only supply pressure needs to be connected to cycle the actuator. For more information on how to use the “Pneumatic Manual Override” see chapter 6.

REMARK:
In case of air leakage over the limit stop bolts, turn the lock nut of the limit stop bolts tighter, until leakage stops.

4 Removing and mounting of the FieldQ Modules

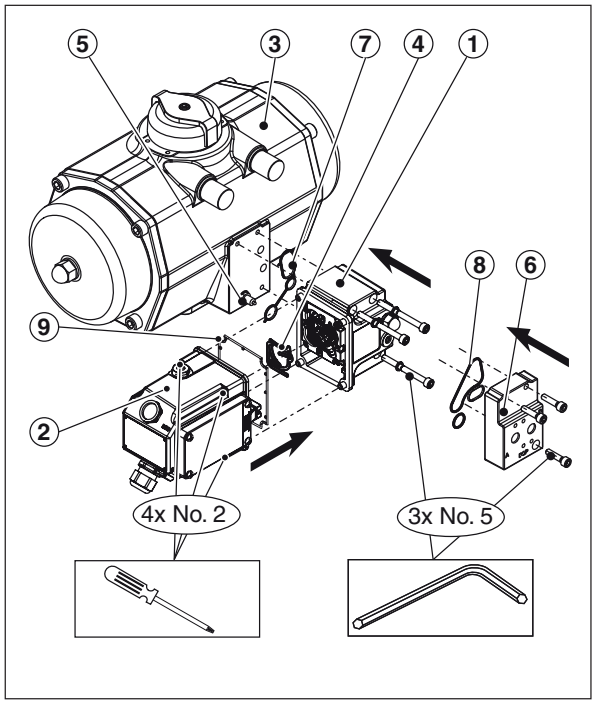


Fig. 4.1

WARNING
FieldQ pneumatic actuators must be isolated both pneumatically and electrically before (dis)assembly.

The Pneumatic Module (1) is placed between the Control module (2) and the housing (3) of the actuator. It controls the air going in and out the actuator. The actuator can be equipped with a NAMUR plate (6) for direct solenoid mounting.

4.1 Removing the FieldQ modules

1 To prevent warping of the modules and damage to the threads:
   - First loosen the all screws 1/4 to 1/2 turns.
   - The screws can now be removed completly.
2 Prevent damage to the position probe (5) to guarantee accurate position feedback.

4.2 Mounting the FieldQ modules

1 Take care that the following mating surfaces are clean.
   - Between the actuator housing and the Pneumatic Module (or NAMUR plate)
   - Between the Pneumatic Module and the Control Module.
2 To align the position probe (5) properly to the Control Module:
   - First mount the Pneumatic Module.
   - Then mount the Control Module.
3 Press the O-rings (8) and seals (4, 7 & 9) firmly in their mating grooves to keep them in place during mounting.
4 Prevent damage to the position probe (5) to guarantee accurate position feedback.
5 When fastening the module turn each screw two to three turns at a time, in sequence, to assure an air tight connection.

4.3 Tightning moments

The Control Module and the Pneumatic module should be fastened by using the allen keys as indicated and applying the following tightning moments:

- Phillips head size 2, 1.8 to 2.2 Nm (16 - 19.5 In.lbs)
- Allen Key No 5: 6.1 to 6.6 Nm (54 - 58.4 In.lbs)

4.4 Connecting air supply

To connect air supply see the Installation Guide shipped with the control module.

TIP
Grease the O-rings and seals before mounting. This makes them sticky and prevents that these O-rings and seals fall away during mounting.

5 Speed Control Options

WARNING
FieldQ pneumatic actuators must be isolated both pneumatically and electrically before any (dis)assembly is begun.

Two integrated speed control options are available:

A "One-way" Speed control throttle

This throttle controls only the air flow exhausted from an air chamber and as such limits the speed of the "Opening" or "Closing" stroke (see table "Speed control configuration").
It consists of :
1 Nut cover
2 Main throttle with set screw
3 Spring loaded counter part

B "Two-way" Speed control throttle

This throttle controls the air flow in and out of an air chamber and as such limits the speed of the "Opening" and "Closing" stroke simultaneously (see table "Speed control configuration"). It consists of :
1 Nut cover
2 Main throttle with set screw.

Note:

With the "Two-Way" speed control you can set simultaneously the speed of the "opening" and "closing" stroke. This does not mean that for both strokes, the cycle times can be set to an equal time.
The actual cycle times depend on the actual load on the actuator during the different strokes.

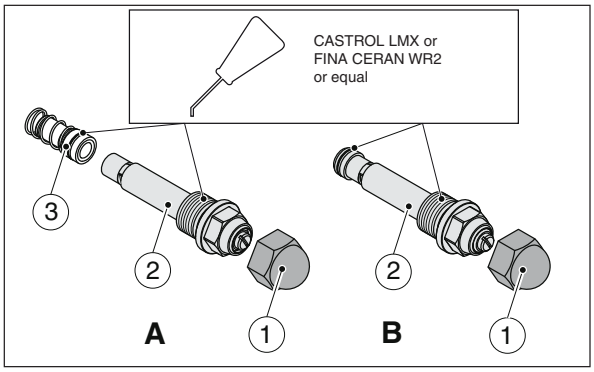
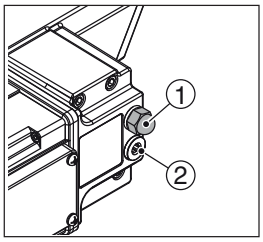


Fig. 5.1

5.1 Speed control on spring return actuators

On spring return actuators only the "central" air chamber is pressurized and vented. Therefore both the "One-Way" or the "Two-Way" throttles must be mounted in the port for the central air chamber port (1). Port (2) must be plugged.



Ps = Pressure supply
Ra = Exhaust
Rb = Exhaust
Pvv = Pilot valve vent
Opv = Over pressure vent

Options:
SC = Speed Control
Pmo = Pneumatic Manual Override

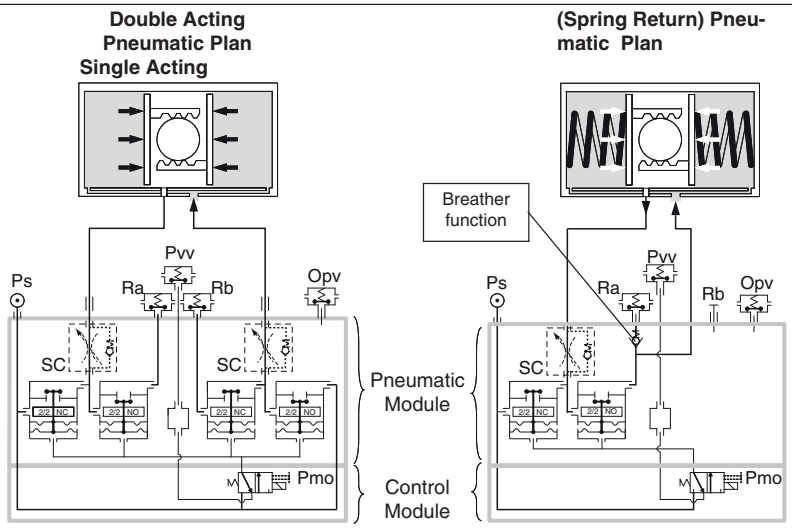
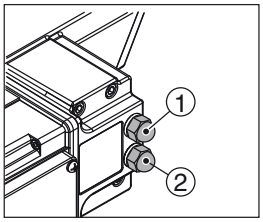


Fig. 5.2

5.2 Speed control on double acting actuators

On double acting actuators both the “central-” and “end cap” air chambers are pressurized and vented. Therefore both the “One-Way” and “Two-Way” throttles can be mounted in either ports (1) or (2).



5.3 Speed control configuration (see table below)

“Opening” or “Closing” stroke

* Whether the speed of the “Opening” or “Closing” stroke is limited, depends on the assembly code of the actuator.

Independently adjusting of the “Opening” or “Closing” stroke speed

* The speed of the “opening” stroke and “closing” stroke on double acting actuators with 2x “One-Way” throttles, can be set independently from each other.

5.4 Speed Control mounting and setting instructions.

1 Remove plug from pneumatic module, using a 6 mm allen key.
2 Before mounting, apply a light film of grease to the O-rings and the threads of the throttles (see fig 5.1).

For the “One Way” speed control.

- Use the main throttle to push the spring loaded counter part into the hole with the spring side first.

3 Turn in the main throttle, using a 13mm wrench. Take care that the flange under the hexagon meets the housing surface. Do not use excesive force.
4 Clockwise rotation of the adjustment screw reduces the speed.
5 Counter clockwise rotation of the adjustment screw increases the speed.
6 Replace the nut cap.

5.5 Speed control removal

In case the Speed Control throttle must be removed, take care the hole is plugged with a 1/4”BSP blind plug.

5.6 Speed control and actuator sizing

Installing a Speed control option can result in a non-smooth operation of the actuator (“Stick - Slip” behaviour). This behaviour can happen when the actuator size is to small. Selecting an actuator 1 size larger will solve this “Stick - Slip” behaviour.

Speed control configuration			**Spring return actuators**		**Double acting actuators**	
Option code	**Throttle or Plug**	**in air chamber port**	**“Air Fail to Close” (Code CW) Standard”**	**“Air Fail to Open” (Code CC)”**	**“(Code CW) Standard”**	**(Code CC)**
QP	Plug	Central	No Speed Control	No Speed Control	No Speed Control	No Speed Control
	Plug	End cap				
Q1	“One way SC”	Central	Clock wise stroke (closing)	Counter Clock wise stroke (opening)	Clock wise stroke (closing)	Counter Clock wise stroke (opening)
	Plug	End cap				
Q2	“Two way SC”	Central	Both strokes simultaneously adjustable	Both strokes simultaneously adjustable	Both strokes simultaneously adjustable	Both strokes simultaneously adjustable
	Plug	End cap				
Q3	“One way SC”	Central	Not applicable	Not applicable	Both strokes independently adjustable	Both strokes independently adjustable
	“One way SC”	End cap				
Q4	Plug	Central	Not applicable	Not applicable	Counter Clock wise stroke (opening)	Clock wise stroke (closing)
	“One way SC”	End cap				

6 Pneumatic Manual Override options

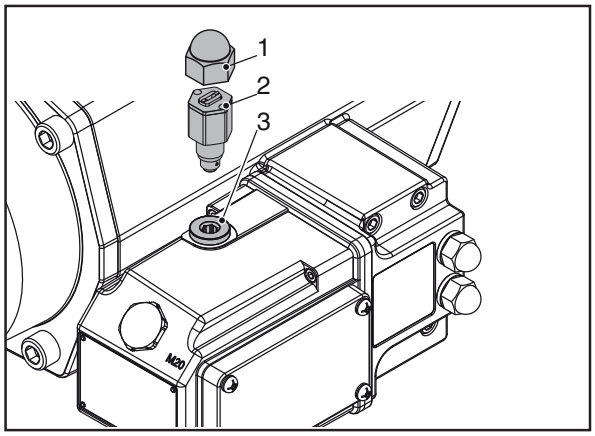


Fig. 6. 1 Pneumatic Manual Override mounting

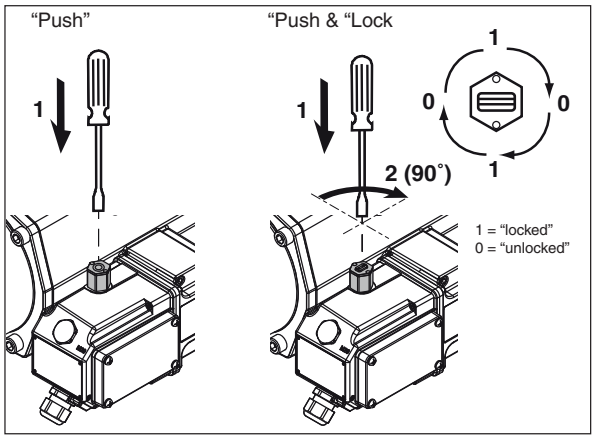


Fig. 6.2 Pneumatic Manual Override operation

WARNING
FieldQ pneumatic actuators must be isolated both pneumatically and electrically before (dis)assembly.

For commissioning, emergency or maintenance purposes, the FieldQ can be supplied with Pneumatic Manual Override options. These options can operate the actuator when there is air pressure available, but no control signal or power supply. Two versions are available:

1 "Push" version.
2 "Push & Lock" version.

6.1 Mounting instructions.

1 Remove plug (3) from the Pneumatic Manual Override port on the Control module (use a 6mm Allen key). Take care that no dirt or moisture enters in this port.
2 Turn in and tighten the Pneumatic Manual Override (2), using a 19mm wrench. Take care that the flange under the hexagon meets the housing surface. Do not use excessive force.
3 Replace the nut cap (1).

6.2 Operating instructions.

1 **"Push" version.** Pressing the spring return button will operate the actuator. Releasing the button will bring back the actuator in its original position.

2 **"Push & Lock" version.** To operate this optional local manual control, use a screw driver. Push and turn it 90°, to lock it in position and keep the actuator in its operated state.

It is possible to rotate the screw multiple cycles. The unit will toggle every 90° between "locked" (1) and "unlocked" (0).

7 Trouble shooting FieldQ

7.1 Mechanical problems

Problem	Possible error	Solution	Where to find
Feedback position and actual position are not the same.	Actuator and valve are mounted 90° rotated in relation to each other.	Remove actuator from valve. Check assembly code of actuator. Put both valve and actuator in “Closed” position. Mount actuator on valve.	Chapter 1 and 2 of DOC.IOM.Q.E
Valve is in “Closed” position, actuator is in “Open” position and will not move anymore.			
Valve does not reach the completely “Closed” or “Open” position.	Limit stop screws are not set correctly.	Readjust the limit stop screws	Chapter 3 of DOC.IOM.Q.E Chapter 2, §2.5 of DOC.IOM.Q. E
	Insert is not mounted properly	Mount the insert in the right position. Remark: Rotate insert for one cam = 22.5°	
	Pressure to low	Apply pressure as per sizing	Data sheets DA = 1.602.01. SR = 1.602.02 or 1.602.03
	Sizing is wrong	Check valve torque data with actuator torque data	
Actuator rotates, valve does not.	No coupling between actuator shaft and valve spindle.	Install a coupling between actuator shaft and valve spindle.	Chapter 2 of DOC.IOM.Q.E

7.2 Pneumatic problems

Problem	Possible error	Solution	Where to find
Actuator does not react to electrical control signal.	There is no supply pressure at the actuator.	Supply the right pressure to the actuator.	See supplied documentation of the Control Module.
	Supply pressure is connected to one to the exhausts.	Connect supply pressure to port “Ps”.	See supplied documentation of the Control Module.
Actuator does not react good to electrical control signal.	There is sufficient supply air pressure but insufficient supply air capacity.	Take care the supply air tubing has the right dimensions.	See chapter 2, §2.6 of DOC.IOM.Q.E
	Control Module is not mounted properly.	Mount the “Control Module” in the right way to the “Pneumatic Control Module”.	See chapter 4, of DOC.IOM.Q.E
	Speed control (if present) blocks air flow.	Turn the speed control more open. Select 1 size larger actuator	See chapter 5 of DOC.IOM.Q.E
	Manual override (if present) on the Control Module is locke	Unlock manual override on the Control Module.	See chapter 6 of DOC.IOM.Q.E
Air leakage out of main exhaust or out of the Control Module	Sealing between Control Module and Pneumatic Module is not mounted air tight. Sealing position probe leaks.	Reassemble function- and Pneumatic Module taking care, that all seals are in place.	See chapter 4, of DOC.IOM.Q.E
Double acting actuator will only move to “open” position.	Actuator has wrong Pneumatic Module.	Mount a Pneumatic Module suitable for double acting actuators	See chapter 4, of DOC.IOM.Q.E

7.3 Electrical problems

Problem	Possible error	Solution	Where to find
Actuator does not react to control signals	Control wiring, Power supply wiring or feedback wiring are not right connected.	Connect all wiring in the right way.	See documentation shipped with the Control Module. (DOC.IG.QCxx)
	The power supply voltage is not the same as the voltage of the applicable Control Module.	Connect the right power supply voltage.	See documentation shipped with the Control Module. (DOC.IG.QCxx)
Actuator does not react consistent.	Initialization was not completed in the right way.	Execute the initialization procedure or set feedback signal manuall	See documentation shipped with the Control Module. (DOC.IG.QCxx)
	Sizing is wrong	Re size the actuator to the valve	Data sheets DA = 1.602.01. SR = 1.602.02 or 1.602.03
There are problems with position feedback after sending the actuator to either the “Open” or “Closed” position.	The wiring of the feedback signals may be switched.	Connect the feedback wiring in the right way.	See documentation shipped with the Control Module. (DOC.IG.QCxx)

8 Maintenance

CAUTION:
Actuator must be isolated both pneumatically and electrically before any (dis)assembly is begun. Before mounting or (dis)assembling the actuator consult the relevant sections of this manual.

IMPORTANT
Under the European Pressure Equipment Directive, conversion of actuators may only be performed by companies or personnel, authorized by Emerson Process Management .

8.1 General

All FieldQ actuators are supplied with sufficient lubrication for their normal working life. If required, recommended lubrication for all standard actuators is a Castrol LMX, FINA Cera WR2 or equivalent. Periodic checks should be performed to make certain that all fasteners remain tight.

Depending upon the conditions under which the actuator must work such as extended duty, or abnormal operating conditions, periodic replacement of internal seals is recommended. Repair kits containing all necessary seals and instructions can be obtained through authorized FieldQ distributors.

8.2 Single acting / Spring Return actuators

On spring return actuators, the springs can be replaced.

SPRINGS SHOULD ALWAYS BE REPLACED IN COMPLETE SETS.

Spring kits are available through authorized FieldQ distributors.

8.3 FieldQ recommended spare parts

All soft seals, bearings, and nonreusable parts are included in the FieldQ recommended spare parts kit.
The spare parts kit is identical for both the double acting and the spring return models. For the spring return models we recommend a set of spare springs for each different model in addition to the recommended spare parts kit. Keep in mind that, when necessary, springs are to be replaced in complete sets. The following spare parts kits are available:

1 Repair kit for FieldQ actuator and all modules, available per actuator size.
2 Module seals kit, suitable for all module variations.

8.4 Position tracking device kits

The position tracking device takes care of the mechanical part of the feedback signal. In case the position tracking device malfunctions, spares are available. Position tracking device kits are available per actuators size and contain all necessary seals and lubricants. They can be obtained through authorized FieldQ distributors.

8.5 Conversion kits

When the action of an actuator needs to be changed from spring return to double acting or visa versa, conversion kits can be utilized. Two kinds of conversion kits are available:

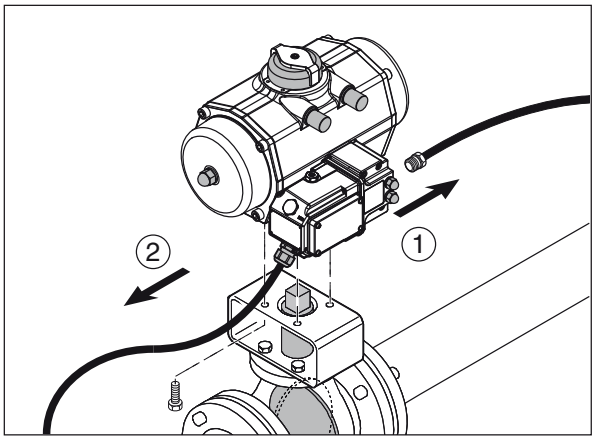
1 Single acting (spring return) Conversion kits, to make a spring return actuator.
2 Double acting Conversion kits, to make a double acting actuator.

8.6 High Temp and Low Temp Conversion kits

For the FieldQ actuators with the NAMUR plate, special conversion kits are available to make the FieldQ suitable for High temperature or Low temperature applications.
There are no “High temp” or “Low temp” conversion kits available for FieldQ actuators with modules

9 Disassembly

9.1 Before starting

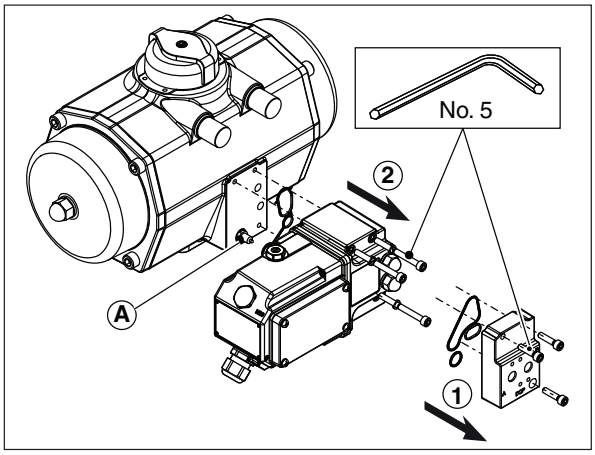


9.1.1

9.1.1

Caution! Never disassemble a valve that is under pressure!

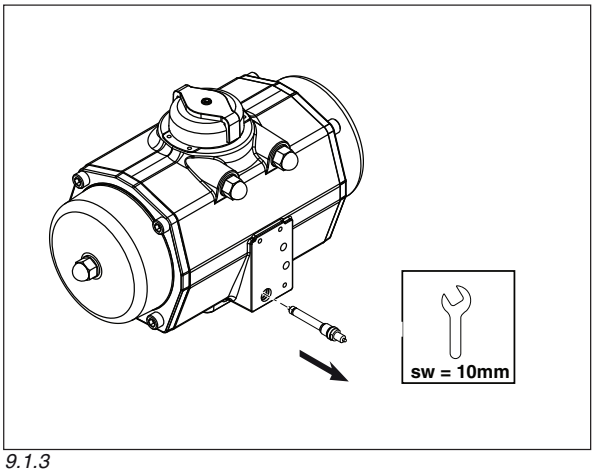
Caution! Ball valves and plug valves can trap pressurized media in the cavity. Isolate the piping system in which the actuator valve assembly is mounted and relieve any pressure on the valve.



9.1.2

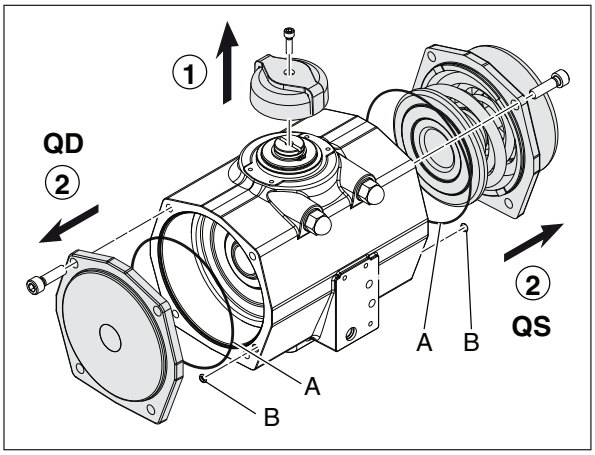
9.1.1 / 9.1.2

Prevent damage to the position probe (A) to guarantee accurate position feedback.



9.1.3

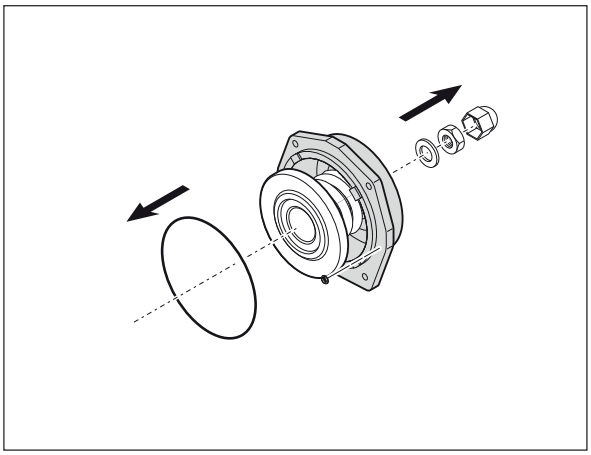
9.2 Removing end caps all types QD and QS 40 to QS 350



9.2.1

9.2.1

Be careful not to damage the endcap (A) and B-port (B) O-rings.

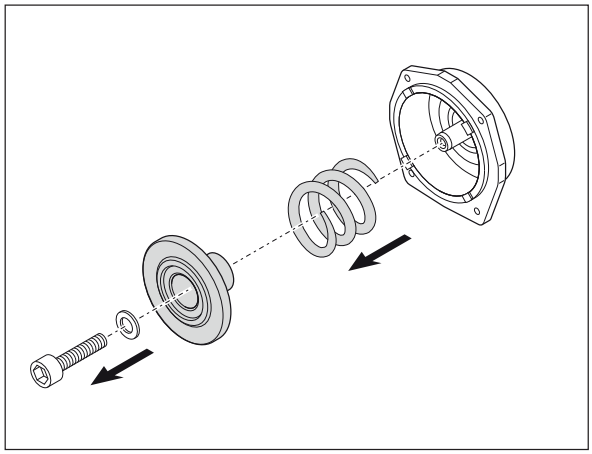


9.2.2

9.2.2 / 9.2.3

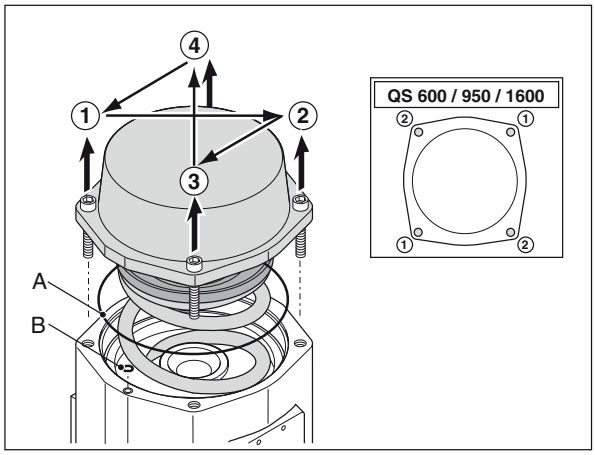
Caution! If the actuator is a “spring return” model, uniformly loosen all endcaps screws, 1/4 - 1/2 turns at a time, in sequence, to relieve pre-load of the springs.

On all actuators with springs use caution when removing endcaps.

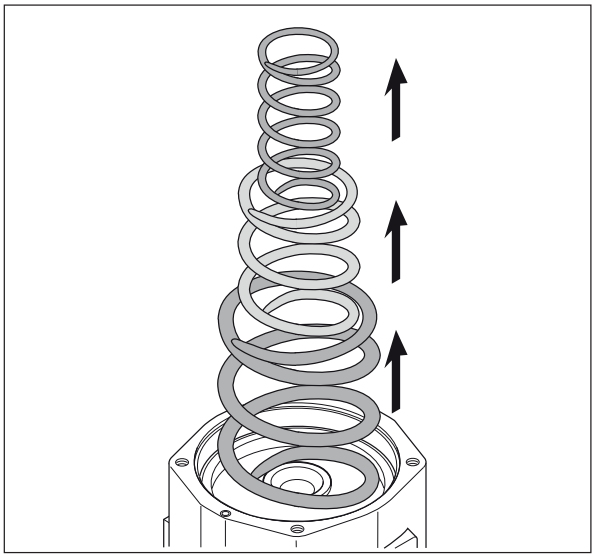


9.2.3

9.3 Removing end caps type QS 600 to 1600



9.3.1



9.3.2

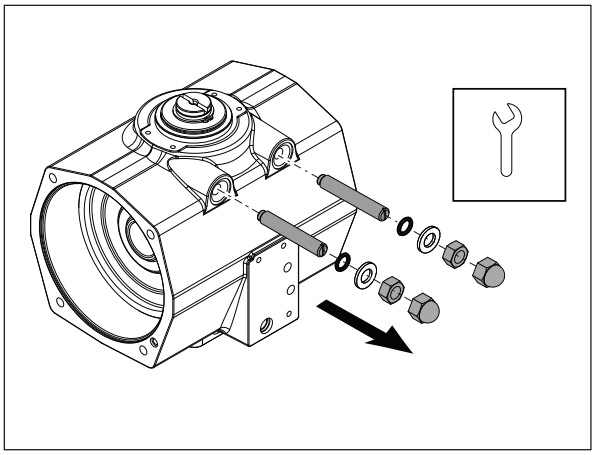
9.3.1

Be careful not to damage the endcap (A) and B-port (B) O-rings.

Caution! If the actuator is a “spring return” model, loosen endcap screws in sequence as shown, 1/4 - 1/2 turns at a time, to relieve pre-load of the springs.

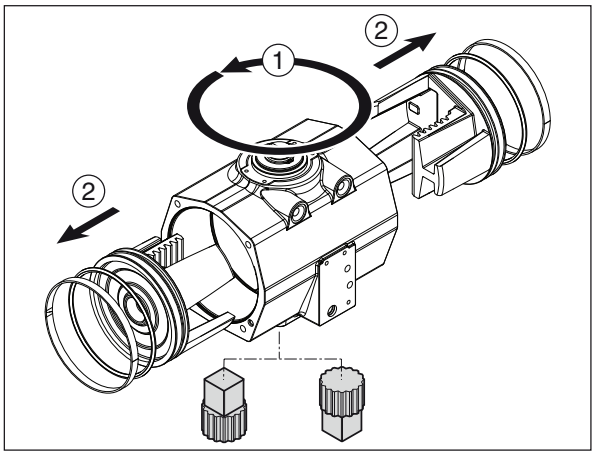
On all actuators with springs use caution when removing endcaps.

9.4 Removing limit stop bolts, pistons and pinion assembly.



9.4.1

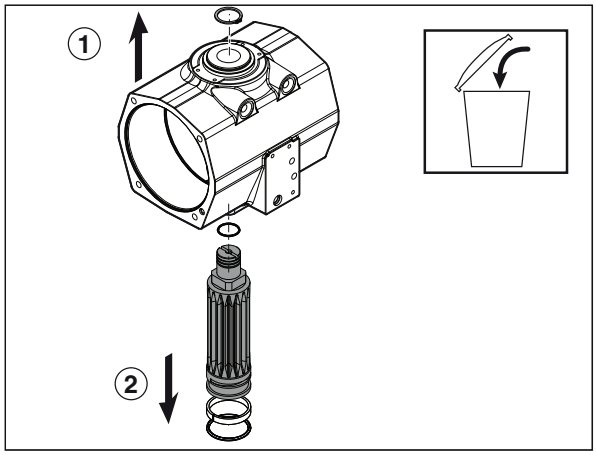
9.4.1
Remove limit stop bolts.



9.4.2

9.4.2
Remove the two pistons by using an adaptor fitted in a vice.

Place the actuator on top of the adaptor (either the square end or the insert shape end). Turn the complete actuator and the pistons will come out.



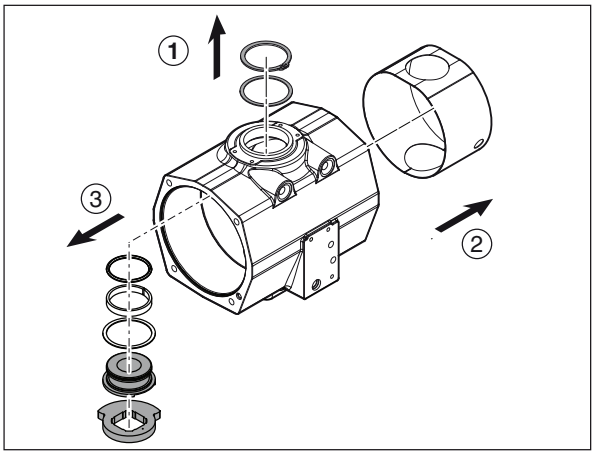
9.4.3

9.4.3

Before removing the pinion be sure the position probe is removed (see chapter 1.1)

Remove spring clip from pinion top and remove pinion.

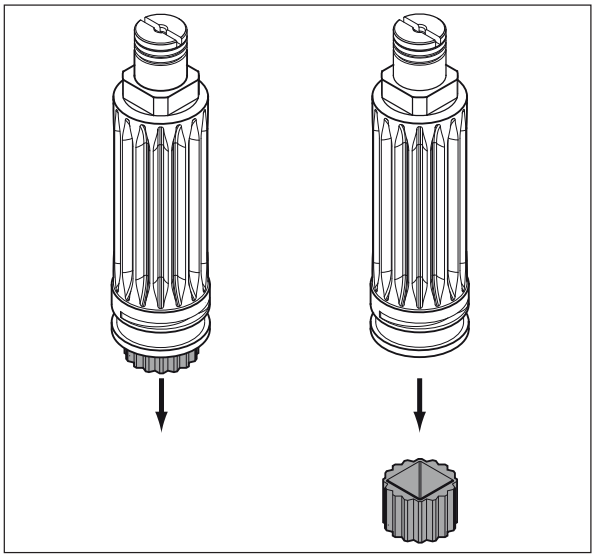
For removing the circlip, circlip pliers are required.



9.4.4

9.4.4
Remove spring clip form upper pinion part and remove upper pinion part through bore of housing

For removing the circlip, circlip pliers are required.

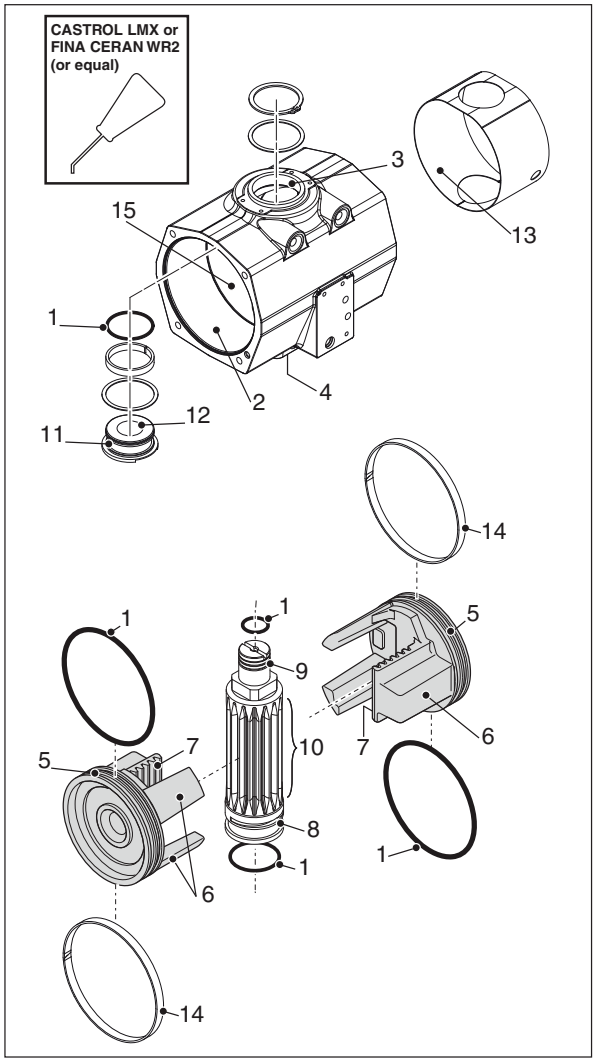


9.4.5

9.4.5
Removing the insert requires an extraction tool. Please contact your local FieldQ representative for more information about this extraction tool.

10 Reassembly

10.1 Reassembly guide band and pinion assembly



10.1.1

Before reassembly check the requested assembly code (see chapter 2.7).

10.1.1

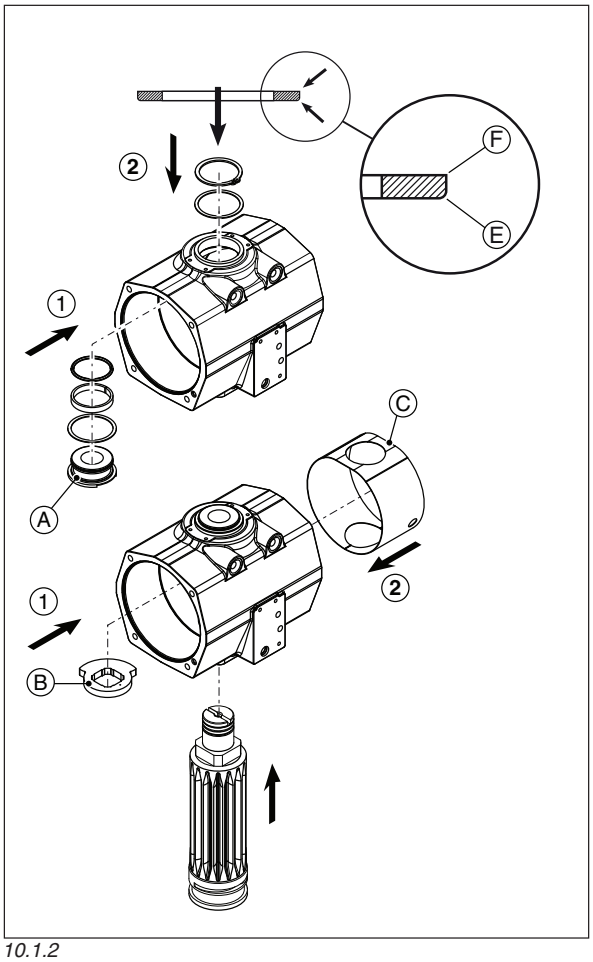
Apply grease to the parts as per table 10.1 and figure 10.1.1

Table 10.1 Grease instructions

Part	Section of part	Amount of grease
O-rings		
1	Completely	Light film
Housing		
2	Piston bore	Light film
3	Top pinion bore	Light film
4	Bottom pinion bore	Light film
Pistons		
5	O-ring & guideband groove	Fully greased
6	Outer side of legs	Light film
7	Gear teeth	Half the teeth depth full with grease
Pinion		
8	Bottom O-ring groove	Fully greased
9	Top O-ring groove	Light film
10	Gear teeth	Half the teeth depth full with grease
Upper pinion part		
11	Outer diameter	Fully greased
12	Inner diameter	Light film
Housing guideband		
13	Inner diameter	Light film
Piston Guidebands		
14	Completely	Light film

Important:
Do not grease the middle part of the piston bore (15) and the outer diameter of the housing guideband .

Take care that half the gear depth is full with grease.



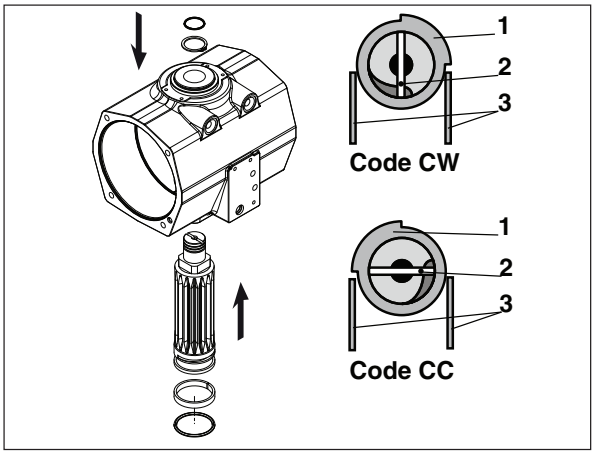
10.1.2

10.1.2

1. Mount the upper pinion part (A),
2. Mount the stroke adjustment cam (B) and housing guide band (C).

Keep the stroke adjustment cam in position while mounting the pinion.

The two circlips have one side with bevelled edges (E) which must go DOWN onto the thrust washer, the square edge side (F) must face UPWARDS.



10.1.3

2.1.3

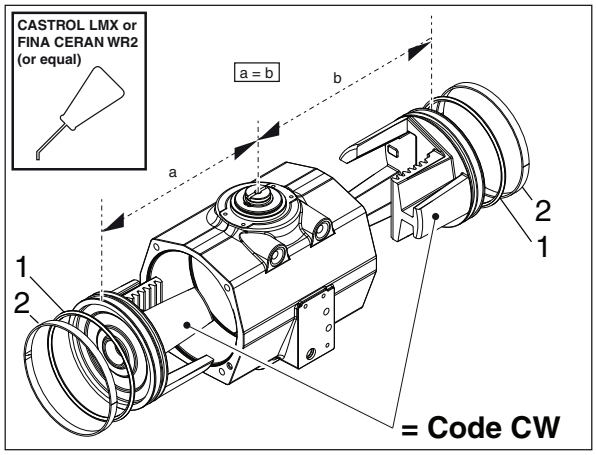
Mount the pinion.

For fastening the circlips, circlip pliers are required.

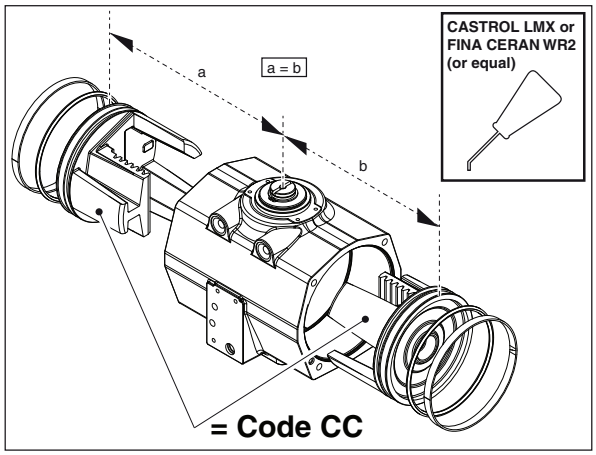
Use limit stop screws (3) as a reference to position limit stop cam (1) and pinion (2) as shown. See indication dot in the Pinion top slot. Views are from above.

The position of the pinion and the limit stop cam, as shown, is the position where the pistons are in the inward position (see next paragraph).

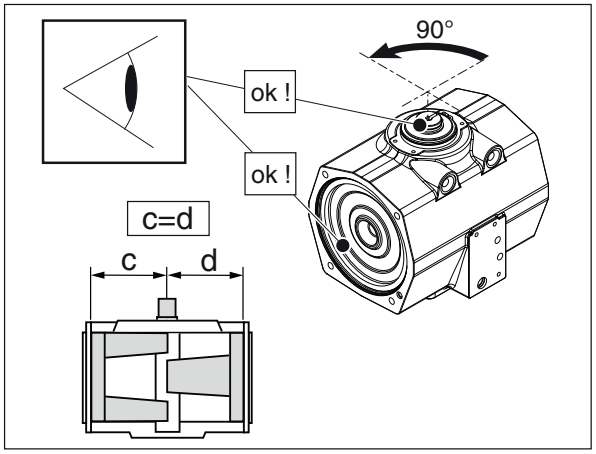
10.2 Reassemble the pistons



10.2.1



10.2.2



10.2.3

10.2.1 / 10.2.2

1 Check required assembly code.
2 Apply a light film of grease to the bore of the housing.
3 Ensure that O-rings (1) and guide bands (2) are kept in place during assembly.
4 Align the pinion so that the teeth on the pinion will "pickup" the pistons rack teeth when turning the top of the pinion:
   - clockwise (CW) for assembly code CW or
   - counter clockwise (CCW) for assembly code CC

☞ Turn the pinion gently to guide the guide band into the housing, taking care not to damage the guide band.

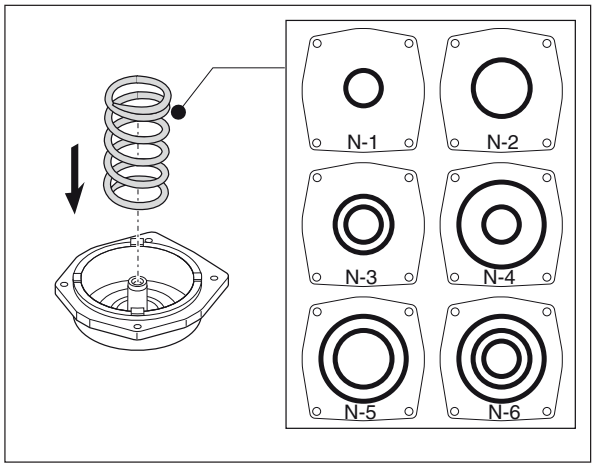
10.2.3

☞ Ensure that smooth movement and 90 degree operation can occur without moving the pistons out of the actuator body.

☞ Ensure that the slot on the pinion top is:
- exactly perpendicular (code CW) or
- in line (code CC) with the actuators centre line.

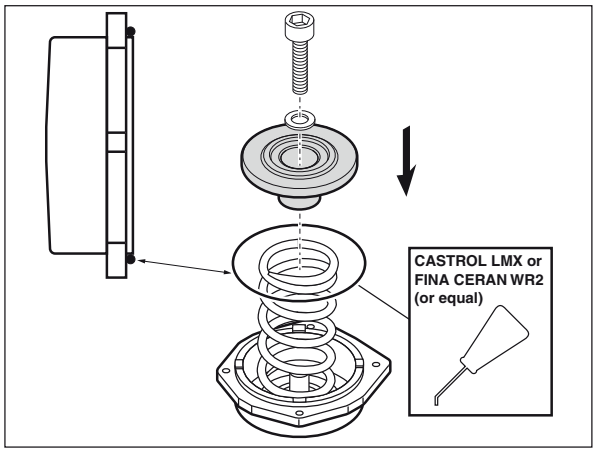
☞ If not, turn the pistons outward until they disengage from the pinion. Shift one tooth of the pinion, reassemble and check again.

10.3 Reassembly end caps, all types QD and QS 40 to QS 350



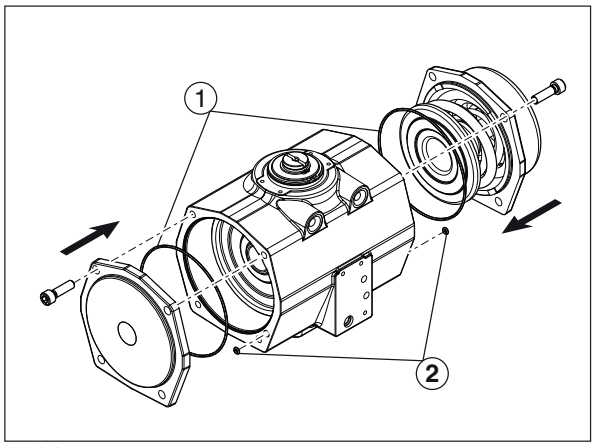
10.3.1

10.3.1
When replacing springs in a spring return actuator, ensure that the springs are replaced in their identical position in the spring pack from where they were removed. Before assembling the springs and endcaps, make sure that the pistons are inwards.



10.3.2

10.3.2
Put some grease on the endcap O-ring before mounting.

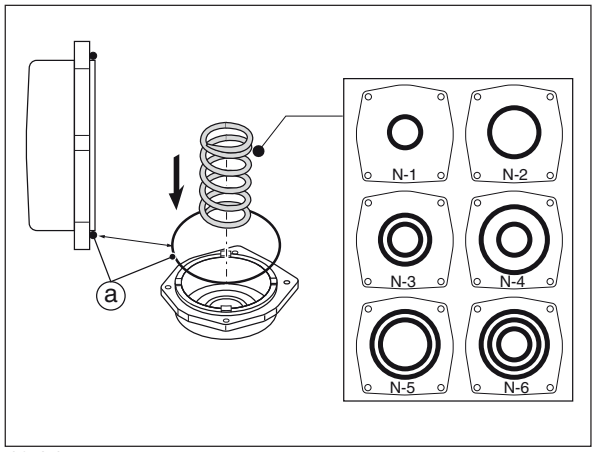


10.3.3

10.3.3
Ensure that endcap O-rings (1) and airport O-rings (2) are in place on both sides.

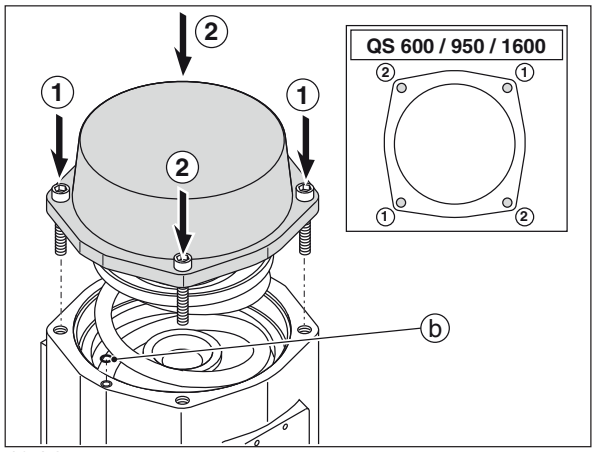
Put some grease on the air port O-rings (2), so they and stay in place while mounting.

10.4 Reassembly end caps single acting actuators QS 600 to QS 1600



10.4.1

10.4.1
When replacing springs in a spring return actuator, ensure that the springs are replaced in their identical position in the endcap from where they were removed.
Before assembling the springs and endcaps, make sure that the pistons are inwards.



10.4.2

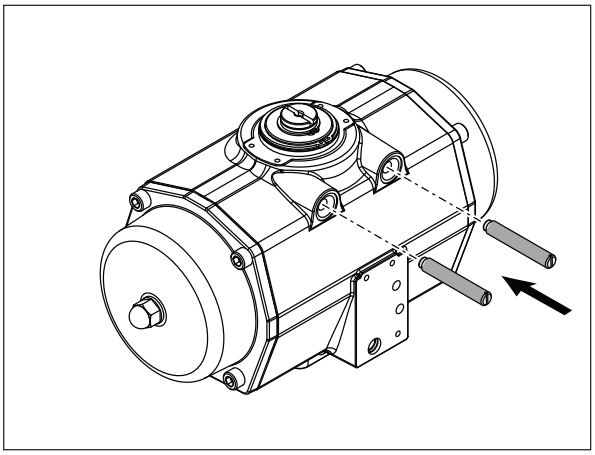
10.4.2
Ensure that endcap O-rings (a) and airport O-rings (b) are in place on both sides.

Engage the bolts with the tapped holes in the actuator body by forcing down slightly on the cap.
Tighten each bolt in small and equal turns.

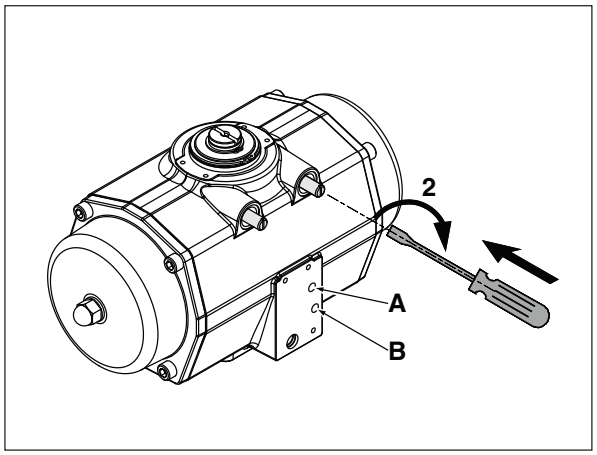
Table 10.3 Tightening torque FieldQ end-cap bolts

Actuator Type	Cap Bolt Size	Hexagon Key size	Tightening Torque			
			Nm		in.lb	
			max.	min.	max.	min.
40	M5	4mm	1,7	1,3	15	11
65	M6	5 mm	3,2	2,7	28	24
100	M6	5mm	3,2	2,7	28	24
200	M8	6mm	7,1	5,2	63	46
350	M10	8mm	14	11,2	124	99
600	M12	10mm	44,2	25	391	222
950	M12	10mm	44,2	25,1	391	222
1600	M14	12mm	70,6	39,6	624	350

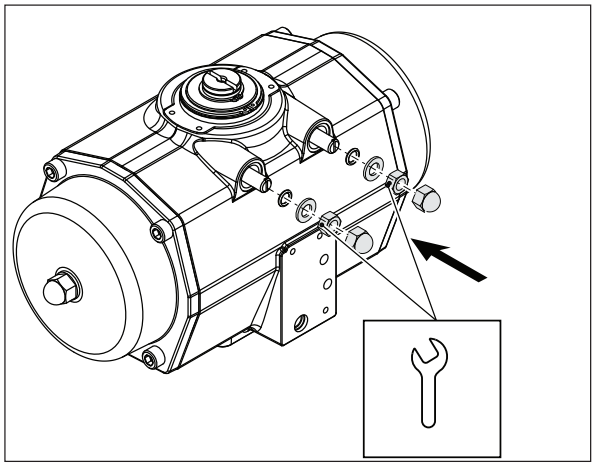
10.5 Mounting and setting of limit stops



10.5.1



10.5.2



10.5.3

Setting of limit stops

Closed position

1 Move actuator to the “Closed” position(1.
2 Turn the “Closed” limit stop screw in until it blocks.
3 Move actuator to the “Open” position(1.
4 Turn the “Closed” limit stop screw in as shown in table 2.5.2

Open position

1 Repeat the steps 1 to 4 as described for the “Closed” position but now for the “Open” position.

(1 Apply pressure to port A or B

REMARK

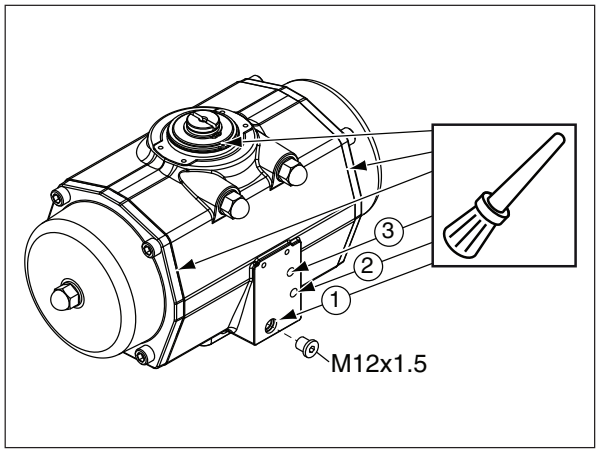
This procedure does not apply for setting the exact end positions of a “FieldQ mounted on a valve”.
To set the end positions of a FieldQ mounted on a valve, do as described above, check the valve position and adjust where necessary.

Table 3.1 Angular Displacment & Tools

Actuator Size	Angular displacement	Tools	
		Nut	Bolt
Q40	3.0 °	W10 mm	SD1.2 mm
Q65	3.6 °	W13 mm	SD1.2 mm
Q100	2.7 °	W13 mm	SD1.2 mm
Q150	2.7 °	W17 mm	SD1.5 mm
Q200	2.3 °	W17 mm	SD1.5 mm
Q350	2.7 °	W19 mm	SD1.5 mm
Q600	2.7 °	W24 mm	W10 mm
Q950	2.5 °	W24 mm	W10 mm
Q1600	2.7 °	W30 mm	W10 mm

W = Wrench
SD = Screwdriver

10.6 Final assembly and airtightness test

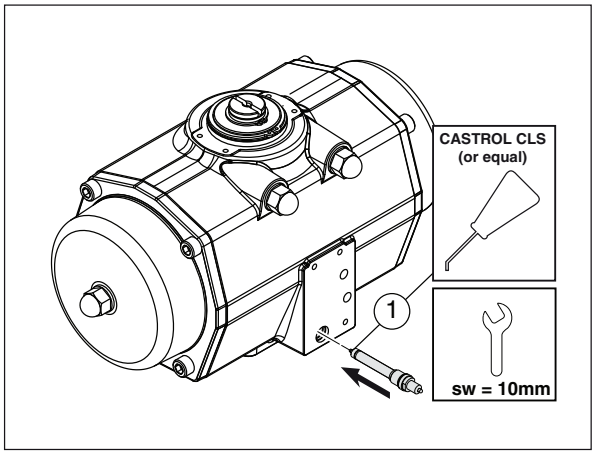


10.6.1

10.6.1
Plug the IPT device hole (1) with a M12x1.5 plug. Apply pressure (max. 8 barg / 116 PSI) to ports (2) and (3). Use some soapsuds at the indicated points.

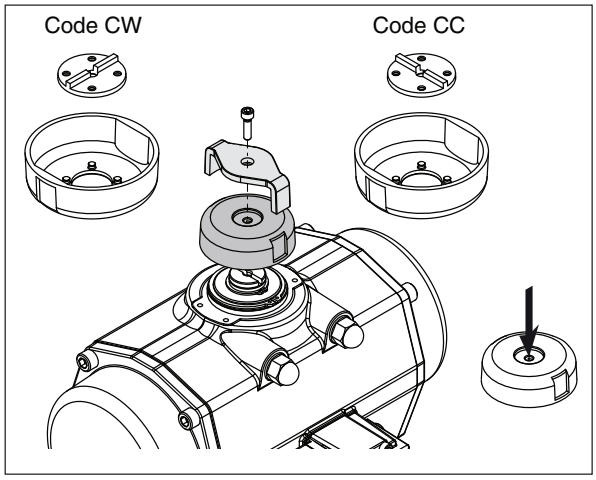
Applying pressure to the actuator will cause the actuator/valve assembly to operate.

In case of leakage around :
1 The limit stop bolts (and/or the spring-package-bolt at spring return models):
   - Turn the lock nut of the bolts tighter, until leakage stops.
2 The endcaps :
   - Disassemble the endcaps, replace O-rings and reassemble the endcaps.
3 The pinion top or bottom and A- or B-port:
   - Disassemble the complete actuator, replace O-rings and reassemble the actuator.



10.6.2

10.6.2
Take care that the position probe and the mounting hole is clean. Apply Castrol CLS grease to the tip (1) to ensure proper functioning.



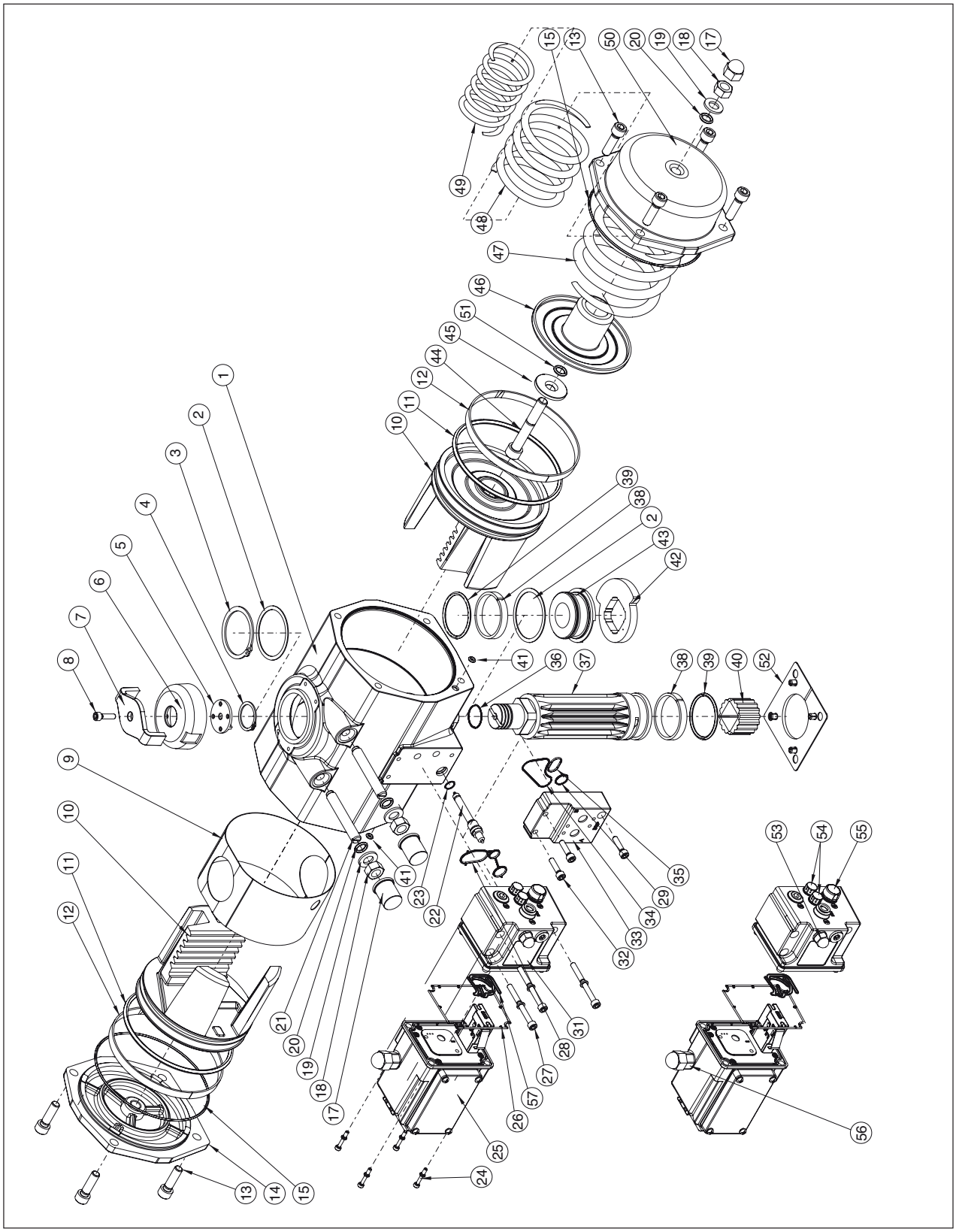
10.6.3

10.6.3
Check the position of the inner part of the position indication knob. When mounted to the pinion top, the projection of the inner part will fit in the groove on the pinion top.
To disassemble the inner part, press as shown.

For assembly of the Pneumatic and Control modules see Chapter 4

11 FieldQ Parts

11.1 Exploded view FieldQ



11.2 Bill Of Material

Pos.	Qty.	Description	Note
1	1	Body	
2	2	Washer	1
3	1	Circlip	1
4	1	Circlip	1
5	1	Indicator insert	
6	1	Indicator knob	
7	1	Indicator arrow	
8	1	Screw	
9	1	Guide band (housing)	1
10	2	Piston	
11	2	O-ring	1
12	2	Guide band (piston)	1
13	8	End cap screws	
14	2	End cap QD	
15	2	O-ring	1
17	4	Nut cover	
18	4	Nut	
19	4	Washer	1
20	4	O-ring	1
21	2	Limit stop screw	
22	1	IPT-device	
23	1	O-ring	1
24	4	Screw	
25	1	Control Module	
26	1	Seal Control Module	1/2
27	3	Screw	
28	1	Seal Pneumatic module	2

Pos.	Qty.	Description	Note
31	1	Pneumatic Module	
32	3	Screw	
33	1	NAMUR plate	
34	1	O-ring	
35	1	O-ring	
36	1	O-ring	
37	1	Pinion	
38	2	Bearing ring	1
39	2	O-ring	1
40	1	Insert	
41	2	O-ring	1
42	1	Limitstop cam	
43	1	Upper pinion part	
44	2	Springpack bolt (QS)	
45	2	Washer	
46	2	Spring retainer	
47	2	Outer spring	
48	2	Middle spring	
49	2	Inner spring	
50	2	End cap QS	
51	2	O-ring	1
52	1	Center plate	3
53	1	Speed Control	3
54	2	Module Vent Valves	
55	1 or 2	Exhaust	3
56	1	Pneumatic Manual Override	3
57	1	Seal Booster block	2

NOTES
1. Included in repair kits.
2. Included in seal kit for the modules
3. Options

Contact Us: Emerson Process Management, Valve Automation facilities at your nearest location:

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February 2009

67CF Series Installation Sheet

Introduction

This installation sheet covers the installation and startup of the 67CF Series filter regulators. If maintenance is required, refer to the 67CF Series Instruction Manual, form 5469. Contact your local Sales Office to receive a copy of the instruction manual.

Specifications

- **Maximum Inlet Pressure:**

  250 psig (17,2)

- **Maximum Outlet Pressure:**

  50 psi (3,4 bar) over outlet pressure setting

- **Outlet Pressure Ranges:**

  0 to 35 psig (0 to 2,4 bar)

  0 to 60 psig (0 to 4,1 bar)

  0 to 125 psig (0 to 8,6 bar)

- **Temperature Capabilities with Nitrile (NBR):**

  -40° to 180°F (-40° to 82°C)

Installation

WARNING

Personal injury, property damage, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is overpressured or is installed where service conditions could exceed the limits given in the specifications, or where conditions exceed any ratings of the adjacent piping or piping connections. To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding those limits.

The internal relief valve in the Type 67CFR regulator does not provide full overpressure protection. The internal relief valve is designed for minor seat leakage only. If maximum inlet pressure to the Type 67CFR exceeds the maximum pressure ratings of the downstream equipment or exceeds themaximum allowable outlet pressure of the Type 67CFR, additional overpressure protection is required.

1. Regulator operation within ratings does not preclude the possibility of physical damage from external sources or debris in the lines. Regulators should be inspected for damage periodically and after an overpressure condition.
2. Only personnel qualified through training and experience should install, operate, and maintain a regulator. Make sure there is no damage to or foreign material in the regulator and all tubing or piping is free of debris.
3. Install the regulator so that flow is from the IN to the OUT connection as marked on the regulator body.
4. For best drainage, orient the drain valve (key 2) to the lowest possible point on the dripwell (key 5). This orientation may be improved by rotating the dripwell with respect to the body (key 1).

WARNING

A regulator may vent some gas to the atmosphere. In hazardous or flammable gas service, vented gas may accumulate and cause personal injury, death, or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air

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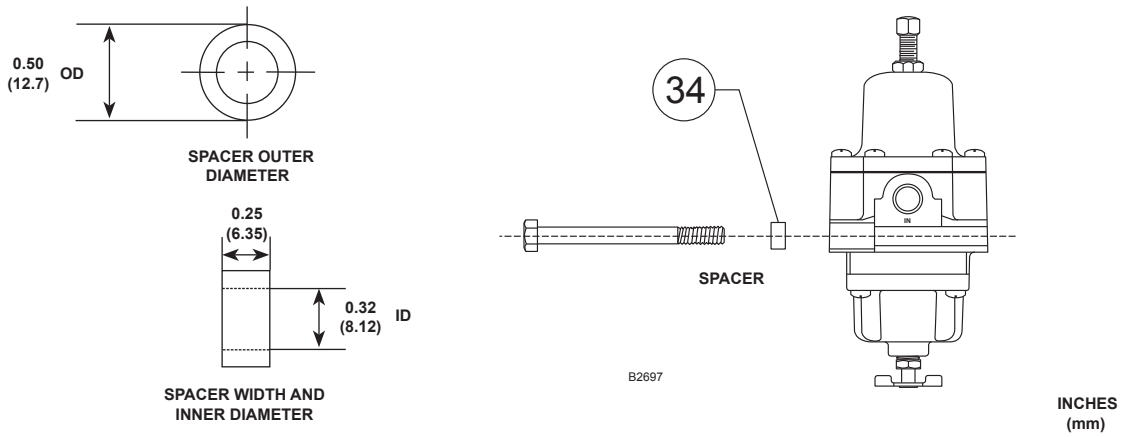


***Figure 1**. Spacer Diameter and Installation*

intakes or any hazardous area. The vent line or stack opening must be protected against condensation or clogging.

5. A clogged spring case vent hole may cause the regulator to function improperly. To keep this vent hole from being plugged (and to keep the spring case from collecting moisture, corrosive chemicals, or other foreign material) orient the vent to the lowest possible point on the spring case or otherwise protect it. Inspect the vent hole regularly to make sure it is not plugged. Spring case vent hole orientation may be changed by rotating the spring case with respect to the body. A 1/4 NPT spring case vent may be remotely vented by installing tubing or piping into the vent.
6. For regulator shutdown, install upstream block and vent valves and downstream block and vent valves (if required), or provide some other suitable means of properly venting the regulator inlet and outlet pressures.
7. Apply a good grade of pipe compound to the male pipe threads before making connections, making sure not to get the pipe compound inside the regulator.
8. Install tubing fitting or piping into the 1/4 NPT inlet connection on the body (key 1) and into the 1/4 NPT body outlet connection.
9. The second 1/4 NPT outlet can be used for a gauge or other use. If not used, it must be plugged.
10. When installing a 67CF Series regulator in an existing installation, it may be necessary to use spacers to adapt the installation. If the mounting bolts are too long, place a spacer on the bolt. To be sure the regulator is secure, the bolts should have at least two full threads of engagement.

Startup and Adjustment

1. With proper installation completed and downstream equipment properly adjusted, slowly open the upstream and downstream shutoff valve (when used) while using pressure gauges to monitor pressure.

WARNING

To avoid personal injury, property damage, or equipment damage caused by bursting of pressure containing parts or explosion of accumulated gas, never adjust the control spring to produce an outlet pressure higher than the upper limit of the outlet pressure range for that particular spring. If the desired outlet pressure is not within the range of the control spring, install a spring of the proper range.

2. If outlet pressure adjustment is necessary, monitor outlet pressure with a gauge during the adjustment procedure. The regulator is adjusted by loosening the locknut (key 19), if used, and turning the adjusting screw or handwheel (key 18) clockwise to increase or counterclockwise to decrease the outlet pressure setting. Tighten the locknut to maintain the adjustment position.

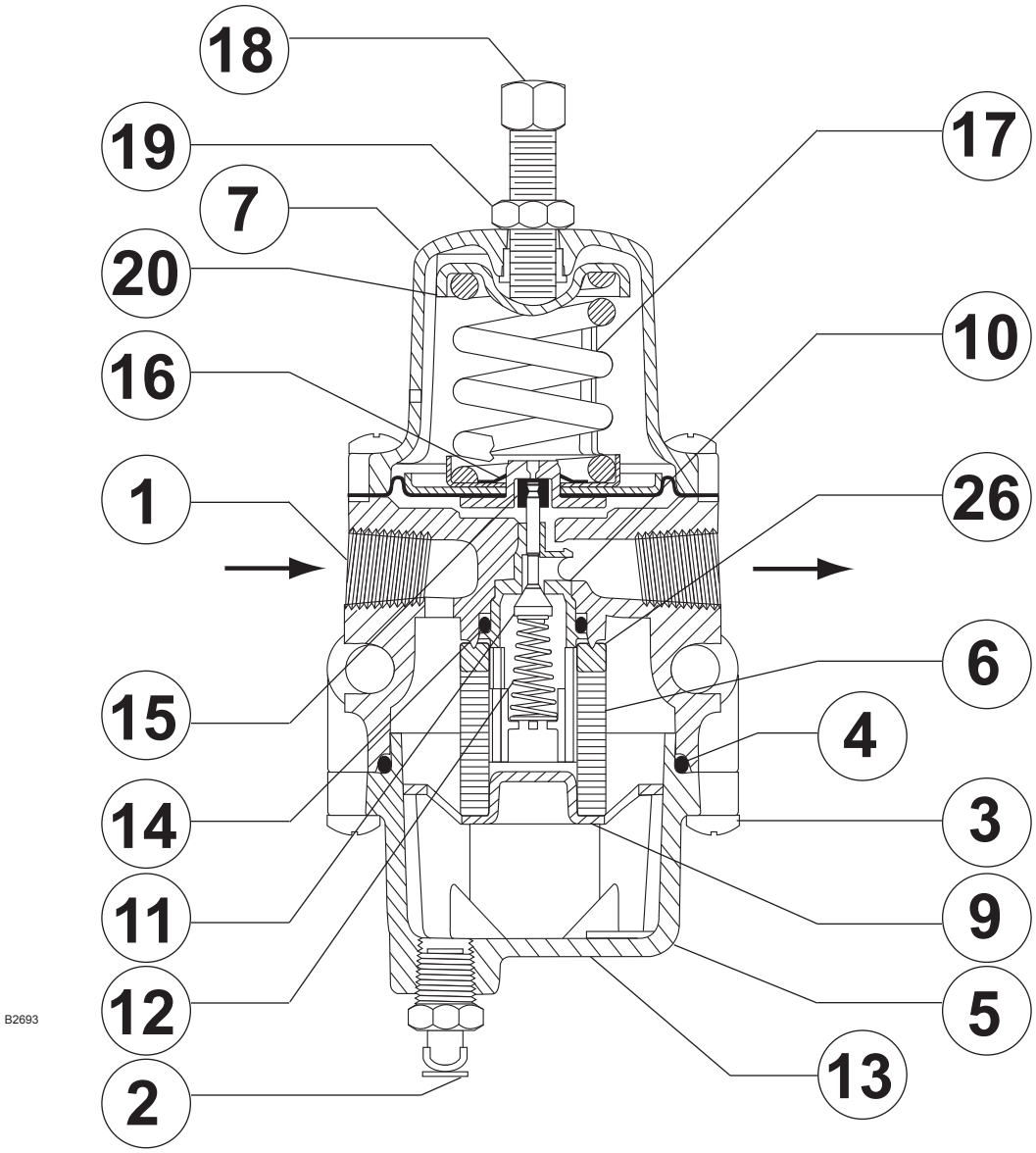


***Figure 2**. 67CF Series Assembly Drawings*

Parts List

Key	Description
1	Body
2	Drain Valve
3	Flange Screw
4*	O-Ring
5	Dripwell
6*	Filter Element
7	Spring Case
9	Filter Retainer
10*(1)	Valve Cartridge
11*(1)	Valve Plug
12*(1)	Valve Spring
13*(1)	Valve Retainer
14*(1)	O-Ring
15*(1)	Soft Seat

Key	Description
16*	Diaphragm Assembly
17	Spring
18	Adjusting Screw
19	Locknut
20	Upper Spring Seat
22	Pressure Gauge
23	1/4-Inch Pipe Plug
24	Tire Valve
26*	Filter Gasket
31	Panel Mounting Nut
32	Wire Seal
33	Closing Cap
34	Spacer

*Recommended Spare Part
1. Valve cartridge assembly includes keys 10, 11, 12, 13, 14, 15.

Industrial Regulators

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Regulator Technologies, Inc.

USA - Headquarters
McKinney, Texas 75069-1872 USA
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67C Series Instrument Supply Regulators



TYPE 67CF FILTER REGULATOR
WITH OPTIONAL GAUGE



TYPE 67C OR 67CR REGULATOR

Figure 1. *67C Series Regulators*

Introduction

Scope of the Manual

This manual provides instructions and parts lists for 67C Series instrument supply regulators. Instructions and parts lists for other equipment mentioned in this instruction manual, as well as for other 67C Series regulators, are found in separate manuals.

Product Descriptions

The 67C Series direct-operated regulators are typically used to provide constantly controlled, reduced pressures to pneumatic and electro-pneumatic controllers and other instruments. They are suitable for most air or gas applications. Other applications include providing reduced pressures to air chucks, air jets and spray guns.

- The Types 67C and 67CS are the standard instrument supply regulators without a filter or internal relief.
- The Types 67CF and 67CFS are equipped with a filter for removing particles from the supply gas.
- The Types 67CR and 67CSR have an internal relief valve with a soft seat for reliable shutoff with no discernible leakage.
- The Types 67CFR and 67CFSR have a filter and internal relief valve with a soft seat for reliable shutoff with no discernible leakage.

Principle of Operation

Downstream pressure is registered internally on the lower side of the diaphragm. When the downstream pressure is at or above the set pressure, the valve plug is held against the orifice and there is no flow through the regulator. When demand increases, downstream pressure drops slightly allowing the spring to extend, moving the stem down and the valve plug away from the orifice. This allows flow through the regulator.

Specifications

The Specifications section gives some general specifications for the 67C Series regulator. A label on the spring case gives the control spring range for a given regulator as it comes from the factory.

Body Size, Inlet and Outlet Connection Style
1/4 NPT

Maximum Inlet Pressure (Body Rating)[1]
All except Types 67CS and 67CSR:
250 psig / 17.2 bar
Types 67CS and 67CSR: 400 psig / 27.6 bar

Outlet Pressure Ranges
See Table 1

Maximum Emergency Outlet Pressure[1]
50 psi / 3.4 bar over outlet pressure setting

Wide-Open Flow Coefficients
Main Valve: C_g: 11.7; C_v: 0.36; C_1: 32.2
Internal Relief Valve: C_g: 1.45; C_v: 0.045; C_1: 32.8

IEC Sizing Coefficients
Main Valve: X_T: 0.66; F_L: 0.89; F_D: 0.50

Accuracy
Inlet Sensitivity for Nitrile (NBR) and Silicone (VMQ) Elastomers: Less than 0.2 psig / 14 mbar change in outlet pressure for every 25 psig / 1.7 bar change in inlet pressure
Inlet Sensitivity for Fluorocarbon (FKM) Elastomers: Less than 0.4 psig / 28 mbar change in outlet pressure for every 25 psig / 1.7 bar change in inlet pressure
Repeatability for Nitrile (NBR) and Silicone (VMQ) Elastomers: 0.1 psig / 7 mbar[2]
Repeatability for Fluorocarbon (FKM) Elastomers: 0.3 psig / 21 mbar[2]
Air Consumption: Testing repeatedly shows no discernible leakage

Types 67CR, 67CSR, 67CFR and 67CFSR Internal Relief Performance
Low capacity for minor seat leakage only; other overpressure protection must be provided if inlet pressure can exceed the maximum pressure rating of downstream equipment or exceeds maximum outlet pressure rating of the regulator.

Approximate Weights
Types 67C, 67CR, 67CF and 67CFR:
1 lb / 0.5 kg
Types 67CS and 67CSR:
2.5 lbs / 1.1 kg
Types 67CFS and 67CFSR:
4 lbs / 1.8 kg

Temperature Capabilities[1]
With Nitrile (NBR)
Standard Bolting: -20 to 180°F / -29 to 82°C
Stainless Steel Bolting: -40 to 180°F / -40 to 82°C
With Fluorocarbon (FKM):
Polyethylene Filter[5] ***(standard)****:*
0 to 180°F / -18 to 82°C
Polyvinylidene (PVDF), Stainless steel or Glass Filter (Optional):
0 to 300°F / -18 to 149°C
With Silicone (VMQ)[3] **Diaphragm and Low Temperature bolting:** -60 to 180°F / -51 to 82°C
With Gauges: -40 to 180°F / -40 to 82°C

Smart Bleed™ Check Valve Setpoint
6 psi / 0.41 bar differential

Types 67CF, 67CFR, 67CFS and 67CFSR Filter Capabilities
Free Area: 12 times pipe area
Micron Rating:
Polyethylene Filter[5] ***(standard)****:* 5 microns
Glass Fiber Filter (Optional): 5 microns
PVDF or Stainless Steel Filter (Optional): 40 microns

Drain Valve and Spring Case Vent Location
Aligned with inlet standard, other positions optional

Pressure Registration
Internal

Options
All Types
- Handwheel adjusting screw
- Inlet screen
- NACE MR0175 or NACE MR0103 construction[4]
- Panel mount (includes spring case with 1/4 NPT vent, handwheel and panel mounting nut)
- Closing cap (available on spring case with 1/4 NPT vent)
- Fluorocarbon (FKM) elastomers for high temperatures and/or corrosive chemicals
- Silicone (VMQ) elastomers for cold temperatures
- Fixed Bleed Restriction
- Triple scale outlet pressure gauge (Brass or Stainless steel)
- Stainless steel stem on the valve plug
- Tire valve or pipe plug in second outlet

Types 67CFR and 67CFSR only
- Smart Bleed internal check valve
- Large dripwell with manual or automatic drain

Types 67CF and 67CFR only
- Stainless steel drain valve

1. The pressure/temperature limits in this Instruction Manual and any applicable standard or code limitation should not be exceeded.
2. Repeatability is the measure of the regulator's ability to return to setpoint consistently when traveling from steady state to transient to steady state.
3. Silicone (VMQ) is not compatible with hydrocarbon gas.
4. Product complies with the material requirements of NACE MR0175. Environmental limits may apply.
5. Do not use in high aromatic hydrocarbon service.

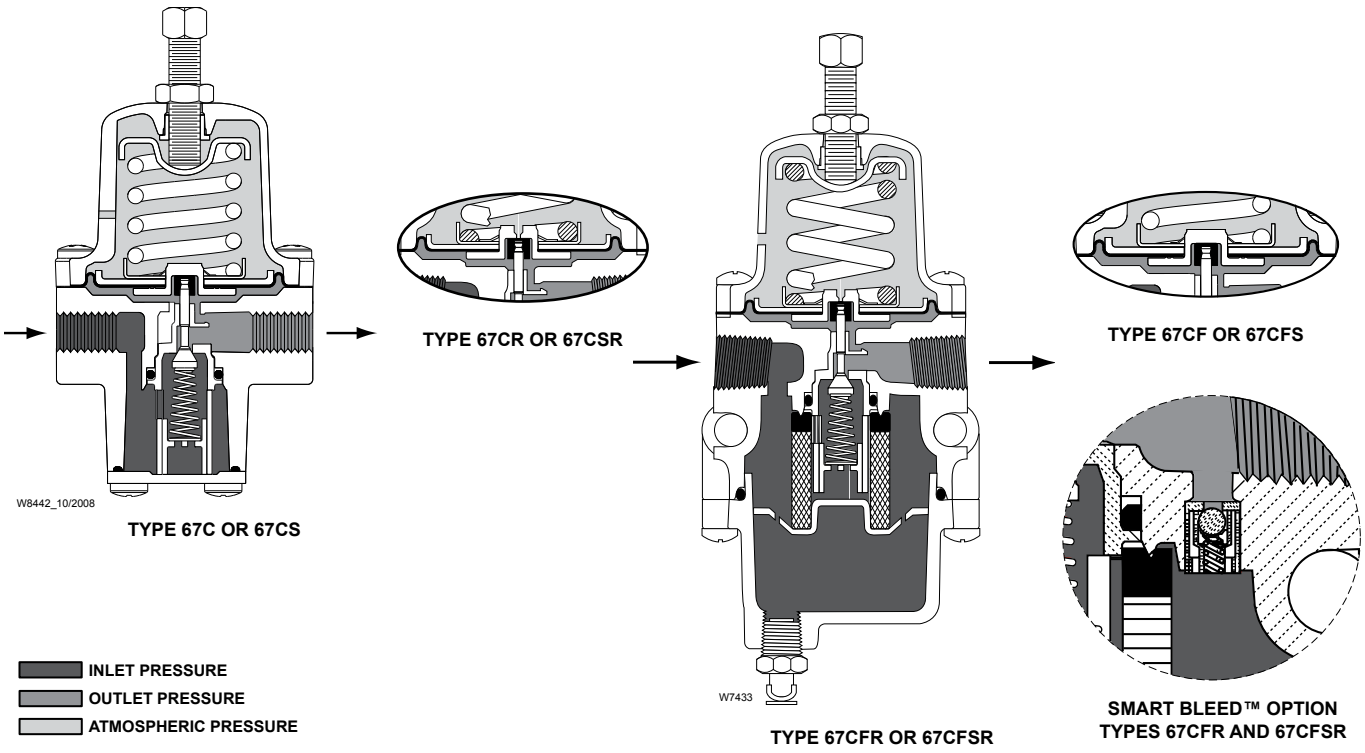


Figure 2. *67C Series Operational Schematics*

Internal Relief (Types 67CR, 67CSR, 67CFR and 67CFSR)

If for some reason, outside of normal operating conditions, the downstream pressure exceeds the setpoint of the regulator, the force created by the downstream pressure will lift the diaphragm until the diaphragm is lifted off the relief seat. This allows flow through the token relief. The relief valve on the Type 67CR, 67CSR, 67CFR or 67CFSR is an elastomer plug that prevents leakage of air from the downstream to atmosphere during normal operation, thereby conserving plant air.

Smart Bleed Airset

In some cases, it is desired to exhaust downstream pressure if inlet pressure is lost or drops below the setpoint of the regulator. For example, if the regulator is installed on equipment that at times has no flow demand but is expected to backflow on loss of inlet pressure. The Types 67CFR and 67CFSR can be ordered with the Smart Bleed option which includes an internal check valve for this application. During operation, if inlet pressure is lost or decreases below the setpoint of the regulator, the downstream pressure will back flow upstream through the regulator and check valve. This option eliminates the need for a fixed bleed downstream of the regulator, thereby conserving plant air.

Note

During normal operation the check valve's metal to metal seat allows limited flow through the regulator from the inlet to outlet, even when there is no downstream demand. To prevent downstream pressure buildup, the Smart Bleed option is only available with the internal relief version of the 67C Series.

Overpressure Protection

The 67C Series regulators have maximum outlet pressure ratings that are lower than their maximum inlet pressure ratings. A pressure relieving or pressure limiting device is needed if inlet pressure can exceed the maximum outlet pressure rating.

Types 67CR, 67CSR, 67CFR and 67CFSR have a low capacity internal relief valve for minor seat leakage only. Other overpressure protection must be provided if the maximum inlet pressure can exceed the maximum pressure rating of the downstream equipment or exceeds the maximum outlet pressure rating of the regulator.

Table 1. *Outlet Pressure Ranges and Control Spring Data*

TYPE	OUTLET PRESSURE RANGES		CONTROL SPRING DATA						
			Color	Material	Part Number	Wire Diameter		Free Length	
	psig	bar				In.	mm	In.	mm
67C, 67CR, 67CF and 67CFR	0 to 20	0 to 1.4	Green stripe	Music Wire	GE07809T012	0.135	3.43	1.43	36.2
	0 to 35	0 to 2.4	Silver		T14059T0012	0.156	3.96	1.43	36.2
	0 to 60	0 to 4.1	Blue stripe		T14058T0012	0.170	4.32	1.43	36.2
	0 to 125	0 to 8.6	Red stripe		T14060T0012	0.207	5.26	1.43	36.2
	0 to 35	0 to 2.4	Silver stripe	Inconel®	T14113T0012	0.156	3.96	1.43	36.2
	0 to 60	0 to 4.1	Blue		T14114T0012	0.172	4.37	1.43	36.2
	0 to 125	0 to 8.6	Red		T14115T0012	0.207	5.26	1.43	36.2
67CS, 67CSR, 67CFS and 67CFSR	0 to 20	0 to 1.3	Green	Inconel®	10C1729X012	0.135	3.43	1.50	38.1
	0 to 35	0 to 2.4	Silver stripe		T14113T0012	0.156	3.96	1.43	36.2
	0 to 60	0 to 4.1	Blue		T14114T0012	0.172	4.37	1.43	36.2
	0 to 125	0 to 8.6	Red		T14115T0012	0.207	5.26	1.43	36.2
	0 to 150	0 to 10.3	Black		10C1730X012	0.250	6.35	1.77	44.9

Installation

Note

If the regulator is shipped mounted on another unit, install that unit according to the appropriate Instruction Manual.

WARNING

Personal injury, property damage, equipment damage or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is overpressured or is installed where service conditions could exceed the limits given in the Specifications section or where conditions exceed any ratings of the adjacent piping or piping connections. To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation or standard) to prevent service conditions from exceeding those limits.

The internal relief valve of the Type 67CR, 67CSR, 67CFR or 67CFSR does not provide full overpressure protection. The internal relief valve is designed for minor seat leakage only. If maximum inlet pressure to the regulator exceeds maximum pressure ratings of the downstream equipment or exceeds maximum allowable outlet pressure of the regulator, additional overpressure protection is required.

A regulator may vent some gas to the atmosphere. In hazardous or flammable gas service, vented gas may accumulate and cause personal injury, death or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air intakes or any hazardous area. The vent line or stack opening must be protected against condensation or clogging.

Before installing a Type 67C, 67CR, 67CS, 67CSR, 67CF, 67CFR, 67CFS or 67CFSR regulator, be sure the installation complies with the following installation guidelines:

1. Regulator operation within ratings does not preclude the possibility of damage from debris in the lines or from external sources. Regulators should be inspected for damage periodically and after any overpressure condition.
2. Only personnel qualified through training and experience should install, operate and maintain a regulator. Make sure that there is no damage to or foreign material in the regulator. Also ensure that all tubing and piping is free of debris.
3. Install the regulator so that flow is from the IN to the OUT connection as marked on the regulator body.
4. For best drainage, orient the drain valve (key 2) to the lowest possible point on the dripwell (key 5). This orientation may be improved by rotating the dripwell with respect to the body (key 1).
5. A clogged spring case vent hole may cause the regulator to function improperly. To keep this vent hole from being plugged (and to keep the spring case from collecting moisture, corrosive

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chemicals or other foreign material) orient the vent to the lowest possible point on the spring case or otherwise protect it.

Inspect the vent hole regularly to make sure it is not plugged. Spring case vent hole orientation may be changed by rotating the spring case with respect to the body. A 1/4 NPT spring case vent may be remotely vented by installing obstruction-free tubing or piping into the vent. Protect the remote vent by installing a screened vent cap on the remote end of the vent pipe.

6. For use in regulator shutdown, install upstream block and vent valves and downstream block and vent valves (if required) or provide some other suitable means of properly venting the regulator inlet and outlet pressures. Install a pressure gauge to monitor instruments on startup.
7. Apply a good grade of pipe compound to the external pipe threads before making connections, making sure not to get the pipe compound inside the regulator.
8. Install tubing fitting or piping into the 1/4 NPT inlet connection on the body (key 1) and into the 1/4 NPT body outlet connection.
9. The second 1/4 NPT outlet can be used for a gauge or other use. If not used, it must be plugged.

Installing a 67CF Series Regulator in an Existing Installation

When installing a 67CF Series regulator in an existing installation, it may be necessary to use spacers (key 34, Figure 13) to adapt the installation. If the mounting bolts are too long, place a spacer on the bolt (see Figure 13). To be sure the regulator is secure, the bolts should have at least two full threads of engagement.

Startup and Adjustment

Key numbers are referenced in Figures 3 through 9.

1. With proper installation completed and downstream equipment properly adjusted, slowly open the upstream and downstream shutoff valve (when used) while using pressure gauges to monitor pressure.

WARNING

To avoid personal injury, property damage or equipment damage caused by bursting of pressure containing parts or explosion of accumulated gas, never adjust the control spring to produce an outlet pressure higher than the upper limit of the outlet pressure range for that particular spring. If the desired outlet pressure is not within the range of the control spring, install a spring of the proper range according to the diaphragm parts maintenance procedure.

2. If outlet pressure adjustment is necessary, monitor outlet pressure with a gauge during the adjustment procedure. The regulator is adjusted by loosening the locknut (key 18), if used, and turning the adjusting screw or handwheel (key 19) clockwise to increase or counterclockwise to decrease the outlet pressure setting. Retighten the locknut to maintain the adjustment position.

Shutdown

First, close the nearest upstream block valve and then close the nearest downstream block valve (when used). Next, open the downstream vent valve. Since the regulator remains open in response to the decreasing downstream pressure, pressure between the closed block valves will be released through the open vent valve.

Maintenance

Regulator parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement of parts depends on the severity of service conditions and applicable codes and government regulations. Open the Type 67CF, 67CFR, 67CFS or 67CFSR drain valve (key 2) regularly to empty accumulated liquid from the dripwell (key 5).

Note

If sufficient clearance exists, the body (key 1) may remain mounted on other equipment or in a line or panel during maintenance unless the entire regulator will be replaced.

WARNING

To avoid personal injury, property damage or equipment damage caused by sudden release of pressure or explosion of accumulated gas, do not attempt any maintenance or disassembly without first isolating the regulator from system pressure and relieving all internal pressure from the regulator.

Types 67C, 67CR, 67CS and 67CSR

Trim Maintenance

Key numbers are referenced in Figures 3, 4 and 12.

1. Remove four bottom plate screws (key 3) from the bottom plate (key 39) and separate the bottom plate and O-ring (key 4) from the body (key 1).
2. Inspect the removed parts for damage and debris. Replace any damaged parts.
3. To remove the valve cartridge assembly, grasp the end of cartridge (key 10) and pull it straight out of body (key 1). Replace with new cartridge assembly. The cartridge assembly may be disassembled and parts may be cleaned or replaced. If the soft seat (key 15) was removed, make sure it is properly snapped into place before installing the valve cartridge assembly.
4. Check O-ring (key 14) for wear and replace, if necessary. Apply lubricant to the O-ring and place in the body. Align cartridge key to keyway in body and insert. Reinstall the O-ring (key 4), secure the bottom plate (key 39) with screws (key 3) and torque to 15 to 30 in. lbs. / 1.7 to 3.4 N•m.

Diaphragm Maintenance

Key numbers are referenced in Figures 3 and 4.

1. Back out the adjusting screw or handwheel (key 18) until compression is removed from the spring (key 17).
2. Remove the spring case screws (key 3) to separate the spring case (key 7) from the body (key 1). Remove the upper spring seat (key 20) and spring (key 17).
3. Remove the diaphragm assembly (key 16), inspect the diaphragm and replace the assembly, if necessary.
4. Place the diaphragm assembly (key 16) on the body (key 1) as shown in Figure 3 or 4. Push down on the diaphragm assembly to make sure the valve plug (key 11) strokes smoothly and approximately 1/16 in. / 1.6 mm.

Note

In step 5, if installing a control spring of a different range, be sure to delete the spring range originally appearing on the label and indicate the new spring range.

5. Stack the control spring (key 17) and upper spring seat (key 20) onto the diaphragm assembly (key 16).
6. Install the spring case (key 7) on the body (key 1) with the vent oriented to prevent clogging or entrance of moisture. Install the six spring case screws (key 3) using a crisscross pattern and torque to 15 to 30 in. lbs. / 1.7 to 3.4 N•m.

Note

On Types 67CS and 67CSR, lubricate the adjusting screw (key 18) thread to reduce galling of the Stainless steel.

7. When all maintenance is complete, refer to the Startup and Adjustment section to put the regulator back into operation and adjust the pressure setting. Tighten the locknut (key 19) if used and install the closing cap (key 33) if used.

Types 67CF, 67CFR, 67CFS and 67CFSR

Filter Element and Trim Maintenance

Key numbers are referenced in Figures 5, 6 and 12.

1. Remove four dripwell screws (key 3) from the dripwell (key 5) and separate the dripwell and O-ring (key 4) from the body (key 1). The filter retainer (key 9), thrust washer (key 37), filter element (key 6) and gasket (key 26) may come off with dripwell. If not, remove these parts.
2. Inspect the removed parts for damage and debris. Replace any damaged parts. If a replacement is not available, the filter element may be cleaned.
3. To remove the valve cartridge assembly, grasp the end of cartridge and pull it straight out of body (key 1). Replace with new cartridge assembly. The cartridge assembly may be disassembled and parts may be cleaned or replaced. If the soft seat (key 15) was removed, make sure it is properly snapped into place before installing the valve cartridge assembly.

4. Check O-ring (key 14) for wear and replace, if necessary. Apply lubricant to the O-ring (key 14), then align cartridge key to keyway in body and insert. Reinstall the gasket (key 26), filter element (key 6), thrust washer (key 37) and filter retainer (key 9). Reinstall the O-ring (key 4), secure the dripwell with screws (key 3) and torque to 15 to 30 in. lbs. / 1.7 to 3.4 N•m.

Diaphragm Maintenance

Key numbers are referenced in Figures 5 and 6.

5. Back out the adjusting screw or handwheel (key 18) until compression is removed from the spring (key 17).
6. Remove the six spring case screws (key 3) to separate the spring case (key 7) from the body (key 1). Remove the upper spring seat (key 20) and spring (key 17).
7. Remove the diaphragm assembly (key 16), inspect the diaphragm and replace the assembly, if necessary.
8. Place the diaphragm assembly (key 16) on the body (key 1) as shown in Figure 5. Push down on the diaphragm assembly to make sure the valve plug (key 11) strokes smoothly and approximately 1/16 in. / 1.6 mm.

Note

In step 5, if installing a control spring of a different range, be sure to delete the spring range originally appearing on the label and indicate the new spring range.

9. Stack the control spring (key 17) and upper spring seat (key 20) onto the diaphragm assembly (key 16).
10. Install the spring case (key 7) on the body (key 1) with the vent oriented to prevent clogging or entrance of moisture. Install the six spring case screws (key 3) using a crisscross pattern and torque to 15 to 30 in. lbs. / 1.7 to 3.4 N•m.

Note

On Types 67CFS and 67CFSR, lubricate the adjusting screw (key 18) thread to reduce galling of Stainless steel.

11. When all maintenance is complete, refer to the Startup and Adjustment section to put the regulator back into operation and adjust the pressure setting. Tighten the locknut (key 19) if used and install the closing cap (key 33) if used.

Parts Ordering

When corresponding with the local Sales Office about this regulator, include the type number and all other pertinent information printed on the label. Specify the eleven-character part number when ordering new parts from the following parts list.

Parts List

Key	Description	Part Number
	Parts Kits	
	Types 67C, 67CR, 67CS and 67CSR	
	Includes valve cartridge assembly (contains keys 10, 11, 12, 13, 14 and 15), O-ring (key 4), diaphragm assembly (key 16), and four screws (key 3)	
	Type 67C (without relief)	
	Brass stem with Nitrile (NBR) plug	R67CX000012
	Aluminum stem with Nitrile (NBR) plug (NACE)	R67CX000N12
	Type 67CR (with relief)	
	Brass stem with Nitrile (NBR) plug	R67CRX00012
	Aluminum stem with Nitrile (NBR) plug (NACE)	R67CRX00N12
	Type 67CS (without relief)	
	Stainless steel stem with Nitrile (NBR) plug (NACE)	R67CSX00012
	Type 67CSR (with relief)	
	Stainless steel stem with Nitrile (NBR) plug (NACE)	R67CSRX0012
	Types 67CF, 67CFR and 67CFSR	
	Includes valve cartridge assembly (contains keys 10, 11, 12, 13, 14 and 15), diaphragm assembly (key 16), O-ring (key 4), filter element (key 6), filter gasket (key 26), thrust washer (key 37) and four screws (key 3)	
	Type 67CF (without relief)	
	Brass stem with Nitrile (NBR) plug	R67CFX00012
	Aluminum stem with Nitrile (NBR) plug (NACE)	R67CFX00N12
	Type 67CFR (with relief)	
	Brass stem with Nitrile (NBR) plug	R67CFRX0012
	Aluminum stem with Nitrile (NBR) plug (NACE)	R67CFRX0N12
	Type 67CFSR (with relief)	
	Stainless steel stem with Nitrile (NBR) plug (NACE)	R67CFSRX012
	Valve Cartridge Assembly Only[1]	
	Type 67C, 67CR, 67CF or 67CFR	
	Brass stem with Nitrile (NBR) plug	
	with Nitrile (NBR) O-ring	T14121T0012
	with Silicone (VMQ) O-ring	T14121T0032
	Aluminum stem	
	with Fluorocarbon (FKM) plug	T14121T0022
	with Nitrile (NBR) plug	T14121T0042
	Aluminum stem (NACE)	
	with Nitrile (NBR) plug	T14121T0052
	with Fluorocarbon (FKM) plug	T14121T0062
	Stainless steel stem	
	with Nitrile (NBR) plug	T14121T0072
	Type 67CS, 67CSR, 67CFS or 67CFSR	
	316 Stainless steel stem	
	with Nitrile (NBR) plug and O-rings (NACE)	T14121T0092
	with Fluorocarbon (FKM) plug and O-rings	T14121T0102
	with Nitrile (NBR) plug and Silicone (VMQ) O-rings	T14121T0112

*Recommended Spare Part.
1. Valve cartridge assembly includes keys 10, 11, 12, 13, 14 and 15.

Key	Description	Part Number
	Automatic Drain Conversion Kits	
	Types 67CF, 67CFR, 67CFS and 67CFSR	
	Includes auto-drain (key 2), four flange screws (key 3), dripwell O-ring (key 4) and dripwell (key 5).	
	Note: Temperature rating is 40 to 175°F / 4 to 79°C.	
	Types 67CF and 67CFR	
	Nitrile (NBR)	R67ADNX0012
	Fluorocarbon (FKM)	R67ADFX0012
	Types 67CFS and 67CFSR	
	Nitrile (NBR)	R67ADNX0022
	Fluorocarbon (FKM)	R67ADFX0022
1	Body	
	Type 67C or 67CR, Aluminum	T40643T0RG2
	Type 67CS or 67CSR, CF3M/CF8M Stainless steel	GE00909X012
	Type 67CF or 67CFR, Aluminum	T80510T0012
	Type 67CFS or 67CFSR, CF3M/CF8M Stainless steel	40C1887X012
	Type 67CFR with Smart Bleed™, Aluminum	GE03477X012
2	Drain Valve	
	Manual Type 67CF or 67CFR	
	Brass	1K418918992
	316 Stainless steel	AH3946X0052
	Type 67CFS or 67CFSR	
	316 Stainless steel	AH3946X0052
	Automatic (only used with large capacity dripwell)	
	Type 67CFS or 67CFSR	
	Nitrile (NBR)	GG00554X012
	Fluorocarbon (FKM)	GG00554X022
3	Flange Screw	
	Type 67C, 67CR, 67CF or 67CFR	
	Standard spring case and spring case with 1/4 NPT vent (10 required)	T13526T0012
	For wire seal	
	Zinc-plated steel (9 required)	T13526T0012
	Steel (with hole) (1 required)	14B3987X012
	Type 67CS, 67CSR, 67CFS or 67CFSR (10 required)	T13526T0042
4*	O-ring	
	Type 67C, 67CR, 67CS or 67CSR	
	Nitrile (NBR)	T14380T0012
	Fluorocarbon (FKM)	T14380T0022
	Silicone (VMQ)	T14380T0032
	Type 67CF, 67CFR, 67CFS or 67CFSR	
	Nitrile (NBR)	T14057T0042
	Fluorocarbon (FKM)	T14057T0022
	Silicone (VMQ)	T14057T0032
5	Dripwell	
	Type 67CF or 67CFR, Aluminum	
	Standard	T21040T0012
	Large Capacity, manual drain	GE34605X012
	Large Capacity, automatic drain	GE34606X012
	Type 67CFS or 67CFSR, CF3M/CF8M Stainless steel	
	Standard	20C1726X012
	Large Capacity, manual drain	GE34607X012
	Large Capacity, automatic drain	GE31792X012
6*	Filter Element	
	(Types 67CF, 67CFR, 67CFS and 67CFSR)	
	Polyethylene (5 microns) **(standard)**	GE32761X012
	Glass fiber (5 microns)	17A1457X012
	Polyvinylidene fluoride (PVDF) (40 microns)	GE32762X012
	316 Stainless steel (40 microns)	15A5967X022

*Recommended Spare Part.
1. Valve cartridge assembly includes keys 10, 11, 12, 13, 14 and 15.
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Rynite® is a mark owned by E.I. du Pont de Nemours and Co.

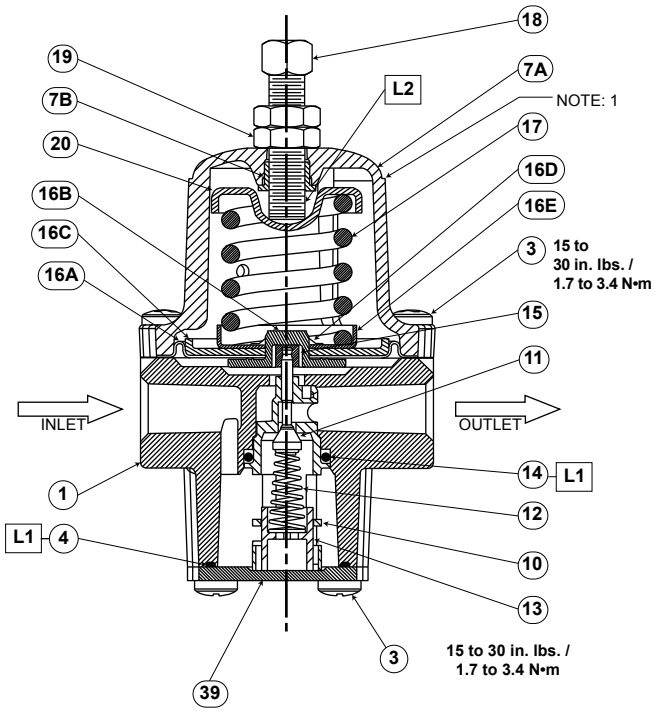
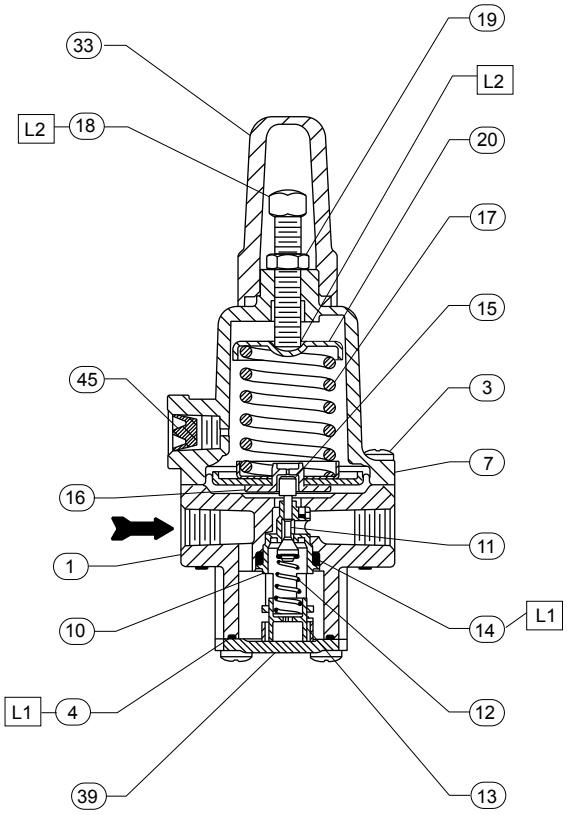


Figure 3. *Type 67C or 67CR Assembly*

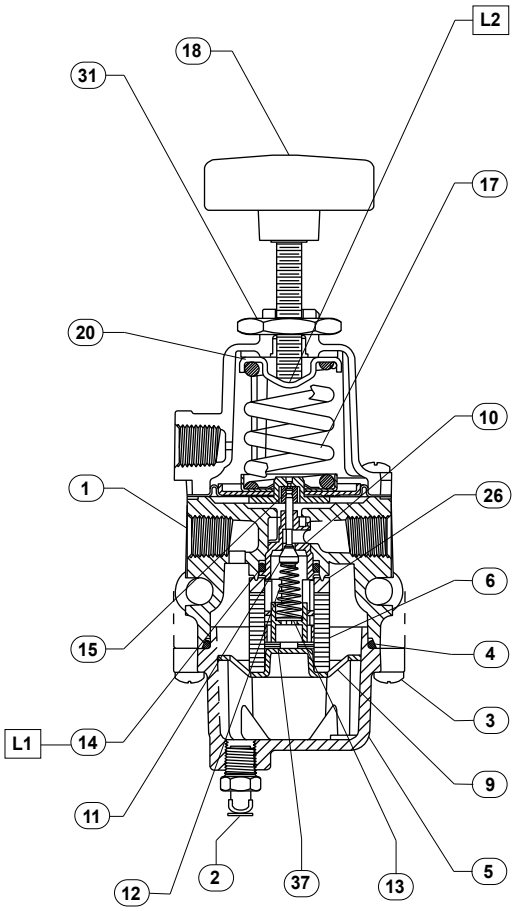
Key	Description	Part Number
7	Spring Case Assembly	
	Type 67C, 67CR, 67CF or 67CFR, Aluminum/Steel	
	Drilled hole vent **(standard)**	T14070T0012
	Single hole vent	T14070T0022
	Type 67CS, 67CSR, 67CFS or 67CFSR, CF3M/CF8M Stainless steel	20C1727X012
9	Filter Retainer	
	Type 67CF or 67CFR, Zinc-plated	T14052T0012
	Type 67CFS or 67CFSR, 316 Stainless steel	T14052T0022
10*(1)	Valve Cartridge	T80434T0012
11*(1)	Valve Plug	
	Type 67C, 67CR, 67CF or 67CFR	
	Brass stem, Nitrile (NBR) plug	T14053T0012
	Aluminum stem, Fluorocarbon (FKM) plug	T14053T0022
	Aluminum stem, Nitrile (NBR) plug	T14053T0032
	Type 67CS, 67CSR, 67CFS or 67CFSR	
	Stainless steel stem, Nitrile (NBR) plug	T14053T0042
	Stainless steel stem, Fluorocarbon (FKM) plug	T14053T0052
12*(1)	Valve Spring	
	Type 67C, 67CR, 67CF or 67CFR	
	302 Stainless steel	T14105T0012
	Inconel® (NACE)	T14116T0012
	Type 67CS, 67CSR, 67CFS or 67CFSR, Inconel® (NACE)	T14116T0012
13*(1)	Valve Retainer, Rynite®	T14071T0012
14*(1)	O-ring	
	Nitrile (NBR)	T14063T0012
	Fluorocarbon (FKM)	T14063T0022
	Silicone (VMQ)	T14063T0032
15*(1)	Soft Seat	
	Nitrile (NBR)	T14055T0012
	Fluorocarbon (FKM)	T14055T0022



GE03521

☐ **APPLY LUBRICANT (L):**
L1 = MULTI-PURPOSE POLYTETRAFLUOROETHYLENE (PTFE) LUBRICANT
L2 = ANTI-SEIZE COMPOUND

Figure 4. *Type 67CS or 67CSR Assembly*



T40580

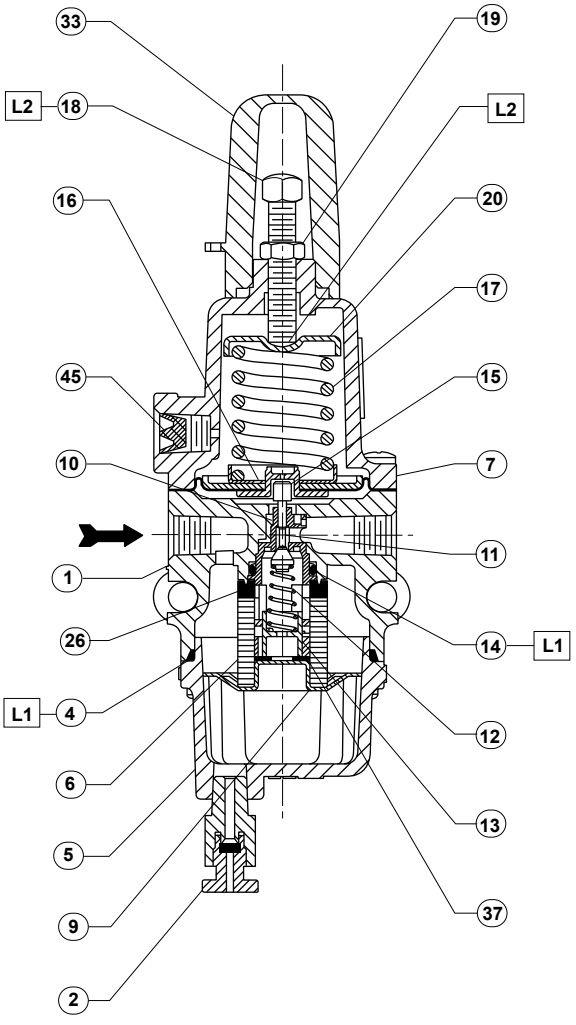
☐ **APPLY LUBRICANT (L):**
L1 = MULTI-PURPOSE POLYTETRAFLUOROETHYLENE (PTFE) LUBRICANT
L2 = ANTI-SEIZE COMPOUND

Figure 5. *Type 67CF or 67CFR Assembly*

Key	Description	Part Number
16*	Diaphragm Assembly	
	Type 67C or 67CF (without relief)	
	Nitrile (NBR)	T14119T0022
	Fluorocarbon (FKM)	T14119T0042
	Type 67CR or 67CFR (with relief)	
	Nitrile (NBR)	T14119T0012
	Fluorocarbon (FKM)	T14119T0032
	Silicone (VMQ)	T14119T0052
	Type 67CS or 67CFS (without relief)	
	Nitrile (NBR)	T14119T0062
	Fluorocarbon (FKM)	T14119T0072
	Type 67CSR or 67CFSR (with relief)	
	Nitrile (NBR)	T14119T0082
	Fluorocarbon (FKM)	T14119T0092
	Silicone (VMQ)	T14119T0102
17	Spring	
	Type 67C, 67CR, 67CF or 67CFR,	
	Plated steel **(standard)**	
	0 to 20 psig / 0 to 1.4 bar, Green stripe	GE07809T012
	0 to 35 psig / 0 to 2.4 bar, Silver	T14059T0012
	0 to 60 psig / 0 to 4.1 bar, Blue stripe	T14058T0012
	0 to 125 psig / 0 to 8.6 bar, Red stripe	T14060T0012

Key	Description	Part Number
17	Spring (continued)	
	Type 67CR or 67CFR (NACE), Inconel® (NACE)	
	0 to 35 psig / 0 to 2.4 bar, Silver stripe	T14113T0012
	0 to 60 psig / 0 to 4.1 bar, Blue	T14114T0012
	0 to 125 psig / 0 to 8.6 bar, Red	T14115T0012
	Type 67CS, 67CSR, 67CFS or	
	67CFSR, Inconel® (NACE)	
	0 to 20 psig / 0 to 1.3 bar, Green	10C1729X012
	0 to 35 psig / 0 to 2.4 bar, Silver stripe	T14113T0012
	0 to 60 psig / 0 to 4.1 bar, Blue	T14114T0012
	0 to 125 psig / 0 to 8.6 bar, Red	T14115T0012
	0 to 150 psig / 0 to 10.3 bar, Black	10C1730X012
18	Adjusting Screw	
	Type 67C, 67CR, 67CF or 67CFR,	
	Zinc-plated steel	
	For standard spring case	
	Square head **(standard)**	T14061T0012
	Handwheel	T14102T0012
	Wire seal (not shown)	T14104T0012
	For spring case with 1/4 NPT vent,	
	Zinc-plated steel	
	Square head for closing cap,	T14101T0012
	Handwheel	T14103T0012
	Wire seal (not shown)	T14198T0012

*Recommended Spare Part.
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☐ **APPLY LUBRICANT (L):**
L1 = MULTI-PURPOSE POLYTETRAFLUOROETHYLENE (PTFE) LUBRICANT
L2 = ANTI-SEIZE COMPOUND

Figure 6. *Type 67CFS or 67CFSR Assembly*

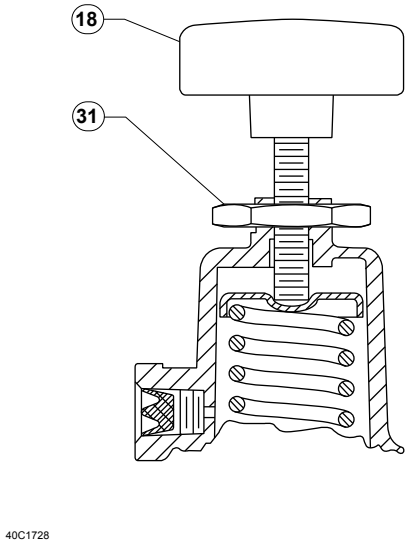


Figure 7. *67C Series Optional Panel Mount*

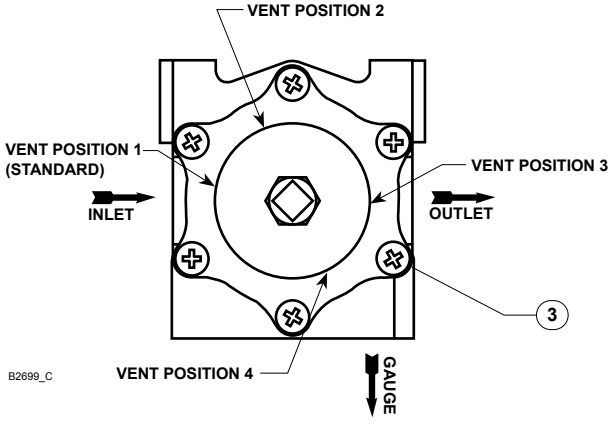


Figure 8. *67C Series Spring Case Vent Positions*

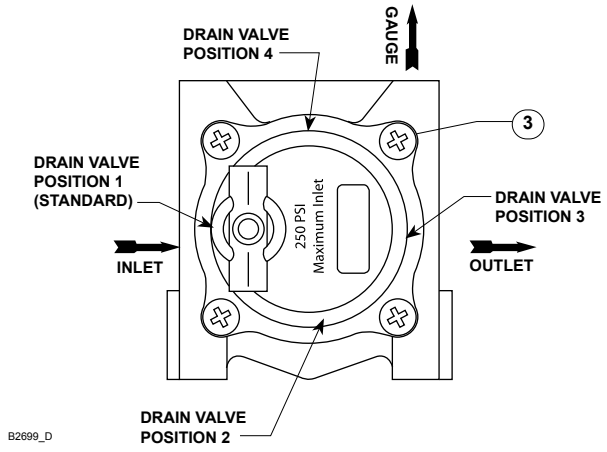


Figure 9. *Types 67CF, 67CFR, 67CFS and 67CFSR Drain Valve Positions*

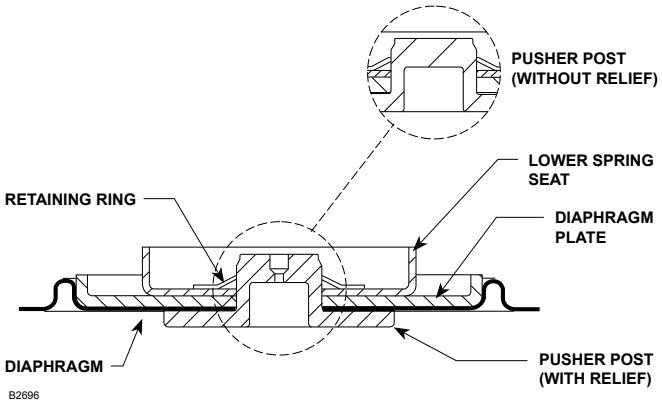


Figure 10. *Diaphragm Assembly (key 16)*

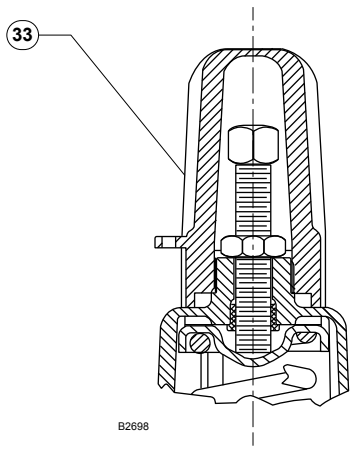


Figure 11. *Optional Closing Cap*
(Only Available with the 1/4 in. / 6.4 mm Spring Case Vent)

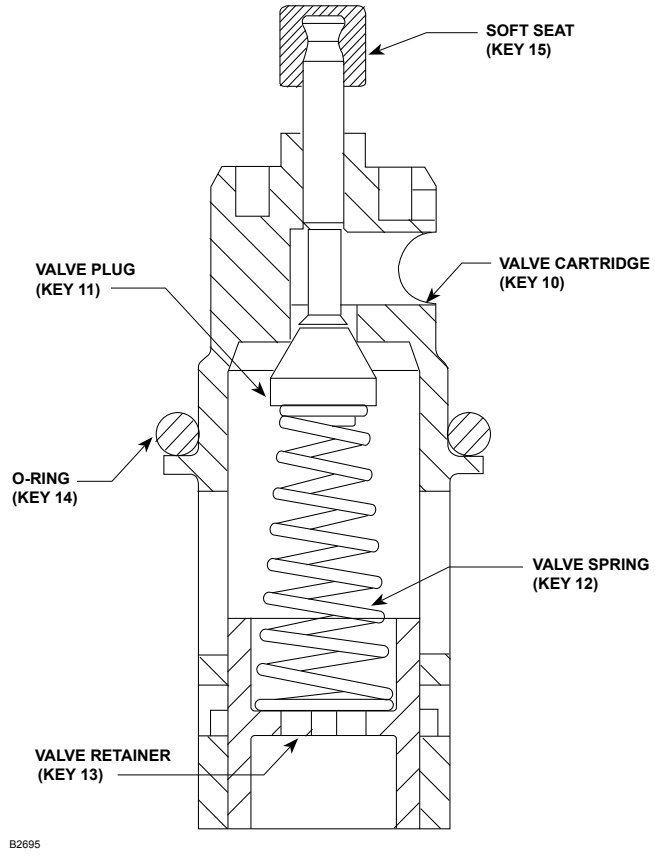


Figure 12. *Valve Cartridge Assembly*

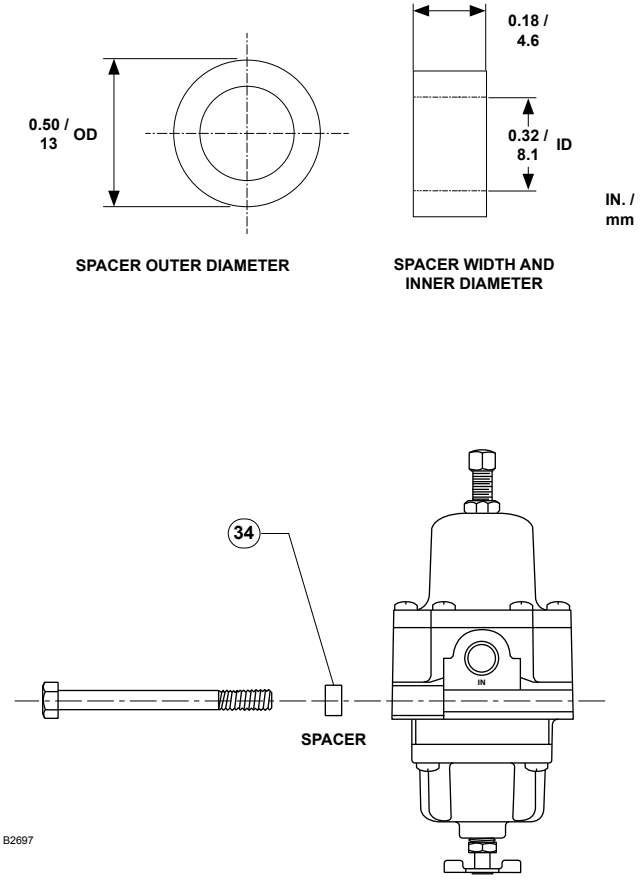


Figure 13. *Spacer Diameter and Assembly*
(For Installing in an Existing Installation
if the Mounting Bolts are Too Long)

Key	Description	Part Number
18	Adjusting Screw (continued)	
	Type 67CS, 67CSR, 67CFS or 67CFSR	
	Square head with or without closing cap,	
	316 Stainless steel	T14101T0022
	Handwheel, Zinc-plated steel	T14103T0012
19	Locknut	
	Type 67C, 67CR, 67CF or 67CFR	
	Zinc-plated steel	1A946324122
	316 Stainless steel	1A9463X0042
	Type 67CS, 67CSR, 67CFS or 67CFSR	
	316 Stainless steel	1A9463X0042
20	Upper Spring Seat	
	Type 67C or 67CR only	
	1/4 NPT Vent	T14051T0042
	Type 67C, 67CR, 67CF or 67CFR	
	Standard	T14051T0012
22	Pressure Gauge (not shown)	
	Type 67C, 67CR, 67CF or 67CFR, Brass	
	0 to 30 psig / 0 to 2.1 bar / 0 to 0.2 MPa	11B8579X022
	0 to 60 psig / 0 to 4.1 bar / 0 to 0.4 MPa	11B8579X032
	0 to 160 psig / 0 to 11.0 bar / 0 to 1.1 MPa	11B8579X042
	For all types, Stainless steel	
	0 to 30 psig / 0 to 2.1 bar / 0 to 0.2 MPa	11B9639X012
	0 to 60 psig / 0 to 4.1 bar / 0 to 0.4 MPa	11B9639X022
	0 to 160 psig / 0 to 11.0 bar / 0 to 1.1 MPa	11B9639X032
23	1/4 in. / 6.4 mm Pipe Plug (not shown)	
	Type 67C, 67CR, 67CF or 67CFR	
	Socket head, Steel	1C333528992
	For all types	
	Hex head, Stainless steel	1A767535072
24	Tire Valve (not shown)	
	Type 67C, 67CR, 67CF or 67CFR	1H447099022

Key	Description	Part Number
26*	Filter Gasket	
	Type 67CF, 67CFR, 67CFS or 67CFSR	
	with Nitrile (NBR) O-ring	T14081T0012
	with Fluorocarbon (FKM) O-ring	T14081T0022
30	NACE Tag (not shown), 18-8 Stainless steel	19A6034X012
31	Panel Mounting Nut, 303 Stainless steel	10B2657X012
32	Wire Seal (not shown)	
	Type 67C or 67CR	
	304 Stainless steel	1U7581000A2
33	Closing Cap, Resin	23B9152X012
34	Spacer (2 required) (Figure 13)	
	Type 67CF or 67CFR, Steel	T14123T0012
	Type 67CFS or 67CFSR, 18-8 Stainless steel	T14123T0022
37*	Thrust Washer	
	(Type 67CF, 67CFR, 67CFS or 67CFSR)	
	with Nitrile (NBR) O-rings	T14196T0012
	with Fluorocarbon (FKM) O-rings	T14196T0022
39	Bottom Plate, 316 Stainless steel	
	Type 67C or 67CR	GE03520XRG2
	Type 67CS or 67CSR	GE03520X012
45	Screen Vent, 18-8 Stainless steel	
	Type 67CS, 67CSR, 67CFS or 67CFSR	0L078343062

Parts for Mounting on Fisher™ 2500 Series Controller (Type 67CF or 67CFR)

Key	Description	Part Number
35	Mounting adaptor plate, Steel (not shown)	T21043T0012
36	O-ring, Nitrile (NBR) (not shown)	1E591406992
38	Gasket, Neoprene (CR) (not shown)	1C898603012

*Recommended Spare Part.

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EMERSON™

299H Series Pressure Reducing Regulators

WARNING

Failure to follow these instructions or to properly install and maintain this equipment could result in an explosion and/or fire causing property damage and personal injury or death.

Fisher™ regulators must be installed, operated and maintained in accordance with federal, state and local codes, rules and regulations and Emerson Process Management Regulator Technologies, Inc. (Emerson) instructions.

If the regulator vents gas or a leak develops in the system, service to the unit may be required. Failure to correct trouble could result in a hazardous condition.

Call a gas service person to service the unit. Only a qualified person must install or service the regulator.



Figure 1. *299H Series Pressure Reducing Regulator*

Introduction

Scope of the Manual

This Instruction Manual provides installation, adjustment and maintenance instructions and parts ordering information for the 299H Series regulators. Instructions and parts list for the 67C Series Instrument Supply Regulators are found in Instruction Manual D102601X012. Instructions and parts list for the P590 Series Filters are found in Instruction Manual D101555X012. Instructions and parts list for the Type VSX2 slam-shut are found in Instruction Manual D103695X012. Instructions and parts list for the Type VSX8 slam-shut are found in Instruction Manual D103127X012.

Description

The 299H Series pressure reducing regulators provide a broad capacity of controlled pressure ranges and capacities in a wide variety of distribution, industrial and commercial applications. A 299H Series regulator has a pilot integrally mounted to the actuator casing.

The 299H Series regulators can handle inlet pressures up to 175 psi / 12.1 bar depending on orifice size.

The integral token relief on the Types 299HR and 299HSR regulators is located in the pilot and opens to relieve minor overpressure.

The Types 299HS and 299HV provide overpressure or overpressure and underpressure protection by completely shutting off the flow of gas to the downstream system. It comes with a Type VSX2 (299HS) or VSX8 (299HV) slam-shut device which can be configured for Ovepressure Shutoff (OPSO) or Overpressure and Underpressure Shutoff (OPSO/UPSO). The slam-shut device's actions are independent of the main valve and of variations to the inlet pressure. The Type VSX2 (299HS) or VSX8 (299HV) slam-shut device has internal or external registration. External registration requires a downstream sensing line.

Specifications

Specifications for 299H Series constructions are given below. Some specifications for a given regulator as it originally comes from the factory are stamped on a nameplate located on the actuator upper casing.

Available Constructions

Type 299H: Pilot-operated pressure reducing regulator with a pilot integrally mounted to the actuator casing.

Type 299HR: A Type 299H with a token internal relief valve to relieve minor overpressure caused by thermal expansion.

Type 299HS: Same as the Type 299H with a Type VSX-2 slam-shut valve which provides overpressure or overpressure and underpressure protection.

Type 299HV: Same as the Type 299H with a Type VSX8 slam-shut valve which provides overpressure or overpressure and underpressure protection.

Type 299HSR: Same as the Type 299HS with an internal token relief valve.

Type 299HVR: Same as the Type 299HV with an internal token relief valve.

Body Size and End Connection Styles

See Table 1

Maximum Operating Inlet Pressure by Orifice Size(1)

1/4 x 3/8 in. / 6.4 x 9.5 mm . . . . . .175 psig / 12.1 bar
3/8 in. / 9.5 mm. . . . . .175 psig / 12.1 bar
1/2 in. / 13 mm . . . . . .175 psig / 12.1 bar
3/4 in. / 19 mm . . . . . .150 psig / 10.3 bar
7/8 in. / 22 mm(5) . . . . . .125 psig / 8.6 bar
1 in. / 25 mm(5). . . . . .100 psig / 6.9 bar
1-3/16 in. / 30 mm(5) . . . . . 80 psig / 5.5 bar

Maximum Casing and Emergency Outlet Pressure(1)

66 psig / 4.5 bar

Outlet (Control) Pressure Ranges(1)(2)

See Table 2

Maximum Set Pressure for Types 299HS and 299HV(1)

16 psig / 1.1 bar

Maximum Set Pressure for Slam-Shut Device(1)

See Table 2

Minimum and Maximum Trip Pressure Ranges

See Type VSX2 slam-shut Instruction Manual D103695X012 or Type VSX8 slam-shut Instruction Manual D103127X012.

Types VSX2 and VSX8 Sensing Line Connection

1/4 NPT

Pressure Control Accuracy (Fixed Factor)(PFM)

±1%(3) of absolute control pressure

Minimum Differential Pressure For Full Stroke

1.5 psid / 0.10 bar d

Control Line Connections

3/4 NPT

Temperature Capabilities(1)(6)

-20 to 150°F / -29 to 66°C

Approximate Weight

21 lbs / 10 kg

Pressure Registration

Internal, External or Dual Registration
See Figure 2

Fixed Restriction Sizes

0.044 in. / 1.1 mm, Red (**standard** gain)
0.071 in. / 1.8 mm, Green (low gain)
0.082 in. / 2.1 mm, Blue (lower gain)

Options

- **Filter(3):** A P590 Series filter installed in the pilot supply tubing between main body and pilot
- **Filtered pilot supply regulator(3)(4):** A Type 67CF supply regulator with integral 5 micron Polyethylene filter

1. The pressure/temperature limits in this Instruction Manual and any applicable standard or code limitation should not be exceeded.
2. For optimum performance, a pilot supply regulator may be installed in the pilot supply tubing between the main valve and pilot.
3. A pilot supply regulator or a P590 Series filter (only one may be used, not both) may be ordered with the Type 299H, but not both.
4. For in. w.c., use a pilot supply regulator if actual inlet pressure varies more than ±20 psi / ±1.4 bar and published accuracy is required.
5. This orifice size is not available for Types 299HS, 299HV, 299HSR and 299HVR.
6. Product has passed Emerson testing for lockup, relief start-to-discharge and reseal down to -40°.

Table 1. *Body Sizes and End Connection Styles*

BODY SIZE, IN. / DN	BODY MATERIAL AND END CONNECTION STYLE		
	Cast Iron (For Types 299H and 299HR only)	Ductile Iron	Steel (For Types 299H and 299HR only)
1-1/4 1-1/2	NPT NPT	- - - - NPT	- - - - NPT
2 / 50	NPT and CL125 FF[1] flanged	NPT, CL125 FF and CL250 RF flanged and PN 10/16 flanged	NPT and CL150 RF flanged
1. This flange is available with a face-to-face dimension of 7.5 in. / 190 mm or 10 in. / 254 mm.			

Table 2. *Outlet Pressure Ranges*

OUTLET (CONTROL) PRESSURE RANGE		TYPE		PILOT CONTROL SPRING					
		299H	299HR, 299HS, 299HSR, 299HV and 299HVR	Part Number	Color	Free Length		Wire Diameter	
In. w.c.	mbar					In.	mm	In.	mm
3.5 to 6[1]	9 to 15[1]	X	X	T13707T0012	Black	1.86	47.2	0.055	1.40
5 to 9[1]	12 to 22[1]	X	X	T13589T0012	Yellow	2.05	52.1	0.051	1.30
7 to 20[1]	17 to 50[1]	X	X	1N3112X0012	Unpainted	2.18	55.4	0.075	1.90
16 to 40[1]	40 to 99[1]	X	X	1B413727222	Purple	2.12	53.8	0.092	2.34
1 to 3.25 psig	69 mbar to 0.22 bar	X	X	T13593T0012	Light blue	2.12	53.8	0.105	2.67
2.75 to 6 psig	0.19 to 0.41 bar	X	X	T13671T0012	Orange	2.40	61.0	0.120	3.05
5 to 16 psig	0.34 to 1.1 bar	X	X	T13600T0012	Red	2.10	53.3	0.142	3.61
14 to 35 psig	0.97 to 2.4 bar	X	- - - -	19B0432X012	Zinc	2.15	54.6	0.207	5.26
30 to 60 psig	2.1 to 4.1 bar	X	- - - -	19B0432X022	Green	2.75	69.8	0.225	5.71
1. Use a pilot supply regulator if actual inlet pressure varies more than ±20 psi / ±1.4 bar and the published accuracy is required.									

Principle of Operation

WARNING

Since a pilot-operated regulator is constructed of both a pilot and a main valve, do not exceed the maximum inlet pressure shown on the nameplate.

Letter keys in this section refer to Figure 2 unless otherwise noted. Fast response and accuracy are made possible by the amplifying effect of the pilot and by the two-path control system. The function of the pilot is to sense change in the controlled pressure and amplify it into a larger change in the loading pressure. Any changes in outlet pressure act quickly on both the actuator diaphragm and the loading pilot, thus providing the precise pressure control that is characteristic of a two-path control system.

Upstream or inlet pressure is utilized as the operating medium, which is reduced through pilot operation to load the main diaphragm chamber. Tubing connects the inlet pressure to the pilot. Downstream or outlet pressure registers underneath the main diaphragm (E) and on top of pilot diaphragm (F). There are three different versions of pressure registration for the 299H Series.

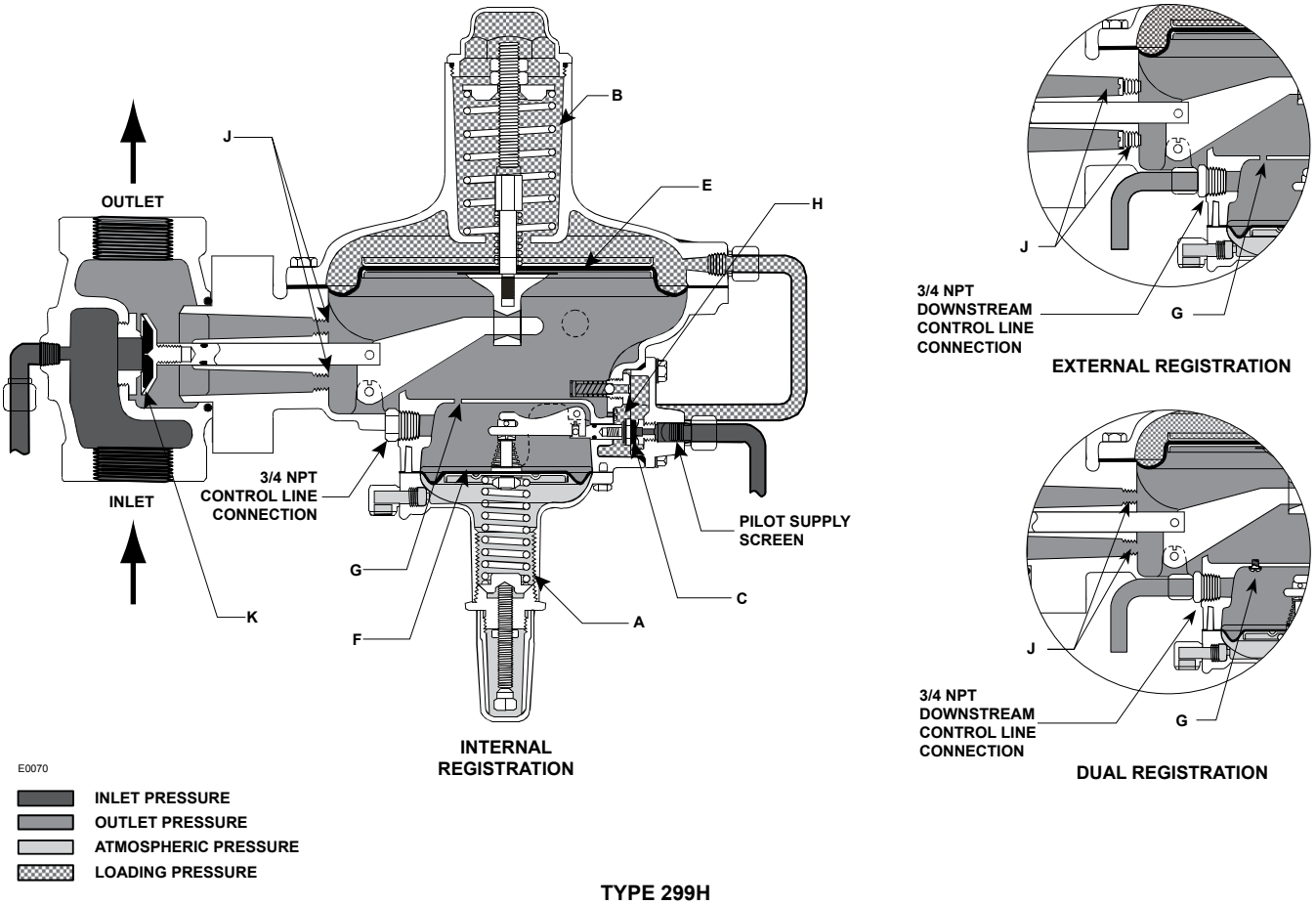
Internal registration—Outlet pressure is registered through the throat (J) to the main diaphragm chamber and then through a small port (G) to the top of the pilot diaphragm.

External registration—The throat (J) is blocked and a downstream control line is connected to the pilot upper diaphragm chamber or the actuator lower diaphragm chamber. A small port (G) connects the two chambers.

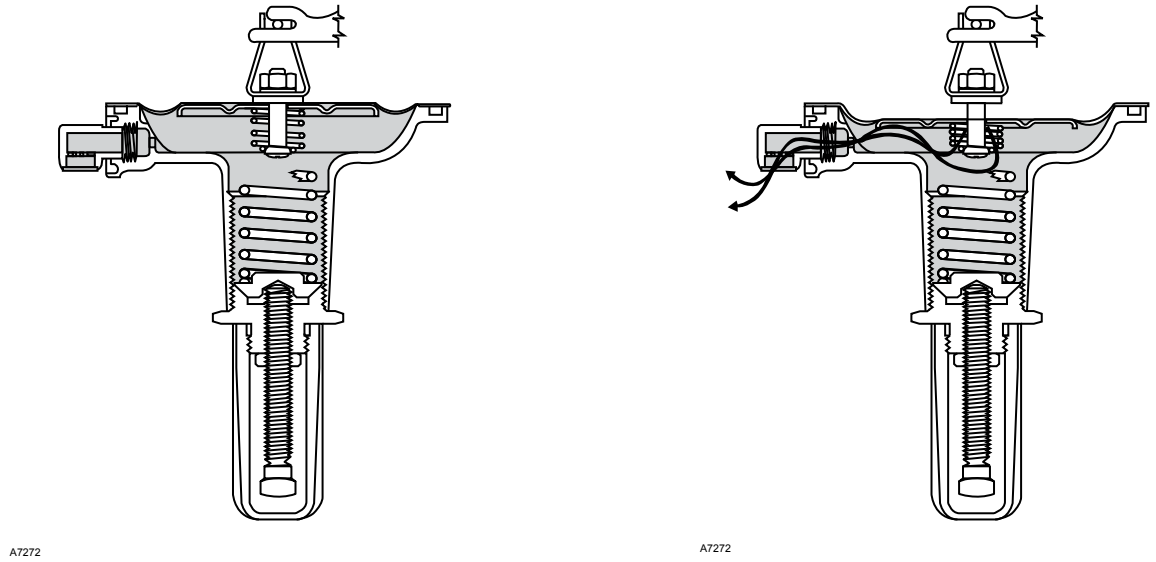
Dual registration—The lower main diaphragm chamber registers outlet pressure through the throat (J) and the upper pilot diaphragm chamber registers downstream pressure by using a downstream control line. The port (G) between the chambers is blocked.

Type 299H

In operation, assume the outlet pressure is less than the setting of the pilot control spring (A). The top side of pilot diaphragm assembly (F) will have a lower pressure than the setting of the control spring (A). The control spring (A) forces the diaphragm assembly upward, opening the pilot orifice (C). Additional loading pressure is supplied from the pilot orifice to the top side of the main diaphragm (E).



TYPE 299H



TOKEN RELIEF CLOSED **TOKEN RELIEF OPEN**

TYPE 299HR (TOKEN RELIEF DETAIL)

Figure 2. *299H Series Operational Schematics*

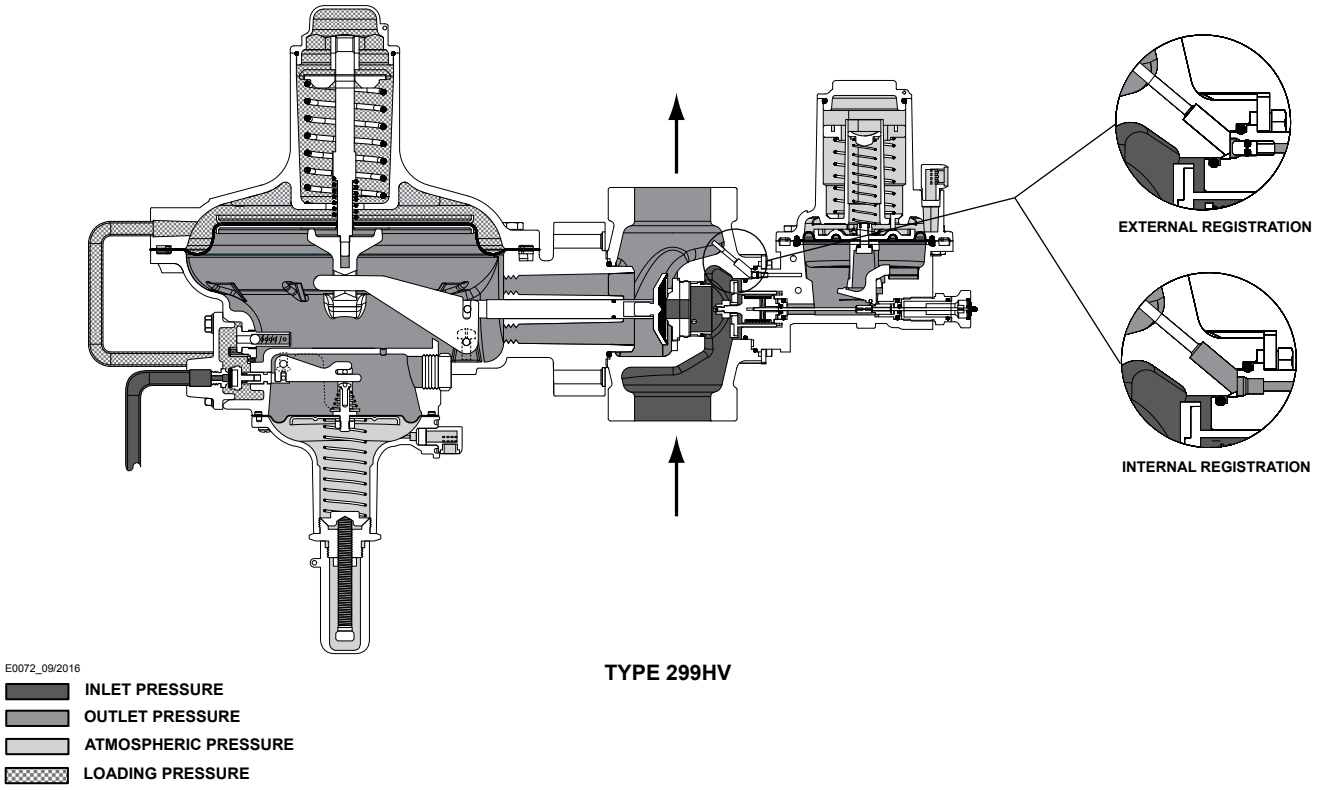


Figure 2. *299H Series Operational Schematics (continued)*

This creates a higher pressure on the top side of the main diaphragm (E) than on the bottom side, forcing the diaphragm downward. This motion is transmitted through a lever, which pulls the valve disk (K) open, allowing inlet pressure to flow through the valve.

When the demand in the downstream system has been satisfied, the outlet pressure increases. The increased pressure is transmitted through the downstream control line (for external or dual registration) or through the port (G) (for internal registration) and acts on top of the pilot diaphragm (F). This pressure exceeds the pilot spring setting and forces the diaphragm down, closing the orifice (C). The loading pressure acting on the main diaphragm (E) bleeds to the downstream system through a bleed restriction (H).

With a decrease in loading pressure on top of the main diaphragm (E), the main closing spring (B) exerts an upward force on the diaphragm post which is connected to the main diaphragm (E), pulling it upward. This moves the main valve disk (K) toward its seat, decreasing flow to the downstream system.

Type 299HR

During normal operation the Type 299HR performance is identical to the Type 299H. If an overpressure condition occurs, the pilot diaphragm head will separate from the pilot diaphragm post and travel until it contacts the pilot spring case. The movement of the diaphragm head creates a path and a token or small amount of gas will be released.

When the overpressure condition ceases, the pilot diaphragm head will return to the diaphragm post and the regulator will return to normal operation.

Type 299HS or 299HV

The Type VSX2 (299HS) or VSX8 (299HV) slam-shut device on the Type 299HS or 299HV regulator is a fast acting slam-shut valve which provides overpressure or overpressure and underpressure protection by completely shutting off the flow of gas to the downstream system. The slam-shut module's actions are independent of the Type 299HS or 299HV main regulator and of the variations to the inlet pressure. The Types VSX2 and VSX8 have internal or external registration. External registration requires a downstream sensing line.

The slam-shut disk is held in the open position (reset position) by an internal latching mechanism that holds the valve stem and disk assembly. If the pressure below the diaphragm increases (or decreases) reaching the Types VSX2 and VSX8 setpoint, the diaphragm will travel upwards (or downwards) operating a lever which in turn releases the valve stem assembly.

Once released, the spring force on the stem will push the stem and disk to the closed position against the seat shutting off all gas flow. The pilot supply pressure is also shut off when the Type VSX2 or VSX8 is closed. The manual reset has an internal bypass to equalize the reset pressure on either side on the slam-shut disk.

In order for the Underpressure Shutoff (UPSO) of any slam shut to be triggered, the downstream pipe pressure must drop below the UPSO setpoint. In the case of a downstream line break, numerous factors can prevent the downstream pipe pressure from decreasing below the slam-shut UPSO setpoint. These factors include the distance of pipe to the break, the diameter of the pipe, size of the break and the number of restrictions, such as valves, elbows and bends, downstream of the regulator and/or slam-shut device. Due to these factors additional protections should be installed to stop flow in the event of a line break.

Overpressure Protection

Like most regulators, the Type 299H has outlet pressure ratings lower than the inlet pressure ratings. Complete downstream overpressure protection is needed if the actual inlet pressure exceeds the outlet pressure rating.

Overpressure protection for internal parts is built into the main and pilot diaphragms by means of a small spring on each post. The springs will allow the diaphragm heads to move farther on the posts avoiding damage to or bending of the valve trim.

Overpressuring any portion of a regulator or associated equipment may cause leakage, parts damage or personal injury due to bursting of pressure-containing parts or explosion of accumulated gas. Regulator operation within ratings does not preclude the possibility of damage from external sources or from debris in the pipeline. A regulator should be inspected for damage periodically and after any overpressure condition.

The pilot vent is provided with a 1/4 NPT tapped connection in the spring case.

Installation

WARNING

Personal injury, equipment damage or leakage due to escaping gas or bursting of pressure-containing parts might result if this regulator is overpressured or is installed where service conditions could exceed the limits for which the regulator was designed or where conditions exceed any ratings of the adjacent piping or piping connections. To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation or standard) to prevent service conditions from exceeding those limits.

A regulator may vent some gas to the atmosphere in hazardous or flammable gas service. Vented gas might accumulate and cause personal injury, death or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air intakes or any hazardous location. Protect the vent line or stack opening against condensation or clogging.

If the regulator is exposed to an overpressure condition, it should be inspected for any damage that may have occurred. Operation below these limits does not preclude the possibility of damage from external sources or from debris in the pipeline.

If the Type VSX2 or VSX8 is exposed to an overpressure condition, it should be inspected for any damage that may have occurred. Operation below these limits does not preclude the possibility of damage from external sources or from debris in the pipeline.

In the case of a downstream line break, numerous factors affect the capability to evacuate gas from the pipeline. These factors include the distance of pipe to the break, the diameter of the pipe, size of the break and the number of restrictions, such as valves, elbows and bends, downstream of the regulator

and/or slam-shut device. Due to these factors additional protections should be installed to stop flow in the event of a line break.

Like most regulators, the 299H Series regulators have an outlet pressure rating lower than its inlet pressure rating. Complete downstream overpressure protection is needed if the actual inlet pressure can exceed the regulator outlet pressure rating or the pressure ratings of any downstream equipment. Regulator operation within ratings does not preclude the possibility of damage from external sources or from debris in the lines. A regulator should be inspected for damage periodically and after any overpressure condition.

Clean out all pipelines before installation. Check for damage which might have occurred during shipment. Also, check for and remove any dirt or foreign material which may have accumulated in the regulator body.

Apply pipe compound to the external pipe threads of threaded bodies or use suitable line gaskets and good bolting practices with a flanged body. This regulator may be installed in any position desired as long as the flow through the body is in the direction indicated by the arrow on the body. Install a three-valve bypass around the regulator if continuous operation is necessary during maintenance or inspection.

Although the standard orientation of the actuator and pilot to the main valve body is as shown in Figure 1, this orientation may be changed in 90° intervals by rotating the actuator lower casing (key 1, Figure 4) and the elbow fitting (key 19) by 90° and then reinstalling the cap screws.

To keep the pilot spring case from being plugged or the spring case from collecting moisture, corrosive chemicals or other foreign material, the vent must be pointed down oriented to the lowest possible point on the spring case or otherwise protected. Vent orientation may be changed by rotating the pilot spring case with respect to the pilot body.

To remotely vent the pilot, remove the screwed-in vent assembly (key 27, Figure 3) from the pilot spring case and install obstruction-free tubing or piping into the 1/4 NPT vent tapping. Provide protection on a remote vent by installing a screened vent cap into the remote end of the vent pipe.

An upstream pilot supply line is not required because of the integral pilot supply tubing (key 21, Figure 4). However, as long as the 1/4 NPT tapping in the main valve body is plugged, this tubing may be disconnected from the main valve (key 17) in order to install a pilot supply line from a desired remote location into the pilot.

If using a control line, attach the control line from the pilot tap 2 to 3 ft. / 0.61 to 0.91 m downstream of the regulator in a straight run of pipe. If impossible to comply with this recommendation due to the pipe arrangement, it may be better to make the control line tap nearer the regulator outlet rather than downstream of a block valve. Do not make the tap near any elbow, swage or nipple which might cause turbulence. For optimal performance, use as large of a control line as practical.

In many instances, it will be necessary to enlarge the downstream piping to keep flow velocities within good engineering practices. Expand the piping as close to the regulator outlet as possible.

WARNING

Adjustment of the pilot control spring to produce an outlet pressure higher than the upper limit of the outlet pressure range for that particular spring can cause personal injury or equipment damage due to bursting of pressure-containing parts or the dangerous accumulation of gases if the maximum actuator emergency casing pressure is exceeded. If the desired outlet pressure is not within the range of the pilot control spring, install a spring of the proper range according to the Maintenance section.

Each regulator is factory-set for the pressure setting specified on the order. If no setting was specified, the outlet pressure is set midrange of the pilot control spring. In all cases, check the control spring setting to make sure it is correct for the application.

Registration Conversion

To convert the 299H Series regulators from one type of registration to another, all that is required is adding or removing screws and O-rings.

To change an internal registration regulator to an external registration regulator with a downstream control line, block the two ports in the throat with screws and O-rings (J in Figure 2). Remove either the 3/4 NPT pipe plug in the pilot casing or the 3/4 NPT pipe plug in the lower casing and add a downstream control line.

To convert an external registration regulator to a dual registration regulator, remove the two screws and O-rings (J in Figure 2) from the throat and use a screw and an O-ring to block the port (G in Figure 2) between the lower diaphragm chamber and pilot diaphragm chamber. Remove the 3/4 NPT pipe plug in the pilot lower casing and add a downstream control line.

Type VSX2 Slam-Shut Device

Refer to the Instruction Manual for Type VSX2 slam-shut, document D103695X012, for Adjustment and Maintenance of the Slam-shut.

Type VSX2 Installation Startup

Note

The Type VSX2 slam-shut module should be mounted so that the spring case vent points towards the ground.

The overpressure and underpressure trip points can only be reset if the Type 299HS outlet pressure is between the overpressure and underpressure trip points.

Startup

With proper installation completed and downstream equipment properly adjusted, perform the following procedure while monitoring the pressure with gauges.

1. Very slowly open the upstream block valve.
2. On a Type 299HS, the Type VSX2 is shipped in the tripped position and will need to be reset. If the Type VSX2 is a high trip only, it can be reset before starting the regulator. If the Type VSX2 is a high and low trip, the regulator will need to be started and the downstream system pressurized before the Type VSX2 can be reset. See the section for Type VSX2 reset.
3. Use the following procedure to reset the Type VSX2:
   a. Unscrew the brass resetting knob to open the equalizing bypass.
   b. Pull out the knob until it stops. This resets the tripping mechanism.
   c. Push in and tighten the knob.
4. Slowly open the hand valve (if used) in the control line. The regulator will control downstream pressure at the pilot control spring setting. See the Adjustment section following these numbered steps if changes in the setting are necessary during the start-up procedure.
5. Slowly open the downstream block valve.
6. Slowly close the bypass valve, if used.
7. Check all connections for leaks.

Type VSX8 Slam-Shut Device

Refer to the Instruction Manual for Type VSX8 Slam-shut, document D103127X012, for Adjustment and Maintenance of the Slam-shut.

Type VSX8 Installation Startup

Note

The Type VSX8 slam-shut device can be rotated 360° for easy installation and maintenance.

Equipment installed downstream the Type VSX8 slam shut device can be damaged if the following procedure for resetting the Type VSX8 slam shut device is not followed. This equipment includes the integral Type VSX8 regulator configurations.

Before proceeding with the adjustment of the slam-shut device springs, the operator must ensure upstream and downstream valves are closed and adjusting screws are unscrewed.

With proper installation completed and downstream equipment properly adjusted, perform the following procedure while monitoring the pressure with gauges.

1. Very slowly open the upstream block valve.
2. On a Type 299HV, the Type VSX8 is shipped in the tripped position and will need to be reset. If the Type VSX8 is OPSO only, it can be reset before starting the regulator. If the Type VSX8 is OPSO/UPSO, the regulator will need to be started and the downstream system pressurized before the Type VSX8 can be reset. See the section for Type VSX8 reset.

3. Use the following procedure to reset the Type VSX8:
   a. To properly reset the Type VSX8 slam shut after it has been tripped to the closed position, a flat-head screwdriver must be inserted into the backside of the reset button.
   b. The screwdriver should be slowly rotated to gradually pull the reset button away from the Type VSX8 device. This slow movement allows for a slow bleed of the pressure across the Type VSX8 slam shut's disk and seat area. The operator should be able to hear the pressure bleeding through the system.
   c. When the pressure has equalized and the air bleeding sound has dissipated, the reset button should be pulled completely away from the Type VSX8 slam shut device by hand until the internal shut-off mechanism has been re-latched.
   d. Once the operator feels the click of the re-latch occurring, the reset button should be pushed completely back into its original position.
4. Slowly open the hand valve (if used) in the control line. The regulator will control downstream pressure at the pilot control spring setting. See the Adjustment section following these numbered steps if changes in the setting are necessary during the start-up procedure.
5. Slowly open the downstream block valve.
6. Slowly close the bypass valve, if used.
7. Check all connections for leaks.

299H Series Adjustment

Keys are referenced in Figure 5. The only adjustment on a 299H Series regulator is the reduced pressure setting of the pilot control spring (key 32). Remove the closing cap (key 29) and turn the adjusting screw (key 36). Turning the adjusting screw clockwise into the spring case increases the controlled or reduced pressure setting. Turning the screw counterclockwise decreases the reduced pressure setting. Always tighten the locknut (key 35) and replace the closing cap after making adjustments.

Shutdown

Installation arrangements may vary, but in any installation it is important to open and close valves slowly and the outlet pressure be vented before venting inlet pressure to prevent damage caused by reverse pressurization of the regulator. Isolate the regulator from the system. Vent the downstream pressure; then vent inlet pressure to release any remaining pressure in the regulator.

Maintenance

Regulator parts are subject to normal wear and must be inspected periodically and replaced as necessary. The frequency of inspection and replacement depends upon the severity of service conditions and upon applicable codes and government regulations.

Due to the care Emerson takes in meeting all manufacturing requirements (heat treating, dimensional tolerances, etc.), use only replacement parts manufactured or furnished by Emerson.

WARNING

Avoid personal injury or damage to property from sudden release of pressure or uncontrolled gas or other process fluid. Before starting to disassemble, carefully release all pressures according to the Shutdown procedure. Use gauges to monitor inlet, loading and outlet pressures while releasing these pressures.

On reassembly of the regulator, it is recommended that a good quality pipe thread sealant be applied to pressure connections and fittings and a good quality lubricant be applied to all O-rings. Also apply an anti-seize compound to the adjusting screw threads and other areas as needed.

Note

The regulator body may remain in the pipeline during maintenance procedures.

Main Actuator Diaphragm

Follow this procedure to change the actuator diaphragm or to inspect, clean or replace any other parts in the main actuator. Part key numbers are referenced in Figures 3 and 4.

1. Cut the wire seal (key 68) (being careful not to lose the warning tag) and remove the closing cap (key 3). Inspect the O-ring (key 9) and replace if necessary.
2. Carefully loosen and remove the double nuts (key 5) on the actuator diaphragm post (key 10). When removing the adjusting nuts, do not twist or unscrew the diaphragm post, as this action will loosen the joint between the diaphragm post and the pusher post (keys 10 and 11).
3. Remove the spring seat (key 4) and closing spring (key 6).
4. Remove the eight hex head cap screws (key 23) and lift off the upper casing (key 2).
5. Remove the diaphragm assembly (key 8) by tipping it so that the lever (key 26) slips out of the pusher post (key 11).
6. Separate the diaphragm assembly by unscrewing the diaphragm post (key 10) from the pusher post (key 11) and remove the diaphragm post, pressure equalization spring (key 7), diaphragm head (key 81), diaphragm (key 8), the second diaphragm head (key 81) and diaphragm pad (key 80). Inspect the diaphragm parts for damage and replace if necessary.
7. Inspect the lever (key 26) and replace if necessary. To replace the valve stem (key 16), also perform Main Body Valve Disk and Orifice maintenance procedure steps 1, 2 and 3, remove disk (key 13) and pull the stem out of the lower casing assembly (key 1). Lightly lubricate the replacement stem O-ring (key 14) and install it on the valve stem. Reinstall the valve stem into the lower casing assembly. Reinstall the body (key 17) or continue with the reassembly of the diaphragm.

Note

When assembling the diaphragm assembly (keys 8, 80 and 81), lubricate the actuator diaphragm post (key 10) threads.

8. Loosely reassemble the diaphragm and diaphragm post parts so that the bolt holes in the diaphragm align with the corresponding holes in the lower casing (key 1) when the lever (key 26) is fitted properly into the pusher post. When this orientation is made, tighten the diaphragm post into the pusher post (keys 10 and 11).
9. Reinstall the diaphragm assembly using the reverse order of step 5.
10. Install the upper casing (key 2) and secure it to the lower casing (key 1) with the eight hex head screws (key 23). Tighten the hex head screws evenly using a crisscross pattern to avoid placing an uneven strain on the regulator. Tighten the screws to a final bolt torque of 10 to 13 ft-lbs / 13 to 17 N•m to avoid crushing the diaphragm.

CAUTION

In step 11, the spring seat (key 4) is under spring pressure. Use constant hand pressure to hold the spring down when installing the hex nuts (key 5), see Figure 3.

11. Install the closing spring (key 6) and the spring seat (key 4). Push and hold down on the spring seat, cocking it to one side until the seat catches onto the threads of the diaphragm post (key 10). Then, pull up on the diaphragm post allowing access to the post threads so that the two adjusting hex nuts (key 5) can be installed. Install the adjusting hex nuts as shown in Figure 3. The closing spring must be adjusted down to a depth of 1/2 in. / 13 mm from the top of the upper case opening to the top of the spring seat. When tightening the two hex nuts, use care not to rotate the diaphragm post, which may damage the post.
12. Lightly lubricate the O-ring (key 9) on the closing cap and reinstall the closing cap (key 3).

WARNING

The wire seal and warning tag (keys 68 and 69) contain important safety information, make sure they are attached when maintenance is completed.

13. Install the wire seal and warning tag (keys 68 and 69).

Main Body Valve Disk and Orifice

Follow this procedure to inspect, clean or replace the main body valve disk or to inspect or replace the orifice. Part key numbers are referenced in Figures 3 and 4.

Note

The regulator body may remain in the pipeline during maintenance procedures.

1. Disconnect the pilot supply tubing (key 21) from the main body (key 17).
2. Remove the two hex head cap screws (key 18) which hold the lower casing (key 1) to the body. Separate the lower casing from the body. Inspect the body O-ring (key 15) and replace if worn or damaged.
3. Examine the valve disk (key 13) and orifice (key 12) for nicks, cuts and other damage. Unscrew the disk holder assembly from the valve stem assembly (key 16) and replace it with a new part if necessary. For the Type 299HS, also examine the insert and O-ring (keys 82 and 83, Figure 6) for any damage. Replace if needed.
4. If the orifice is being replaced with a new or differently sized orifice, change the nameplate (key 63) to state the new size and maximum inlet pressure. Lubricate the threads and flat face of the orifice with a good grade of anti-seize lubricant. Install the orifice using 100 to 120 ft-lbs / 136 to 163 N•m of torque.
5. After replacing all damaged parts, slide the entire assembly into the valve body (key 17) and secure with the two hex head cap screws (key 18).
6. Connect the pilot supply tubing (key 21), then refer to the Startup section for putting the regulator into operation.

Integral Pilot Valve Disk and Orifice

Follow this procedure to inspect, clean or replace the integral pilot valve disk or orifice. Part key numbers are referenced in Figures 3 and 4.

1. Remove or loosen the pilot supply tubing (key 21).
2. Remove the inlet fitting (key 47) and the four machine screws (key 46).
3. Examine the valve disk (key 52) for nicks, cuts and other damage. Unscrew the disk holder assembly from the valve stem (key 48) and replace if necessary.
4. If the seating edge of the orifice (key 50) is nicked or rough, use a thin-walled socket to remove the orifice from the inlet fitting (key 47). Install a new orifice and a lightly lubricated O-ring (key 49) when reassembling the regulator.
5. Inspect the check valve assembly (key 45) and the bleed restriction (key 70) for damage and replace if necessary.
6. The Type 299H has a wire inlet screen (key 51) in the pilot supply inlet fitting (key 47). If clogging is suspected in the pilot supply, remove the elbow fitting (key 19) and clean the wire screen.
7. Lightly lubricate the O-ring (key 54) on the inlet fitting (key 47) and reinstall using the four machine screws (key 46). Torque the machine screws to 30 to 40 in-lbs / 3.4 to 4.5 N•m. Then install and tighten the pilot supply tubing.

Integral Pilot Control Spring and Diaphragm

Follow this procedure to change the pilot control spring or to inspect, clean or replace the diaphragm. Part key numbers are referenced in Figures 3, 4 and 5.

1. Remove the pilot closing cap (key 29) and loosen the hex lock nut (key 35). Turn the adjusting screw (key 36) counterclockwise to ease spring compression.
2. Unscrew the bonnet (key 34).
3. Remove the bonnet (key 34), spring seat (key 33) and control spring (key 32).
4. If only replacing the control spring (key 32), sparingly apply lubricant to the control spring seat (key 33) and reassemble in the reverse order.

Note

When replacing the control spring with a different spring range, be sure to delete the spring range appearing on the nameplate and indicate the new range.

5. Remove the machine screws (key 30) and spring case (key 31) from the lower casing (key 1).
6. Remove the diaphragm assembly (key 28) by tilting them so that the pusher post (key 40) slips off the lever (key 57). To separate the diaphragm from the attached parts, unscrew the hex nut (key 37) and separate the parts: washer (key 38), diaphragm post (key 39), pusher post (key 40), overtravel spring (key 41), machine screw (key 42), spring seat (key 88) (Types 299HR and 299HSR), rivet (key 43) and retaining ring (key 44).
7. To replace the lever assembly (key 57), remove the lever pin (key 25). To replace the valve stem (key 48), also perform Integral Pilot Valve Disk and Orifice maintenance procedure steps 1, 2 and 3 and pull the stem (key 48) out of the lower casing assembly (key 1). Lightly lubricate the replacement stem O-ring (key 53) and install it on the valve stem.

8. Install the valve stem (key 48) into the lower casing assembly (key 1). Be careful not to cut the O-ring (key 53) when sliding the valve stem into the lower casing.
9. Reinstall the diaphragm (key 28) assembly using the reverse order of step 6.
10. Place the spring case (key 31) on the lower casing (key 1) with the vent (key 27) oriented downwards to prevent clogging or entrance or moisture. Install the machine screws (key 30) and tighten in a crisscross pattern using 12 to 18 in-lbs / 1.4 to 2.0 N•m of torque.
11. When all maintenance is complete, refer to the Startup section to put the regulator back into operation and adjust the pressure setting. Tighten the locknut (key 35) and install the closing cap (key 29).

Types VSX2 and VSX8 Maintenance

Maintenance instructions for the Type VSX2 slam-shut are found in Instruction Manual D103695X012. Maintenance instructions for the Type VSX8 slam-shut are found in Instruction Manual D103127X012.

Refer to the Instruction Manual for Type VSX2 slam-shut, document D103695X012, for Adjustment and Maintenance of the Slam-shut. Refer to the Instruction Manual for Type VSX8 Slam-shut, document D103127X012, for Adjustment and Maintenance of the Slam-shut.

Note

The Type VSX2 is not interchangeable with the Type VSX8 module. Each slam-shut module requires a mating valve body. Both slam-shut and body can be replaced in the field. See parts list for part numbers.

Optional P590 Series Filter

For complete installation, maintenance and parts list refer to the P590 Series Filters Instruction Manual D101555X012.

Optional Type 67CF Pilot Supply Regulator

For complete installation, maintenance and parts list refer to the 67C Series Instruction Manual D102601X012.

Parts Ordering

The type number, orifice size, spring range and date of manufacture are stamped on the nameplate. Provide this information along with the eleven-character part number to your local Sales Office when ordering parts. If construction changes are made in the field, be sure that the nameplate is also changed to reflect the most recent construction.

Note

It is recommended that the 299H Series regulator use a complete matching casing set that includes an upper case, a lower case and spring case in the old blank configuration or new swirl configuration. However, these parts are interchangeable with each other.

Parts List

299H Series Regulator (Figures 3, 4 and 5)

Key	Description	Part Number
	Parts Kit (Includes keys 8, 9, 13, 14, 15, 28, 49, 52, 53, 54, 60, 61 and 80)	R299X000012
1	Lower Casing, Aluminum	
	Types 299HS and 299HSR	T80447T0012
	Types 299H, 299HV and 299HVR	ERAA10462A1
2	Upper Casing, Aluminum	
	Type 299HS	T40577T0012
	Type 299HV	ERAA10463A1
3	Closing Cap, Aluminum	1L928308012
4	Spring Seat	
	Delrin® (standard)	ERAA21736A0
	Steel (High vibration or engine applications - used with key 93)	T13831T0012
5	Adjustment Nut, Steel (2 required)	1A341224122
6	Closing Spring, Steel	T13918T0012
7	Pressure Equalization Spring, Steel	T13463T0012
8*	Diaphragm, Nitrile (NBR)	T20986T0012
9*	O-ring, Nitrile (NBR)	1F914106992
10	Diaphragm Post, Steel	T13814T0012
11	Pusher Post, Aluminum	1L143311992
12	Orifice, Aluminum	
	1/4 x 3/8 in. / 6.4 x 9.5 mm	T13833T0012
	3/8 in. / 9.5 mm	1H979309022
	1/2 in. / 13 mm	1H979409022
	3/4 in. / 19 mm	1H979509022
	7/8 in. / 22 mm (for Types 299H and 299HR only)	T14098T0012
	1 in. / 25 mm (for Types 299H and 299HR only)	1H979609022
	1-3/16 in. / 30 mm (for Types 299H and 299HR only)	1H979709022
13*	Disk, Nitrile (NBR)	1P7349000A2
14*	O-ring, Nitrile (NBR)	1E216306992

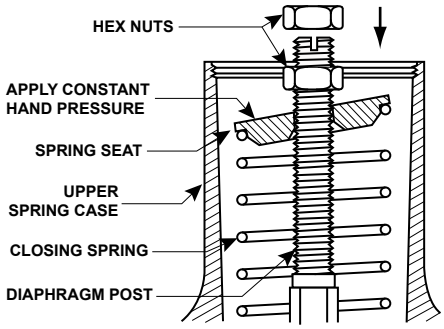
* Recommended spare part.
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Key	Description	Part Number
15*	O-ring, Nitrile (NBR)	T12587T0012
16	Valve Stem Assembly	1L1426000A2
17	Valve Body	
	Cast Iron, For Types 299H and 299HR only	
	1-1/4 NPT	T40578T0012
	1-1/2 NPT	1J190419012
	2 NPT	1H968919012
	NPS 2 / DN 50	
	CL125 FF flanged	
	7.5 in. / 90 mm face-to-face dimension	T80445T0012
	10 in. / 254 mm face-to-face dimension	2L425119012
	Ductile Iron, For all 299H Series	
	1-1/2 NPT	ERAA11740A0
	2 NPT	ERAA11741A0
	NPS 2 / DN 50	
	CL125 FF flanged	ERAA11742A0
	CL250 RF flanged	ERAA11743A0
	PN 10/16 flanged	ERAA11744A0
	Steel, For Types 299H and 299HR only	
	1-1/2 NPT	1J1904T0022
	2 NPT	1H9689T0022
	NPS 2 / DN 50	
	CL150 RF flanged	T80415T0012
18	Cap Screw, Steel (2 required)	
	Types 299H and 299HR	T14034T0012
	Types 299HS, 299HSR, 299HV and 299HVR	T14082T0012
19	Elbow (3 required for Cast Iron or Steel bodies; 2 required for Ductile Iron Bodies)	- - - - - - - - - - -
20	Connector[1]	- - - - - - - - - - -
21	Pilot Supply Tubing, Without filter	- - - - - - - - - - -
22	Loading Tubing	- - - - - - - - - - -
23	Cap Screw, Steel (8 required)	1C379124052
24	Machine Screw, Steel (2 required)	1B420428982
25	Lever Pin, Stainless steel (2 required)	1H972935032
26	Lever, Steel	T13813T0012
27	Vent Hood (Type Y602-12 Vent Assembly)	27A5516X012
28	Diaphragm Assembly, Nitrile (NBR) diaphragm and steel diaphragm head	T14259T0012
29	Closing Cap, Plastic	24B1301X012
30	Machine Screw, Steel (8 required)	T14069T0012
31	Spring Case, Aluminum	T14097T0012
	Spring Case, Aluminum	ERAA10464A1
32	Control Spring	See Table 2
33	Spring Seat, Steel	T13917T0012
34	Bonnet, Steel	T14135T0012
35	Locknut, Steel	1A352224122
36	Adjusting Screw, Steel	T14133T0012
37	Hex Nut, Steel	1E985324142
38	Washer, Steel	1F230328992
39	Diaphragm Post, Stainless steel	
	Types 299H, 299HS and 299HV	T13915T0012
	Types 299HR, 299HSR and 299HVR	T14033T0012
40	Pusher Post, Steel	T13914T0012
41	Overtravel Spring, Stainless steel	
	Types 299H, 299HS and 299HV	T14136T0012
	Types 299HR, 299HSR and 299HVR	T14031T0012
42	Machine Screw, Steel	1A954828992
43	Rivet, Flat head, Stainless steel	T13916T0012
44	Retaining Ring, Steel	16A6977X012
45	Check Valve Assembly	T14258T0012
46	Machine Screw, Steel (4 required)	T13920T0012
47	Inlet Fitting, Aluminum	T13824T0012
48	Stem Assembly, Aluminum	1H9666T0012
49*	O-ring, Nitrile (NBR)	T13939T0012
50	Pilot Orifice, Aluminum	T13825T0012
51	Inlet Screen, Stainless steel	T13791T0012
52*	Pilot Disk Assembly, Hydrogenated Nitrile (NBR) and Aluminum disk holder	T13955T0012
53*	O-ring, Nitrile (NBR)	1D682506992
54*	O-ring, Nitrile (NBR)	13A2331X022
56	Screw, Steel (External Registration - 2 required or Dual Registration - 1 required)	1E175828982
57	Lever, Steel	T14134T0012
58	Pipe Plug, Steel	1A7715T0012
59	Pipe Plug, Internal Registration only, Steel	
	3/4 NPT	1A7715T0012
	1/4 NPT	1A767524662
61	O-ring, Nitrile (NBR) (External Registration - 2 required or Dual Registration - 1 required)	17A0960X012
62	Drive Screw, Steel (2 required)	1E501728982
63	Nameplate, Aluminum	- - - - - - - - - - -
68*	Wire Seal	T14088T0012
69	Warning Tag, Aluminum	- - - - - - - - - - -
70	Bleed Restriction, Steel	
	0.044 in. / 1.1 mm, Red **(standard)**	17A2029X012
	0.071 in. / 1.8 mm, Green	17A2030X012
	0.082 in. / 2.1 mm, Blue	17A7277X012
72	Filter Assembly, See P590 Series	
	Type P593-1	AJ5004T0012
	Type P594-1	AJ5004000A2
78	Pilot Supply Tubing, Long (for constructions with filter or pilot supply option)	- - - - - - - - - - -
79	Pilot Supply Tubing, Short (for constructions with filter or pilot supply option)	- - - - - - - - - - -
80	Pad, Nitrile (NBR)	T13830T0012
81	Diaphragm Head, Steel (2 required)	T13812T0012
82	Insert (for Types 299HS, 299HSR, 299HV and 299HVR only, see Figure 6) Aluminum[2]	T14013T0012
83	O-ring (for Types 299HS, 299HSR, 299HV and 299HVR only, see Figure 6) Nitrile (NBR)[2]	T1072606562
84	Plate (for Types 299H and 299HR only), Steel[2]	T14039T0012
85	O-ring (for Types 299H and 299HR only), Nitrile (NBR)[2]	T13769T0012
86	O-ring (for Types 299H and 299HR only), Nitrile (NBR)[2]	T13772T0012
87	Set Screw (for Types 299H and 299HR only) (4 required)[2]	1C629828992
88	Spring Seat, Types 299HR and 299HSR	T14030T0012
89	Label[3]	
	Types 299H and 299HS	T1215806032
	Types 299HR and 299HSR	T1215906032
92	Tee, Stainless steel	- - - - - - - - - - -
93	Spring Seat Washer, Delrin® (high vibration and engine applications - used with key 4)[3]	19B0553X012
94	Plastic Plugs[3]	T13543T0042

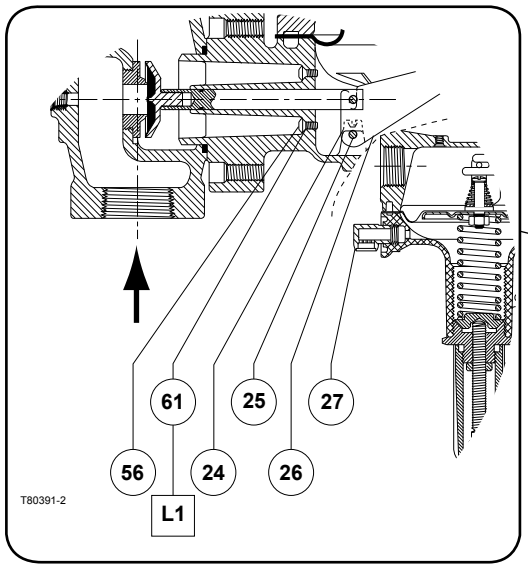
* Recommended spare part

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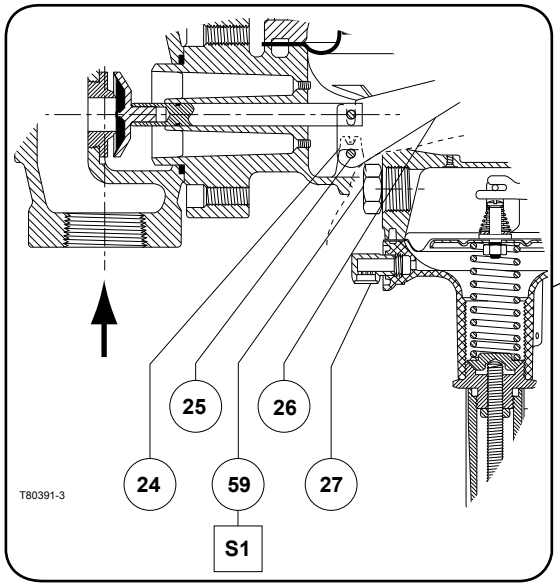
1. Cast iron or steel bodies without filter and pilot supply regulator require 1 connector; all other combinations of filter and/or pilot supply regulator require 3 connectors. Ductile iron bodies without filter and pilot supply regulator require 2 connectors; all other combinations of filter and/or pilot supply regulator require 4 connectors.
2. Ductile iron bodies only.
3. Not shown.



LOCKING DOWN THE SPRING SEAT TO FACILITATE INSTALLING THE HEX NUTS



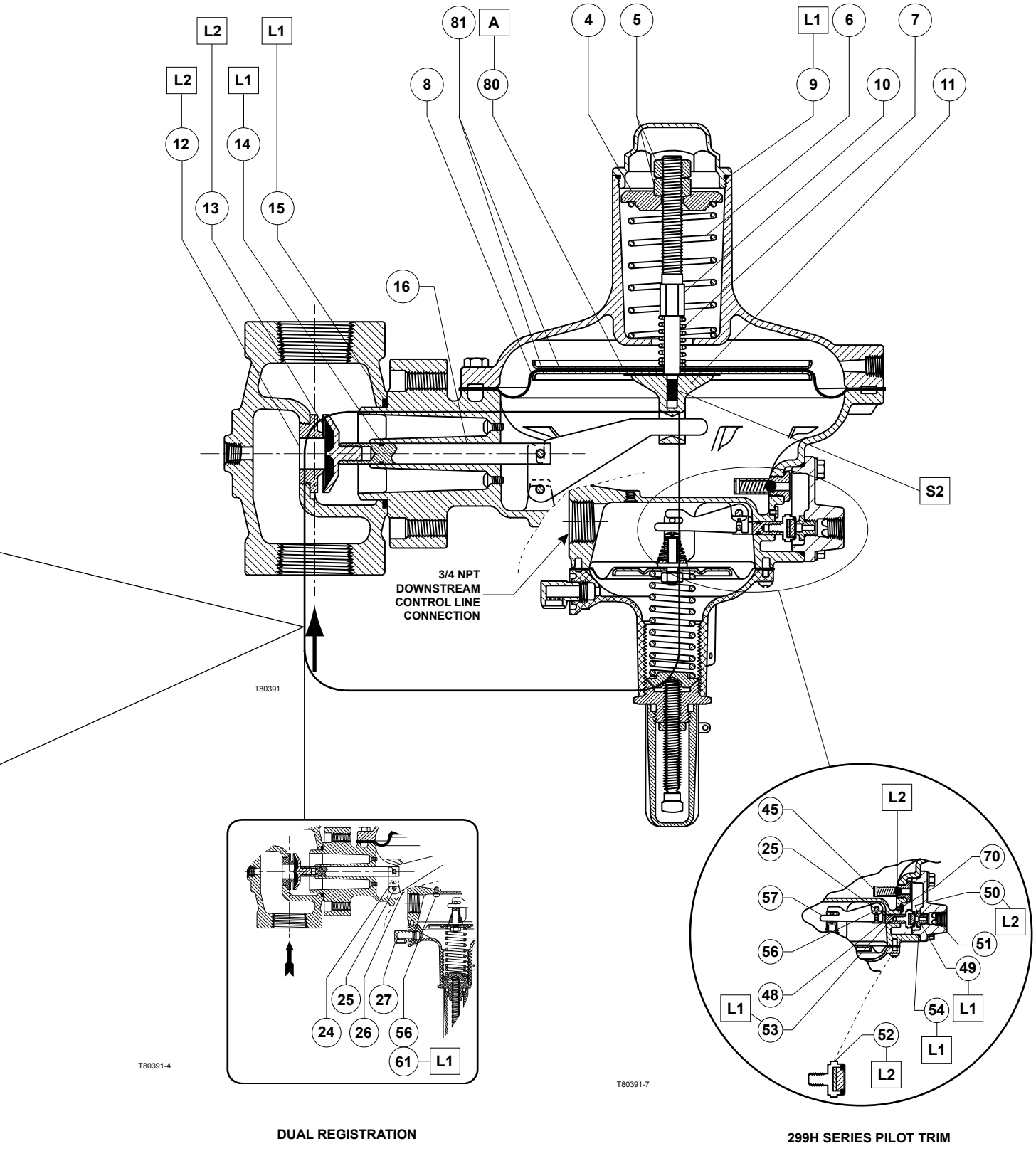
EXTERNAL REGISTRATION



INTERNAL REGISTRATION

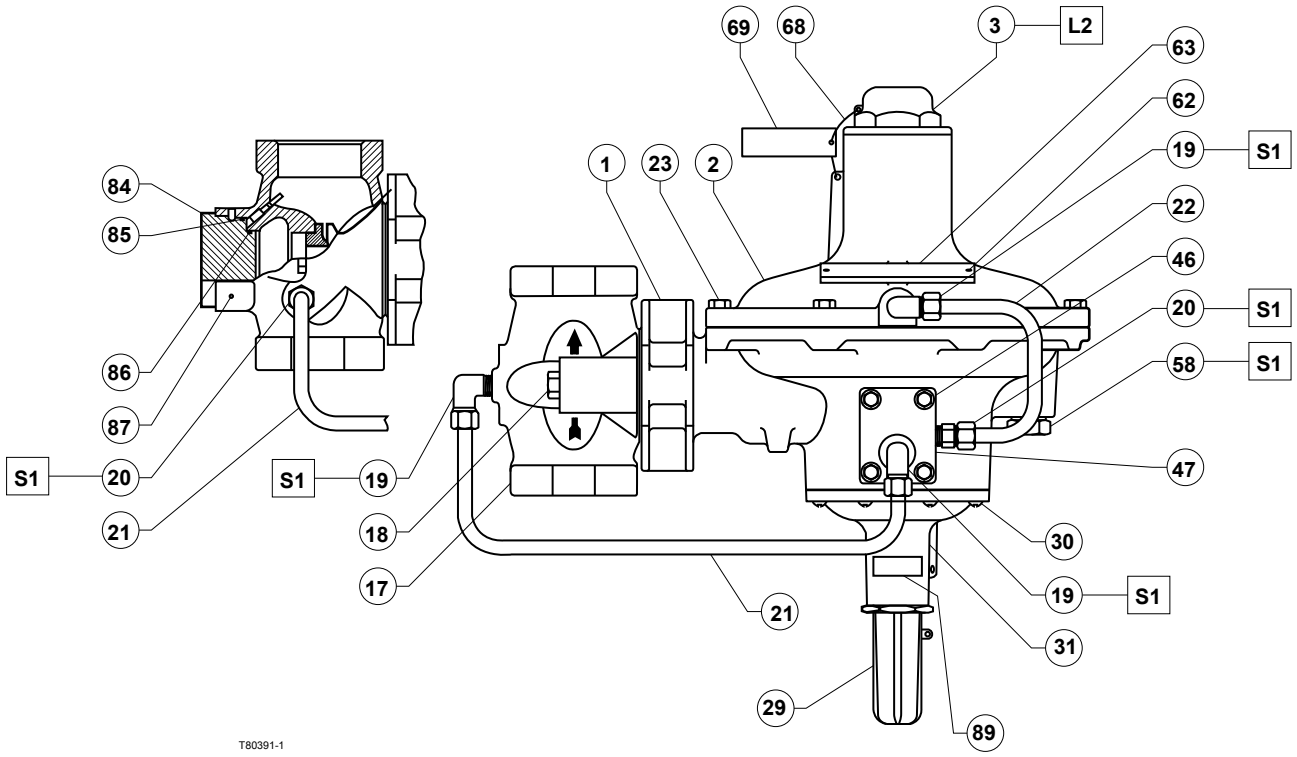
☐ **APPLY MULTI-PURPOSE LUBRICANT (L1) / MULTI-PURPOSE POLYTETRAFLUOROETHYLENE (PTFE) THREAD SEALANT (S1)**

Figure 3. *299H Series Interior Assembly*



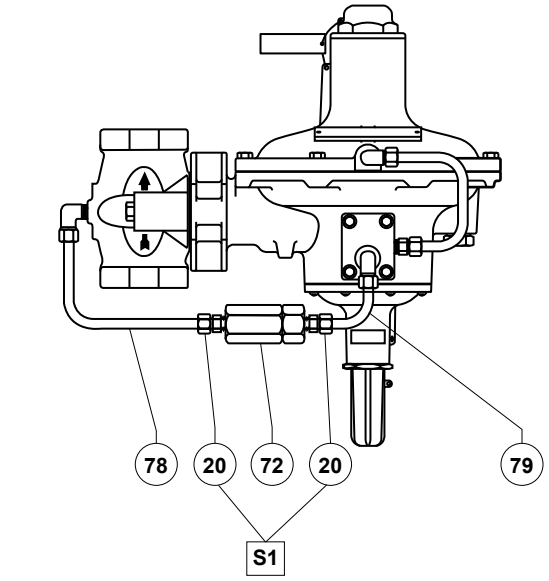
☐ APPLY MULTI-PURPOSE LUBRICANT (L1) / ANTI-SEIZE COMPOUND (L2) / THREAD LOCK SEALANT (S1) / ADHESIVE (A)

Figure 3. *299H Series Interior Assembly (continued)*

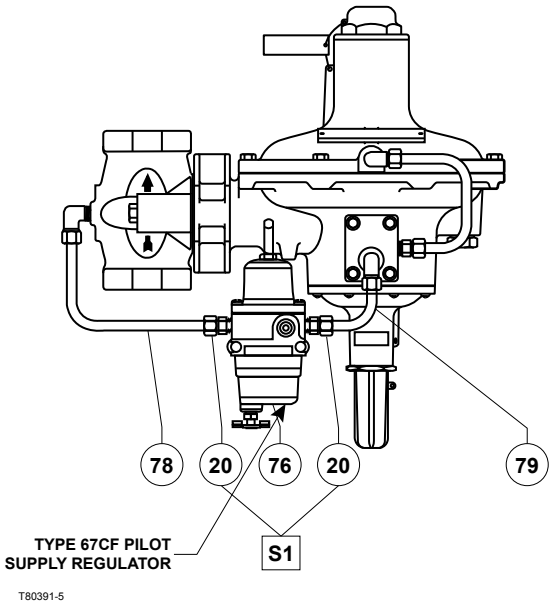


299H SERIES EXTERIOR VIEW

Figure 4. *299H Series Exterior Assembly*



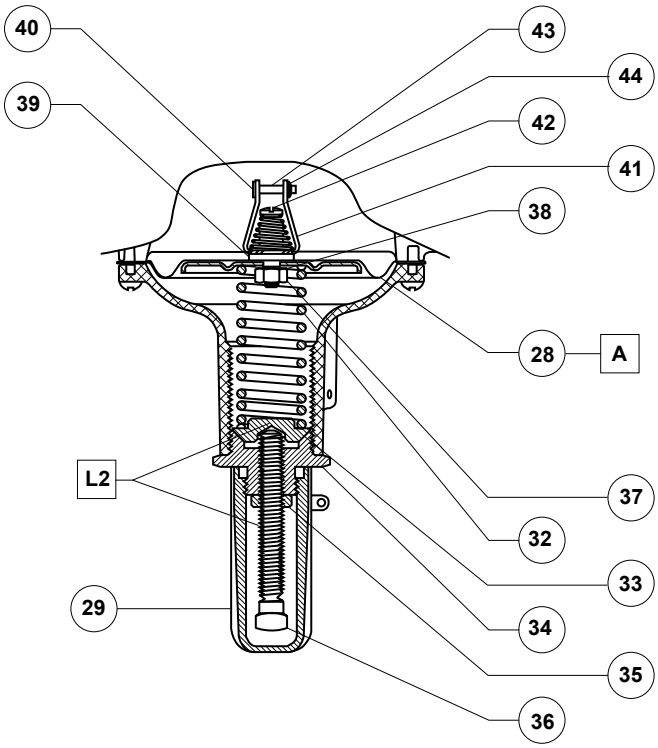
TUBING AND FITTINGS WITH OPTIONAL TYPE P590 FILTER



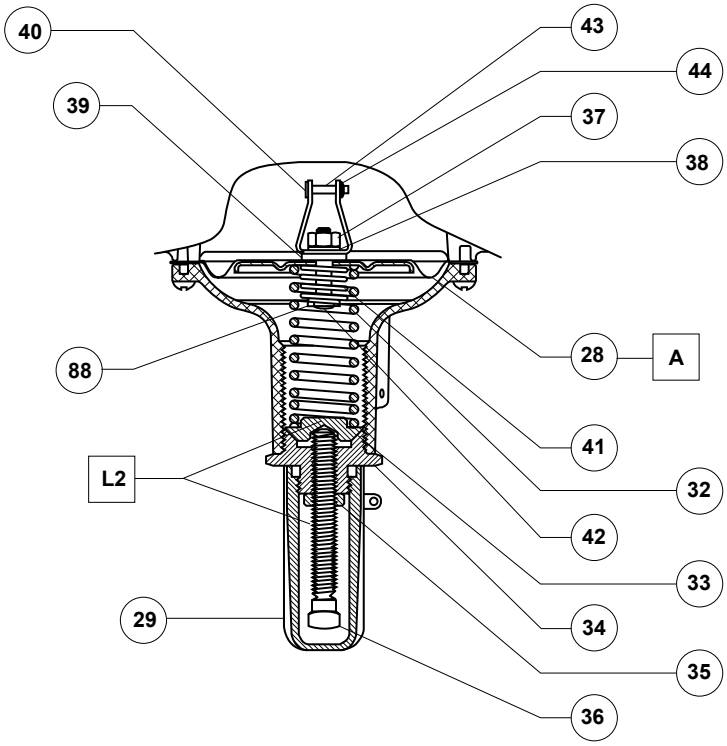
TUBING AND FITTINGS WITH OPTIONAL TYPE 67CF PILOT SUPPLY REGULATOR

☐ **APPLY ANTI-SEIZE COMPOUND (L2) / MULTI-PURPOSE PTFE THREAD SEALANT (S1).**

Figure 4. *299H Series Exterior Assembly (continued)*



TYPE 299H PILOT WITHOUT RELIEF VALVE



TYPE 299HR PILOT WITH TOKEN RELIEF VALVE

T80391-6

☐ APPLY ANTI-SEIZE COMPOUND (L2) / ADHESIVE (A)

Figure 5. *299H Series Pilot Assemblies*

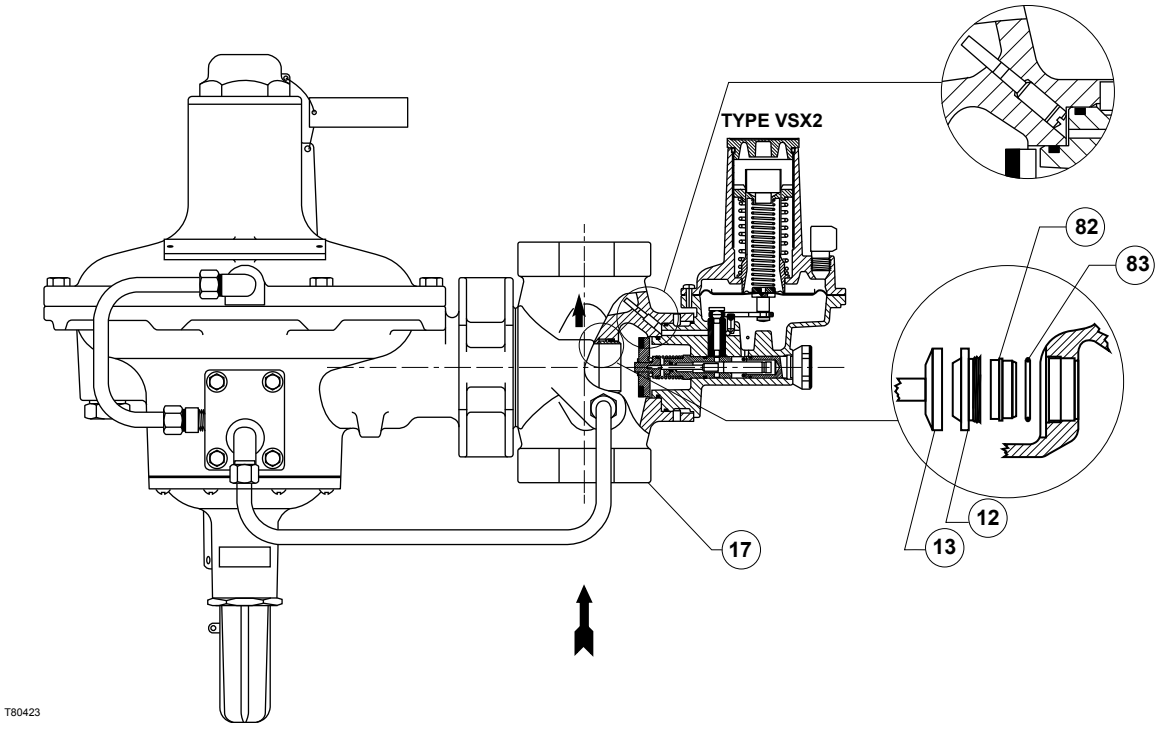


Figure 6a. *Type VSX2 Assembly (for Types 299HS and 299HSR)*

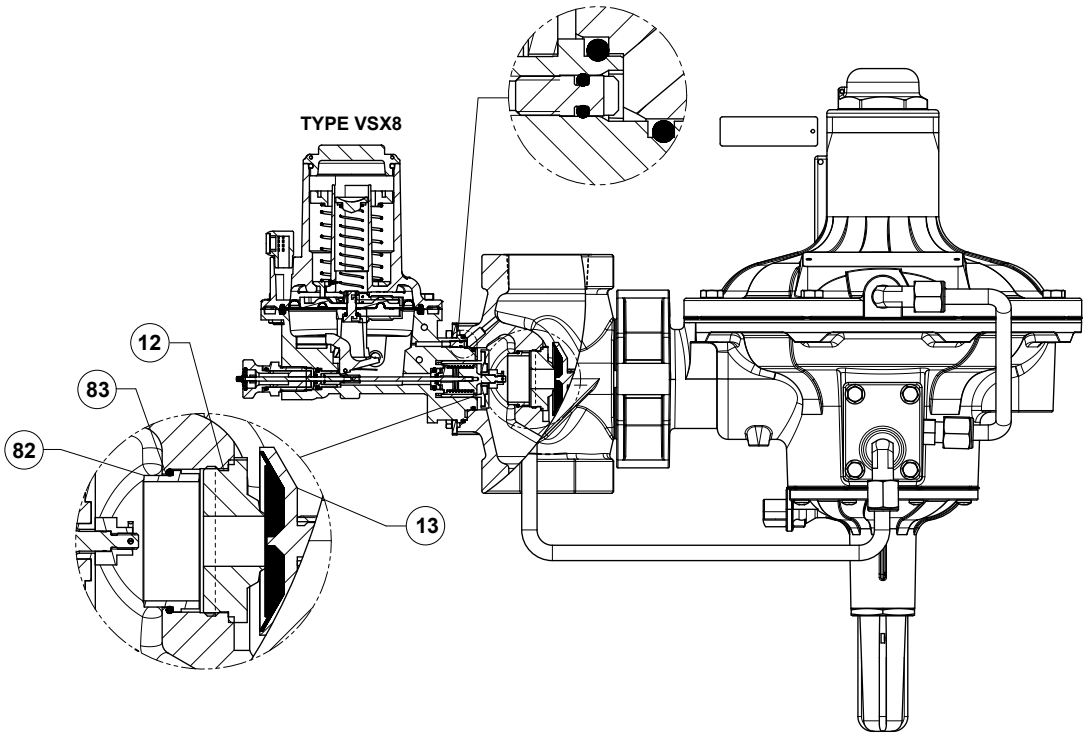


Figure 6b. *Type 299HV with Type VSX8 Assembly*

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The distinctive swirl pattern cast into every actuator casing uniquely identifies the regulator as part of the Fisher™ brand Commercial Service Regulator family and assures you of the highest-quality engineering, performance, and support traditionally associated with Fisher™, Francel™ and Tartarini™ regulators. Visit www.fishercommercialservice.com to access interactive applications.

EMERSON™

627 Series Pressure Reducing Regulators

WARNING

Failure to follow these instructions or to properly install and maintain this equipment could result in an explosion and/or fire causing property damage and personal injury or death.

Fisher® regulators must be installed, operated, and maintained in accordance with federal, state, and local codes, rules and regulations, and Emerson Process Management Regulator Technologies, Inc. (Regulator Technologies) instructions.

If the regulator vents gas or a leak develops in the system, service to the unit may be required. Failure to correct trouble could result in a hazardous condition.

Call a gas service person to service the unit. Only a qualified person must install or service the regulator.



W4793

Figure 1. *Typical 627 Direct-Operated Pressure Reducing Regulator*

Introduction

Scope of the Manual

This manual provides instructions for the installation, adjustment, maintenance, and parts ordering information for the 627 Series regulators. These regulators are usually shipped separate for line installation, although sometimes they are shipped installed on other equipment. Refer to the Instruction Manual of the other equipment for installation and operating instructions.

Description

The 627 Series direct-operated pressure reducing regulators (Figure 1) are for high and low pressure systems. These regulators can be used with natural gas, air, or a variety of other gases. Performance characteristics vary according to construction.

WARNING

Personal injury, property damage, equipment damage, or leakage due to escaping gas or bursting of pressure-containing parts may result if this regulator is overpressured or is installed where service conditions could exceed the limits given in the Specifications section, Tables 1, 2, 3, and 4, or where conditions exceed any ratings of the adjacent piping or piping connections.

To avoid such injury or damage, provide pressure-relieving or pressure-limiting devices (as required by the appropriate code, regulation, or standard) to prevent service conditions from exceeding

D101328X012

Specifications

The Specifications section gives some general specifications for the 627 Series regulators. The nameplates give detailed information for a particular regulator as it comes from the factory.

Available Constructions

Type 627: Direct-operated pressure reducing regulator equipped with a pitot tube for greater regulated capacities (Figure 7).
Type 627R: Type 627 with internal relief and with an open throat (Figure 8).
Type 627LR: Type 627R with light rate relief spring (Figure 9).
Type 627M: Type 627 with a stem seal between the body outlet pressure and diaphragm case. Pressure is measured under the diaphragm through the 1/4 NPT downstream control line connection (Figure 10).
Type 627MR: Type 627M with internal relief (Figure 11).
Type 627H: Type 627 with a diaphragm limiter to deliver a higher outlet pressure (Figure 12).
Type 627HM: Type 627H with a stem seal between the body outlet pressure and diaphragm case. Pressure is measured under the diaphragm through the 1/4 NPT downstream control line connection (Figure 13).

Body Sizes and End Connection Styles

BODY SIZE		END CONNECTION STYLE	CONSTRUCTION AVAILABLE
NPS	DN		
3/4	- - - -	NPT	All
1	25	NPT, CL150 RF, CL300 RF, CL600 RF, and Long Body	
2	50	NPT, CL150 RF, CL300 RF, CL600 RF, and Long Body	

Maximum Inlet Pressure(1) (Body Rating)
NPT Stainless Steel: 2000 psig / 138 bar
Flanged Stainless Steel: 1440 psig / 99.3 bar
NPT Steel: 2000 psig / 138 bar
Flanged Steel: 1500 psig / 103 bar
Ductile Iron: 1000 psig / 69.0 bar

Maximum Valve Disk Inlet Pressure Rating(1)
Nylon (PA) Disk: 2000 psig / 138 bar
Nitrile (NBR) Disk: 1000 psig / 69.0 bar
Fluorocarbon (FKM) Disk: 300 psig / 20.7 bar

Maximum Operating Inlet Pressure, Pressure Differential, and Outlet Pressure Ranges(1)
See Table 1 for pressures by orifice size and spring range

Maximum Spring and Diaphragm Casing Pressure(1)
See Table 2

Maximum Body Outlet Pressure(1)(2) (Types 627M, 627MR, and 627HM Only)
NPT Steel: 2000 psig / 138 bar
Flanged Steel: 1500 psig / 103 bar
Ductile Iron: 1000 psig / 69.0 bar

Orifice Sizes
See Table 1

Internal Relief Performance
Type 627R: See Table 3
Type 627LR: See Table 4
Type 627MR: Limited by field-installed control line piping

Elastomer Temperature Capabilities(1)(3)

MATERIAL	DISK/ DIAPHRAGM	TEMPERATURE	
		°F	°C
Nitrile (NBR)	Disk	-40 to 180	-40 to 82
	Diaphragm		
Fluorocarbon (FKM)	Disk	0 to 180	-18 to 82
	Diaphragm		
Nylon (PA)	Disk	-40 to 180	-40 to 82
Neoprene (CR) for Types 627H and 627HM only	Diaphragm	-40 to 180	-40 to 82

Flow Coefficients
See Table 5

IEC Sizing Coefficients
See Table 6

Pressure Registration
Type 627, 627H, 627R, or 627LR: Internal
Type 627M, 627HM, or 627MR: External through 1/4 NPT control line connection in the diaphragm casing

De-Icer System
See Figure 3 and Type 627M Regulator De-Icer System Application section

Relief Indicator
For Types 627R, 627LR, and 627MR (see Figures 8, 9, and 11)

Spring Case Vent Connection
3/4 NPT with removable screened vent assembly

Approximate Weights
Ductile Iron, Steel, or Stainless Steel Casings: 10 pounds / 4 kg
Aluminum Casings: 6.3 pounds / 3 kg

1. The pressure/temperature limits in this Instruction Manual or any applicable standard limitation should not be exceeded.
2. Types 627, 627H, 627R, and 627LR are limited by maximum diaphragm casing pressure.
3. Stainless steel body is rated to -40°F / -40°C. Steel and Ductile Iron bodies are rated to -20°F / -29°C.

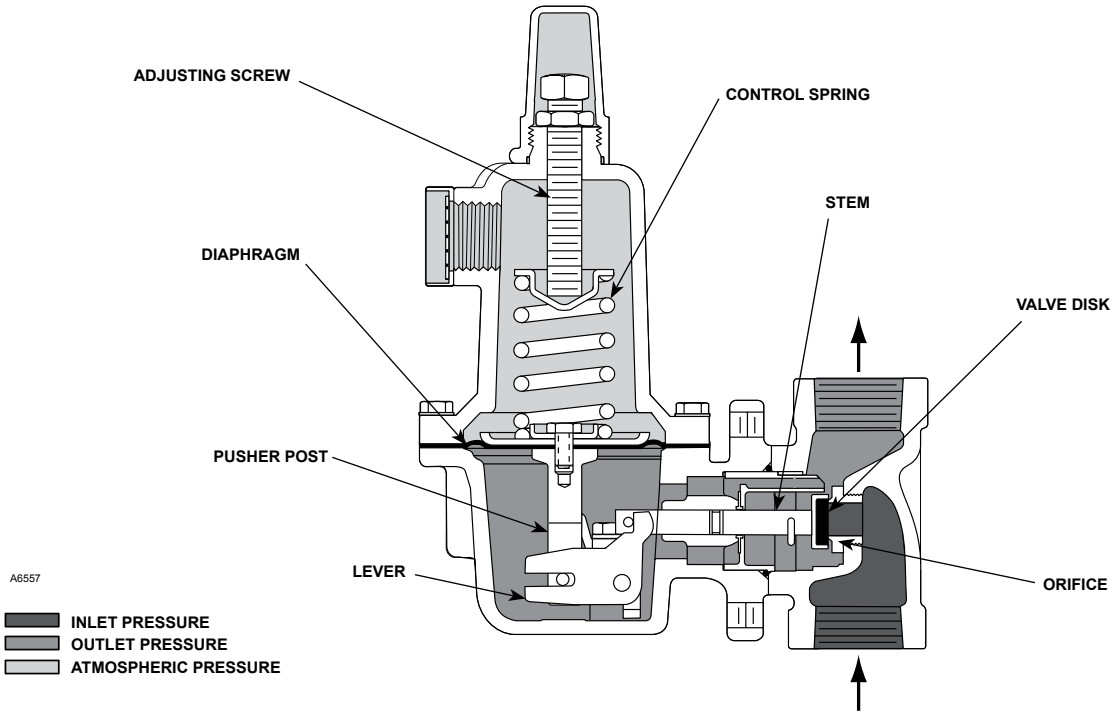


Figure 2. *Type 627 Operational Schematic*

those limits. The Type 627R, 627LR, or 627MR regulator with internal relief will provide downstream overpressure protection within the limits given in the Specifications section, Tables 1, 2, 3, and 4. If these limits are exceeded, additional downstream overpressure protection must be provided by the user.

Additionally, physical damage to the regulator could cause personal injury or property damage due to escaping gas. To avoid such injury or damage, install the regulator in a safe location.

Principle of Operation

Refer to Figure 2. When downstream demand decreases, the pressure under the diaphragm increases. This pressure overcomes the regulator setting (which is set by a spring). Through the action of the pusher post assembly, lever, and valve stem the valve disk moves closer to the orifice and reduces gas flow. If demand downstream increases, pressure under the diaphragm decreases. Spring force pushes the pusher post assembly downward and the valve disk moves away from the orifice.

Product Description

Types 627 and 627H Direct-Operated Pressure Reducing Regulators—The Types 627 and 627H regulators provide economical pressure reducing control for a variety of residential, commercial, and industrial applications. The regulator pitot tube located in a high velocity stream provides dynamic boost that compensates for outlet pressure drop.

Type 627 Long Body—The Type 627 Long Body regulator can be used as a drop-in replacement for existing Type 630 installations without the need to modify piping.

Internal Relief for Type 627R, 627LR, or 627MR Regulator—The Type 627R internal relief performance values were obtained **by removing the disk assembly** from the regulator. For the Type 627R, 627LR, or 627MR regulator, the internal relief across the diaphragm provides overpressure protection in many applications. As outlet pressures build up above the start-to-discharge point, the diaphragm moves off the relief valve seat allowing the excess pressure to bleed out through the screened vent.

For extra protection, should failure conditions exist which would prevent normal operation of the regulator

Table 1. *Maximum Inlet Pressures and Outlet Pressure Ranges*

TYPE	OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	ORIFICE SIZE		MAXIMUM INLET PRESSURE[1]					
				Nylon (PA) Disk		Nitrile (NBR) Disk		Fluorocarbon (FKM) Disk	
		Inches	mm	psig	bar	psig	bar	psig	bar
627 and 627M[3]	5[2] to 20 psig / 0.34 to 1.4 bar 10B3076X012 Yellow	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1000	69.0	1000	69.0	300	20.7
		3/16	4.8	750	51.7	750	51.7	300	20.7
		1/4	6.4	500	34.5	500	34.5	300	20.7
		3/8	9.5	300	20.7	300	20.7	300	20.7
		1/2	13	250	17.2	250	17.2	250	17.2
	15 to 40 psig / 1.0 to 2.8 bar 10B3077X012 Green	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1500	103	1000	69.0	300	20.7
		3/16	4.8	1000	69.0	1000	69.0	300	20.7
		1/4	6.4	750	51.7	750	51.7	300	20.7
		3/8	9.5	500	34.5	500	34.5	300	20.7
		1/2	13	300	20.7	300	20.7	300	20.7
	35 to 80 psig / 2.4 to 5.5 bar 10B3078X012 Blue	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	2000	138	1000	69.0	300	20.7
		3/16	4.8	1750	121	1000	69.0	300	20.7
		1/4	6.4	1500	103	1000	69.0	300	20.7
		3/8	9.5	1000	69.0	1000	69.0	300	20.7
		1/2	13	750	51.7	750	51.7	300	20.7
	70 to 150 psig / 4.8 to 10.3 bar 10B3079X012 Red	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	2000	138	1000	69.0	300	20.7
		3/16	4.8	2000	138	1000	69.0	300	20.7
		1/4	6.4	1750	121	1000	69.0	300	20.7
		3/8	9.5	1250	86.2	1000	69.0	300	20.7
		1/2	13	750	51.7	750	51.7	300	20.7
627R and 627MR	5[2] to 20 psig / 0.34 to 1.4 bar 10B3076X012 Yellow	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1000	69.0	1000	69.0	300	20.7
		3/16	4.8	750	51.7	750	51.7	300	20.7
		1/4	6.4	500	34.5	500	34.5	300	20.7
		3/8	9.5	300	20.7	300	20.7	300	20.7
		1/2	13	200	13.8	200	13.8	200	13.8
	15 to 40 psig / 1.0 to 2.8 bar 10B3077X012 Green	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1500	103	1000	69.0	300	20.7
		3/16	4.8	1000	69.0	1000	69.0	300	20.7
		1/4	6.4	750	51.7	750	51.7	300	20.7
		3/8	9.5	300	20.7	300	20.7	300	20.7
		1/2	13	200	13.8	200	13.8	200	13.8
	35 to 80 psig / 2.4 to 5.5 bar 10B3078X012 Blue	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1750	121	1000	69.0	300	20.7
		3/16	4.8	1000	69.0	1000	69.0	300	20.7
		1/4	6.4	750	51.7	750	51.7	300	20.7
		3/8	9.5	300	20.7	300	20.7	300	20.7
		1/2	13	200	13.8	200	13.8	200	13.8
	70 to 150 psig / 4.8 to 10.3 bar 10B3079X012 Red	3/32	2.4	2000	138	1000	69.0	300	20.7
		1/8	3.2	1000	69.0	1000	69.0	300	20.7
		3/16	4.8	500	34.5	500	34.5	300	20.7
		1/4	6.4	300	20.7	300	20.7	300	20.7
		3/8	9.5	200	13.8	200	13.8	200	13.8
		1/2	13	200	13.8	200	13.8	200	13.8
627LR	15 to 40 psig / 1.0 to 2.8 bar 10B3077X012 Green	3/32	2.4			1000	69.0	300	20.7
		1/8	3.2			1000	69.0	300	20.7
		3/16	4.8			750	51.7	300	20.7
		1/4	6.4			500	34.5	300	20.7
627H and 627HM[3]	140 to 250 psig / 9.7 to 17.2 bar 10B3078X012 Blue	3/32	2.4	2000	138	1000	69.0		
		1/8	3.2	2000	138	1000	69.0		
		3/16	4.8	1750	121	1000	69.0		
		1/4	6.4	1500	103	1000	69.0		
		3/8	9.5	1000	69.0	750	51.7		
		1/2	13	750	51.7	500	34.5		
	240 to 500 psig / 16.5 to 34.5 bar 10B3079X012 Red	3/32	2.4	2000	138	1000	69.0		
		1/8	3.2	2000	138	1000	69.0		
		3/16	4.8	1750	121	1000	69.0		
		1/4	6.4	1500	103	1000	69.0		
		3/8	9.5	1000	69.0	1000	69.0		
		1/2	13	750	51.7	750	51.7		

1. For inlet pressure in excess of 1000 psig / 69.0 bar, refer to the maximum body and disk pressure ratings in the Specifications section.
2. For pressure settings under 10 psig / 0.69 bar, inlet pressure should be limited to approximately 100 psig / 6.9 bar so the setpoint adjustment can be obtained.
3. The unbalance forces change from the wide-open monitor mode to an active regulator mode such that the Type 627M or 627HM should have a 3/8 inch / 9.5 mm or larger orifice.

▭ - Shaded areas indicate that Fluorocarbon (FKM) and Nylon (PA) disk material are not available.

Table 2. *Maximum Spring and Diaphragm Casing Pressure*[1]

MAXIMUM PRESSURE DESCRIPTION	DIAPHRAGM CASING MATERIAL	TYPE 627		TYPES 627R AND 627LR		TYPE 627M		TYPE 627MR		TYPES 627H AND 627HM	
		psig	bar	psig	bar	psig	bar	psig	bar	psig	bar
Maximum pressure to spring and diaphragm casings to prevent leak to atmosphere other than relief action (internal parts damage may occur)	Die cast aluminum	250	17.2	250	17.2	Not Available		Not Available		Not Available	
	Ductile iron					250	17.2				
	Steel or Stainless steel							250	17.2	800	55.2
Maximum pressure to spring and diaphragm casings to prevent burst of casings during abnormal operation (leak to atmosphere and internal parts damage may occur)	Die cast aluminum	375	25.9	375	25.9	Not Available		Not Available		Not Available	
	Ductile iron	465	32.1	465	32.1	465	32.1	465	32.1		
	Steel or Stainless steel	1500	103	1500	103	1500	103	1500	103	1500	103
Maximum diaphragm casing overpressure (above setpoint) to prevent damage to internal parts	All materials	60	4.1	120	8.3	60	4.1	120	8.3	120	8.3

1. If the spring case is pressurized, a metal adjusting screw cap is required. Contact your local Sales Office for details.

(for example, disk broken off or disk erosion), the pusher post contacts the lever retainer causing the relief valve assembly to open. Since the diaphragm continues to rise as downstream pressure builds, it opens the relief valve; thereby, opening the valve. This internal relief may be adequate for the application.

Downstream Control Line for Type 627M, 627HM, or 627MR Regulator—A Type 627M, 627HM, or 627MR regulator has a blocking throat stem seal with O-rings and a 1/4 NPT control line connection in the diaphragm case. A regulator with a downstream control line is used for monitoring applications or other applications where other equipment is installed between the regulator and the pressure control point. The stem seal separates the body outlet pressure from the diaphragm case.

Installation

Regulator operation within ratings does not preclude the possibility of damage from debris in the lines or from external sources. A regulator should be inspected for damage periodically and after any overpressure condition. Key numbers referenced in this section are shown in Figures 7 through 13. Ensure that the operating temperature capabilities listed in Specifications section are not exceeded.

Note

If the regulator is shipped mounted on another unit, install that unit according to the appropriate Instruction Manual.

Perform steps 1 through 6 for all types of regulators:

1. Only personnel qualified through training and experience should install, operate, or maintain this regulator.
2. For a regulator that is shipped separately, make sure that there is no damage to or foreign material in the regulator.
3. Ensure that all tubing and piping have been blown free of foreign debris.
4. The regulator may be installed in any position as long as the flow through the body is in the direction indicated by the arrow cast on the body.
5. If continuous operation is required during inspection or maintenance, install a three-valve bypass around the regulator.

WARNING

A regulator may vent some gas to the atmosphere. In hazardous or flammable gas service, vented gas may accumulate and cause personal injury, death, or property damage due to fire or explosion. Vent a regulator in hazardous gas service to a remote, safe location away from air intakes or any hazardous area. The vent line or stack opening must be protected against condensation or clogging.

6. Position the body (key 1) and/or diaphragm spring case (key 29) so it will not collect moisture or debris into the screened vent. If the regulator requires repositioning, refer to the Body Area Maintenance Procedures and/or the Diaphragm and Spring Case Area Maintenance Procedures in the Maintenance section to reposition the screened vent for the application.

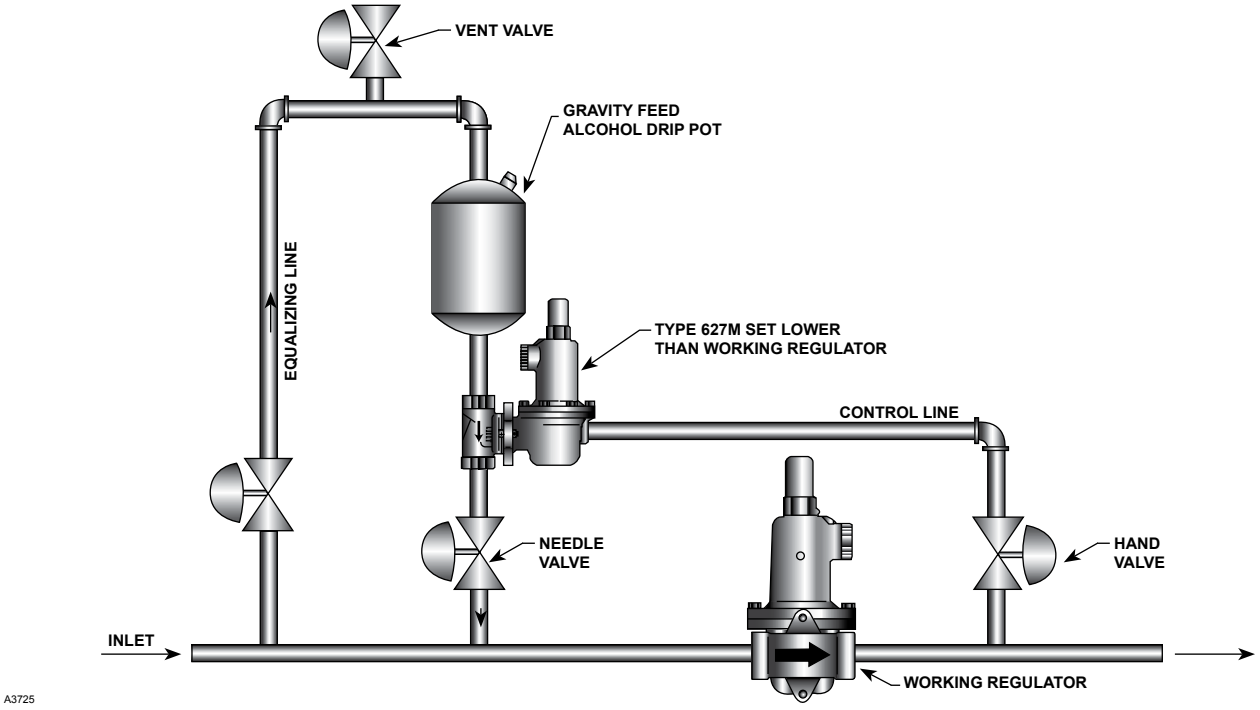


Figure 3. *De-Icer System Operational Schematic*

Perform steps 7 through 9 for Types 627M, 627HM, and 627MR regulators only:

7. A Type 627M, 627HM, or 627MR regulator requires a downstream control line. Install the control line before putting the regulator into operation.
8. Ensure that the downstream control line piping is at least 3/8 inch / 9.5 mm or larger outside diameter tubing and connected to a straight section of outlet piping 10 diameters downstream of the regulator.
9. A hand valve should be installed in the control line. This hand valve can be used to throttle down and dampen outlet pulsations in control pressure which may cause instability or cycling of the regulator.

Remote Vent Line Installation

All 627 Series regulators have a vent assembly installed in the 3/4 NPT spring case vent opening. The vent assembly can be removed to install a remote vent line if necessary. Remote vent lines must have the largest practical diameter. It should be as short as possible with minimum number of bends or elbows.

Protect the remote vent opening against entrance of rain, snow, or any other foreign material that may plug the vent or vent line and prevent proper operation of the regulator. Periodically check the vent opening to be sure it is not plugged with foreign debris.

Type 627M or 627HM Regulator De-Icer System Application

For the Type 627M or 627HM regulator de-icer system, refer to the application shown in Figure 3. With a large pressure drop across the working regulator, ice can form within this regulator. The formation of ice decreases the size of the orifice, so the regulator is unable to supply enough flow to satisfy the downstream demand. When the downstream pressure falls below the outlet pressure setting of the Type 627M or 627HM regulator, the disk assembly of the Type 627M or 627HM regulator moves off its orifice, permitting alcohol to flow into the main gas line. The alcohol carried to the main regulator by the flowstream prevents additional ice from forming on the orifice. When normal flow resumes, and as pressure in the downstream system is restored, the Type 627M or 627HM regulator shuts off.

Overpressure Protection

627 Series regulators have outlet pressure ratings that are lower than their inlet pressure ratings. A pressure-

Table 3. *Type 627R Internal Relief Performance*[1]

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING		MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE		MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED[2]											
					Orifice Size, Inches / mm											
					3/32 / 2.4		1/8 / 3.2		3/16 / 4.8		1/4 / 6.4		3/8 / 9.5		1/2 / 13	
	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar
5[3] to 20 psig / 0.34 to 1.4 bar 10B3076X012 Yellow	10	0.69	60	4.1	1250	86.2	740	51.0	320	22.1	190	13.1	95	6.6	75	5.2
			100	6.9	2000	138	1500	103	620	42.7	390	26.9	180	12.4	130	9.0
			125	8.6	2000	138	1900	131	830	57.2	480	33.1	220	15.2	160	11.0
			175	12.1	2000	138	2000	138	1100	75.8	670	46.2	320	22.1	220	15.2
			200	13.8	2000	138	2000	138	1300	89.6	770	53.1	360	24.8	260	17.9
			250	17.2	2000	138	2000	138	1600	110	960	66.2	450	31.0	320	22.1
	15	1.0	60	4.1	1000	69.0	620	42.7	260	17.9	170	11.7	90	6.2	70	4.8
			100	6.9	2000	138	1400	96.5	610	42.1	370	25.5	170	11.7	130	9.0
			125	8.6	2000	138	1900	131	810	55.8	480	33.1	220	15.2	160	11.0
			175	12.1	2000	138	2000	138	1100	75.8	670	46.2	320	22.1	220	15.2
			200	13.8	2000	138	2000	138	1300	89.6	770	53.1	360	24.8	260	17.9
			250	17.2	2000	138	2000	138	1600	110	960	66.2	450	31.0	320	22.1
	20	1.4	60	4.1	850	58.6	490	33.8	210	14.5	130	9.0	80	5.5	65	4.5
			100	6.9	2000	138	1300	89.6	600	41.4	360	24.8	170	11.7	120	8.3
			125	8.6	2000	138	1800	124	800	55.2	480	33.1	220	15.2	160	11.0
			175	12.1	2000	138	2000	138	1100	75.8	670	46.2	320	22.1	220	15.2
			200	13.8	2000	138	2000	138	1300	89.6	770	53.1	360	24.8	260	17.9
			250	17.2	2000	138	2000	138	1600	110	960	66.2	450	31.0	320	22.1
15 to 40 psig / 1.0 to 2.8 bar 10B3077X012 Green	15	1.0	60	4.1	1000	69.0	380	26.2	210	14.5	130	9.0	80	5.5	65	4.5
			100	6.9	2000	138	1300	89.6	590	40.7	350	24.1	170	11.7	120	8.3
			125	8.6	2000	138	1800	124	800	55.2	470	32.4	220	15.2	160	11.0
			175	12.1	2000	138	2000	138	1100	75.8	640	44.1	320	22.1	220	15.2
			200	13.8	2000	138	2000	138	1300	89.6	780	53.8	370	25.5	260	17.9
			250	17.2	2000	138	2000	138	1600	66.2	960	66.2	450	31.0	320	22.1
	20	1.4	60	4.1	630	43.4	200	13.8	150	10.3	100	6.9	70	4.8	65	4.5
			100	6.9	2000	138	1200	82.7	550	37.9	330	22.8	160	11.0	120	8.3
			125	8.6	2000	138	1700	117	760	52.4	450	31.1	210	14.5	160	11.0
			175	12.1	2000	138	2000	138	1100	75.8	630	43.4	320	22.1	220	15.2
			200	13.8	2000	138	2000	138	1300	89.6	770	53.1	360	24.8	260	17.9
			250	17.2	2000	138	2000	138	1600	66.2	960	66.2	460	31.7	320	22.1
	30	2.1	100	6.9	2000	138	950	65.5	450	31.1	260	17.9	140	9.7	110	7.6
			125	8.6	2000	138	1500	103	670	46.2	400	27.6	190	13.1	150	10.3
			175	12.1	2000	138	2000	138	1000	69.0	610	42.1	300	20.7	220	15.2
			200	13.8	2000	138	2000	138	1200	82.7	760	52.4	360	24.8	260	17.9
			250	17.2	2000	138	2000	138	1600	110	970	66.9	460	31.7	320	22.1
	40	2.8	100	6.9	1500	103	700	48.3	330	22.8	200	13.8	120	8.3	108	7.4
			125	8.6	2000	138	1300	89.6	560	38.6	340	23.4	180	12.4	140	9.7
			175	12.1	2000	138	1800	124	1000	69.0	550	37.9	290	20.0	220	15.2
			200	13.8	2000	138	2000	138	1200	82.7	730	50.3	350	24.1	250	17.2
			250	17.2	2000	138	2000	138	1600	110	970	66.9	460	31.7	320	22.1

1. The internal relief performance values are obtained by removing the disk assembly.
2. For inlet pressures in excess of 1000 psig / 69.0 bar, refer to the maximum body and disk pressure ratings in the Specifications section.
3. For pressure settings under 10 psig / 0.69 bar, inlet pressure should be limited to approximately 100 psig / 6.9 bar so the setpoint adjustment can be obtained.

▭ - Shaded areas indicate maximum inlet pressures allowed during system malfunction only. Table 1 gives the maximum inlet pressure for normal regulator operation.

- continued -

relieving or pressure-limiting device must be provided by the user for the Types 627, 627H, 627M, and 627HM regulators if the inlet pressure can exceed the outlet pressure rating, since these regulators do not have internal relief.

Types 627R and 627LR regulators provide internal relief which limits the total outlet pressure buildup over setpoint. Use Tables 3 and 4 to determine the total outlet pressure. This internal relief may be adequate for the application, if not, provide additional pressure relief or a pressure-limiting device downstream.

Startup and Adjustment

Startup

WARNING

To avoid personal injury or property damage due to explosion or damage to regulator or downstream components during startup, release downstream

Table 3. *Type 627R Internal Relief Performance[1] (continued)*

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING		MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE		MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED[2][3]											
					Orifice Size, Inches / mm											
					3/32 / 2.4		1/8 / 3.2		3/16 / 4.8		1/4 / 6.4		3/8 / 9.5		1/2 / 13	
	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar
35 to 80 psig / 2.4 to 5.5 bar 10B3078X012 Blue	40	2.8	125	8.6	2000	138	1100	75.8	500	34.5	300	20.7	170	11.7	140	9.7
			150	10.3	2000	138	1600	110	750	51.7	440	30.3	230	15.9	180	12.4
			175	12.1	2000	138	2000	138	980	67.6	580	40.0	290	20.0	220	15.2
			200	13.8	2000	138	2000	138	1200	82.7	720	49.6	340	23.4	250	17.2
			250	17.2	2000	138	2000	138	1600	110	940	64.8	450	31.0	320	22.1
	50	3.4	125	8.6	1400	96.5	820	56.5	400	27.6	230	15.9	150	10.3	140	9.7
			150	10.3	2000	138	1400	96.5	650	44.8	370	25.5	210	14.5	170	11.7
			175	12.1	2000	138	1900	131	700	48.3	530	36.5	270	18.6	210	14.5
			200	13.8	2000	138	2000	138	1100	75.8	670	46.2	330	22.8	240	16.5
			250	17.2	2000	138	2000	138	1500	103	920	63.4	430	29.6	320	22.1
	60	4.1	125	8.6	900	62.1	450	31.0	270	18.6	190	13.1	140	9.7	130	9.0
			150	10.3	1700	117	1100	75.8	540	37.2	300	20.7	190	13.1	160	11.0
			175	12.1	2000	138	1700	117	780	53.8	470	32.4	250	17.2	200	13.8
			200	13.8	2000	138	2000	138	1000	69.0	610	42.1	310	21.4	230	15.9
			250	17.2	2000	138	2000	138	1400	96.5	880	60.7	420	29.0	310	21.4
	70	4.8	150	10.3	1200	82.7	850	58.6	430	29.6	250	17.2	170	11.7	160	11.0
			175	12.1	2000	138	1400	96.5	670	46.2	400	27.6	230	15.9	190	13.1
			200	13.8	2000	138	2000	138	920	63.4	550	37.9	280	19.3	230	15.9
			250	17.2	2000	138	2000	138	1300	89.6	830	57.2	400	27.6	310	21.4
	80	5.5	150	10.3	800	55.2	500	34.5	300	20.7	200	13.8	160	11.0	150	10.3
			175	12.1	1500	103	1200	82.7	550	37.9	330	22.8	210	14.5	190	13.1
			200	13.8	2000	138	1700	117	800	55.2	480	33.1	270	18.6	220	15.2
			250	17.2	2000	138	2000	138	1200	82.7	770	53.1	390	26.9	300	20.7
70 to 150 psig / 4.8 to 10.3 bar 10B3079X012 Red	70	4.8	175	12.1	1900	131	600	41.4	400	27.6	260	17.9	200	13.8	175	12.1
			200	13.8	2000	138	1200	82.7	630	43.4	380	26.2	250	17.2	210	14.5
			250	17.2	2000	138	2000	138	1100	75.8	680	46.9	360	24.8	290	20.0
	80	5.5	175	12.1	1400	96.5	250	17.2	240	16.5	200	13.8	190	13.1	175	12.1
			200	13.8	2000	138	960	66.2	520	35.9	330	22.8	240	16.5	210	14.5
			250	17.2	2000	138	2000	138	1000	69.0	620	42.7	350	24.1	280	19.3
	100	6.9	200	13.8	1500	103	250	17.2	240	16.5	230	15.9	210	14.5	210	14.5
			250	17.2	2000	138	1600	110	770	53.1	520	35.9	320	22.1	270	18.6
	125	8.6	250	17.2	2000	138	1000	69.0	500	34.5	390	26.9	290	20.0	260	17.9
	150	10.3	250	17.2	1200	82.7	260	17.9	260	17.9	260	17.9	260	17.9	260	17.9

1. The internal relief performance values are obtained by removing the disk assembly.
2. For inlet pressures in excess of 1000 psig / 69.0 bar, refer to the maximum body and disk pressure ratings in the Specifications section.
3. For pressure settings under 10 psig / 0.69 bar, inlet pressure should be limited to approximately 100 psig / 6.9 bar so the setpoint adjustment can be obtained.

▭ - Shaded areas indicate maximum inlet pressures allowed during system malfunction only. Table 1 gives the maximum inlet pressure for normal regulator operation.

Table 4. *Type 627LR Internal Relief Performance[1]*

OUTLET PRESSURE RANGE, SPRING PART NUMBER, AND COLOR CODE	OUTLET PRESSURE SETTING		MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE		MAXIMUM INLET PRESSURE TO KEEP MAXIMUM ALLOWABLE DOWNSTREAM SYSTEM PRESSURE FROM BEING EXCEEDED[2]							
					Orifice Size, Inches / mm							
					3/32 / 2.4		1/8 / 3.2		3/16 / 4.8		1/4 / 6.4	
	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar	psig	bar
15 to 40 psig / 1.03 to 2.8 bar 10B3077X012 Green	30	2.1	55	3.8	500	34.5	270	18.6	110	7.6	80	5.5
			60	4.1	850	58.6	480	33.1	200	13.8	120	8.3
			66	4.5	1000	69.0	660	45.5	290	20.0	175	12.1
	40	2.8	66	4.5	380	26.2	190	13.1	85	5.9	80	5.5
			70	4.8	700	48.3	370	25.5	150	10.3	115	7.9
			75	5.2	1000	69.0	560	38.6	240	16.5	160	11.0

1. The internal relief performance values are obtained by removing the disk assembly.
2. For inlet pressures in excess of 1000 psig / 69.0 bar, refer to the maximum body and disk pressure ratings in the Specifications section.

Table 5. *Flow Coefficients*

ORIFICE		3/4 NPT			NPS 1 / DN 25 BODY			NPS 2 / DN 50 BODY		
Inch	mm	Wide-Open C_g for External Relief Sizing	Wide-Open C_v for External Relief Sizing	C_1	Wide-Open C_g for External Relief Sizing	Wide-Open C_v for External Relief Sizing	C_1	Wide-Open C_g for External Relief Sizing	Wide-Open C_v for External Relief Sizing	C_1
3/32	2.4	6.9	0.24	29.2	6.9	0.24	28.5	6.9	0.23	29.7
1/8	3.2	12.5	0.43	29.1	12.5	0.43	29.4	12.5	0.42	29.5
3/16	4.8	29	1.01	28.6	29	0.93	31.2	29	1.02	28.5
1/4	6.4	50	1.63	30.6	50	1.71	29.3	52	1.66	31.3
3/8	9.5	108	2.99	36.1	108	3.42	31.6	115	3.39	33.9
1/2	13	190	4.87	39.0	190	5.29	35.9	200	5.01	39.9

Table 6. *IEC Sizing Coefficients*

ORIFICE SIZE		X_T			F_D	F_L
Inch	mm	3/4 NPT Body	NPS 1 / DN 25 Body	NPS 2 / DN 50 Body		
3/32	2.4	0.539	0.514	0.558	0.50	0.85
1/8	3.2	0.536	0.547	0.539		0.79
3/16	4.8	0.517	0.616	0.514		0.85
1/4	6.4	0.592	0.543	0.620		0.87
3/8	9.5	0.824	0.632	0.727		0.89
1/2	13	0.962	0.815	1.01		0.86

Table 7. *Maximum Torque Values*

KEY NUMBER(1)	DESCRIPTION	MAXIMUM TORQUE	
		FOOT-POUNDS	N•m
2	Orifice	25	34
3	Cap screw (with aluminum diaphragm casing)	16	22
	Cap screw (with ductile iron or steel/stainless steel diaphragm casing)	25	34
18	Lever cap screw	7	9.5
22	Diaphragm connector nut	17	23
26	Guide retainer (for Types 627R, 627LR, and 627MR only)	3	4.1
37	Spring case cap screw (with aluminum or ductile iron diaphragm casing)	7	9.5
	Spring case cap screw (with steel/stainless steel diaphragm casing)	35	47
46	Diaphragm cap screw (with Type 627 or 627M)	7	9.5
	Diaphragm cap screw (with Type 627H or 627HM)	14	19

1. Refer to Figures 7 through 13 for key number locations.

pressure to prevent an overpressure condition on the diaphragm of the regulator.

In order to avoid an overpressure condition and possible equipment damage, pressure gauges should always be used to monitor pressures during startup.

1. Slowly open the upstream shut-off valve.
2. Slowly open the downstream shut-off valve.
3. Check all connections for leaks.
4. Make final control spring adjustments according to the adjustment procedures.

Adjustment

The range of allowable pressure settings is marked on the nameplate. If a pressure setting beyond this range is necessary, substitute the appropriate regulator control spring. Change the nameplate to indicate the new pressure range.

Before increasing the setting, refer to Table 1, 2, 3, or 4. Review the pressure limits for the control spring range being used and be certain that the new pressure setting will not result in an overpressure condition.

Note

Always use a pressure gauge to monitor pressure when making adjustments.

Refer to Figures 7 through 13 for key number locations.

1. Remove the adjusting screw cap (key 36).
2. Loosen the locknut (key 34).
3. Increase the outlet pressure setting by turning the adjusting screw (key 35) clockwise. Decrease the outlet pressure setting by turning the adjusting screw counterclockwise.
4. When the desired pressure is obtained, hold the adjusting screw (key 35) in place and tighten the locknut (key 34).

Shutdown

WARNING

To avoid personal injury or property damage due to explosion or damage to regulator or downstream components during shutdown, release downstream pressure to prevent an overpressure condition on the diaphragm of the regulator.

1. Close the nearest upstream shut-off valve.
2. Close the nearest downstream shut-off valve.
3. Open the vent valve between the regulator and the downstream shut-off valve nearest to it.
4. For a Type 627, 627H, 627R, or 627LR regulator, the regulator will open to release pressure between the upstream shut-off valve and the regulator.
5. A Type 627M, 627HM, or 627MR regulator requires venting the control line and downstream pressure from the regulator before maintenance. The pressure between these shut-off valves is released through the open regulator because the disk assembly remains open in response to the decrease in control line pressure.

Maintenance

Unless otherwise specified, the following maintenance procedures apply to all types of regulators. For a summary of maximum torque values required for all types of regulators, refer to Table 7.

Due to normal wear, damage from external sources, or debris in the air or gas line, regulator parts such as the disk assembly, orifice, and diaphragm must be inspected periodically and replaced as necessary to ensure correct performance. The frequency of inspection and replacement depends upon the severity of conditions and the requirements of state and federal laws. Normal wear of the orifice and disk assembly is accelerated with high pressure drops and with large amounts of impurities in the flowstream. Instructions are given below for replacing the disk assembly, orifice, diaphragm, and O-rings. These procedures may also be used for disassembly required for inspection and replacement of other parts.



Figure 4. *Relief Indicator*

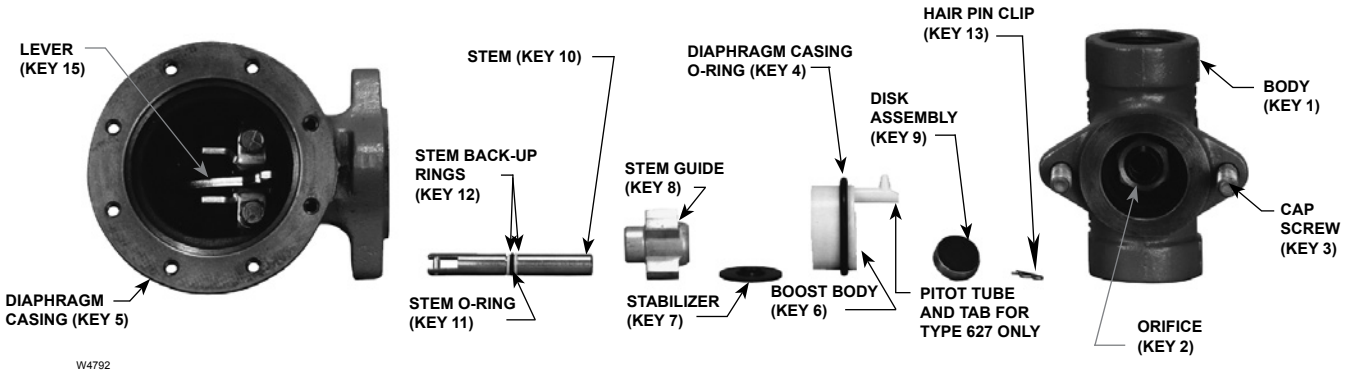
Problem Indication for Types 627R, 627LR, and 627MR Regulators

WARNING

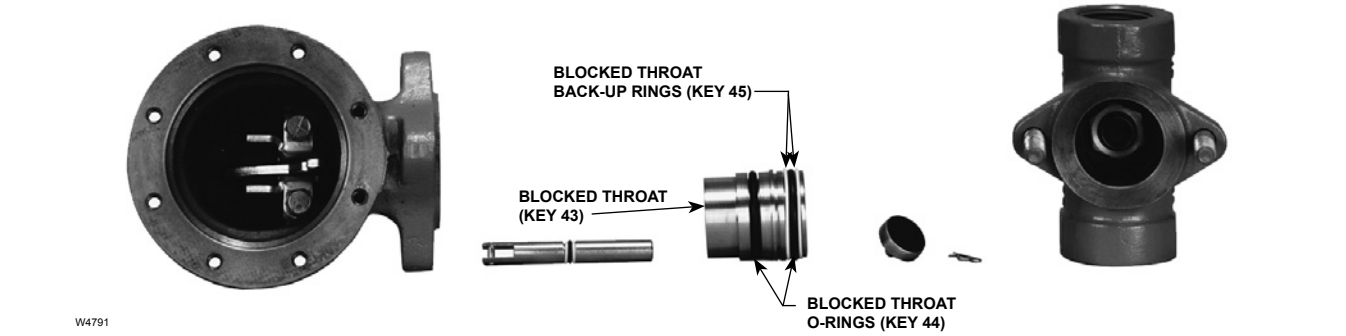
Isolate the regulator from all pressure to avoid personal injury and equipment damage due to explosion or sudden release of process pressure. Cautiously release pressure from the regulator before attempting disassembly.

The vent assembly is equipped with a relief indicator (key 49, Figure 4). The cap for the relief indicator snaps over the vent assembly opening. If the relief valve opens wide, exhaust gas pops the cap off the screen vent assembly opening indicating a problem with the regulator. If the cap pops off, refer to the shutdown and to the Body Area Maintenance Procedures to inspect the disk assembly and orifice.

If the disk assembly and orifice are not damaged, refer to the Diaphragm and Spring Case Area Maintenance Procedures in this section.



TYPES 627, 627H, 627R, AND 627LR



TYPES 627M, 627HM, AND 627MR

Figure 5. *Stem Assemblies*

The disk assembly and orifice can be inspected, removed, and replaced without removing the regulator body from the line connections. Refer to the Body Area Maintenance Procedures.

Body Area Maintenance Procedures

These procedures are for gaining access to the disk assembly, orifice, diaphragm casing O-ring, and stem assembly. All pressure must be released from the diaphragm casing before performing these steps.

While using the following procedures, refer to Figures 7 through 13 for key number locations.

Replacing the Disk Assembly or Orifice

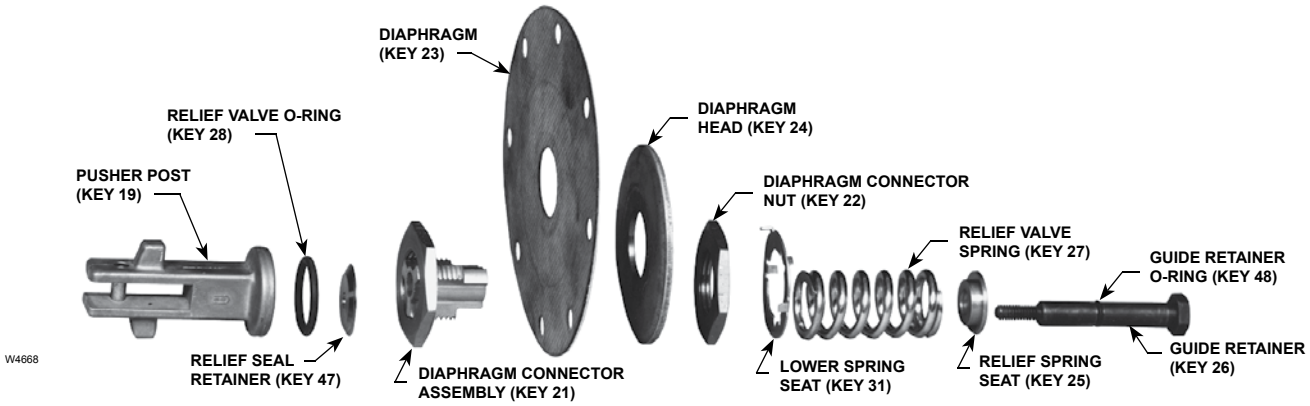
1. To inspect and replace the disk assembly (key 9) or orifice (key 2), remove the cap screws (key 3, Figure 5), and separate the diaphragm casing (key 5) from the body (key 1).
2. Inspect and, if necessary, remove the orifice (key 2). If removed, coat the threads of the replacement orifice with lubricant and torque to 25 foot-pounds / 34 N•m.
3. Inspect the disk assembly (key 9) and, if necessary, remove the hair pin clip (key 13) that holds the disk assembly (key 9) in place. If replacing the disk assembly is the only maintenance required, skip to step 16.

Replacing the Stem Assembly

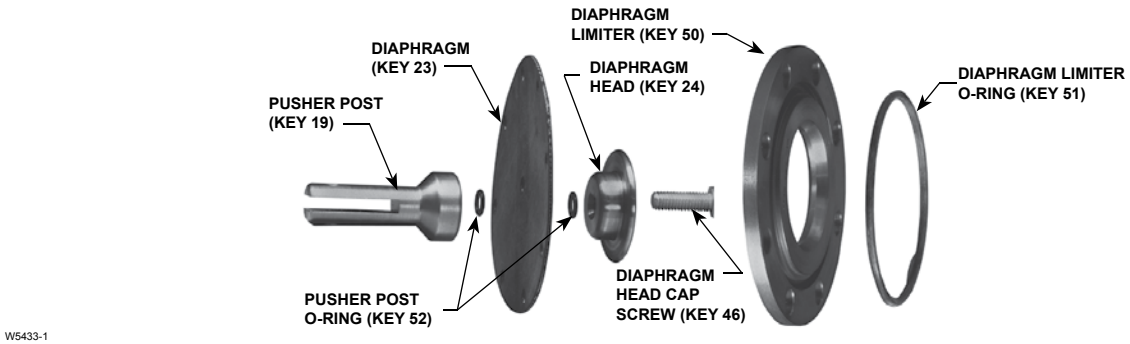
If it is necessary to perform maintenance on the stem assembly, continue with steps 4 through 8 and 15 through 19 for Types 627, 627H, 627R, and 627LR regulators, or steps 9 through 19 for Types 627M, 627HM, and 627MR regulators.

Perform steps 4 through 8 for Types 627, 627H, 627R, and 627LR Regulators only:

4. Use steps 5 through 8 to remove and replace the stem assembly.
5. Remove the boost body (key 6), stabilizer (key 7), and stem guide (key 8) from the diaphragm casing (key 5). Unhook and remove the stem (key 10) from the diaphragm casing (key 5).
6. Remove and inspect the diaphragm casing O-ring (key 4, Figure 7, 8, 9, or 12) and replace it if necessary.



TYPE 627, 627R, 627LR, 627M, OR 627MR



TYPES 627H AND 627HM

Figure 6. *Diaphragm Assemblies*

7. Apply lubricant to a replacement diaphragm casing O-ring (key 4, Figure 7, 8, 9, or 12) and install it onto the boost body (key 6). Skip to step 14.
8. For the Type 627 or 627H regulators, be sure to insert the pitot tube (tab) into the outlet side of the body (see Figure 7 or 12). Skip to step 14.

Perform steps 9 through 19 for Types 627M, 627HM, and 627MR Regulators only:

9. Use steps 10 through 14 to remove and replace the stem assembly.
10. To remove the blocked throat (key 43), insert a screw driver blade into the groove provided in the throat and pry it out of the diaphragm casing (key 5). Inspect and replace parts as necessary.
11. Inspect and, if necessary, replace the blocked throat O-rings (key 44, Figure 5) and back-up rings (key 45, Figure 5).
12. Apply lubricant to replacement blocked throat O-rings (key 44) and back-up rings (key 45).
13. Apply lubricant to the replacement stem O-ring (key 11) and stem back-up rings (key 12) and install them on the stem (key 10).
14. For assembly, lubricate the stem (key 10) and insert the diaphragm casing (key 5) and hook it on the lever (key 15).
15. Lubricate the contact points of the lever (key 15).
16. Insert parts into the diaphragm casing (key 5) that were removed in steps 5 and 6 or step 10 (see Figure 5).
17. Install the disk assembly (key 9), line up the hole in the disk assembly and stem (key 10) and insert the hair pin clip (key 13).
18. Position the diaphragm casing (key 5) plus attached parts in relation to the body (key 1) so that they are correct for the application.

19. Secure the diaphragm casing (key 5) to the body with the cap screws (key 3, Figure 5). For an aluminum diaphragm casing, torque the cap screws (key 3) to 16 foot-pounds / 22 N•m. For ductile iron or steel diaphragm casings, torque the cap screws (key 3) to 25 foot-pounds / 34 N•m.

20. It may be necessary to reposition the diaphragm spring case to prevent rain, ice, and foreign debris from entering the spring case. Refer to the Diaphragm and Spring Case Area Maintenance Procedures, steps 1, 2, and 21 through 25.

Diaphragm and Spring Case Area Maintenance Procedures

These procedures are for gaining access to the control spring, diaphragm assembly, and lever assembly. All spring pressure must be released from the diaphragm casing before these steps can be performed.

While using the following procedures, refer to Figures 7 through 13 for key number locations.

1. Remove the adjusting screw cap (key 36), loosen the lock nut (key 34), and turn the adjusting screw (key 35) counterclockwise until all compression is removed from the control spring (key 32).

2. Remove the spring case cap screws (key 37), the nameplates, and lift off the spring case (key 29). If changing the control spring (key 32) or repositioning the spring case (key 29) is the only maintenance required, install the replacement control spring or rotate the spring case so it is correct for the application. Skip to step 21. For diaphragm area maintenance, continue with step 3.

3. Remove the diaphragm limiter O-ring and diaphragm limiter (keys 51 and 50, on the Type 627H or 627HM only). Remove the diaphragm assembly by tilting it so that the pusher post (key 19) slips off the lever (key 15).

4. If it is necessary to replace the lever assembly, remove the lever cap screws (key 18).

5. Install the replacement lever (key 15) into the lever retainer (key 16) by inserting the lever pin (key 17). Secure the lever assembly into the diaphragm casing with the cap screws (key 18) and torque the cap screws to 7 foot-pounds / 9.5 N•m.

   If it is necessary to perform maintenance on the diaphragm assembly, continue with steps 6 through 11 and step 20 for Types 627, 627H, 627M, and 627HM regulators, or steps 12 through 19 for Types 627R, 627LR, and 627MR regulators.

Perform steps 6 through 11 for Types 627, 627H, 627M, and 627HM Regulators only:

6. For Types 627, 627H, 627M, and 627HM regulators (Figures 5 and 6), use steps 7 through 11 to disassemble and reassemble the diaphragm assembly.

7. Remove the diaphragm head cap screw (key 46), lower spring seat (key 31, Type 627 or 627M only), and diaphragm head (key 24). On the Type 627H or 627HM, remove the pusher post O-rings (key 52). Separate the diaphragm (key 23) from the pusher post (key 19).

8. Install the diaphragm (key 23), in reverse order in step 7, on the pusher post (key 19), insert and finger tighten the diaphragm head cap screw (key 46).

9. Hook the pusher post on the lever (key 15), then turn the diaphragm (key 23) to match the holes in the diaphragm with the holes in the spring casing.

10. Unhook the pusher post from the lever (key 15) and torque the diaphragm head cap screw (key 46) to 7 foot-pounds / 9.5 N•m for the Type 627 or 627M. On the Type 627H or 627HM, torque the diaphragm head cap screw to 14 foot-pounds / 19 N•m.

11. Hook the pusher post on the lever (key 15) and check the hole alignment. If necessary, loosen the cap screw (key 46) and reposition the diaphragm (key 23) on the pusher post (key 19). Retorque the screw (see step 10). Skip to step 20.

Perform steps 12 through 19 for Types 627R, 627LR, and 627MR Regulators only:

12. For Types 627R, 627LR, and 627MR regulators (Figure 6), use steps 13 through 19 to disassemble and reassemble the diaphragm assembly.

13. Remove the guide retainer (key 26) and separate the diaphragm parts. Refer to Figure 6 for the sequence of parts.

14. To remove the diaphragm (key 23), remove the diaphragm connector nut (key 22) and lift off the diaphragm head (key 24) and diaphragm (key 23) from the connector assembly (key 21). Do not attempt to disassemble the connector assembly (key 21).

15. Position the replacement diaphragm (key 23) on the connector assembly (key 21), install the diaphragm head (key 24) and connector nut (key 22), then torque to 17 foot-pounds / 23 N•m.
16. If necessary, replace the guide retainer O-ring (key 48) and, set the guide retainer (key 26) aside, ready for assembly.
17. On the pusher post (key 19) install the relief seal O-ring (key 28) and apply lubricant. Also, install the relief seal retainer (key 47), diaphragm connector assembly (key 21, with attached parts) relief spring (key 27), upper relief spring seat (key 33), and guide retainer (key 26). Torque the guide retainer (key 26) to 3 foot-pounds / 4.1 N•m.
18. Hook the pusher post (key 19) (with attached parts) on the lever (key 15) to check the alignment of the holes in the diaphragm with the holes in the spring casing. If the holes do not line up, unhook the pusher post from the lever, hold the pusher post, and rotate the diaphragm to the correct position.
19. Install the lower spring seat (key 31) over the relief spring so it rests flat on the connector nut (key 22).
20. Insert the diaphragm assembly into the diaphragm casing (key 5) and hook the pusher post on the lever (key 15).
21. Install the control spring (key 32) and upper spring seat (key 33), and apply lubricant to the upper spring seat (key 33).
22. Install the spring case (key 29) so that the screened vent assembly (key 30) is in the correct position for the application. Place the nameplates over the screw holes, insert the spring case cap screws (key 37), and finger tighten.
23. Screw in the adjusting screw (key 35) to put slack into the diaphragm (key 23).
24. Using a crisscross pattern, finish tightening the spring case cap screws (key 37) to 7 foot-pounds / 9.5 N•m of torque.
25. If necessary, refer to the installation and/or the Startup and Adjustment procedures.
26. Install the adjusting locknut (key 34) after regulator adjustment.

Parts Ordering

When corresponding with your local Sales Office about this equipment, always reference the equipment serial number or FS number that can be found on the nameplate.

When ordering replacement parts, reference the key number of each needed part as found in the following parts list. Separate kits containing all recommended spare parts are available.

Parts List

Note

In this parts list, parts marked NACE are intended for corrosion-resistant service as detailed in the NACE International Standard MR0175.

Key	Description	Part Number
	Type 627 Parts Kit with Aluminum/Nitrile (NBR) trim (include keys 4, 9, 11, 12, and 23)	R627X000A12
	Type 627 Parts Kit with Stainless steel/ Nitrile (NBR) trim (include keys 4, 9, 11, 12, and 23)	R627X000S12
	Type 627H Parts Kit with SST/Nylon (PA) trim	R627HX00S12
	Type 627R Parts Kit with Aluminum/ Nitrile (NBR) trim (include keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00A12
	Type 627R Parts Kit with Stainless steel/ Nitrile (NBR) trim (include keys 4, 9, 11, 12, 23, 28, and 48)	R627RX00S12
1	Body(1)	
	Ductile iron	
	1000 psig / 69.0 bar maximum inlet pressure	
	3/4 NPT	30B3046X012
	1 NPT	30B3048X012
	2 NPT	30B3096X012
	Ductile iron (Long Body)	
	1000 psig / 69.0 bar maximum inlet pressure	
	1 NPT	39B2451X012
	2 NPT	39B0414X012
	Steel	
	2000 psig / 138 bar maximum inlet pressure	
	3/4 NPT	30B3050X012
	1 NPT	30B3051X012
	2 NPT	30B7452X012
	Steel (Long Body)	
	2000 psig / 138 bar maximum inlet pressure	
	1 NPT	39B0412X012
	2 NPT	39B0415X012
	Steel, CL600 RF flanged	
	1500 psig / 103 bar maximum inlet pressure	
	NPS 1 / DN 25	40B6754X012
	NPS 2 / DN 50	40B6756X012
	Steel, CL300 RF flanged	
	750 psig / 51.7 bar maximum inlet pressure	
	NPS 1 / DN 25	41B8978X012
	NPS 2 / DN 50	41B8080X012

1. Bodies can be used for both standard and NACE constructions.

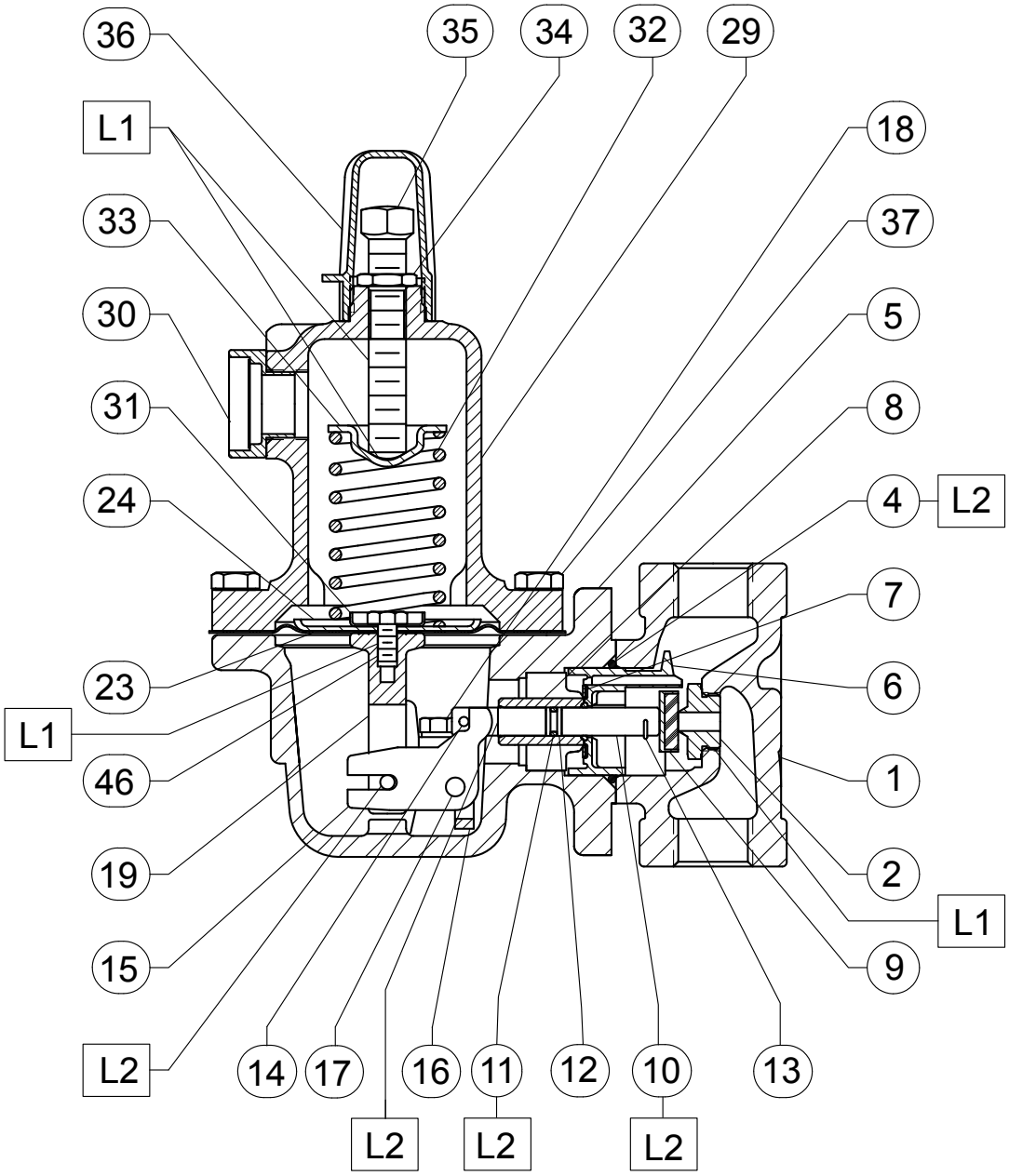
Key	Description	Part Number
1	Body[1] (continued)	
	Steel, CL150 RF flanged	
	290 psig / 20.0 bar maximum inlet pressure	
	NPS 1 / DN 25	43B8656X022
	NPS 2 / DN 50	44B0666X012
	Steel, BWE	
	1000 psig / 69.0 bar maximum inlet pressure	
	NPS 1 / DN 25	33B6723X012
	NPS 2 / DN 50	38B1688X012
	Steel, PN 16/25/40 RF	
	580 psig / 40.0 bar maximum inlet pressure	
	NPS 1 / DN 25	44B0386X012
	NPS 2 / DN 50	44B3342X012
	Stainless Steel[2], NPT	
	2000 psig / 138 bar maximum inlet pressure	
	3/4 NPT	30B3050X062
	1 NPT	30B3051X092
	2 NPT	30B7452X052
	Stainless Steel[2], CL150 RF flanged	
	275 psig / 18.9 bar maximum inlet pressure	
	NPS 1 / DN 25	43B8656X052
	NPS 2 / DN 50	44B0666X022
	Stainless Steel[2], CL300 RF flanged	
	720 psig / 49.6 bar maximum inlet pressure	
	NPS 1 / DN 25	41B8978X072
	NPS 2 / DN 50	41B8080X072
	Stainless Steel[2], CL600 RF flanged	
	1440 psig / 99.2 bar maximum inlet pressure	
	NPS 1 / DN 25	40B6754X102
	NPS 2 / DN 50	40B6756X062
	Stainless Steel[2], PN 16/25/40 RF	
	580 psig / 40.0 bar maximum inlet pressure	
	NPS 1 / DN 25	44B0386X032
	NPS 2 / DN 50	44B3342X032
2*	Orifice	
	Aluminum	
	3/32 inch / 2.4 mm	0R044109022
	1/8 inch / 3.2 mm	1A936709012
	3/16 inch / 4.8 mm	00991209012
	1/4 inch / 6.4 mm	0B042009012
	3/8 inch / 9.5 mm	0B042209012
	1/2 inch / 13 mm	1A928809012
	303 Stainless steel	
	3/32 inch / 2.4 mm	0R044135032
	1/8 inch / 3.2 mm	1A936735032
	3/16 inch / 4.8 mm	00991235032
	1/4 inch / 6.4 mm	0B042035032
	3/8 inch / 9.5 mm	0B042235032
	1/2 inch / 13 mm	1A928835032
	316 Stainless steel, NACE construction only	
	3/32 inch / 2.4 mm	0R0441X0012
	1/8 inch / 3.2 mm	1A9367X0022
	3/16 inch / 4.8 mm	009912X0012
	1/4 inch / 6.4 mm	0B0420X0012
	3/8 inch / 9.5 mm	0B0422X0012
	1/2 inch / 13 mm	1A9288X0012
3	Cap Screw (not shown), (2 required)	
	627 Series	
	For Ductile iron/Steel diaphragm case	1A560724052
	For Aluminum diaphragm case (not applicable for Types 627H and 627HM)	1A352524052
	Type 627 Only	
	For Ductile iron/Steel diaphragm case	1A5607X0052
	For Aluminum case with Steel diaphragm case	10A3869X012
	For SST Case and body	1A5607X0052
	For Aluminum Case and SST body	10A3869X022

Key	Description	Part Number
4*	Diaphragm Case O-ring	
	Nitrile (NBR)	
	For Type 627, 627H, or 627R only	17A2325X022
	Fluorocarbon (FKM)	
	For Types 627, 627R, and 627LR only	10A0037X012
5	Diaphragm Case	
	For Type 627, 627R, or 627LR	
	Aluminum without 1/8-inch / 3.2 mm gauge tap	40B3084X012
	Aluminum with 1/8-inch / 3.2 mm gauge tap for 627 Series (except Types 627H and 627HM)	11B5380X012
	Ductile iron without 1/8-inch / 3.2 mm gauge tap	30B3053X012
	Ductile iron with 1/8-inch / 3.2 mm gauge tap for 627 Series (except Types 627H and 627HM)	31B0641X012
	For Type 627, 627R, or 627LR	
	Steel	30B3104X012
	Ductile iron with 1/4 NPT gauge tap for 627 Series (except Types 627H and 627HM)	39A5987X012
	Steel with 1/4 NPT gauge tap for 627 Series (except Type 627H)	30B8734X012
	For Type 627M or 627MR	
	Ductile iron	39A5987X012
	Steel	30B8734X012
	For Type 627H, Steel	30B3104X012
	For Type 627, Stainless steel	30B3104X082
	For Type 627HM, Steel	30B8734X012
6	Boost Body (not for Type 627M, 627HM, or 627MR), Delrin®	
	For Type 627 or 627H	30B3056X012
	For Type 627R or 627LR	30B3057X012
7	Stabilizer	
	Nitrile (NBR)	
	For Types 627, 627H, 627R, and 627LR only	10B3060X012
	Fluorocarbon (FKM)	
	For Types 627, 627R, and 627LR only	10B3060X022
8	Stem Guide (for Types 627, 627H, 627R, and 627LR only), Powdered metal	20B3061X012
9*	Disk Assembly (for all Orifice Size)	
	Aluminum holder and Nitrile (NBR) disk	1C4248X0212
	303 Stainless steel holder and Nitrile (NBR) disk	1C4248X0202
	Aluminum holder and Nylon (PA) disk	1C4248X00A2
	303 Stainless steel holder and Nylon (PA) disk	1C4248X0062
	316 Stainless steel holder and Nylon (PA) disk	1C4248X0262
	316 Stainless steel holder and Nitrile (NBR) disk	1C4248X0252
	303 Stainless steel holder and Fluorocarbon (FKM) disk	1C4248X0052
	Aluminum holder and Fluorocarbon (FKM) disk	1C4248X0182
	316 Stainless steel holder and Fluorocarbon (FKM) disk	1C4248X0192
10	Stem	
	303 Stainless steel	10B3059X012
	316 Stainless steel (NACE)	10B3059X022
11*	Stem O-ring	
	Nitrile (NBR)	1D687506992
	Fluorocarbon (FKM) For Types 627, 627R, 627LR, 627M, and 627MR only	1N430406382
12*	Stem Back-up Ring, Polytetrafluoroethylene (PTFE) (2 required)	1K786806992
13	Hair Pin Clip, Stainless steel	10B3058X012
14	Drive Pin, Plated steel	1H3671X0012
15	Lever, Plated steel	20B3063X012
16	Lever Retainer, Plated steel	30B3097X012
17	Lever Pin	
	Stainless steel	10B3083X012
	316 Stainless steel (NACE)	10B3083X022

*Recommended spare part.
1. Bodies can be used for both standard and NACE constructions.
2. Stainless steel body material can be used for applications in temperature ranges down to -40°F / -40°C and are only available for Types 627, 627R, and 627H.
Delrin® is a mark owned by E.I. du Pont de Nemours and Co.

Key	Description	Part Number
18	Lever Cap Screw (2 required)	
	Plated steel	10B7454X012
	316 Stainless steel (NACE)	1B2905X0012
19	Pusher Post, Aluminum	
	For Type 627 or 627M	10B3098X012
	For Type 627R, 627LR, or 627MR	10B3098X022
	For Type 627H or 627HM,	
	416 Stainless steel	10B3098X032
	Stainless steel (NACE)	10B3098X102
21	Diaphragm Connector (for Type 627R, 627LR, or 627MR only), Stainless steel	28B8832X012
22	Diaphragm Connector Nut (for Type 627R, 627LR, or 627MR only), Stainless steel	10B7449X012
23*	Diaphragm	
	Nitrile (NBR)	
	For Type 627 or 627M with Aluminum or Ductile iron diaphragm case	10B3069X012
	For Type 627 or 627M with Steel diaphragm case	10B8735X012
	For Type 627R, 627LR, or 627MR with Aluminum or Ductile iron diaphragm case	10B3068X012
	For Type 627R, 627LR, or 627MR with Steel diaphragm case	10B8736X012
	For Type 627H or 627HM with Steel diaphragm case (diaphragm is Neoprene (CR) with Nylon (PA) fabric)	12B0178X012
	Fluorocarbon (FKM)	
	For Types 627R, 627LR, and 627MR with Steel case	10B8736X022
	For Types 627 and 627M with Steel case	10B8735X042
	For Types 627R, 627LR, and 627MR with Ductile Iron and Aluminum Casing	10B3068X022
	For Types 627 and 627M with Ductile Iron and Aluminum Casing	10B3069X032
24	Diaphragm Head, Plated steel	
	For Type 627 or 627M, Plated steel	1D666428982
	For Type 627R, 627LR, or 627MR, Plated steel	10B3071X012
	For Type 627H or 627HM, 416 Stainless steel	12B0175X012
25	Relief Spring Seat (For Type 627R or 627MR only), Steel	10B7446X012
26	Guide Retainer (For Type 627R, 627LR, or 627MR only), Stainless steel	10B7450X012
27	Relief Spring (For Type 627R or 627MR only),	
	Plated steel	10B6757X012
	For Type 627LR	1B541327022
28*	Relief Seal O-ring	
	Nitrile (NBR)	
	For Type 627R, 627LR, or 627MR only	1J108506992
	Fluorocarbon (FKM)	
	For Types 627R, 627LR, and 627MR only	1J1085X0042
29	Spring Case	
	For Type 627, 627R, or 627LR	
	Aluminum	40B3086X012
	Ductile iron	30B3055X012
	Steel	30B3102X012
	Stainless steel (Types 627 and 627R only)	30B3102X092
29	Spring Case (continued)	
	For Type 627M or 627MR	
	Ductile iron	30B3055X012
	Steel	30B3102X012
	For Type 627H or 627HM	
	Steel	30B3102X012
	Stainless steel (Type 627H only)	30B3102X092
30	Screened Vent Assembly, Plastic	10B3093X012
31	Lower Spring Seat, Plated steel	
	For Type 627 or 627M	1D666625072
	For Type 627R, 627LR, or 627MR	20B3073X012
32	Control Spring, Plated steel	
	5 to 20 psig / 0.34 to 1.4 bar, Yellow	10B3076X012
	15 to 40 psig / 1.0 to 2.8 bar, Green	10B3077X012
	35 to 80 psig / 2.4 to 5.5 bar, Blue	10B3078X012
	70 to 150 psig / 4.8 to 10.3 bar, Red	10B3079X012
	140 to 250 psig range / 9.7 to 17.2 bar, Blue, used for Type 627H or 627HM	10B3078X012
	240 to 500 psig range / 16.5 to 34.5 bar, Red, used for Type 627H or 627HM	10B3079X012
33	Upper Spring Seat, Plated steel	1D667125072
34	Locknut, Plated steel	1D667728982
35	Adjusting Screw, Plated steel	
	For Type 627, 627M, 627H, or 627HM	10B3081X012
	For Type 627R, 627LR, or 627MR	10B3080X012
36	Adjusting Screw Cap, Plastic	20B3082X012
37	Spring Case Cap Screw, Plated steel (8 required)	
	For Aluminum or ductile iron diaphragm case	1A391724052
	For Steel diaphragm case	1A368324052
	For Stainless steel case and body	1A3683X0062
	For Aluminum case and SST body	1A3917X0062
	For Type 627H/HM, steel diaphragm case	1A346424052
	For Type 627H, Stainless steel case and body	1A3464X0022
43	Blocked Throat (For Type 627M, 627HM, or 627MR only), Stainless steel	10B3085X012
44*	Blocked Throat O-ring	
	Nitrile (NBR) For Type 627M, 627HM, or 627MR only (2 required)	1E264306992
	Fluorocarbon (FKM)	
	For Types 627M and 627MR only	1E2643X0022
45*	Blocked Throat Back-up Ring (For Type 627M, 627HM, or 627MR only), PTFE (2 required)	10B3106X012
46	Diaphragm Head Cap Screw, Steel	
	For Type 627 or 627M	1B290524052
	For Type 627H or 627HM	1C379124052
47	Relief Seal Retainer (For Type 627R, 627LR, or 627MR only), Stainless steel	10B7445X012
48*	Guide Retainer O-ring	
	Nitrile (NBR)	
	For Type 627R, 627LR, or 627MR only	1D682506992
	Fluorocarbon (FKM)	
	For Types 627R, 627LR, and 627MR only	1N423906382
49	Relief Indicator (For Type 627R, 627LR, or 627MR only), Rubber (not shown)	30B3100X012
50	Diaphragm Limiter (For Types 627H and 627HM only)	22B0176X012
51*	Diaphragm Limiter O-ring	
	For Types 627H and 627HM only	1K877606992
52*	Pusher Post O-ring (2 required)	
	For Types 627H and 627HM only	1C853806992
58	Pipe Plug, Zinc	1D8293T0022
67	Drive Screw, 18-8 Stainless steel	1A368228982
72	Pipe Plug, Zinc-plated steel	1A767524662

*Recommended spare part.

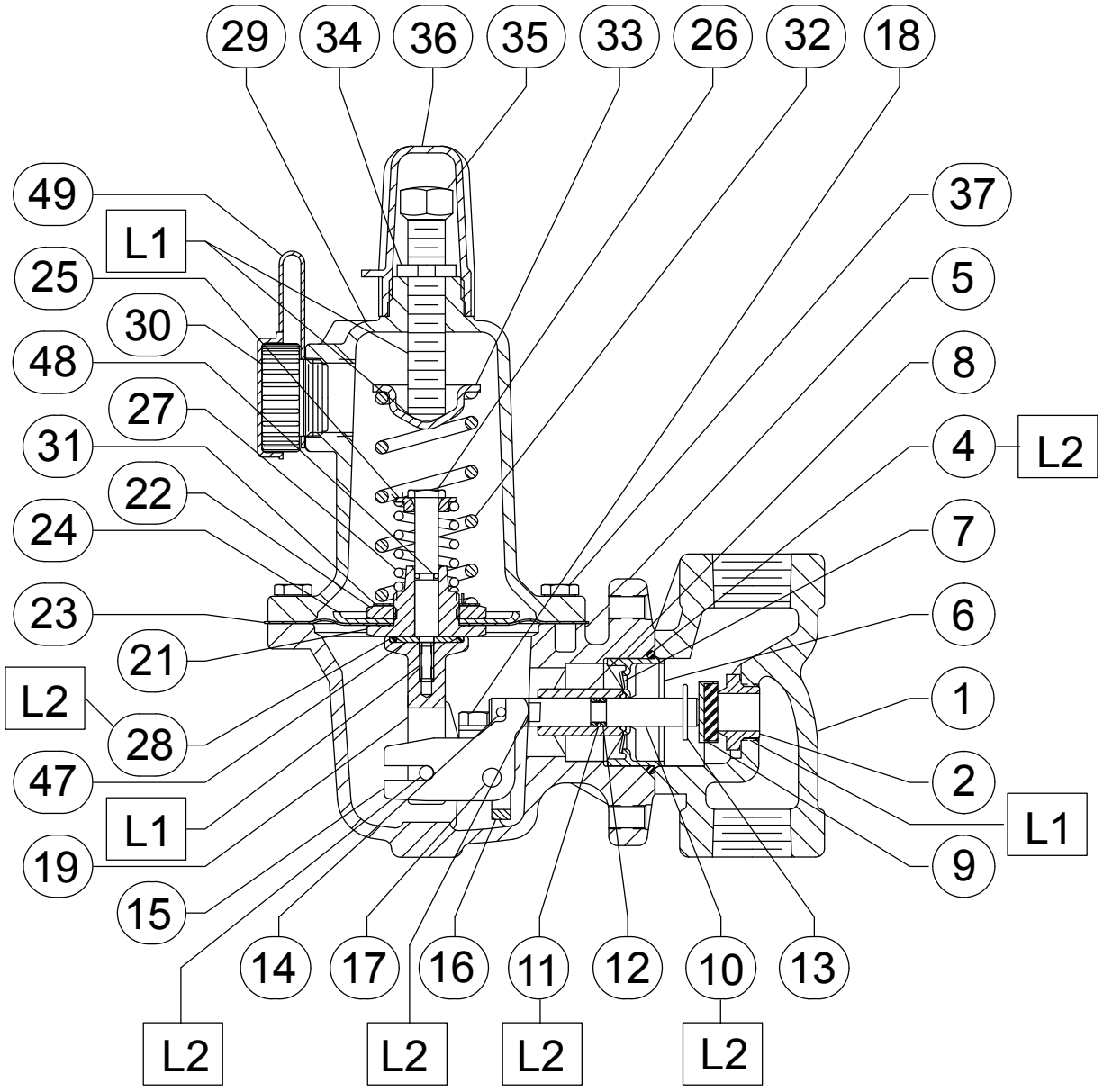


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□ **APPLY LUBRICANT(1)**
L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 7. *Type 627 Regulator Assembly*

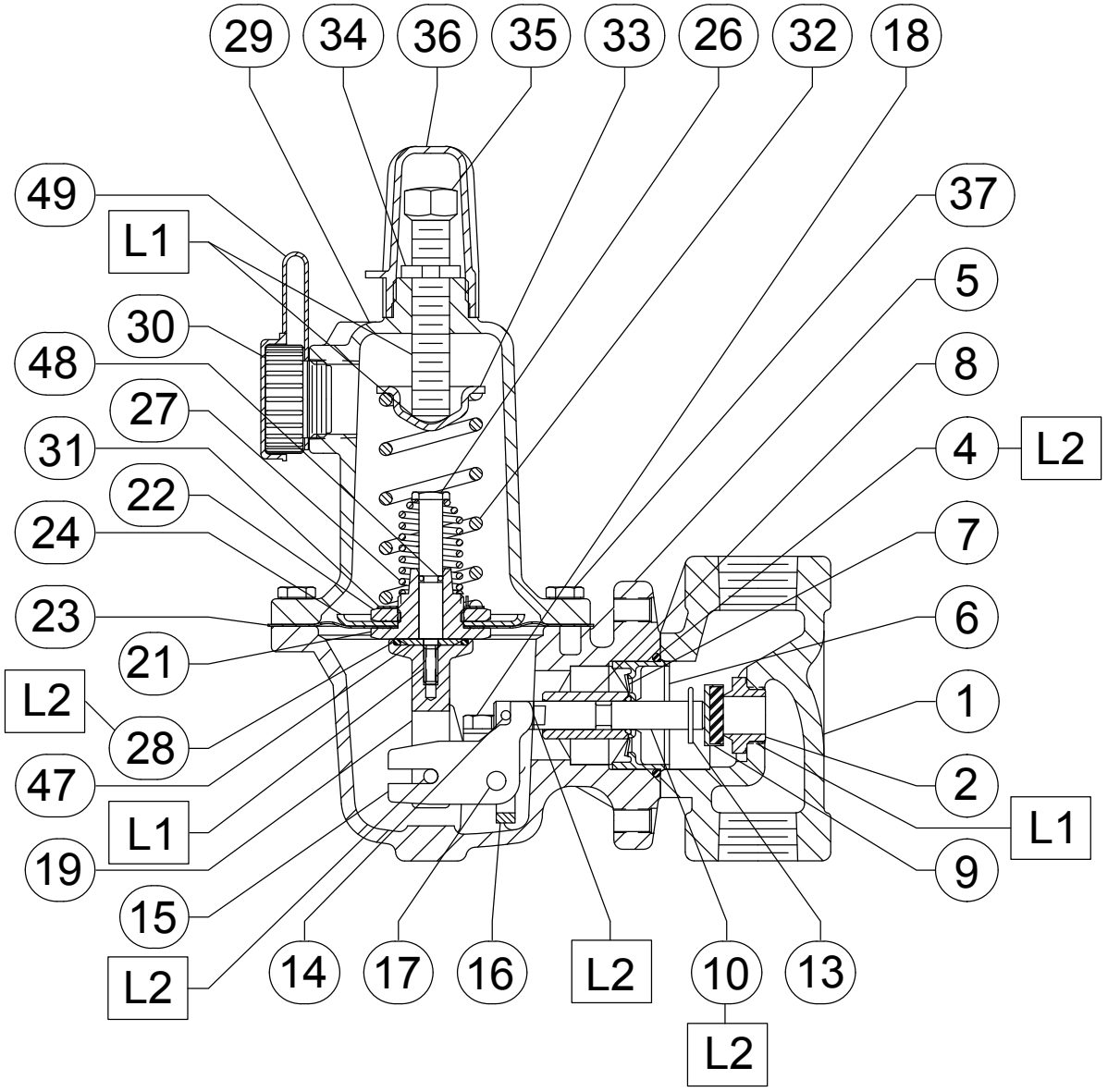


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□ **APPLY LUBRICANT(1)**
L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 8. *Type 627R Regulator Assembly*

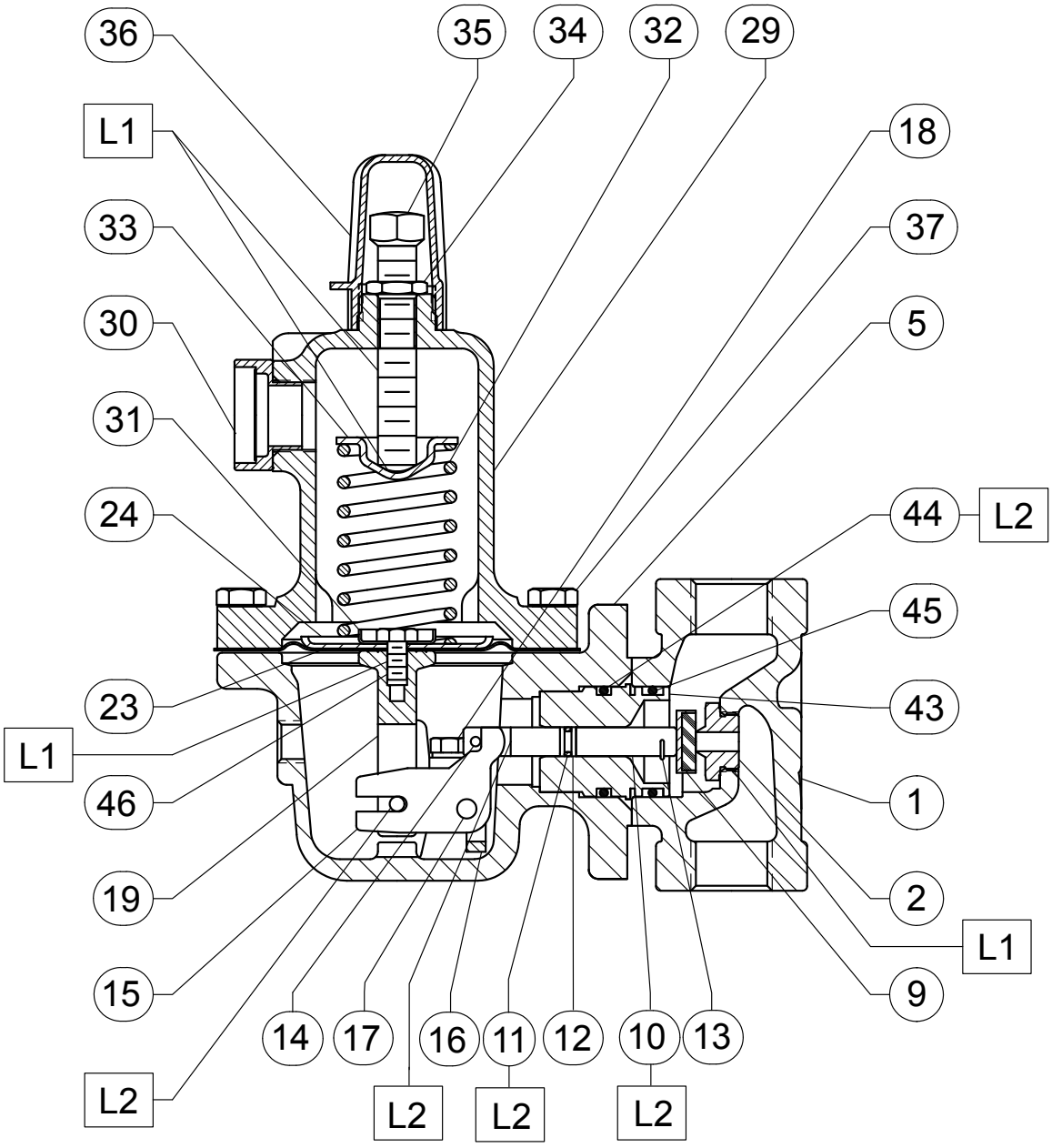


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☐ **APPLY LUBRICANT(1)**
L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 9. *Type 627LR Regulator Assembly*

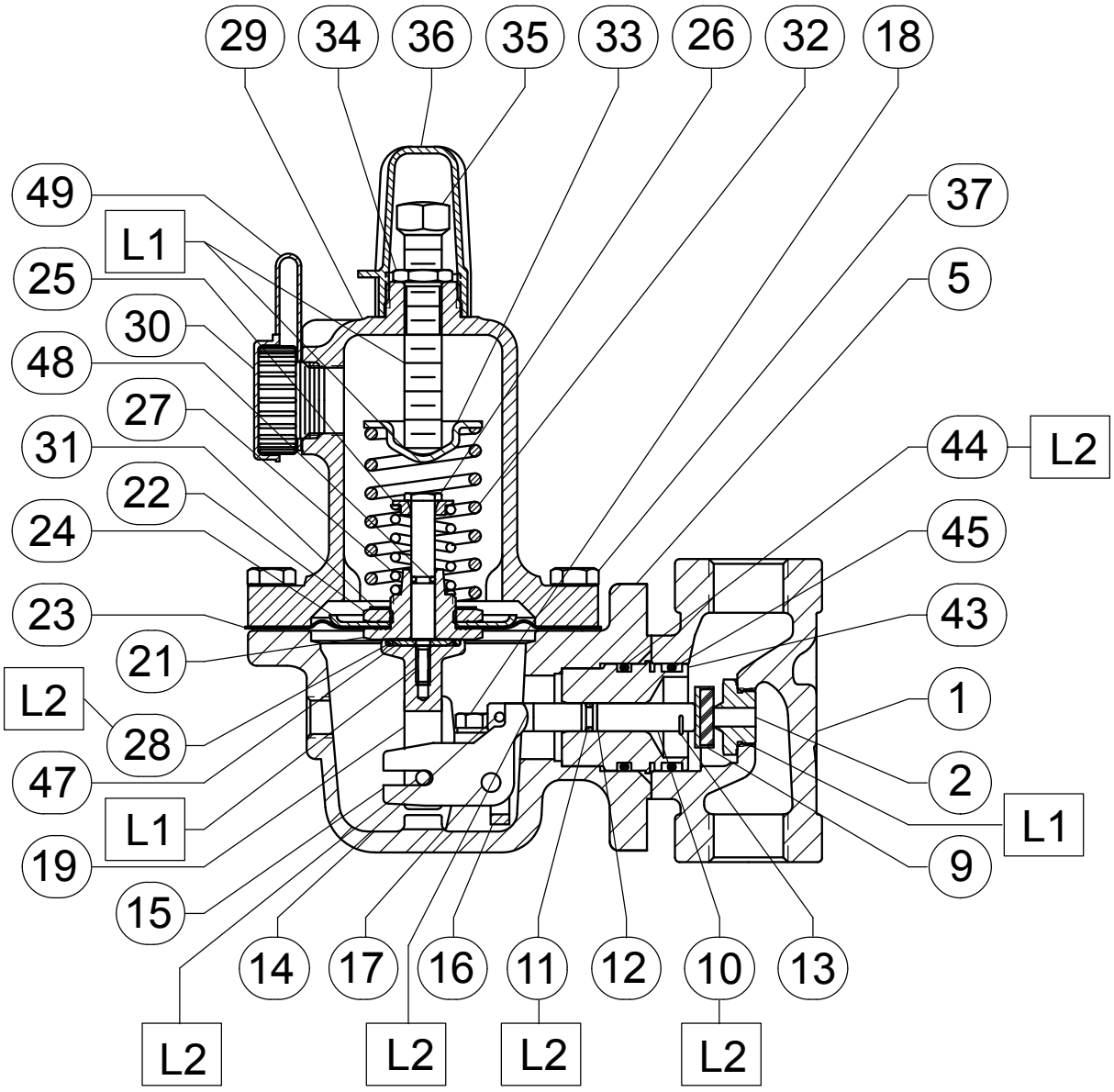


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□ **APPLY LUBRICANT(1)**
L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 10. *Type 627M Regulator Assembly*

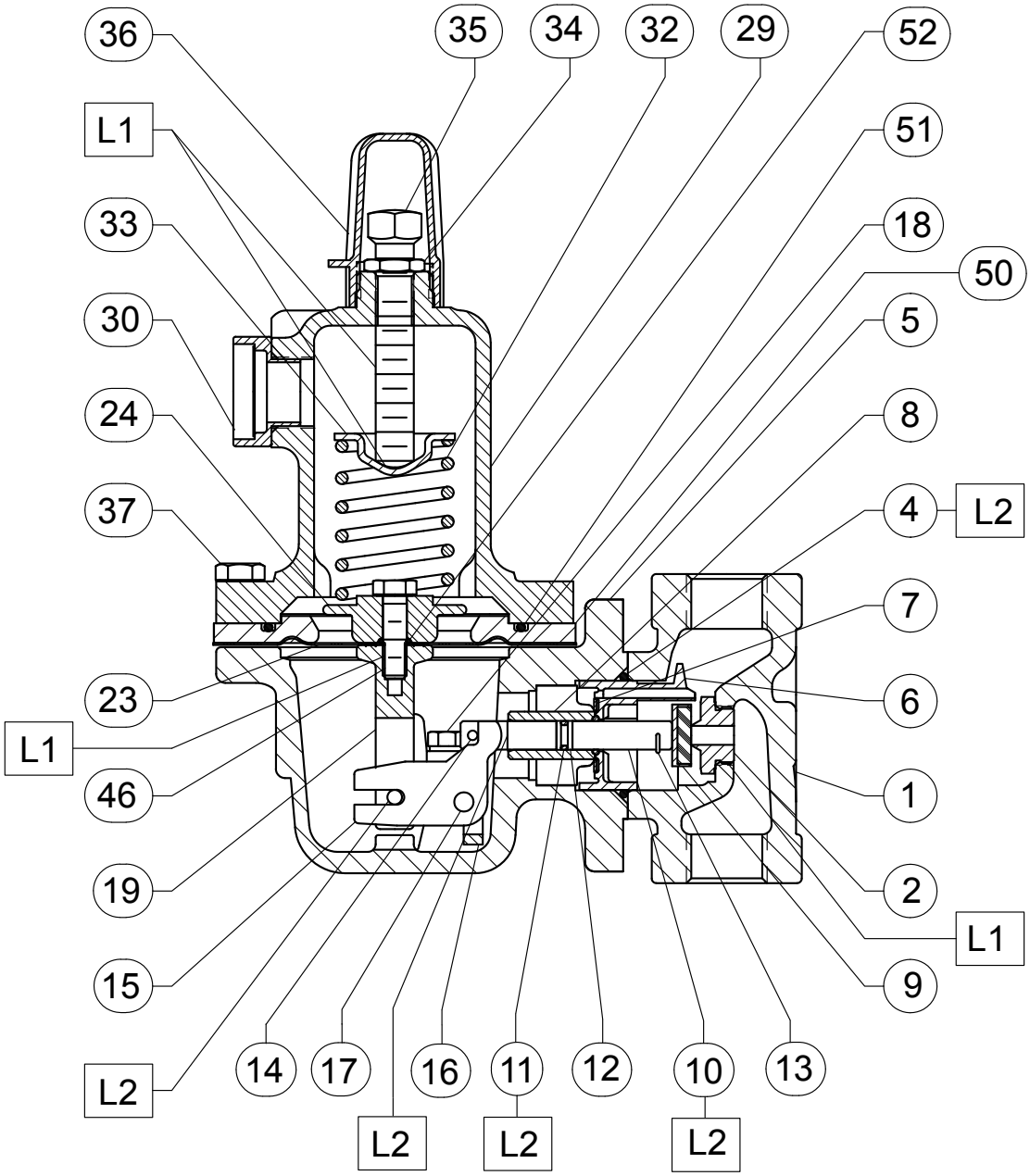


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□ **APPLY LUBRICANT(1)**
L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 11. *Type 627MR Regulator Assembly*

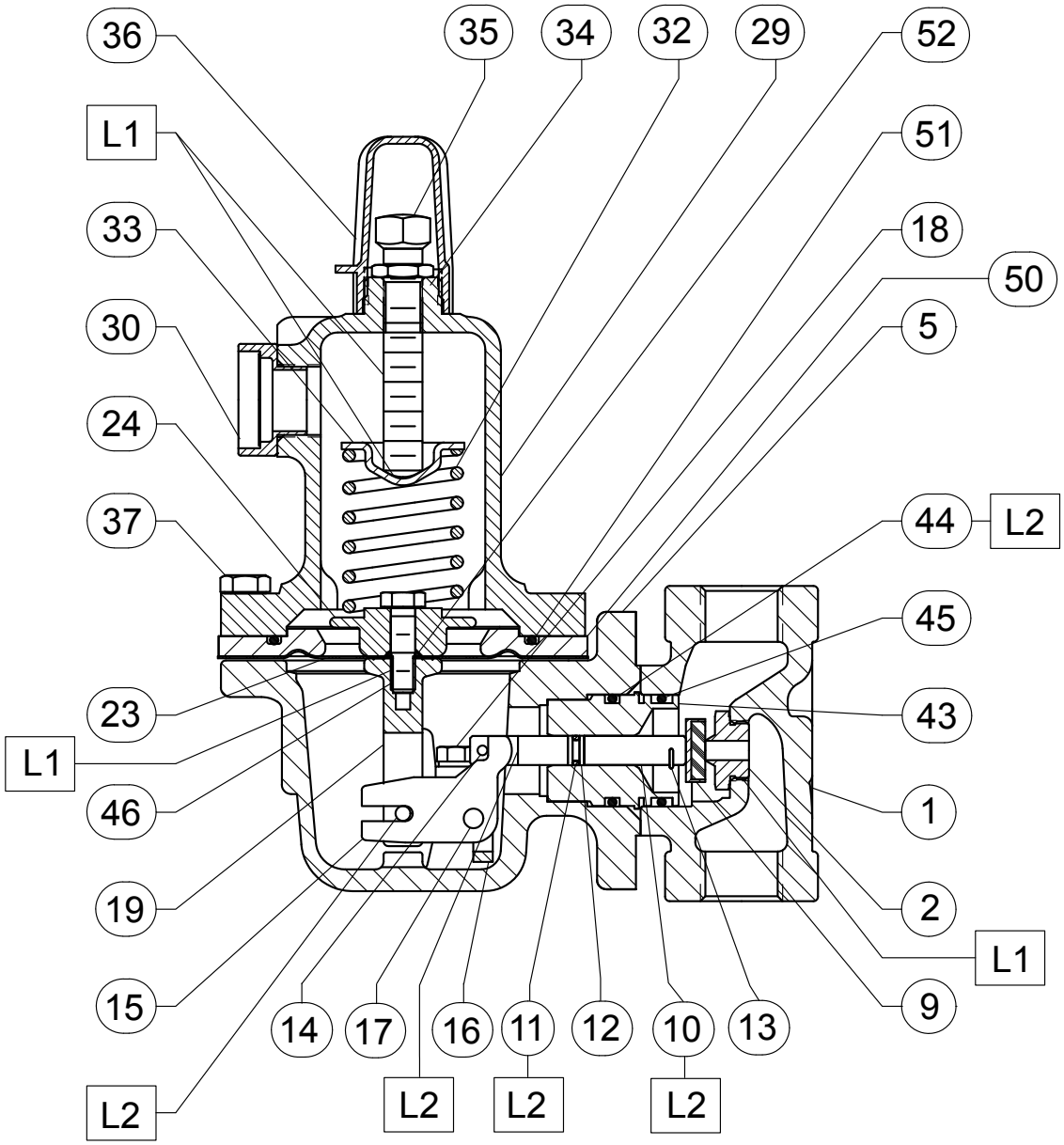


31B5374_D

□ **APPLY LUBRICANT(1)**
L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 12. *Type 627H Regulator Assembly*



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☐ **APPLY LUBRICANT(1)**
L1 = MULTI-PURPOSE LITHIUM POLYMER TYPE GREASE
L2 = EXTREME LOW-TEMPERATURE BEARING GREASE
PARTS NOT SHOWN: 3

1. Lubricants must be selected such that they meet the temperature requirements.

Figure 13. *Type 627HM Regulator Assembly*

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For further information visit www.fisherregulators.com

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Fisher™ 657 Diaphragm Actuator Sizes 30/30i through 70/70i and 87

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Figure 1. Fisher 657 Actuator Mounted on an easy-e™ Valve



Introduction

Scope of Manual

This instruction manual provides information on installation, adjustment, maintenance, and parts ordering for the Fisher 657 actuator in sizes 30/30i through 70/70i and size 87. The 657-4 actuator in sizes 70/70i and 87 is also covered. Refer to separate instruction manuals for information about the valve positioner and other accessories used with these actuators.

Do not install, operate, or maintain a 657 actuator without being fully trained and qualified in valve,actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson sales office or Local Business Partner before proceeding.

Table 1. Specifications

SPECIFICATION[1]		ACTUATOR SIZE								
		30/30i	34/34i	40/40i	45/45i	46/46i	50/50i	60/60i	70/70i[1]	87[1]
Nominal Effective Area	cm^2	297	445	445	677	1006	677	1006	1419	1419
	$Inch^2$	46	69	69	105	156	105	156	220	220
Yoke Boss Diameters	mm	54	54	71	71	71	90	90	90	127
	Inches	2-1/8	2-1/8	2-13/16	2-13/16	2-13/16	3-9/16	3-9/16	3-9/16	5
Acceptable Valve Stem Diameters	mm	9.5	9.5	12.7	12.7	12.7	19.1	19.1	19.1	25.4
	Inches	3/8	3/8	1/2	1/2	1/2	3/4	3/4	3/4	1
Maximum Allowable Output Thrust[4]	N	10230	10230	12010	25131	33582	25131	30246	39142	39142
	Lb	2300	2300	2700	5650	7550	5650	6800	8800	8800
Maximum Travel[2]	mm	19	29	38	51	51	51	51	76[3]	76[3]
	Inches	0.75	1.125	1.5	2	2	2	2	3[3]	3[3]
Maximum Casing Pressure for Actuator Sizing[4]	Bar	8.6	4.5	4.5	3.4	2.8	3.4	2.8	3.8	3.8
	Psig	125	65	65	50	40	50	40	55	55
Maximum Diaphragm Casing Pressure[4][5]	Bar	9.6	5.2	5.2	4.1	3.4	4.1	3.4	4.5	4.5
	Psig	140	75	75	60	50	60	50	65	65
Material Temperature Capabilities	°C	Nitrile Elastomers: -40 to 82°C, Silicone Elastomers: -54 to 149°C, Fluorocarbons: -18 to 149°C								
	°F	Nitrile Elastomers: -40 to 180°F, Silicone Elastomers: -65 to 300°F, Fluorocarbons: 0 to 300°F								
Pressure Connections (internal)	1/4 NPT	X	X	X	X	X	X	X	---	---
	1/2 NPT	---	---	---	---	---	---	---	X	X
Approximate Weights	kg	16/17	22/25	23/25	37/40	49/52	42/45	53/56	107/109	116
	Lb	36/38	48/54	51/56	82/84	107/114	92/99	116/125	235/240	255

1. These values also apply to the 657-4 actuator construction.
2. Actuator travel may be less than the value listed after connecting the actuator to the valve.
3. Maximum travel for 657-4 is 102 mm (4 inches).
4. Normal operating diaphragm pressure must not exceed maximum diaphragm casing pressure and must not produce a force on the actuator stem greater than the maximum allowable output thrust or the maximum allowable valve stem load. Contact your Emerson sales office or Local Business Partner with questions concerning maximum allowable valve stem load.
5. This maximum casing pressure is not to be used for normal operating pressure. Its purpose is to allow for typical regulator supply settings and/or relief valve tolerances.

Description

The 657 actuator (figure 1) and the 657-4 actuator are direct-acting, spring-opposed diaphragm actuators. They provide automatic operation of control valve body assemblies. The 657 actuator offers 76 mm (3 inches) maximum actuator travel. The 657-4 actuator provides 102 mm (4 inches) maximum actuator travel. Both actuators position the valve plug in response to varying pneumatic loading pressure on the actuator diaphragm. Figure 2 shows the operation of these actuators.

A 657 or 657-4 actuator can be equipped with either a top-mounted or a side-mounted handwheel assembly. A top-mounted handwheel assembly is used as an adjustable up travel stop to limit actuator travel in the up direction (see figure 2). A side-mounted handwheel assembly is usually used as an auxiliary manual actuator. Adjustable casing-mounted up or down travel stops are also available for this actuator.

Note

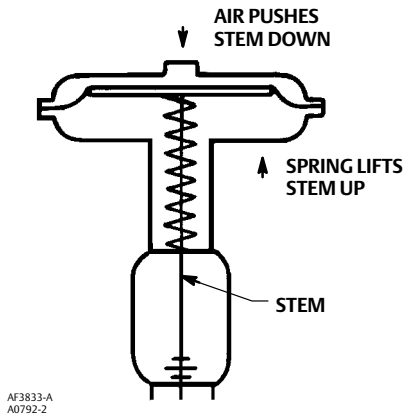
If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel.

The side-mounted handwheel is designed for more frequent use as a manual operator.

Specifications

Refer to table 1 for Specifications of the 657 and 657-4 actuators. See the actuator nameplate for specific information about your actuator.

Figure 2. Schematic of Fisher 657 and 657-4 Actuators



Educational Services

For information on available courses for Fisher 657 diaphragm actuators, as well as a variety of other products, contact:

Emerson Automation Solutions
Educational Services - Registration
Phone: 1-641-754-3771 or 1-800-338-8158
E-mail: education@emerson.com
emerson.com/fishervalvetraining

Instructional Videos

Click here or access the following QR code for a video on mounting a DVC6200 Digital Valve Controller on a 657 actuator.

Click here or access the following QR code for a video on installing a side-mounted handwheel on a 657 actuator.

Installation

Key number locations are shown in figures 6, 7, 8, 9, and 10, unless otherwise indicated. Also, refer to figure 3 for location of parts.

⚠ WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

CAUTION

To avoid parts damage, do not use an operating pressure that exceeds the Maximum Diaphragm Casing Pressure (table 1) or produces a force on the actuator stem greater than the Maximum Allowable Output Thrust (table 1) or the maximum allowable valve stem load. (Contact your Emerson sales office or Local Business Partner with questions concerning maximum allowable valve stem load.)

- Valve/Actuator Assembly: If the actuator and valve are shipped together as a control valve assembly, it has been adjusted at the factory, and may be installed in the pipeline. After installing the valve in the pipeline, refer to the Loading Connection procedures.
- Actuator Mounting: If the actuator is shipped separately or the actuator has been removed from the valve, it is necessary to mount the actuator on the valve before placing the valve in the pipeline. Refer to the actuator mounting procedures before placing the valve in service. You may perform the Bench Set Spring Adjustment procedures in this section to confirm that the adjustment has not changed since it was shipped from the factory.
- Positioner: If a positioner is installed, or is to be installed on the actuator, refer to the positioner instruction manual for installation. During the adjustment procedures, it will be necessary to provide a temporary loading pressure to the actuator diaphragm.

Mounting the Actuator on the Valve

The 657 actuator spring loading pushes the actuator stem up towards the actuator diaphragm (see figure 2). This spring action moves the stem away from the valve while installing the actuator.

CAUTION

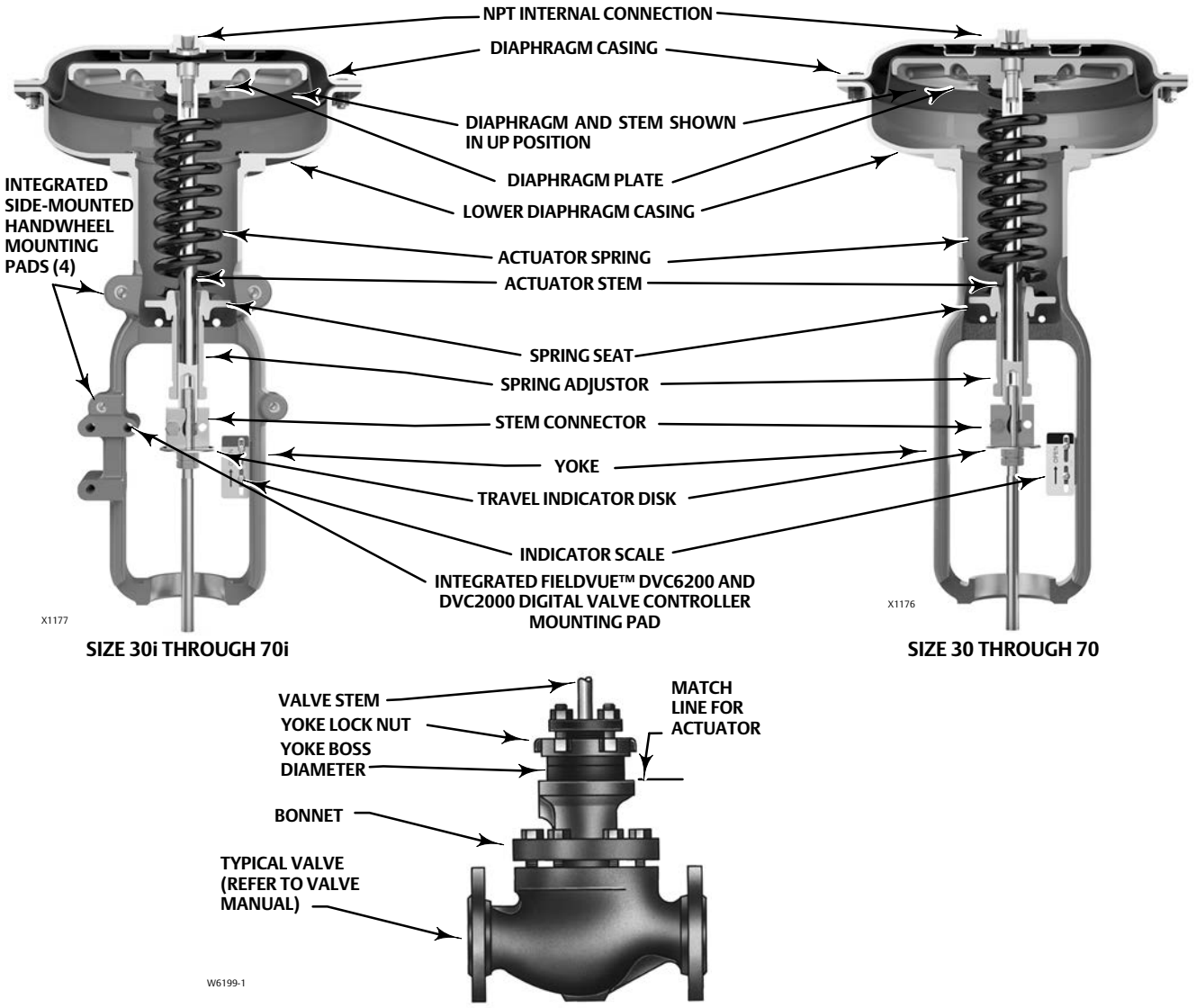
If the valve stem is allowed to remain in the up position (towards the actuator) during mounting, it can interfere with the actuator mounting, possibly damage valve stem threads or bend the valve stem. Be sure the valve stem is pushed down (into the valve body), away from the actuator while mounting.

Provide a temporary method of applying diaphragm loading pressure to the diaphragm to extend the actuator stem during bench set spring adjustments.

1. Provide a vise or some other method of supporting the valve and the weight of the actuator during assembly. For direct or reverse acting valves, push the valve stem down away from the actuator while mounting the actuator.
2. Screw the stem locknuts all the way onto the valve stem. With the concave side of the travel indicator disk (key 14) facing the valve, install the travel indicator disk on the valve stem. (Note: The travel indicator disk is not used with size 87 actuators.)
3. Lift or hoist the actuator onto the valve bonnet:
   a. For size 87 actuators, insert the cap screws and tighten the hex nuts, securing the actuator to the bonnet.
   b. For all other size actuators, screw the yoke locknut onto the valve bonnet and tighten the locknut. (Note: On small size actuators, it may be necessary to remove the indicator disk and re-install it while lowering the actuator on to the valve because the disk will not go through the actuator yoke opening.)

4. Do **not** connect the actuator stem to the valve stem at this time. Whenever the actuator is installed on the valve, it is recommended to perform the Bench Set Spring Adjustment procedure to verify that the actuator is still adjusted correctly.

Figure 3. Actuator Mounting Components for Size 30/30i through 70/70i Actuators



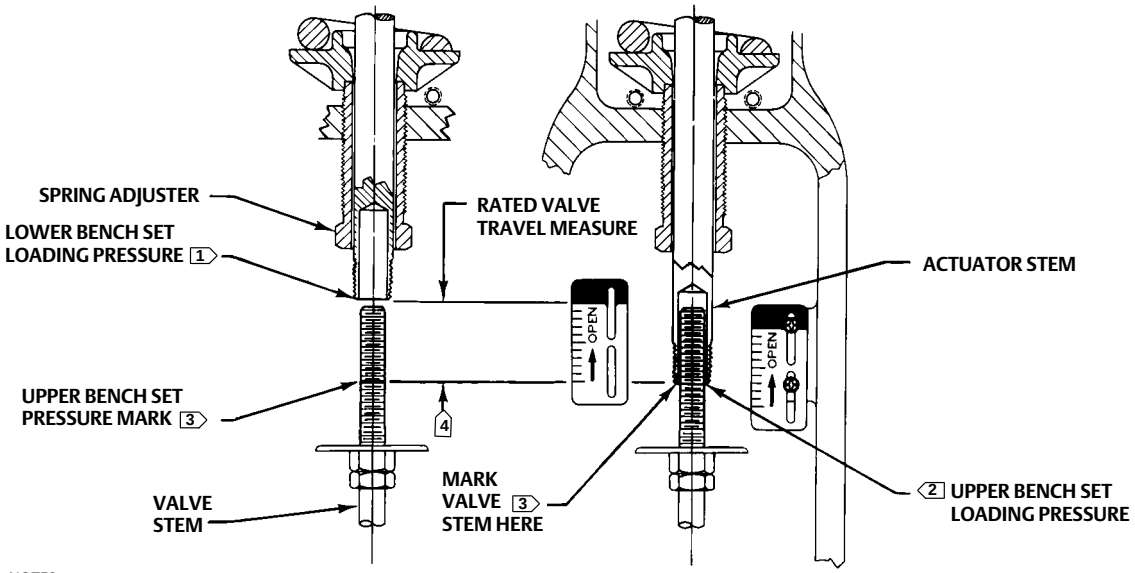
Discussion of Bench Set

The bench set pressure values are used to adjust the initial compression of the actuator spring with the valve-actuator assembly "on the bench." The correct initial compression is important for the proper functioning of the valve-actuator assembly when it is put into service and the proper actuator diaphragm operating pressure is applied.

The bench set values are established with the assumption that there is no packing friction. When attempting to adjust the spring in the field, it is very difficult to ensure that there is no friction being applied by "loose" packing.

Accurate adjustment to the bench set range can be made during the actuator mounting process by making the adjustment before the actuator is connected to the valve (see the Spring Verification procedure).

Figure 4. Bench Set Adjustment



NOTES:
1 THE LOWER PSIG LOADING PRESSURE (MARKED ON NAMEPLATE) WHERE THE FIRST MOVEMENT OF ACTUATOR STEM IS DETECTED.
2 THE UPPER PSIG LOADING PRESSURE EXTENDS ACTUATOR STEM.
3 MARK THIS POINT WITH TAPE OR A MARKER.
4 MEASURE DISTANCE OF TRAVEL. IT SHOULD EQUAL THE TRAVEL SPAN SHOWN ON THE NAMEPLATE.

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B2426

Spring Verification

Ensure that the actuator stem is at the top of its travel as shown in figure 4 and not connected to the valve. (Note: Some spring compression is required to move the diaphragm to the top of its travel.) The steps provided are the same for push-down-to-close (direct acting) or push-down-to-open (reverse acting) valves.

⚠ WARNING

When moving the actuator stem with diaphragm loading pressure, use caution to keep hands and tools out of the actuator stem travel path. Personal injury and/or property damage is possible if something is caught between the actuator stem and other control valve assembly parts.

Also, provide a certified pressure gauge suitable to accurately read the diaphragm pressure from 0 through 0.3 bar (5 psig) above the upper operating range pressure marked on the nameplate. Apply loading pressure to the diaphragm.

CAUTION

Stroke the actuator a few times to ensure that the pressure gauge is working correctly, and that the actuator is functioning properly. To prevent actuator damage, it is important to ensure that the actuator stem is stroking smoothly and not

exhibiting binding or excessive friction. Binding or excessive friction could be an indicator of incorrect assembly or damaged parts.

1. If not already accomplished, provide a temporary means of applying an adjustable loading pressure to the actuator during bench set adjustments.
2. Set the diaphragm loading pressure at 0 bar (0 psig). Then, slowly raise the pressure towards the lower bench set pressure, as indicated on the nameplate, while checking for the first linear movement of the actuator stem. The actuator stem should show movement at the lower bench set pressure. If movement occurs before or after the lower pressure is reached, adjust the spring adjuster (see figure 4) into or out of the yoke until the actuator stem's movement is first detected at the lower bench set pressure.

Note

Before turning the spring adjuster on size 70/70i or 87 actuators, assemble the stem connector around the actuator stem and the anti-rotating lug on the yoke. Mark the actuator stem as a visual reference to verify that stem rotation does not occur. Remove the stem connector before rechecking the bench set.

3. Be sure the spring adjuster is adjusted to meet the requirements of step 2 above.
4. Apply the upper bench set pressure, as indicated on the nameplate. This pressure extends the actuator stem down towards the valve. (Note: The actuator stem may slide over the valve stem as shown in figure 4.) At the end of the actuator stem, use a marker or a piece of tape to mark the valve stem (see figure 4). (Note: If the actuator stem does not pass over the valve stem, provide a method to mark this point of stem travel.)
5. Slowly decrease the diaphragm loading pressure to the lower bench set pressure, as indicated on the nameplate.
6. Measure the distance between the marker or tape on the valve stem to the end of the actuator stem. The distance should match the rated travel indicated on the nameplate.
7. If the measured travel matches the nameplate travel, bench set is complete. Proceed to the Installing the Stem Connector Assembly subsection.
8. If the measured travel is not exact, consider the spring free-length and spring rate tolerances may produce a slightly different bench set than specified. Contact your Emerson sales office or Local Business Partner for assistance.

Installing the Stem Connector Assembly

When installing the stem connector assembly (key 26), the actuator and valve stem threads should engage the threads of the stem connector by the distance equal to the diameter of the stem.

⚠ WARNING

Install the stem connector securely before a positioner is mounted to the actuator and pressurized, using only a regulator-controlled air supply, not the positioner, to move the actuator stem.

To avoid personal injury or property damage, keep hands and tools out of the actuator stem travel path while applying loading pressure to move the actuator stem in the following steps.

CAUTION

To avoid damaging the seating surfaces, do not rotate the valve plug while it is seated. Exercise care while installing the stem connector assembly to avoid damage to the valve plug stem and valve stem threads.

Note

Replacement stem connectors are an assembly of two stem connector halves, cap screws, and a spacer between the connector halves. Remove the spacer and discard, if present, before clamping the actuator and valve stems together. Use only a mated pair of stem connector halves.

1. If necessary, push the valve stem down so that it is touching the seat ring on direct acting valves. For reverse acting valves, push the stem down to the open position.

If necessary, screw the valve stem locknuts down, away from the connector location. For all actuators except size 87, ensure that the travel indicator disk (key 14) is located on top of the locknuts.

2. Slowly increase the diaphragm pressure to the upper bench set pressure. This should be the same pressure used in the Spring Verification steps, and it is marked on the nameplate.
3. Place the stem connector half with the threaded holes, approximately half way between the actuator and valve stems, and align with the stem connector. A slight change to loading pressure may be necessary to align the threads. Refer to figures 6, 7, 8, 9, and 10 to help locate the connector position.

CAUTION

Incomplete engagement of either the valve stem or actuator stem in the stem connector can result in stripped threads or improper operation. Be sure that the length of each stem clamped in the stem connector is equal to or greater than one diameter of that stem. Damage to threads on either stem or in the stem connector can cause the parts to be replaced prematurely. Do not loosen the cap screws when the stem connector has spring or loading pressure force applied.

4. Install the other half of the stem connector and insert the cap screws and tighten them while ensuring even spacing between the stem connector halves on all sides. If installing a positioner, also attach the feedback bracket at the same time.

CAUTION

Over-tightening the valve stem locknuts can make disassembly difficult.

5. Screw the valve stem locknuts up against the stem connector for the size 87 actuator. For all other actuator sizes, screw the valve stem locknuts up until the indicator disk contacts the bottom of the stem connector. Do not overtighten the locknuts.
6. Slowly stroke the valve from fully open to fully closed and verify full rated travel is achieved.

Be sure that the valve is in the closed position. Loosen the screws on the travel indicator scale (key 18), and align it with the travel indicator disk (key 14) or stem connector for the size 87 actuator. Stroke the valve full travel to ensure that the travel matches the rated travel on the nameplate. If valve travel is not correct, repeat the stem connector procedure.

Friction Discussion

If you are attempting to adjust the bench set after the actuator is connected to the valve and the packing tightened, you must take friction into account. Make the spring adjustment so full actuator travel occurs at the bench set values

(a) plus the friction force divided by the effective diaphragm area with increasing diaphragm pressure or (b) minus the friction force divided by the effective diaphragm area with decreasing diaphragm pressure.

If the stem connector assembly has been installed, the valve friction may be determined by the following procedure:

1. Install a pressure gauge in the actuator loading pressure line that connects to the actuator diaphragm casing.

Note

Steps 2 and 4 require that you read and record the pressure shown on the pressure gauge.

2. Increase the actuator diaphragm pressure and read the diaphragm pressure as the actuator reaches a travel position in the rated travel of the valve that does not contact a travel stop. Make a reference mark on the travel indicator scale using tape or some other method at this point.
3. Increase the actuator diaphragm pressure until the actuator is at a travel position greater than the position referenced in step 2 using the reference point to identify first movement.
4. Decrease the actuator diaphragm pressure and read the diaphragm pressure as the actuator returns to the position referenced in step 2.

The difference between the two diaphragm pressure readings is the change in the diaphragm pressure required to overcome the friction forces in the two directions of travel.

5. Calculate the actual friction force:

$$\text{Friction Force, = pounds} \quad 0.5 \left(\text{Difference in pressure readings, psig} \right) \times \left(\text{Effective diaphragm area, inches}^2 \right)$$

Refer to table 1 for the effective diaphragm area.

It is difficult to rotate the spring adjustor (key 74, figures 6, 7, 8, 9, and 10) when the full actuator loading pressure is applied to the actuator. Release the actuator loading pressure before adjusting. Then re-apply loading pressure to check the adjustment.

Note

For push-down-to-close valves, the valve plug seat is the limit for downward travel and the actuator up-stop is the limit for upward (away from the valve) movement. For push-down-to-open valves, the actuator down stop is the limit for downward movement, and the valve seat is the limit for upward (away from the valve) movement.

Deadband Measurement

Deadband is caused by packing friction, unbalanced forces, and other factors in the control valve assembly. Deadband is the range a measured signal can vary without initiating a response from the actuator (see figure 5). Each actuator spring has a fixed spring rate (force divided by compression). You have verified that the right spring was installed in the actuator by completing the Spring Verification steps.

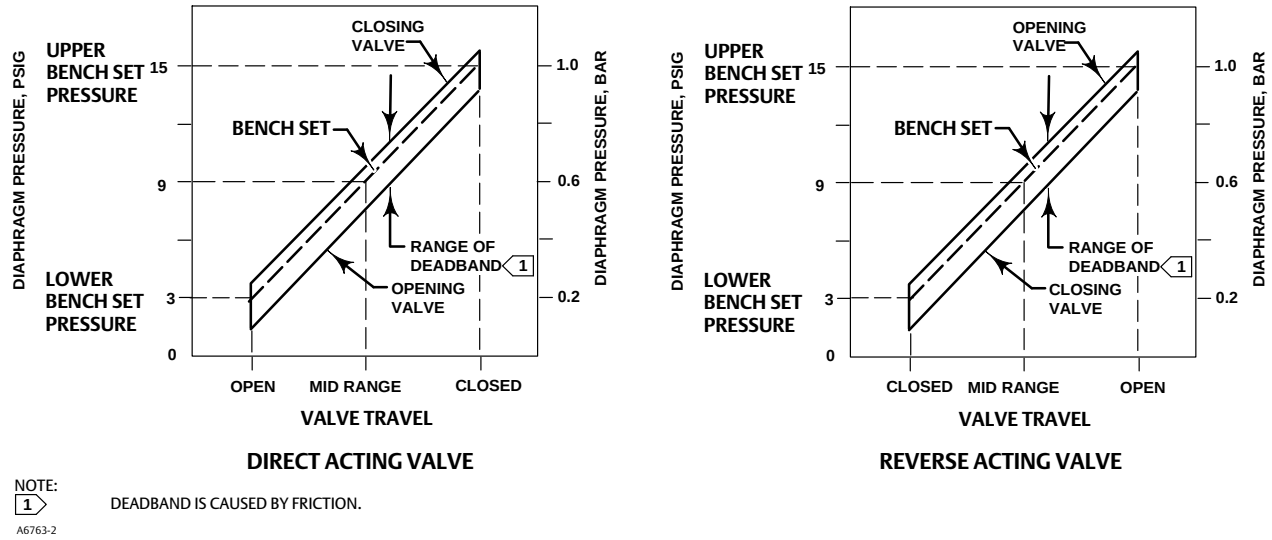
Deadband is one factor that affects the control valve assembly operation during automatic loop control. The control loop tolerance for deadband varies widely depending on the loop response. Some common symptoms of the

deadband being too wide are no movement, a “jump” movement, or oscillating movements of the actuator during automatic loop control. The following steps are provided to determine the span of deadband. The percent of deadband is helpful in troubleshooting problems with the process control loop.

1. Start at a pressure near the lower bench set pressure, slowly increase pressure until the valve is approximately at mid-travel. Note this pressure reading.
2. Slowly decrease pressure until movement of the valve stem is detected, and note this pressure.
3. The difference between these two pressures is deadband, in psi.
4. Calculate the percent of deadband by:

$$\text{Deadband} = \frac{\text{Deadband, psi}}{\text{Bench Set Span, psi}} = \text{nn\%}$$

Figure 5. Typical Valve Response to Deadband



NOTE:
1 DEADBAND IS CAUSED BY FRICTION.

A6763-2

Loading Connection

The loading pressure connections are made at the factory if the valve, actuator, and positioner come as a unit. Keep the length of tubing or piping as short as possible to avoid transmission lag in the control signal. If a volume booster, valve positioner or other accessory is used, be sure that it is properly connected to the actuator. Refer to the positioner instruction manual or other manuals as necessary.

For actuators shipped separately or whenever the actuator pressure connections are installed, use the following steps:

1. Connect the loading pressure piping to the NPT internal connection in the top of the diaphragm casing.
2. For sizes 70/70i and 87 actuators, if necessary, remove the 1/4 NPT bushing if a 1/2 NPT internal connection is needed to increase connection size. The connection can be made with either piping or tubing.
3. Cycle the actuator several times to be sure that the valve stem travel is correct when the correct pressure ranges are applied to the diaphragm.

⚠ WARNING

If valve stem travel appears to be incorrect, refer to the Bench Set Spring Adjustment procedures at the beginning of this section. To avoid personal injury or product damage, do not place the valve into service if it is not reacting correctly to diaphragm loading pressure changes.

Maintenance

Actuator parts are subject to normal wear and must be inspected and replaced when necessary. The frequency of inspection and replacement depends on the severity of service conditions.

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the power actuator loading pressure and relieve any actuator spring precompression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline.* Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

Actuator Maintenance

This procedure describes how the actuator can be completely disassembled and assembled. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job; then, start the assembly at the appropriate step.

Key numbers refer to figures 6, 7, 8, 9, or 10 unless otherwise indicated. Figure 6 shows the size 30 through 60 actuators, figure 7 shows the size 30i through 60i actuators, figure 8 illustrates the size 70 actuator, figure 9 illustrates the size 70i actuator, and figure 10 shows the size 87 actuator.

Actuator Disassembly

1. Bypass the control valve. Reduce the loading pressure to atmospheric, and remove the tubing or piping from the upper diaphragm casing (key 1).

⚠ WARNING

To avoid personal injury from the precompressed spring force thrusting the upper diaphragm casing (key 1) away from the actuator, relieve spring compression (step 2, below), and carefully remove casing cap screws (key 22) (step 4, below).

2. Thread the spring adjuster (key 12) out of the yoke (key 9) until all spring compression is relieved.
3. If required, remove the actuator from the valve body by separating the stem connector (key 26) and removing the yoke locknut or, for the size 87 actuator, the stud bolt nuts. Separate the stem connector by loosening the stem nuts (keys 15 and 16) and unscrewing the two cap screws.

4. Remove the diaphragm casing cap screws and nuts (keys 22 and 23), then lift off the upper diaphragm casing (key 1).
5. Remove the actuator diaphragm (key 2).
6. Remove the diaphragm plate, actuator stem, and cap screw (keys 4, 10 and 3) as an assembly. This assembly can be broken down further, if required, by removing the cap screw (key 3).
7. Remove the actuator spring (key 6) and the spring seat (key 11).
8. If required, remove the lower diaphragm casing (key 5) from the yoke (key 9) by loosening the cap screws (key 8) that hold it in place.
9. If required, remove the spring adjuster (key 12) by unscrewing it from the yoke (key 9).

Table 2. Actuator Assembly Recommended Torque Values

DESCRIPTION, KEY NUMBER	ACTUATOR SIZE	THREAD SIZE, INCH	TORQUE	
			N • m	Lbf • ft
Diaphragm plate to stem, key 3	30/30i	3/8-24	41	30
	34/34i and 40/40i	1/2-20	54	40
	45/45i to 70/70i and 87	3/4-16	149	110
MO U-bolt, key 170	34 and 40	1/2-13	81	60
	45 to 60	5/8-11	163	120
MO U-bolt, key 147	34 and 40	3/8-16	41	30
MO U-bolt, key 144	45 to 60	3/8-16	41	30
Diaphragm casing, key 23(1)	30/30i to 70/70i and 87	3/8-24	27	20
Hex cap screw,key 256	34i to 40i	1/2-13	92	68
	45i to 60i	5/8-11	163	120
Hex cap screw,key 257	34i to 60i	3/8-16	39	29
Casing to yoke, key 8	30/30i to 60/60i	3/8-16	39	29
	70/70i and 87	1/2-13	92	68
Top-mounted handwheel and travel stop mounting, key 141	30/30i to 60/60i	3/8-16	39	29
Stem connector, key 26(2)	30/30i through 40/40i	5/16-18	23	17
	45/45i through 70/70i	3/8-16	39	29
	87	1/2-13	91	67

1. Observe tightening pattern and procedure described in the appropriate Actuator Assembly section.
2. Torque values when lithium grease is used on the threads.

Actuator Assembly

Refer to table 2 as appropriate.

1. Coat the threads and the spring seat bearing surface of the spring adjuster (key 12) with lithium grease (key 241), and thread the spring adjuster into the yoke (key 9). Place the spring seat (key 11) in the yoke on the spring adjuster and turn the spring adjuster to ensure that threads are properly engaged.
2. Position the lower diaphragm casing (key 5) on the yoke (key 9), and fasten the parts together by installing and evenly tightening the cap screws (key 8).
3. Set the actuator spring (key 6) squarely onto the spring seat (key 11).
4. If the diaphragm plate and actuator stem (keys 4 and 10) are separate, fasten them together using the cap screw and washer (keys 3 and 25). Coat the cap screw threads with lithium grease (key 241). Tighten the cap screw (key 3) to 41 N•m (30 lbf•ft) torque for size 30/30i actuators, 54 N•m (40 lbf•ft) torque for size 34/34i and 40/40i actuators, or 149 N•m (110 lbf•ft) torque for size 45/45i to 87 actuators. Slide the actuator stem and diaphragm plate (keys 10 and 4) into the yoke (key 9) so that the actuator spring (key 6) fits squarely between the diaphragm plate and the spring seat (key 11). Then slide the diaphragm rod through the spring adjuster (key 12).
5. Place the diaphragm (key 2) pattern-side up on the diaphragm plate (key 4). Align the holes in the diaphragm and the lower diaphragm casing (key 5).

6. Position the upper diaphragm casing (key 1) on the diaphragm (key 2) and align the holes.

Note
When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing bolts are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 30/30i-70/70i and 87 actuators.

CAUTION

Over-tightening the diaphragm casing cap screws and nuts (keys 22 and 23) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

Note
Do not use lubricant on these bolts and nuts. Fasteners must be clean and dry.

7. Insert the cap screws (key 22), and tighten the hex nuts (key 23) in the following manner. The first four hex nuts tightened should be diametrically opposed and 90 degrees apart. Tighten these four hex nuts to 13 N•m (10 lbf•ft).
8. Tighten the remaining hex nuts in a clockwise, criss-cross pattern to 13 N•m (10 lbf•ft).
9. Repeat this procedure by tightening four hex nuts, diametrically opposed and 90 degrees apart, to a torque of 27 N•m (20 lbf•ft).
10. Tighten the remaining hex nuts in a clockwise, criss-cross pattern to 27 N•m (20 lbf•ft).
11. After the last hex nut is tightened to 27 N•m (20 lbf•ft), all of the hex nuts should be tightened again to 27 N•m (20 lbf•ft) in a circular pattern around the bolt circle.
12. Once completed, no more tightening is recommended.
13. Mount the actuator on the valve by following the procedures in the Installation section.

Top-Mounted Handwheel Assembly

A top-mounted handwheel assembly (figures 11 and 12) is usually used as an adjustable casing-mounted up travel stop to limit full retraction of the actuator stem. Turning the handwheel clockwise moves the the handwheel stem (key 133, figures 11 and 12) down, compressing the spring.

Instructions are given below for complete disassembly and assembly of the top-mounted handwheel assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then, begin the assembly at the appropriate step.

Key numbers refer to figure 11 (sizes 30/30i through 60/60i) and figure 12 (sizes 70/70i and 87), unless otherwise indicated.

Disassembly for Top-Mounted Handwheel

1. Turn the handwheel (key 51) counter-clockwise so that the handwheel assembly is not causing any spring compression.
2. Bypass the control valve, reduce loading pressure to atmospheric, and remove the tubing or piping from the upper handjack body (key 142, figures 11 or 12).

⚠ WARNING

To avoid personal injury from the precompressed spring force thrusting the upper diaphragm casing (key 1) away from the actuator, thread the spring adjuster (key 12) out of the yoke until all spring compression is relieved, then carefully remove casing cap screws (key 22).

3. Remove the diaphragm casing cap screws and nuts (keys 22 and 23, figures 6, 7, 8, 9, or 10), and lift off the upper diaphragm casing and handwheel assembly.
4. If necessary, the handwheel assembly can be separated from the diaphragm casing by removing the cap screws (key 141). This may be necessary to replace the O-ring (key 139), or for ease of handling.
5. Loosen the travel stop locknut (key 137), and turn the handwheel (key 51) counter-clockwise. Remove the cotter pin and stop nut (keys 247 and 54), then lift off the handwheel.
6. Unscrew the travel stop locknut (key 137) from the handwheel stem (key 133), and turn the stem out of the bottom of the body (key 142). A screwdriver slot is provided on the top of the stem for this purpose.
7. Replace the O-ring (key 138) in the body (key 142).
8. For a handwheel assembly used on sizes 30/30i through 60/60i actuators, complete the disassembly by driving out the groove pin (key 140, figure 11) and sliding the pusher plate (key 135, figure 11) off the stem.

For a handwheel assembly used on a sizes 70/70i or 87 actuator, complete the disassembly by unscrewing the retaining screw (key 174, figure 12) and removing the thrust bearing and pusher plate (keys 175 and 135, figure 12). Because the retaining screw (key 174) has left-hand threads, turn clockwise to loosen.

Assembly for Top-Mounted Handwheel

1. For a handwheel assembly used on sizes 30/30i through 60/60i actuators, coat the end of the handwheel stem (key 133, figure 11) with anti-seize lubricant (key 244). Slide the pusher plate (key 135, figure 11), onto the stem, and drive in the groove pin (key 140, figure 11) to lock the pieces together.

For a handwheel assembly used on a sizes 70/70i or 87 actuator, pack the thrust bearing (key 175, figure 12) with anti-seize lubricant (key 244). Place the thrust bearing in the pusher plate (key 135, figure 12), slide the two parts onto the handwheel stem (key 133). Coat the retaining screw threads with thread locking sealant (key 242). Insert and tighten the retaining screw (key 174, figure 12).

2. Coat the O-ring (key 138) with lithium grease (key 241), and insert the O-ring in the body (key 142).
3. Coat the threads of the handwheel stem (key 133) with anti-seize lubricant (key 244). Screw the stem into the body (key 142).
4. Thread the travel stop locknut (key 137) onto the handwheel stem (key 133).
5. Place the handwheel (key 51), and the stop nut (key 54) on the handwheel stem (key 133). Tighten the hex nut to fasten the parts together. Secure the nut with the cotter pin (key 247).
6. If the body (key 142) was separated from the upper diaphragm casing (key 1, figures 6, 7, 8, 9, or 10), lubricate the O-ring (key 139) with lithium grease (key 241), and place the O-ring in the body. Align the holes in the diaphragm casing and the body, insert the cap screws (key 141), and tighten them evenly following a crisscross pattern to ensure a proper seal.
7. Position the upper diaphragm casing (key 1) on the diaphragm (key 2) and align the holes.

Note

When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing bolts are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 30/30i-70/70i and 87 actuators.

CAUTION

Over-tightening the diaphragm casing cap screws and nuts (keys 22 and 23) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

Note

Do not use lubricant on these bolts and nuts. Fasteners must be clean and dry.

8. Insert the cap screws (key 22), and tighten the hex nuts (key 23) in the following manner. The first four hex nuts tightened should be diametrically opposed and 90 degrees apart. Tighten these four hex nuts to 13 N•m (10 lbf•ft).
9. Tighten the remaining hex nuts in a clockwise, criss-cross pattern to 13 N•m (10 lbf•ft).
10. Repeat this procedure by tightening four hex nuts, diametrically opposed and 90 degrees apart, to a torque of 27 N•m (20 lbf•ft).
11. Tighten the remaining hex nuts in a clockwise, criss-cross pattern to 27 N•m (20 lbf•ft).
12. After the last hex nut is tightened to 27 N•m (20 lbf•ft), all of the hex nuts should be tightened again to 27 N•m (20 lbf•ft) in a circular pattern around the bolt circle.
13. Once completed, no more tightening is recommended.
14. Mount the actuator on the valve following the procedures in the Installation section.

Side-Mounted Handwheel for Sizes 34 through 60 and 34i through 60i Actuators

A side-mounted handwheel assembly is normally used as a manual actuator for sizes 34 through 60 (figures 13 and 15) and 34i through 60i actuators (figures 14 and 16). Turning the handwheel counter-clockwise past the neutral position opens the valve. Two levers (key 146, figures 13, 14, 15, and 16) on a handwheel assembly operate the valve by moving the valve stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then begin the assembly at the appropriate step.

Disassembly for Side-Mounted Handwheel (Sizes 34-60 and 34i-60i)

1. Use **step a. for size 34 through size 60** actuators, and use **step b. for sizes 34i through 60i**.

   a. **For Size 34 through 60:** If desired, the handwheel assembly can be removed from the actuator yoke. To do this, remove the hex nuts (keys 147 and 170) from the U-bolts (key 166 and 143) that hold the assembly to the yoke for the size 30 and size 40. Remove the hex nuts (key 144 and 170) from the U-bolts (key 166 and 143) that hold the assembly to the yoke for the size 45 through size 60.

   b. **For Size 34i through 60i:** If desired, the handwheel assembly can be removed from the actuator yoke. To do this, remove the cap screws (key 256 and 257) and spacers (key 258) that hold the assembly to the yoke for the size 30i through size 60i.

2. Remove the retaining ring (key 154) and drive out the lever pivot pin (key 153).
3. Two screws (key 156) hold the right- and left-hand levers (key 146) together. Remove the screw from the top of the levers so that the levers will drop down out of the assembly. Disassemble further, if necessary, by removing the other screw.
4. Remove the screw (key 161) and pointer mounting bolt (key 159, not shown) located behind the pointer (key 160).
5. Remove the stop nut (key 54), lockwasher (key 150), and washer (key 149). Then remove the handwheel (key 51), being careful not to lose the small ball (key 55) and spring (key 56).
6. Loosen the locking set screw (key 168, figure 16). Then, using a suitable tool, unscrew the bearing retainer (key 136).

7. Pull the handwheel screw assembly (key 145) out of the handwheel body. The operating nut (key 132) will come out with the screw. Also remove the bushing (key 151, figure 13 or 14) on size 34 and 40.
8. If required, remove the two ball bearings (key 152), one from the bearing retainer and the other from the handwheel body.

Assembly for Side-Mounted Handwheel (Sizes 34-60 and 34i-60i)

Click here or access the following QR code for a video on installing a side-mounted handwheel on a 657 actuator.

1. Pack the ball bearings (key 152) with anti-seize lubricant (key 244). Insert one bearing and the bushing (key 151, figure 13 or 14) into the handwheel body (key 142). The bushing is not used in a handwheel assembly for sizes 45/45i through 60/60i actuators.
2. Coat the handwheel screw assembly (key 145) threads with anti-seize lubricant (key244), and thread the operating nut (key 132) onto the screw. Slide the second ball bearing (key 152) onto the screw, and insert the end of the screw into either the bushing (key 151, figure 13 or 14) for sizes 34/34i and 40/40i, or into the bearing for sizes 45/45i through 60/60i.
3. Thread the bearing retainer (key 136) into the body (key 142). Completely tighten the bearing retainer, and then loosen it one-quarter turn. Tighten the set screw (key 168, figure 13 or 14) to hold the bearing retainer in place.
4. Coat the groove in the handwheel body (key 142) with lithium grease (key 241). Insert the spring (key 56) and ball (key 55) into the handwheel (key 51).Holding the ball and spring in the handwheel, put the handwheel, the washer (key 149), the lockwasher (key 150), and the stop nut (key 54) onto the end of the end of the handwheel screw (key 145). Tighten the stop nut.
5. Position the pointer mounting bolt (key 159, not shown) and pointer (key 160). Insert and tighten the screw (key 161).
6. Assemble the two levers (key 146) with the cap screws (key 156) for handwheel assemblies for sizes 45/45i, 50/50i, and 60/60i actuators, or with the machine screws (key 156) for handwheel assemblies on sizes 34/34i and 40/40i actuators.
7. Use **step a. for size 34 through size 60** actuators, and use **step b. for sizes 34i through 60i**.

   a. **For Size 34 through 60:** If the handwheel assembly was removed from the yoke (key 9, figures 6, 8, or 10), remount the handjack assembly to the yoke using the dowel pins for alignment. For the size 34 and size 40, position the U-bolts and J-bolts (keys 166 and 143) on the yoke, and hand-tighten the hex nuts (keys 170 and 147) to hold the handwheel assembly in position. For the size 45 through size 60, position the U-bolts (keys 166 and 143) on the yoke, and hand-tighten the hex nuts (keys 170 and 144) to hold the handwheel assembly in position. Cap screws (key 163) should be tight against the yoke legs to provide stability. Tighten the nuts (key 144 for size 30 and size 40, key 158 for the size 45 through size 60). For the size 34 and size 40 finish tightening the U-bolt nuts to 81 N • m [60lbf • ft] (key170) and 41 N • m [30 lbf • ft] (key 147). For the sizes 45 through 60 finish tightening the U-bolt nuts to 163 N • m [120lbf • ft] (key170) and 41 N • m [30 lbf • ft] (key 144). Be sure the handwheel assembly remains flat against the mounting pad and perpendicular to the yoke.

   b. **For Size 34i through 60i:** If the handwheel assembly was removed from the yoke (key 9, figures 7, 9, or 10), remount the handjack assembly to the yoke using the dowel pins for alignment. Position the upper cap screws (key 256) on the assembly and hand-tighten to hold the handwheel assembly in position. Place the spacers (key 258) between the yoke and handjack assembly, position cap screws (key 257), and hand-tighten. For the size 34i and size 40i, finish tightening the cap screws (key 256) to 81 N • m [60 lbf • ft] and (key 257) to 41 N • m [30 lbf • ft]. For the sizes 45i through 60i, finish tightening the cap screws (key 256) to 163 N • m [120 lbf • ft] and (key 257)to 41 N • m [30 lbf • ft].

8. Position the levers (key 146) as shown in figures 11 or 12. Insert the lever pivot pin (key 153), and snap the retaining ring (key 154) onto the lever pivot pin.

Side-Mounted Handwheel for Sizes 70 and 87 Actuators

A side-mounted handwheel assembly (figure 17) is normally used as a manual actuator for sizes 70 and 87 actuators. Turning the handwheel counter-clockwise past the neutral position opens the valve body. A pair of sleeves (keys 34 and 46, figure 17) operates the valve by moving the valve stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; and then begin the assembly at the appropriate step.

Key numbers refer to figures 8 or 10, and 13.

Disassembly for Side-Mounted Handwheel (Size 70 & 87)

1. Bypass the control valve, reduce loading pressure to atmospheric, and remove the tubing or piping from the upper diaphragm casing (key 1).
2. Remove cover band (key 60), and relieve spring compression by turning the spring adjuster (key 12) counter-clockwise.
3. Remove the cap screws and casing screws and nuts (keys 22 and 23), lift off the upper diaphragm casing (key 1), and remove the diaphragm (key 2).
4. Remove the cap screw (key 3) and the washer (key 25), then take off the diaphragm plate (key 4).
5. Remove the actuator spring (key 6), the upper sleeve (key 34), and the spring seat (key 11) from the yoke cylinder. This exposes the needle bearing and races (keys 37 and 38).
6. Separate the halves of the stem connector assembly (key 26) by removing the two cap screws. Remove the actuator stem (key 10).
7. Remove the travel indicator (key 14).

CAUTION

To avoid possible product damage, do not move the neutral indicator scale after completing the following step.

8. Turn the handwheel to raise the lower sleeve (key 46) until it is free of the worm gear (key 44). Lift out the lower sleeve and the key (key 47). DO NOT move the neutral indicator scale (key 59).
9. Loosen two set screws (key 40), then unscrew the bearing retainer flange (key 39) and the attached spring adjuster (key 12), using a suitable tool in the open neck of the flange. Take out the gear and two needle bearings (key 42), one on each side of the gear.
10. Remove the spring adjuster (key 12) from the bearing retainer flange (key 39). If desired, the worm shaft (key 45) and associated parts can be disassembled to replace or lubricate them. To do so, first remove the stop nut (key 54) and the handwheel (key 51). Do not lose the small ball (key 55) and spring (key 56).
11. Loosen the two set screws (key 41), and unscrew the front and back retainers (keys 48 and 49). The ball bearings (key 50) will come out with the retainers. Remove the worm shaft (key 45).

Assembly for Side-Mounted Handwheel (Size 70 & 87)

1. The front and back retainers (keys 48 and 49) each have a slot in their threads for a set screw (key 41). Pack the ball bearings (key 50) with anti-seize lubricant (key 244), and insert one ball bearing into the back retainer (key 49) as shown in figure 17.
2. Thread the back retainer and ball bearing (keys 49 and 50) into the yoke (key 9). Align the slot in the bearing retainer with the set screw hole in the yoke, insert the set screw (key 41), and tighten it.

3. Coat the worm shaft (key 45) threads with anti-seize lubricant (key 244), and slide the shaft into the yoke so that the end of the shaft fits snugly into the back retainer (key 49).
4. Insert the bearing into the front retainer (key 48), and thread the retainer and ball bearing into the yoke (key 9). Align the slot in the retainer with the hole in the yoke, insert the set screw (key 41), and tighten it.
5. Put the spring and ball (keys 56 and 55) into the handwheel (key 51). Slide the handwheel onto the worm shaft (key 45). Thread the stop nut (key 54) onto the shaft.
6. Pack the two needle bearings (key 42) and coat the worm gear (key 44) threads with anti-seize lubricant (key 244). Insert the key (key 47), the bearings, and the gear into the yoke (key 9) as shown in figure 17.
7. Slots are cut into the threads of the bearing retainer flange (key 39). Thread the flange into the yoke (key 9) so that the slots and the holes for the set screws (key 40) align. Insert the screws, and tighten them.
8. The lower sleeve (key 46) has milled slots in one end. Coat the sleeve threads with lithium grease (key 241), then slide the end of the lower sleeve with the milled slots into the bearing retainer flange (key 39).
9. Turn the handwheel (key 51), and feed the sleeve through the gear so that the slot in the lower sleeve (key 46) engages the key (key 47) in the yoke (key 9). Continue turning the handwheel until the lower sleeve protrudes 93.7 mm (3.69 inches) below the surface of the yoke. The pin in the side of the lower sleeve should line up with the extension on the neutral indicator.
10. Slide the square end of the actuator stem (key 10) through the lower sleeve (key 46) so the stem contacts the valve stem. Clamp both stems in the two halves of the stem connector (key 26). The stem connector should not be closer than 3.2 mm (1/8 inches) to the lower sleeve when the actuator stem is in the retracted position. This adjustment will provide approximately 3.2 mm (1/8 inches) of free travel of the lower sleeve in either direction for manual operation. Fasten the stem connector halves together with the cap screws.
11. Pack the needle bearing and race (keys 37 and 38) with lithium grease (key 241), and slide the bearing onto the spring adjuster (key 12).
12. Put the spring seat and actuator spring (keys 11 and 6) into the yoke (key 9). Slide the upper sleeve (key 34) onto the actuator stem (key 10).
13. Put the diaphragm plate and washer (keys 4 and 25) onto the actuator stem (key 10). Insert and tighten the cap screw (key 3) to fasten the parts together.
14. Place the diaphragm (key 2) pattern-side up onto the diaphragm plate (key 4). Align the holes in the diaphragm and the lower diaphragm casing (key 5).
15. Position the upper diaphragm casing (key 1) onto the diaphragm (key 2) and align the holes.

Note

When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing bolts are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 30-70, 30i-70i, and 87 actuators.

CAUTION

Over-tightening the diaphragm casing cap screws and nuts (keys 22 and 23) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

Note

Do not use lubricant on these bolts and nuts. Fasteners must be clean and dry.

16. Insert the cap screws (key 22), and tighten the hex nuts (key 23) in the following manner. The first four hex nuts tightened should be diametrically opposed and 90 degrees apart. Tighten these four hex nuts to 13 N•m (10 lbf•ft).
17. Tighten the remaining hex nuts in a clockwise, criss-cross pattern to 13 N•m (10 lbf•ft).
18. Repeat this procedure by tightening four hex nuts, diametrically opposed and 90 degrees apart, to a torque of 27 N•m (20 lbf•ft).
19. Tighten the remaining hex nuts in a clockwise, criss-cross pattern to 27 N•m (20 lbf•ft).
20. After the last hex nut is tightened to 27 N•m (20 lbf•ft), all of the hex nuts should be tightened again to 27 N•m (20 lbf•ft) in a circular pattern around the bolt circle.
21. Once completed, no more tightening is recommended.
22. Mount the actuator onto the valve, following the procedures in the Installation section.
23. Return the actuator to service after completing the Loading Connection procedure in the Installation section and the procedures in the Adjustments section.

Casing-Mounted Adjustable Travel Stops

Note

If repeated or daily manual operation is expected, the actuator should be equipped with a manual top-mounted or side-mounted handwheel. Refer to the Top-Mounted Handwheel and Side-Mounted Handwheel sections of this instruction manual.

The casing-mounted adjustable up travel stop (figures 18 or 19) limits the actuator stroke in the upward direction. To adjust, first relieve actuator loading pressure before removing the travel stop cap (key 187, figure 18 or 19). Loosen the travel stop nut (key 137). Then turn the travel stop stem (key 133) clockwise into the diaphragm case to move the actuator stem downward (or counter-clockwise to move the stem upward). Finally, tighten the travel stop nut and replace the travel stop cap.

The adjustable down travel stop (figure 20) limits the actuator stroke in the downward direction. To adjust, first relieve actuator loading pressure before removing the travel stop cap (key 187). Then loosen the jam nut and adjust the stop nut (keys 189 and 54) either down on the stem to limit travel, or up on the stem to allow more travel. Lock the jam nut against the stop nut, then replace the closing cap.

Instructions are given below for disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then, begin the assembly at the appropriate step.

Key numbers are shown in figures 18, 19, and 20.

Disassembly for Casing-Mounted Travel Stop

Bypass the control valve. Reduce the loading pressure to atmospheric, and remove the tubing or piping from the connection in the body (key 142).

Casing-Mounted Adjustable Up Travel Stops

⚠ WARNING

To avoid personal injury from the precompressed spring force thrusting the upper diaphragm casing (key 1) away from the actuator, relieve spring compression (steps 1 and 2, below), and carefully remove casing cap screws (key 22) (step 3, below).

1. Thread the spring adjuster (key 12) out of the yoke (key 9) until all spring compression is relieved.
2. Remove the travel stop cap (key 187) and loosen the travel stop nut (key 137). Rotate the travel stop stem (key 133) counter-clockwise until the travel stop assembly is no longer compressing the spring.
3. Remove the upper diaphragm casing (key 1, figures 6, 7, 8, 9, or 10) as outlined in the Maintenance section.
4. Remove the cap screws (keys 141) and separate the travel stop assembly from the upper casing.
5. Remove and inspect the O-rings (keys 138 and 139); replace if necessary.
6. Proceed with the following procedure, based on actuator size:

- For sizes 30/30i through 60/60i, drive out the groove pin (key 140), and slide the pusher plate (key 135) off the travel stop stem (key 133) or....
- For sizes 70/70i and 87, remove the retaining screw (key 174) to inspect the thrust bearing (key 175).

Casing-Mounted Adjustable Down Travel Stops

⚠ WARNING

To avoid personal injury from the precompressed spring force thrusting the upper diaphragm casing (key 1) away from the actuator, relieve spring compression (steps 1 and 2, below), and carefully remove casing cap screws (key 22) (step 3, below).

1. Thread the spring adjuster (key 12) out of the yoke (key 9) until all spring compression is relieved.
2. Remove the travel stop cap (key 187). Unscrew the jam nut and stop nut (keys 189 and 54) until the travel stop assembly is no longer compressing the spring. Remove the jam nut and stop nut.
3. Remove the upper diaphragm casing (key 1, figures 6, 7, 8, 9, or 10) as outlined in the Maintenance section.
4. Remove the cap screws (keys 141) and separate the travel stop assembly from the upper casing.
5. Remove and inspect the O-ring (keys 139); replace if necessary.
6. For all actuator sizes: Loosen the stop nut (key 54), then unscrew the travel stop stem (key 133) out of the actuator stem. The lower diaphragm plate can now be removed.

Assembly for Casing-Mounted Travel Stop

1. Reassemble the up or down travel stop in the reverse order of the disassembly steps, being sure to apply lubricant as shown by the lubrication boxes (key 241) in figures 6, 7, 8, 9, 10, 18, 19, or 20, as appropriate.
2. Readjust the travel stop to obtain the appropriate restriction by following the adjustment procedures presented in the introductory portion of the Casing-Mounted Adjustable Travel Stops section. Return the unit to operation.

Parts Ordering

Each actuator has a serial number stamped on the nameplate. Always mention this number when corresponding with your Emerson sales office or Local Business Partner regarding technical information or replacement parts. Also, reference the complete 11-character part number of each needed part as found in the following Parts List.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Automation Solutions should not, under any circumstances, be used in any Fisher valve, because they may void your warranty, might adversely affect the performance of the valve, and could cause personal injury and property damage.

Parts Kits

Kits for Side-Mounted Handwheels

Retrofit kit includes parts to add a side-mounted handwheel.

Description	Part Number
Size 34 push down to close	30A8778X0A2
Size 34 push down to open	30A8778X0B2
Size 40 push down to close	30A8778X0C2
Size 40 push down to open	30A8778X0D2
Size 45 & 46 push down to close	40A8779X0A2
Size 45 & 46 push down to open	40A8779X0B2
Size 50 & 60 push down to close	40A8779X0C2
Size 50 & 60 push down to open	40A8779X0D2
Size 34i push down to close	GE71635X0A2
Size 34i push down to open	GE71635X0B2
Size 40i push down to close	GE71635X0C2
Size 40i push down to open	GE71635X0D2
Size 45i & 46i push down to close	GE71636X0A2
Size 40i & 60i push down to open	GE71636X0B2
Size 50i & 60i push down to close	GE71636X0C2
Size 50i & 60i push down to open	GE71636X0D2

Transition Kits for Side-Mounted Handwheels

Transition kits include fasteners necessary to remount an existing side-mounted handwheel to an actuator where the yoke has been changed to a size i yoke.
Contains key numbers 256, 257, and 258.

Description	Part Number
Size 34i/40i push-down-to-close or push-down-to-open	GE71635X0J2
Size 45i - 60i push-down-to-close or push-down-to-open	GE71636X0E2

Kits for Top-Mounted Handwheels

Retrofit kit includes parts to add a top-mounted handwheel. Kit 1 includes the handwheel assembly only. Kit 2 includes kit 1 and a new diaphragm case that is required to mount the handwheel assembly.

Description	Part Number
KIT 1	
Size 30/30i	28A1205X012
Sizes 34/34i & 40/40i	28A1205X022
Sizes 45/45i, 50/50i, & 60/60i	28A1205X032
Sizes 70/70i & 87	CV8010X0032
KIT 2	
Size 30/30i	28A1205X042
Sizes 34/34i & 40/40i	28A1205X052
Sizes 45/45i & 50/50i	28A1205X062
Sizes 46/46i & 60/60i	28A1205X072
Sizes 70/70i & 87	CV8010X0042

Parts List

Note
Contact your Emerson sales office or Local Business Partner for part numbers.

Actuator Assembly (figures 6, 7, 8, 9, or 10)

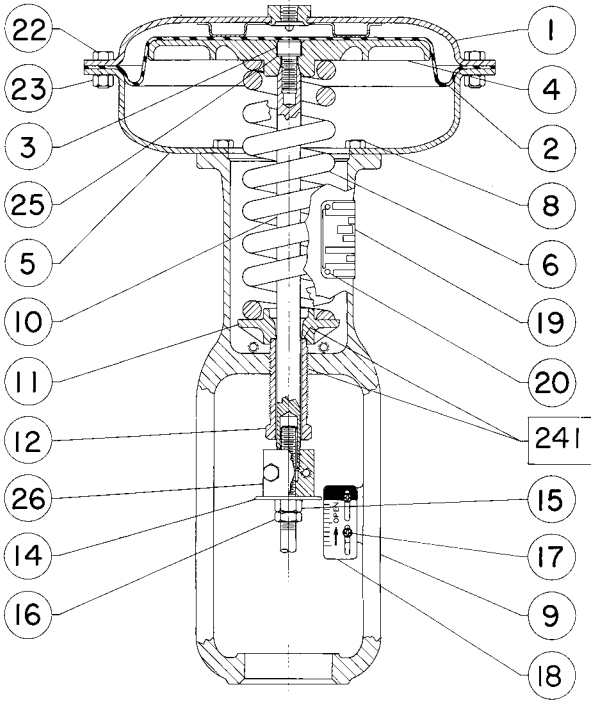
Key	Description
1	Upper Diaphragm Casing
2*	Diaphragm Molded nitrile/nylon Standard construction With down travel stop (style 2) Molded silicone/polyester Standard Construction
3	Cap Screw
4	Diaphragm Plate
5	Lower Diaphragm Casing
6	Actuator Spring
7	Travel Stop Cap Screw
8	Cap Screw
9	Yoke
10	Actuator Stem
11	Spring Seat
12	Spring Adjuster
13	Lower Diaphragm Plate
14	Travel Indicator Disk, SST
15	Stem Nut
16	Stem Jam Nut
17	Self-Tapping Screw
18	Travel Indicator Scale
19	Nameplate, SST
20	Drive Screw
22	Cap Screw
23	Hex Nut
24	Twin Speed Nut
25	Washer
26	Stem Connector Assy, Steel Zn Pl
28	Screw
29	Yoke Extension
30	Indicator Adaptor
31	Machine Screw
32	Washer
33	Pipe Bushing
61	Nameplate
73	Cap Screw
238	Warning label
241	Lubricant, Lithium Grease (not furnished with the actuator)
249	Caution nameplate

Top Mounted Handwheel (figure 11 or 12)

Key	Description
51	Handwheel
54	Stop Nut
133	Handwheel Stem, brass
134	Washer
135	Pusher Plate
137	Casing-Mounted Travel Stop Locknut
138*	O-Ring, nitrile
139*	O-Ring, nitrile
140	Groove Pin
141	Cap Screw
142	Body
169	Grease Fitting
174	Retaining Screw
175	Thrust Bearing
176	Thrust Race
241	Lubricant, Lithium Grease (not furnished with actuator)
242	Sealant, Thread-Locking (not furnished with handwheel)
244	Lubricant, Anti-Seize (not furnished with handwheel)
246	Spacer
247	Cotter Pin

*Recommended spare parts

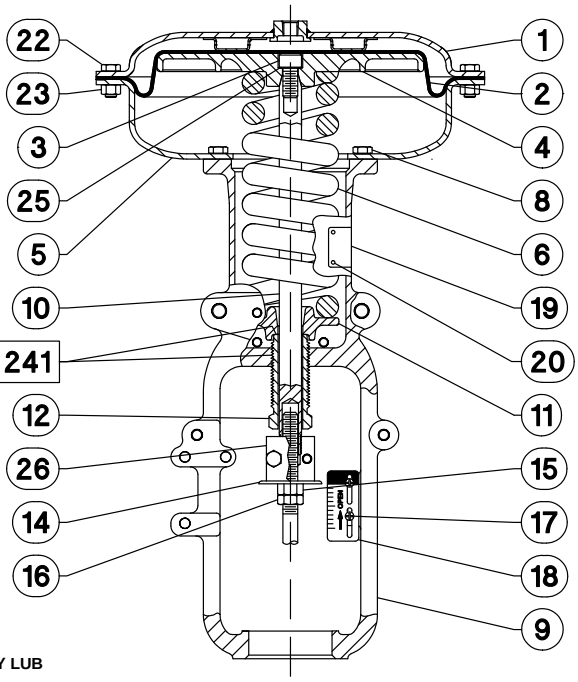
Figure 6. Fisher 657 Actuator Sizes 30 through 60



☐ APPLY LUB

40A8765-C

Figure 7. Fisher 657 Actuator Sizes 30i through 60i



☐ APPLY LUB

PARTS NOT SHOWN: KEY 7, 24, AND 249

GE71419-A

Figure 8. Fisher 657 Size 70 Actuator

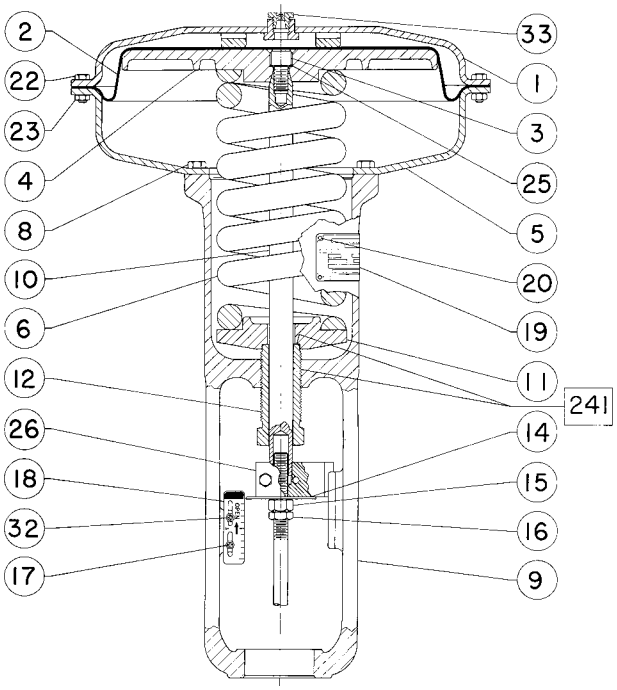
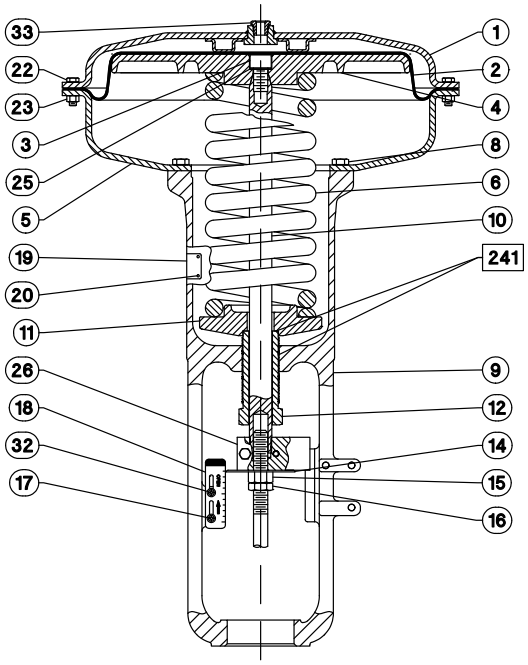


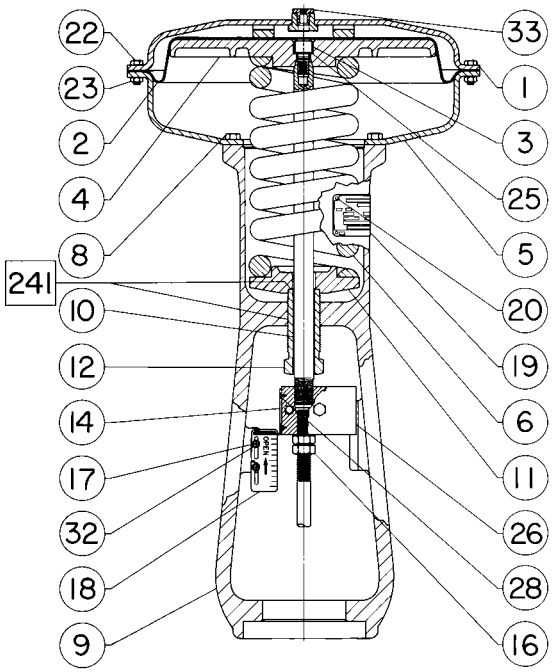
Figure 9. Fisher 657 Size 70i Actuator



PARTS NOT SHOWN: KEY 7, 24, AND 249

GE71634-A

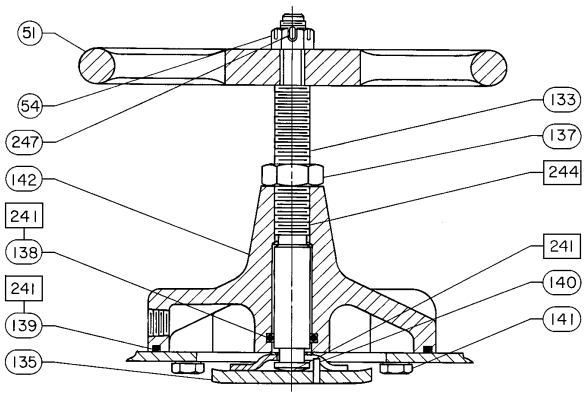
Figure 10. Fisher 657 Size 87 Actuator



Side-Mounted Handwheel (figures 13 - 17)

Key	Description
34	Upper Sleeve
37	Needle Bearing
38	Needle Bearing Race
39	Bearing Retainer Flange
40	Set Screw
41	Set Screw
42	Needle Bearing
43	Needle Bearing Race
44	Worm Gear
45	Worm Shaft
46	Lower Sleeve
47	Key
48	Front Retainer
49	Back Retainer
50	Ball Bearing
51	Handwheel
52	Handgrip
53	Handgrip Bolt
54	Stop Nut
55	Ball
56	Spring
59	Handwheel Indicator
60	Cover Band Ass'y
61	Grease Fitting
132	Operating Nut
136	Bearing Retainer
142	Handwheel Body
143	U-Bolt
144	Hex Nut, pl steel
145	Handwheel Screw
146	Lever & Pin Ass'y
147	Hex Jam Nut
148	Dowel Pin
149	Washer
150	Lockwasher
151	Bushing
152	Ball Bearing
153	Lever Pivot Pin
154	Retaining Ring
155	Lever Spacer
156	Screw
157	Lockwasher
158	Hex Nut
159	Pointer Mounting Bolt
160	Pointer
161	Screw
162	Indicator Plate
163	Cap Screw
166	U-Bolt
167	Guide Bolt
168	Set Screw
169	Grease Fitting
170	Hex Nut
177	Spring Cap
178	Machine Screw
241	Lubricant, Lithium Grease (not furnished with handwheel)
244	Lubricant, Anti-Seize (not furnished with handwheel)
256	Capscrew
257	Capscrew
258	Spacer

Figure 11. Top-Mounted Handwheel Assembly for Size 30/30i through 60/60i Actuators

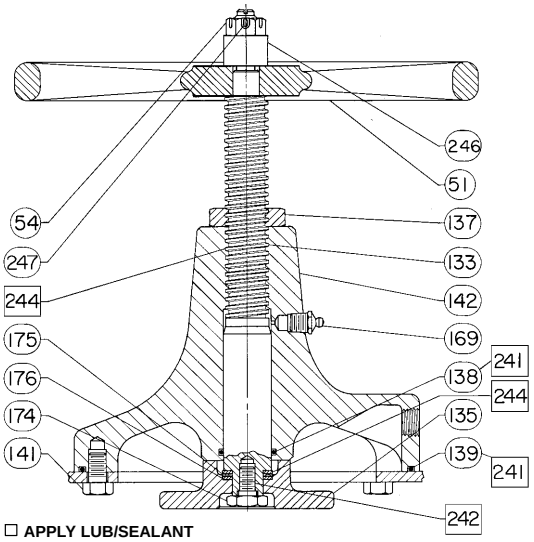


☐ **APPLY LUB/SEALANT**

NOTES:
THE TOP MOUNTED HANDWHEEL IS NOT DESIGNED FOR USE UNDER HEAVY LOAD OR FOR FREQUENT USE.

28A1205-D

Figure 12. Top-Mounted Handwheel Assembly for Sizes 70/70i through 87 Actuators



☐ **APPLY LUB/SEALANT**

NOTES:
THE TOP MOUNTED HANDWHEEL IS NOT DESIGNED FOR USE UNDER HEAVY LOAD OR FOR FREQUENT USE.

CV8010-G

Figure 13. Side-Mounted Handwheel Assembly for Size 34 and 40 Actuators

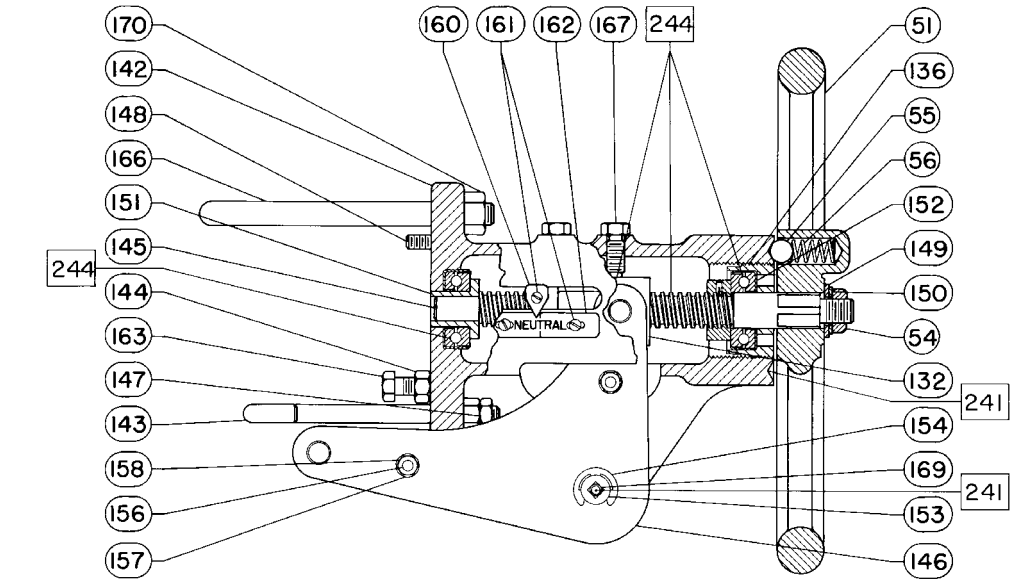


Figure 14. Side-Mounted Handwheel Assembly for Size 34i and 40i Actuators

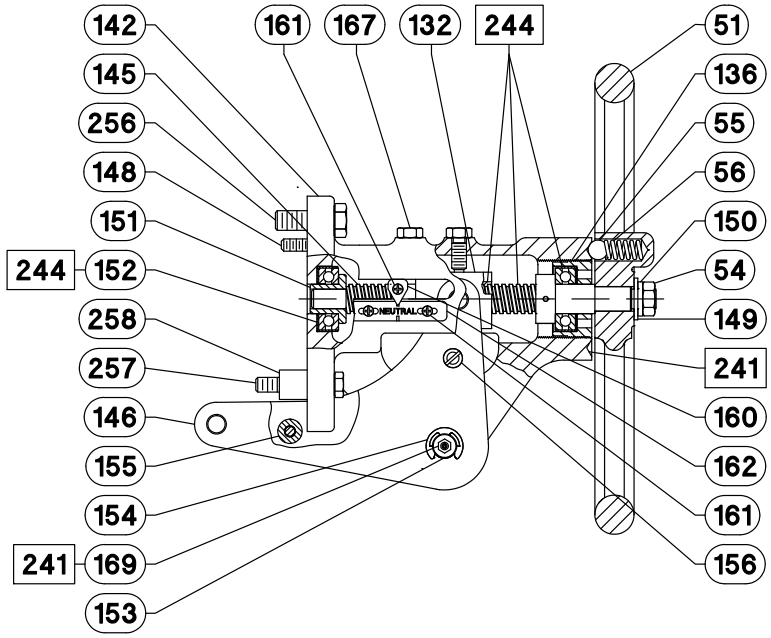


Figure 15. Side-Mounted Handwheel Assembly for Size 45, 46, 50, and 60 Actuators

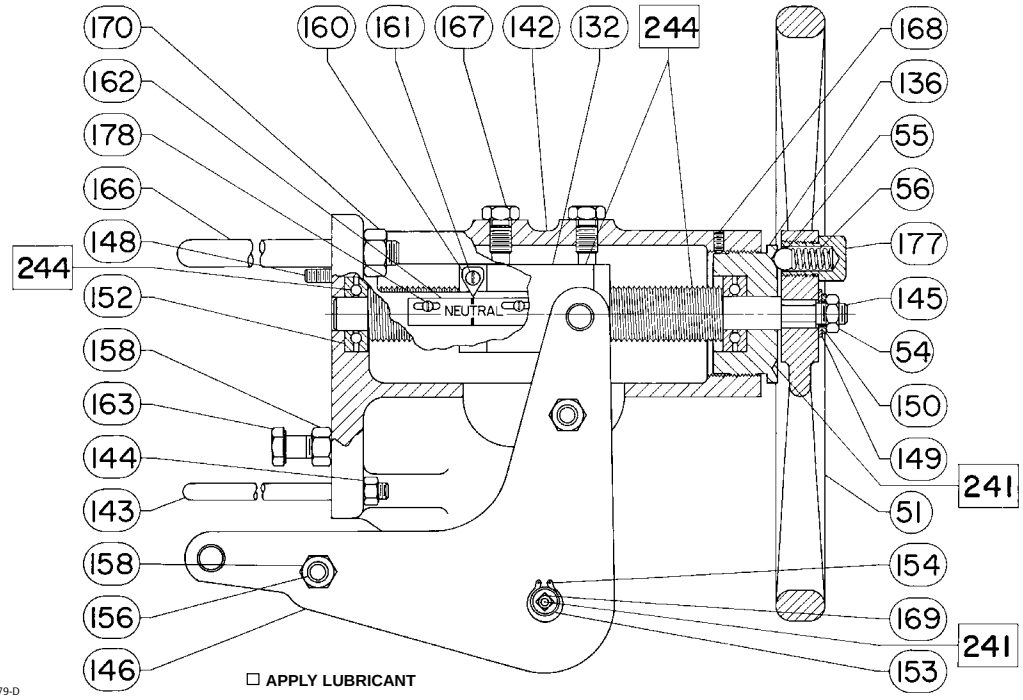


Figure 16. Side-Mounted Handwheel Assembly for Size 45i, 46i, 50i, and 60i Actuators

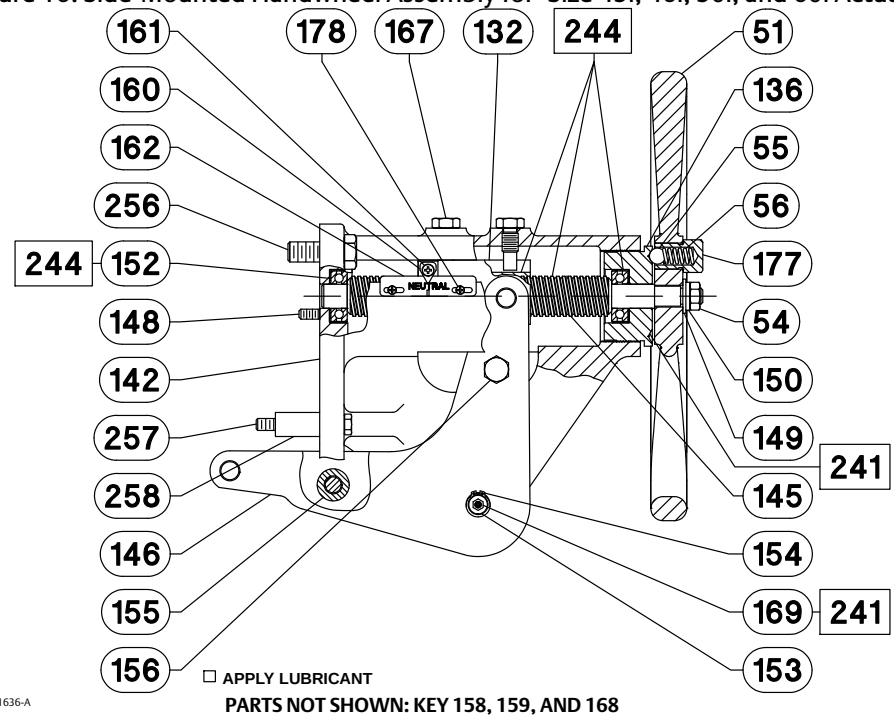
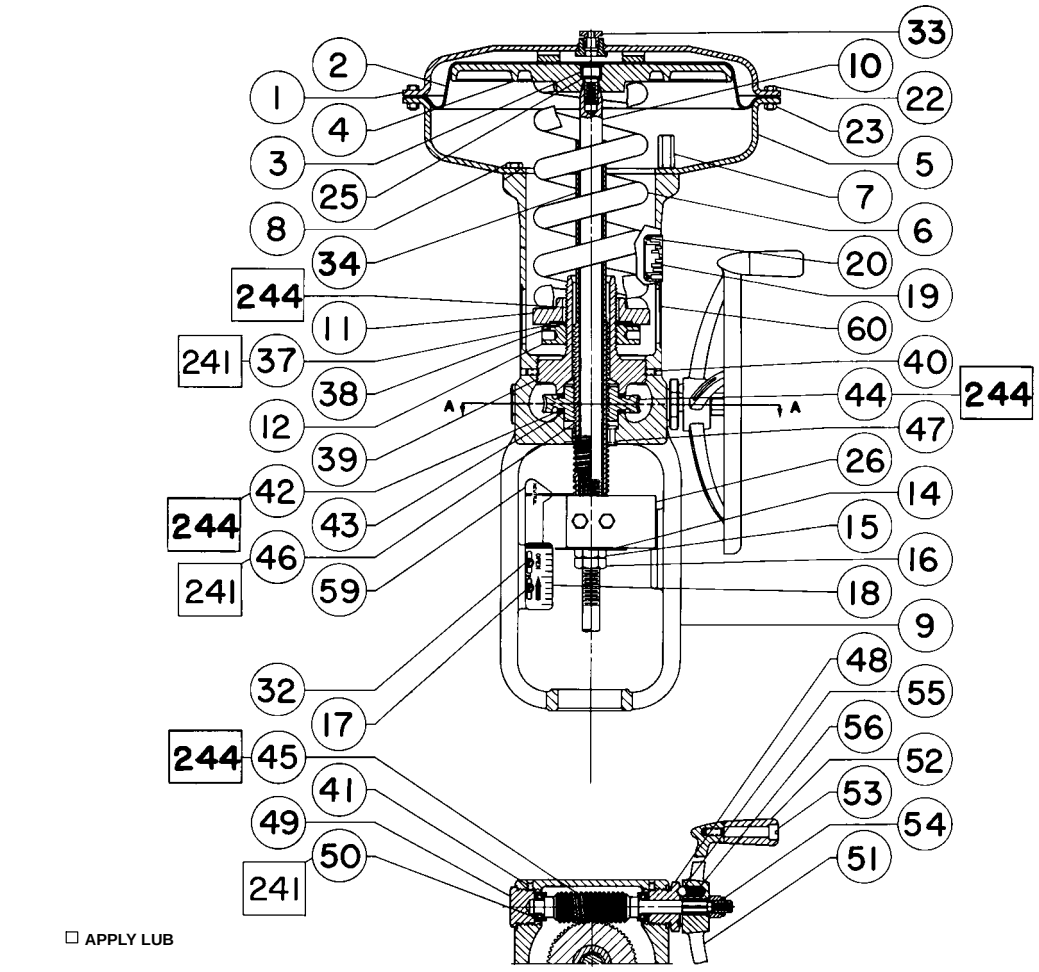


Figure 17. Fisher 657 Size 70 and 87 Actuators with Side-Mounted Handwheel



SECTION A-A

Figure 18. Casing-Mounted Adjustable Up Travel Stop for Sizes 30/30i through 60/60i Actuators (Style 1)

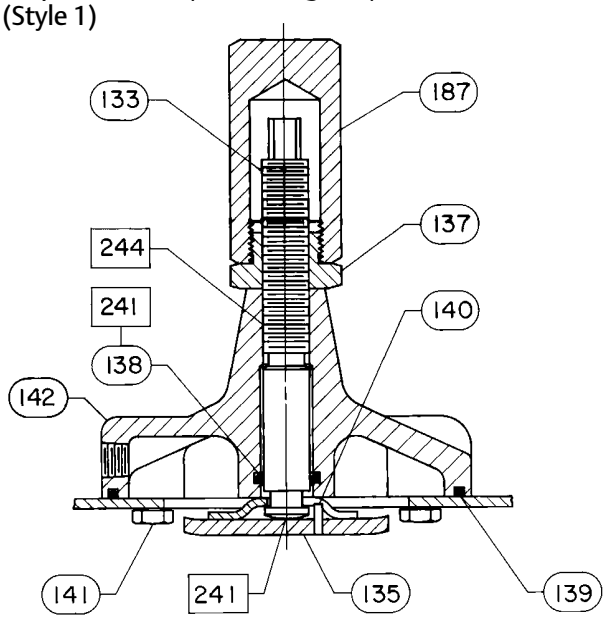
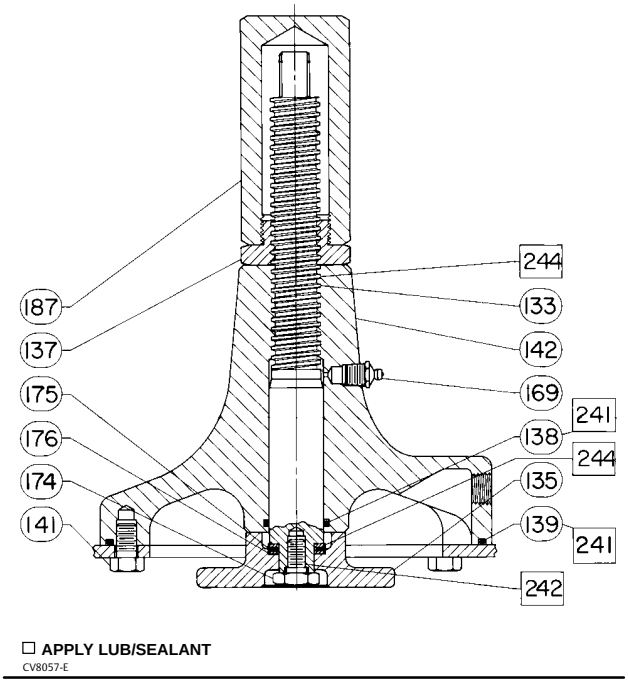


Figure 19. Casing-Mounted Adjustable Up Travel Stop for Sizes 70/70i and 87 Actuators (Style 1)

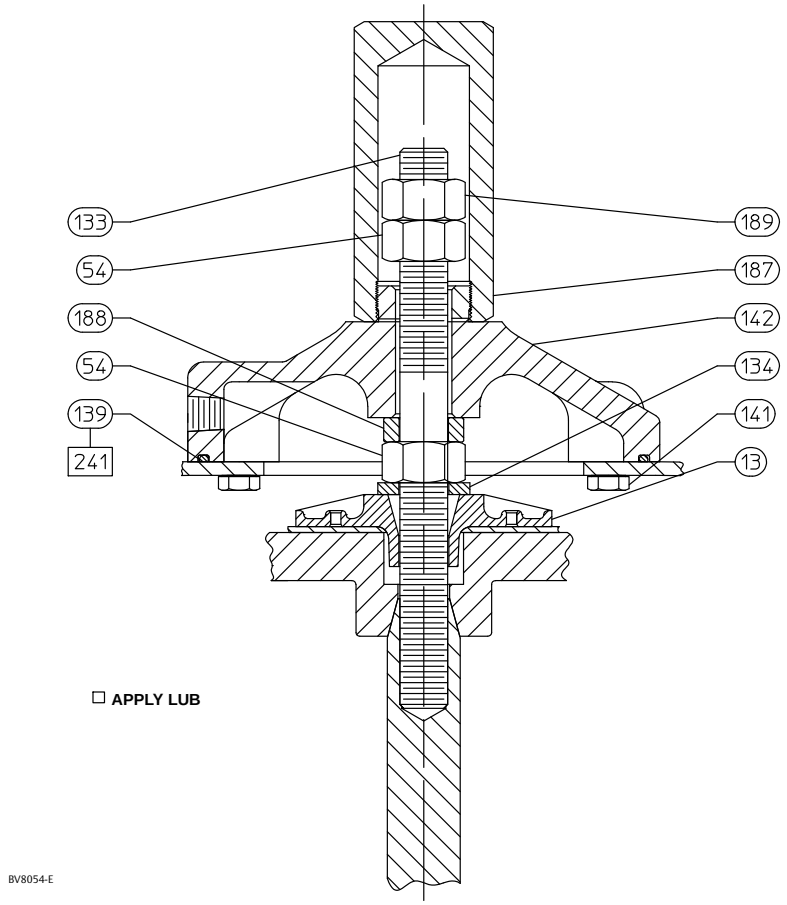


Casing-Mounted Adjustable Up Travel Stops (figures 18 or 19)

Key	Description
133	Travel Stop Stem
135	Pusher Plate
137	Travel Stop Nut
138*	O-Ring, nitrile
139*	O-Ring, nitrile
140	Groove Pin
141	Cap Screw
142	Body
169	Grease Fitting
174	Retaining Screw
175	Thrust Bearing
176	Thrust Bearing Race
187	Travel Stop Cap
241	Lubricant, Lithium Grease (not furnished with travel stop)
244	Lubricant, Anti-Seize (not furnished with handwheel)

*Recommended spare parts

Figure 20. Casing-Mounted Adjustable Down Travel Stop for Size 30/30i and 40/40i Actuators (Style 2)



Casing-Mounted Adjustable Down Travel Stop (figure 20)

Key	Description
54	Stop Nut
133	Travel Stop Stem
134	Washer
139*	O-Ring, nitrile
141	Cap Screw
142	Body
187	Travel Stop Cap
189	Jam Nut
241	Lubricant, Lithium Grease (not furnished with travel stop)

*Recommended spare parts

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Fisher™ 667 Diaphragm Actuator Sizes 30/30i-76/76i and 87

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Figure 1. Fisher 667 Actuator Mounted on easy-e™ Valve



Introduction

Scope of Manual

This instruction manual provides information on installation, adjustment, maintenance, and parts ordering for the Fisher 667 actuator in sizes 30/30i through 76/76i and size 87. The 667-4 actuator in sizes 70/70i and 87 is also covered. Refer to separate instruction manuals for information about the valve positioner and other accessories used with these actuators.

Do not install, operate, or maintain a 667 actuator (see figure 1) without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson sales office or Local Business Partner before proceeding.

Table 1. Specifications

SPECIFICATION(1)		ACTUATOR SIZE									
		30/30i	34/34i	40/40i	45/45i	46/46i	50/50i	60/60i	70/70i(1)	76/76i	87(1)
Nominal Effective Area	Sq cm	297	445	445	667	1006	677	1006	1419	1006	1419
	Sq Inch	46	69	69	105	156	105	156	220	156	220
Yoke Boss Diameter	mm	54	54	71	71	71	90	90	90	90	125
	Inch	2-1/8	2-1/8	2-13/16	2-13/16	2-13/16	3-9/16	3-9/16	3-9/16	3-9/16	5
Acceptable Valve Stem Diameter	mm	9.5	9.5	12.7	12.7	12.7	19.1	19.1	19.1	19.1	25.4
	Inch	3/8	3/8	1/2	1/2	1/2	3/4	3/4	3/4	3/4	1
Maximum Allowable Output Thrust(4)	N	10230	10230	12010	25131	33582	25131	30246	39142	30246	39142
	LB	2300	2300	2700	5650	7550	5650	6800	8800	6800	8800
Maximum Travel(2)	mm	19	29	38	51	51	51	51	76(3)	51	76(3)
	Inch	0.75	1.125	1.5	2	2	2	2	3(3)	2	3(3)
Maximum Casing Pressure for Actuator Sizing(4,6)	Bar	3.8	4.8	4.8	4.5	3.8	4.5	3.8	3.4	3.4	3.4
	Psig	55	70	70	65	55	65	55	50	50	50
Maximum Excess Diaphragm Pressure(4,5)	Bar	3.8	1.4	1.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7
	Psig	55	20	20	10	10	10	10	10	10	10
Maximum Diaphragm Casing Pressure(4,6,7)	Bar	7.6	6.2	6.2	5.2	4.5	5.2	4.5	4.1	4.1	4.1
	Psig	110	90	90	75	65	75	65	60	60	60
Approximate Weight	Kg	15/17	22/26	23/26	41/44	55/59	43/48	55/60	115/118	86/89	118
	Pounds	34/37	48/58	50/56	90/98	121/129	94/105	122/133	254/260	190/196	260
Material Temperature Capabilities	Nitrile Elastomers	-40 to 82°C (-40 to 180°F)									
	Silicone Elastomers	-54 to 149°C (-65 to 300°F)									

1. These values also apply to the 667-4 actuator construction.
2. Actuator travel may be less than the value listed after connected to the valve.
3. Maximum actuator travel for 667-4 is 102 mm (4 inches).
4. See also the Specifications portion of the introduction section.
5. Additional pressure may be added when the actuator is at full travel. If the Maximum Excess Diaphragm Pressure is exceeded, damage to the diaphragm or diaphragm casing might result. See the Maximum Pressure Limitation section.
6. Maximum diaphragm casing pressure must not be exceeded and must not produce a force on the actuator stem greater than the maximum allowable actuator output thrust or the maximum allowable stem load. See the Maximum Pressure Limitation section.
7. This maximum casing pressure is not to be used for normal operating pressure. Its purpose is to allow for typical regulator supply settings and/or relief valve tolerances.

Description

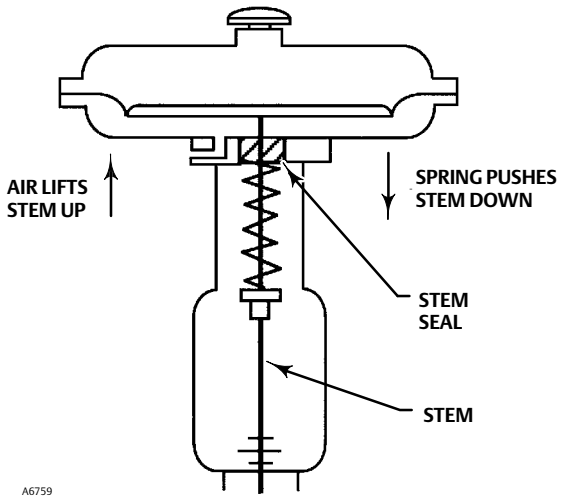
The 667 actuator (figure 1) and the 667-4 actuator are reverse-acting, spring-opposed diaphragm actuators. They provide automatic operation of control valves. The 667 actuator provides 76 mm (3 inches) maximum actuator travel. The 667-4 actuator provides 102 mm (4 inches) maximum actuator travel. Both actuators position the valve plug in response to varying pneumatic loading pressure on the diaphragm. Figure 2 shows the operation of these actuators.

A 667 or 667-4 actuator can be furnished with either a top-mounted or a side-mounted handwheel assembly. A top-mounted handwheel assembly is normally used as an adjustable down travel stop. (A down travel stop limits actuator travel in the down direction [when the stem is traveling out of the actuator]. Travel in the up direction is when the stem is traveling into the actuator.) A side-mounted handwheel assembly is normally used as an auxiliary manual actuator. The side-mounted handwheel can also be used as an adjustable up or down travel stop. Casing-Mounted adjustable up or down travel stops are also available on this actuator.

Note

If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as a manual operator.

Figure 2. Schematic of Fisher 667 and 667-4 Actuators



Specifications

Refer to table 1 for Specifications of the 667 and 667-4 actuators. See the actuator nameplate for specific information for your actuator.

Educational Services

For information on available courses for Fisher 667 diaphragm actuators, as well as a variety of other products, contact:

Emerson Automation Solutions
Educational Services - Registration
Phone: 1-641-754-3771 or 1-800-338-8158
E-mail: education@emerson.com
emerson.com/fishervalvetraining

Instructional Videos

Click here or access the following QR code for a video on mounting a DVC6200 Digital Valve Controller on a 667 actuator.

Click here or access the following QR code for a video on installing a side-mounted handwheel on a 667 actuator.

⚠ WARNING

To avoid personal injury or damage to equipment that may result in the malfunction of the control valve or loss of control of the process caused by excessive pressure, do not exceed the Maximum Pressures listed in table 1. Refer to the Maximum Pressure Limitations section.

Maximum Pressure Limitations

The casing and diaphragm of 667 actuators are pressure operated. This air pressure provides energy to compress the spring, to stroke the actuator, and to seat the valve. The following explanations describe the maximum pressure limits for an actuator. Refer to the nameplate or table 1 for maximum values for your actuator.

- Maximum Casing Pressure for Actuator Sizing: This is the maximum pressure that can be applied at less than full travel of the actuator. If this stroking pressure is exceeded before the upper diaphragm plate contacts the travel stop, damage to the stem or other parts might result.
- Maximum Excess Diaphragm Pressure: Additional pressure may be added when the actuator is at full travel. If the Maximum Excess Diaphragm Pressure is exceeded, damage to the diaphragm or diaphragm casing might result.

Because the actuator has traveled its specified travel, and the diaphragm head is physically stopped from movement, the energy from any additional air pressure is transmitted to the diaphragm and diaphragm casings. The amount of air pressure that can be added once the actuator has traveled to the stops is limited by the resultant adverse effects that may occur. Exceeding this limiting factor could result in leakage or casing fatigue due to the deformation of the upper diaphragm casing.

- Maximum Diaphragm Casing Pressure: If the Maximum Diaphragm Casing Pressure is exceeded, damage to the diaphragm, diaphragm casing, or actuator might result.

Installation

⚠ WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations.

Check with your process or safety engineer for any other hazards that may be present from exposure to process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

Key number locations are shown in figures 6, 7, 8, 9, and 10, unless otherwise noted. Also, refer to figure 3 for location of parts.

CAUTION

To avoid parts damage, do not use an operating pressure that exceeds the Maximum Diaphragm Casing Pressure (table 1) or produces a force on the actuator stem greater than the Maximum Allowable Output Thrust (table 1) or the Maximum Allowable Valve Stem Load.

- Valve/Actuator Assembly: If the actuator and valve are shipped together as a control valve assembly, it has been adjusted at the factory, and may be installed in the pipeline. After installing the valve in the pipeline, refer to the Loading Connection procedures.
- Actuator Mounting: If the actuator is shipped separately or the actuator has been removed from the valve, it is necessary to mount the actuator on the valve before placing the valve in the pipeline. Refer to the following actuator mounting procedures before placing the valve in service. It is recommended that you perform the Bench Set Spring Adjustment procedures in this section to confirm that the actuator is adjusted correctly for the valve travel.
- Positioner: If a positioner is installed, or is to be installed on the actuator, refer to the positioner instruction manual for installation. During the adjustment procedures, it will be necessary to provide a temporary loading pressure to the actuator diaphragm.
- Handwheel Cap: If the handwheel cap (key 247, figures 11, 13, or 21) is not in place, install the cap by pushing it on by hand until it snaps into place.

Mounting the Actuator on the Valve

CAUTION

The 667 actuator spring load pushes the stem down out of the actuator yoke (see figure 2), and it can come in contact with the valve stem during actuator mounting.

If the valve stem is allowed to remain in the up position (towards the actuator) during actuator mounting, it can interfere with the actuator stem during mounting. It is possible to damage valve stem threads or bend the valve stem. Be sure the valve stem is pushed down (into the valve body), away from the actuator while mounting.

It may be necessary to apply a temporary loading pressure to the actuator to move the actuator stem away from the valve during installation.

If it is not possible to provide a temporary loading pressure, be very careful when lowering the actuator over the valve stem to prevent damage to valve stem and threads.

⚠ WARNING

When moving the actuator stem with loading pressure applied, exercise caution to keep hands and tools out of the actuator stem travel path. If the loading pressure is accidently disconnected, personal injury and property damage may result if something is caught between the actuator stem and other control valve parts.

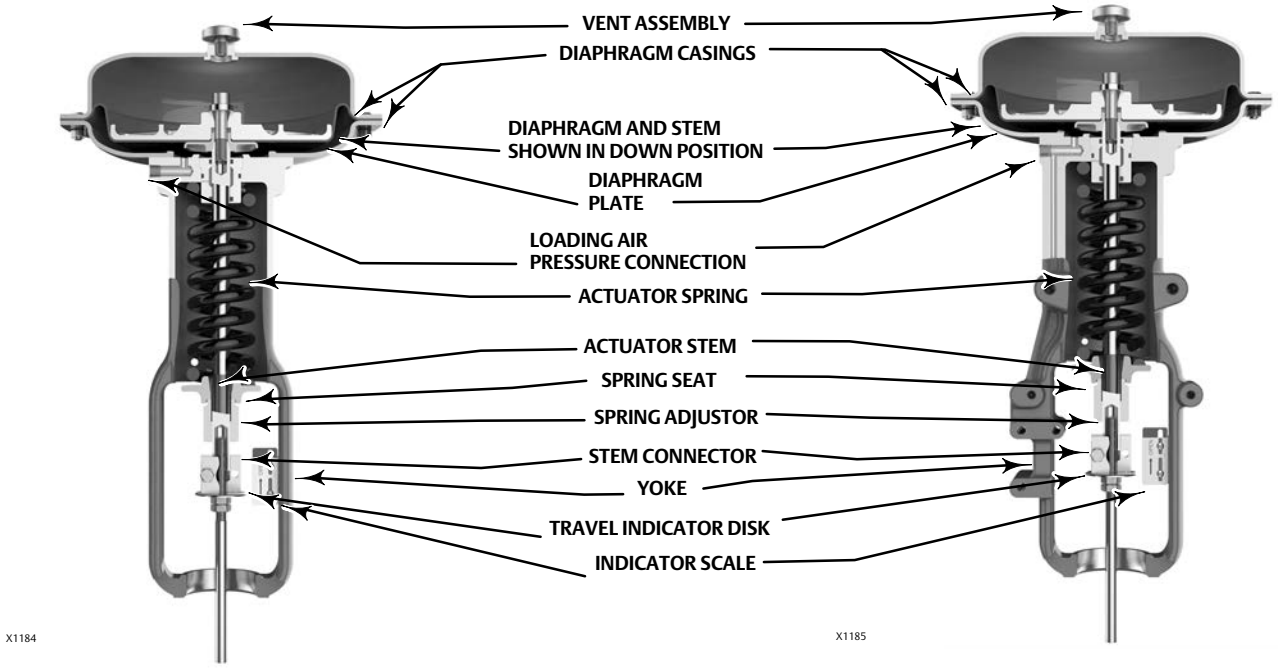
1. Provide a vise or some other method of supporting the valve and the weight of the actuator during assembly. For direct or reverse acting valves, push the valve stem down away from the actuator while mounting the actuator.
2. Screw the stem locknuts all the way onto the valve stem. With the concave side of the travel indicator disk (key 34) facing the valve, install the travel indicator disk on the valve stem. (Note: The travel indicator disk is not used with size 87 actuators.)
3. Lift or hoist the actuator onto the valve bonnet:
   a. For size 87 actuators: Slowly lower the actuator down onto the valve while guiding the valve stem into the opening in the end of the actuator stem (see figure 4). Once the actuator is in place, insert the cap screws and tighten the hex nuts, securing the actuator to the bonnet.

b. For all other size actuators:

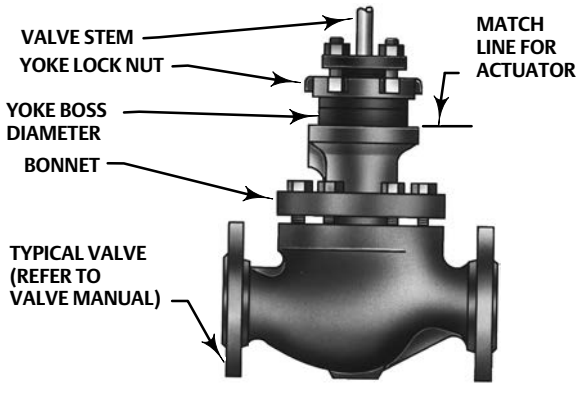
- Slowly lower the actuator down onto the valve. As the yoke passes over the end of the valve stem, place the yoke locknut over the valve stem. (Note: On small size actuators, it may be necessary to remove the indicator disk and re-install it while lowering the actuator onto the valve because the disk will not go through the actuator yoke opening).
- Continue to lower the actuator while guiding the valve stem into the opening in the end of the actuator stem until the actuator is in place (see figure 4).
- Screw the yoke locknut onto the valve bonnet and tighten the locknut.

4. Do not connect the actuator stem to the valve stem at this time. Whenever the actuator is installed on the valve, it is recommended that you perform the Bench Set Spring Adjustment procedures below, to verify that the actuator is still adjusted correctly.

Figure 3. Actuator-Mounting Components for Size 30/30i through 70/70i Actuators



SIZE 30 THROUGH 76 **SIZE 30i THROUGH 76i**



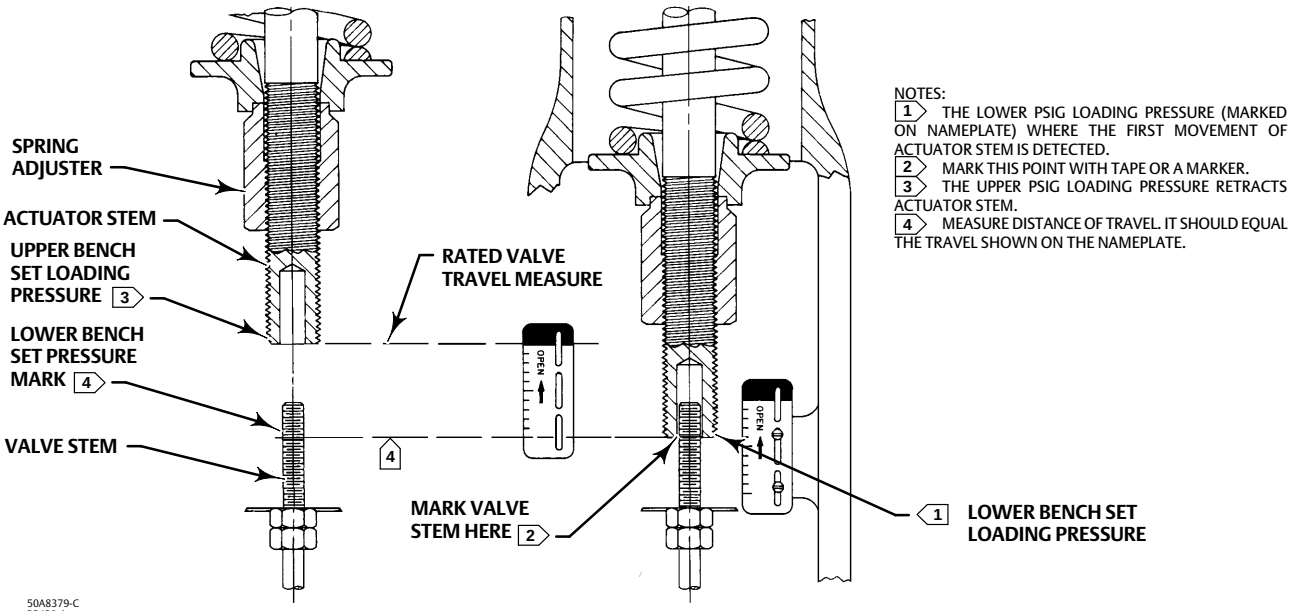
Discussion of Bench Set

The bench set pressure values are used to adjust the initial compression of the actuator spring with the valve-actuator assembly "on the bench." The correct initial compression ensures that the valve-actuator assembly will function properly when it is put into service and the proper actuator diaphragm operating pressure is applied.

The bench set values are established with the assumption that there is no packing friction. When attempting to adjust the spring in the field, it is very difficult to ensure that there is no friction being applied by "loose" packing.

Accurate adjustment to the bench set range can be made during the actuator mounting process by making the adjustment before the actuator is connected to the valve (see the Spring Verification Procedure).

Figure 4. Bench Set Adjustment



Spring Verification

Ensure that the actuator diaphragm is at the bottom of its travel as shown in figure 4 and not connected to the valve. (Note: Some spring compression is required to move the diaphragm to the bottom of its travel.)

Also, provide a certified pressure gauge that will accurately read the diaphragm pressure from 0 through 0.3 bar (5 psig) above the upper operating range pressure marked on the nameplate. Apply loading pressure to the diaphragm.

Stroke the actuator a few times to ensure that the pressure gauge is working correctly, and that the actuator is functioning properly.

CAUTION

To prevent actuator damage, it is important to ensure that the actuator stem is stroking smoothly and not exhibiting binding or excessive friction between the actuator stem and the bushing (key 7). Binding or excessive friction could be an indicator of incorrect assembly or damaged parts.

Key numbers are shown in figures 6, 7, 8, 9, and 10.

Note

For 667 actuators installed on push-down-to-close (direct acting) valves with fail-close action, the valve plug seat is the limit for downward travel and the actuator is the limit for upward (away from the valve) movement.

For 667 actuators installed on push-down-to-open (reverse acting) valves with fail-open action, the actuator down stop is the limit for downward movement, and the valve seat is the limit for upward (away from the valve) movement.

Ensure the correct Spring Verification procedure is followed for the type of valve on which the 667 actuator is installed.

For Push Down to Close (Direct Acting) Valves

1. If not already accomplished, push the valve stem down away from the actuator to the closed position.
2. Set the diaphragm loading pressure to 0.3 bar (5 psig) over the upper operating range pressure. The travel stop cap screw (key 12) should be contacting the upper diaphragm casing.
3. Slowly decrease the pressure towards the upper bench set pressure, as indicated on the nameplate, while checking for the **first** linear movement of the actuator stem.

Note

Before turning the spring adjuster on size 70/70i, 76/76i, or 87 actuators, assemble the stem connector around the actuator stem and the anti-rotating lug on the yoke. Mark the actuator stem as a visual reference to verify that stem rotation does not occur. Remove the stem connector before rechecking the bench set.

4. If movement occurs before or after the upper bench set pressure is reached, adjust the spring adjuster (see figure 4). Thread the adjuster up or down on the actuator stem until the actuator stem movement is **first** detected at the upper bench set pressure. (Note: You may need to lower the loading pressure to reduce spring compression, allowing the spring adjuster to turn.)
5. Be sure the spring adjuster is adjusted to meet the requirements of step 4 above.
6. Slowly decrease diaphragm loading pressure to the lower bench set pressure, as indicated on the nameplate. This will extend the actuator stem toward the valve. Mark the end of the actuator stem on a nearby surface using tape or some other method.
7. Slowly increase the diaphragm loading pressure until the upper bench set pressure is reached. Again, the travel stop cap screw (key 12) should be against the upper diaphragm casing.
8. Measure the distance between the mark or tape to the end of the actuator stem. This distance should match the rated travel indicated on the nameplate.
9. If the measured travel matches the nameplate travel, bench set is complete. Proceed to the Installing the Stem Connector Assembly subsection.
10. If the measured travel is not exact, consider the spring free-length and spring rate tolerances may produce a slightly different bench set than specified. Contact your Emerson Automation Solutions sales office for assistance.

For Push Down to Open (Reverse Acting) Valves

1. If not already accomplished, push the valve stem down away from the actuator to the open position. Later, when installing the connector, pull up the valve stem to the closed position.

2. Set the diaphragm loading pressure to a value less than the lower bench set pressure, as indicated on the nameplate, or near zero. The down travel stops (key 77) should be contacting the yoke.
3. Slowly increase the pressure towards the lower bench set pressure while checking for the **first** linear movement of the actuator stem.

Note

Before turning the spring adjuster on size 70/70i, 76/76i, or 87 actuators, assemble the stem connector around the actuator stem and the anti-rotating lug on the yoke. Mark the actuator stem as a visual reference to verify that stem rotation does not occur. Remove the stem connector before rechecking the bench set.

4. If movement occurs before or after the lower pressure is reached, adjust the spring adjuster (see figure 4). Thread the adjuster up or down on the actuator stem until the actuator stem movement is **first** detected at the lower bench set pressure.
5. Apply the upper bench set pressure indicated on the nameplate to the diaphragm. This will retract the actuator stem away from the valve. Mark the end of the actuator stem on a nearby surface using tape or some other method.
6. Slowly decrease the diaphragm pressure until the lower bench set pressure is applied. Again, the down travel stops (key 77) should be against the yoke.
7. Measure the distance between the mark or tape to the end of the actuator stem. This distance should match the rated travel indicated on the nameplate.
8. If the measured travel matches the nameplate travel, bench set is complete. Proceed to the Installing the Stem Connector Assembly subsection.
9. If the measured travel is not exact, consider the spring free-length and spring rate tolerances may produce a slightly different bench set than specified. Contact your Emerson Automation Solutions sales office for assistance.

Installing the Stem Connector Assembly

When installing the stem connector assembly (key 31), the actuator and valve stem threads should engage the threads of the stem connector by a distance equal to the diameter of the stem.

⚠ WARNING

Install the stem connector securely before a positioner is mounted to the actuator and pressurized, using only a regulator-controlled air supply, not the positioner, to move the actuator stem.

To avoid personal injury or property damage, keep hands and tools out of the actuator stem travel path while applying loading pressure to move the actuator stem in the following steps.

CAUTION

To avoid damaging the seating surfaces, do not rotate the valve plug while it is seated. Exercise care while installing the stem connector assembly to avoid damage to the valve plug stem and valve stem threads.

Note

Replacement stem connectors are an assembly of two stem connector halves, cap screws, and a spacer between the connector halves. Remove the spacer and discard it, if present, before clamping the actuator and valve stems together. Use only a mated pair of stem connectors.

1. If necessary, push the valve stem down so that the valve plug is touching the seat ring on direct-acting valves. For reverse-acting valves, pull the stem up to the closed position. Always start with the valve plug on the seat.
2. If necessary, screw the valve stem locknuts down, away from the connector location. For all actuators except size 87, ensure that the travel indicator disk (key 34) is on top of the locknuts.
3. Adjust the diaphragm pressure to the lower bench set pressure (or, the upper bench set pressure for reverse-acting valves.) This should be the same pressure used in the Spring Verification steps, and it is marked on the nameplate.
4. Place the stem connector half with the threaded holes approximately half way between the actuator and valve stems, and align the actuator stem and valve stem with threads from both stems mated root-to-crest with the stem connector. If the threads from one of the stems do not fully align with the stem connector, a slight change to loading pressure may be necessary to align the threads. Refer to figures 6, 7, 8, 9, and 10 to help locate the connector position.

CAUTION

Incomplete engagement of either the valve stem or actuator stem in the stem connector can result in stripped threads or improper operation. Be sure that the length of each stem clamped in the stem connector is equal to or greater than one diameter of that stem. Damage to threads on either stem or in the stem connector can cause the parts to be replaced prematurely. Do not loosen the cap screws when the stem connector has spring or loading pressure force applied.

5. Install the other half of the stem connector and insert the cap screws and tighten them while ensuring even spacing between the stem connector halves on all sides. If installing a positioner, also attach the feedback bracket at the same time.

CAUTION

Over-tightening the valve stem locknuts can make disassembly difficult.

6. Screw the valve stem locknuts up against the stem connector for the size 87 actuator. For all other actuator sizes, screw the valve stem locknuts up until the indicator disk contacts the bottom of the stem connector. Do not overtighten the locknuts.
7. Slowly stroke the valve from fully open to fully closed and verify full rated travel is achieved.

Be sure that the valve is in the closed position. Loosen the screws on the travel indicator scale (key 32), and align it with the travel indicator disk (key 34). Stroke the valve full travel to ensure that the travel matches the rated valve travel on the nameplate. If valve travel is not correct, repeat the stem connector procedure.

Friction Discussion

If you are attempting to adjust the bench set after the actuator is connected to the valve and the packing tightened, you must take friction into account. Make the spring adjustment so full actuator travel occurs at the bench set values (a) plus the friction force divided by the effective diaphragm area with increasing diaphragm pressure or (b) minus the friction force divided by the effective diaphragm area with decreasing diaphragm pressure.

If the stem connector assembly has been installed, the valve friction may be determined by the following procedure:

1. Install a pressure gauge in the actuator loading pressure line that connects to the actuator diaphragm casing.

Note

Steps 2 and 4 require that you read and record the pressure shown on the pressure gauge.

2. Increase the actuator diaphragm pressure and read the diaphragm pressure as the actuator reaches a travel position in the rated travel of the valve that does not contact a travel stop. Make a reference mark on the travel indicator scale using tape or some other method at this point.
3. Increase the actuator diaphragm pressure until the actuator is at a travel position greater than the position referenced in step 2 using the reference point to identify first movement.
4. Decrease the actuator diaphragm pressure and read the diaphragm pressure as the actuator returns to the position referenced in step 2.

The difference between the two diaphragm pressure readings is the change in the diaphragm pressure required to overcome the friction forces in the two directions of travel.

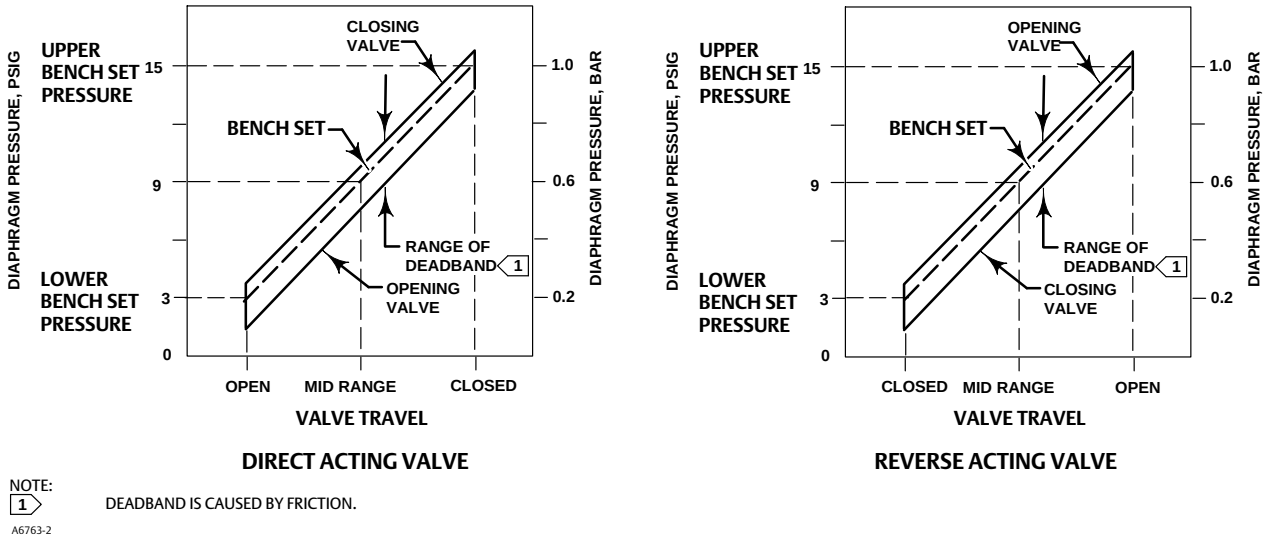
5. Calculate the actual friction force:

$$\text{Friction Force, = pounds} \quad 0.5 \left(\text{Difference in pressure readings, psig} \right) \times \left(\text{Effective diaphragm area, inches}^2 \right)$$

Refer to table 1 for the effective diaphragm area.

It is difficult to rotate the spring adjustor (key 74, figures 6, 7, 8, 9, and 10) when the full actuator loading pressure is applied to the actuator. Release the actuator loading pressure before adjusting. Then re-apply loading pressure to check the adjustment.

Figure 5. Typical Valve Response to Deadband



NOTE:
1 DEADBAND IS CAUSED BY FRICTION.

A6763-2

Deadband Measurement

Deadband is caused by packing friction, unbalanced forces, and other factors in the control valve assembly. Deadband is the range a measured signal can vary without initiating a response from the actuator (see figure 5). Each actuator spring has a fixed spring rate (force divided by compression). You have verified that the right spring was installed in the actuator by completing the Spring Verification steps.

Deadband is one factor that affects the control valve assembly operation during automatic loop control. The control loop tolerance for deadband varies widely depending on the loop response. Some common symptoms of the

deadband being too wide are no movement, a “jump” movement, or oscillating movements of the actuator during automatic loop control. The following steps are provided to determine the span of deadband. The percent of deadband is helpful in troubleshooting problems with the process control loop.

1. Start at a pressure near the lower bench set pressure, slowly increase pressure until the valve is approximately at mid-travel. Note this pressure reading.
2. Slowly decrease pressure until movement of the valve stem is detected, and note this pressure.
3. The difference between these two pressures is deadband, in psi.
4. Calculate the percent of deadband by:

Deadband, psi

$$\text{Deadband} = \frac{\text{Deadband, psi}}{\text{Bench Set Span, psi}} = \text{nn \%}$$

Loading Connection

Key number locations are shown in figures 6, 7, 8, 9, and 10, unless otherwise noted.

The loading pressure connections are made at the factory if the valve, actuator, and positioner come as a unit. Keep the length of tubing or piping as short as possible to avoid transmission lag in the control signal. If a volume booster, valve positioner, or other accessory is used, be sure that it is properly connected to the actuator. Refer to the positioner instruction manual or other manuals as necessary. For actuators shipped separately or whenever the actuator pressure connections are installed, use the following steps:

1. Connect the loading pressure piping to the NPT internal connection in the side of the yoke (key 73).
2. For size 70/70i and 87 actuators, if necessary, remove the 1/4 NPT bushing if a 1/2 NPT internal connection is needed to increase connection size. The connection can be made with either piping or tubing.
3. Cycle the actuator several times to be sure that the valve stem travel is correct when the correct pressure ranges are applied to the diaphragm.
4. If valve stem travel appears to be incorrect, refer to the Bench Set Spring Adjustment procedures at the beginning of this section. Do not place the valve in service if it is not reacting correctly to diaphragm loading pressure changes.

Maintenance

Actuator parts are subject to normal wear and must be inspected regularly and replaced when necessary. The frequency of inspection and replacement depends on the severity of service conditions.

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or uncontrolled movement of parts. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**

- **Vent the power actuator loading pressure and relieve any actuator spring pre-compression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline.* Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

The maintenance instructions are divided into several sections: Actuator, Top-Mounted Handwheel Assembly (Adjustable Down Travel Stop), Side-Mounted Handwheel Assembly for Size 34/34i through 60/60i Actuators (Manual Actuator), Side-Mounted Handwheel Assembly for Size 70, 76 and 87 Actuators (Manual Actuator), and Casing-Mounted Travel Stops.

Actuator

This procedure describes how the actuator can be completely disassembled and assembled. When inspection or repairs are required, disassemble only those parts necessary to accomplish the job; then, start the assembly at the appropriate step.

Key numbers are shown in figures 6, 7, 8, 9, or 10, unless otherwise noted. Figure 6 shows the size 30 through 60 actuators, figure 7 shows the size 30i through 60i actuators, figure 8 shows the size 70 actuator, figure 9 shows the size 70i actuator, and figure 10 shows the size 87 actuator.

Actuator Disassembly

Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Also shut off all pressure lines to the power actuator, release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.

1. If equipped, remove the tubing or piping from the connection in the top of the yoke (key 73).
2. Turn the spring adjuster (key 74) counterclockwise (toward the valve body) until all spring compression is relieved.

⚠ WARNING

To avoid personal injury due to the sudden uncontrolled movement of parts, do not loosen the stem connector cap screws when the stem connector has spring force applied to it.

3. If necessary, remove the actuator from the valve body by separating the stem connector (key 31). Loosen the stem locknuts for the size 87 actuator, and remove the stem connector nuts. For all other sizes, separate the stem connector by loosening the stem locknuts (keys 69 and 75) and unscrewing the two stem connector cap screws.
4. Unscrew the spring adjuster (key 74) from the actuator stem (key 144). Also lift the spring seat and spring (key 19 and 18) out of the yoke.
5. Remove the diaphragm casing cap screws and nuts (keys 13 and 14), and lift off the upper diaphragm casing (key 1).

CAUTION

Be careful during disassembly to avoid damaging the O-rings (key 8).

6. Remove the following connected parts: the diaphragm (key 3), upper diaphragm plate (key 4), spacer (key 2), cap screw (key 12), lower diaphragm plate (key 71), and actuator stem (key 144). Be careful when pulling the threads of the actuator stem through the seal bushing (key 7) to avoid damaging the O-rings (key 8).
7. Remove the cap screw (key 12) to separate the parts of this assembly.
8. To remove the seal bushing, remove the snap ring (key 72), and lift out the bushing. Inspect, and if necessary, replace O-rings (keys 8 and 9).
9. Remove cap screws (key 30), and take off the lower diaphragm casing (key 64) and the gasket (key 70, size 30/30i through 60/60i and 76/76i) or O-ring (key 70, size 70/70i or 87). If necessary, the down travel stops (key 77) can be removed.

Table 2. Actuator Assembly Recommended Torque Values

DESCRIPTION, KEY NUMBER	ACTUATOR SIZE	THREAD SIZE, INCH	TORQUE	
			N • m	Lbf • ft
Casing to yoke, key 30(1)	30/30i to 60/60i and 76/76i	3/8-16	41	30
	70/70i and 87	1/2-13	95	70
Travel stop, key 12	30/30i	3/8-24	41	30
	34/34i and 40/40i	1/2-20	68	50
	45/45i to 76/76i and 87	3/4-16	183	135
MO U-bolt nut, key 170	34 and 40	1/2-13	81	60
	45 to 60	5/8-11	163	120
MO U-bolt nut, key 147	34 and 40	3/8-16	41	30
MO U-bolt nut, key 144	45 to 60	3/8-16	41	30
Diaphragm casing, key 14(1)	30/30i to 76/76i and 87	3/8-24	27	20
Hex cap screw,key 256	34i to 40i	1/2-13	92	68
	45i to 60i	5/8-11	163	120
Hex cap screw,key 257	34i to 60i	3/8-16	39	29
Stem connector, key 26(2)	30/30i through 40/40i	5/16-18	23	17
	45/45i through 70/70i	3/8-16	39	29
	87	1/2-13	91	67

1. Observe tightening pattern and procedure described in the appropriate Actuator Assembly section.
2. Torque values when lithium grease is used on the threads.

Actuator Assembly

Refer to table 2 as appropriate.

1. Coat the O-rings (key 70/70i, sizes 70 and 87) with lithium grease (key 237), or, coat the gasket with lithium grease (key 237). Place a new gasket or O-ring (key 70) on the yoke (key 73). Position the lower diaphragm casing (key 64) on the yoke and align the holes. Insert the cap screws (key 30) and tighten evenly in a crisscross pattern to 41 N•m (30 lbf•ft) for size 30/30i-60/60i and 76/76i actuators or 95 N•m (70 lbf•ft) for size 70/70i and 87 actuators. If down travel stops (key 77) were removed, insert and tighten them.
2. Coat the O-rings (keys 8 and 9) with lithium grease (key 237) and place the O-rings in the seal bushing (key 7).
3. Fill the seal bushing with lithium grease (key 237), slide the bushing into the yoke (key 73), and install the snap ring (key 72).

CAUTION

Be careful during assembly to avoid damaging the O-rings (key 8).

4. Assemble the actuator stem (key 144), lower diaphragm plate (key 71), diaphragm (key 3), upper diaphragm plate (key 4), and the travel stop cap screw and spacer (keys 12 and 2). Coat the cap screw threads with lithium grease

(key 237). Tighten the cap screw (key 12) to the appropriate torque as shown in table 2. Place this assembly in the actuator. Take care when pushing the actuator stem through the seal bushing so that the threads do not damage the O-rings.

Note

When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing bolts are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 30/30i-76/76i and 87 actuators.

CAUTION

Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

Note

Do not use lubricant on these bolts and nuts. Fasteners must be clean and dry.

5. Install the upper diaphragm casing (key 1), and install the cap screws and nuts (keys 13 and 14). Tighten the diaphragm cap screws and nuts in the following manner.
6. The first four bolts tightened should be diametrically opposed and 90 degrees apart. Tighten these four bolts to 13 N•m (10 lbf•ft).
7. Tighten the remaining bolts in a clockwise, criss-cross pattern to 13 N•m (10 lbf•ft).
8. Repeat this procedure by tightening four bolts, diametrically opposed and 90 degrees apart, to a torque of 27 N•m (20 lbf•ft).
9. Tighten the remaining bolts in a clockwise, criss-cross pattern to 27 N•m (20 lbf•ft).
10. After the last bolt is tightened to 27 N•m (20 lbf•ft), all of the bolts should be tightened again to 27 N•m (20 lbf•ft) in a circular pattern around the bolt circle.
11. Once completed, no more tightening is recommended.
12. Install the actuator spring (key 18) and spring seat (key 19). Apply anti-seize lubricant (key 239) to the threads of the actuator stem and to the surface of the spring adjuster (key 74) that contacts the spring seat. Thread the spring adjuster onto the actuator stem.
13. Mount the actuator onto the valve in accordance with the procedures in the Installation section.

Top-Mounted Handwheel Assembly (Adjustable Down Travel Stop)

Actuator key numbers are shown in figures 6, 7, 8, 9, and 10. And, top-mounted handwheels are shown in figures 11, 12, 13, 14, and 15.

Note

If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as a manual operator.

A top-mounted handwheel assembly (figures 11, 12, 13, 14, and 15) is usually used as an adjustable down travel stop to limit full extension of the actuator stem. Turning the handwheel counterclockwise pulls the extension rod (key 150, figures 11, 13, and 14) up, retracting the actuator stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then, begin the assembly at the appropriate step.

Note

For size 70/70i and 87 actuators with handjack bars (figure 15) it is recommended that the handjack bar (key 58) be removed when not in use and the handwheel cap (key 247) be installed for weather protection of the internal components.

Disassembly for Top-Mounted Handwheel

1. Bypass the control valve, reduce loading pressure to atmospheric, and if equipped, remove the tubing or piping from the connection in the top of the yoke (key 73, figures 6, 8, 9, and 10).
2. Turn the handwheel (key 58) clockwise so that the handwheel assembly is not causing any spring compression.
3. Turn the actuator spring adjuster (key 74) to relieve all the compression from the spring (key 18).
4. If servicing just the thrust bearing, races, and handwheel screw (keys 180, 181, and 160), use the following steps:

- Remove the cap and take out the cotter pin. Remove the castle nut, bearing retainer, thrust bearing, and races (keys 247, 167, 166, 180, and 181).
- Use the handwheel to remove the handwheel screw (key 160) from the handwheel body (key 148).
- If necessary, remove the extension rod (key 150) at this time. Most maintenance procedures do not require the rod to be removed.
- Clean and inspect all parts or replace parts as necessary. Upon re-assembly, lubricate handwheel threads, bearings, and races with anti-seize lubricant (key 239).
- Lubricate and re-install the handwheel screw into handwheel body (key 148). Lubricate and replace the races, bearing, and retainer (keys 181, 180, and 182). Replace the castle nut (key 166), tighten it, and insert the cotter pin (key 167). Replace the handwheel cap (key 247).

5. For size 30/30i through 60/60i and 76/76i actuator handwheels (figures 11 and 13):

- Remove the cap screws (key 161). Make sure that the guide plate can turn between the handwheel body and the mounting plate (keys 157, 148 and 158).
- Remove the cap (key 247) and cotter pin (key 167). Remove the castle nut (key 166) and, if necessary, unscrew the extension rod (key 150). Remove the rod, the handwheel body (key 148), and the attached parts.
- Remove the hex nuts and cap screws (keys 14 and 13, figures 6, 7, 8, 9, and 10) from the diaphragm casings. Lift off the upper diaphragm casing (key 1) and the mounting plate (key 158).
- Turn the handwheel (key 58) to remove the handwheel screw (key 160) from the handwheel body (key 148). Remove the retaining ring (key 60) if the handwheel (key 58) must be separated from the handwheel screw.
- If necessary, perform other actuator maintenance before returning to the following assembly steps.

6. For size 70/70i and 87 actuator handwheels (figures 14 and 15):

- Remove the cap (key 247). Take out the cotter pin (key 167) and remove the castle nut, the bearing retainer, and thrust bearing (keys 166, 182, 181, and 180). It is not necessary to remove the extension rod (key 150) at this time.
- Remove the hex nuts and cap screws (keys 14 and 13, figures 6, 7, 8, 9, and 10) from the diaphragm casings. Lift off the upper diaphragm casing (key 1), handwheel body (key 148) and attached parts.
- If travel stops (key 152) are used, note and record their position relative to the cap screws (key 154) for use in assembly. Remove the travel stops and cap screws, and remove either the mounting plate (key 158, figure 14) or the handwheel body (key 148, figure 14) and attached parts.
- Turn the handwheel (key 58) to remove the handwheel screw (key 160) from the handwheel body (key 148). Remove the retaining ring (key 60) if the handwheel (key 58) must be separated from the handwheel screw.
- If necessary, perform other actuator maintenance before returning to the following assembly steps.

Assembly for Top-Mounted Handwheel

For size 30/30i through 60/60i and 76/76i actuator handwheels:

Refer to figures 11, 12, and 13 for top-mounted handwheel assemblies.

1. If it was removed, slide the handwheel (key 58) onto the end of the handwheel screw (key 160), and snap the retaining ring (key 60) into place. Also, install the guide post (key 150) if it was removed.
2. Generously coat the threads of the handwheel screw (key 160) with anti-seize lubricant (key 239). Turn the screw into the handwheel body (key 148).
3. Install the mounting plate (key 158) to the diaphragm casing (key 1, figures 6, 8, 9, and 10) with the cap screws (key 154). Finger tighten the screws.
4. If travel stops were used, install the travel stops to their original positions as recorded in the proceeding Disassembly steps. Tighten the screws and travel stops.

Note

When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing bolts are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 30/30i-76/76i and 87 actuators.

CAUTION

Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

Note

Do not use lubricant on these bolts and nuts. Fasteners must be clean and dry.

5. Position the diaphragm casing (key 1, figures 6, 7, 8, 9, and 10), mounting plate (key 158), travel stops (key 152), if used, and cap screws (key 154) on the diaphragm. Install the cap screws and hex nuts (keys 13 and 14, figures 6, 7, 8, 9, and 10) and tighten in the following manner.

6. The first four bolts tightened should be diametrically opposed and 90 degrees apart. Tighten these four bolts to 13 N•m (10 lbf•ft).
7. Tighten the remaining bolts in a clockwise, criss-cross pattern to 13 N•m (10 lbf•ft).
8. Repeat this procedure by tightening four bolts, diametrically opposed and 90 degrees apart, to a torque of 27 N•m (20 lbf•ft).
9. Tighten the remaining bolts in a clockwise, criss-cross pattern to 27 N•m (20 lbf•ft).
10. After the last bolt is tightened to 27 N•m (20 lbf•ft), all of the bolts should be tightened again to 27 N•m (20 lbf•ft) in a circular pattern around the bolt circle.
11. Once completed, no more tightening is recommended.
12. If necessary, screw the extension rod (key 150 into the connector (key 27). Slide the guide plate (key 157) onto the extension rod (key 150). For size 45/45i through 76/76i, place the spacer (key 253) on top of the guide plate (key 157). If necessary, replace the extension rod (key 150). Slide the handwheel body (key 148) over the extension rod, position the handwheel body on the spacer (key 253), align the holes, and insert and tighten the cap screws (key 161).
13. Lubricate and install the thrust bearings (keys 181 and 180), install the bearing retainer (key 182), install the castle nut (key 166) on the extension rod. Do not overtighten the castle nut on the bearing. Install the cotter pin (key 167). Replace the cap (key 247).
14. Refer to the Assembly portion of the Actuator maintenance section.

For size 70/70i and 87 actuators handwheels (figures 14 and 15):

Refer to figure 14 for top-mounted handwheel assemblies and figure 15 for handjack bar assemblies.

1. If removed, slide the handwheel (key 58) onto the end of the handwheel screw (key 160), and snap the retaining ring (key 60) into place.
2. Generously coat the threads of the handwheel screw (key 160) with anti-seize lubricant (key 239). Turn the screw into the handwheel body (key 148).
3. If necessary, install the extension rod (key 150) into the connector (key 27) and tighten it. Position the handwheel body (key 148) on the diaphragm casing (key 1, figures 6, 7, 8, 9, and 10), and align the holes. Insert the cap screws (key 154). Finger tighten the screws.
4. If travel stops were used, return the travel stops to their original positions as recorded in the proceeding Disassembly steps. Tighten the screws and travel stops.

Note

When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing bolts are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 30/30i-76/76i and 87 actuators.

CAUTION

Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

Note

Do not use lubricant on these bolts and nuts. Fasteners must be clean and dry.

5. Slide the extension rod (key 150) into the handwheel screw (key 160), and position the diaphragm casing (key 1, figures 6, 7, 8, 9, and 10) with the attached parts on the diaphragm. Install the cap screws and hex nuts (keys 13 and 14, figures 6, 7, 8, 9, and 10) and tighten in the following manner.
6. The first four bolts tightened should be diametrically opposed and 90 degrees apart. Tighten these four bolts to 13 N•m (10 lbf•ft).
7. Tighten the remaining bolts in a clockwise, criss-cross pattern to 13 N•m (10 lbf•ft).
8. Repeat this procedure by tightening four bolts, diametrically opposed and 90 degrees apart, to a torque of 27 N•m (20 lbf•ft).
9. Tighten the remaining bolts in a clockwise, criss-cross pattern to 27 N•m (20 lbf•ft).
10. After the last bolt is tightened to 27 N•m (20 lbf•ft), all of the bolts should be tightened again to 27 N•m (20 lbf•ft) in a circular pattern around the bolt circle.
11. Once completed, no more tightening is recommended.
12. Lubricate and install the thrust bearings (keys 180 and 181), install the bearing retainer (key 182), install the castle nut (keys 166) on the extension rod. Do not overtighten the castle nut on the bearing. Install the cotter pin (key 167). Replace the cap (key 247).
13. Refer to the Assembly portion of the Actuator maintenance section.

Side-Mounted Handwheel for Sizes 34 through 60 and 34i through 60i Actuators

A side-mounted handwheel assembly is normally used as a manual actuator for sizes 34 through 60 (figures 16 and 18) and 34i through 60i actuators (figures 17 and 19). Turning the handwheel counter-clockwise past the neutral position opens the valve. Two levers (key 146, figures 16, 17, 18, and 19) on a handwheel assembly operate the valve by moving the valve stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then begin the assembly at the appropriate step.

Disassembly for Side-Mounted Handwheel (Sizes 34-60 and 34i-60i)

1. Use **step a. for size 34 through size 60** actuators, and use **step b. for sizes 34i through 60i**.

   a. **For Size 34 through 60:** If desired, the handwheel assembly can be removed from the actuator yoke. To do this, remove the hex nuts (keys 147 and 170) from the U-bolts (key 166 and 143) that hold the assembly to the yoke for the size 30 and size 40. Remove the hex nuts (key 144 and 170) from the U-bolts (key 166 and 143) that hold the assembly to the yoke for the size 45 through size 60.

   b. **For Size 34i through 60i:** If desired, the handwheel assembly can be removed from the actuator yoke. To do this, remove the cap screws (key 256 and 257) and spacers (key 258) that hold the assembly to the yoke for the size 30i through size 60i.

2. Remove the retaining ring (key 154) and drive out the lever pivot pin (key 153).
3. Two screws (key 156) hold the right- and left-hand levers (key 146) together. Remove the screw from the top of the levers so that the levers will drop down out of the assembly. Disassemble further, if necessary, by removing the other screw.
4. Remove the screw (key 161) and pointer mounting bolt (key 159, not shown) located behind the pointer (key 160).
5. Remove the stop nut (key 54), lockwasher (key 150), and washer (key 149). Then remove the handwheel (key 51), being careful not to lose the small ball (key 55) and spring (key 56).
6. Loosen the locking set screw (key 168, figure 19). Then, using a suitable tool, unscrew the bearing retainer (key 136).

7. Pull the handwheel screw assembly (key 145) out of the handwheel body. The operating nut (key 132) will come out with the screw. Also remove the bushing (key 151, figure 16 or 17) on size 34 and 40.
8. If required, remove the two ball bearings (key 152), one from the bearing retainer and the other from the handwheel body.

Assembly for Side-Mounted Handwheel (Sizes 34-60 and 34i-60i)

Click here or access the following QR code for a video on installing a side-mounted handwheel on a 667 actuator.

1. Pack the ball bearings (key 152) with anti-seize lubricant (key 244). Insert one bearing and the bushing (key 151, figure 16 or 17) into the handwheel body (key 142). The bushing is not used in a handwheel assembly for sizes 45/45i through 60/60i actuators.
2. Coat the handwheel screw assembly (key 145) threads with anti-seize lubricant (key244), and thread the operating nut (key 132) onto the screw. Slide the second ball bearing (key 152) onto the screw, and insert the end of the screw into either the bushing (key 151, figure 16 or 17) for sizes 34/34i and 40/40i, or into the bearing for sizes 45/45i through 60/60i.
3. Thread the bearing retainer (key 136) into the body (key 142). Completely tighten the bearing retainer, and then loosen it one-quarter turn. Tighten the set screw (key 168, figure 16 or 17) to hold the bearing retainer in place.
4. Coat the groove in the handwheel body (key 142) with lithium grease (key 241). Insert the spring (key 56) and ball (key 55) into the handwheel (key 51). Holding the ball and spring in the handwheel, put the handwheel, the washer (key 149), the lockwasher (key 150), and the stop nut (key 54) onto the end of the end of the handwheel screw (key 145). Tighten the stop nut.
5. Position the pointer mounting bolt (key 159, not shown) and pointer (key 160). Insert and tighten the screw (key 161).
6. Assemble the two levers (key 146) with the cap screws (key 156) for handwheel assemblies for sizes 45/45i, 50/50i, and 60/60i actuators, or with the machine screws (key 156) for handwheel assemblies on sizes 34/34i and 40/40i actuators.
7. Use **step a. for size 34 through size 60** actuators, and use **step b. for sizes 34i through 60i**.

   a. **For Size 34 through 60:** If the handwheel assembly was removed from the yoke (key 9, figures 6, 8, or 10), remount the handjack assembly to the yoke using the dowel pins for alignment. For the size 34 and size 40, position the U-bolts and J-bolts (keys 166 and 143) on the yoke, and hand-tighten the hex nuts (keys 170 and 147) to hold the handwheel assembly in position. For the size 45 through size 60, position the U-bolts (keys 166 and 143) on the yoke, and hand-tighten the hex nuts (keys 170 and 144) to hold the handwheel assembly in position. Cap screws (key 163) should be tight against the yoke legs to provide stability. Tighten the nuts (key 144 for size 30 and size 40, key 158 for the size 45 through size 60). For the size 34 and size 40 finish tightening the U-bolt nuts to 81 N • m [60lbf • ft] (key170) and 41 N • m [30 lbf • ft] (key 147). For the sizes 45 through 60 finish tightening the U-bolt nuts to 163 N • m [120lbf • ft] (key170) and 41 N • m [30 lbf • ft] (key 144). Be sure the handwheel assembly remains flat against the mounting pad and perpendicular to the yoke.

   b. **For Size 34i through 60i:** If the handwheel assembly was removed from the yoke (key 9, figures 7, 9, or 10), remount the handjack assembly to the yoke using the dowel pins for alignment. Position the upper cap screws (key 256) on the assembly and hand-tighten to hold the handwheel assembly in position. Place the spacers (key 258) between the yoke and handjack assembly, position cap screws (key 257), and hand-tighten. For the size 34i and size 40i finish tightening the cap screws (key 256) to 92 N • m [68 lbf • ft] and (key 257) to 39 N • m [29 lbf • ft]. For the sizes 45i through 60i finish tightening the cap screws (key 256) to 163 N • m [120 lbf • ft] and (key 257)to 39 N • m [29 lbf • ft].

8. Position the levers (key 146) as shown in figures 11 or 12. Insert the lever pivot pin (key 153), and snap the retaining ring (key 154) onto the lever pivot pin.

Side-Mounted Handwheel Assembly for Size 70, 76, and 87 Actuators

A side-mounted handwheel assembly (figure 20) is usually used as a manual actuator. Turning the handwheel clockwise past the neutral position always closes the valve body. A sleeve (key 123, figure 20) on a handwheel assembly for a size 70, 76 or 87 actuator opens the valve body by moving the valve stem.

Instructions are given below for complete disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; and then begin the assembly at the appropriate step.

Disassembly for Side-Mounted Handwheel (Sizes 70, 76, and 87)

1. Bypass the control valve. Reduce the loading pressure to atmospheric. Disconnect the loading pressure tubing or piping at the yoke.
2. Remove the cover band (key 87), and relieve spring compression by turning the spring adjuster (key 74) counterclockwise.
3. Remove the cap screws and nuts (keys 13 and 14) and lift off the upper diaphragm casing (key 1).
4. Remove the travel stop screw (key 12) and spacer (key 2), and take off the diaphragm plate (key 4), the diaphragm (key 3), and the lower diaphragm plate (key 71).
5. Unscrew the cap screws (key 90) and remove the following connected parts: the lower diaphragm casing (key 64), the O-ring (key 70), spring case adaptor (key 89), the seal bushing, O-rings, and snap ring (keys 7, 8, 9, and 72).
6. Remove the snap ring (key 72), and slide the seal bushing and O-rings (keys 7, 8, and 9) out of the spring case adaptor (key 89).
7. Take out the actuator spring (key 18).
8. Remove the stem connector (key 31) and stem connector cap screws.
9. Pull the actuator stem (key 144) up and out of the yoke. The spring seat (key 19), spring adjuster (key 74), thrust bearing (key 128), and the pinned adjusting screw (key 131) will come out with the actuator stem.
10. Turn the handwheel so that the lower sleeve (key 123) extends out of the bottom of the yoke. DO NOT move the neutral indicator scale (key 125).
11. Loosen two set screws (key 121), and unscrew the bearing retainer flange (key 45). Take out the worm gear and two thrust bearings (key 132), one on each side of the gear.
12. The worm shaft (key 51) and associated parts can be disassembled, if desired, by first removing the handwheel nut (key 127) and the handwheel (key 58). Do not lose the small ball (key 141) and spring (key 142).
13. Loosen the set screw (key 52) for each worm shaft retainer (keys 48 and 49). Unscrew the two worm retainers (keys 48 and 49). The ball bearings (key 50) will come out with the retainers.

Assembly for Side-Mounted Handwheel (Sizes 70, 76, and 87)

1. The front and back worm retainers (keys 48 and 49) each have a slot in their threads for a set screw (key 52). Pack the ball bearings (key 50) with anti-seize lubricant (key 239), and insert one ball bearing in the back worm retainer (key 49) as shown in figure 20.
2. Thread the back bearing retainer and ball bearing (keys 49 and 50) into the yoke. Align the slot in the bearing retainer with the set screw hole in the yoke, insert the set screw (key 52), and tighten it.
3. Coat the worm shaft (key 51) threads with anti-seize lubricant (key 239), and slide the shaft into the yoke so that the end of the shaft fits snugly into the back bearing retainer.
4. Insert the bearing in the front bearing retainer (key 49), and thread the retainer and ball bearing into the yoke. Align the slot in the retainer with the hole in the yoke, insert the set screw (key 52), and tighten it.
5. Put the spring and ball (keys 141 and 142) in the handwheel (key 58). Slide the handwheel onto the worm shaft (key 51). Thread the hex nut (key 127) onto the worm shaft.

6. Pack the two needle bearings (key 132) and coat the worm gear (key 44) threads with anti-seize lubricant (key 239). Insert the key (key 122), the bearings, and the worm gear in the yoke (key 73) as shown in figure 20.
7. Slots are cut in the threads of the bearing retainer flange (key 45). Thread the flange into the yoke so that the slots and the holes for the set screws (key 121) align. Insert the screws, and tighten them.
8. The lower sleeve (key 123) has a milled groove in one end. Coat the sleeve threads with anti-seize lubricant (key 239), slide the end of the lower sleeve with the groove into the bearing retainer flange, turn the handwheel, and feed the sleeve through the worm gear so that the slot in the lower sleeve engages the key (key 122) in the yoke. Continue turning the handwheel until the lower sleeve protrudes 81 mm (3.19 inches) below the surface of the yoke. The bottom of the lower sleeve should be even with the bottom of the extension on the neutral indicator.
9. Pack the thrust bearing (key 128) with anti-seize lubricant (key 239). Slide the actuator stem (key 144) and the attached adjusting screw (key 131), pin (key 130), thrust bearing (key 128), spring seat (key 19), and spring adjuster (key 74) into the yoke. The lower end of the stem slides through the lower sleeve (key 123) and the lower sleeve slides into the adjusting screw (key 131), as shown in figure 20.
10. Position the actuator stem (key 144) against the valve stem. Clamp both stems between the two halves of the stem connector (key 31), and be sure the threads are engaged properly on both stems. The stem connector should not be closer than 3.2 mm (1/8 inches) to the lower sleeve when the actuator stem is in the retracted position. This adjustment will provide approximately 3.2 mm (1/8 inches) of free travel of the lower sleeve in either direction for manual operation. Fasten the halves together with the cap screws.
11. Put the actuator spring (key 18) in the yoke on the spring seat (key 19).
12. Coat the O-rings (keys 8 and 9) with lithium grease (key 237), and insert them in the seal bushing (key 7). Slide the seal bushing and O-rings into the spring case adaptor (key 89).
13. Install the snap ring (key 72).
14. Slide the seal bushing and O-rings (keys 7, 8, and 9) over the actuator stem (key 144), and position the spring case adaptor (key 89), lower diaphragm casing (key 64), and O-ring (key 70) on the yoke.
15. Insert and tighten the cap screws (key 90).
16. Slide the lower diaphragm plate (key 71), the diaphragm (key 3) with the patterned side up, the diaphragm plate (key 4), the spacer (key 2), and the cap screw (key 12) on the actuator stem (key 144). Tighten the cap screw.
17. Put the diaphragm casing (key 1) on the diaphragm. Align the holes in the diaphragm (key 3) and the diaphragm casings (keys 1 and 64).

Note

When you replace actuator diaphragms in the field, take care to ensure the diaphragm casing bolts are tightened to the proper load to prevent leakage, but not crush the material. Perform the following tightening sequence with a manual torque wrench for size 30/30i-76/76i and 87 actuators.

CAUTION

Over-tightening the diaphragm cap screws and nuts (keys 13 and 14) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

Note

Do not use lubricant on these bolts and nuts. Fasteners must be clean and dry.

18. Install the cap screws and hex nuts (keys 13 and 14) and tighten in the following manner.

19. The first four bolts tightened should be diametrically opposed and 90 degrees apart. Tighten these four bolts to 13 N•m (10 lbf•ft).
20. Tighten the remaining bolts in a clockwise, criss-cross pattern to 13 N•m (10 lbf•ft).
21. Repeat this procedure by tightening four bolts, diametrically opposed and 90 degrees apart, to a torque of 27 N•m (20 lbf•ft).
22. Tighten the remaining bolts in a clockwise, criss-cross pattern to 27 N•m (20 lbf•ft).
23. After the last bolt is tightened to 27 N•m (20 lbf•ft), all of the bolts should be tightened again to 27 N•m (20 lbf•ft) in a circular pattern around the bolt circle.
24. Once completed, no more tightening is recommended.
25. Return the actuator to service after completing the Loading Connection procedure in the Installation section and the procedures in the Adjustments section.

Casing-Mounted Travel Stops

Note

If repeated or daily manual operation is expected, the actuator should be equipped with a side-mounted handwheel rather than a casing-mounted travel stop or top-mounted handwheel. The side-mounted handwheel is designed for more frequent use as manual operator.

Casing-mounted adjustable travel stops (shown in figures 21 through 25) are available to limit travel in the down direction (extending the actuator stem) or in the up direction (retracting the actuator stem). The travel stop in figure 21 is a down travel stop, the travel stop in figure 22 is an up and down travel stop, and the travel stops in figures 23, 24, and 25 are up travel stops.

Use the locknuts (key 151, figures 21 and 22), stem (key 150, figure 23), handwheel (key 58, figure 24) or cap screw (key 177, figure 25) to set the point at which the travel stop limits travel. Be sure to tighten the locknuts and replace the cap (key 149, figures 21 and 23; key 247, figure 22) after setting the travel stop.

Instructions are given below for disassembly and assembly. Perform the disassembly only as far as necessary to accomplish the required maintenance; then, begin the assembly at the appropriate step.

Key numbers are shown in figures 21 through 25.

1. Remove the cap (key 149 or 247) if the travel stop uses one. For down travel stops, loosen the locknuts (key 151, figures 21 and 22) so that the stop is not causing any spring compression.
2. Bypass the control valve, reduce loading pressure to atmospheric, and remove the tubing or piping from the connection on top of the yoke (key 73, figures 6, 8, and 10).
3. For down travel stops, turn the spring adjuster (key 74, figures 6, 8, and 10) out of the yoke toward the stem connector (key 31) to relieve all the compression in the spring (key 18).
4. For style 11 travel stops (figure 22), unscrew the cap screws (key 161), and make sure that the guide plate (key 157) can turn between the handwheel body (key 148) and the mounting plate (key 158).
5. Use a wrench on the nuts (key 151) to unscrew the extension rod (key 150). Remove the rod, the handwheel body (key 148), and the attached parts.
6. Unscrew the hex nuts and cap screws (keys 14 and 13, figures 6, 8, and 10) from the diaphragm casings. Lift off the upper diaphragm casing (key 1, figures 6, 8, and 10) and, for the style 11 travel stop, the mounting plate (key 158). For styles 10, 12 and 13, the travel stop assembly will be removed with the casing.
7. Note and record the position of travel stops (key 152) relative to the cap screws (key 154) for use in assembly. Unscrew the travel stops and cap screws, and remove either the mounting plate (key 158) or the handwheel body (key 148) and attached parts.

8. Separate the stem (key 150) and screw (key 160, figure 22) from the handwheel body.
9. Before reassembling, lubricate parts indicated by key 239 in figures 21 through 25. Use anti-seize lubricant (key 239).
10. Reassemble parts in the reverse order of removal.
11. When replacing the cap screws (key 154) and, if used, the travel stops (key 152), be sure to return them to their original position as recorded in step 7.

CAUTION

Over-tightening the diaphragm cap screws and nuts (keys 13 and 14), figures 6, 7, 8, 9, and 10 can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

12. Install the cap screws and nuts (keys 13 and 14, figures 6, 7, 8, 9, and 10) and finger tighten. Tighten the diaphragm cap screws and nuts to 27 N•m (20 lbf•ft) torque in a crisscross pattern.
13. Return the spring adjuster (key 74, figure 6, 7, 8, 9, and 10) to its original position. Re-adjust the travel stop.

Parts Ordering

Each actuator has a serial number stamped on the nameplate. Always mention this number when corresponding with your Emerson sales office or Local Business Partner regarding technical information or replacement parts. Also, reference the complete 11-character part number of each needed part as found in the following Parts Kits and Parts List sections.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Automation Solutions should not, under any circumstances, be used in any Fisher valve, because they may void your warranty, might adversely affect the performance of the valve, and could cause personal injury and property damage.

Parts Kits

Actuator Repair Kits

Parts kit includes keys 8, 9, and 70. O-ring material is nitrile, and gasket material is composition.

Key	Description	Part Number
	Size 30/30i	R667X000302
	Sizes 34/34i & 40/40i	R667X000402
	Sizes 45/45i through 60/60i	R667X000502
	Sizes 70/70i & 87	R667X000702
	Size 76/76i	R667X000762

Side-Mounted Handwheels Retrofit Kits

Key	Description	Part Number
Retrofit Kit includes parts to add a Side-Mounted Handwheel.		
	Size 34 Push-Down-To-Close	30A8778X0E2
	Size 34 Push-Down-To-Open	30A8778X0F2
	Size 40 Push-Down-To-Close	30A8778X0G2
	Size 40 Push-Down-To-Open	30A8778X0H2
	Size 45 & 46 Push-Down-To-Close	40A8779X0A2
	Size 45 & 46 Push-Down-To-Open	40A8779X0B2
	Size 50 & 60 Push-Down-To-Close	40A8779X0C2
	Size 50 & 60 Push-Down-To-Open	40A8779X0D2
	Size 34i push down to close	GE71635X0E2
	Size 34i push down to open	GE71635X0F2
	Size 40i push down to close	GE71635X0G2
	Size 40i push down to open	GE71635X0H2
	Size 45i & 46i push down to close	GE71636X0A2
	Size 40i & 60i push down to open	GE71636X0B2
	Size 50i & 60i push down to close	GE71636X0C2
	Size 50i & 60i push down to open	GE71636X0D2

Transition Kits for Side-Mounted Handwheels

Transition kits include fasteners necessary to remount an existing side-mounted handwheel to an actuator where the yoke has been changed to a size i yoke.
Contains key numbers 256, 257, and 258.

Description	Part Number
Size 34i/40i push-down-to-close or push-down-to-open	GE71635X0J2
Size 45i - 60i push-down-to-close or push-down-to-open	GE71636X0E2

Top-Mounted Handwheels Retrofit Kits

Retrofit Kit includes parts to add a Top-Mounted Handwheel. Kit number 1 includes the handwheel assembly only. Kit number 2 includes Kit number 1 and a new diaphragm case that is required to mount the handwheel assembly.

Key	Description	Part Number
	Kit 1	
	Size 30/30i	30B3940X102
	Sizes 34/34i	30B3940X022
	Size 40/40i	30B3940X042
	Sizes 45/45i & 50/50i	33B9224X012
	Sizes 46/46i, 60/60i, & 76/76i	33B9224X012
	Sizes 70/70i & 87	CV8060X0012
	Kit 2	
	Size 30/30i	30B3940X052
	Size 34/34i	30B3940X062
	Size 40/40i	30B3940X092
	Sizes 45/45i & 50/50i	33B9224X022
	Sizes 46/46i, 60/60i, & 76/76i	33B9224X032
	Sizes 70/70i & 87	CV8060X0022

Parts List

Note
Contact your Emerson sales office or Local Business Partner for Part Ordering information.

Actuator Assembly

Key	Description
1	Upper Diaphragm Casing
2	Travel Stop Spacer
3*	Diaphragm Molded Nitrile/Nylon Molded Silicone/Polyester
4	Upper Diaphragm Plate
7*	Bushing, Seal Brass S41600 [416 stainless steel (SST)] PTFE w/25% Glass
8*	O-Ring Nitrile Fluorocarbon
9*	O-Ring Nitrile Fluorocarbon
12	Screw, Cap, hex hd
13	Hex hd Cap Screw
14	Hex Nut
17	Vent Assembly
18	Spring
19	Seat, Lower Spring
27	Extension Rod Conn
30	Hex hd Cap Screw
31	Stem Connector Assembly
32	Travel Indicator Scale
33	Screw, Self Tapping
33	Screw, Mach, Fill hd
34	Disk, Travel Indicator
39	Nameplate
40	Screw, Drive
64	Lower Diaphragm Casing
69	Nut, Hex, Jam
70*	Gasket Composition [up to 232°C (450°F)]
70*	O-Ring Nitrile
71	Lower Diaphragm Plate
72	Ring, Snap
73	Yoke
74	Spring Adjuster
75	Nut, Hex
76	Nut, Speed, Twin
77	Stop, Travel
78	Bushing, Pipe, Hex
79	Screw, Mach, Flat Hd
81	Screw, Mach, Rd Hd
82	Indicator, Travel, Adaptor
83	Washer, Plain
89	Spring Case Adaptor
90	Screw, Cap
102	Plug, Pipe, Hex Hd
144	Actuator Stem
227	Washer, Plain
228	Stem Disk Spacer
237	Lubricant, lithium grease not furnished with actuator
239	Lubricant, anti-seize not furnished with actuator
254	Caution Nameplate

*Recommended spare parts

Top-Mounted Handwheel (figures 11, 12, 13, 14, and 15)

Key	Description
58	Handwheel / Handjack Bar
60	Retainer Ring
148	Handwheel Body
150	Extension Rod
152	Up Travel Stop
154	Cap Screw
156	Vent Assembly
157	Guide Plate
158	Mounting Plate
159	Lock Nut
160	Handwheel Screw
161	Cap Screw
166	Castle Nut
167	Cotter Pin
178	Machine Screw
179	Lockwasher
180	Thrust Bearing
181	Thrust Race
182	Bearing Retainer
183	Pipe Nipple
239	Lubricant, anti-seize not furnished with handwheel
247	Handwheel Cap
253	Spacer, Handjack

Figure 6. Fisher 667 Actuator Sizes 30 through 60

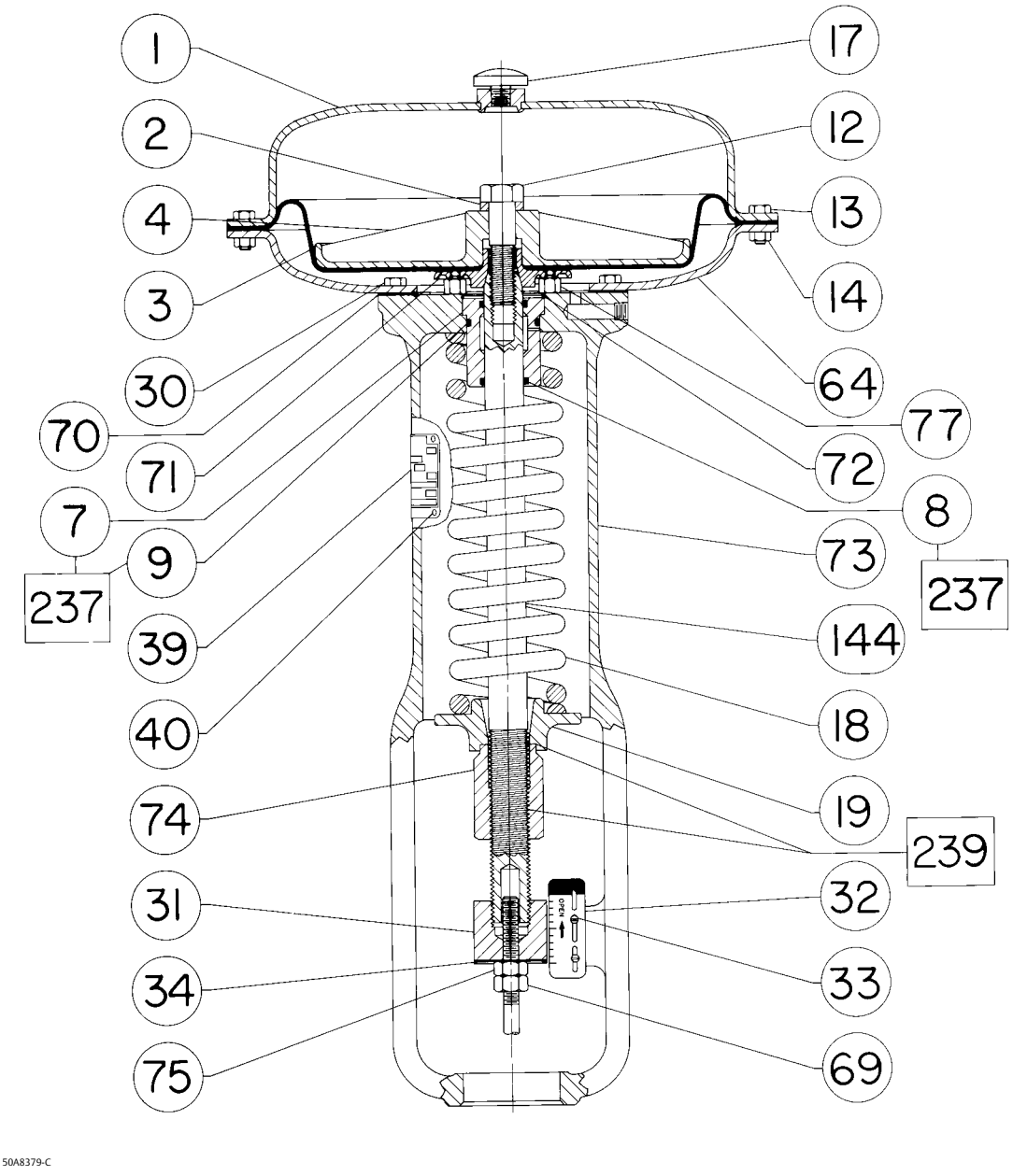
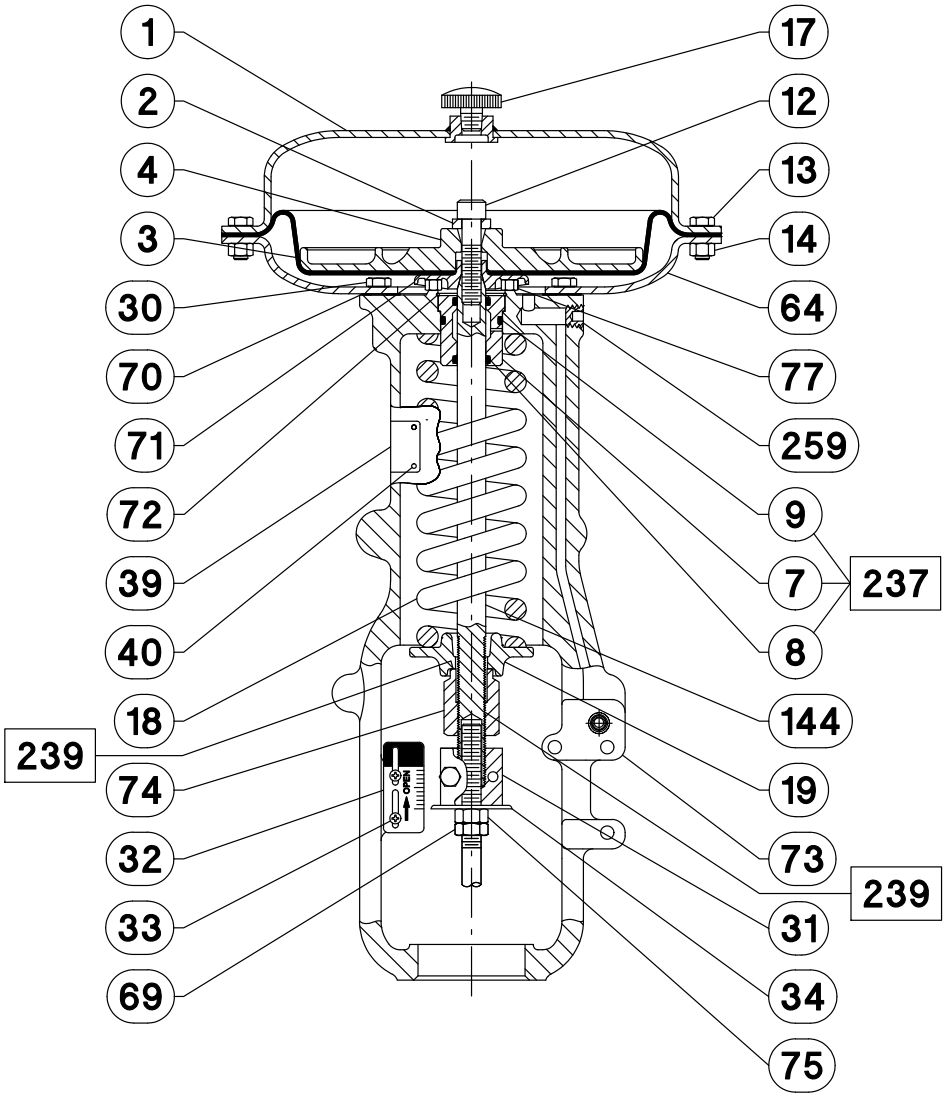


Figure 7. Fisher 667 Actuator Sizes 30i through 60i



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PARTS NOT SHOWN: KEY 76 AND 254

GE71547-A

Figure 8. Fisher 667 Size 70 and 76 Actuator

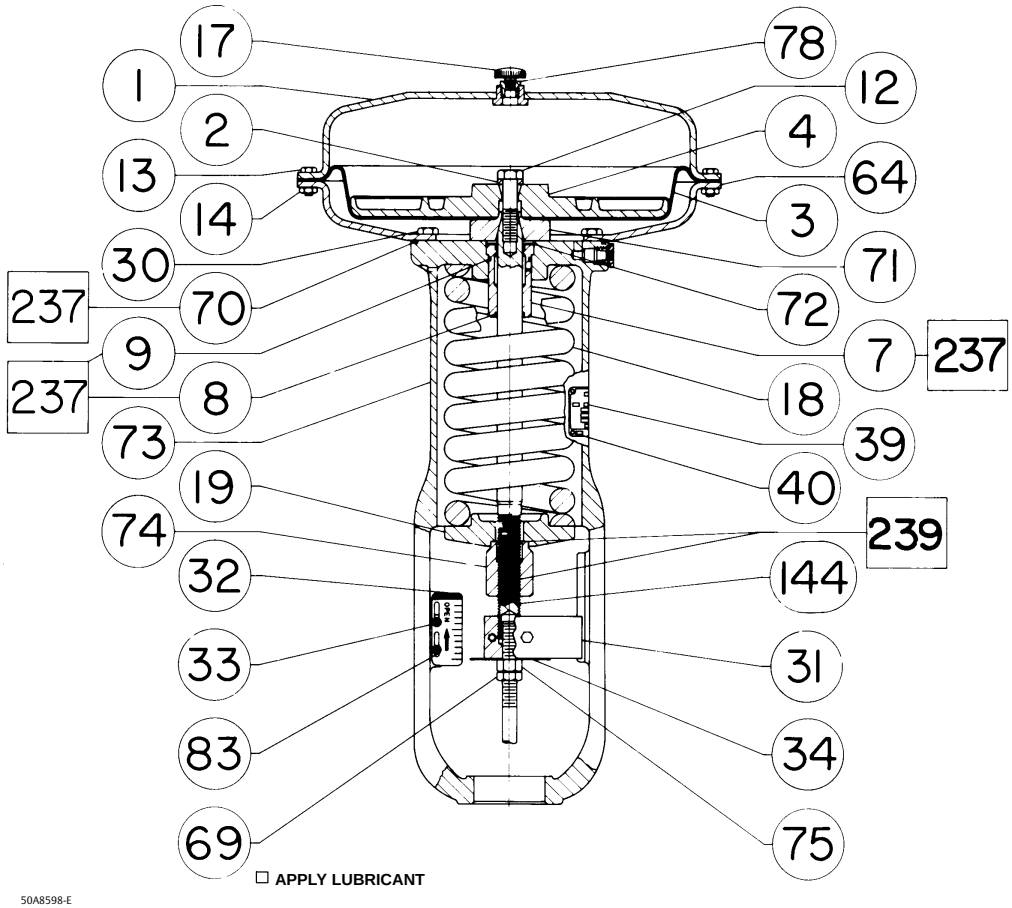
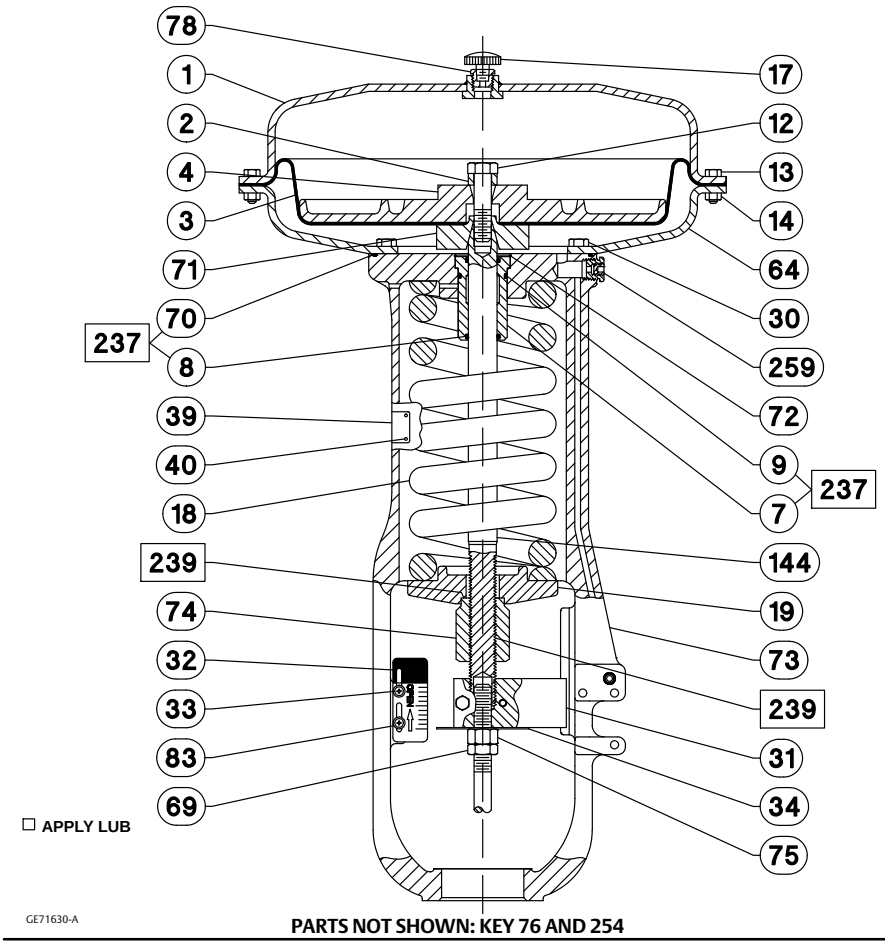


Figure 9. Fisher 667 Size 70i and 76i Actuator



PARTS NOT SHOWN: KEY 76 AND 254

Figure 10. Fisher 667 Size 87 Actuator

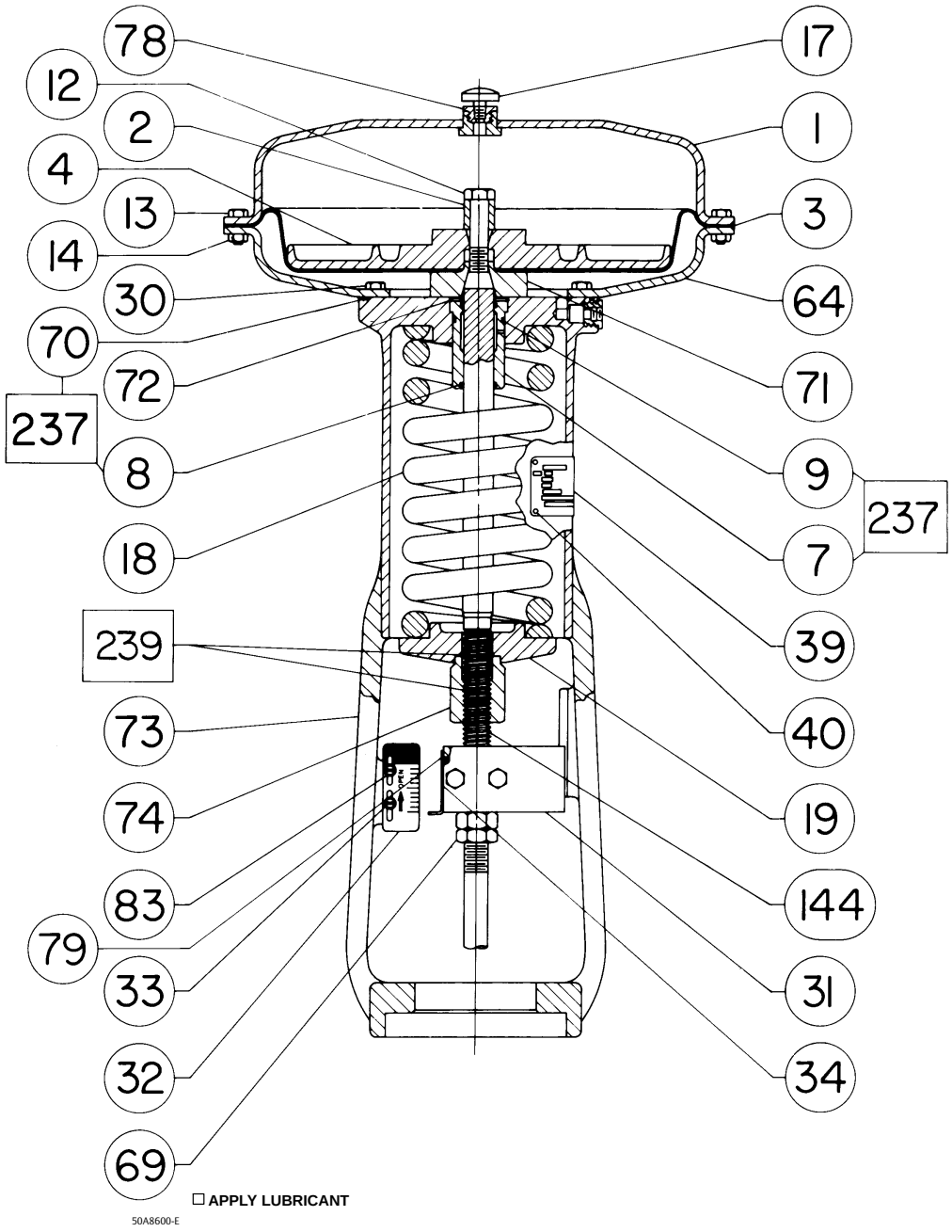


Figure 11. Top-Mounted Handwheel Assembly for Size 30/30i through 40/40i Actuators

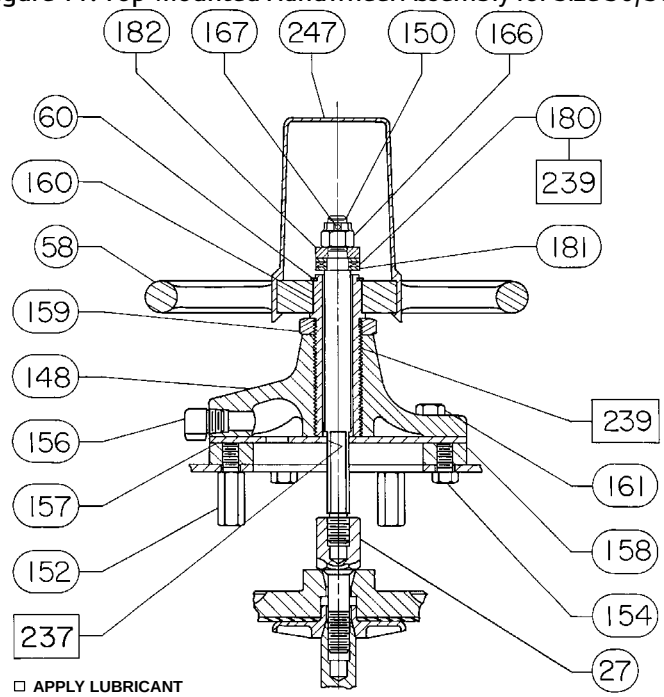


Figure 12. Top-Mounted Handwheel Assembly, Style P2 for Size 45/45i, 50/50i, 60/60i, and 76/76i Actuators

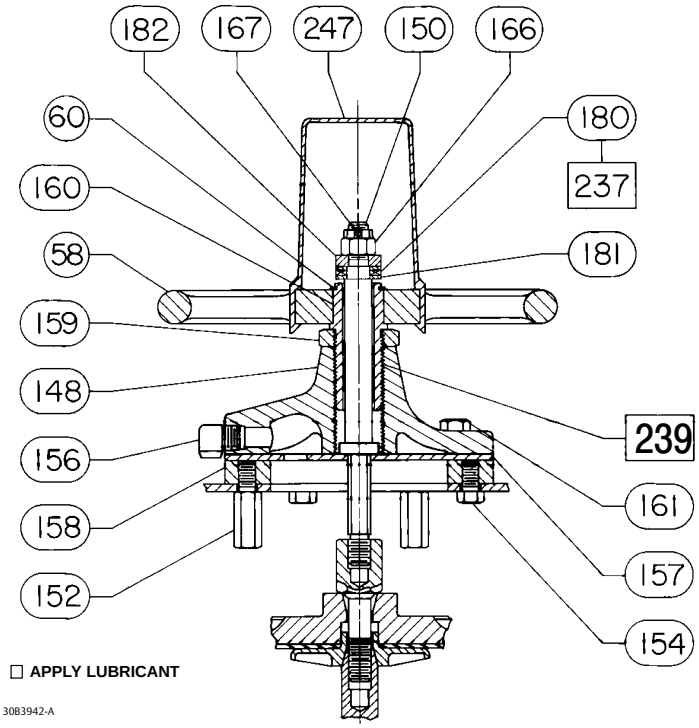


Figure 13. Top-Mounted Handwheel Assembly for Size 45/45i-76/76i Actuators

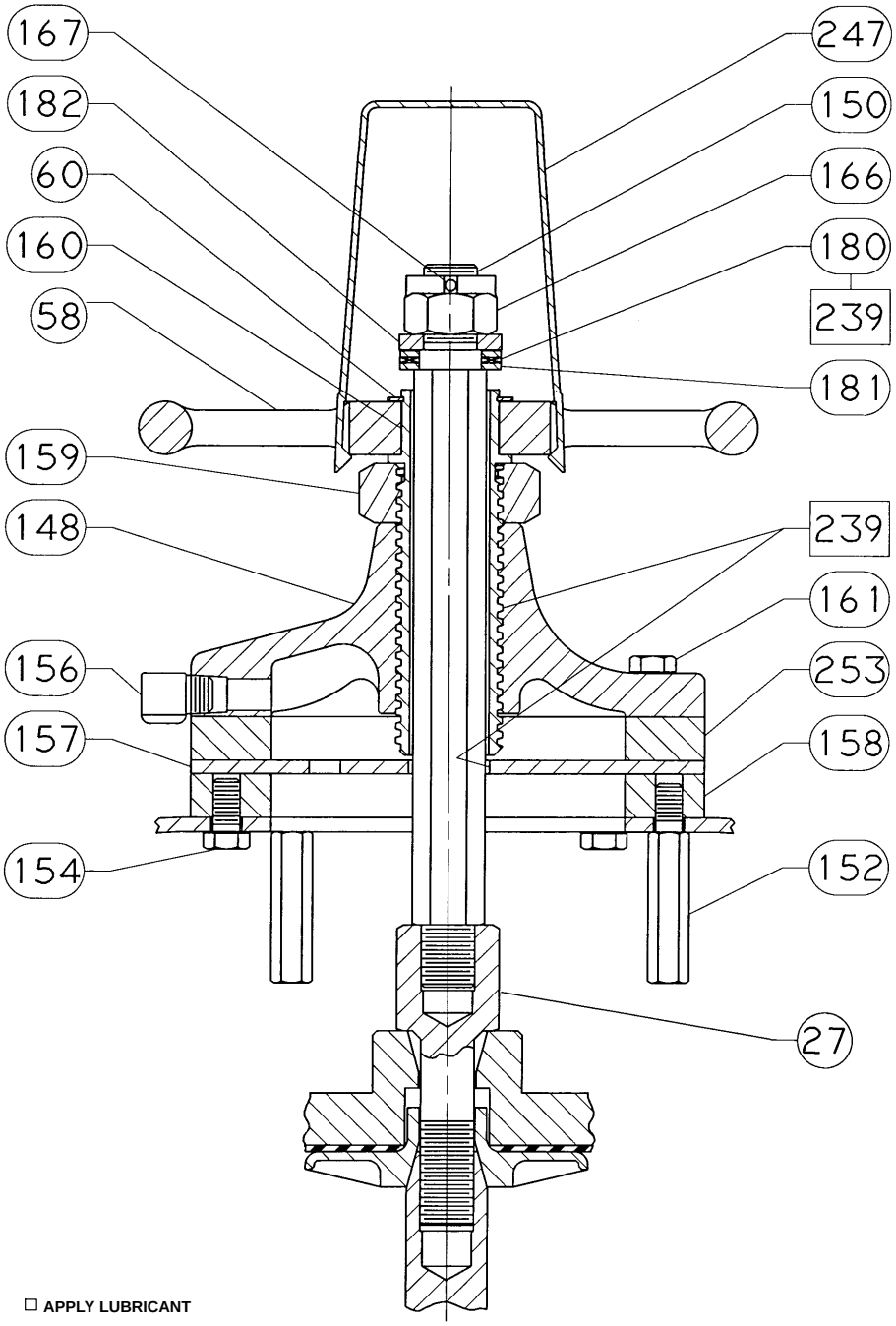


Figure 14. Top-Mounted Handwheel Assembly for Size 70/70i and 87 Actuators

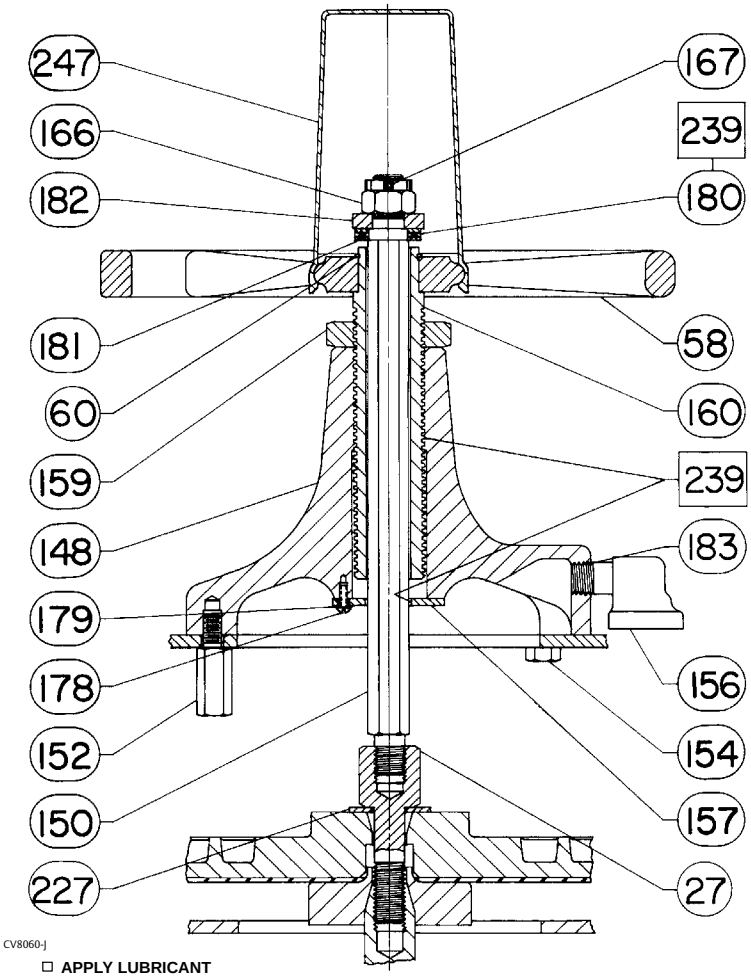
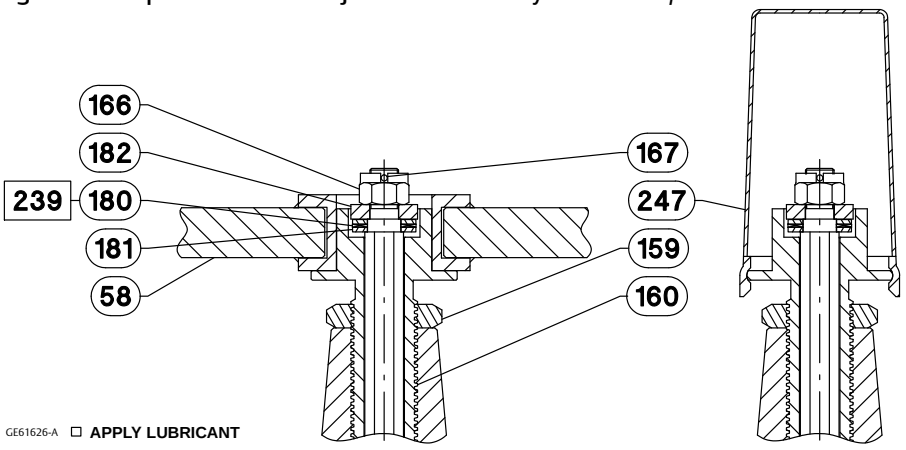


Figure 15. Top-Mounted Handjack Bar Assembly for Size 70/70i and 87 Actuators



NOTE:
THE TOP MOUNTED HANDJACK BAR SHOULD BE REMOVED WHEN NOT IN USE AND THE HANDWHEEL CAP INSTALLED FOR WEATHER PROTECTION OF INTERNAL COMPONENTS.

Figure 16. Side Mounted Handwheel Assembly for Size 34 and 40 Actuators

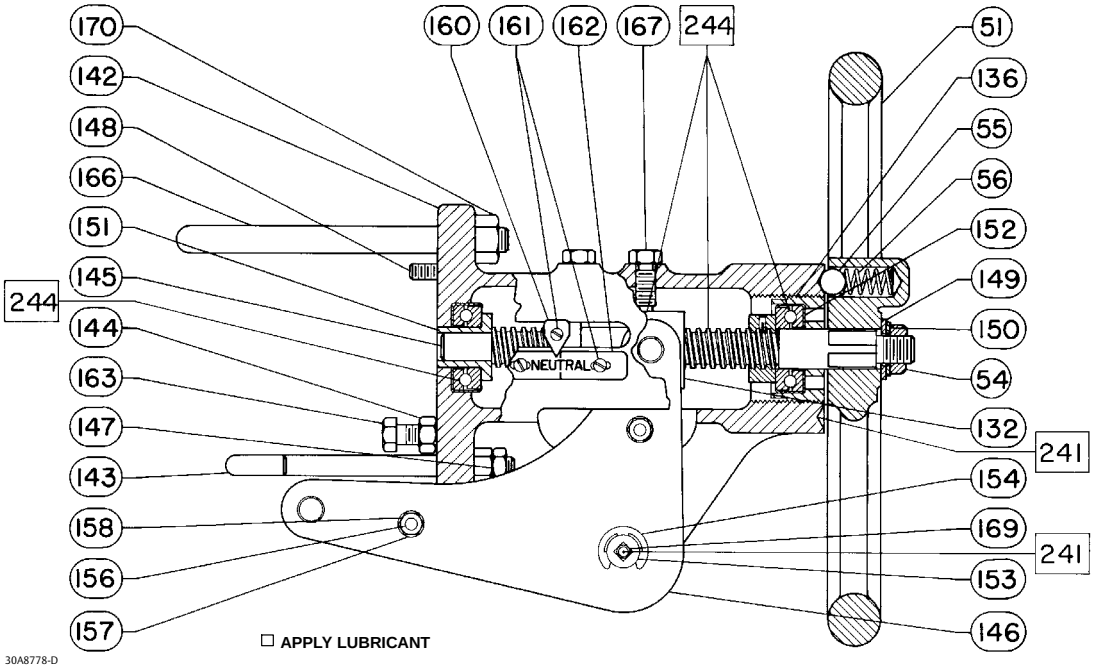


Figure 17. Side Mounted Handwheel Assembly for Size 34i and 40i Actuators

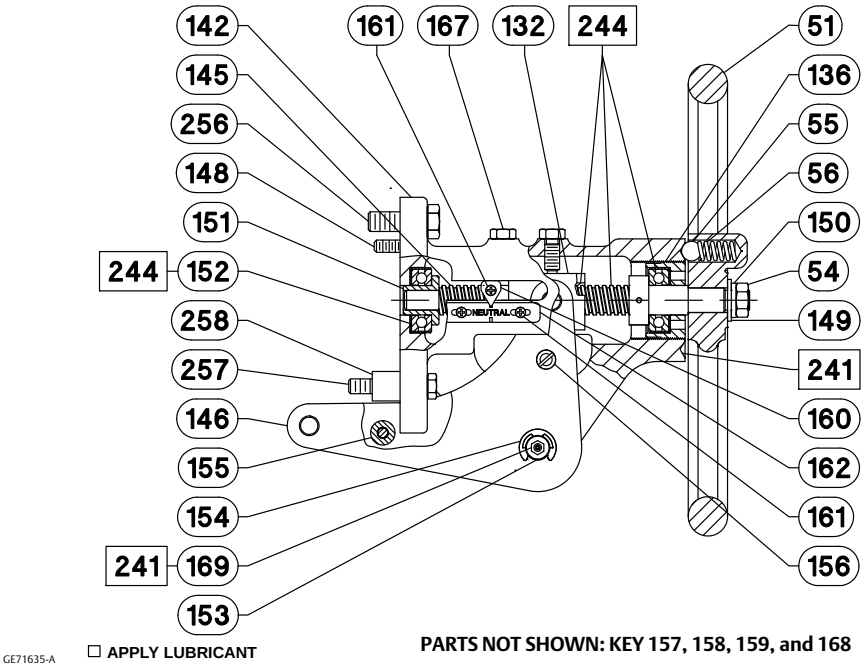


Figure 18. Side-Mounted Handwheel Assembly for Size 45 through 60 Actuators

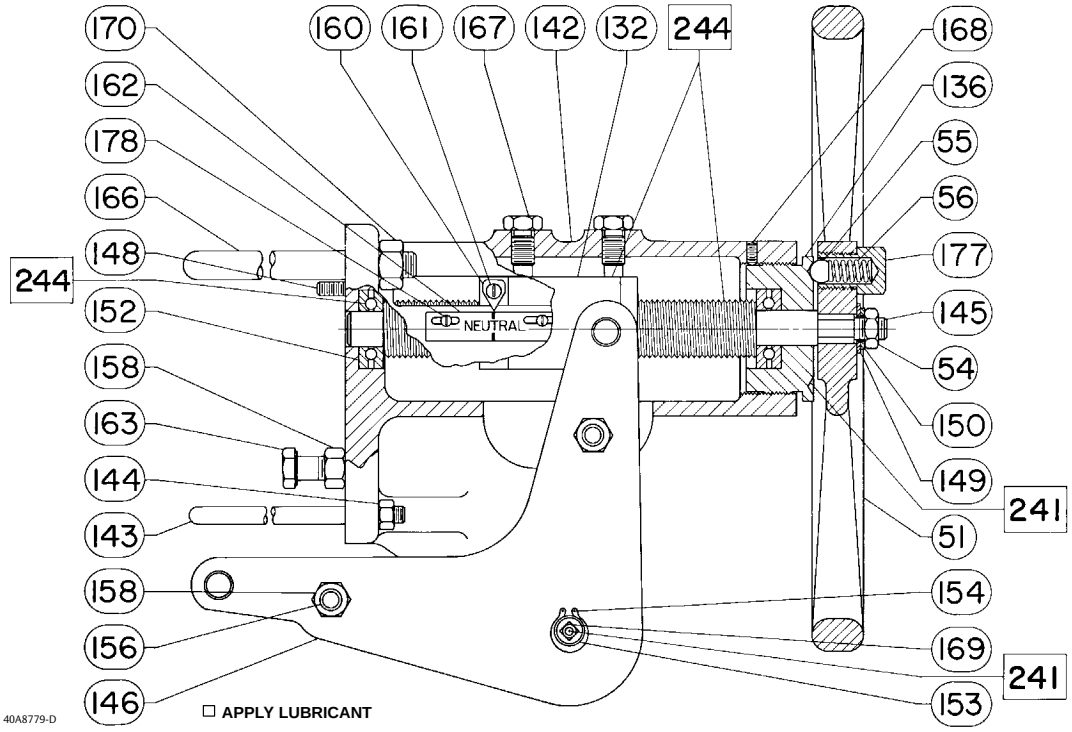
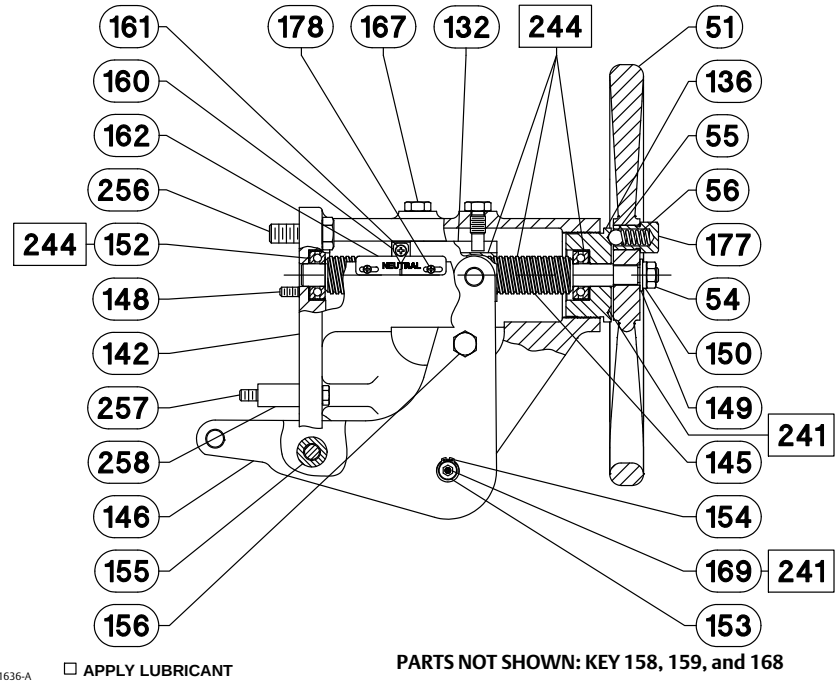


Figure 19. Side Mounted Handwheel Assembly for Size 45i through 60i Actuators



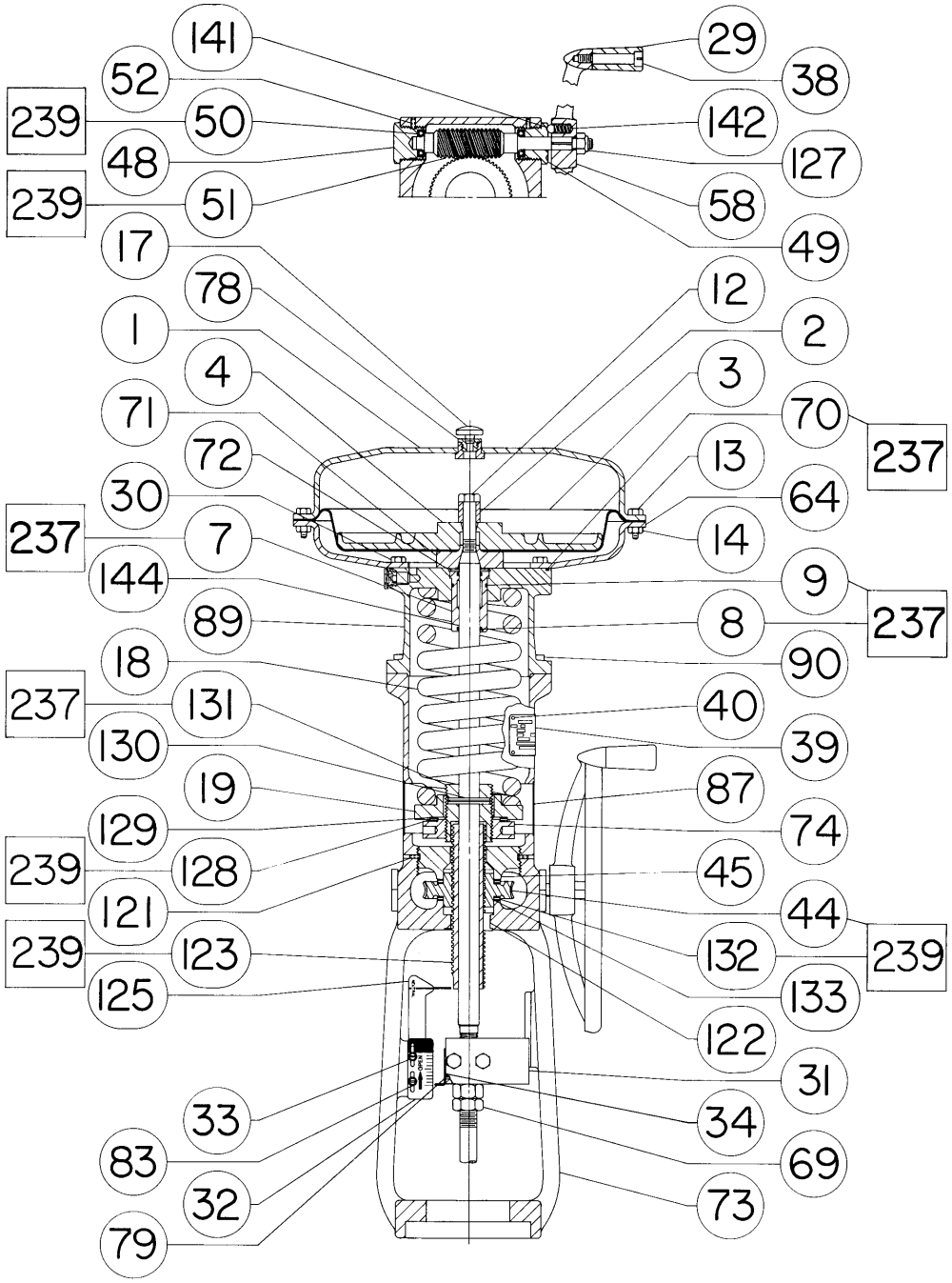
Side-Mounted Handwheel, Size 34-60 and 34i-60i (figures 16 and 18)

Key	Description
51	Handwheel
54	Hex Jam Nut
55	Ball
56	Spring
132	Operating Nut
136	Bearing Retainer
142	Handwheel Body
143	Mounting Bolts
144	Hex Nut
145	Handwheel Screw
146	Lever & Pin Assembly
147	Hex Jam Nut
148	Dowel Pin
149	Washer
150	Lockwasher
151	Bushing
152	Ball Bearing
153	Lever Pivot Pin
154	Retaining Ring
155	Spacer
156	Screw
157	Lockwasher
158	Hex Nut
159	Pointer Mounting Bolt
160	Pointer
161	Machine Screw
162	Indicator Plate (Aluminum)
163	Cap Screw
166	U-Bolt
167	Guide Bolt
168	Set Screw
169	Grease Fitting
170	Hex Nut
177	Spring Cap
178	Machine Screw
241	Lubricant, lithium grease Not furnished with handwheel
244	Lubricant, anti-seize Not furnished with handwheel
256	Cap Screw
257	Cap Screw
258	Spacer

Side-Mounted Handwheel, Size 70, 76 and 87 (figure 20)

Key	Description
29	Handgrip
38	Handgrip Bolt
44	Worm Gear
45	Bearing Retainer Flange
48	Back Worm Retainer
49	Front Worm Retainer
50	Ball Bearing
51	Worm Shaft
52	Set Screw
57	Grease Fitting
58	Handwheel
87	Cover Band Ass'y
89	Spring Case Adaptor
90	Cap Screw
121	Set Screw
122	Key
123	Lower Sleeve
125	Handwheel Indicator
127	Handwheel Cap
128	Needle Bearing
129	Needle Bearing Race
130	Roll Pin
131	Spring Adjusting Screw
132	Needle Bearing
133	Needle Bearing Race
141	Ball
142	Spring
237	Lubricant, lithium grease Not Furnished with Handwheel
239	Lubricant, anti-seize Not Furnished with Handwheel
245	Yoke Extension

Figure 20. Size 70, 76, and 87 Actuator with Side Mounted Handwheel Assembly



PART NOT SHOWN: 57
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Casing-Mounted Travel Stops (figures 21 through 25)

Key	Description
58	Handwheel
102	Plug, Pipe
127	Hex Nut
148	Travel Stop Body
149	Travel Stop Cap
150	Extension Rod
150	Travel Stop Stem
151	Hex Jam Nut
152	Up Travel Stop
153	Nut, Hex
154	Screw, Cap, Hex Hd
155	Washer
156	Vent
157	Guide Plate
158	Mounting Plate
159	Nut, Travel Stop
160	Screw, Handwheel
161	Screw, Cap, Hex Hd
162	Washer
177	Travel Stop Screw
184	Nipple, Pipe, NPT
237	Lubricant, lithium grease
239	Lubricant, anti-seize
247	Travel Stop Cap
248	Mounting Plate

Figure 21. Style 10 Down Travel Stop - For All Sizes (Casing Mounted)

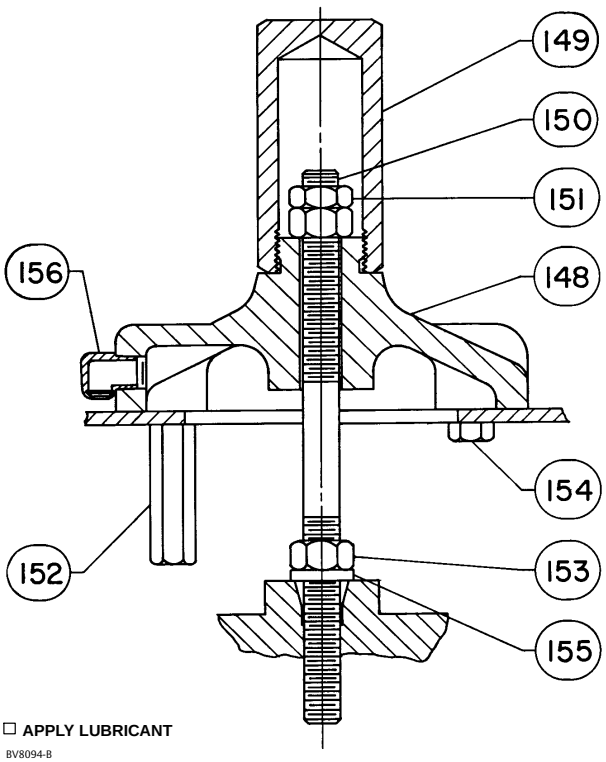


Figure 22. Style 11 Up Or Down Travel Stop - For Sizes 30/30i to 60/60i and 76/76i (Casing Mounted)

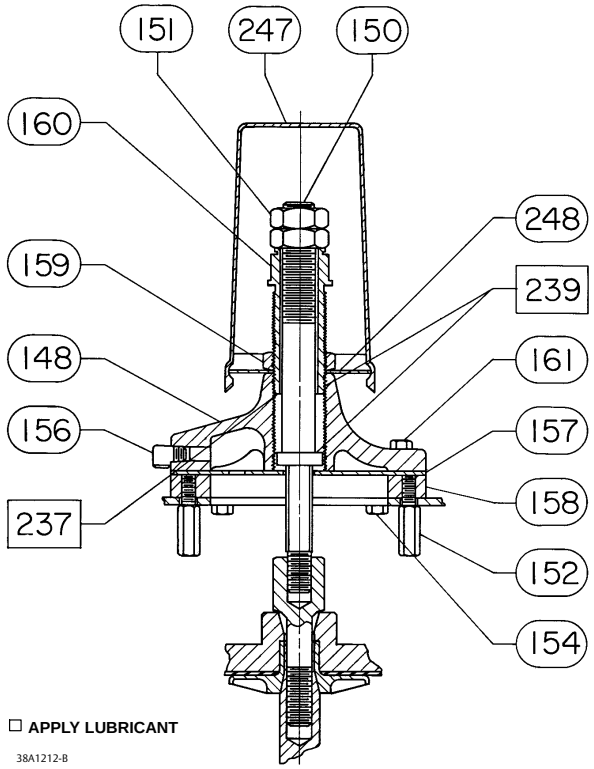


Figure 23. Style 12 Up Travel Stop (Casing Mounted)

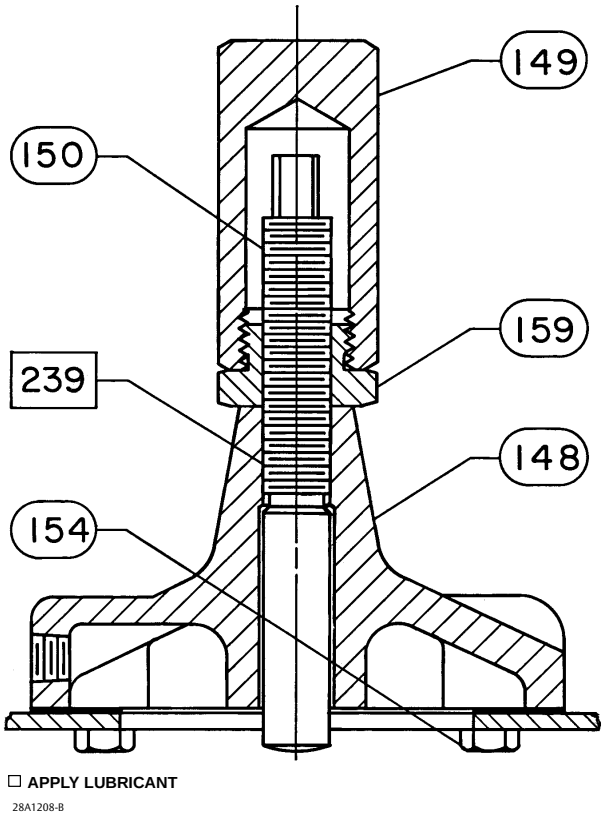


Figure 24. Style 13 Up Travel Stop - For Sizes 30/30i to 60/60i and 76/76i, Size 30/30i Shown (Casing Mounted)

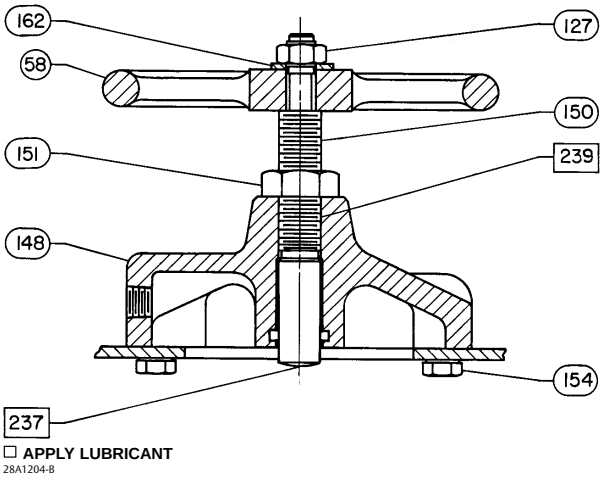
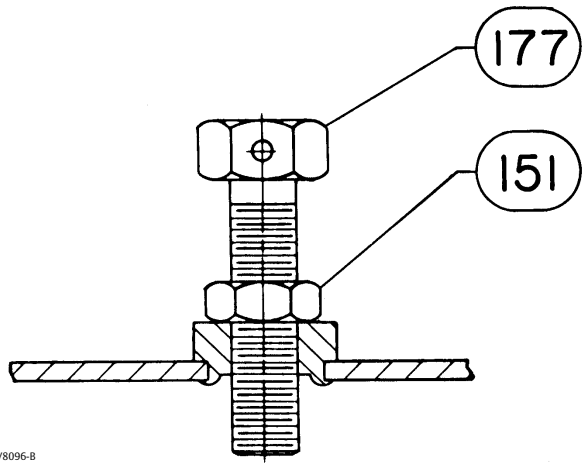


Figure 25. Style 14 Up Travel Stop (Casing Mounted)



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Fisher® 846 Current-to-Pressure Transducer

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Figure 1-1. Fisher 846 Current-to-Pressure Transducer



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Section 1 Introduction

Scope of Manual

This instruction manual provides installation, operating, calibration, maintenance, and parts ordering information Fisher 846 current-to-pressure transducers. Refer to separate manuals for instructions covering equipment used with the transducers.

Do not install, operate or maintain an 846 current-to-pressure transducer without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all of the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Description

The 846 current-to-pressure transducer, shown in figure 1-1, accepts an electrical input signal and produces a proportional pneumatic output. Typically, 4 to 20 mA is converted to 0.2 to 1.0 bar (3 to 15 psi). Models are available in direct or reverse action and field-selectable full or split range inputs. Refer to the Calibration section for more information on input/output combinations.

The most common application of the transducer is to receive an electrical signal from a controller and produce a pneumatic output for operating a control valve actuator or positioner. The 846 may also be used to transduce a signal for a pneumatic receiving instrument.

The 846 is an electronic I/P transducer. It has a single electronic circuit board, as shown in figure 1-2. The circuit contains a solid-state pressure sensor that monitors output pressure and is part of an electronic feedback network. The self-correcting ability provided by the sensor/circuit combination allows the transducer to produce a very stable and responsive output signal.

All active mechanical and electrical components of the 846 are incorporated into a single, field-replaceable module called the module final assembly, shown in figure 1-2. The module final assembly contains the electronic circuit board, pilot/actuator assembly, and booster stage. The module final assembly is easily removed by unscrewing the module cover. Its design minimizes parts and reduces the time required for repair and troubleshooting.

The terminal compartment and module compartment are separated by a sealed compartment wall. This multi-compartment housing also protects the electronics from contaminants and moisture in the supply air.

Specifications

⚠ WARNING

This product is intended for a specific range of pressures, temperatures, and other application specifications. Applying different pressure, temperature and other service conditions could result in a malfunction of the product, property damage or personal injury.

Specifications for the 846 transducer are listed in table 1-1.

Table 1-1. Specifications

Input Signal

Standard Performance:
4 to 20 mA DC, 4 to 12 mA DC, or 12 to 20 mA DC. Field adjustable split ranging.

Multirange Performance:
4 to 20 mA DC. Consult factory for split range input.

Equivalent Circuit

See figure 1-3

Output Signal(1)

Standard Performance:
(Consult factory for split range output)
Direct Action (Minimum span of 6 psi)
Typical outputs: 0.2 to 1.0 bar (3 to 15 psi).
Rangeability between 0.1 and 1.2 bar (1 and 18 psi)
Reverse Action (Minimum span of 11 psi)
Typical outputs: 1.0 to 0.2 bar (15 to 3 psi)
Rangeability between 1.2 and 0.1 bar (18 and 1 psi)

Multirange Performance:
Direct Action (Minimum span of 6 psi)
Typical outputs: 0.2 to 1.9 bar (3 to 27 psi), 0.4 to 2 bar (6 to 30 psi), and 0.3 to 1.7 bar (5 to 25 psi)
Rangeability between 0.03 and 2.3 bar (0.5 and 33 psi)
Reverse Action (Minimum span of 11 psi)
Typical outputs: 1.9 to 0.2 bar (27 to 3 psi), 2 to 0.4 bar (30 to 6 psi), and 1.7 to 0.3 bar (25 to 5 psi)
Rangeability between 2.3 and 0.03 bar (33 and 0.5 psi)

Supply Pressure(2)

Standard Performance: 1.2 to 1.6 bar (18 to 24 psi)

Multirange Performance:
0.2 bar (3 psi)(3) greater than the maximum calibrated output pressure

Maximum: 2.4 bar (35 psi)

Supply Pressure Medium

Clean, dry air

Per ISA Standard 7.0.01
A maximum 40 micrometer particle size in the air system is acceptable. Further filtration down to 5 micrometer particle size is recommended. Lubricant content is not to exceed 1 ppm weight (w/w) or volume (v/v) basis. Condensation in the air supply should be minimized

Per ISO 8573-1
Maximum particle density size: Class 7
Oil content: Class 3
Pressure Dew Point: Class 3 or at least 10°C less than the lowest ambient temperature expected

Output Air Capacity(4)

Standard: 6.4 m^3/hr (240 scfh) at 1.4 bar (20 psi) supply pressure

Multirange: 9.7 m^3/hr (360 scfh) at 2.5 bar (35 psig) supply pressure

Maximum Steady-State Air Consumption(4)

0.3 m^3/hr (12 scfh) at 1.4 bar (20 psi) supply pressure

Temperature Limits(2)

Operating: -40 to 85°C (-40 to 185°F)

Storage :-40 to 93°C (-40 to 200°F)

Humidity Limits

0 to 100% condensing relative humidity

Performance(5)

Note: The performance of all 846 I/Ps is verified using computer automated manufacturing systems to ensure that every unit shipped meets its performance specifications.

Linearity, Hysteresis, and Repeatability: ± 0.3% of span.

Temperature Effect (total effect including zero and span): ± 0.07%/°C (0.045%/°F) of span

Vibration Effect: ± 0.3% of span per g during the following conditions:
5 to 15 Hz at 4 mm constant displacement
15 to 150 Hz at 2 g. 150 to 2000 Hz at 1 g.
per SAMA Standard PMC 31.1, Sec. 5.3, Condition 3, Steady State

Shock Effect: ± 0.5% of span, when tested per SAMA Standard PMC 31.1, Sec. 5.4.

Supply Pressure Effect: Negligible

-Continued-

Table 1-1. Specifications (continued)

Performance (continued)(5)

Electromagnetic Interference (EMI): Tested per IEC 61326-1 (Edition 1.1). Meets emission levels for Class A equipment (industrial locations) and Class B equipment (domestic locations). Meets immunity requirements for industrial locations (Table A.1 in the IEC specification document). Immunity performance is shown in table 1-2.

Leak Sensitivity(4): Less than 1.0% of span for up to 4.8 m^3/hr (180 scfh) downstream leakage.

Overpressure Effect: Less than 0.25% of span for misapplication of up to 7.0 bar (100 psi) supply pressure for less than 5 minutes to the input port.

Reverse Polarity Protection:

No damage occurs from reversal of normal supply current (4 to 20 mA) or from misapplication of up to 100 mA.

Connections

Supply Air, Output Signal, and Output Gauge: 1/4-18 NPT internal connection
Electrical: 1/2-14 NPT internal conduit connection

Adjustments

Zero and Span: screwdriver adjustments located in terminal compartment.

Remote Pressure Reading (RPR) Jumper selectable, ON or OFF, if unit includes option

Frequency Range: 0 to 10,000 Hz
Amplitude: 0.4 to 1.0 V_{p-p}

Required Operating Voltage with Remote pressure Reading Off

Min. 6.0 V (at 4 mA)
Max. 7.2 V (at 20 mA)

Required Operating Voltage with Remote Pressure Reading On

Min 6.4 V (at 4 mA)
Max. 8.2 V (at 20 mA)

Electrical Classification

Hazardous area:

CSA C/US—Intrinsically Safe, Explosion-proof, Non-Incendive

FM—Intrinsically Safe, Explosion-proof, Non-Incendive

ATEX—Intrinsically Safe, Flameproof, Type n

IECEx—Intrinsically Safe, Flameproof

Refer to Hazardous Area Classifications and Special Instructions for "Safe Use" and Installation in Hazardous Locations in Section 2 for additional information

Electrical Housing:

Tropicalization (Fungus test per MIL-STD-810)

CSA C/US—Type 4X

FM—Type 4X

ATEX—IP66(6)

IECEx—IP66(6)

Other Classifications/Certifications

INMETRO—National Institute of Metrology, Quality, and Technology (Brazil)

KGS—Korea Gas Safety Corporation (South Korea)

NEPSI— National Supervision and Inspection Centre for Explosion Protection and Safety of Instrumentation (China)

Contact your Emerson Process Management sales office for classification/certification specific information

Construction Materials

Housing: Low-copper aluminum with polyurethane paint, or 316 stainless steel
O-Rings: Nitrile, except silicone for sensor O-rings.

Options

Fisher 67CFR filter regulator, supply and output gauges or tire valve remote pressure reading, module cover with multiple stroke ports, stainless steel housing, or stainless steel mounting bracket.

Weight

Aluminum: 2.9 kg (6.5 lb) excluding options
Stainless Steel: 6.7 kg (14.8 lb) excluding options

-continued-

Table 1-1. Specifications (continued)

Declaration of SEP Fisher Controls International LLC declares this product to be in compliance with Article 3 paragraph 3 of the Pressure Equipment Directive (PED) 97 / 23 / EC. It was designed and manufactured in accordance	with Sound Engineering Practice (SEP) and cannot bear the CE marking related to PED compliance. However, the product *may* bear the CE marking to indicate compliance with *other* applicable European Community Directives.

NOTE: Specialized instrument terms are defined in ANSI/ISA Standard 51.1 - Process Instrument Terminology.
1. Metric calibration also available.
2. The pressure/temperature limits in this document, and any applicable standard or code limitation should not be exceeded.
3. 0.14 bar (2 psi) for a 2.3 bar (33 psi) output.
4. Normal m^3/hr—Normal cubic meters per hour (0°C and 1.01325 bar, absolute). Scfh—Standard cubic feet per hour (60°F and 14.7 psia).
5. Reference Conditions: 4.0 to 20 mA DC input, 0.2 to 1.0 bar (3 to 15 psi) output, and 1.4 bar (20 psi) supply pressure.
6. ATEX and IECEx Flameproof — IP66 per CSA Letter of Attestation.

Table 1-2. EMC Immunity Performance Criteria

Port	Phenomenon	Basic Standard	Test Level	Performance Criteria(1)
Enclosure	Electrostatic discharge (ESD)	IEC 61000-4-2	4 kV contact 8 kV air	A
	Radiated EM field	IEC 61000-4-3	80 to 1000 MHz @ 10V/m with 1 kHz AM at 80% 1400 to 2000 MHz @ 3V/m with 1kHz AM at 80% 2000 to 2700 MHz @ 1V/m with 1kHz AM at 80%	A
I/O signal/control	Burst (fast transients)	IEC 61000-4-4	1 kV	A
	Surge	IEC 61000-4-5	1 kV (line to ground only, each)	B
	Conducted RF	IEC 61000-4-6	150 kHz to 8 MHz at 3 Vrms	B
			8 MHz to 80 MHz at 3 Vrms	A

Specification limit = ±1% of span
1. A = No degradation during testing. B = Temporary degradation during testing, but is self-recovering.

Related Documents

This section lists other documents containing information related to the 846 transducer. These documents include:

- INMETRO Hazardous Area Approvals for Fisher 846 Current-to-Pressure Transducers Instruction Manual (D103623X012)
- NEPSI Hazardous Area Approvals for Fisher 846 Current-to-Pressure Transducers Instruction Manual (D103618X012)

All documents are available from your Emerson Process Management sales office. Also visit our website at www.Fisher.com.

Figure 1-2. Transducer Modular Construction

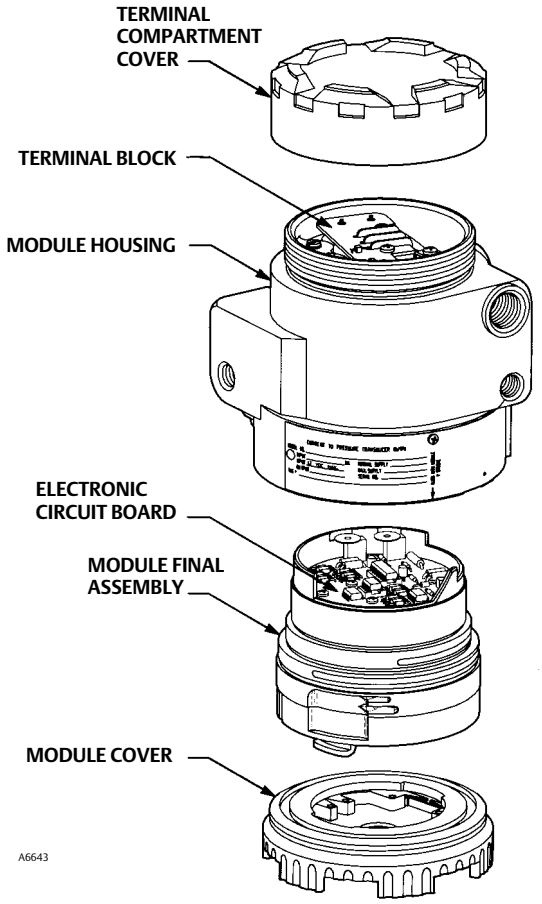
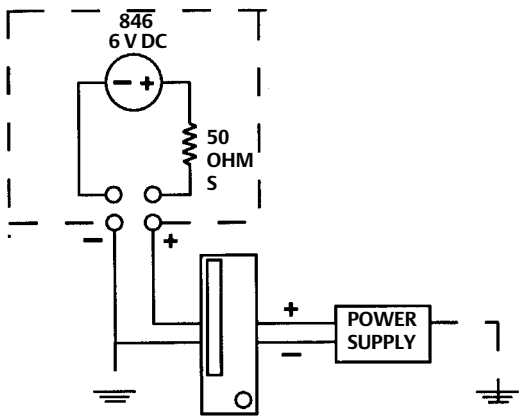


Figure 1-3. Equivalent Circuit



NOTE:
THE 846 IS NOT A CONSTANT RESISTOR IN SERIES WITH AN INDUCTOR. IT IS BETTER MODELED IN THE LOOP AS A 50 OHM RESISTOR IN SERIES WITH A 6-VOLT DC VOLTAGE DROP WITH NEGLIGIBLE INDUCTANCE.

A6325

Educational Services

For information on available courses for the 846 current-to-pressure transducer, as well as a variety of other products, contact:

Emerson Process Management
Educational Services - Registration
Phone: +1-641-754-3771 or +1-800-338-8158
Email: education@emerson.com
http://www.emersonprocess.com/education

Section 2 Installation

⚠ WARNING

To avoid personal injury or property damage from the sudden release of pressure or air:

- **Always wear protective clothing, gloves, and eyewear when performing any installation operations.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

This section presents information on installing the 846 current-to-pressure transducer. Figures 2-1, 2-2, 2-3, and 2-5 can be used as references for instructions contained in this section.

When a control valve is ordered with a 846 transducer specified to be mounted on the actuator, the factory-mounted transducer is connected to the actuator with the necessary tubing and calibrated to the specifications on the order.

If the transducer is purchased separately for mounting on a control valve already in service, all the necessary mounting parts are furnished, if ordered. This includes the appropriate bracket for attaching the unit to an actuator boss (with tapped holes) or for attaching it to the diaphragm casing.

If preferred, mounting parts can be supplied for mounting the transducer on a 51 mm (2-inch) diameter pipestand, a flat surface, or a bulkhead.

Transducers also can be ordered separately for mounting on a control valve assembly already in service. The transducer may be ordered with or without mounting parts. Mounting parts include the appropriate bracket and bolts for attaching the unit to an actuator boss (with tapped holes) or for attaching it to the diaphragm casing.

Hazardous Area Classifications and Special Instructions for “Safe Use” and Installation in Hazardous Locations

Certain nameplates may carry more than one approval, and each approval may have unique installation/wiring requirements and/or conditions of “safe use”. These special instructions for “safe use” are in addition to, and may override, the standard installation procedures. Special instructions are listed by approval.

Note

This information supplements the nameplate markings affixed to the product.

Always refer to the nameplate itself to identify the appropriate certification. Contact your Emerson Process Management sales office for approval/certification information not listed here.

⚠ WARNING

Failure to follow these conditions of safe-use could result in personal injury or property damage from fire or explosion, and area re-classification.

CSA

Intrinsically Safe, Explosion-proof, Non-Incendive

No special conditions for safe use.

Refer to table 2-1 for approval information.

Table 2-1. Hazardous Area Classifications for Canada—cCSAus

Certification Body	Certification Obtained	Entity Rating	Temperature Code
CSA	Ex ia Intrinsically Safe Class I Division 1 Groups A,B,C,D T4 per drawing GE59146 (see figure 8-1)	Vmax = 30 VDC Imax = 100 mA Ci = 0.016 μF Li = 20 μH	T4 (Tamb ≤ 60°C)
	XP Explosion-proof Class I Division 1 Groups C,D DIP Dust Ignition-proof Class II III Division I Groups E,F,G T4 NI Non-incendive Class I, Division 2, Groups A,B,C,D T4	---	T4 (Tamb ≤ 60°C)

FM

Special Conditions of Use

Intrinsically Safe, Explosion-proof, Non-Incendive

1. The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.

Refer to table 2-2 for additional approval information.

Table 2-2. Hazardous Area Classification for United Stated—FM

Certification Body	Certification Obtained	Entity Rating	Temperature Code
FM	IS Intrinsically Safe Class I, II, III Division 1 Groups A,B,C,D,E,F,G per drawing GE59147 (see figure 8-2)	Vmax = 30 VDC Imax = 100 mA Pmax = 1.0 W Ci = 0.016 μF Li = 20 μH	T4 (Tamb ≤ 60°C)
	XP Explosion-proof Class I Division 1 Groups B,C,D DIP Dust Ignition-proof Class II, III Division I Groups EFG NI Non-incendive Class I Division 2 Groups A,B,C,D	---	T4 (Tamb ≤ 60°C)

ATEX

Special Conditions for Safe Use

Intrinsically Safe

This equipment is intrinsically safe and can be used in potentially explosive atmospheres.

The apparatus must be only connected to a certified associated intrinsically safe equipment and this combination must be compatible as regards intrinsic safety rules.

The electrical parameters of certified equipment which can be connected to the sensor must not exceed one of these following values:

$U_0 \leq 30$ V
$I_0 \leq 100$ mA
$P_0 \leq 1.0$ W

Ambient temperature: -40°C to +80°C

Flameproof

Refer to page 10.

Type n

No special conditions for safe use.

Refer to table 2-3 for additional approval information.

Table 2-3. Hazardous Area Classifications—ATEX

Certificate	Certification Obtained	Entity Rating	Temperature Code
ATEX	Intrinsically Safe ⟨Ex⟩ II 1 GD Gas Ex ia IIC T4,T5 Ga Dust Ex ia IIIC IP66 Da T90°C (Tamb ≤ 80°C) Ex ia IIIC IP66 Da T50°C (Tamb ≤ 40°C)	Ui = 30 VDC Ii = 100 mA Pi = 1.0 W Ci = 8 nF Li = 20 μH	T4 (Tamb ≤ 80°C) T5 (Tamb ≤ 40°C)
	Flameproof ⟨Ex⟩ II 2 G Gas Ex d IIB T5/T6 Gb	---	T5 (Tamb ≤ 80°C) T6 (Tamb ≤ 65°C)
	Type n ⟨Ex⟩ II 3 GD Gas Ex nA IIC T5/T6 Gc Dust Ex tc IIIC T88°C T_{500} Dc IP66 Ex tc IIIC T77°C T_{500} Dc IP66	---	T5 (Tamb ≤ 85°C) T6 (Tamb ≤ 74°C)

IECEx

Special Conditions for Safe Use

Intrinsically Safe

No special conditions for safe use.

Flameproof

See below.

Refer to table 2-4 for additional approval information.

Table 2-4. Hazardous Area Classifications—IECEx

Certificate	Certification Obtained	Entity Rating	Temperature Code
IECEx	Intrinsically Safe Gas Ex ia IIC T4/T5 Ga	Ui = 40 VDC Ii = 200 mA Pi = 1.0 W Ci = 8 nF Li = 20 μH	T4 (Tamb ≤ 80°C) T5 (Tamb ≤ 40°C)
	Flameproof Gas Ex d IIB T5/T6 Gb	---	T5 (Tamb ≤ 80°C) T6 (Tamb ≤ 65°C)

ATEX/IECEx

Special Conditions for Safe Use

Flameproof

1. The equipment incorporates flameproof joints which have a maximum gap less than that stated in EN 60079-1. The user shall refer to the manufacturer's installation, operation, and maintenance document for guidance.
2. The cable entry device used shall be certified Ex d IIB or Ex d IIC.
3. The user shall ensure that the maximum system pressure does not exceed 35 psi.
4. Refer to figures 2-2 and 2-3 for proper bolting engagement length for ATEX and IECEx flameproof units.
5. A cable entry hole is provided for the accommodation of a flameproof cable entry device, with or without the interposition of a flameproof thread adaptor.

For ATEX certified versions of 846 transducers—the cable entry device and thread adapter shall be suitable for the equipment, the cable and the conditions of use and shall be certified as Equipment (not a Component) under an EC Type Examination Certificate to Directive 94/9/EC. Refer to table 2-3 for additional approval information.

For IECEx certified versions of 846 transducers—the cable entry device and thread adapter shall be suitable for the equipment, the cable and the conditions of use and shall be certified as Equipment (not a Component). Refer to table 2-4 for additional approval information.

Mounting

⚠ WARNING

This unit will vent to the atmosphere through the stroke port in the module cover and the exhaust port, located under the nameplate. Do not remote vent this unit.

The transducer is designed for mounting on a control valve, 51 mm (2-inch) diameter pipestand, wall, or panel. Figures 2-2, 2-3, 2-4, and 2-5 show recommended mounting configurations. The mounting positions shown allow any moisture buildup in the terminal compartment to drain to the signal wire conduit entrance. Any moisture in the pilot stage area will be expelled through the stroke port without affecting pilot stage operation. In applications with excessive moisture in the supply air, vertical mounting allows the most effective drainage through the stroke port.

CAUTION

Do not mount the transducer with the terminal compartment cover on the bottom as moisture, or any corrosive elements in the plant atmosphere, may accumulate in the terminal compartment or pilot stage, resulting in transducer malfunction.

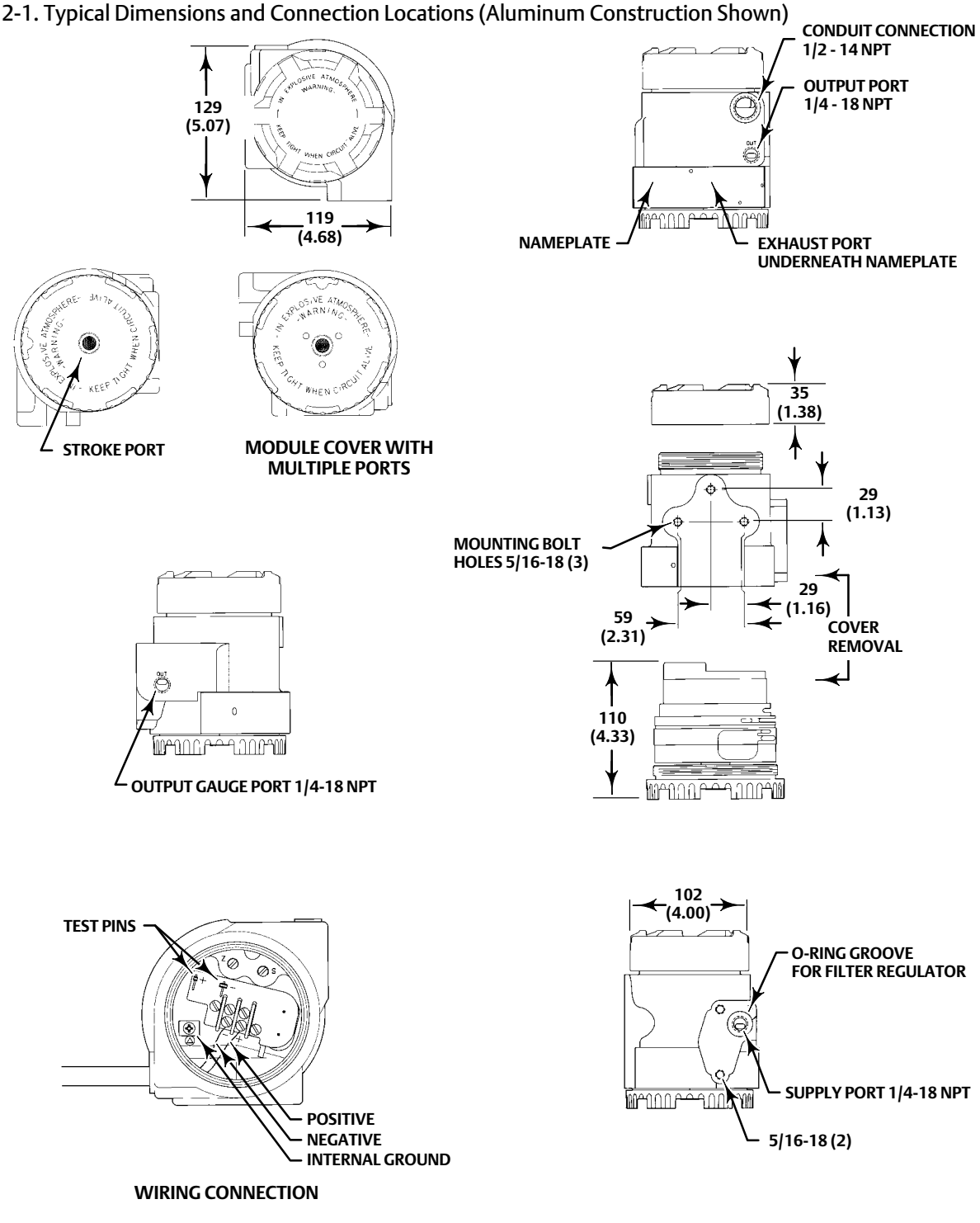
Mounting is accomplished with an optional universal mounting bracket. Before mounting the transducer, note the following recommendations:

- Ensure that all bolts are fully tightened. The recommended torque is 22 N•m (16 lbf•ft).
- Bolts that connect to the transducer and to a valve actuator should have the lock washer placed directly beneath the bolt head and the flat washer placed between the lock washer and bracket. All other bolts should have the lock washer next to the nut, and the flat washer placed between the lock washer and bracket.
- Do not mount the transducer in a location where foreign material may cover the stroke port or exhaust port. See the descriptions of the stroke port and exhaust port later in this section.

Pressure Connections

As shown in figure 2-1, all pressure connections are 1/4-18 NPT internal connections. Use 9.5 mm (3/8-inch) outside diameter tubing for the supply and output connections.

Figure 2-1. Typical Dimensions and Connection Locations (Aluminum Construction Shown)



NOTE:

REFER TO FIGURE 2-5 FOR TRANSDUCER DIMENSIONS WITH ATEX / IECEx FLAMEPROOF CERTIFICATIONS

B2473-1

mm
(INCHES)

Supply Pressure

⚠ WARNING

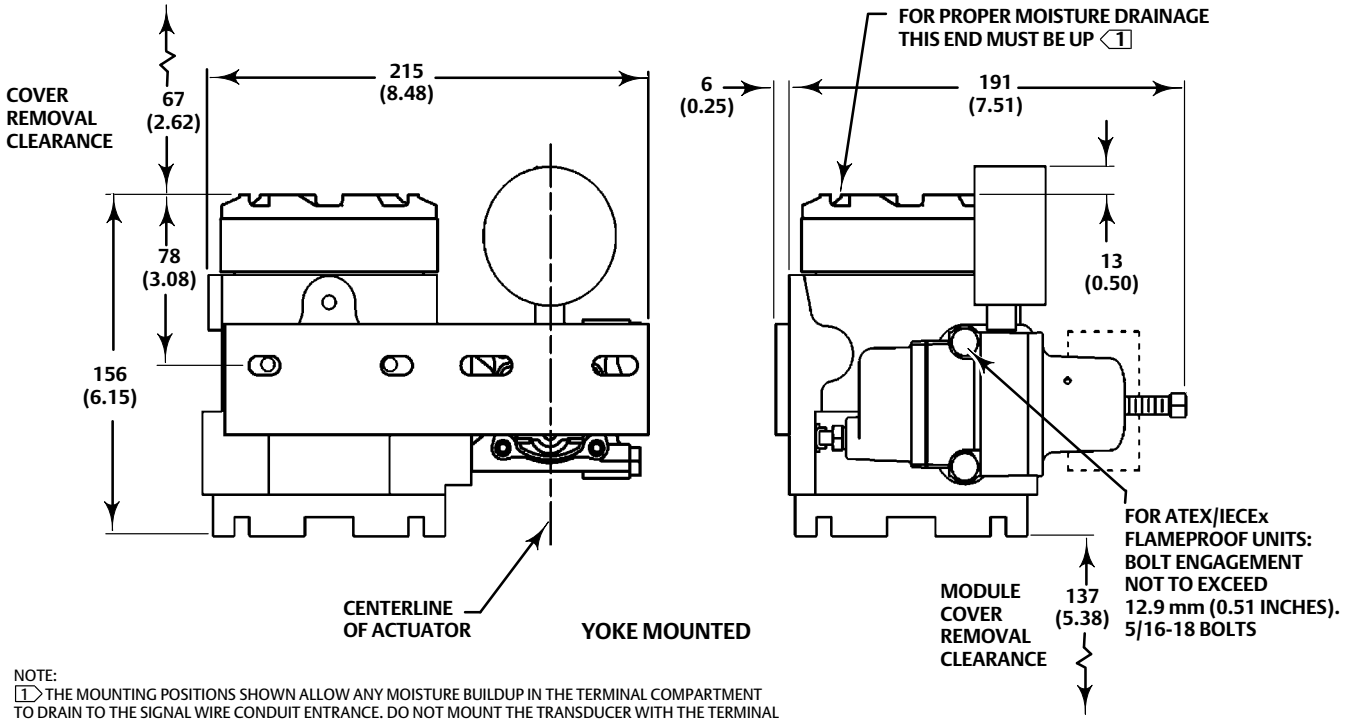
Severe personal injury or property damage may occur from process instability if the instrument supply medium is not clean, dry air. While use and regular maintenance of a filter that removes particles larger than 40 micrometers in diameter will suffice in most applications, check with an Emerson Process Management field office and industry instrument air quality standards if you are unsure about the proper amount or method of air filtration or filter maintenance.

The supply medium must be clean, dry air that meets the requirements of ISA Standard 7.0.01 or ISO 8573-1. An output span of 0.2 to 1.0 bar (3 to 15 psi) requires a nominal supply pressure of 1.4 bar (20 psi) and a flow capacity not less than 6.4 normal m^3/hr (240 scfh).

For multirange performance units with higher output spans, the supply pressure should be at least 0.2 bar (3 psi) greater than the maximum calibrated output pressure.

The air supply line can be connected to the 1/4-18 NPT supply port, or to the supply port of a filter-regulator mounted directly to the transducer. Figures 2-2, 2-3, 2-4, and 2-5 show the installation options.

Figure 2-2. Typical Dimensions with Fisher 67CFR Filter/Regulator and Gauges

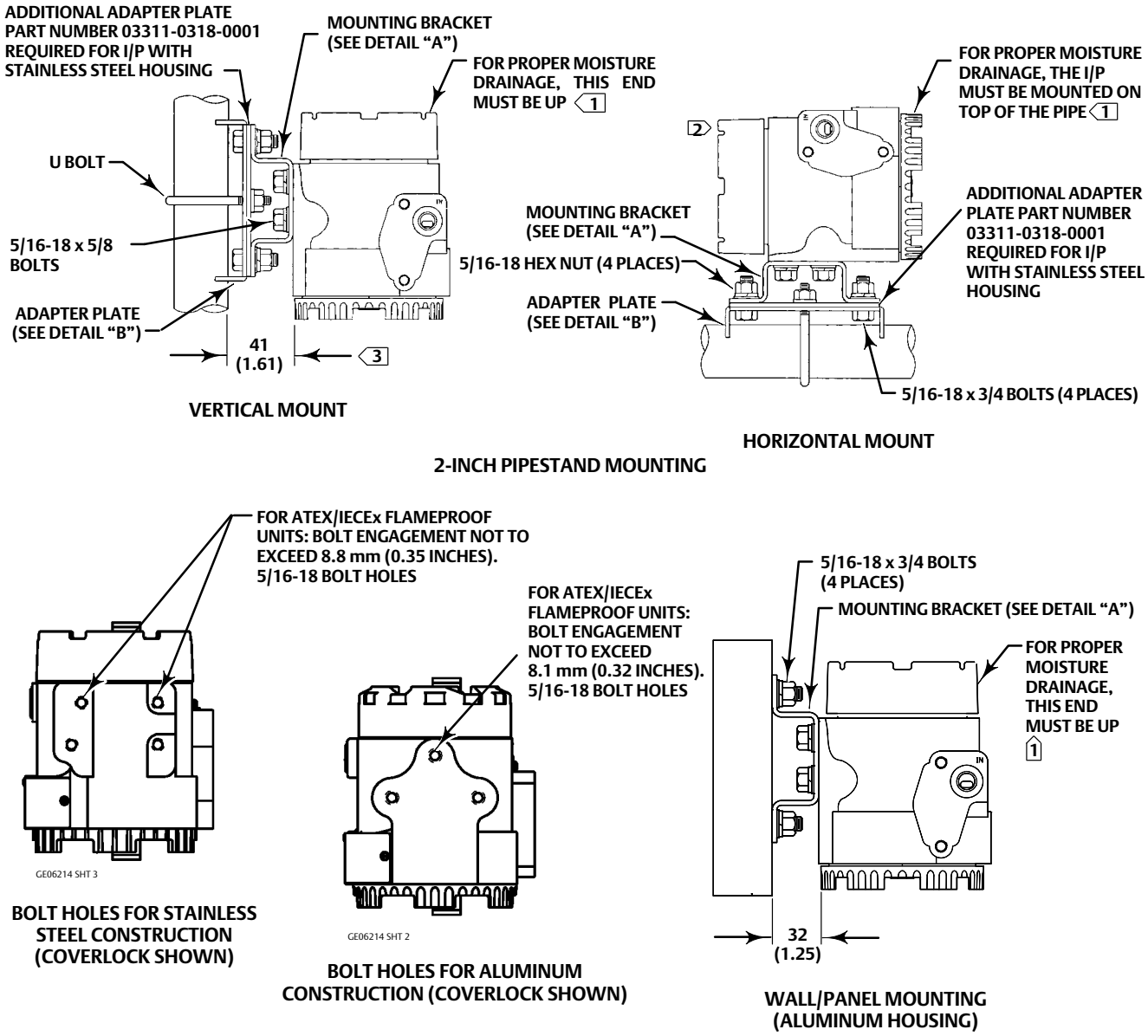


NOTE:
1 THE MOUNTING POSITIONS SHOWN ALLOW ANY MOISTURE BUILDUP IN THE TERMINAL COMPARTMENT TO DRAIN TO THE SIGNAL WIRE CONDUIT ENTRANCE. DO NOT MOUNT THE TRANSDUCER WITH THE TERMINAL COMPARTMENT COVER ON THE BOTTOM; MOISTURE MAY ACCUMULATE IN THE TERMINAL COMPARTMENT OR PILOT STAGE, PREVENTING PROPER TRANSDUCER OPERATION. THE VERTICAL MOUNT IS MOST EFFECTIVE FOR MOISTURE DRAINAGE IN WET APPLICATIONS.

14B7361-D
A6626-3

mm
(INCH)

Figure 2-3. Typical Transducer Mounting with Universal Mounting Bracket

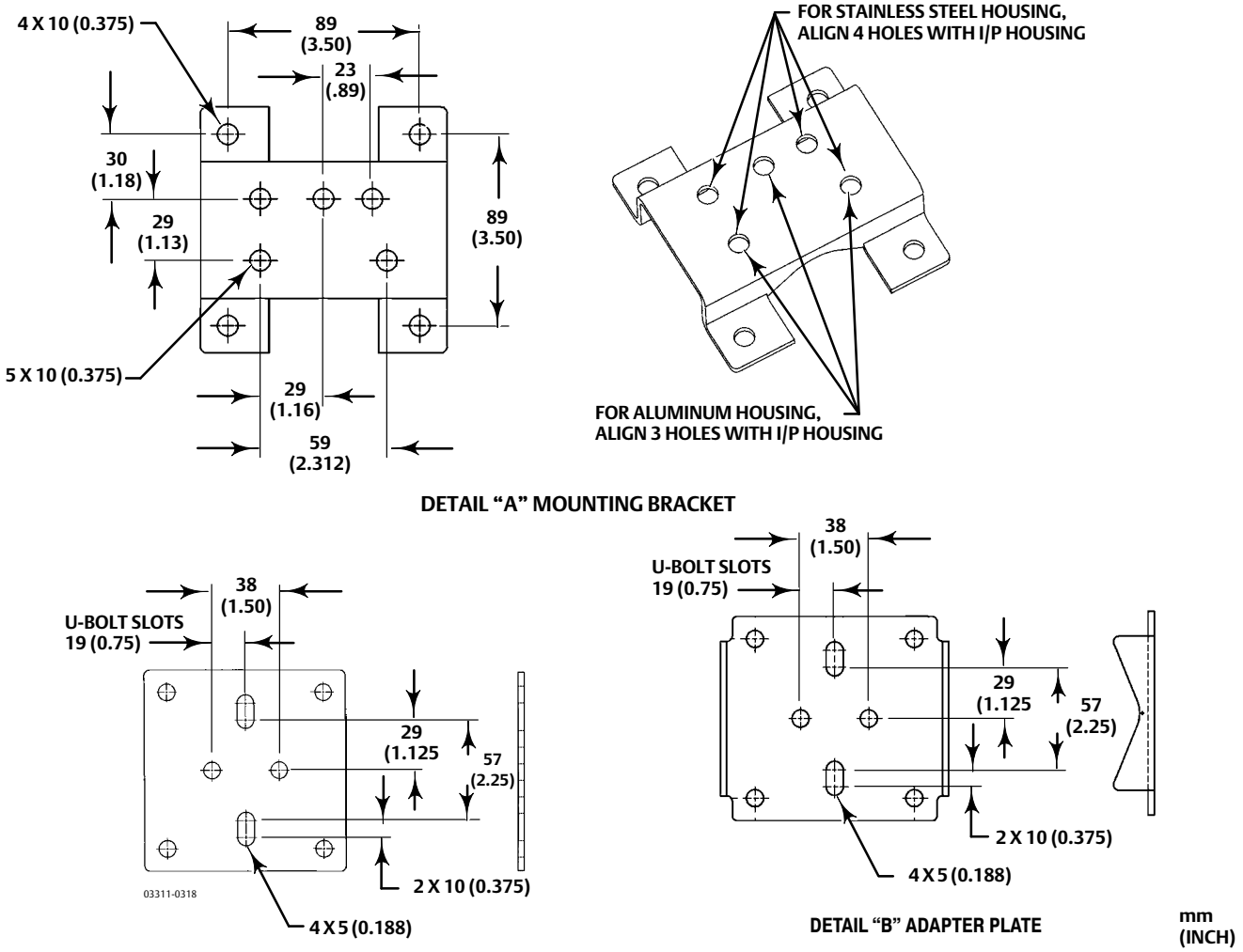


NOTES:
1 THE MOUNTING POSITIONS SHOWN ALLOW ANY MOISTURE BUILDUP IN THE TERMINAL COMPARTMENT TO DRAIN TO THE SIGNAL WIRE CONDUIT ENTRANCE. DO NOT MOUNT THE TRANSDUCER WITH THE TERMINAL COMPARTMENT COVER ON THE BOTTOM; MOISTURE MAY ACCUMULATE IN THE TERMINAL COMPARTMENT OR PILOT STAGE, PREVENTING PROPER TRANSDUCER OPERATION. THE VERTICAL MOUNT IS MOST EFFECTIVE FOR MOISTURE DRAINAGE IN WET APPLICATIONS.
2 IF MOUNTED ON HORIZONTAL PIPE, THE I/P MUST BE ON TOP OF THE PIPE FOR PROPER MOISTURE DRAINAGE.
3 THIS DIMENSION IS 44 (1.74) FOR STAINLESS STEEL HOUSING.

mm (INCH)

14B7332
19B9484-B
E0786

Figure 2-3. Typical Transducer Mounting with Universal Mounting Bracket (continued)



ADDITIONAL ADAPTOR PLATE (PART NUMBER 03311-0318-0001) REQUIRED FOR I/P WITH STAINLESS STEEL HOUSING

NOTES:

1. ATTACH THE BRACKET SHOWN IN DETAIL "A" TO THE TRANSDUCER
2. ATTACH THE ADAPTER PLATE SHOWN IN DETAIL "B" TO THE VALVE OR PIPE.
3. CONNECT THE TWO PIECES.

34B4990-C
34B5000-B
E0787

The mounting boss for the air supply connection contains two 5/16-18 UNC tapped holes that are 2-1/4 inches apart. The tapped holes allow direct connection (integral mount) of a 67CFR filter-regulator, if desired. When the filter-regulator is factory mounted, the mounting hardware consists of two 5/16-18 x 3-1/2 inch stainless steel bolts and one O-ring. When the filter-regulator is field mounted, the mounting hardware consists of two 5/16-18 x 3-1/2 inch stainless steel bolts, two spacers (which may or may not be required) and two O-rings (of which only one will fit correctly into the housing O-ring groove and the other may be discarded). This is due to the fact that the current housing has been slightly modified from its original design, hence, the additional hardware (if needed) when field mounting the 67CFR filter-regulator.

Figure 2-4. Typical Transducer Dimensions with Gauges

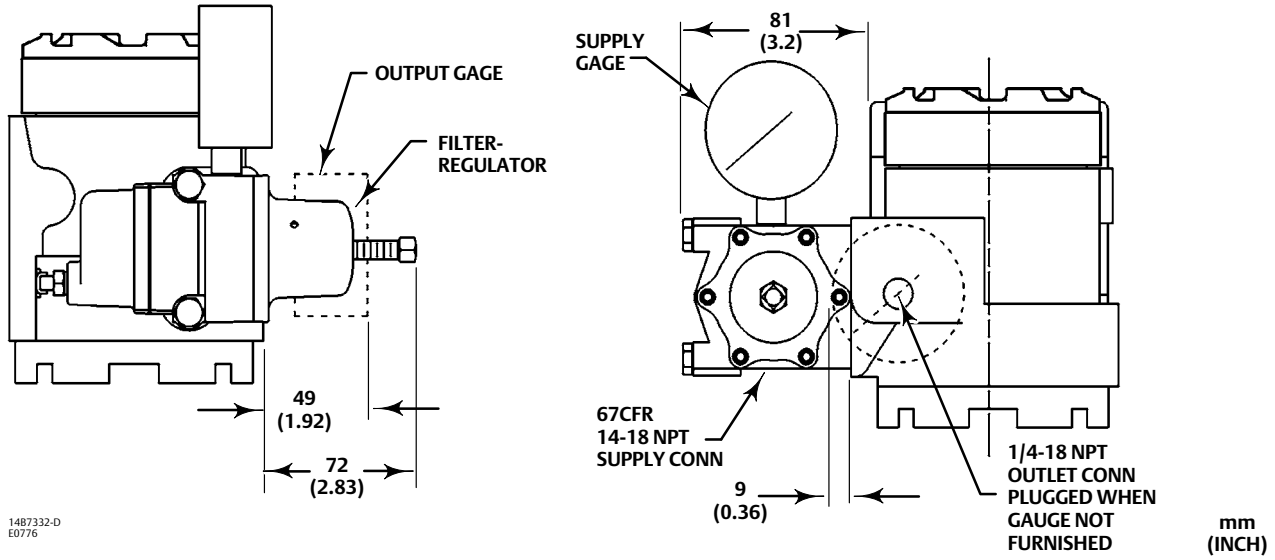
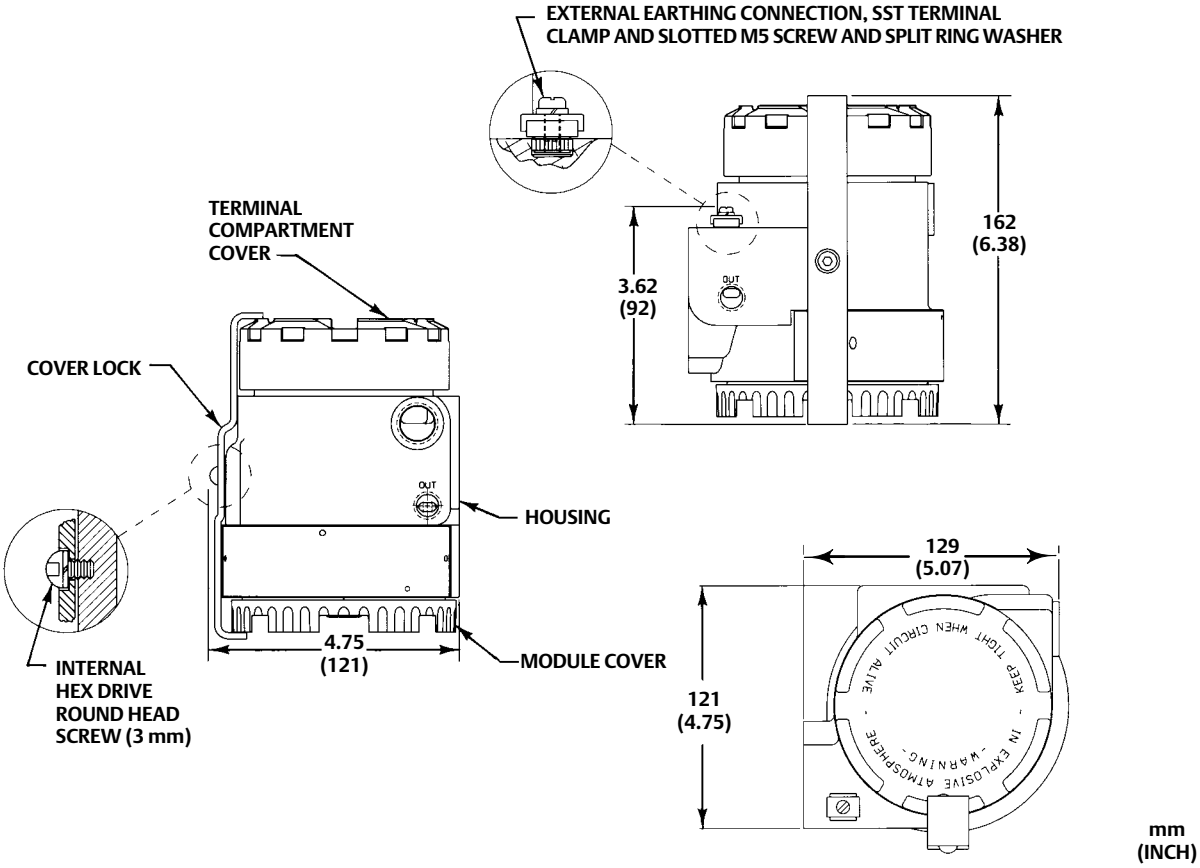


Figure 2-5. Transducer Dimensions with ATEX / IECEx Flameproof Certifications



Output Pressure

Connect the output signal line to the transducer at the output port. The output port is 1/4-18 NPT, as shown in figure 2-1. The output gauge port can be used as an alternate signal port. If the gauge port is used as a signal port, a threaded plug must be installed in the output port.

The output gauge port allows connection of an output gauge to provide local output signal indication. The output gauge port is 1/4-18 NPT. If an output gauge is not specified, a threaded plug is shipped with the transducer. The plug must be installed in the output gauge port when the port is not used.

Electrical Connections

⚠ WARNING

Personal injury or property damage could result from fire or explosion. In explosive atmospheres, remove power and shut off the air supply to the I/P unit before attempting to remove the terminal compartment cover or module cover. Failure to do so could result in an electrical spark or explosion.

Personal injury or property damage could result from an uncontrolled process. Unscrewing the module cover removes power from the electronics and the output signal will be 0.0 psi. Perform the steps in the WARNING at the beginning of this section before removing the module cover to ensure the process is properly controlled.

CAUTION

Excessive current can damage the transducer. Do not connect an input current of more than 100 mA to the transducer.

Note

For North American explosion-proof applications, 846 transducers have been designed so that a conduit seal is not required. For all other applications install the product per local, regional, or national code, rules, and regulations.

⚠ WARNING

Select wiring and/or cable glands that are rated for the environment of use (such as hazardous location, ingress protection, and temperature). Failure to use properly rated wiring and/or cable glands can result in personal injury or property damage from fire or explosion.

Signal wiring is brought to the terminal compartment through a 1/2-14 NPT housing conduit connection, shown in figure 2-1. Where condensate is common, use a conduit drip leg to help reduce liquid buildup in the terminal compartment and avoid shorting of the input signal. Electrical connections are made at the terminal block. Internal and external grounding lugs are provided to facilitate a separate ground when required. The internal ground is shown in figure 2-1, and the external grounding lug is shown in figure 2-5.

Connect the positive signal lead to the positive terminal, marked +. Connect the negative signal lead to the negative terminal, marked -.

Note

Units with the Remote Pressure Reading (RPR) option may cause interference with the analog output signal from some instrumentation systems. This problem may be solved by placing a 0.2 microfarad capacitor or a HART filter across the output terminals.

Venting Ports

⚠ WARNING

This unit will vent to the atmosphere through the stroke port in the module cover and the exhaust port, located under the nameplate. Do not remote vent this unit.

Stroke Port

The constant bleed of supply medium from the pilot stage is directed out the stroke port, which is a screened hole located at the center of the module cover. Figure 2-1 shows the location of the stroke port.

Before installing the transducer, ensure the stroke port is clear. Do not mount the transducer in a location where foreign material may cover the stroke port. For information on using the stroke port, refer to the Troubleshooting section.

Exhaust Port

The transducer exhausts through a screened port located beneath the instrument nameplate. Figure 2-1 shows the location of the exhaust port. The nameplate holds the screen in place. Exhaust will occur with a reduction in output pressure. The transducer should not be mounted in a location where foreign material may clog the exhaust port.

Signal Interruption

Upon loss of input current, or if input current decreases below 3.3 $\pm$ 0.3 mA, the output of the direct action unit will decrease to less than 0.1 bar (1 psi).

In the same situation, the output of the reverse action unit will increase to near supply pressure.

Section 3 Calibration

⚠ WARNING

The following calibration procedures require taking the transducer out of service. To avoid personal injury and property damage caused by an uncontrolled process, provide some temporary means of control for the process before taking the transducer out of service. Also refer to the WARNING at the beginning of the Maintenance section.

Calibration of the 846 requires either an accurate current generator or an accurate voltage generator with a precision 250-ohm, 1/2-watt resistor. Figure 3-1 shows how to connect either device.

Calibration also requires a precision output indicator and a minimum non-surging air supply of 5.0 normal m^3/hr (187 scfh) at 1.4 bar (20 psi) for standard performance units. For multirange performance units, the air supply must be at least 0.2 bar (3 psi) greater than the maximum calibrated output pressure, up to 2.4 bar (35 psi) maximum.

For ease of calibration, the output load volume, including the output tubing and output indicator, should be a minimum of 33 cm^3 (2 cubic inches). Review the information under Signal Interruption in the Installation section before beginning the calibration procedure.

Before calibration, determine the type of input (full or split range), and the type of output action (direct or reverse). Consult the factory for split range output calibration. Also, determine if the unit offers standard or multirange performance. The unit supports eight basic input/output combinations:

Standard Performance

- Full Range Input, Direct Action
- Split Range Input, Direct Action
- Full Range Input, Reverse Action
- Split Range Input, Reverse Action

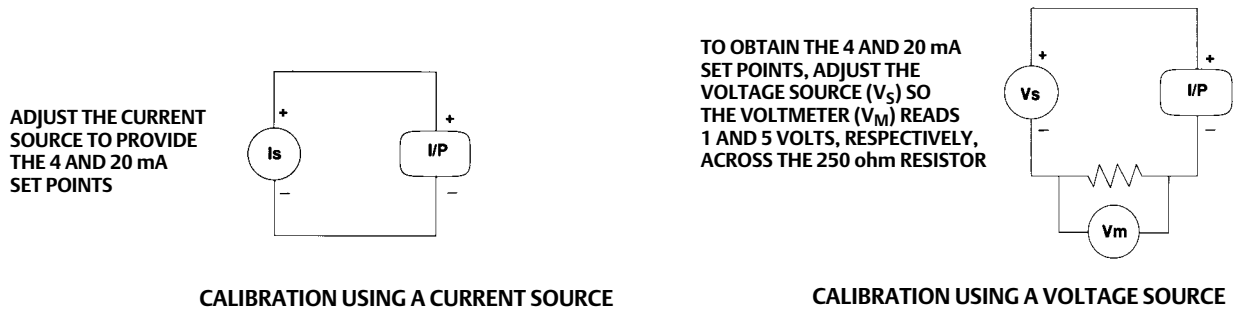
Multirange Performance

- Full Range Input, Direct Action
- Split Range Input, Direct Action (see note below)
- Full Range Input, Reverse Action
- Split Range Input, Reverse Action (see note below)

Note

Consult your Emerson Process Management sales office or the factory for calibration of multirange performance units with split range input or split range output, or both.

Figure 3-1. Connecting a Current or Voltage Source for Calibration



CAUTION

Excessive current can damage the transducer. Do not connect an input current of more than 100 mA to the transducer.

Table 3-1 lists the various input and output ranges over which the unit may be calibrated.

The input range is selected by changing the position of a jumper located on the electronic circuit board.

Refer to Electronic Circuit Board in the Maintenance section, and figure 6-4 for the location and instruction on placement.

Table 3-1. Fisher 846 I/P Rangeability Matrix

Input Range	Output Pressure Range (psi) (Performance Code)															
	Common Ranges					Misc.		Std. Split		High Range Splits						
	3-15 (S,M)	.5-30 (M)	3-27 (M)	6-30 (M)	5-25 (M)	0.5-6 (S,M)	.5-18 (S,M)	3-9 (S,M)	9-15 (S,M)	.5-15 (S,M)	15-30 (M)	15-27 (M)	6-18 (S,M)	18-30 (M)	5-15 (S,M)	15-25 (M)
4-20	✓	✓	✓	✓	✓	D	✓	D	D	✓	U	U	✓	U	✓	U
4-12	✓	✓	✓	✓	✓	D	✓	D	D	✓	U	U	✓	U	✓	U
12-20	✓		J	J	J	D	J	D	D	J	✓	✓	✓	✓	✓	✓
4-8	✓					✓		✓	✓				✓		✓	
8-12	✓					✓		✓	✓				✓		✓	
12-16	J					J		J	✓				J		J	
16-20	J					J		J	J				J		J	

S=Standard Performance Unit
M=Multirange Performance Unit
✓=Available in Direct or Reverse Action
D=Available in Direct Action Only
J=Available, but if the desired calibration cannot be achieved by adjusting the zero/span screws, unit may require Hi/Lo jumper to be moved. The jumper is located on the circuit board assembly, and is usually in the Hi position. Disengaging the master module and moving the jumper to the Lo position will allow calibration to the desired range.
U=Special Build Required.

Standard Performance: Full Range Input, Direct Action

⚠ WARNING

Refer to the WARNING at the beginning of the Maintenance section.

Use the following procedure to achieve a standard 0.2 to 1.0 bar (3 to 15 psi) output span for a 4 to 20 mA input signal:

1. Remove the module final assembly from the housing. Refer to Removing the Module Final Assembly in the Maintenance section for an explanation of how to disengage the module final assembly.
2. Confirm that the unit is direct acting. A green electronic circuit board identifies direct-acting units. Refer to Action under the heading Electronic Circuit Board in the Maintenance section for more information on direct acting units.
3. Position the range jumper in the Hi position for High Range. Figure 6-4 shows the circuit board jumper positions.
4. Replace the module final assembly in the housing. Refer to Replacing the Module Final Assembly in the Maintenance section for an explanation of how to engage the module final assembly.
5. Connect the air supply to the air supply port.
6. Connect a precision output indicator to the output signal port.
7. Make sure that the output gauge port has an output gauge or a threaded plug installed. A threaded plug is provided for units shipped without output gauges.
8. Remove the terminal compartment cover.
9. Connect the current source (or voltage source) positive lead (+) to the terminal block positive (+) and the current source (250-ohm resistor lead) negative lead (-) to the terminal block negative (-). Refer to figure 3-1.

CAUTION

Excessive current can damage the transducer. Do not connect an input current of more than 100 mA to the transducer.

10. Apply a 4.0 mA (Vm = 1.0 V) signal, and adjust the zero screw to achieve a 0.2 bar (3.0 psi) output. The output increases with clockwise rotation of the zero screw.
11. Apply a 20.0 mA (Vm = 5.0 V) signal, and adjust the span screw to achieve a 1.0 bar (15.0 psi) output. The output increases with clockwise rotation of the span screw.
12. Repeat steps 10 and 11 to verify and complete the calibration.

Multirange Performance: Full Range Input, Direct Action

⚠ WARNING

Refer to the WARNING at the beginning of the Maintenance section.

Note

Consult your Emerson Process Management sales office or the factory for calibration of multirange performance units with split range input.

Use the following procedure with a multirange performance unit to achieve the desired direct action output span for a 4 to 20 mA input signal:

1. Perform steps 1 through 9 of the calibration procedure for Standard Performance: Full Range Input, Direct Action.
2. Apply a 4.0 mA (Vm = 1.0 V) signal, and adjust the zero screw to achieve the desired lower limit of the output range. The lower limit must be between 0.03 and 0.6 bar (0.5 and 9.0 psi). The output increases with clockwise rotation of the zero screw.
3. Apply a 20.0 mA (Vm = 5.0 V) signal, and adjust the span screw to achieve the desired upper limit of the output range. The span must be at least 0.4 bar (6.0 psi). The maximum upper limit is 2.0 bar (30.0 psi). The output increases with clockwise rotation of the span screw.
4. Repeat steps 2 and 3 to verify and complete the calibration.

Standard Performance: Split Range Input, Direct Action

⚠ WARNING

Refer to the WARNING at the beginning of the Maintenance section.

4 to 12 mA Input Signal

Use the following calibration procedure to produce a 0.2 to 1.0 bar (3 to 15 psi) output span for a 4 to 12 mA input signal:

1. Perform steps 1 through 9 of the calibration procedure for Standard Performance: Full Range Input, Direct Action.
2. Apply an input of 4.0 mA (Vm = 1.0 V), and adjust the zero screw to achieve an output of 0.2 bar (3.0 psi).
3. Apply an input of 12.0 mA (Vm = 3.0 V), and adjust the span screw to achieve an output of 1.0 bar (15.0 psi).
4. Repeat steps 2 and 3 to verify and complete the calibration.

12 to 20 mA Input Signal

Use the following calibration procedure to produce a 0.2 to 1.0 bar (3 to 15 psi) output span for a 12 to 20 mA input signal:

Note

There may be some span interaction with zero in this range, and the following steps compensate for this.

1. Perform steps 1 through 9 of the calibration procedure for Standard Performance: Full Range Input, Direct Action.
2. Apply an input of 4.0 mA (Vm = 1.0 V), and adjust the zero screw to achieve an output of 0.2 bar (3.0 psi).
3. Apply an input of 12.0 mA (Vm = 3.0 V), and adjust the span screw to achieve an output of 1.0 bar (15.0 psi).
4. Maintain the input of 12.0 mA (Vm = 3.0 V), and adjust the zero screw to achieve an output of 0.2 bar (3.0 psi). The unit may not turn down this low; if it does not, go to step 7.
5. If the output reaches 0.2 bar (3.0 psi) in step 4, apply an input of 20.0 ma (Vm = 5.0 V) and note the error (the actual reading versus 15.0 psi). Adjust the span screw to overcorrect the error by a factor of two. For example, if the reading was 0.9 bar (14.95 psi), adjust the span screw to achieve an output of 1.1 bar (15.05 psi).

6. Repeat steps 4 and 5 to verify and complete the calibration.
7. Turn off the air supply. Remove the module final assembly from the housing. Place the range jumper in the Lo position for Low Range, as indicated in figure 6-4. Replace the module final assembly. Turn on the air supply.
8. Apply an input of 12.0 mA (Vm = 3.0 V), and adjust the zero screw to achieve an output of 0.2 bar (3.0 psi).
9. Apply an input of 20.0 mA (Vm = 5.0 V), and note the error (the actual reading versus 15.0 psi). Adjust the span screw to overcorrect the error by a factor of two. For example, if the reading was 0.9 bar (14.95 psi), adjust the span screw to achieve an output of 1.1 bar (15.05 psi).
10. Repeat steps 8 and 9 to verify and complete the calibration.

Standard Performance: Full Range Input, Reverse Action

⚠ WARNING

Refer to the WARNING at the beginning of the Maintenance section.

Use the following procedure on reverse action units to achieve a 1.0 to 0.2 bar (15 to 3 psi) output span for a 4 to 20 mA input signal:

1. Perform steps 1 through 9 under Standard Performance: Full Range Input, Direct Action, except for step 2. In place of step 2, confirm that the unit is reverse acting. A red electronic circuit board identifies reverse-acting units. Refer to Action under the heading Electronic Circuit Board in the Maintenance section for more information on reverse acting units.
2. Apply an input of 4.0 mA (Vm = 1.0 V), and adjust the zero screw to achieve an output of 1.0 bar (15.0 psi).
3. Apply an input of 20.0 mA (Vm = 5.0 V), and adjust the span screw to achieve an output of 0.2 bar (3.0 psi).
4. Repeat steps 2 and 3 to verify and complete the calibration.

Multirange Performance: Full Range Input, Reverse Action

⚠ WARNING

Refer to the WARNING at the beginning of the Maintenance section.

Note

Consult your Emerson Process Management sales office or the factory for calibration of multirange performance units with split range input.

Use the following procedure with a multirange unit to achieve the desired reverse action output span for a 4 to 20 mA input signal:

1. Perform steps 1 through 9 of the calibration procedure for Standard Performance: Full Range Input, Direct Action, except for step 2. In place of step 2, confirm that the unit is reverse acting. A red electronic circuit board identifies reverse-acting units. Refer to Action under the heading Electronic Circuit Board in the Maintenance section for more information on reverse acting units.
2. Apply an input of 4.0 mA (Vm = 1.0 V), and adjust the zero screw to achieve the desired upper limit of the output range. The 4 mA point must be between 0.6 and 2.0 bar (9.0 and 30.0 psi). The output increases with clockwise rotation of the zero screw.

3. Apply an input of 20.0 mA (Vm = 5.0 V), and adjust the span screw to achieve the desired lower limit of the output range. The span must be at least 0.7 bar (11.0 psi). The lower limit of the 20.0 mA setting is 0.03 bar (0.5 psi). The output increases with clockwise rotation of the span screw.
4. Repeat steps 2 and 3 to verify and complete the calibration.

Standard Performance: Split Range Input, Reverse Action

⚠ WARNING

Refer to the WARNING at the beginning of the Maintenance section.

4 to 12 mA Input Signal

Use the following procedure on reverse action units to achieve a 1.0 to 0.2 bar (15 to 3 psi) output signal for a 4 to 12 mA input signal:

1. Perform steps 1 through 9 of the calibration procedure for Standard Performance: Full Range Input, Direct Action, except for step 2. In place of step 2, confirm that the unit is reverse acting. A red electronic circuit board identifies reverse-acting units. Refer to Action under the heading Electronic Circuit Board in the Maintenance section for more information on reverse acting units.
2. Apply an input of 4.0 mA (Vm = 1.0 V), and adjust the zero screw to achieve an output of 1.0 bar (15.0 psi).
3. Apply an input of 12.0 mA (Vm = 3.0 V), and adjust the span screw to achieve an output of 0.2 bar (3.0 psi).
4. Repeat steps 2 and 3 to verify and complete the calibration.

12 to 20 mA Input Signal

Use the following procedure on reverse action units to achieve a 1.0 to 0.2 bar (15 to 3 psi) output signal for a 12 to 20 mA input signal:

Note

There may be some span interaction with zero in this range, and the following steps compensate for this.

1. Perform steps 1 through 9 of the calibration procedure for Standard Performance: Full Range Input, Direct Action, except for step 2. In place of step 2, confirm that the unit is reverse action. A red electronic circuit board identifies reverse-acting units. Refer to Action under the heading Electronic Circuit Board in the Maintenance section for more information on reverse acting units.
2. Apply an input of 4.0 mA (Vm = 1.0 V), and adjust the zero screw to achieve an output of 1.0 bar (15.0 psi).
3. Apply an input of 12.0 mA (Vm = 3.0 V), and adjust the span screw to achieve an output of 0.2 bar (3.0 psi).
4. Maintain the input of 12.0 mA (Vm = 3.0 V), and adjust the zero screw to achieve an output of 1.0 bar (15.0 psi). The unit may not turn up this high; if it does not, go to step 7.
5. If the output reaches 15.0 psi in step 4, apply an input of 20 mA, and adjust the span screw to achieve a 3.0 psi output. Apply an input of 20 mA (Vm = 5.0 V), and note the error (the actual reading versus 3.0 psi). Adjust the span screw to overcorrect the error by a factor of two. For example, if the reading was 2.95 psi, adjust the span screw to achieve an output of 3.05 psi.

6. Repeat steps 4 and 5 to verify and complete the calibration.
7. If the 12.0 mA (Vm = 3.0 V) cannot be adjusted to 1.0 bar (15.0 psi) in step 4, turn off the air supply. Remove the module final assembly from the housing. Place the range jumper in the Lo position for Low Range, as shown in figure 6-4. Replace the module final assembly. Turn on the air supply.
8. Apply an input of 12.0 mA (Vm = 3.0 V), and adjust the zero screw to achieve an output of 1.0 bar (15.0 psi).
9. Apply an input of 20 mA (Vm = 5.0 V), and note the error (the actual reading versus 3.0 psi). Adjust the span screw to overcorrect the error by a factor of two. For example, if the reading was 2.95 psi, adjust the span screw to achieve and output of 3.05 psi.
10. Repeat steps 8 and 9 to verify and complete the calibration.

Transporting the Module Final Assembly

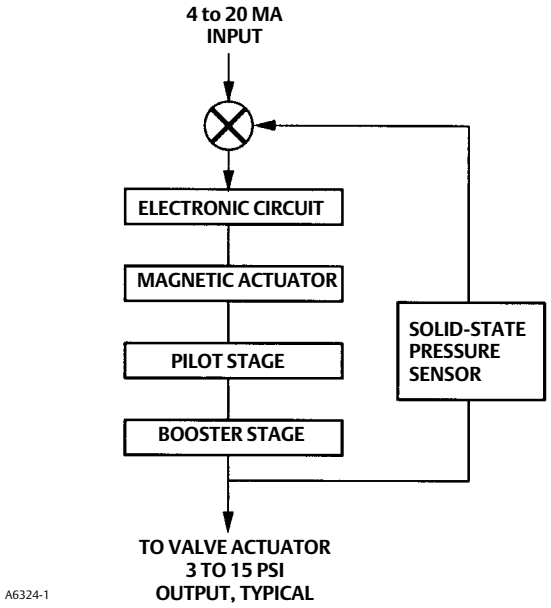
The transducer allows the module final assembly to be removed while the housing is in its installed position. In the event the transducer does not function properly, an operational module final assembly can be taken to the field and exchanged with the nonfunctional module.

After the transducer is calibrated in the shop, the module final assembly can be removed from the housing. At the time the span and zero screws disengage, there will be minimal effect on the calibrated span. The calibrated module can now be taken to the field. Ensure that the span and zero potentiometers are not moved from their calibrated positions.

Section 4 Principle of Operation

The following paragraphs describe the functional parts of the 846. Figure 4-1 shows the block diagram.

Figure 4-1. Functional Parts Block Diagram



Electronic Circuit

During operation, the input current signal is received by the transducer's electronic circuit and compared to the output pressure from the booster stage. A solid-state pressure sensor is part of the electronic circuit and monitors the booster stage output. The silicon-based sensor uses strain gauge thin film technology.

The sensors pressure signal is fed to a simple internal control circuit. By using this technique, the transducer's performance is set by the sensor/circuit combination. Changes in output load (leaks), variations in supply pressure, or even component wear are sensed and corrected by the sensor/circuit combination. Electronic feedback allows crisp dynamic performance and readily compensates for output changes induced by vibration.

Note

Because the transducer is electronic in nature, it is not well-modeled in the loop as a simple resistor in series with an inductor. It is better thought of as a 50-ohm resistor in series with a 6.0 V voltage drop, with negligible inductance.

This is important when calculating the loop load. When the transducer is used in series with a microprocessor-based transmitter, the noninductive nature of the transducer allows digital signals to successfully pass through undistorted.

Magnetic Actuator

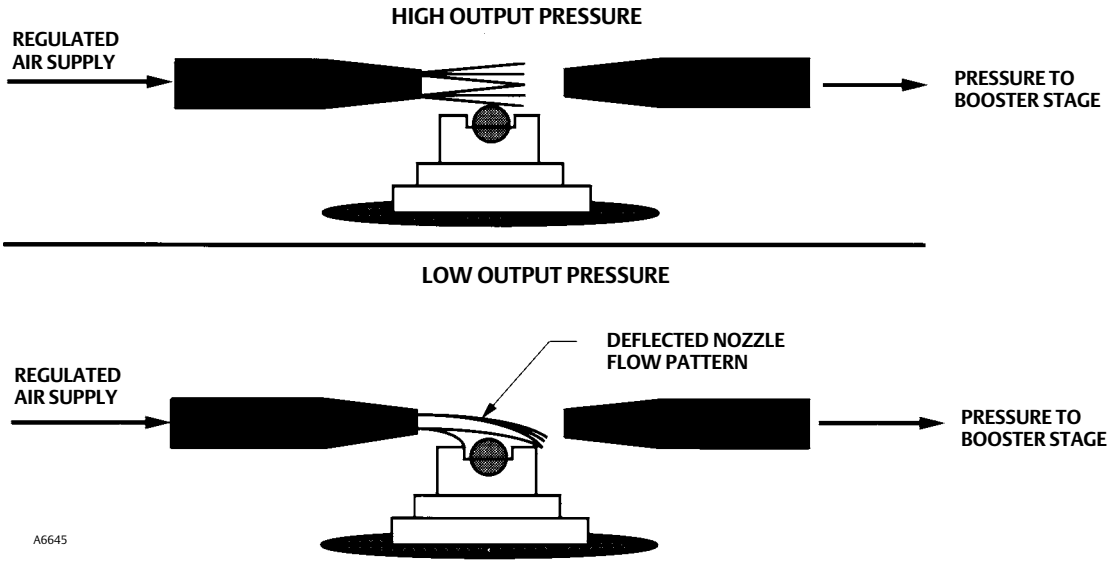
The electronic circuit controls the level of current flowing through the actuator coil, which is located in the pilot/actuator assembly. A change to the level of coil current is made by the electronic circuit when it senses a discrepancy between the pressure measured by the sensor and the pressure required by the input signal.

The actuator performs the task of converting electrical energy (current) to motion. It uses a coaxial moving magnet design optimized for efficient operation and is highly damped at its mechanical resonance. A silicone rubber diaphragm helps to protects its working magnetic gaps from contamination.

Pilot Stage

The pilot stage contains two opposed fixed nozzles: the supply nozzle and the receiver nozzle. It also contains the deflector, which is the moving element. See figures 4-2 and 4-3. The supply nozzle is connected to the supply air and provides a high-velocity air stream. The receiver nozzle captures the air stream and converts it back to pressure. The receiver nozzle pressure is the output pressure of the pilot stage.

Figure 4-2. Deflector/Nozzle Pilot Stage Operation (Direct Action)



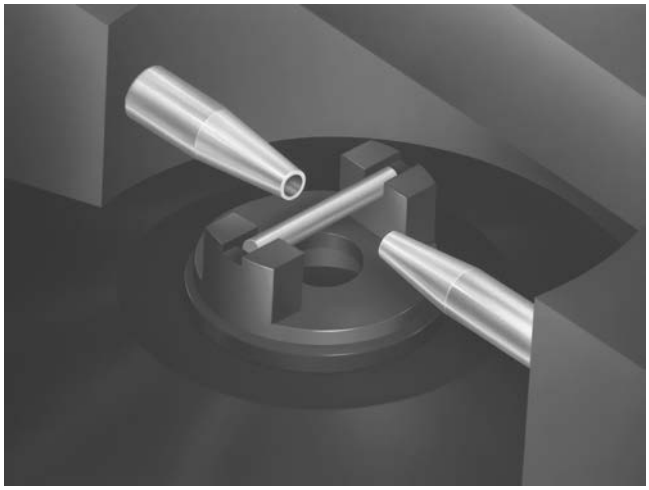
To vary the pilot output pressure, the high-velocity stream is diverted away from the receiver nozzle by the deflector, which is a cylindrical, aerodynamic body located between the two nozzles.

In response to a change in actuator coil current, the deflector is repositioned between the nozzles. There is a linear relationship between the coil current and the pilot stage output pressure. For direct action units, the power-off, or fail-safe, position of the top of the deflector is near the center of the stream and results in nearly zero pilot output pressure. As the coil is energized, the deflector is drawn out of the stream.

For reverse action units, the power-off, or fail-safe, position of the deflector is completely out of the stream. The result is maximum pilot output pressure. As the coil is energized, the deflector moves into the stream, resulting in a decreased pilot output pressure.

The deflector material is tungsten carbide, and the nozzles are 316 stainless steel. The nozzles have a large bore of 0.41 mm (0.016 inches), which provides good resistance to plugging.

Figure 4-3. Detail of Deflector/Nozzle Pilot Stage



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Booster Stage

The receiver nozzle pressure controls the booster stage, which has a poppet valve design. An increase in receiver nozzle pressure positions the valving in the booster stage to produce an increase in the transducer output signal. A decrease in the receiver nozzle pressure positions the valving in the booster stage to allow exhaust to occur, decreasing the output signal.

The booster stage operates using a 3:1 pressure gain from the pilot stage. High flow rate capability is achieved by large flow area poppet design and internal porting having low flow resistance. The booster stage design provides very good stability in high vibration applications, and the poppet valve technology provides resistance to plugging.

Section 5 Troubleshooting

The modular design and unitized subassemblies of the 846 allows for quick and easy troubleshooting and repair. This section presents information on the diagnostic features and procedures for troubleshooting both models in service or in the shop.

Diagnostic Features

If a control loop does not perform properly and the cause of malfunction has not been determined, two features of the transducer can be used to determine if the transducer is at fault: the stroke port and Remote Pressure Reading.

Stroke Port

The stroke port provides a way to quickly increase the transducer output, giving a rough measure of the unit's functionality. A hole in the module cover vents the constant bleed from the pilot stage. When the hole is covered, pressure at the pilot stage receiver nozzle increases, which in turn increases the output. Output pressure will increase to within 2 psi of supply pressure for either direct or reverse action. If output pressure does not increase to this level, it may indicate that supply air is not reaching the pilot stage or that a pilot stage nozzle is plugged.

Note

If the stroke port diagnostic feature is not desired, the transducer is available with an optional cover that contains multiple stroke ports, as shown in figure 2-1. This prevents increasing the output by covering the stroke port.

Remote Pressure Reading (RPR)

Remote Pressure Reading (RPR) is an optional diagnostic feature that enables the user to determine the output pressure from any location along the signal wire path. For loop troubleshooting, this allows the user to confirm the functionality of the transducer from a remote location.

A frequency signal directly proportional to the output pressure is superimposed on the input signal loop. The frequency range of the RPR function is 0 to 10,000 Hz.

A jumper on the circuit board activates the Remote Pressure Reading function. The Maintenance section provides instruction on positioning the jumper. The jumper, shown in figure 6-4, has two positions: N for ON, or D for OFF. The RPR jumper is in the N (ON) position when the unit ships from the factory, unless otherwise specified.

Using a Frequency Counter to Read the RPR Signal

A frequency counter can be used for Remote Pressure Reading. The frequency counter displays the RPR output frequency that can be converted to output pressure using a simple mathematical line formula as shown below. Figure 5-1 shows the wiring connections.

Notes

The Remote Pressure Reading (RPR) frequency signal has an amplitude of 0.4 to 1.0 V peak-to-peak. If other noise (frequency) with a comparable or greater amplitude is present on the line, it may make the RPR frequency signal unreadable.

The following procedure is applicable for 846 transducers manufactured starting March 2015. Contact your Emerson Process Management sales office for information on reading the RPR signal for products purchased prior to this date.

Equations

(1) $P = m(f) + b$
P = pressure
f = frequency

(2) $m = \frac{P_2 - P_1}{f_2 - f_1}$

Procedure

1) Find frequencies at zero and span pressure.

2) Solve for m, using equation (2).

3) Solve for b by inserting m, initial pressure, and initial frequency into equation (1).

4) Insert m and b into equation (1) to find conversion formula.

Example

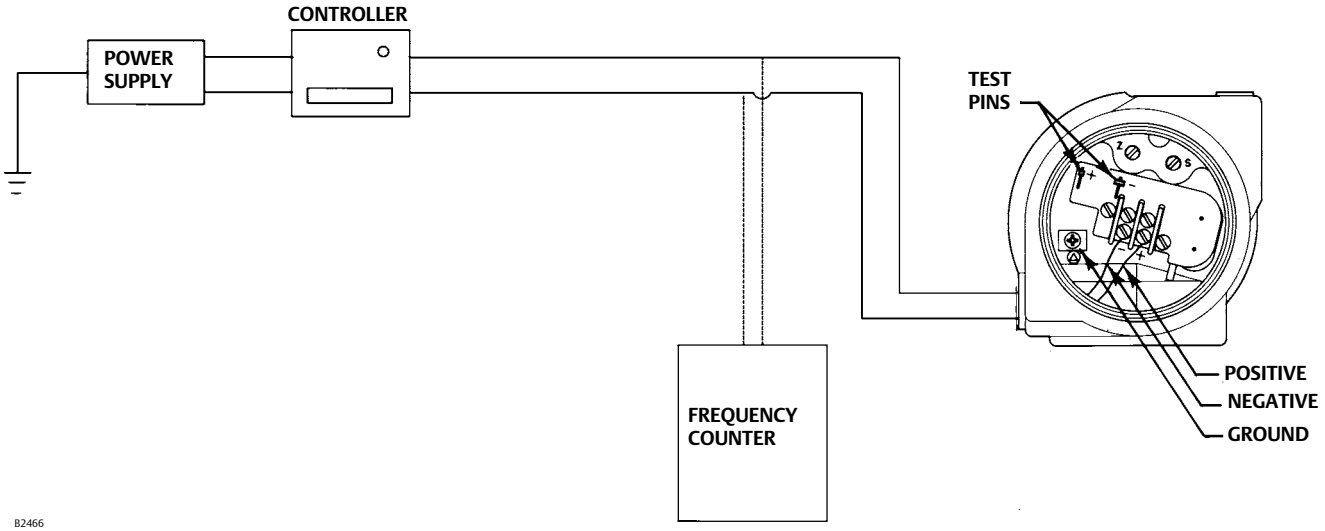
1) $P_1 = 3$ psig $\quad f_1 = 6000$ Hz
$P_2 = 15$ psig $\quad f_2 = 9000$ Hz

2) $m = \frac{15 - 3}{9000 - 6000} = \frac{12}{3000}$

3) $3 = \frac{12}{3000}(6000) + b$
$b = 3 - 24$
$b = -21$

4) $P = \frac{12}{3000}(f) - 21$

Figure 5-1. Wiring Connections for Frequency Counter

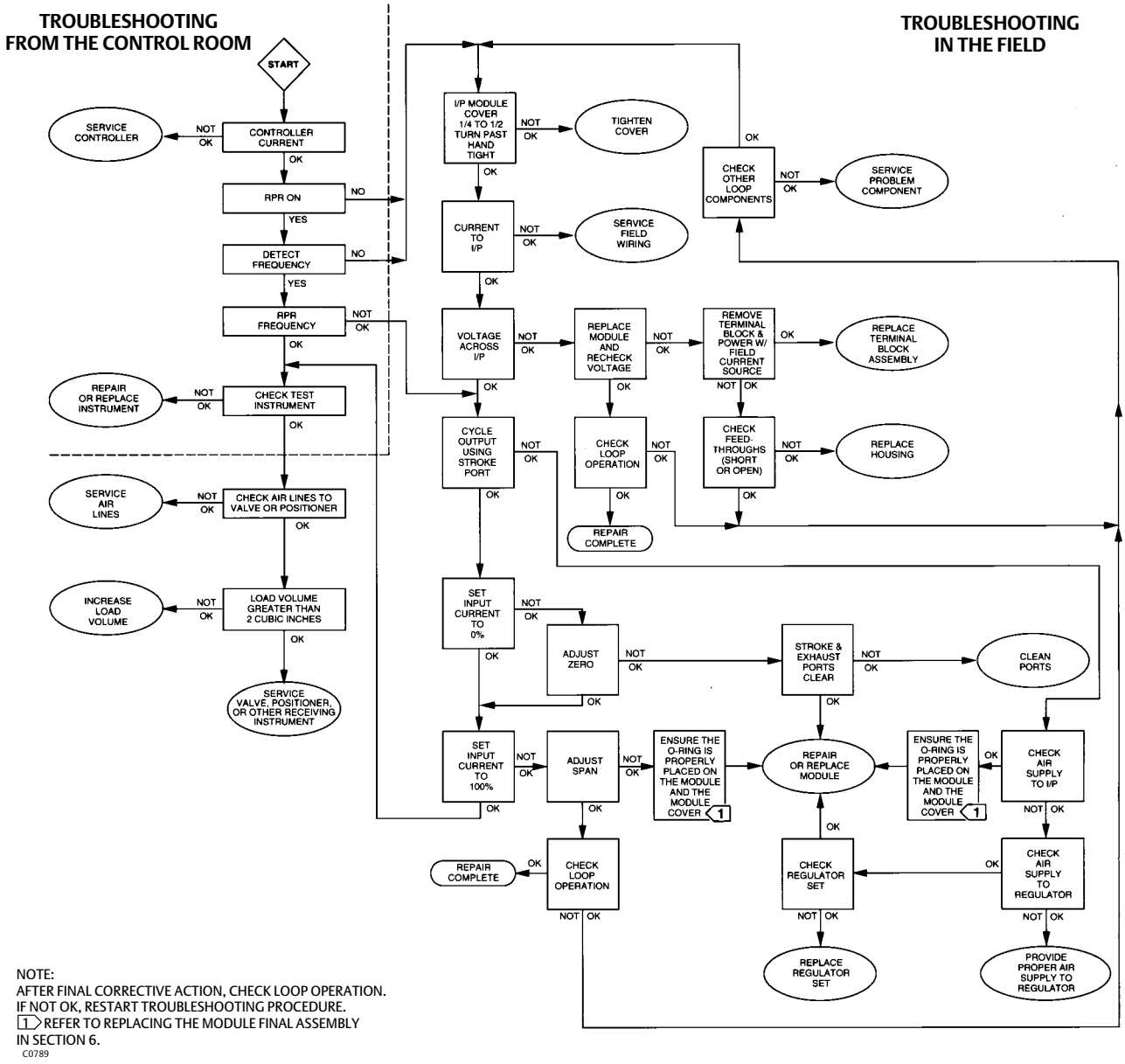


In-service Troubleshooting

A number of simple checks can be made on the transducer while the unit is in service. Figure 5-2 shows a troubleshooting flowchart.

1. Make sure that the module cover is tight. The cover should be hand-tightened and then advanced 1/4 to 1/2 turn (24 to 27 N•m) (18 to 20 lbf•ft).
2. Confirm the general functionality of the unit by using the diagnostic features described earlier in this section.

Figure 5-2. Field Troubleshooting Flowchart



3. Confirm that the filter-regulator is not full of water or oil and that supply air is reaching the unit. The air supply pressure should be at least 0.2 bar (3 psi) greater than the maximum calibrated output pressure.
4. Confirm that there are no major leaks in the output signal line or from the output gauge port.
5. Confirm that there are no obstructions and the screens are clean in the stroke port or the exhaust port.

⚠ WARNING

Personal injury or property damage could result from an uncontrolled process. Unscrewing the module cover removes power from the electronics and the output signal will be 0.0 psi. Before removing the module cover, ensure the process is properly controlled.

⚠ WARNING

Personal injury or property damage could result from fire or an explosion. In explosive atmospheres, remove power and shut off the air supply to the transducer before attempting to remove the terminal compartment cover or module cover. Failure to do so could result in an electrical spark or explosion.

6. If applicable, remove the cover lock and screw to allow access to the terminal compartment cover.
7. Remove the terminal compartment cover (see Warning above), and use a milliammeter, or a digital voltmeter to confirm that proper input current is supplied to the transducer.
8. Remove the terminal compartment cover (see Warning above), and short the loop across the positive (+) and the negative (-) terminals to check the output. The output should be nearly 0 psi. If the output is not 0 psi, replace the module final assembly.
9. Remove the terminal compartment cover (see Warning above), and, using a digital voltmeter, check the voltage between the transducer positive (+) and negative (-) terminals. The voltage should measure 6.0 to 8.2 V. A lower voltage can indicate a short in the input wires or defective controller. No voltage can indicate an open circuit in the control loop. A voltage of greater than 8.5 volts indicates a problem with the transducer, a faulty or corroded connection at the transducer, or an overcurrent condition. Replace the module final assembly. If the voltage is still not in the proper range (6.0 to 8.2 V), remove the terminal block and terminal block connection board. Apply power to the electrical feedthroughs. (Note the polarity of the feedthroughs, shown in figure 6-8.) Recheck the voltage. If the voltage is in the proper range, replace the terminal block and terminal block connection board. If the voltage is still not in the proper range, replace the housing.
10. Prepare to remove the module final assembly from the housing, or to remove the transducer from its mounting bracket. Refer to Module Final Assembly in the Maintenance section for instructions on removing the module final assembly from the module housing.

⚠ WARNING

Personal injury or property damage could result from an uncontrolled process. Unscrewing the module cover removes power from the electronics and the output signal will be 0.0 psi. Before removing the module cover, ensure the process is properly controlled.

With the module final assembly removed from the housing, the following checks can be made.

1. Review the position of the Remote Pressure Reading jumper (if so equipped) and range jumper to confirm that they are placed in the desired position. Refer to Electronic Circuit Board in the Maintenance section, and figure 6-4 for the location of these jumpers and instructions on placement.
2. Observe the position and condition of the three module O-rings to confirm they make a tight seal.
3. Verify that the O-ring is correctly positioned in the groove on the flat face of the module cover. Refer to figure 6-8 for an exploded view.
4. Inspect the porting on the module final assembly to determine if large amounts of contaminants have entered the transducer.

Before making the following checks, disconnect both signal wires from the transducer, and ensure the module final assembly is removed from the housing.

1. Using an ohmmeter, check the electrical connections in the housing terminal compartment. The circuit should show an open between the positive (+) and negative (-) terminals. If not, replace the housing or terminal block and connection board.
2. Use a wire jumper to connect the two electrical feedthroughs located in the module compartment. The resistance between the positive (+) and negative (-) terminals in the terminal compartment should be 10 ohms. If not, check the electrical feedthroughs for short or open circuits. If a short or open circuit is found, replace the housing.
3. With the electrical feedthroughs jumpered as stated above, connect the ohmmeter to either the positive (+) or negative (-) terminal and the grounding lug. The circuit should show an open. If not, check for a short to the housing.
4. Remove the module from the module cover and inspect the pilot/actuator assembly for damage or clogging.

Some of the previous troubleshooting steps may be inconvenient to perform in the field. It may be best to make use of the modular design of the 846 and keep a spare, calibrated module final assembly available for exchange. If the module final assembly is to be transported to the shop for repair, first remove it from the module cover. Attach the spare module final assembly to the module cover. Refer to Module Final Assembly in the Maintenance section for complete instructions. The nonfunctioning module can then be returned to the shop for troubleshooting.

Troubleshooting in the Shop

If the entire transducer is brought to the shop for troubleshooting, then the preceding sequence applies. If only the module final assembly has been brought to the shop, then use another 846 housing as a test fixture. Insert the module into the test fixture. Perform the previous steps (as they apply) of the In-service Troubleshooting procedure.

To further aid troubleshooting, the module final assembly can be broken down into three subassemblies. The troubleshooting sequence consists of exchanging the subassemblies with known working ones to determine which is at fault. The three subassemblies are the pilot/actuator assembly, the electronic circuit board, and the module subassembly. The module subassembly consists of the module final assembly with both the pilot/actuator assembly and electronic circuit board removed.

1. Remove the pilot/actuator assembly. Refer to Pilot/Actuator Assembly in the Maintenance section for complete removal information.

CAUTION

Do not apply force to the deflector bar while cleaning the nozzles. Doing so could alter the alignment or disable the deflector bar mechanism.

CAUTION

Do not use chlorinated solvents for cleaning the pilot/actuator assembly. The chlorinated solvents will deteriorate the rubber diaphragm.

a. Inspect the nozzles and deflector. If they show a buildup of contaminants, clean the nozzles by gently inserting a wire with a maximum diameter of 0.38 mm (0.015 inches). Clean the deflector, if necessary, by spraying with contact cleaner.

b. Make sure the O-rings are lightly lubricated with silicone grease and properly seated.

c. Reassemble and check operation.

d. If after cleaning the transducer does not function, replace the pilot/actuator assembly with a new one.

e. Reassemble and check operation.

2. Remove the electronic circuit board from the module final assembly. The Maintenance section describes how to remove the board.

   a. Inspect the O-rings around the sensor for damage and replace them if necessary.

   b. Check the sensor port and areas around the sensor for foreign material, and clean if necessary.

   c. Reassemble and check operation.

   d. If the transducer does not function, replace the electronic circuit board with a new one. Refer to Electronic Circuit Board in the Maintenance section for complete removal information.

   e. Reassemble and check operation.

3. The module subassembly is aligned at the factory and should not be further disassembled. If the above steps fail to produce a working unit, the module subassembly is faulty and should be replaced.

Section 6 Maintenance

This section describes the major components, assembly, and disassembly of 846 current-to-pressure transducers.

⚠ WARNING

To avoid personal injury or property damage from the sudden release of pressure or air:

- **Always wear protective clothing, gloves, and eyewear when performing any maintenance operations.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

⚠ WARNING

The presence of Emerson Process Management personnel and approval agency personnel may be required if you service (other than normal, routine maintenance, such as calibration) or replace components on an 846 transducer that carries a third-party approval. When replacing components, use only components specified by the factory. Substitution with other components may void the third-party approval and result in personal injury or property damage.

Use only the procedures, and component replacement techniques specifically referenced in this manual. Unauthorized procedures and improper techniques can cause poor quality repairs, impair the safety features of the device, and affect product performance and the output signal used to control a process.

Module Final Assembly

⚠ WARNING

Refer to the Maintenance WARNINGS at the beginning of this section.

The active mechanical and electrical components of the transducer are incorporated into a single, field-replaceable module called the module final assembly, as shown in figure 6-1. Electrical connection between the terminal compartment and module final assembly is made by electrical feedthroughs that extend into the module compartment. The feedthroughs enter sockets on the electronic circuit board. The span and zero screws extend through the terminal compartment wall into the module compartment. Connection to the span and zero potentiometers on the electronic circuit board is made by hook and loop fasteners.

The module final assembly has three separate radial ports. The upper port is for supply air, the middle port for the output signal, and the lower ports for exhaust. Three O-rings separate the ports. The two lower O-rings are the same size, and the upper O-ring is slightly smaller. Table 6-1 shows O-ring sizes.

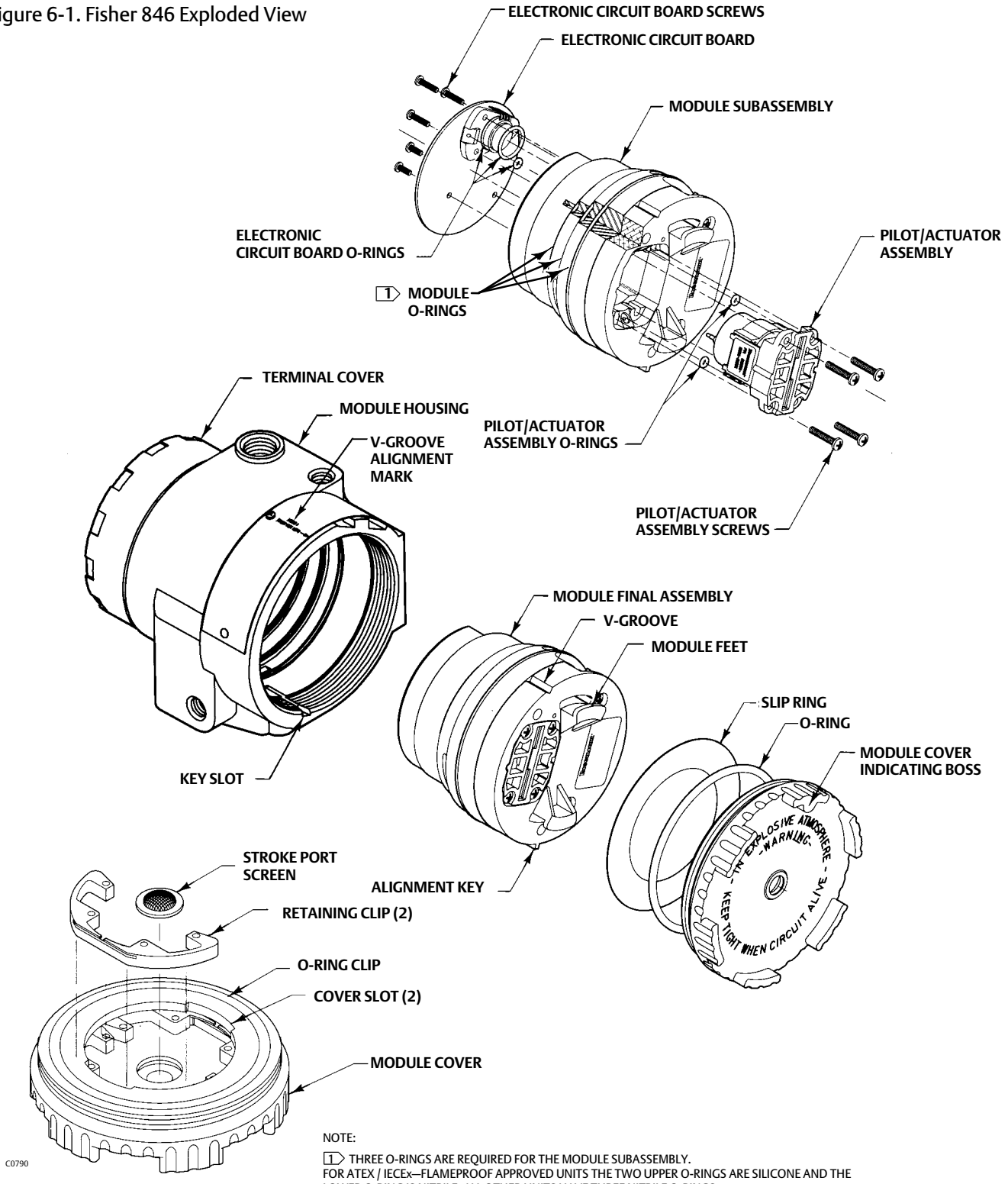
The module final assembly is attached to the module cover, which allows insertion and removal, and can be separated from the module cover for further disassembly. A module cover O-ring provides a seal between the module cover and module final assembly. Table 6-1 shows the O-ring sizes. A slip ring is located around the module feet. It allows the module cover to turn easily when the module final assembly is being removed from the housing.

The module final assembly consists of three major subassemblies, as shown in figure 6-1. They are the electronic circuit board, pilot/actuator assembly, and module subassembly.

Table 6-1. O-Ring Sizes

Description	Qty.	Size
Module O-rings	1 2	043 042
Pilot/Actuator O-rings	2	006
Circuit Board O-rings	2 1	016 005
Module Cover O-ring	1	238
Terminal Cover O-ring	1	238
Filter-Regulator O-ring	1	114

Figure 6-1. Fisher 846 Exploded View



NOTE:
1 THREE O-RINGS ARE REQUIRED FOR THE MODULE SUBASSEMBLY.
FOR ATEX / IECEx—FLAMEPROOF APPROVED UNITS THE TWO UPPER O-RINGS ARE SILICONE AND THE LOWER O-RING IS NITRILE. ALL OTHER UNITS HAVE THREE NITRILE O-RINGS.

Removing the Module Final Assembly

The module final assembly is attached to the module cover. Removing the module cover automatically removes the module final assembly from the housing. When the module cover is unscrewed, the electrical feedthroughs and span and zero adjustments automatically disengage. The internal air ports are also disengaged. The air supply to the transducer should be turned off to prevent uncontrolled air loss through the housing.

⚠ WARNING

Personal injury or property damage could result from an uncontrolled process. Unscrewing the module cover removes power from the electronics and the output signal will be 0.0 psi.

Refer to the WARNING at the beginning of this section before removing the module cover to ensure the process is properly controlled.

⚠ WARNING

Personal injury or property damage could result from fire or an explosion. In explosive atmospheres, remove power and shut off the air supply to the transducer before attempting to remove the terminal compartment cover or module cover. Failure to do so could result in an electrical spark or explosion.

Use the following steps to remove the module final assembly from the housing and module cover:

1. Shut off the air supply. If applicable, remove the cover lock and screw to allow access to the terminal compartment cover. Unscrew the module cover. When the module cover threads clear the housing, slowly pull on the cover, and the module final assembly will gradually come out of the housing.

Note

The module and the housing are designed for minimal clearance; therefore, patience may be required while pulling on the cover. Time must be allowed for release of the vacuum effect between the housing and module. If the module becomes tilted and cannot be removed, reinsert it completely into the housing and fully engage the module cover threads. Then proceed again with removal, ensuring that you pull slowly in a straight line.

Support both the module cover and the module final assembly as it comes out of the housing. This is to prevent dropping them, should they become detached accidentally.

⚠ WARNING

Do not grip the module cover threads. The threads are sharp and may cause minor injury. Wear gloves when removing the module cover.

2. Prepare to remove the module final assembly from the module cover. Align the module feet with the two interior cover slots. To accomplish this, identify the indicating boss on the module cover, shown in figure 6-2.

Grasp the module cover with one hand and the module final assembly with the other hand. Rotate the module final assembly so that the module alignment key is directly above the indicating boss on the module cover. Figure 6-2 shows the module alignment key and the indicating boss. The module feet are now aligned with the cover slots.

3. Remove the module final assembly from the module cover. To accomplish this, hold the cover steady, and push the module final assembly in the direction of the module cover indicating boss. At the same time, lift the opposite foot of the module final assembly out of the cover slot, as shown in figure 6-3.

Figure 6-2. Alignment Key Above Module Cover Indicating Boss

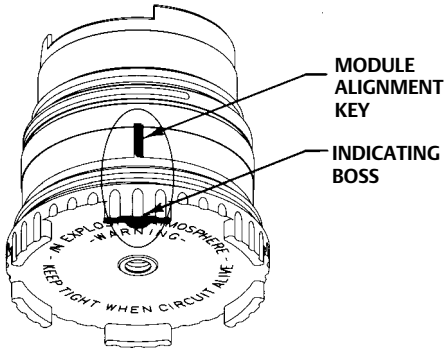
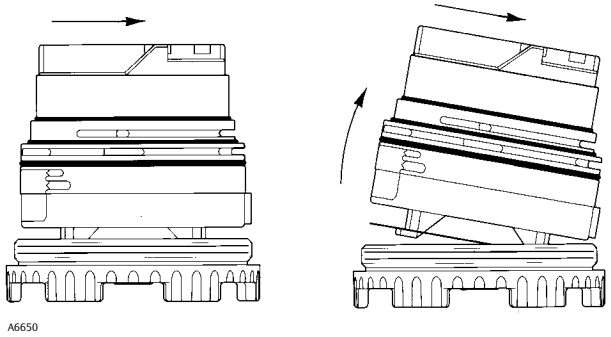


Figure 6-3. Removing the Module Final Assembly from the Module Cover



Replacing the Module Final Assembly

Use the following procedure to attach the module cover and replace the module final assembly:

1. Ensure that the electronic circuit board and the pilot actuator assembly provide the desired action (direct or reverse). See the Electronic Circuit Board and Pilot/actuator Assembly Action descriptions later in this section.
2. Ensure that the slip ring is in place around the feet of the module final assembly. The module cover O-ring should be lightly lubricated with silicone grease and placed in the O-ring gland. The stroke port screen should be clean and in place.

Note

The module cover O-ring must be in the O-ring gland, not down on the threads of the cover. This will ensure proper sealing of the pilot pressure area.

3. Position the retaining clips in the module cover so they are ready to accept the feet of the module final assembly. Ensure the leaves on the retaining clips are facing up. Figure 6-1 shows the correct orientation.
4. Insert one of the module feet into a cover slot, and push on the module final assembly to compress the retaining clip. Insert the opposite foot into the opposite cover slot, and rotate the module 90 degrees in the module cover to secure it in place.
5. Ensure that the three module O-rings are in the O-ring glands and are lightly lubricated with silicone grease. Inspect the O-rings to ensure that they are not twisted or stretched.
6. Apply lubricant to module cover threads for ease of assembly.
7. Prepare to insert the module into the housing. Align the V-groove located on the module final assembly with the indicating mark located on the nameplate. This positions the alignment key with the key slot. Figure 6-1 shows the location of the V-groove and the indicating mark.
8. Insert the module, engage the module cover threads, and screw on the module cover. The module final assembly will automatically engage the electrical feedthroughs and span and zero screws.

9. Hand tighten the module cover as much as possible. Use a wrench or long screwdriver shaft to tighten the module cover an additional 1/4 to 1/2 turn [24 to 27 N•m (18 to 20 lbf•ft)]. For units with ATEX/IECEx Flameproof approvals, make sure the cover lock and screw are securely re-installed. The screw accepts a 3 mm hex drive.

Note

When the module cover is tightened, connection is made with the electrical feedthroughs and span and zero screws, and the module final assembly O-rings become seated. Failure to fully tighten the module cover may prevent the transducer from operating properly.

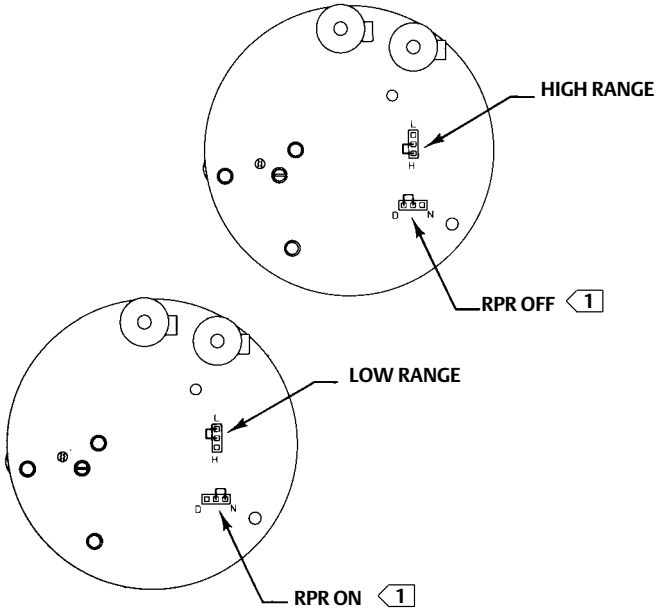
Electronic Circuit Board

⚠ WARNING

Refer to the Maintenance WARNINGS at the beginning of this section.

The electronic circuit board is located on top of the module final assembly, as shown in figure 6-1. Beneath the circuit board and permanently attached to it is the pressure sensor. Two jumpers on the circuit board control various functions of the transducer. Figure 6-4 shows the location of these jumpers.

Figure 6-4. Circuit Board Jumper Positions



Optional Remote Pressure Reading (RPR) Jumper

Remote Pressure Reading (RPR) is an optional diagnostic feature that enables the operator to determine the transducer output signal from any location along the signal wire path. The transducer generates a frequency signal

that can be received by a frequency counter. Operation of the RPR feature is jumper-selectable, in units so equipped. The RPR feature operates when the jumper is located in the N position on the circuit board. With the jumper in the D position, the RPR feature does not operate. When the RPR feature is included, the transducer is shipped with the RPR jumper in the N position, unless otherwise specified. For more information about the RPR feature, refer to Remote Pressure Reading (RPR) in the Troubleshooting section.

Note

When operating 846 transducers in series, only one unit may be configured for Remote Pressure Reading. Activating the RPR feature in two units will result in an unusable RPR signal.

Range Jumper

The range jumper is positioned according to the calibration specified. All full span calibrations and some split range calibrations can be accomplished with the range jumper in the High Range position. Some split range calibrations require the jumper to be in the Low Range position. For more information about the range jumper, refer to Standard Performance: Split Range Input, Direct Action in the Principle of Operation section.

Action

For direct action units, output changes directly with a corresponding change in input. For example, as the input increases from 4 to 20 mA the output increases from 0.2 to 1.0 bar (3 to 15 psi). Direct action circuit boards are green in color.

For reverse action units, output changes inversely with a change in input. For example, as the input increases from 4 to 20 mA the output decreases from 1.0 to 0.2 bar (15 to 3 psi). Reverse action circuit boards are red in color.

Upon loss of input current, or if input current decreases below 3.3 $\pm$ 0.3 mA, the output of the direct action unit decreases to less than 0.1 bar (1 psi). In the same situation, the output of the reverse action unit increases to near supply pressure.

Removing the Electronic Circuit Board

The electronic circuit board is connected to the module final assembly by five mounting screws. The circuit board must be removed to inspect the pressure sensor located beneath it. To remove the circuit board, remove the five mounting screws and pull upward on the plastic board standoff (black=multirange; white=standard).

CAUTION

Standard electronic assembly handling procedures apply. Do not attempt to remove the circuit board by pulling on the components. Doing so could weaken the connections and disable the electronics.

Be careful when handling the pressure sensor located beneath the circuit board. The pressure sensor lead frame is bent to allow the pressure sensor to fit properly in the sensor cavity of the module final assembly, and to maintain flush contact with the pressure sensor manifold.

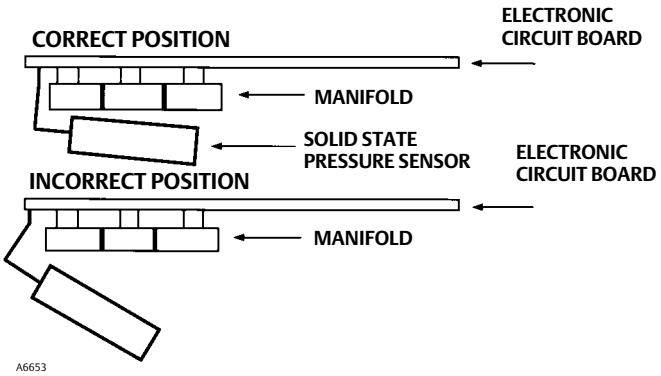
Three O-rings accompany the pressure sensor. Two O-rings of the same size are located on each side of the pressure sensor. A third, smaller O-ring is positioned in the beveled O-ring gland of the module sub-assembly. Table 6-1 shows

the O-ring sizes. The pressure sensor may be gently bent away from the pressure sensor manifold to access the sensor O-ring and confirm that the pressure ports are clear.

Replacing the Electronic Circuit Board

1. Verify that the circuit board is green for assembly into a direct action unit, or red for assembly into a reverse action unit.
2. Ensure that the three O-rings are in the proper position. The small O-ring is positioned in the beveled O-ring gland of the module subassembly. The two sensor O-rings are each positioned on the shoulders of the sensor. They should be lightly lubricated with silicone grease.
3. Ensure that the pressure sensor is correctly positioned against the manifold. The pressure sensor should be centered and in contact with the manifold, as shown in figure 6-5.
4. Position the circuit board on the module subassembly. Ensure that the circuit board mounting holes match those on the module subassembly. Place the three long screws in the mounting holes adjacent to the pressure sensor.
5. Place the two short screws in the remaining mounting holes. Tighten the three long screws first, then tighten the remaining two screws.

Figure 6-5. Positioning the Pressure Sensor



Pilot/Actuator Assembly

⚠ WARNING

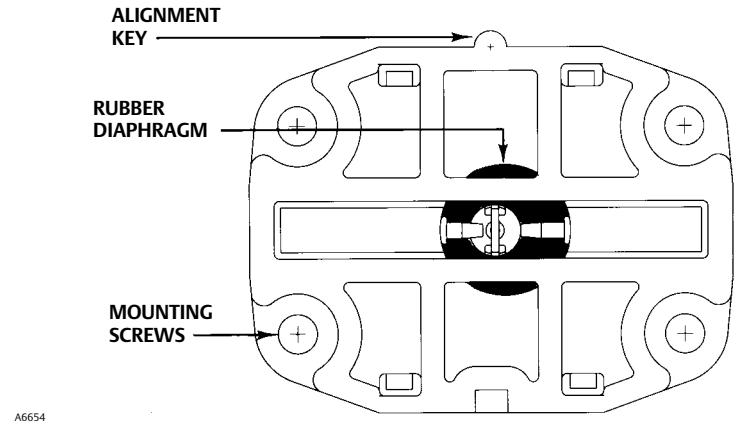
Refer to the Maintenance WARNINGS at the beginning of this section.

The pilot/actuator assembly is located at the bottom of the module final assembly, as shown in figure 6-1. It is a unitized assembly consisting of the coil, magnet, and spring of the actuator, and the deflector and nozzles of the pilot stage. Two O-rings are part of the pilot/actuator assembly. Table 6-1 shows the O-ring sizes. They are located in the beveled O-ring glands of the module subassembly, adjacent to the nozzles. The pilot/actuator assembly is held in place by four mounting screws.

Action

A blue rubber diaphragm under the deflector bar and nozzle area identifies the direct action pilot/actuator assembly. A red diaphragm under the nozzle area identifies the reverse action pilot/actuator assembly. Figure 6-6 shows the bottom view of the pilot/actuator assembly.

Figure 6-6. Pilot/Actuator Assembly (Bottom View)



Removing the Pilot/Actuator Assembly

To remove the pilot/actuator assembly, disengage the four mounting screws, and gently pull the assembly out of the module subassembly. To aid removal, the pilot/actuator framework may be gently gripped with a pair of pliers.

CAUTION

Do not attempt to remove the pilot/actuator assembly by gripping or pulling on the deflector or nozzles. Doing so could alter the alignment or disable the deflector/nozzle mechanism.

Inspect the assembly for a buildup of foreign material. The nozzle passageways should be clear, and the deflector should be clean. The deflector can be cleaned by spraying it with contact cleaner. Clean the nozzles by gently inserting a wire with a maximum diameter of 0.38 mm (0.015 inches).

- Insert the wire into each nozzle **separately** from the outside as shown in figure 6-7.
- **Do not** try to put the wire through both nozzles simultaneously.
- **Do not** push the wire on the deflector bar.

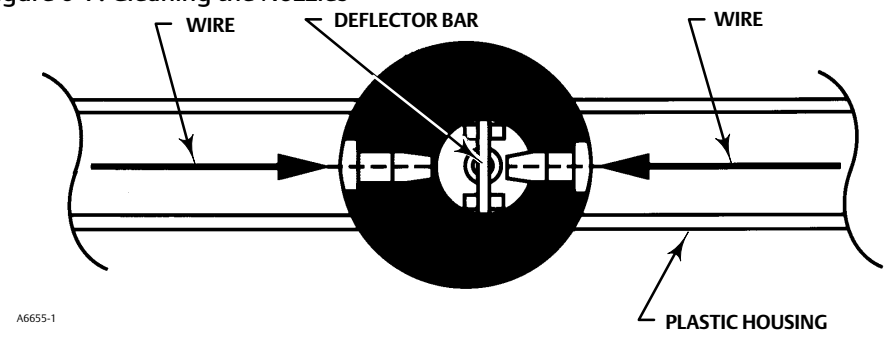
CAUTION

Do not apply force to the deflector bar while cleaning the nozzles. Doing so could alter the alignment or disable the deflector mechanism.

CAUTION

Do not use chlorinated solvents for cleaning the pilot/actuator assembly. The chlorinated solvents will deteriorate the rubber diaphragm

Figure 6-7. Cleaning the Nozzles



Replacing the Pilot/Actuator Assembly

1. Verify that the rubber diaphragm under the nozzle area is blue for pilot/actuators inserted into a direct action unit, or red for pilot/actuators inserted into a reverse action unit.
2. Inspect the pilot/actuator assembly cavity in the module final assembly to ensure that it is clean.
3. Lightly lubricate the two O-rings with silicone grease, and place them in the beveled O-ring glands. O-rings between the pilot/actuator assembly and the module should be installed justified to the lower portion of the O-ring gland. When properly positioned, the air passageway should be visible through the O-ring inside diameter.
4. Prepare to insert the assembly by aligning the key on the pilot/actuator assembly with the key slot in the module subassembly.
5. Insert the assembly into the module subassembly, and engage the four mounting screws.

Module Subassembly

⚠ WARNING

Refer to the Maintenance WARNING at the beginning of this section.

The module subassembly, shown in figure 6-1, consists of the module final assembly with both the electronic circuit board and pilot/actuator assembly removed. The module subassembly contains the porting and valving for the booster stage.

Note

The module subassembly is aligned at the factory and should not be further disassembled. Disassembling the module subassembly may result in performance outside specifications.

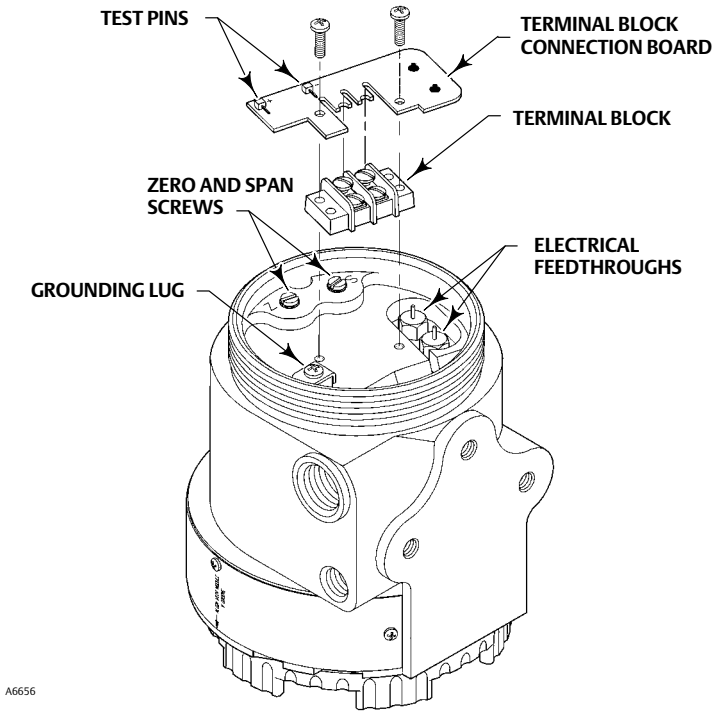
Terminal Compartment

⚠ WARNING

Refer to the Maintenance WARNING at the beginning of this section.

The terminal compartment contains the terminal block, terminal block connection board, span and zero screws, electrical feedthroughs, and internal grounding lug, as shown in figure 6-8. The terminal block connection board is attached to the terminal block and to the electrical feedthroughs.

Figure 6-8. Terminal Compartment Exploded View



Separate test points are provided that have a 10-ohm resistor in series with the signal negative (-) terminal. The test points allow the input current to be determined with a voltmeter without disconnecting a signal lead. A 4 to 20 mA span produces a 40 to 200 mV DC voltage drop across the 10-ohm resistor. The test points can accommodate different connections, including alligator clips and E-Z hooks.

The terminal block and terminal block connection board can be removed by disengaging the two terminal block mounting screws. Lubricate the terminal compartment cover threads with anti-seizing paste or a low temperature lubricant. See table 6-1 for the size of the terminal compartment cover O-ring.

Exhaust and Stroke Port Screens

⚠ WARNING

Refer to the Maintenance WARNING at the beginning of this section.

Two identical screens, the exhaust port screen and the stroke port screen, allow air to vent to the outside environment. The exhaust port screen is located behind the nameplate. Removing the two nameplate screws and rotating the nameplate to the side allows access to the exhaust port screen. Figure 7-3 shows an exploded parts view.

The stroke port screen is located at the center of the module cover. Removing the module final assembly from the housing and then from the module cover allows access to the stroke port screen. Removing the Module Final Assembly earlier in this section describes this procedure. Figure 7-3 shows an exploded parts view.

Section 7 Parts

Whenever corresponding with your Emerson Process Management sales office about this equipment, always mention the transducer serial number.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management should not, under any circumstances, be used in any Fisher instrument. Use of components not supplied by Emerson Process Management may void your warranty, might adversely affect the performance of the instrument, and could cause personal injury and property damage.

Parts Kit

Description	Part Number
Repair Kit [Kit includes O-rings and slip ring]	R846X000012

Parts List

See table 7-1.

Note
Contact your Emerson Process Management sales office for part numbers.

Table 7-1. Parts List

Key No.	Description	Spares Category(6)
*	Module, standard - Final Assembly(1) Standard Performance Direct Action 4-20 mA Reverse Action 4-20 mA Multirange Performance Direct Action 4-20 mA Reverse Action 4-20 mA Module, ATEX/IECEx Ex d and Dust - Final Assembly(1) Standard Performance Direct Action 4-20 mA Reverse Action 4-20 mA Multirange Performance Direct Action 4-20 mA Reverse Action 4-20 mA	 B B B B B B B B
9*	Module Subassembly(1,2) Standard Performance (Direct or Reverse Action) ATEX/IECEx Ex d and Dust (Direct or Reverse Action)	 B B
12*	Pilot/Actuator Assembly(2) Direct Action Reverse Action	 B B
8*	Circuit Board Assembly(2) Standard Performance Direct Action Reverse Action	 B B
3*	Housing(3,4) Standard ATEX/IECEx Ex d and Dust	 C C
15*	Module Cover Single Stroke Port Multiple Ports Threaded Stroke Port	 C C C

*Recommended spare parts

Table 7-1. Parts List (continued)

Key No.	Description	Spares Category[6]
1*	Terminal Compartment Cover	C
5*	Terminal Block Kit[5]	B
16*	Screens (12/pkg)	B
	O-Rings	
10*	Module (5/kit)[7]	B
	Module (5/kit, ATEX/IECEx Ex d and Dust)[7]	B
11*	Pilot/Actuator (5/kit)[7]	B
7*	Circuit Board (5/kit)[7]	B
2*, 21*, & 23*	Cover (12 O-rings, 12 slip rings)[7]	B
	Filter-Regulator (10/kit)[7,8]	B
	Screws	
13*	Pilot/Actuator (3/kit)[7]	C
6*	Circuit Board (3/kit)[7]	C
14*	Nameplate (3/kit)[7]	C
18*	Retaining Clips (3/kit)[7]	C
22*	Module Cap (5/pkg)[7]	B
	Filter-Regulator Direct Mounting Kit[9,10]	
	SST Bolts	B
	Filter-Regulator with Direct Mounting Kit[9,10]	
	SST Bolts	C
	Universal Mounting Bracket	
	Epoxy Painted Carbon Steel, Carbon Steel Nuts/Bolts	C
	Epoxy Painted Carbon steel, SST Nuts/Bolts	C
	316 SST, SST Nuts/Bolts for use with SST Housing	C
	316 SST, SST Nuts/Bolts for use with Aluminum Housing	C
*	Supply Gauge (see figure 7-1)	
	0-60 psi/0-400 kPa/0-4 bar	B
	SST 0-60 psi/0-400 kPa/0-4 bar	B
	Output Gauge (see figure 7-2)	
	0-30 psi/0-200 kPa/0-2 bar	B
	0-60 psi/0-400 kPa/0-4 bar	B
	SST 0-60 psi/0-400 kPa/0-4 bar	B
	Tire Valve Adapter Assembly	

1. For units with approvals other than ATEX/IECEx Ex d, use standard module.
2. Includes O-rings.
3. Includes housing, span and zero screws, electrical feedthroughs, and grounding lug.
4. For units with approvals other than ATEX/IECEx Ex d, use standard housing.
5. Includes terminal block, connection board, and screws.
6. **Spares Categories**
   Category A - Recommend 1 spare part per 25 transducers
   Category B - Recommend 1 spare part per 50 transducers
   Category C - None normally required.
7. #/kit indicates number of transducers that may be serviced.
8. Contains O-rings for both housing styles.
9. Filter-Regulator Direct Mounting Kit includes O-ring.
10. Extra O-ring and spacer included for both housing styles.

Figure 7-1. Supply Gauge

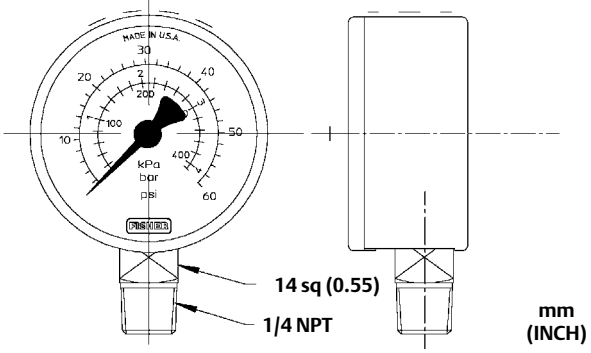
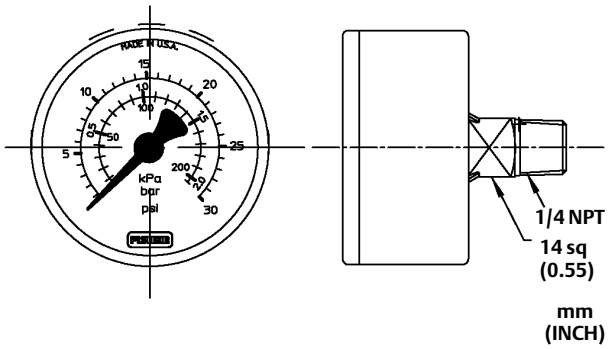
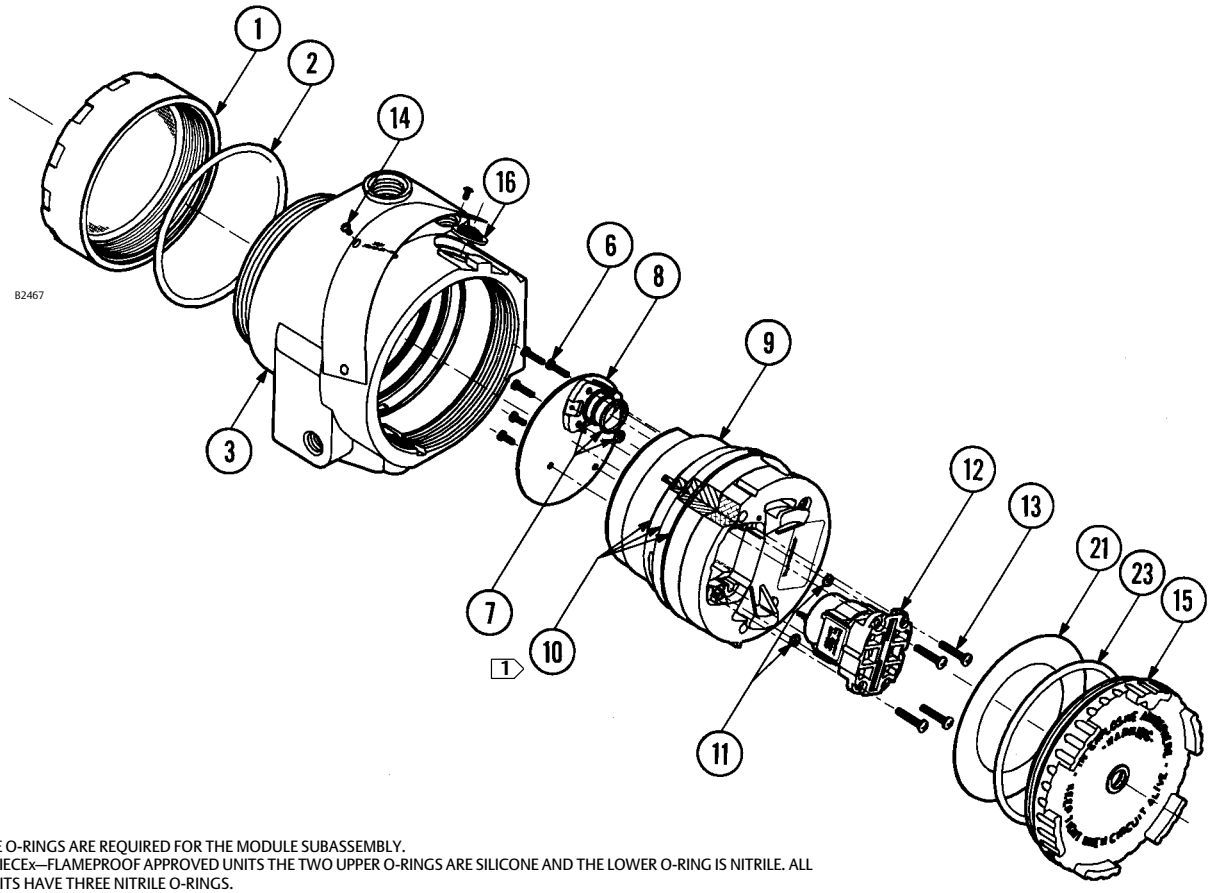


Figure 7-2. Output Gauge



*Recommended spare parts

Figure 7-3. Exploded Parts Drawing (also see table 7-2)



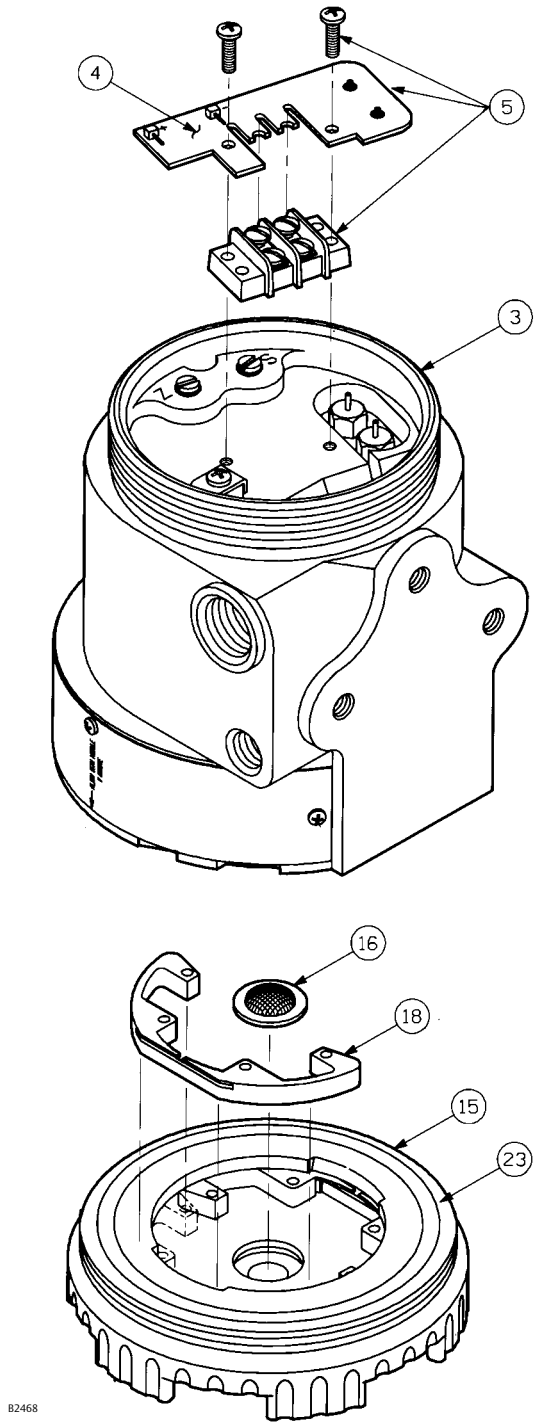
NOTE:

1 THREE O-RINGS ARE REQUIRED FOR THE MODULE SUBASSEMBLY.
FOR ATEX/IECEx—FLAMEPROOF APPROVED UNITS THE TWO UPPER O-RINGS ARE SILICONE AND THE LOWER O-RING IS NITRILE. ALL OTHER UNITS HAVE THREE NITRILE O-RINGS.

Table 7-2. Key Number Quick Reference

Key No.	Description
1	Terminal Compartment Cover
2	Terminal Compartment Cover O-ring
3	Housing
5	Terminal Block Kit
6	Electronic Circuit Board Screws
7	Electronic Circuit Board O-rings
8	Electronic Circuit Board Assembly
9	Module Subassembly
10	Module O-rings
11	Pilot/Actuator Assembly O-rings
12	Pilot/Actuator Assembly
13	Pilot Actuator Assembly Screws
14	Nameplate Screws
15	Module Cover
16	Exhaust/Stroke Port Screen
18	Retaining Clip
21	Slip Ring
23	Module Cover O-ring

Figure 7-3. Exploded Parts Drawing (also see table 7-2) (continued)



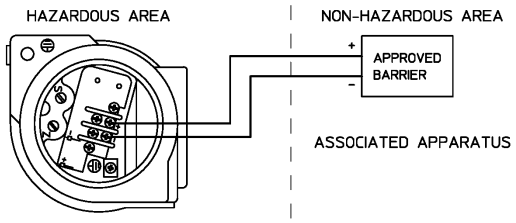
Section 8 Installation Drawings

This section includes installation drawings required for wiring of intrinsically safe installations. If you have any questions, contact your Emerson Process Management sales office.

Figure 8-1. CSA Installation Drawing GE59146

CSA ENTITY CONCEPT APPROVALS

THE FISHER TYPE 846 CURRENT TO PRESSURE (I/P) TRANSDUCER IS APPROVED AS INTRINSICALLY SAFE FOR USE IN CLASS I, II AND III, DIVISION I, GROUPS A,B,C,D,E,F AND G HAZARDOUS LOCATIONS, WHEN CONNECTED IN ACCORDANCE WITH THIS DOCUMENT. THE TYPE 846 IS ALSO CSA APPROVED AS NONINCENDIVE FOR CLASS I, DIVISION 2, GROUPS A,B,C AND D HAZARDOUS LOCATIONS.



THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIFICALLY EXAMINED IN SUCH COMBINATION. THE CRITERIA FOR INTERCONNECTION IS THAT THE VOLTAGE (Vmax OR Ui), THE CURRENT (Imax OR Ii), AND THE POWER (Pmax OR Pi) OF THE INTRINSICALLY SAFE APPARATUS MUST BE EQUAL TO OR GREATER THAN THE VOLTAGE (Voc OR Uo), AND THE CURRENT (Isc OR iO), AND THE POWER (PO) DEFINED BY THE ASSOCIATED APPARATUS, IN ADDITION, THE SUM OF THE MAX UNPROTECTED CAPACITANCE (Ci) AND MAX UNPROTECTED INDUCTANCE (Li), INCLUDING THE INTERCONNECTING CABLING CAPACITANCE, (Ccable) AND CABLING INDUCTANCE (Lcable), MUST BE LESS THAN THE ALLOWABLE CAPACITANCE (Co) AND INDUCTANCE (Lo) DEFINED BY THE ASSOCIATED APPARATUS. IF THE ABOVE CRITERIA IS MET, THEN THE COMBINATION MAY BE CONNECTED.

Vmax OR Ui ≥ Voc OR Uo Imax OR Ii ≥ Isc OR Io Ci + Ccable ≤ Co Li + Lcable ≤ La

CLASS I, II AND III, DIV I GROUPS A, B, C, D, E, F AND G

APPARATUS PARAMETER	BARRIER PARAMETER
Vmax = 30 VDC	Voc MUST BE LESS THAN OR EQUAL TO 30 VDC
Imax = 100mA	Isc MUST BE LESS THAN OR EQUAL TO 100mA
Li = 20uH	La MUST BE GREATER THAN 20 MICROHENRIES
Ci = 0.016uF	Ca MUST BE GREATER THAN 0.016 MICROFARADS

NOTES:
1. THE APPROVED ASSOCIATED APPARATUS MUST BE A LINEAR OUTPUT DEVICE.
2. MAXIMUM SAFE AREA VOLTAGE SHOULD NOT EXCEED 250Vrms.
3. RESISTANCE BETWEEN INTRINSICALLY SAFE GROUND AND EARTH GROUND MUST BE LESS THAN ONE OHM.
4. INSTALLATION MUST BE IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE (CEC) PART 1 AND ANSI/ISA RP12.06.01 "INSTALLATION OF INTRINSICALLY SAFE SYSTEMS FOR HAZARDOUS (CLASSIFIED) LOCATIONS" AND THE NATIONAL ELECTRICAL CODE (ANSI/NFPA 70).
5. DUST-TIGHT CONDUIT SEAL MUST BE USED WHEN INSTALLED IN CLASS II AND CLASS III ENVIRONMENTS.
6. THE NON-INCENDIVE FIELD WIRING IS THE SAME AS THE INTRINSIC SAFETY FIELD WIRING.

WARNING: FOR INTRINSICALLY SAFE APPLICATIONS THE APPARATUS ENCLOSURE CONTAINS ALUMINUM AND IS CONSIDERED TO CONSTITUE A POTENTIAL RISK OF IGNITION BY IMPACT AND FRICTION. AVOID IMPACT AND FRICTION DURING INSTALLATION AND USE TO PREVENT RISK OF IGNITION.

WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.

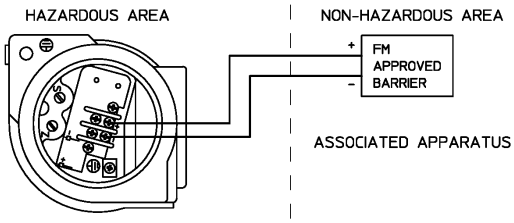
WARNING: TO PREVENT IGNITION OF FLAMMABLE OR COMBUSTIBLE ATMOSHPERES, DISCONNECT POWER BEFORE SERVICING.

GE59146

Figure 8-2. FM Installation Drawing GE59147

FM ENTITY CONCEPT APPROVALS

THE FISHER TYPE 846 CURRENT TO PRESSURE (I/P) TRANSDUCER IS FM APPROVED AS INTRINSICALLY SAFE FOR USE IN CLASS I, II AND III, DIVISION I, GROUPS A,B,C,D,E,F AND G HAZARDOUS LOCATIONS, WHEN CONNECTED IN ACCORDANCE WITH THIS DOCUMENT. THE TYPE 846 IS ALSO FM APPROVED AS NONINCENDIVE FOR CLASS I, DIVISION 2, GROUPS A,B,C AND D HAZARDOUS LOCATIONS.



THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIFICALLY EXAMINED IN SUCH COMBINATION. THE CRITERIA FOR INTERCONNECTION IS THAT THE VOLTAGE (Vmax OR Ui), THE CURRENT (Imax OR Ii), AND THE POWER (Pmax OR Pi) OF THE INTRINSICALLY SAFE APPARATUS MUST BE EQUAL TO OR GREATER THAN THE VOLTAGE (Voc OR Uo), AND THE CURRENT (Isc OR iO), AND THE POWER (PO) DEFINED BY THE ASSOCIATED APPARATUS, IN ADDITION, THE SUM OF THE MAX UNPROTECTED CAPACITANCE (Ci) AND MAX UNPROTECTED INDUCTANCE (Li), INCLUDING THE INTERCONNECTING CABLING CAPACITANCE, (Ccable) AND CABLING INDUCTANCE (Lcable), MUST BE LESS THAN THE ALLOWABLE CAPACITANCE (Ca) AND INDUCTANCE (Lo) DEFINED BY THE ASSOCIATED APPARATUS. IF THE ABOVE CRITERIA IS MET, THEN THE COMBINATION MAY BE CONNECTED.

Vmax OR Ui ≥ Voc OR Uo Imax OR Ii ≥ Isc OR Io Pmax OR Pi ≥ Po Ci + Ccable ≤ Ca Li + Lcable ≤ La

CLASS I, II AND III, DIV I GROUPS A, B, C, D, E, F AND G

APPARATUS PARAMETER	BARRIER PARAMETER
Vmax = 30 VDC	Voc MUST BE LESS THAN OR EQUAL TO 30 VDC
Imax = 100mA	Isc MUST BE LESS THAN OR EQUAL TO 100mA
Pi = 1W	Po MUST BE LESS THAN OR EQUAL TO Pi
Li = 20uH	La MUST BE GREATER THAN 20 MICROHENRIES
Ci = 0.016uF	Ca MUST BE GREATER THAN 0.016 MICROFARADS

NOTES:

1. THE FM APPROVED ASSOCIATED APPARATUS MUST BE A LINEAR OUTPUT DEVICE.
2. MAXIMUM SAFE AREA VOLTAGE SHOULD NOT EXCEED 250Vrms.
3. RESISTANCE BETWEEN INTRINSICALLY SAFE GROUND AND EARTH GROUND MUST BE LESS THAN ONE OHM.
4. INSTALLATION MUST BE IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE (CEC) PART 1 AND ANSI/ISA RP12.06.01 "INSTALLATION OF INTRINSICALLY SAFE SYSTEMS FOR HAZARDOUS (CLASSIFIED) LOCATIONS" AND THE NATIONAL ELECTRICAL CODE (ANSI/NFPA 70).
5. DUST-TIGHT CONDUIT SEAL MUST BE USED WHEN INSTALLED IN CLASS II AND CLASS III ENVIRONMENTS.
6. THE NON-INCENDIVE FIELD WIRING IS THE SAME AS THE INTRINSIC SAFETY FIELD WIRING.

WARNING: FOR INTRINSICALLY SAFE APPLICATIONS THE APPARATUS ENCLOSURE CONTAINS ALUMINUM AND IS CONSIDERED TO CONSTITUE A POTENTIAL RISK OF IGNITION BY IMPACT AND FRICTION. AVOID IMPACT AND FRICTION DURING INSTALLATION AND USE TO PREVENT RISK OF IGNITION.

WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.

WARNING: TO PREVENT IGNITION OF FLAMMABLE OR COMBUSTIBLE ATMOSHPERES, DISCONNECT POWER BEFORE SERVICING.

GE59147

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Fisher™ 2052 Diaphragm Rotary Actuator

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Figure 1. Fisher Control-Disk™ Valve with 2052 Actuator and DVC6200 Digital Valve Controller



Introduction

Scope of Manual

This instruction manual includes installation, adjustment, operation, maintenance, and parts information for the Fisher 2052 diaphragm rotary actuator (figure 1). Instructions for the control valve, positioner, manual actuator, and other accessories are included in separate manuals.

Do not install, operate, or maintain a 2052 actuator without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Description

2052 spring-and-diaphragm rotary actuators are used on rotary-shaft valve bodies for throttling or on-off applications. The 2052 may be used for on-off service without a positioner, or it may be used for throttling service with a positioner, depending on service conditions. The 2052 has an ISO 5211 mating interface that allows installation to non-Fisher valves. Refer to separate bulletins for valve and positioner information.

A top-mounted handwheel option is available for infrequent service as a manual actuator. For repeated or daily manual operation, the unit should be equipped with a side-mounted declutchable 1078 manual actuator. Externally adjustable travel stops are used to limit the degree of rotation at both ends of the actuator stroke.

The lever for the 2052 actuator is supported by bushings. The lever may be changed to accommodate valve bodies with different size valve shafts.

Table 1. Fisher 2052 Actuator Specifications

Specifications	
Actuator Mounting Connections	Splined shaft connection, ISO 5211 actuator-to-bracket connection **Size 1:** F07, **Size 2:** F10, **Size 3:** F14
Actuator Sizes	See table 2
Operating Pressure(1)	See table 3
Maximum Diaphragm Casing Pressure	Size 1, 2, and 3 Actuators: 5 barg (73 psig)
Pressure Connection	See table 5
Torque Output	See table 3
Actuator Temperature Capabilities(1)	Standard: -45 to 80°C (-50 to 176°F) Optional: -45 to 100°C (-50 to 212°F)(3) or -60 to 80°C (-76 to 176°F)(4)
Operation	Field reversible between PDTC and PDTO; right- and left-hand mounting, any angle of orientation
Approximate Weight	Size 1: 22.2 kg (49 lb) Size 2: 54.4 kg (120 lb) Size 3: 113 kg (250 lb)
Controller/Positioners Available	DVC2000, DVC6020, DVC6030, DVC6200, 3610J, 3620J, 4190, C1
Adjustable Travel Stops	Standard adjustable up and down stops capable of 30 degrees of adjustment per stop.
Accessories Available	846, 646, 2625, and 67C Series, switches, i2P-100, VBL, DXP, GO Switch™
Handwheel	Top-mounted handwheel: Optional on Size 1, 2, and 3 actuators Declutchable handwheel: Optional on Size 1, 2, and 3 actuators
Operational Lockout(2)	Available for customer-supplied padlock to lock the actuator in the spring-fail position

1. The pressure/temperature limits in this manual should not be exceeded. The current SIL certification for the 2052 actuator is only relevant for the standard temperature ratings shown.
2. Lockout and declutchable handwheel cannot be used together on size 2 and size 3 actuators.
3. Temperature range only applies when using silicone diaphragm material. Silicone diaphragm is not available with the top-mounted handwheel option.
4. Temperature range requires use of stainless steel bolting for yoke and travel stops. Not available with top-mounted handwheel.

Table 2. Actuator and Shaft Size Availability

SHAFT SIZE		ACTUATOR SIZE		
mm	**Inches**	**1**	**2**	**3**
12.7	1/2	X		
14.3 x 15.9	9/16 x 5/8	X	X	
15.9	5/8	X	X	
19.1	3/4	X	X	X
22.2	7/8		X	X
25.4	1		X	X
28.6 x 31.8	1-1/8 x 1-1/4		X	X
31.8	1-1/4		X	X
31.8 x 38.1	1-1/4 x 1-1/2			X
38.1	1-1/2			X
39.7 x 44.5	1-9/16 x 1-3/4			X
44.5	1-3/4			X
50.8	2			X

Table 3. Torque versus Actuator Size

ACTUATOR SIZE AND ACTION	OPERATING PRESSURE							
	2 barg (29 psig)(1)		3 barg (44 psig)(1)		4 barg (58 psig)(1)		4.7 barg (68 psig)(1)	
	Torque							
	N•m	**lbf•in**	**N•m**	**lbf•in**	**N•m**	**lbf•in**	**N•m**	**lbf•in**
1 (PDTO)	25.5	226	25.5	226	51.2	453	51.2	453
1 (PDTC)	25.5	226	36.2	320	51.2	453	72.4	641
2 (PDTO)	105	930	105	930	210	1860	210	1860
2 (PDTC)	105	930	175	1550	210	1860	320	2840
3 (PDTO)	327	2890	327	2890	631	5580	631	5580
3 (PDTC)	280	2480	557	4930	584	5170	930	8230

1. Do not interpolate between operating pressures. Consult your Emerson Process Management sales office for assistance.

Table 4. Fisher 2052 Actuator Mounting Styles

MOUNTING	ACTION(1)	VALVE SERIES OR DESIGN			VALVE SERIES OR DESIGN	
		BALL/PLUG ROTATION TO CLOSE	V150, V200 & V300	CV500 V500	DISK/BALL ROTATION TO CLOSE	A11, 8510B, 8532, 8560, 8580, 9500, and Control-Disk Valve
Right-Hand	PDTC PDTO	CCW CCW	A B	A B	CW CW	B A
Left-Hand	PDTC PDTO	CCW CCW	D C	D C	CW CW	C D
Left-Hand (Optional)(2)	PDTC PDTO	CW CW	C D	NA NA	NA NA	NA NA

1. PDTC—Push-down-to-close, and PDTO—Push-down-to-open.
2. A left hand mounted ball will be required for the NPS 3 through 12 Vee-Ball Series B and the NPS 14 and 16, with or without attenuator.

Figure 2. Fisher 2052 Actuator Mounting Styles

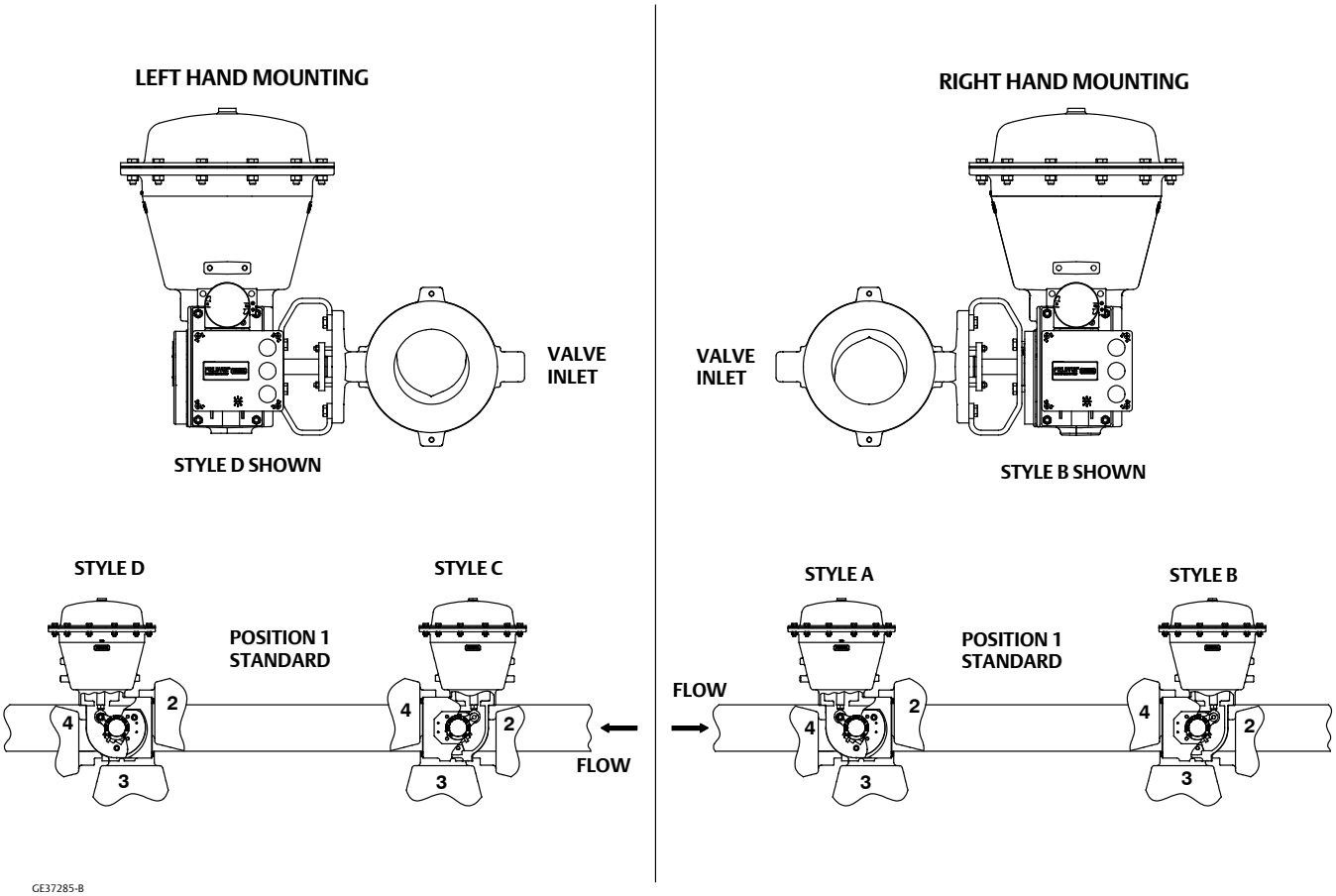


Table 5. Pressure Connections

ACTUATOR SIZE	PRESSURE CONNECTION			
	1/4 NPT	1/2 NPT	3/4 NPT	G 1/4
1	standard	optional	not available	optional
2	standard	optional	not available	optional
3	not available	standard	optional	not available

Educational Services

For information on available courses for Fisher 2052 actuators, as well as a variety of other products, contact:

Emerson Process Management
Educational Services - Registration
Phone: 1-641-754-3771 or 1-800-338-8158
E-mail: education@emerson.com
http://www.emersonprocess.com/education



Specifications

Specifications are shown in table 1 for 2052 actuators. Specifications for actuator operation are stamped on a metal nameplate attached to the actuator.

Table 6. Bolting Torque Requirements(1)

DESCRIPTION KEY NUMBER	ACTUATOR SIZE	TORQUE		FASTENER LUBRICATION
		N•m	Lbf•ft	
Rod End Bearing Clamping Bolt Torque , Key 16	1 2 3	38 180 400	28 130 295	None
End Plate to Housing Bolt Torque, Key 4	1 2 3	68 120 210	50 90 155	None
Diaphragm Plate to Rod Bolt Torque, Key 7	1 2 3	27 115 300	20 85 220	Anti-Seize Lubricant
Casing Bolt Torque, Key 8	1 2 3	55 55 55	40 40 40	None
Housing to Yoke Bolt Torque, Key 28	1 2 3	27 68 245	20 50 180	None
Lever-Spline Clamping Bolt Torque, Key 15	1 2 3	38 115 175	28 85 130	None
Optional Lockout Kit Mounting Bolt Torque, Key 53	1 2 3	NA 88 340	NA 65 250	None

1. Exceeding any torque requirements could damage the actuator and impair safe operation.

Installation

⚠ WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations.

Check with your process or safety engineer for any other hazards that may be present from exposure to process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

CAUTION

To avoid parts damage, do not apply pressure that exceeds the Maximum Diaphragm Casing Pressure in table 1. Use pressure-limiting or pressure-relieving devices to prevent the Operating Pressure from exceeding the values shown in table 3.

The actuator, as it comes from the factory, is normally mounted on a valve body. If the actuator is shipped separately or if it is necessary to mount the actuator on the valve, perform the procedures presented in the Actuator Mounting section. Follow the procedures given in the valve instruction manual when installing the control valve in the pipeline.

If a positioner is ordered with the actuator, the pressure connection to the actuator is normally made at the factory. If it is necessary to make this connection, run tubing of the appropriate size for the diaphragm casing pressure connection (reference table 5) between the pressure connection and the instrument. Keep the length of tubing or pipe as short as possible to avoid transmission lag in the control signal.

When the control valve is completely installed and connected to the controlling instrument, check to make sure that the action is correct (air-to-open or air-to-close) and that the controlling instrument is properly configured for the desired action. For successful operation, the diaphragm rod assembly, lever, and valve shaft must move freely in response to changes in the loading pressure on the diaphragm.

Actuator Mounting

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Safely vent the power actuator loading pressure.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline.* Process fluids may spray out under pressure when removing the packing hardware or packing rings.**
- **Check with your process or safety engineer for any hazards that may be present from exposure to process media.**

Use the following steps to mount the actuator or to change actuator mounting style or position.

Unless otherwise specified, key numbers referenced in the following procedures are shown in figure 7 for the 2052 actuator.

If the Actuator is mounted on a valve body and it is necessary to change mounting style or position, the actuator must first be separated from the valve body.

1. Isolate the valve body from the process. Release process pressure and vent all actuator pressure.
2. Remove the cover or plug (key 2).

⚠ WARNING

To avoid personal injury and equipment damage from moving parts, keep fingers and tools clear while stroking the actuator with the cover removed.

3. Loosen the cap screw (key 15).
4. Separate the actuator from the valve body by removing the cap screws and nuts which secure the valve to the mounting yoke (key 27). Proceed to step 5.

If the actuator is not mounted on a valve body ensure the up and down travel stops (see figure 3) are adjusted correctly to achieve the desired actuator rotation. Use the travel indicator (key 21) and travel scale (key 19) as reference.

Note

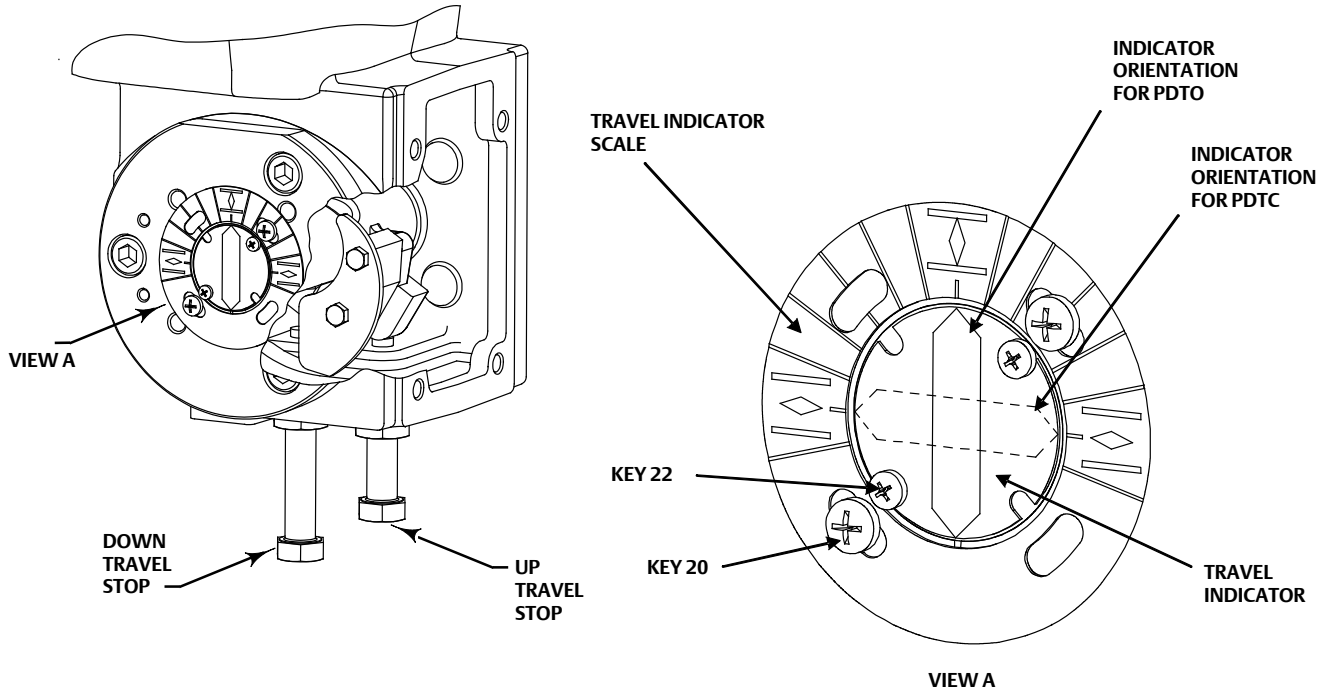
Once each travel stop is properly positioned, adequately tighten the hex nut (key 24) to lock the travel stop in place.

5. Refer to figure 2 and table 4 for available mounting styles and positions. The actuator is normally positioned vertically with the valve in a horizontal pipeline.
6. Determine whether the actuator mounting yoke (key 27) will be mounted on the end plate assembly (key 3) side or on the actuator housing boss side of the actuator. If the desired mounting position and style require moving the mounting yoke (key 27) and travel indicator components to opposite sides of the actuator, remove the machine screws (keys 20 and 22), the travel indicator scale (key 19), and the travel indicator (key 21). Remove the cap screws (key 28) and the mounting yoke (key 27). Install the mounting yoke in the desired position (on the end plate assembly or on the actuator housing boss). Tighten the mounting cap screws to the torque specified in table 6. Install the travel indicator components on the opposite side of the actuator.

⚠ WARNING

To avoid personal injury or property damage, ensure the travel indicator is installed correctly to coincide with the desired actuator action. Refer to figure 3 for more information.

Figure 3. Fisher 2052 Actuator Travel Stops and Travel Indication



7. Before sliding the valve shaft into the lever, position the valve ball or disk as follows:

For push-down-to-close action, the valve ball or disk should be in the fully open position.

For push-down-to-open action, the valve ball or disk should be in the fully closed position (see the valve body instruction manual).

8. Make sure that the index markings on the valve shaft are properly aligned with either the markings on the lever or the travel indicator scale mounting holes. Slide the valve shaft into the lever. (See figure 4 for one possible orientation.) Install the valve mounting cap screws and nuts. Tighten to the torque value given in the appropriate valve body instruction manual.
9. Ensure all end play in the valve shaft is removed by directing the valve shaft and control element toward the actuator as much as possible.
10. Tighten the socket head cap screw (key 15) which compresses the splined lever connection to the valve shaft (see table 6). Install the cover or plug (key 2) into the access hole in the housing.

CAUTION

When adjusting the travel stop for the closed position of the valve ball or disk, refer to the appropriate valve instruction manual for detailed procedures. Undertravel or overtravel at the closed position may result in poor valve performance and/or damage to the equipment.

Over-rotation of the lever could result in the diaphragm stroking to the point where the diaphragm seals off against the air signal connection. This could prevent an air signal from being able to stroke the valve.

11. Adjust the up travel stop (see figure 3) so that the valve ball or disk is in the desired position. When adjusting the up travel stop, ensure the stop is not backed out too far, causing the lever to over-rotate. Over-rotation of the lever may cause damage to valve components. Avoid over-rotation by adjusting the up travel stop so that the travel indicator screws (key 22) align with the travel scale screws (key 20). See figure 3.
12. Stroke the actuator and adjust the down travel stop so that the valve ball or disk is in the desired position.

Note

Once each travel stop is properly positioned, adequately tighten the hex nut (key 24) to lock the travel stop in place.

13. Make sure that the travel indicator pointer matches the ball or disk position. Remove and install in the proper position if necessary.
14. Refer to the table of contents for accessory installation procedures.

Maintenance

Actuator parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement depends upon the severity of service conditions. Instructions are given below for disassembly and assembly of parts. Key numbers referenced in the following steps are shown in figure 7 for the 2052, except as listed below or otherwise specified in the procedures.

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**

- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Safely vent the power actuator loading pressure.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **Check with your process or safety engineer for any hazards that may be present from exposure to process media.**

Replacing Diaphragm

Isolate the valve body from the process. Release process pressure and vent all actuator pressure.

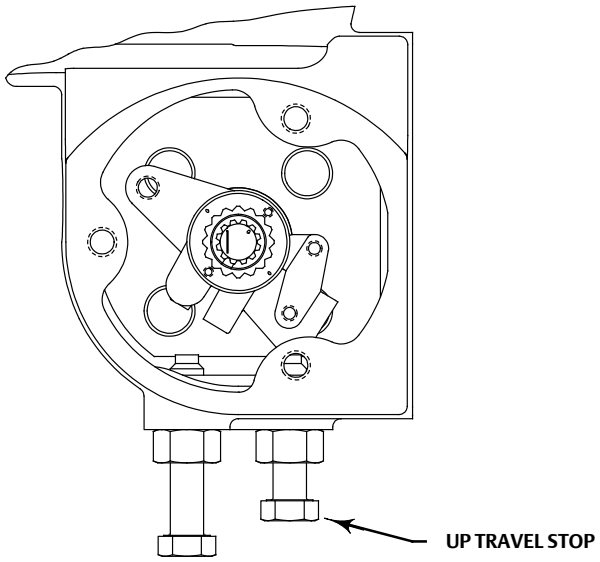
Disassembly

1. Remove the supply tubing or pipe from the top casing assembly (key 5).

⚠ WARNING

To avoid personal injury from precompressed spring force suddenly thrusting parts away from the actuator, spring compression must first be relieved. Closely follow the instructions below.

Figure 4. Orientation of the Fisher 2052 Actuator Lever into the Housing and Aligning the Actuator to the Valve Shaft Markings



2. Loosen, but do not remove, all casing cap screws and hex nuts (keys 8 and 9). Ensure there is no spring force to the top casing assembly (key 5). If spring force is detected against the top casing assembly, ensure the up travel stop cap screw (key 23) is adjusted correctly to prevent over-rotation of the lever (key 14). Refer to figure 3. The travel indicator screws (key 22) in the end of the lever should be in alignment with the travel scale screws (key 20). If the up travel stop is confirmed to be adjusted correctly and force is still detected against the top casing assembly, contact your local Emerson Process Management Instrument and Valves Service Center. Alternatively, replace two oppositely located casing cap screws (key 8) with 100 mm (4 inch) long fully threaded M10 cap screws of ISO 898-1

Property Class 8.8 material or equivalent. Loosen the nuts (key 9) on the two fasteners in an equivalent manner to relieve spring force.

3. Carefully remove all cap screws and hex nuts (keys 8 and 9) from the top casing assembly. The spring forces are retained by the diaphragm rod assembly (key 10), allowing quick removal of the pressure retaining components.
4. Remove the top casing assembly and the diaphragm (key 11).
5. Inspect the diaphragm plate (key 6). If the diaphragm plate is damaged or if further disassembly of the actuator is required, proceed to the Replacing Diaphragm Plate, Diaphragm Rod Assembly, and Spring(s) procedure.
6. Inspect the diaphragm and replace if necessary.

Assembly

1. Place the diaphragm (key 11) on the diaphragm plate (key 6), making certain that it is properly centered.
2. Observe the correct position of the loading connection fitting and install the top casing assembly (key 5). Replace the cap screws and nuts (keys 8 and 9) which secure the top casing assembly to the actuator housing. Tighten the nuts in an alternating fashion (see table 6).
3. Install the inlet piping to the top casing assembly.

Replacing Diaphragm Plate, Diaphragm Rod Assembly, and Spring(s)

Isolate the valve body from the process. Release process pressure and vent all actuator pressure.

Disassembly

1. Remove the supply tubing or pipe from the top casing assembly (key 5).

⚠ WARNING

To avoid personal injury from precompressed spring force suddenly thrusting parts away from the actuator, spring compression must first be relieved. Closely follow the instructions below.

2. Loosen, but do not remove, all casing cap screws and hex nuts (keys 8 and 9). Ensure there is no spring force to the top casing assembly (key 5). If spring force is detected against the top casing assembly, ensure the up travel stop cap screw (key 23) is adjusted correctly to prevent over-rotation of the lever (key 14). Refer to figure 3. The travel indicator screws (key 22) in the end of the lever should be in alignment with the travel scale screws (key 20). If the up travel stop is confirmed to be adjusted correctly and force is still detected against the top casing assembly, contact your local Emerson Process Management Instrument and Valves Service Center. Alternatively, replace two oppositely located casing cap screws (key 8) with 100 mm (4 inch) long fully threaded M10 cap screws of ISO 898-1 Property Class 8.8 material or equivalent. Loosen the nuts (key 9) on the two fasteners in an equivalent manner to relieve spring force.
3. Carefully remove all cap screws and hex nuts (keys 8 and 9) from the top casing assembly. The spring forces are retained by the diaphragm rod assembly (key 10), allowing quick removal of the pressure retaining components.
4. Remove the top casing assembly and the diaphragm (key 11).
5. Inspect the diaphragm plate (key 6).
   a. To relieve spring compression, using a hex wrench, unscrew and remove the socket head cap screw (key 7) which secures the diaphragm plate (key 6) to the diaphragm rod assembly (key 10). Remove the diaphragm plate.
6. Remove the spring (key 13) or springs (keys 12 and 13).

7. The guide assembly (key 48) may be removed for inspection (size 3 only).

Note

At this stage of disassembly, it may be determined that further disassembly is not necessary. If separation of the diaphragm rod assembly from the lever is not warranted, proceed to the Assembly portion within this section of the procedure.

8. To gain access to the cap screw (key 16) which secures the diaphragm rod assembly to the lever, the end plate assembly (key 3) must be removed. Before the end plate assembly can be removed, one of the following procedures must be performed. Proceed as appropriate:

- **For actuators with valve bodies mounted on the end plate assembly (key 3) side of the actuator,** the actuator must be separated from the valve body. Perform steps 1 through 4 of the Actuator Mounting section, remove the mounting yoke (key 27), and then return to step 9 of this section.

- **For actuators with valve bodies mounted on the actuator housing boss side of the actuator [opposite of the endplate (key 3)],** remove the travel indicator pointer (key 21). Proceed to step 9.

9. Remove the socket head cap screws (key 4) and the end plate assembly (key 3).
10. Remove the cap screw (key 16) and nut (key 17) if applicable (size 3 only), that secures the actuator lever (key 14) to the diaphragm rod assembly (key 10). Remove the diaphragm rod assembly.
11. Inspect all parts and replace if necessary.
12. If total disassembly of the actuator is required, or if the actuator will be assembled for use with a valve body with a different valve shaft diameter, proceed to the Changing or Replacing Actuator Lever procedure.

Assembly

1. Fasten the diaphragm rod assembly (key 10) to the lever using the cap screw (key 16) and nut (key 17) if applicable. Tighten per table 6.
2. Install the housing end plate (key 3).
3. Adjust the travel stop bolts to the correct position so that the travel indicator screws (key 22) align with the travel scale screws (key 20). See figure 3.
4. Install the guide assembly (key 48 - size 3 only).
5. Install the spring(s). The outer (larger diameter) spring is standard for the single spring size 1 & 2 constructions. The inner spring is standard for the single spring size 3 construction.
6. Place the diaphragm plate (key 6) onto the spring(s). It is important that the springs be properly seated in their respective counterbores on the bottom side of the plate. If necessary, push or pull the diaphragm plate toward center to ensure the springs are engaged into their respective seats.
7. Lubricate the socket head capscrew (key 7) and tighten per table 6.
8. Place the diaphragm (key 11) on the diaphragm plate (key 6), making certain that it is properly centered.
9. Observe the correct position of the loading connection fitting and install the top casing assembly (key 5). Replace the cap screws and nuts (keys 8 and 9) which secure the top casing assembly to the actuator housing. Tighten the nuts in an alternating fashion (see table 6).
10. Install the inlet piping to the top casing assembly.
11. Install the travel indicator (key 19) if removed.
12. If the actuator was removed from the valve body, refer to the appropriate section in the Actuator Mounting procedure and proceed as applicable.

Changing or Replacing Actuator Lever

⚠ WARNING

Avoid personal injury or property damage. The end plate assembly (key 3) and lever (key 14) may only be removed after the actuator spring compression forces are safely relieved. Refer to the instructions below.

Disassembly

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Safely vent the power actuator loading pressure.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **Check with your process or safety engineer for any other hazards that may be present from exposure to process media.**

1. Isolate the valve body from the process. Release process pressure and vent all actuator pressure.
2. Remove the cover or plug (key 2).

⚠ WARNING

To avoid personal injury and equipment damage from moving parts, keep fingers and tools clear while stroking the actuator with the cover removed.

3. Loosen the cap screw (key 15).
4. Follow steps 2 through 10 in the Replacing Diaphragm Plate, Diaphragm Rod Assembly, and Spring(s) section.
5. Remove and inspect the lever (key 14). If the lever is worn or damaged, or if the actuator will be mounted to a valve body requiring a different size lever, replace the lever.
6. Inspect the bushings located in the end plate (key 3) and housing (key 1) assemblies. If bushings are excessively worn or damaged, remove them with a press. Press in new bushings so that they are flush with the exterior surfaces of the actuator housing and the end plate assembly.

Assembly

1. Refer to figure 4 for the correct orientation of the lever during assembly.
2. If a cam-operated positioner is used, install the cam to the lever with the parts provided by the appropriate instrument mounting kit. Be sure to observe the orientation shown in figure 4 and follow all procedures given in the positioner instruction manual.
3. Insert the lever into the bushing in the actuator housing.
4. Fasten the rod end bearing diaphragm rod assembly to the lever using the cap screw (key 16) and nut (key 17) if applicable. Tighten per table 6.

5. Install the end plate assembly (key 3).
6. Adjust the travel stop bolts to the correct position so that the travel indicator screws (key 22) align with the travel scale screws (key 20). See figure 3.
7. Install the guide assembly (key 48) size 3 only.
8. Install the spring(s). The outer (larger diameter) spring is standard for the single spring size 1 & 2 constructions. The inner spring is standard for the single spring size 3 construction.
9. Place the diaphragm plate (key 6) onto the spring(s). It is important that the springs be properly seated in their respective counterbores on the bottom side of the plate. If necessary, push or pull the diaphragm plate toward center to ensure the springs are engaged into their respective seats.
10. Lubricate the socket head capscrew (key 7) and tighten per table 6.
11. Place the diaphragm (key 11) on the diaphragm plate (key 6), making certain it is properly centered.
12. Observe the correct position of the loading connection fitting and install the top casing assembly (key 5). Replace the cap screws and nuts (keys 8 and 9) which secure the top casing assembly to the actuator housing. Tighten the nuts in an alternating fashion (see table 6).
13. Install the inlet piping to the top casing assembly.
14. Refer to the Actuator Mounting procedure and proceed as applicable:

Positioner Mounting (3610, DVC6020, or DVC6200)

1. Before installing the positioner, the positioner cam must be installed on the lever.
2. Refer to assembly step 2 in the previous section on Changing or Replacing Actuator Lever.
3. Refer to the positioner instruction manual for setup and calibration procedures.

Top-Mounted Handwheel (Size 1 and 2)

Key numbers used in this procedure are shown in figure 9 except where indicated.

The optional top-mounted handwheel can be used as a manual actuator for intermittent service. It is not to be used as an adjustable travel stop. This is built into the housing.

The handwheel assembly is welded to a special top casing assembly (key 5, figure 9). A hex nut (key 43) locks the handwheel in position. For field installation of a handwheel, the special upper diaphragm casing is supplied with the handwheel.

Turning the handwheel (key 32) clockwise into the upper casing forces the pusher plate (key 36) against the diaphragm and diaphragm plate (keys 11 and 6, figure 7) to compress the inner and outer springs (keys 12 and 13, figure 7) and move the diaphragm rod assembly downward. Turning the handwheel counter-clockwise allows the actuator spring(s) to move the diaphragm rod assembly upward.

CAUTION

Damage to the handwheel screw can occur if the handwheel is over-rotated in the counter-clockwise direction. The handwheel should not continue to be rotated once the actuator reaches the up stop and resistance to turning the handwheel significantly drops.

Instructions are given below for complete disassembly and assembly required for inspection and parts replacement.

Disassembly

⚠ WARNING

To avoid personal injury from the precompressed spring force thrusting the upper diaphragm casing away from the actuator, fully turn the handwheel counterclockwise.

1. Perform steps 1 through 6 of the Replacing Diaphragm procedure.
2. Remove the cotter pin, hex nut, handwheel, and locknut (keys 34, 33, 32, and 43). Unscrew the stem (key 35) out through the actuator end of the handwheel body (key 5).
3. Check the condition of the O-ring (key 44); replace if necessary.
4. If it is necessary to remove the pusher plate or spacer (key 36 or 42), drive out the groove pin (key 37).

Assembly

1. Before assembling, lubricate the thread of the stem (key 35) with anti-seize lubricant. Lubricate the bearing surfaces of the stem and rounded end with lithium grease.
2. If the pusher plate or spacer was removed, attach them to the stem and drive in a new groove pin (key 37).
3. With the O-ring (key 44) in place, thread the stem into the handwheel assembly.
4. Install the locknut, handwheel, hex nut, and cotter pin (keys 43, 32, 33, and 34).

Note

Be sure to install the handwheel so that the arrow of operation on the top side coincides with the action of the actuator, as stated on the nameplate. (The arrow should point clockwise for PDTO. The arrow should point counter-clockwise for PDTC.)

5. Install the top casing assembly, making certain the warning tag is in place on the casing flange.

Locking Mechanism

Refer to figures 5 or 6 for the appropriate size locking mechanism when installing or planning to operate the device.

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

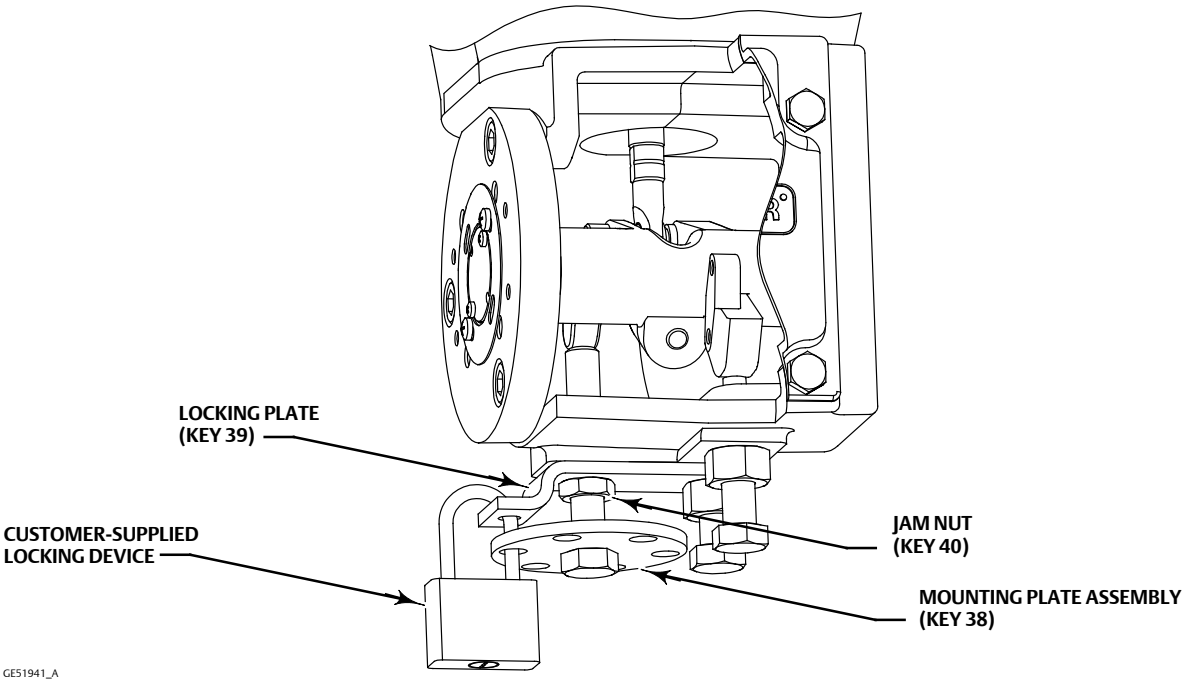
- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Safely vent the power actuator loading pressure.**
- **Check with your process or safety engineer for any hazards that may be present from exposure to process media.**

Installing the Size 1 Locking Mechanism

To add the locking mechanism (figure 5) to an existing actuator, purchase the required kit from Emerson Process Management.

1. Ensure the diaphragm rod assembly (key 10) is in the upward position and the lever (key 14) is against the up travel stop (spring fail position).
2. Thread the supplied jam nut (key 40) all the way onto the threaded bolt portion of the mounting plate assembly.
3. Loosen the down travel stop hex nut (key 24) and remove the travel stop cap screw (key 23).
4. Remove the vent screen (key 47) from the threaded hole in the bottom of the actuator housing.
5. Secure the locking plate (key 39) to the bottom of the housing assembly by reinstalling the down travel stop (key 23) and hex nut (key 24). Ensure the clearance hole in the locking plate is aligned with the threaded hole in the bottom of the housing.
6. Ensure the down travel stop is adjusted correctly to achieve the desired actuator rotational output.
7. Install the mounting plate assembly (key 38) by inserting it through the clearance hole in the locking plate and threading it into the hole in the actuator housing.

Figure 5. Size 1 Locking Mechanism



Operating the Locking Mechanism (Size 1)

To Lock the Actuator

1. Screw the mounting plate assembly into the housing until it contacts the actuator lever.
2. Align the hole in the locking plate (key 39) with one of the holes in the disk of the mounting plate assembly.
3. Tighten the jam nut (key 40) against the locking plate.

4. Insert a padlock (not furnished by Emerson Process Management) to prevent the mounting plate assembly from rotating.

To Unlock the Actuator

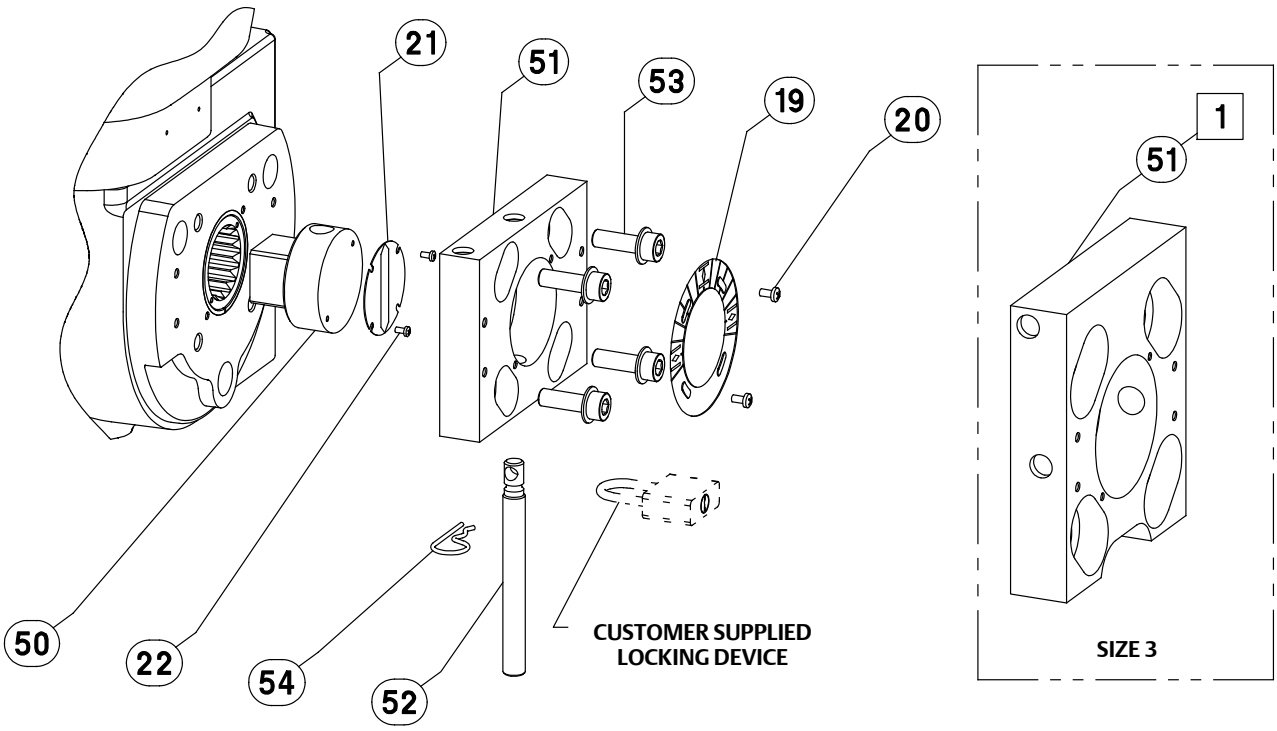
1. Remove the padlock. Loosen the jam nut (key 40), and unscrew the threaded bolt until it no longer protrudes inside the housing.

Note

Ensure the mounting plate assembly bolt is unthreaded far enough that the actuator lever will not contact the bolt during normal actuator operation.

2. If the mounting plate assembly is to be left partially threaded into the housing, lock it with the jam nut (key 40) so that it cannot be screwed further into the housing and interfere with normal actuator operation.

Figure 6. Size 2 and 3 Locking Mechanism



Installing the Size 2 and 3 Locking Mechanism

To add the locking mechanism (figure 6) to an existing actuator, purchase the required kit from Emerson Process Management.

1. The actuator should be mounted to the valve body and both travel stops (key 23) properly positioned prior to installing the locking mechanism.
2. Ensure the actuator lever (key 14) is in the spring-fail position (against the up travel stop).
3. Assemble the lockout kit by positioning the locking shaft (key 50) within the center through-hole of the mounting plate (key 51), as shown in figure 6. Insert the locking pin (key 52) through the center pinhole of the mounting plate and through the pin hole in the locking shaft. Install the hairpin cotter pin (key 54) for retention.
4. If installing the lockout kit on an existing actuator, remove the travel indicator (key 21) and travel indicator scale (key 19) from the actuator by loosening the appropriate screws.
5. Position the lockout kit against the actuator outboard end. The locking shaft will insert and engage the lever end geometry.

Size 2 actuator: The standard size 2 lockout kit orientation shown in figure 6 will accommodate the use of window-mount and end-mount digital valve controllers, positioners, and accessories. This orientation requires removal of the locking pin in the direction of the bottom side of the actuator.

Size 3 actuator: For the window mounted DVC6200 digital valve controller, the size 3 lockout kit should be oriented such that locking pin removal is in the direction of the bottom side of the actuator. This mounting plate position provides necessary clearance with the integral supply pressure regulator. For the end-mount digital valve controller or accessory option, the size 3 lockout kit should be oriented as shown in the inset picture of figure 6.

6. Loosely install the four flanged cap screws (key 53). Prior to tightening the fasteners, ensure the through-hole in the mounting plate is centered around the outside diameter of the locking shaft (key 50). Rotate the assembly by hand in the appropriate direction opposite of anticipated lever rotation to eliminate initial clearance among parts.
7. Tighten the cap screws (key 53) per the recommended torque values in table 6.
8. Install the travel indicator (key 21) and travel indicator scale (key 19) to the lockout parts as illustrated in figure 6.

⚠ WARNING

To avoid personal injury or property damage, ensure the travel indicator is installed correctly to coincide with the desired actuator action. Refer to figure 3 for more information.

9. For normal actuator operation, remove the hairpin cotter pin (key 54) and locking pin (key 52) from the center pinhole of the mounting plate and reinstall these parts in the second pinhole for storage.

Operating the Locking Mechanism (Size 2 & 3)

To Lock the Actuator

1. With the actuator lever (key 14) against the up travel stop (spring-fail position), insert the locking pin (key 52) through the center pinhole of the mounting plate and through the pin hole in the locking shaft. Install the hairpin cotter pin (key 54) for retention.
2. Install the customer-supplied locking device to further prevent removal of the locking pin.

To Unlock the Actuator

1. Remove the customer-supplied locking device.
2. Remove the hairpin cotter pin (key 54) and locking pin (key 52) from the center pinhole of the mounting plate and reinstall these parts in the second pinhole for storage.

⚠ WARNING

To avoid personal injury or property damage, be aware the travel indicator scale (key 19) retains the locking shaft (key 50) during normal actuator operation. Removal of the travel indicator scale could allow the locking shaft to fall out in certain actuator orientations.

Parts Ordering

When corresponding with your Emerson Process Management sales office about this equipment, refer to the serial number found on the actuator nameplate.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management should not, under any circumstances, be used in any Fisher valve, because they may void your warranty, might adversely affect the performance of the valve, and could cause personal injury and property damage.

Parts List

Note
Contact your Emerson Process Management sales office for Part Ordering information.

Key	Description
1	Housing Assembly
1a*	Bushing
2	Cover or Plug
3	End Plate Assembly
3a*	Bushing
4	Cap Screw
5	Top Casing Assembly
6	Diaphragm Plate
7	Cap Screw
8	Cap Screw
9	Hex Nut
10	Diaphragm Rod Assembly
11*	Diaphragm Molded nitrile/nylon Standard Construction Molded silicone/polyester Standard Construction
12	Spring, Inner
13	Spring, Outer
14	Lever
15	Cap Screw
16	Cap Screw
17	Hex Nut
18	Insert
19	Travel Indicator Scale
20	Self Tapping Screw
21	Travel Indicator
22	Machine Screw
23	Cap Screw
24	Hex Nut
25	Cover Plate
26	Cap Screw
27	Mounting Yoke
28	Cap Screw
29	Label
30	Nameplate
31	Drive Screw
32	Handwheel
33	Slotted Hex Nut
34	Cotter Pin
35	Screw
36	Pusher Assembly
37	Groove Pin
41	Warning Label
42	Washer
43	Hex Nut
44*	O-Ring
45	Lubricant
46	Lubricant
47	Vent Screen
48*	Guide Assembly
49	Lockout Kit

Kits for Actuator Locking Mechanisms are available to keep the actuator in a locked position, the same as spring-fail, during maintenance. (Padlock is customer supplied). Not compatible with the declutchable handwheel on size 2 and 3 actuators.

Kits

Description	Part Number
Size 1	GE51941X012
Size 2	GE52968X012
Size 3	GE52968X022

*Recommended spare parts

Figure 7. Fisher 2052 Actuator Assembly

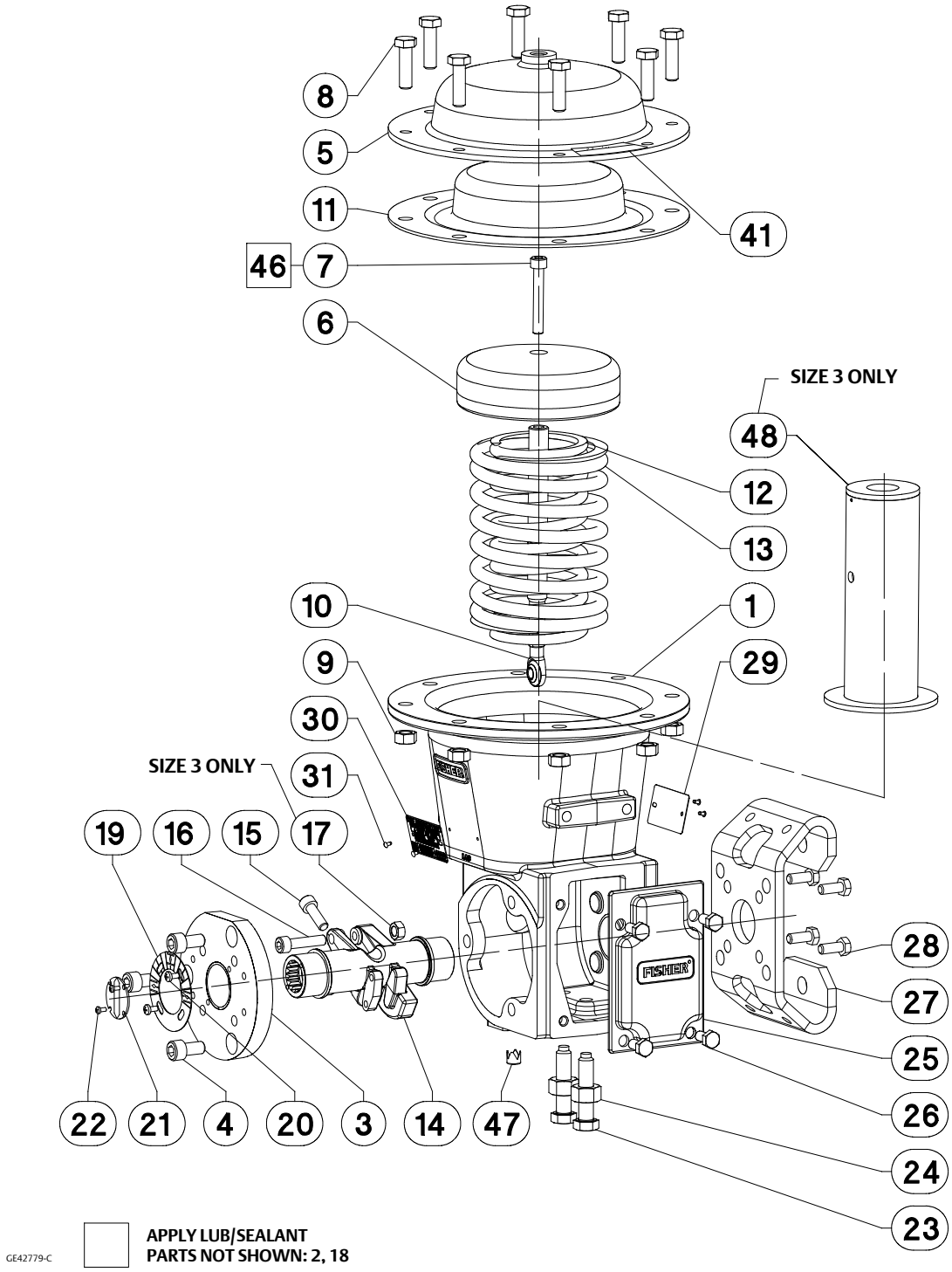


Figure 8. Fisher 2052 Size 3 Actuator Assembly

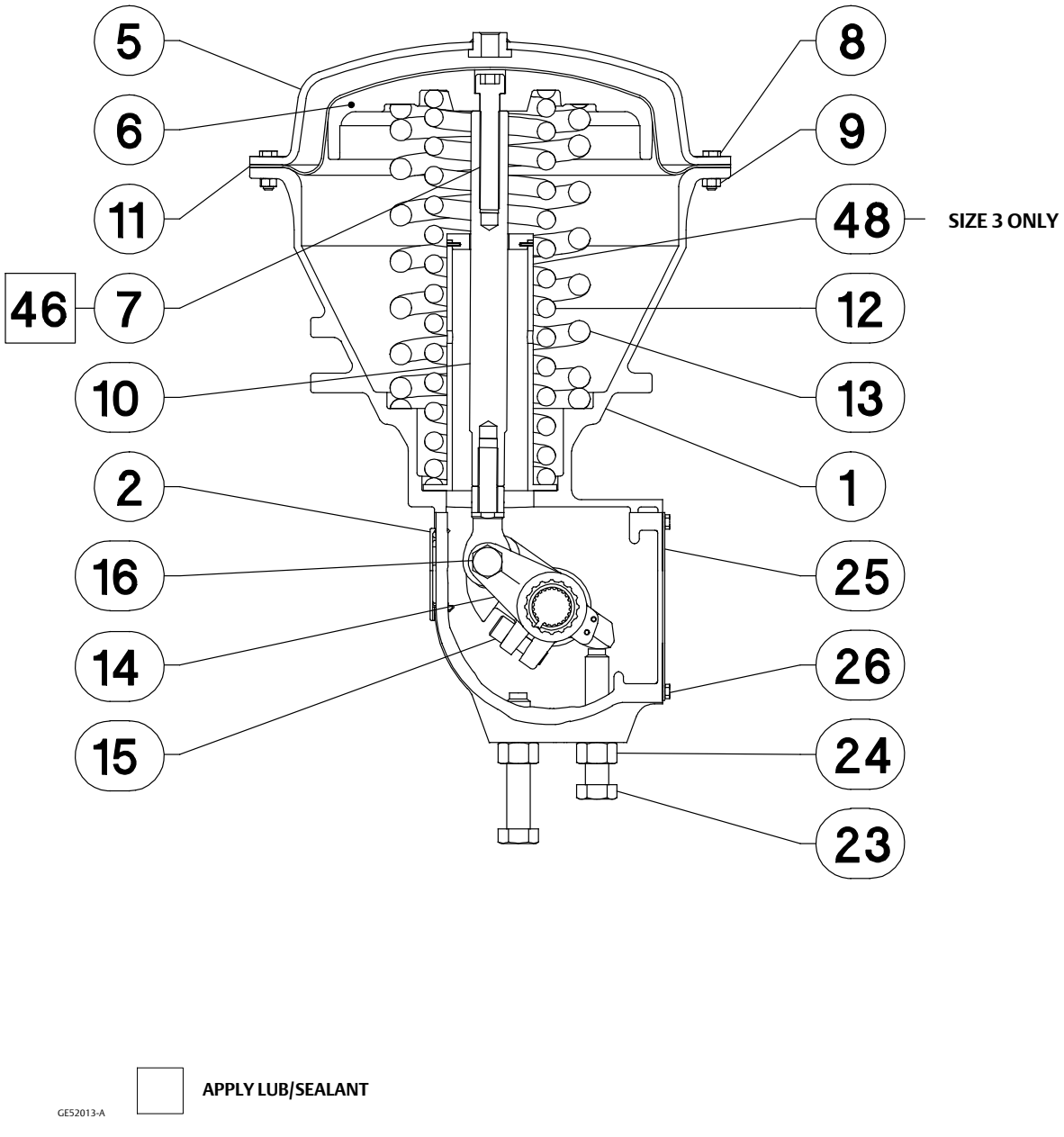
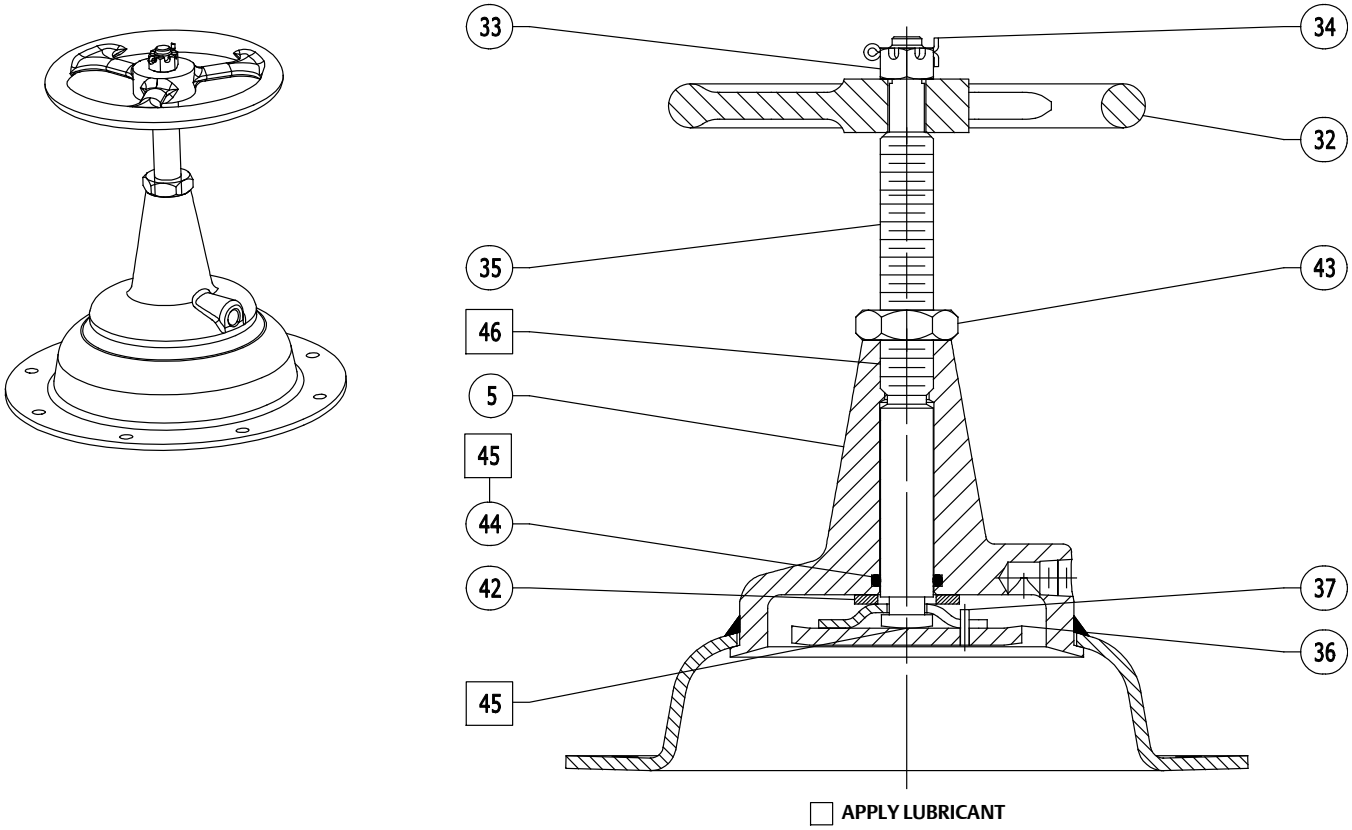


Figure 9. Fisher 2052 Size 1 Handwheel Assembly



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Fisher® D4 Control Valve Assembly

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Figure 1. Fisher D4 Control Valve



W8531

Introduction

Scope of Manual

This instruction manual provides installation, maintenance, and parts information for the Fisher D4 control valve.

Do not install, operate, or maintain a D4 control valve without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Description

The D4 control valve is a compact, rugged valve designed primarily for high-pressure throttling applications. This valve is ideal for use on pressure and flow control applications within the oil and gas production industry. The D4 valve also makes an excellent dump valve for high-pressure separators and scrubbers.

The D4 control valve meets the metallurgical requirements of NACE MR0175/ISO 15156 without environmental limits for temperatures below 135°C (275°F). If the temperature is above 135°C (275°F), the N07718 Belleville washers will impose some limits, as shown in table 3.

Table 1. Specifications

Available Configurations

Spring-to-Close
Spring-to-Open

Valve Body Sizes and End Connection Styles(1)

See table 2

Maximum Inlet Pressures and Temperatures(1)

If the valve nameplate shows an ASME pressure-temperature class, maximum inlet pressure and temperature is consistent with the applicable class per ASME B16.34. If the nameplate does not show an ASME class, it will show a maximum cold working pressure at 38°C (100°F) (for example, 293 bar [4250 psi])

Maximum Pressure Drops(1)

See tables 4, 5, 6, and 7

Input Signal to Actuator

See tables 4, 5, 6, and 7

Actuator Maximum Casing Pressure(1)

3.4 bar (50 psig)

Shutoff Classification per ANSI/FCI 70-2 and IEC 60534-4

Class IV

Material Temperature Capabilities(1)

Actuator Assembly: -40 to 93°C (-40 to 200°F)

Valve Body Assembly:
Standard Bonnet O-Ring: -40 to 135°C (-40 to 275°F)
Optional Fluorocarbon Bonnet O-Ring: -23 to 204°C (-10 to 400°F)

Flow Characteristic

Equal percentage

Flow Direction

Flow up only

Port Diameters

See table 2

Valve Plug Travel

19 mm (0.75 inch)

Valve Plug Style

Micro-Form valve plug

Actuator Diaphragm Effective Area

452 cm^2 (69 $inches^2$)

Actuator Pressure Connection Size

1/4 NPT internal

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.

Specifications

Table 1 lists specifications for the D4 control valve. Some of the specifications for a given control valve as it originally comes from the factory are stamped on a nameplate located on the actuator spring barrel.

Educational Services

For information on available courses for Fisher D4 valves, as well as a variety of other products, contact:

Emerson Process Management
Educational Services - Registration
Phone: 1-641-754-3771 or 1-800-338-8158
E-mail: education@emerson.com
http://www.emersonprocess.com/education

Table 2. Valve Sizes and Connection Styles

VALVE SIZE, NPS	PORT DIAMETER, (INCHES)	SCREWED	RAISED FACE (RF) FLANGED				RING TYPE JOINT (RTJ) FLANGED	
		4250 psi	CL150	CL300	CL600	CL900 and CL1500	CL600	CL900 and CL1500
1	0.25, 0.375, 0.5, 0.75	X	X	X	X	X	X	X
2	0.25, 0.375, 0.5 0.75, 1, 1.25	X	X	X	X	X	X	X

X = Available construction.

Table 3. D4 Environmental Limits for NACE MR0175/ISO 15156 with Sour Trim

MAXIMUM TEMPERATURE		MAXIMUM H_2S PARTIAL PRESSURE		COMPATIBLE WITH ELEMENTAL SULFUR?
°C	°F	MPa	psia	
232	450	0.2	30	No
204	400	1.4	200	No
199	390	2.3	330	No
191	375	2.5	360	No
149	300	2.8	400	No
135	275	No Limit		Yes

Table 4. Maximum Shutoff Pressure Drops(1) for Fisher D4 Control Valves (Spring-to-Close) When Used with Typical Control Instrumentation(2)

INPUT SIGNAL TO ACTUATOR		0 to 1.2 Bar (0 to 18 Psig)		0 to 1.4 Bar (0 to 20 Psig)		0 to 2.0 Bar (0 to 30 Psig)		0 to 2.3 Bar (0 to 33 Psig)		0 to 2.4 Bar (0 to 35 Psig)		0 to 3.4 Bar (0 to 50 Psig)	
SPRING		Light Rate				Heavy Rate							
INITIAL SPRING SETTING		0.77 Bar (11.2 Psig)		0.77 Bar (11.2 Psig)		0.85 Bar (12.4 Psig)		1.05 Bar (15.3 Psig)		1.18 Bar (17.1 Psig)		1.18 Bar (17.1 Psig)	
PORT DIAMETER		Maximum Pressure Drop											
mm	Inches	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
6.4	0.25	293(3)	4250(3)	293(3)	4250(3)	293	4250	293	4250	293	4250	293	4250
9.5	0.375	293(3)	4250(3)	293(3)	4250(3)	293	4250	293	4250	293	4250	293	4250
12.7	0.5	191	2765	191	2765	219	3180	288	4180	293	4250	293	4250
19.1	0.75	80	1160	80	1160	92	1340	123	1785	143	2080	143	2080
25.4	1	42	610	42	610	49	715	67	965	78	1130	78	1130
31.8	1.25	25	365	25	365	30	430	41	590	48	700	48	700

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.
2. For example, use the column marked 0-1.4 bar (0-20 psig) for a 0.21-1.0 bar (3-15 psig) pneumatic controller with 1.4 bar (20 psig) supply pressure.
3. For applications with downstream pressure in excess of 196 bar (2845 psig), use 196 bar (2845 psig) for Maximum Shutoff Pressure.

Table 5. Maximum Shutoff Pressure Drops(1) for Fisher D4 Control Valves (Spring-to-Close) When Used with Instrumentation with Restricted Output Range(2)

INPUT SIGNAL TO ACTUATOR		0.4 to 2.0 Bar (6 to 30 Psig)		0.14 to 2.3 Bar (2 to 33 Psig)	
SPRING		Heavy Rate		Heavy Rate	
INITIAL SPRING SETTING		0.97 Bar (14.0 Psig)		1.17 Bar (17.0 Psig)	
PORT DIAMETER		Maximum Pressure Drop			
mm	Inches	Bar	Psi	Bar	Psi
6.4	0.25	293(3)	4250(3)	293	4250
9.5	0.375	210(3)	3045(3)	293	4250
12.7	0.5	113	1635	282	4095
19.1	0.75	45	655	120	1750
25.4	1	23	330	65	945
31.8	1.25	13	185	39	580

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.
2. For example, an Electro-Pneumatic Transducer calibrated for 0.4-2.0 bar (6-30 psig) output pressure.
3. For applications with downstream pressure in excess of 118 bar (1715 psig), use 118 bar (1715 psig) for Maximum Shutoff Pressure.

Table 6. Maximum Shutoff Pressure Drops[1] for Fisher D4 Control Valves (Spring-to-Open) When Used with Typical Control Instrumentation[2]

INPUT SIGNAL TO ACTUATOR		0 to 1.2 Bar (0 to 18 Psig)		0 to 1.4 Bar (0 to 20 Psig)		0 to 2.0 Bar (0 to 30 Psig)		0 to 2.3 Bar (0 to 33 Psig)		0 to 2.4 Bar (0 to 35 Psig)		0 to 3.4 Bar (0 to 50 Psig)	
SPRING		Light Rate				Heavy Rate							
INITIAL SPRING SETTING		0.23 Bar (3.4 Psig)		0.23 Bar (3.4 Psig)		0.28 Bar (4.0 Psig)		0.28 Bar (4.0 Psig)		0.28 Bar (4.0 Psig)		0.28 Bar (4.0 Psig)	
PORT DIAMETER		Maximum Pressure Drop											
mm	Inches	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi	Bar	Psi
6.4	0.25	293[3]	4250[3]	293[3]	4250[3]	293	4250	293	4250	293	4250	293	4250
9.5	0.375	293[3]	4250[3]	293[3]	4250[3]	293	4250	293	4250	293	4250	293	4250
12.7	0.5	187	2715	233	3380	293	4250	293	4250	293	4250	293	4250
19.1	0.75	78	1135	99	1430	147	2130	178	2575	198	2875	293	4250
25.4	1	41	600	53	765	80	1160	97	1410	109	1575	195	2830
31.8	1.25	24	355	32	465	49	715	60	875	68	985	123	1785

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.
2. For example, use the column marked 0-1.4 bar (0-20 psig) for a 0.21-1.0 bar (3-15 psig) pneumatic controller with 1.4 bar (20 psig) supply pressure.
3. For applications with downstream pressure in excess of 190 bar (2760 psig), use 190 bar (2760 psig) for Maximum Shutoff Pressure.

Table 7. Maximum Shutoff Pressure Drops[1] for Fisher D4 Control Valves (Spring-to-Open) When Used with Instrumentation with Restricted Output Range[2]

INPUT SIGNAL TO ACTUATOR		0.4 to 2.0 Bar (6 to 30 Psig)		0.14 to 2.3 Bar (2 to 33 Psig)	
SPRING		Heavy Rate		Heavy Rate	
INITIAL SPRING SETTING		0.69 Bar (10.0 Psig)		0.42 Bar (6.1 Psig)	
PORT DIAMETER		Maximum Pressure Drop			
mm	Inches	Bar	Psi	Bar	Psi
6.4	0.25	293[3]	4250[3]	293	4250
9.5	0.375	293[3]	4250[3]	293	4250
12.7	0.5	196	2845	293	4250
19.1	0.75	82	1195	156	2265
25.4	1	43	630	85	1235
31.8	1.25	26	380	52	765

1. The pressure or temperature limits in the referenced tables and any applicable ASME code limitations should not be exceeded.
2. For example, an Electro-Pneumatic Transducer calibrated for 0.4-2.0 bar (6-30 psig) output pressure.
3. For applications with downstream pressure in excess of 202 bar (2925 psig), use 202 bar (2925 psig) for Maximum Shutoff Pressure.

Installation

⚠ WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

To avoid personal injury or property damage caused by bursting of pressure-retaining parts or by uncontrolled process fluid, be certain the service conditions do not exceed the limits shown on the valve nameplate and in tables 1, 4, 5, 6, and 7. Use pressure-relieving devices required by government or accepted industry codes and good engineering practices.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

⚠ WARNING

When ordered, the valve configuration and construction materials were selected to meet particular pressure, temperature, pressure drop, and controlled fluid conditions. Responsibility for the safety of process media and compatibility of valve materials with process media rests solely with the purchaser and end-user. Since some body/trim material combinations are limited in their pressure drop and temperature ranges, do not apply any other conditions to the valve without first contacting your Emerson Process Management sales office.

⚠ WARNING

Avoid personal injury or property damage caused by possible actuator failure. The use of a rigidly-mounted support on the actuator casing may cause additional stress on the actuator leading to premature wear and/or failure of the actuator components.

CAUTION

To avoid product damage, inspect the valve before installation for any damage or any foreign material that may have collected in the valve body. Also remove any pipe scale, welding slag, or other foreign material from the pipeline.

1. Before installing the control valve assembly, inspect it for any damage and for any foreign material that may have collected in the valve body.
2. Remove any pipe scale, welding slag, and other foreign material from the pipeline.
3. The control valve can be installed in any position, but normally the actuator is vertical above the valve. Install the valve so the flow direction arrow on the side of the valve indicates the direction of the process flow.
4. Install the valve following local and national piping codes when they apply to the application. For screwed connections, treat the external pipe threads with a good grade pipe compound. For flanged valves, use suitable gaskets between valve and pipeline flanges.
5. If continuous operation is required during maintenance and inspection, install a conventional three-valve bypass around the valve.
6. Connect loading pressure for the Spring-to-Open configuration to the 1/4-18 NPT connection in the upper casing assembly (key 23) as shown in figure 5. The Spring-to-Close configuration loading pressure connection is in the lower casing assembly (key 39) as shown in figure 4.

Spring Adjustment

The spring has a fixed pressure span over which loading pressure will stroke the valve. Adjustment of the spring compression shifts the span so that more or less loading pressure is required to start travel. Since the span does not change, there will be a corresponding increase or decrease in the pressure requirements at the end of the valve stroke.

In order to maximize shutoff pressure drop values, the actuator spring must be accurately adjusted for each Input Signal Pressure Range. If the actuator has been disassembled or pressure conditions have changed, the spring may require adjustment. Refer to tables 2 and 4 to determine the Initial Spring Set values based on the Input Signal range that is available to the actuator. These values include packing friction.

Spring-to-Close

Refer to figure 4.

1. Loosen the adjusting screw nut (key 44).
2. Turn the adjusting screw (key 31) clockwise to compress the spring or counterclockwise to decrease spring compression.
3. After adjustment, tighten the adjusting screw nut (key 44).

Spring-to-Open

Refer to figure 5.

1. Unscrew the spring case assembly (key 27).
2. Turn the adjusting stem nut (key 44) clockwise to compress the spring or counterclockwise to decrease spring compression.
3. After adjustment, replace the spring case assembly (key 27).

Maintenance

Refer to figure 4.

Valve parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and maintenance depends on the severity of the service conditions.

⚠ WARNING

Avoid personal injury from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the power actuator loading pressure and relieve any actuator spring precompression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline.* Process fluids may spray out under pressure when removing the packing hardware or packing rings.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

Valve Plug and Seat Ring

The D4 control valve is designed to allow easy access to the valve plug and seat ring without disturbing the packing. Refer to other sections of this instruction manual if additional maintenance is required.

Disassembly

1. Remove the loading pressure tubing and any accessories that may hamper disassembly.
2. Break the hammer nut (key 6) loose with a hammer. Continue turning the hammer nut by using a hammer or a large adjustable wrench, tightened around one ear of the hammer nut. If the bonnet is stuck on the valve, continue to unscrew the hammer nut. The hammer nut will contact the spring pins (key 7) and will force the bonnet out of the valve. Carefully lift the actuator, bonnet, and valve plug assembly from the valve body.

⚠ WARNING

The spring pins must always be in place during valve operation. They provide a safeguard against injury when the unit is being disassembled.

3. Use a socket wrench to loosen the seat ring (key 3).
4. Remove the seat ring (key 3) and seat ring gasket (key 9) from the valve body.
5. Inspect parts for wear or damage that would prevent proper operation of the valve body. Carefully clean the seat ring gasket surfaces and seat ring threads.

⚠ WARNING

Be careful to avoid damaging the seating surface on the valve plug or seat ring as damage in these areas will allow excessive leakage at shutoff. Avoid damaging the highly polished valve stem surface. A damaged valve stem could cut the packing and allow process fluid to leak to the atmosphere.

Table 8. Torque for Seat Ring (Key 3)

VALVE SIZE	RECOMMENDED TORQUE	
NPS	N•m	Lbf•ft
1	407	300
2	698	515

6. For spring-to-close only: To remove the valve plug (key 2), drive out the groove pin (key 4) and unscrew the valve plug from the stem (key 47). If the groove pin (key 4) is not exposed, verify that downward movement of the stem is not restricted by instrument linkages attached to the stem (key 47).

If the valve plug cannot be easily unscrewed from the stem, use a punch to keep the stem from turning as the plug is removed.

7. For spring-to-open only: To remove the valve plug (key 2), first remove the spring case assembly (key 27). Remove the adjustment screw nut (key 44), the upper spring seat (key 29), and the spring (key 30). Push the adjustment stem (key 31) fully downward until the diaphragm plate (key 40) contacts the cap screws (key 38), exposing the groove pin (key 4) in the plug. If the groove pin (key 4) is not exposed, verify that downward movement of the stem is not restricted by instrument linkages attached to the stem (key 47). Drive out the groove pin (key 4) and unscrew the valve plug from the stem (key 47).

If the valve plug cannot be easily unscrewed from the stem, use a punch to keep the stem from turning as the plug is removed.

Assembly

1. Make sure the bonnet O-ring (key 8) is on the bonnet and lubricated with lithium grease (key 49).

2. Install the plug (key 2) on the stem (key 47) and insert a new groove pin (key 4).
3. Thoroughly clean the seat ring and bonnet threads in the valve body (key 1). Also clean the valve body seat ring gasket surfaces.
4. Apply anti-seize lubricant (key 54) to the threads of the seat ring (key 3), and its mating threads in the valve body.
5. Apply anti-seize lubricant (key 54) to the seat ring gasket (key 9) and install into the valve body.
6. Screw the seat ring into the valve body. Use a socket wrench to tighten the seat ring to the torque values shown in table 8. Remove all excess lubricant after tightening.
7. Lubricate (key 54) the threads on the valve body and hammer nut and the contact surfaces of the bonnet and hammer nut flange. Install the bonnet and actuator assembly with pinned valve plug onto the valve body. Tighten the hammer nut using an adjustable wrench until the nut stops turning. A few hammer blows will be required to ensure that the assembly is tight.
8. See the actuator assembly and spring adjustment sections of this manual.

Valve Packing

Note

These instructions apply to valves manufactured with serial numbers equal to and greater than 18679262. See Appendix A for information on packing constructions with serial numbers less than 18679262.

If your D4 valve assembly has a packing retainer lock ring (see figure 6), proceed to Appendix A.

⚠ WARNING

Observe the warning at the start of the Maintenance section.

The valve stem packing can only be accessed from within the valve body. If packing maintenance is required, first disassemble per steps 1, 2, and 6 or 7 in the Valve Plug and Seat Ring Disassembly section of this document.

Disassembly

1. Unscrew the packing retainer (key 10) from the bonnet (key 5).
2. Remove the five Belleville springs (key 11), packing spacer (key 14), packing (key 13), and two anti-extrusion rings (key 12) from the bonnet, using a formed wire hook.
3. Clean and inspect the packing box wall to ensure that the packing surfaces are not damaged. If the surface condition is damaged, and cannot be improved by light sanding, replace the bonnet by contacting your Emerson Process Management sales office.
4. Inspect the valve stem for scratches or wear, and valve plug for wear or damage. Replace if necessary.

Figure 2. Fisher D4 Packing Installation

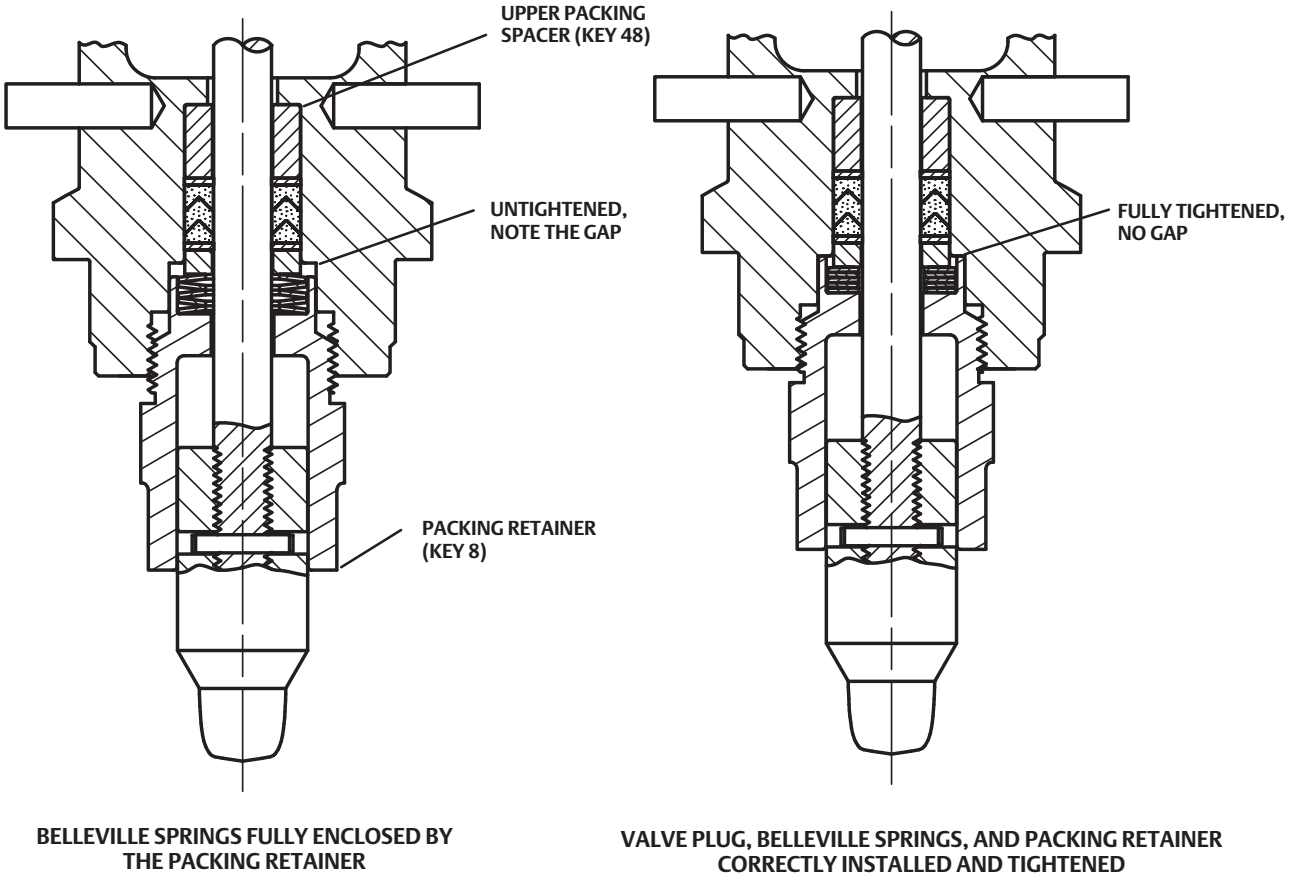
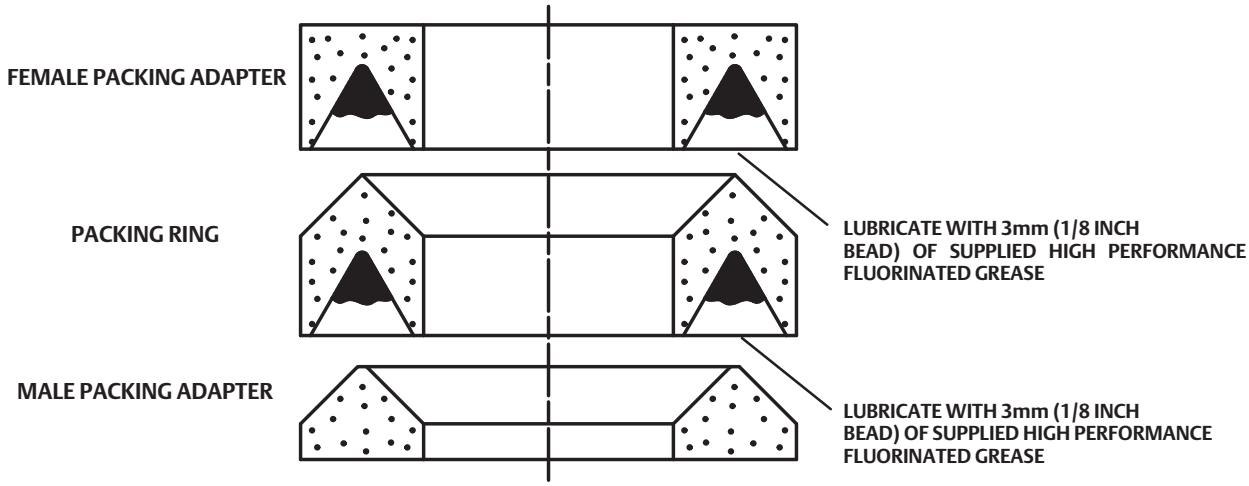


Figure 3. Lubrication Locations on Packing



Assembly

Refer to figures 2, 3, 4, and 5.

Note

If your D4 valve assembly has a packing retainer lock ring (see figure 6), proceed to Appendix A.

1. Ensure the upper packing spacer (key 48) is installed, as shown in figure 2.
2. Using a non-marring installation tool, such as a 12-inch length of 1/2 inch PVC pipe, push the first anti-extrusion washer (key 12) fully into the packing box by hand. Then, use the packing spacer (key 14) to fully seat the anti-extrusion washer by firmly tapping the packing spacer against the anti-extrusion washer with a hammer and the PVC pipe.
3. Remove the packing spacer from the packing bore.

CAUTION

All D4 packing kits include a single use packet of high performance fluorinated grease. This is the only acceptable D4 packing lubricant.

Note

In the following procedure, carefully install each packing ring individually over the valve stem and push completely into the packing box with a non-marring tube. A 12-inch length of 1/2 inch PVC pipe works well for this. It is recommended that the lubricated packing rings be installed individually rather than pushed in as a set.

4. Apply a 3mm (1/8 inch) bead of the supplied high performance fluorinated grease (key 44) around the groove of the female packing adaptor as shown in figure 3 and install over the valve stem (key 16).
5. Apply a 3mm (1/8 inch) bead of the supplied high performance fluorinated grease (key 44) around the groove of the packing ring as shown in figure 3 and install over the valve stem.
6. Install the male packing adaptor, lower anti-extrusion washer (key 10), and lower packing spacer over the valve stem as shown in figure 2.
7. Firmly press all packing parts into the packing bore with a tube.
8. Install the five Belleville springs (key 11) over the valve stem. The Belleville springs should be single-stacked with the inside diameter of the inner spring contacting the packing spacer (key 14), and the outside diameter of the outer spring contacting the packing retainer (key 10).
9. Lubricate the threads of the packing retainer with anti-seize and install into the bonnet using a 1-5/8 inch wrench. Make sure the Belleville springs are completely enclosed by the packing retainer as shown in figure 2.
10. Torque the packing retainer to 136 N•m (100 lbf•ft). The packing retainer has been installed correctly when a metal-to-metal contact has been made between the packing retainer end and the bonnet (key 5). The packing retainer threads should be completely enclosed by the bonnet.

Actuator (Spring-to-Close)

⚠ WARNING

Observe the warning at the start of the Maintenance section.

Refer to figure 4.

Before disassembling the actuator, disassemble the valve plug, seat ring, and packing according to instructions in this manual.

Disassembly

1. Loosen the adjusting screw nut (key 44) and turn the adjusting screw (key 31) counterclockwise to remove all spring compression.
2. Unscrew the casing cap screws and hex nuts (keys 45 and 46), and remove the upper casing assembly (key 23) from the lower casing (key 39).
3. Remove the spring seat (key 29) and actuator spring (key 30).
4. Lift out the diaphragm, diaphragm plate, and stem assembly. Remove the travel indicator (key 32) when the bottom of the stem enters the yoke window.
5. To replace the diaphragm (key 15), separate the diaphragm assembly by using a wrench on the hex nuts (key 42) to unscrew the assembly.
6. Separate the parts--diaphragm washer, actuator O-ring (keys 41 and 25), diaphragm, and diaphragm plate, (keys 15 and 40).
7. Inspect the diaphragm and the actuator O-ring for damage or deterioration, and replace if necessary. If the diaphragm is replaced, a new O-ring should also be installed.
8. Inspect the stem O-ring (key 19) and bonnet bushing (key 20); replace if necessary. To inspect the casing O-ring (key 18), remove the cap screws (key 38) and lift off the lower casing (key 39). Replace the O-ring if necessary.
9. If the hammer nut needs to be removed from the bonnet, the spring pins (key 7) can be removed with locking pliers.

Assembly

1. Before starting assembly, make sure all parts are clean and in good condition. There should be no burrs or sharp edges on any threads or surfaces that might cut or damage an O-ring, bushing, the packing, or the diaphragm. When replacing O-rings and bushings, be sure the O-ring or bushing groove is clean and undamaged. Using a general purpose lubricant (key 49), lubricate all bushings and O-rings and the threads of parts that have to pass through the bushings and O-rings.

CAUTION

The threads on factory-produced valve stems have been specially machined to avoid O-ring, bushing, or packing damage during trim maintenance. Use of other than a factory-produced valve stem may result in early stem O-ring, bushing, and packing failure.

Note

Do not lubricate cap screws (key 38) before inserting them in the following procedure.

2. Place the hammer nut and spring pins on the bonnet, if removed. Install the casing O-ring (key 18), the stem O-ring (key 19), and the bonnet bushing (key 20). Position the lower casing (key 39) on the bonnet. Insert the nonlubricated cap screws (key 38), and torque to 49 N•m (36 lbf•ft).

⚠ WARNING

The spring pins must always be in place during valve operation. They provide a safeguard against injury when the unit is being disassembled.

3. Assemble the diaphragm plate assembly. Place the patterned side of the diaphragm (key 15) against the diaphragm plate (key 40). Be sure to turn the diaphragm washer (key 41) so that the side that is beveled on the inside diameter

is against the O-ring (key 25). Also, make sure that it is assembled for installation with the diaphragm on the loading pressure side and the lockwasher (key 43) and lower spring seat (key 28) are on the spring side.

4. Fasten the diaphragm and diaphragm plate assembly on the stem with hex nuts (key 42). Place the diaphragm and diaphragm plate, and stem assembly into the lower casing and bonnet. Install the travel indicator (key 32) on the stem as the bottom of the stem enters the yoke window.

CAUTION

Over-tightening the diaphragm casing cap screws and nuts (keys 45 and 46) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

5. Replace the spring (key 30) on the diaphragm plate (key 40). Replace the upper spring seat (key 29). Position the upper casing (key 23) on the lower casing (key 39). Insert the cap screws (key 45) and tighten the hex nuts (key 46). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern.
6. Adjust the initial spring set per the Spring Adjustment section in this manual.

Actuator (Spring-to-Open)

⚠ WARNING

Observe the warning at the start of the Maintenance section.

Refer to figure 5.

Before disassembling the actuator, disassemble the valve plug, seat ring, and packing according to instructions in this manual.

Disassembly

1. Unscrew the spring case assembly (key 27). Turn the adjusting screw nut (key 44) counterclockwise to remove all spring compression. Remove the adjusting screw nut, upper spring seat, and spring (keys 44, 29, and 30)
2. Unscrew the casing cap screws and hex nuts (keys 45 and 46), and remove the upper casing assembly (key 23) from the lower casing (key 39). Remove the cotter pin (key 36) and unscrew the adjusting stem (key 31).
3. Lift out the diaphragm (key 15), diaphragm plate (key 40), and stem assembly. Remove the travel indicator (key 32) when the bottom of the stem enters the yoke window.
4. To replace the diaphragm (key 15), separate the diaphragm assembly by using a wrench on the hex nuts (key 42) to unscrew the assembly.
5. Separate the parts--diaphragm washer, actuator O-ring (keys 41 and 25), diaphragm, and diaphragm plate, (keys 15 and 40).
6. Inspect the diaphragm and the actuator O-ring for damage or deterioration, and replace if necessary. If the diaphragm is replaced, a new O-ring should also be installed.
7. Inspect the stem O-ring (key 19) and bonnet bushing (key 20); replace if necessary. To inspect the casing O-ring (key 18), remove the cap screws (key 38) and lift off the lower casing (key 39). Replace the O-ring if necessary. Inspect the adjusting stem bushing (key 26) and actuator stem O-ring (key 53). Replace if necessary.
8. If the hammer nut needs to be removed from the bonnet, the spring pins (key 7) can be removed with locking pliers.

Assembly

1. Before starting assembly, make sure all parts are clean and in good condition. There should be no burrs or sharp edges on any threads or surfaces that might cut or damage an O-ring, bushing, the packing, or the diaphragm.

When replacing O-rings and bushings, be sure the O-ring or bushing groove is clean and undamaged. Using a general purpose lubricant (key 49), lubricate all bushings and O-rings and the threads of parts that have to pass through the bushings and O-rings.

CAUTION

The threads on factory-produced valve stems have been specially machined to avoid O-ring, bushing, or packing damage during trim maintenance. Use of other than a factory-produced valve stem may result in early stem O-ring, bushing, and packing failure.

Note

Do not lubricate cap screws (key 38) before inserting them in the following procedure.

2. Place the hammer nut and spring pins on the bonnet, if removed. Install the casing O-ring (key 18), the stem O-ring (key 19), and the bonnet bushing (key 20). Position the lower casing (key 39) on the bonnet. Insert the nonlubricated cap screws (key 38), and torque to 49 N•m (36 lbf•ft).
3. Assemble the diaphragm plate assembly. Place the patterned side of the diaphragm (key 15) against the diaphragm plate (key 40). Be sure to turn the diaphragm washer (key 41) so that the side that is beveled on the inside diameter is against the O-ring (key 25). Also, make sure that it is assembled for installation with the diaphragm on the loading pressure side and the lockwasher (key 43) and diaphragm washer (key 41) are on the upper side.

⚠ WARNING

The spring pins must always be in place during valve operation. They provide a safeguard against injury when the unit is being disassembled.

4. Fasten the diaphragm and diaphragm plate assembly on the stem with hex nuts (key 42). Place the diaphragm and diaphragm plate, and stem assembly into the lower casing and bonnet. Install the travel indicator (key 32) on the stem as the bottom of the stem enters the yoke window.
5. Screw the adjusting stem (key 31) onto the stem (key 47) and secure the cotter pin (key 36). Make sure the bushing and O-ring are in place in the upper casing.

CAUTION

Over-tightening the diaphragm casing cap screws and nuts (keys 45 and 46) can damage the diaphragm. Do not exceed 27 N•m (20 lbf•ft) torque.

6. Position the upper casing (key 23) on the lower casing (key 39). Insert the cap screws (key 45) and tighten the hex nuts (key 46). Torque the casing cap screws evenly to 27 N•m (20 lbf•ft) using a crisscross pattern.
7. Replace the spring (key 30), spring seat (key 29), and adjusting stem nut (key 44) over the adjusting stem. Replace the spring case assembly (key 27).
8. Adjust the initial spring set per the Spring Adjustment section in this manual.

Parts Ordering

Each D4 control valve is assigned a serial number, which can be found on the nameplate. Refer to the number when contacting your Emerson Process Management sales office for assistance or when ordering replacement parts.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management should not, under any circumstances, be used in any Fisher valve, because they may void your warranty, might adversely affect the performance of the valve, and could cause personal injury and property damage.

Repair Kits

Note
All repair kits are supplied with hydrogenated nitrile bonnet O-ring. FKM (fluorocarbon) bonnet O-ring must be ordered separately when required.

	Description	Part Number
*	Packing Repair Kit Includes key numbers 4, 8, 12 (2 req'd), 13, and high performance fluorinated grease	RD4X0000012
*	Actuator Repair Kit Includes key numbers 4, 8, 12 (2 req'd), 13, 15, 18, 19, 20, 25, 26, 36, 53, and high performance fluorinated grease	RD4X0000022

Parts List

Note
Contact your Emerson Process Management sales office for Part Ordering information.

Key	Description
1	Valve Body
2*	Valve Plug S41000 / S41600 HT S17400 H1150 Dbl Tungsten Carbide
3*	Seat Ring S17400 H1150 Dbl Tungsten Carbide
4*	Groove Pin
5	Bonnet
6	Hammer Nut
7	Spring Pin
8*	Bonnet O-ring Hydrogenated Nitrile FKM
9*	Seat Ring Gasket
10	Packing Retainer
11	Belleville Springs, 5 req'd
12*	Anti-Extrusion Washer, 2 req'd
13*	Packing Set
14	Packing Spacer
15*	Diaphragm
16	Nameplate
17	Drive Screw
18*	Casing O-ring
19*	Stem O-ring
20*	Bonnet Bushing
23	Upper Casing Assembly
25*	Actuator O-ring
26*	Adjusting Stem Bushing (spring-to-open only)
27	Spring Case Assembly
28	Lower Spring Seat
29	Upper Spring Seat
30	Spring Spring-to-Close, Light Rate Spring-to-Close, Heavy Rate Spring-to-Open, Light Rate Spring-to-Open, Heavy Rate
31	Adjustment Screw or Stem
32	Travel Indicator
34	Vent Assembly
36*	Cotter Pin (spring-to-open only)
37	Pipe Plug
38	Cap Screw
39	Lower Casing
40	Diaphragm Plate
41	Diaphragm Washer
42	Hex Nut
43	Lockwasher
44	Adjustment Screw Nut
45	Cap Screw
46	Hex Nut
47*	Valve Stem S20910, Reverse Acting S20910, Direct Acting
48	Upper packing spacer
49	Lubricant (lithium grease)
51	Drive Screw
53*	Actuator Stem O-ring (spring-to-open only)
54	Lubricant (anti-seize)
55	Spring Setting Label (not shown)
56	High Performance Fluorinated Grease Packing Lubricant

*Recommended spare parts

Figure 4. Fisher D4 Valve Assembly (Spring-to-Close)

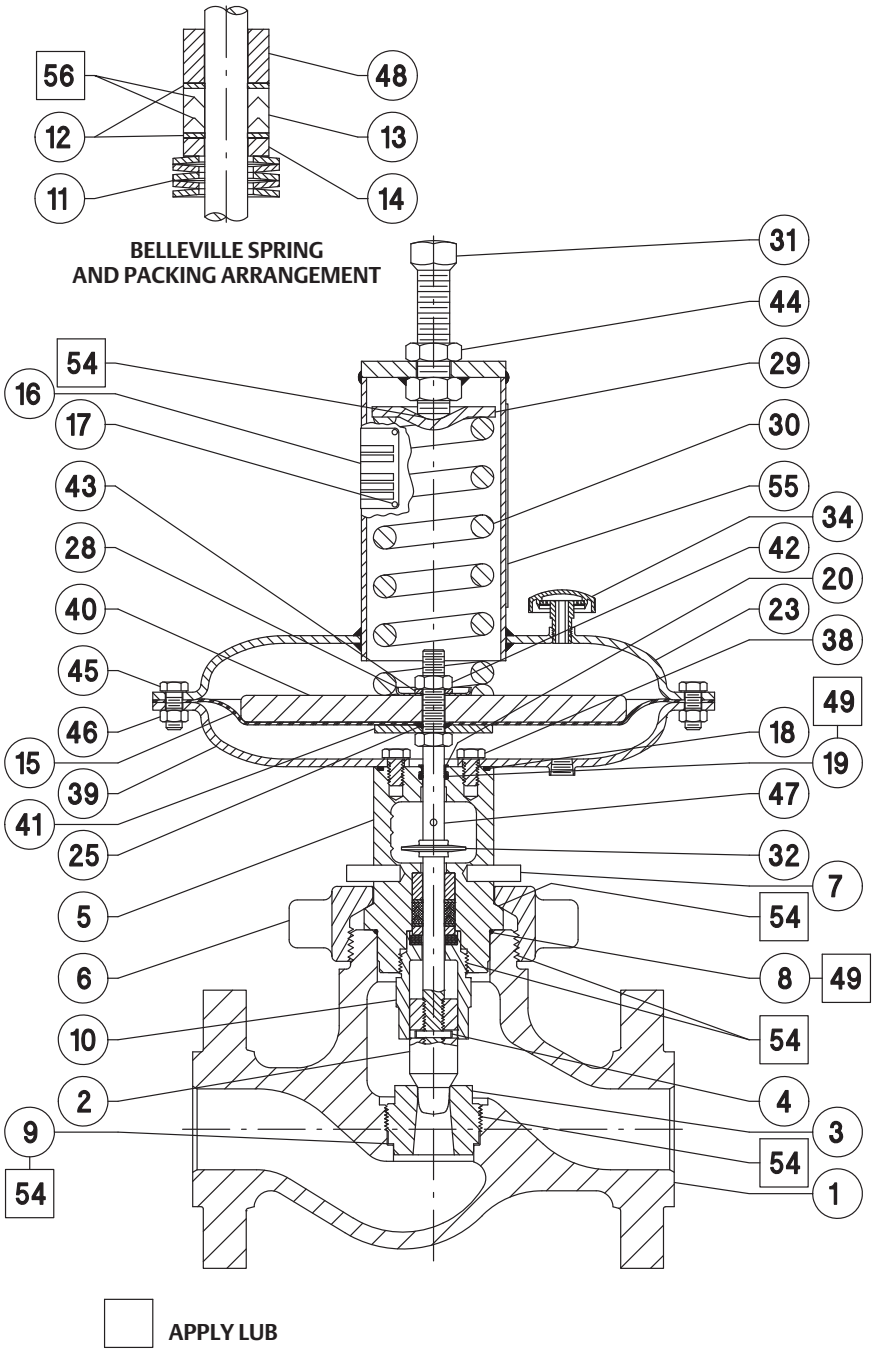
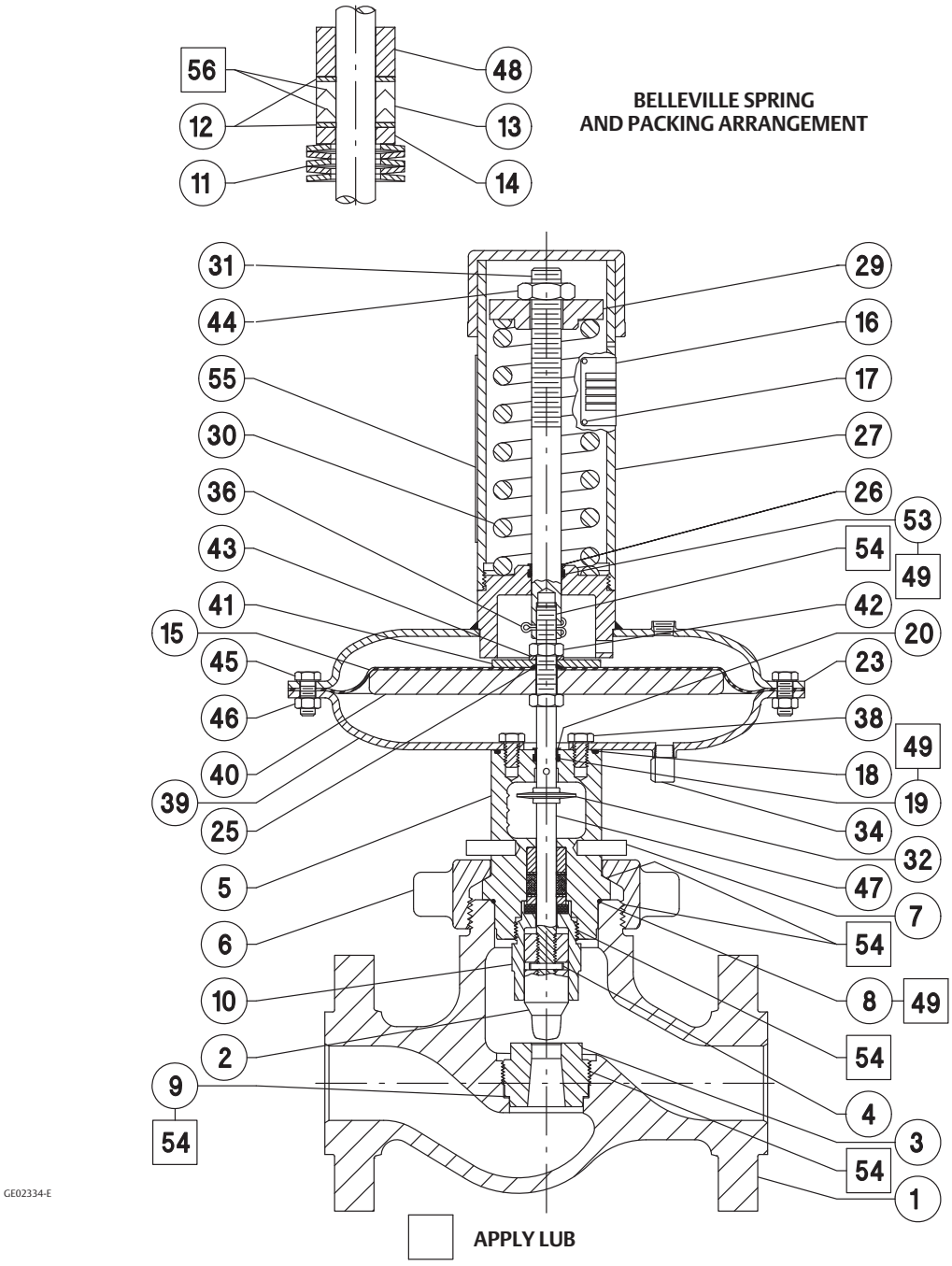


Figure 5. Fisher D4 Valve Assembly (Spring-to-Open)



Appendix A

Note

These instructions apply to valves manufactured with serial numbers less than 18679262.

Valve Packing

⚠ WARNING

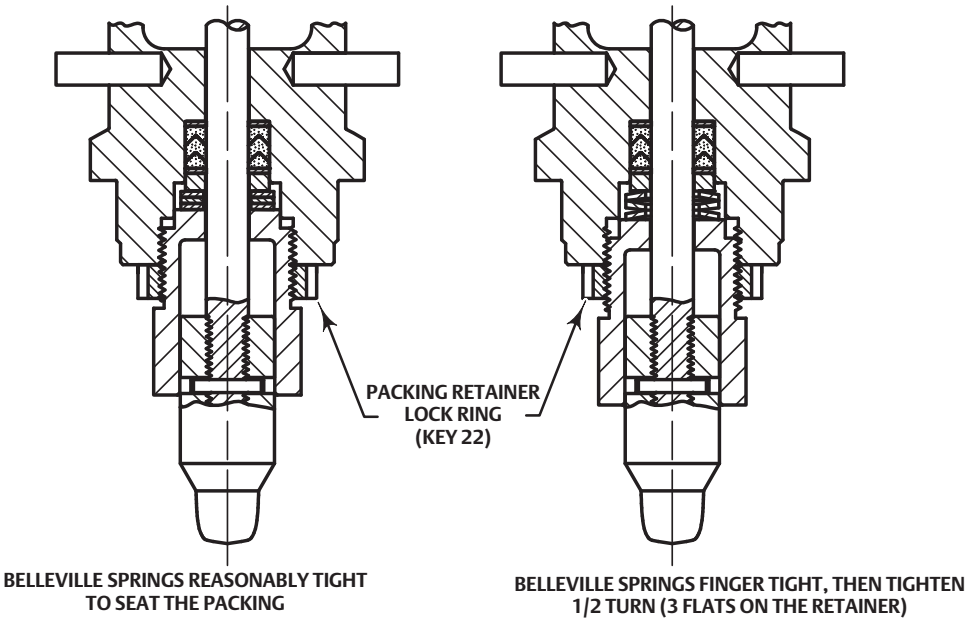
Observe the warning at the start of the Maintenance section.

The valve stem packing can only be accessed from within the valve body. If packing maintenance is required, first disassemble per steps 1, 2, and 6 or 7 in the Valve Plug and Seat Ring Disassembly section of this document.

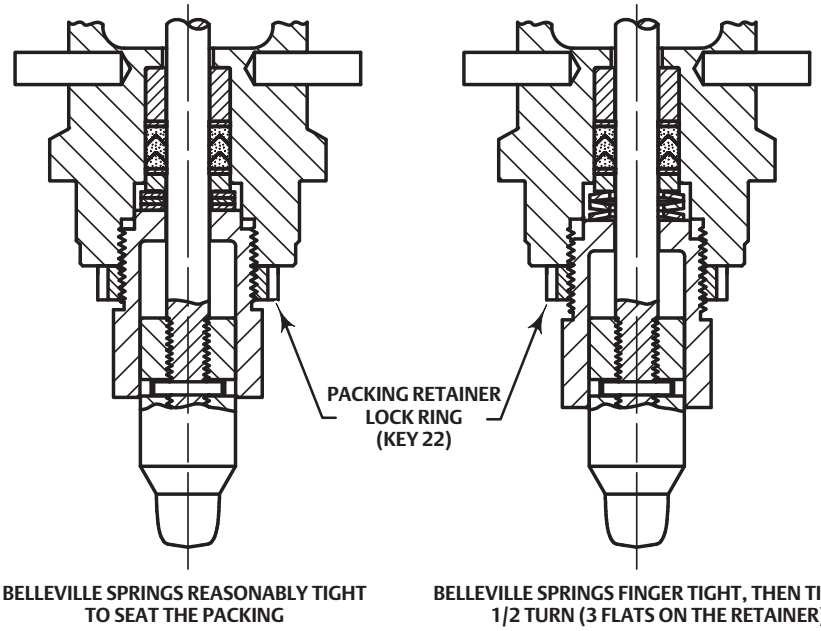
Disassembly

1. Loosen the packing retainer locknut (key 22) with a spanner wrench or with a punch and hammer.
2. Unscrew the packing retainer (key 10) from the bonnet (key 5).
3. Remove the three Belleville springs (key 11), packing spacer (key 14), packing (key 13), and two anti-extrusion rings (key 12) from the bonnet, using a formed wire hook.
4. Clean and inspect the packing box wall to ensure that the packing surfaces are not damaged. If the surface condition is damaged, and cannot be improved by light sanding, replace the bonnet by contacting your Emerson Process Management sales office.
5. Inspect the valve stem for scratches or wear, and valve plug for wear or damage. Replace if necessary.

Figure 6. Fisher D4 Belleville Spring Procedure



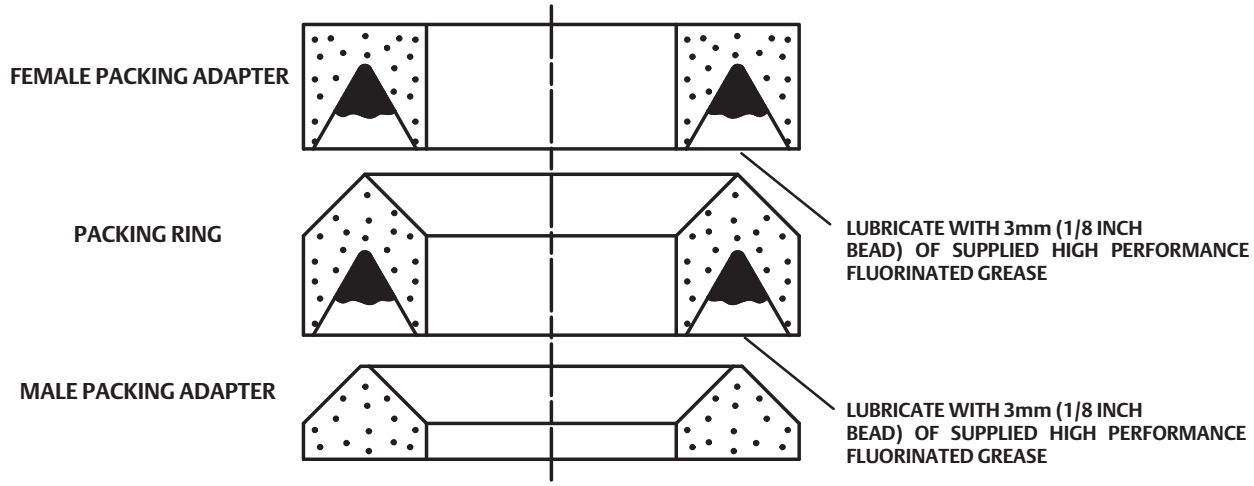
BONNET DESIGN FOR VALVES (BEFORE 2006) WITH SERIAL NUMBERS LESS THAN 18679262



BONNET DESIGN FOR VALVES (2006 AND NEWER) WITH SERIAL NUMBERS LESS THAN 18679262

NOTE: RECOMMENDED SPARE PARTS, INCLUDING PACKING KITS, ARE THE SAME FOR BOTH BONNET DESIGNS.
NOTE: FOR SERIAL NUMBERS GREATER THAN 18679262, SEE THE STANDARD SECTION OF THIS INSTRUCTION MANUAL.

Figure 7. Lubrication Locations on Packing



Assembly

Refer to figures 6 and 7.

1. Install new packing and Belleville springs according to the packing arrangement shown in figure 6.
2. Using a non-marring installation tool, such as a 12-inch length of 1/2 inch PVC pipe, push the first anti-extrusion washer (key 12) fully into the packing box by hand. Then, use the packing spacer (key 14) to fully seat the anti-extrusion washer by firmly tapping the packing spacer against the anti-extrusion washer with a hammer and the PVC pipe.
3. Remove the packing spacer from the packing bore.

CAUTION

All D4 packing kits include a single use packet of high performance fluorinated grease. This is the only acceptable D4 packing lubricant.

Note

In the following procedure, carefully install each packing ring individually over the valve stem and push completely into the packing box with a non-marring tube. A 12-inch length of 1/2 inch PVC pipe works well for this. It is recommended that the lubricated packing rings be installed individually rather than pushed in as a set.

4. Apply a 3mm (1/8 inch) bead of the supplied high performance fluorinated grease (key 44) around the groove of the female packing adaptor as shown in figure 7 and install over the valve stem (key 16).
5. Apply a 3mm (1/8 inch) bead of the supplied high performance fluorinated grease (key 44) around the groove of the packing ring as shown in figure 7 and install over the valve stem.
6. Install the male packing adaptor, lower anti-extrusion washer (key 10), and lower packing spacer over the valve stem as shown in figure 6.
7. Firmly press all packing parts into the packing bore with a tube.

8. Install the Belleville springs (key 11). The Belleville springs (key 11) should be single stacked with the I.D. of the inner spring contacting the packing spacer (key 14) and the O.D. of the outer spring contacting the packing retainer (key 10). The final Belleville spring should be within the 1.26 inch diameter bore of the bonnet.
9. Adjust the packing retainer by hand until it makes contact with the Belleville springs. Do not tighten by hand, simply install the packing retainer until it makes contact with the Belleville springs. Tighten the packing retainer clockwise precisely 1.16 turns (7 flats on the retainer) to seat the packing. This should fully compress the Belleville springs as detected by an increase in torque between 6 and 7 flats.
10. Loosen the packing retainer completely. Adjust the packing retainer by hand until it makes contact with the Belleville springs. Do not tighten by hand, simply install the packing retainer until it makes contact with the Belleville springs. Tighten the packing retainer clockwise precisely 1/2 turn (3 flats on the retainer).
11. Lock the packing retainer (key 10) solidly in place by tightening the packing retainer locknut (key 22) using a spanner wrench or a hammer and punch or chisel.

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Fisher™ FIELDVUE™ DLC3010 Digital Level Controller

This manual applies to:

Device Type	DLC3010
Device Revision	1
Hardware Revision	1
Firmware Revision	8
DD Revision	3

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Section 1 Introduction and Specifications

Scope of Manual

This instruction manual includes specifications, installation, operating, and maintenance information for FIELDVUE DLC3010 digital level controllers.

This instruction manual supports the 475 or 375 Field Communicator with device description revision 3, used with DLC3010 instruments with firmware revision 8. You can obtain information about the process, instrument, or sensor using the Field Communicator. Contact your Emerson Process Management sales office to obtain the appropriate software

Note

AMS Suite: Intelligent Device Manager can also be used to calibrate and configure the DLC3010, and to obtain information about the process, instrument, or sensor.

Do not install, operate, or maintain a DLC3010 digital level controller without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all of the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office.

Conventions Used in this Manual

This manual describes using the Field Communicator to calibrate and configure the digital level controller.

Procedures that require the use of the Field Communicator have the text path and the sequence of numeric keys required to display the desired Field Communicator menu.

For example, to access the *Full Calibration* menu:

Field Communicator	Configure > Calibration > Primary > Full Calibration (2-5-1-1)

Menu selections are shown in italics, e.g., *Calibrate.* An overview of the Field Communicator menu structure is shown in Appendix B.

Description

DLC3010 Digital Level Controllers

DLC3010 digital level controllers (figure 1-1) are used with level sensors to measure liquid level, the level of interface between two liquids, or liquid specific gravity (density). Changes in level or specific gravity exert a buoyant force on a

displacer, which rotates the torque tube shaft. This rotary motion is applied to the digital level controller, transformed to an electrical signal and digitized. The digital signal is compensated and processed per user configuration requirements, and converted back to a 4-20 mA analog electrical signal. The resulting current output signal is sent to an indicating or final control element.

Figure 1-1. FIELDVUE DLC3010 Digital Level Controller



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DLC3010 digital level controllers are communicating, microprocessor-based level, interface, or density sensing instruments. In addition to the normal function of providing a 4-20 milliampere current signal, DLC3010 digital level controllers, using the HART® communications protocol, give easy access to information critical to process operation. You can gain information from the process, the instrument, or the sensor using a Field Communicator with device descriptions (DDs) compatible with DLC3010 digital level controllers. The Field Communicator may be connected at the digital level controller or at a field junction box.

Using the Field Communicator, you can perform several operations with the DLC3010 digital level controller. You can interrogate, configure, calibrate, or test the digital level controller. Using the HART protocol, information from the field can be integrated into control systems or be received on a single loop basis.

DLC3010 digital level controllers are designed to directly replace standard pneumatic and electro-pneumatic level transmitters. DLC3010 digital level controllers mount on a wide variety of caged and cageless 249 level sensors. They mount on other manufacturers' displacer type level sensors through the use of mounting adaptors.

249 Caged Sensors (see table 1-6)

- 249, 249B, 249BF, 249C, 249K, and 249L sensors side-mount on the vessel with the displacer mounted inside a cage outside the vessel. (The 249BF caged sensor is available only in Europe, Middle East, and Africa.)

249 Cageless Sensors (see table 1-7)

- 249BP, 249CP, and 249P sensors top-mount on the vessel with the displacer hanging down into the vessel.
- 249VS sensor side-mounts on the vessel with the displacer hanging out into the vessel.
- 249W wafer-style sensor mounts on top of a vessel or on a customer-supplied cage.

Specifications

Specifications for the DLC3010 digital level controller are shown in table 1-1. Specifications for the 249 sensor are shown in table 1-3. Specifications for the Field Communicator can be found in the Product Manual for the Field Communicator.

Related Documents

Other documents containing information related to the DLC3010 digital level controller and 249 sensors include:

- Bulletin 11.2:DLC3010 - FIELDVUE DLC3010 Digital Level Controller (D102727X012)
- FIELDVUE DLC3010 Digital Level Controller Quick Start Guide (D103214X012)
- Using FIELDVUE Instruments with the Smart HART Loop Interface and Monitor (HIM) (D103263X012)
- Audio Monitor for HART Communications (D103265X012)
- Fisher 249 Caged Displacer Sensors Instruction Manual (D200099X012)
- Fisher 249 Cageless Displacer Sensors Instruction Manual (D200100X012)
- Fisher 249VS Cageless Displacer Sensor Instruction Manual (D103288X012)
- Fisher 249W Cageless Wafer Style Level Sensor Instruction Manual (D102803X012)
- Simulation of Process Conditions for Calibration of Fisher Level Controllers and Transmitters (D103066X012)
- Bolt Torque Information (D103220X012)
- Technical Monograph 7: The Dynamics of Level and Pressure Control
- Technical Monograph 18: Level-Trol Density Transmitter
- Technical Monograph 26: Guidelines for Selection of Liquid Level Control Equipment

These documents are available from your Emerson Process Management sales office. Also visit our website at www.Fisher.com.

Educational Services

For information on available courses for the DLC3010 digital level controller, as well as a variety of other products, contact:

Emerson Process Management
Educational Services, Registration
Phone: +1-641-754-3771 or +1-800-338-8158
e-mail: education@emerson.com
http://www.emersonprocess.com/education

Table 1-1. DLC3010 Digital Level Controller Specifications

Available Configurations

DLC3010 Digital Level Controller:
Mounts on caged and cageless 249 sensors. See tables 1-6 and 1-7 and sensor description.

Function: Transmitter

Communications Protocol: HART

Input Signal

Level, Interface, or Density: Rotary motion of torque tube shaft proportional to changes in liquid level, interface level, or density that change the buoyancy of a displacer.

Process Temperature: Interface for 2- or 3-wire 100 ohm platinum RTD for sensing process temperature, or optional user-entered target temperature to permit compensating for changes in specific gravity

Output Signal

Analog: 4-20 milliamperes DC (■ direct action—increasing level, interface, or density increases output; or ■ reverse action—increasing level, interface, or density decreases output)

High saturation: 20.5 mA
Low saturation: 3.8 mA
High alarm: 22.5 mA
Low Alarm: 3.7 mA

Only one of the above high/low alarm definitions is available in a given configuration. NAMUR NE 43 compliant when high alarm level is selected.

Digital: HART 1200 Baud FSK (frequency shift keyed)

HART impedance requirements must be met to enable communication. Total shunt impedance across the master device connections (excluding the master and transmitter impedance) must be between 230 and 600 ohms. The transmitter HART receive impedance is defined as:
Rx: 42K ohms and
Cx: 14 nF

Note that in point-to-point configuration, analog and digital signalling are available. The instrument may be queried digitally for information, or placed in Burst mode to regularly transmit unsolicited process information digitally. In multi-drop mode, the output current is fixed at 4 mA, and only digital communication is available.

Performance

Performance Criteria	DLC3010 Digital Level Controller(1)	w/ NPS 3 249W, Using a 14-inch Displacer	w/ All Other 249 Sensors
Independent Linearity	± 0.25% of output span	± 0.8% of output span	± 0.5% of output span
Hysteresis	<0.2% of output span	---	---
Repeatability	± 0.1% of full scale output	± 0.5% of output span	± 0.3% of output span
Dead Band	<0.05% of input span	---	---
Hysteresis plus Deadband	---	<1.0% of output span	<1.0% of output span

NOTE: At full design span, reference conditions.
1. To lever assembly rotation inputs.

At effective proportional band (PB)<100%, linearity, dead band, and repeatability are derated by the factor (100%/PB)

Operating Influences

Power Supply Effect: Output changes <±0.2% of full scale when supply varies between min. and max voltage specifications.

Transient Voltage Protection: The loop terminals are protected by a transient voltage suppressor. The specifications are as follows:

Pulse Waveform		Max V_{CL} (Clamping Voltage) (V)	Max I_{PP} (Pulse Peak @ Current) (A)
Rise Time (μs)	**Decay to 50% (μs)**		
10	1000	93.6	16
8	20	121	83

Note: μs = microsecond

Ambient Temperature: The combined temperature effect on zero and span without the 249 sensor is less than 0.03% of full scale per degree Kelvin over the operating range -40 to 80°C (-40 to 176°F)

Process Temperature: The torque rate is affected by the process temperature (see figure 1-2). The process density may also be affected by the process temperature.

Process Density: The sensitivity to error in knowledge of process density is proportional to the differential density of the calibration. If the differential specific gravity is 0.2, an error of 0.02 specific gravity units in knowledge of a process fluid density represents 10% of span.

-continued-

Table 1-1. DLC3010 Digital Level Controller Specifications (continued)

Electromagnetic Compatibility

Meets EN 61326-1:2013 and EN 61326-2-3:2006
Immunity—Industrial locations per Table 2 of EN 61326-1 and Table AA.2 of EN 61326-2-3. Performance is shown in table 1-2 below.
Emissions—Class A
ISM equipment rating: Group 1, Class A

Supply Requirements (See figure 2-10)

12 to 30 volts DC ⎓ ; 22.5 mA
Instrument has reverse polarity protection.

A minimum compliance voltage of 17.75 is required to guarantee HART communication.

Compensation

Transducer compensation: for ambient temperature.
Density parameter compensation: for process temperature (requires user-supplied tables).
Manual compensation: for torque tube rate at target process temperature is possible.

Digital Monitors

Linked to jumper-selected Hi (factory default) or Lo analog alarm signal:
Torque tube position transducer: Drive monitor and signal reasonableness monitor
User-configurable alarms: Hi-Hi and Lo-Lo Limit process alarms

HART-readable only:
RTD signal reasonableness monitor: When RTD installed
Processor free-time monitor.
Writes-remaining in Non Volatile Memory monitor.
User-configurable alarms: Hi and Lo limit process alarms, Hi and Lo limit process temperature alarms, and Hi and Lo limit electronics temperature alarms

Diagnostics

Output loop current diagnostic.
LCD meter diagnostic.
Spot specific gravity measurement in level mode: used to update specific gravity parameter to improve process measurement
Digital signal-tracing capability: by review of "troubleshooting variables", and
Basic trending capability for PV, TV and SV.

LCD Meter Indications

LCD meter indicates analog output on a percent scale bar graph. The meter also can be configured to display:
Process variable in engineering units only.
Percent range only.
Percent range alternating with process variable or *Process variable, alternating with process temperature (and degrees of pilot shaft rotation).*

Electrical Classification

Pollution Degree IV, Overvoltage Category II per IEC 61010 clause 5.4.2 d

Hazardous Area:
CSA— Intrinsically Safe, Explosion-proof, Division 2, Dust Ignition-proof
FM— Intrinsically Safe, Explosion-proof, Non-incendive, Dust Ignition-proof
ATEX— Intrinsically Safe, Type n, Flameproof
IECEx— Intrinsically Safe, Type n, Flameproof

Electrical Housing:

CSA— Type 4X	ATEX— IP66
FM— NEMA 4X	IECEx— IP66

Other Classifications/Certifications
CUTR— Customs Union Technical Regulations (Russia, Kazakhstan, Belarus, and Armenia)
INMETRO— National Institute of Metrology, Standardization, and Industrial Quality (Brazil)
KGS— Korea Gas Safety Corporation (South Korea)
NEPSI— National Supervision and Inspection Centre for Explosion Protection and Safety of Instrumentation (China)
PESO CCOE— Petroleum and Explosives Safety Organisation - Chief Controller of Explosives (India)
TIIS— Technology Institution of Industrial Safety (Japan)
Contact your Emerson Process Management sales office for classification/certification specific information

Minimum Differential Specific Gravity

With a nominal 4.4 degrees torque tube shaft rotation for a 0 to 100 percent change in liquid level (specific gravity=1), the digital level controller can be adjusted to provide full output for an input range of 5% of nominal input span. This equates to a minimum differential specific gravity of 0.05 with standard volume displacers.

-continued-

Table 1-1. DLC3010 Digital Level Controller Specifications (continued)

Minimum Differential Specific Gravity (continued)

See 249 sensor specifications for standard displacer volumes and standard wall torque tubes. Standard volume for 249C and 249CP sensors is ~980 cm^3 (60 in^3), most others have standard volume of ~1640 cm^3 (100 in^3).

Operating at 5% proportional band will degrade accuracy by a factor of 20. Using a thin wall torque tube, or doubling the displacer volume will each roughly double the effective proportional band. When proportional band of the system drops below 50%, changing displacer or torque tube should be considered if high accuracy is a requirement.

Mounting Positions

Digital level controllers can be mounted right- or left-of-displacer, as shown in figure 2-5.

Instrument orientation is normally with the coupling access door at the bottom, to provide proper drainage of lever chamber and terminal compartment, and to limit gravitational effect on the lever assembly. If alternate drainage is provided by user, and a small performance loss is acceptable, the instrument could be mounted in 90 degree rotational increments around the pilot shaft axis. The LCD meter may be rotated in 90 degree increments to accommodate this.

Construction Materials

Case and Cover: Low-copper aluminum alloy
Internal: Plated steel, aluminum, and stainless steel; encapsulated printed wiring boards; Neodymium Iron Boron Magnets

Electrical Connections

Two 1/2-14 NPT internal conduit connections; one on bottom and one on back of terminal box. M20 adapters available.

Options

■ Heat insulator ■ Mountings for Masoneilan™, Yamatake, and Foxboro™-Eckhardt displacers available ■ Level Signature Series Test (Performance Validation Report) available (EMA only) for instruments factory-mounted on 249 sensor ■ Factory Calibration: available for instruments factory-mounted on 249 sensor, when application, process temperature and density(s) are supplied ■ Device is compatible with user-specified remote indicator

Operating Limits

Process Temperature: See table 1-4 and figure 2-7.
Ambient Temperature and Humidity: See below

Conditions	Normal Limits(1,2)	Transport and Storage Limits	Nominal Reference
Ambient Temperature	-40 to 80°C (-40 to 176°F)	-40 to 85°C (-40 to 185°F)	25°C (77°F)
Ambient Relative Humidity	0 to 95%, (non-condensing)	0 to 95%, (non-condensing)	40%

Altitude Rating

Up to 2000 meters (6562 feet)

Weight

Less than 2.7 Kg (6 lb)

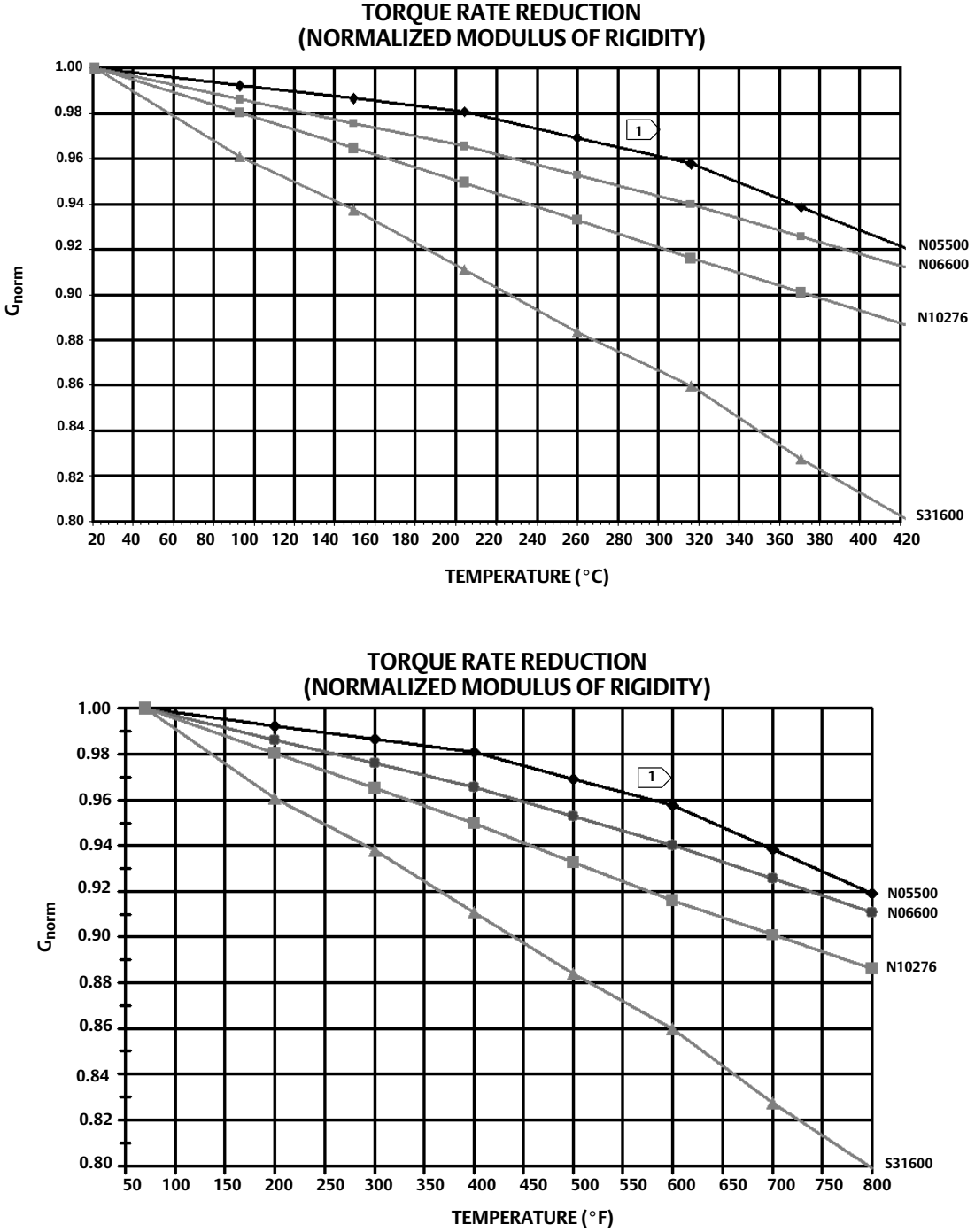
NOTE: Specialized instrument terms are defined in ANSI/ISA Standard 51.1 - Process Instrument Terminology.
1. LCD meter may not be readable below -20°C (-4°F)
2. Contact your Emerson Process Management sales office or application engineer if temperatures exceeding these limits are required.

Table 1-2. EMC Summary Results—Immunity

Port	Phenomenon	Basic Standard	Test Level	Performance Criteria(1)(2)
Enclosure	Electrostatic discharge (ESD)	IEC 61000-4-2	4 kV contact 8 kV air	A
	Radiated EM field	IEC 61000-4-3	80 to 1000 MHz @ 10V/m with 1 kHz AM at 80% 1400 to 2000 MHz @ 3V/m with 1 kHz AM at 80% 2000 to 2700 MHz @ 1V/m with 1 kHz AM at 80%	A
	Rated power frequency magnetic field	IEC 61000-4-8	60 A/m at 50 Hz	A
I/O signal/control	Burst	IEC 61000-4-4	1 kV	A
	Surge	IEC 61000-4-5	1 kV (line to ground only, each)	B
	Conducted RF	IEC 61000-4-6	150 kHz to 80 MHz at 3 Vrms	A

Note: RTD wiring must be shorter than 3 meters (9.8 feet)
1. A = No degradation during testing. B = Temporary degradation during testing, but is self-recovering. Specification limit = +/- 1% of span.
2. HART communication was considered as "not relevant to the process" and is used primarily for configuration, calibration, and diagnostic purposes.

Figure 1-2. Theoretical Reversible Temperature Effect on Common Torque Tube Materials



NOTE:
1 DUE TO THE PERMANENT DRIFT THAT OCCURS NEAR AND ABOVE 260°C (500°F), N05500 IS NOT RECOMMENDED FOR TEMPERATURES ABOVE 232°C (450°F).

Table 1-3. 249 Sensor Specifications

Input Signal

Liquid Level or Liquid-to-Liquid Interface Level: From 0 to 100 percent of displacer length
Liquid Density: From 0 to 100 percent of displacement force change obtained with given displacer volume—standard volumes are ■ 980 cm^3 (60 $inches^3$) for 249C and 249CP sensors or ■ 1640 cm^3 (100 $inches^3$) for most other sensors; other volumes available depending upon sensor construction

Sensor Displacer Lengths

See tables 1-6 and 1-7 footnotes

Sensor Working Pressures

Consistent with applicable ANSI pressure/temperature ratings for the specific sensor constructions shown in tables 1-6 and 1-7

Caged Sensor Connection Styles

Cages can be furnished in a variety of end connection styles to facilitate mounting on vessels; the equalizing connection styles are numbered and are shown in figure 1-3.

Mounting Positions

Most level sensors with cage displacers have a rotatable head. The head may be rotated through 360 degrees to any of eight different positions, as shown in figure 2-5.

Construction Materials

See tables 1-5, 1-6, and 1-7

Operative Ambient Temperature

See table 1-4
For ambient temperature ranges, guidelines, and use of optional heat insulator, see figure 2-7.

Options

■ Heat insulator ■ Gauge glass for pressures to 29 bar at 232°C (420 psig at 450°F), and ■ Reflex gauges for high temperature and pressure applications

Table 1-4. Allowable Process Temperatures for Common 249 Sensor Pressure Boundary Materials

MATERIAL	PROCESS TEMPERATURE	
	Min.	Max.
Cast Iron	-29°C (-20°F)	232°C (450°F)
Steel	-29°C (-20°F)	427°C (800°F)
Stainless Steel	-198°C (-325°F)	427°C (800°F)
N04400	-198°C (-325°F)	427°C (800°F)
Graphite Laminate/SST Gaskets	-198°C (-325°F)	427°C (800°F)
N04400/PTFE Gaskets	-73°C (-100°F)	204°C (400°F)

Table 1-5. Displacer and Torque Tube Materials

Part	Standard Material	Other Materials
Displacer	304 Stainless Steel	316 Stainless Steel, N10276, N04400, Plastic, and Special Alloys
Displacer Stem Driver Bearing, Displacer Rod and Driver	316 Stainless Steel	N10276, N04400, other Austenitic Stainless Steels, and Special Alloys
Torque Tube	N05500(1)	316 Stainless Steel, N06600, N10276

1. N05500 is not recommended for spring applications above 232°C (450°F). Contact your Emerson Process Management sales office or application engineer if temperatures exceeding this limit are required.

Table 1-6. Caged Displacer Sensors(1)

TORQUE TUBE ORIENTATION	SENSOR	STANDARD CAGE, HEAD, AND TORQUE TUBE ARM MATERIAL	EQUALIZING CONNECTION		PRESSURE RATING(2)
			Style	Size (NPS)	
Torque tube arm rotatable with respect to equalizing connections	249(3)	Cast iron	Screwed	1-1/2 or 2	CL125 or CL250
			Flanged	2	
	249B, 249BF(4)	Steel	Screwed or optional socket weld	1-1/2 or 2	CL600
			Raised face or optional ring-type joint flanged	1-1/2	CL150, CL300, or CL600
				2	CL150, CL300, or CL600
	249C(3)	316 stainless steel	Screwed	1-1/2 or 2	CL600
			Raised face flanged	1-1/2	CL150, CL300, or CL600
				2	CL150, CL300, or CL600
	249K	Steel	Raised face or optional ring-type joint flanged	1-1/2 or 2	CL900 or CL1500
	249L	Steel	Ring-type joint flanged	2(5)	CL2500

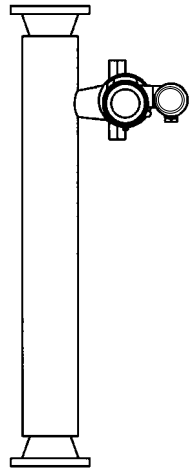
1. Standard displacer lengths for all styles (except 249) are 14, 32, 48, 60, 72, 84, 96, 108 and 120 inches. The 249 uses a displacer with a length of either 14 or 32 inches.
2. EN flange connections available in EMA (Europe, Middle East and Africa).
3. Not available in EMA.
4. The 249BF available in EMA only. Also available in EN size DN 40 with PN 10 to PN 100 flanges and size DN 50 with PN 10 to PN 63 flanges.
5. Top connection is NPS 1 ring-type joint flanged for connection styles F1 and F2.

Table 1-7. Cageless Displacer Sensors(1)

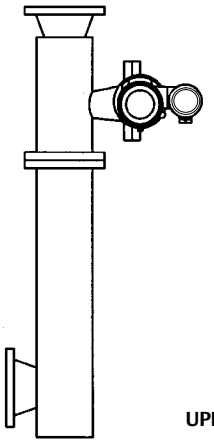
Mounting	Sensor	Standard Head(2), Wafer Body(6) and Torque Tube Arm Material	Flange Connection (Size)	Pressure Rating(3)
Mounts on top of vessel	249BP(4)	Steel	NPS 4 raised face or optional ring-type joint	CL150, CL300, or CL600
			NPS 6 or 8 raised face	CL150 or CL300
	249CP	316 Stainless Steel	NPS 3 raised face	CL150, CL300, or CL600
	249P(5)	Steel or stainless steel	NPS 4 raised face or optional ring-type joint	CL900 or 1CL500 (EN PN 10 to DIN PN 250)
			NPS 6 or 8 raised face	CL150, CL300, CL600, CL900, CL1500, or CL2500
Mounts on side of vessel	249VS	WCC (steel) LCC (steel), or CF8M (316 stainless steel)	For NPS 4 raised face or flat face	CL125, CL150, CL250, CL300, CL600, CL900, or CL1500 (EN PN 10 to DIN PN 160)
		WCC, LCC, or CF8M	For NPS 4 buttweld end, XXZ	CL2500
Mounts on top of vessel or on customer supplied cage	249W	WCC or CF8M	For NPS 3 raised face	CL150, CL300, or CL600
		LCC or CF8M	For NPS 4 raised face	CL150, CL300, or CL600

1. Standard displacer lengths are 14, 32, 48, 60, 72, 84, 96, 108, and 120 inches.
2. Not used with side-mounted sensors.
3. EN flange connections available in EMA (Europe, Middle East and Africa).
4. Not available in EMA.
5. 249P available in EMA only.
6. Wafer Body only applicable to the 249W.

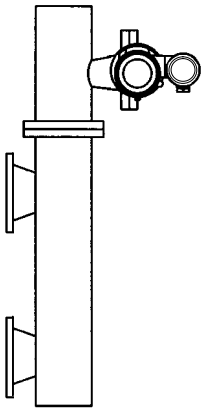
Figure 1-3. Style Number of Equalizing Connections



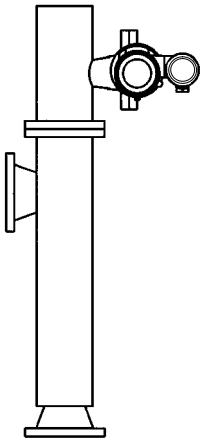
STYLE 1
TOP AND BOTTOM CONNECTIONS,
SCREWED (S-1) OR FLANGED (F-1)



STYLE 2
TOP AND LOWER SIDE CONNECTIONS,
SCREWED (S-2) OR FLANGED (F-2)



STYLE 3
UPPER AND LOWER SIDE CONNECTIONS,
SCREWED (S-3) OR FLANGED (F-3)



STYLE 4
UPPER SIDE AND BOTTOM CONNECTIONS,
SCREWED (S-4) OR FLANGED (F-4)

Section 2 Installation

This section contains digital level controller installation information including an installation flowchart (figure 2-1), mounting and electrical installation information, and a discussion of failure mode jumpers.

Configuration: On the Bench or in the Loop

Configure the digital level controller before or after installation. It may be useful to configure the instrument on the bench before installation to ensure proper operation, and to familiarize yourself with its functionality.

Protecting the Coupling and Flexures

CAUTION

Damage to flexures and other parts can cause measurement errors. Observe the following steps before moving the sensor and controller.

Lever Lock

The lever lock is built in to the coupling access handle. When the handle is open, it positions the lever in the neutral travel position for coupling. In some cases, this function is used to protect the lever assembly from violent motion during shipment.

A DLC3010 controller will have one of the following mechanical configurations when received:

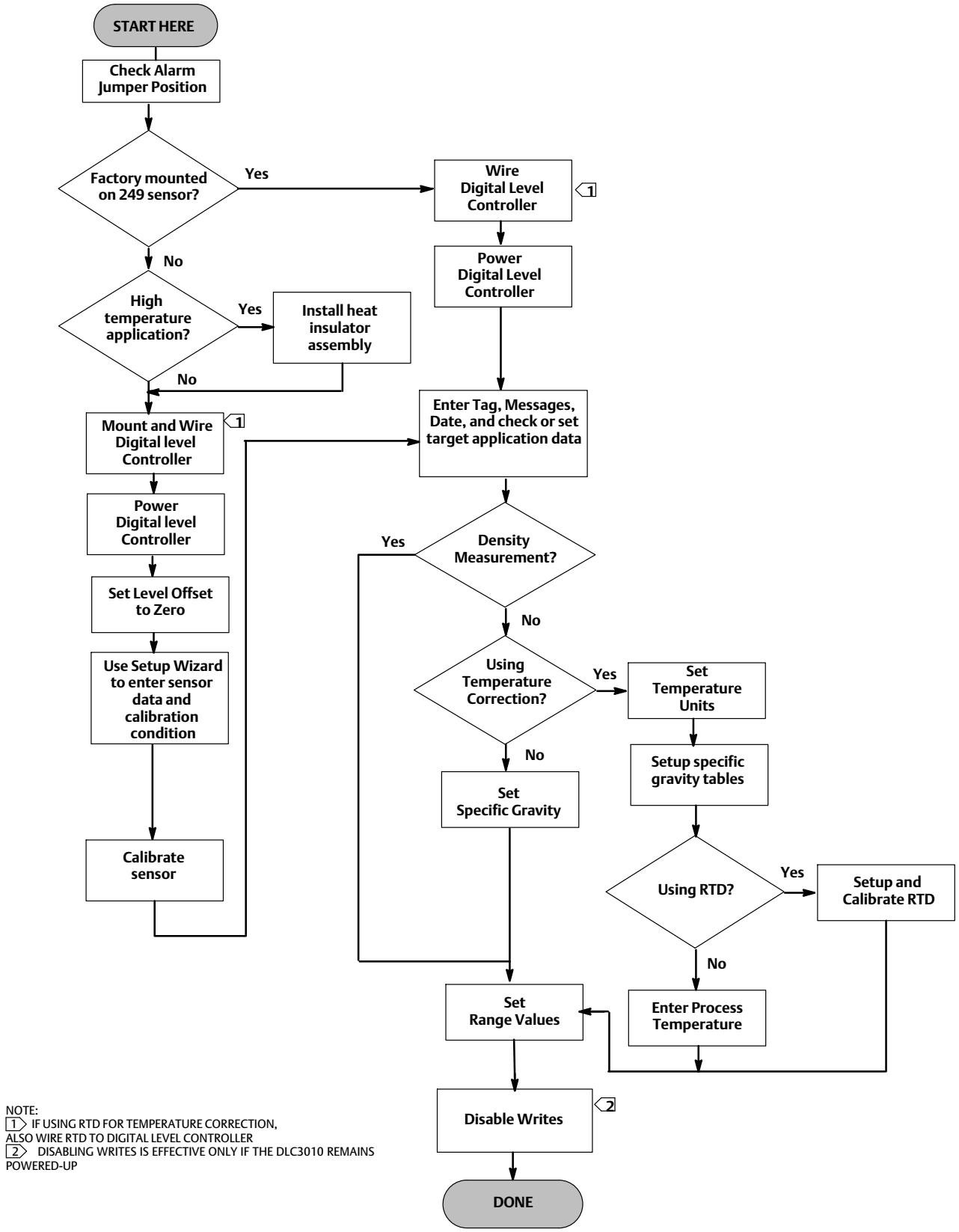
1. A fully assembled and coupled caged-displacer system shipped with the displacer or driver rod blocked within the operating range by mechanical means. In this case, the access handle (figure 2-4) will be in the unlocked position. Remove the displacer-blocking hardware before calibration. (See the appropriate sensor instruction manual). The coupling should be intact.

CAUTION

When shipping an instrument mounted on a sensor, if the lever assembly is coupled to the linkage, and the linkage is constrained by the displacer blocks, use of the lever lock may result in damage to bellows joints or flexure.

2. If the displacer cannot be blocked because of cage configuration or other concerns, the transmitter is uncoupled from the torque tube by loosening the coupling nut, and the access handle will be in the locked position. Before placing such a configuration into service, perform the Coupling procedure found on page 38.
3. For a cageless system where the displacer is not connected to the torque tube during shipping, the torque tube itself stabilizes the coupled lever position by resting against a physical stop in the sensor. The access handle will be in the unlocked position. Mount the sensor and hang the displacer. The coupling should be intact.

Figure 2-1. Installation Flowchart



4. If the controller was shipped alone, the access handle will be in the locked position. All Mounting, Coupling and Calibration procedures must be performed.

The access handle includes a retaining set screw, as shown in figures 2-4 and 2-6. The screw is driven in to contact the spring plate in the handle assembly before shipping. It secures the handle in the desired position during shipping and operation. To set the access handle in the open or closed position, this set screw must be backed out so that its top is flush with the handle surface.

Mounting

⚠ WARNING

To avoid personal injury, always wear protective gloves, clothing, and eyewear when performing any installation operations.

Personal injury or property damage due to sudden release of pressure, contact with hazardous fluid, fire, or explosion can be caused by puncturing, heating, or repairing a displacer that is retaining process pressure or fluid. This danger may not be readily apparent when disassembling the sensor or removing the displacer. Before disassembling the sensor or removing the displacer, observe the appropriate warnings provided in the sensor instruction manual.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

Hazardous Area Classifications and Special Instructions for “Safe Use” and Installations in Hazardous Locations

Refer to the DLC3010 Quick Start Guide (D103214X012) that ships with the instrument for Hazardous Area Classifications and Special Instructions for “Safe Use” and Installations in Hazardous Locations. If a copy of this quick start guide is needed contact your Emerson Process Management sales office or visit our website at www.Fisher.com.

Mounting the 249 Sensor

The 249 sensor is mounted using one of two methods, depending on the specific type of sensor. If the sensor has a caged displacer, it typically mounts on the side of the vessel as shown in figure 2-2. If the sensor has a cageless displacer, the sensor mounts on the side or top of the vessel as shown in figure 2-3.

The DLC3010 digital level controller is typically shipped attached to the sensor. If ordered separately, it may be convenient to mount the digital level controller to the sensor and perform the initial setup and calibration before installing the sensor on the vessel.

Note

Caged sensors have a rod and block installed on each end of the displacer to protect the displacer in shipping. Remove these parts before installing the sensor to allow the displacer to function properly.

Figure 2-2. Typical Caged Sensor Mounting

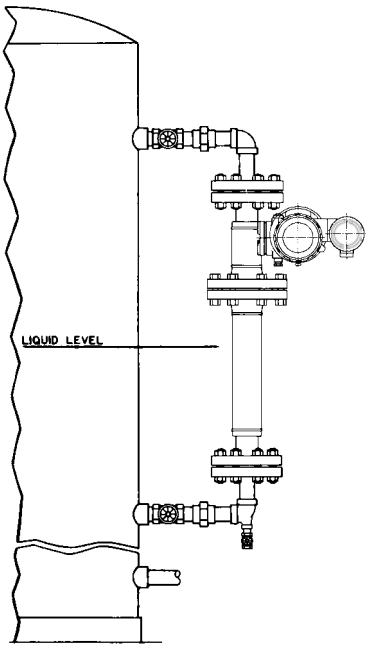
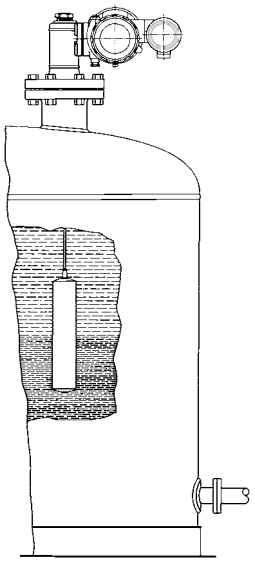


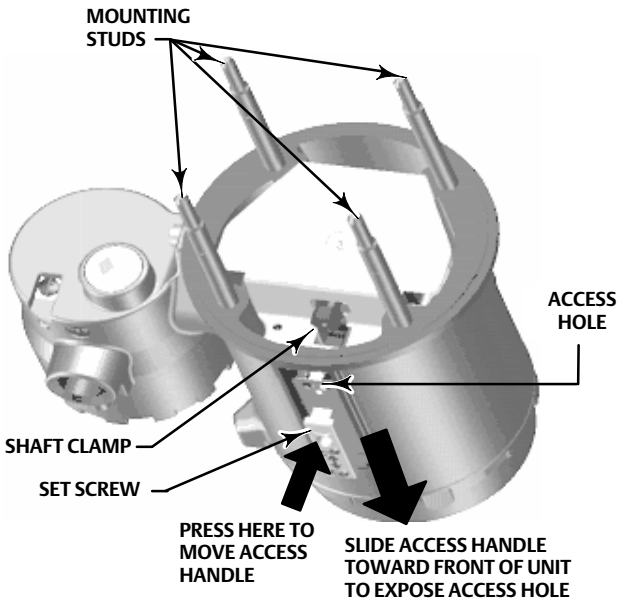
Figure 2-3. Typical Cageless Sensor Mounting



Digital Level Controller Orientation

Mount the digital level controller with the torque tube shaft clamp access hole (see figure 2-4) pointing downward to allow accumulated moisture drainage.

Figure 2-4. Sensor Connection Compartment (Adapter Ring Removed for Clarity)



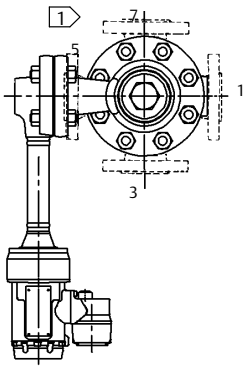
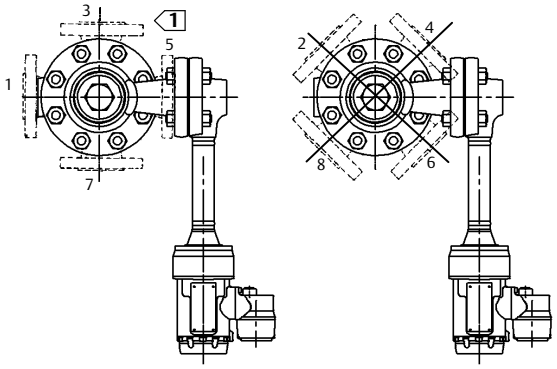
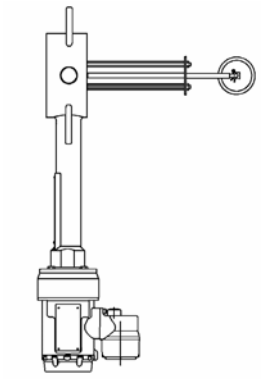
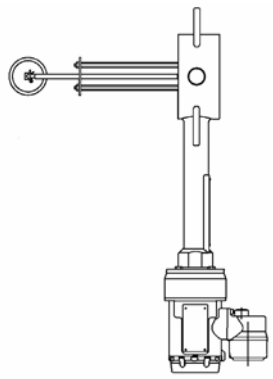
Note

If alternate drainage is provided by the user, and a small performance loss is acceptable, the instrument could be mounted in 90 degree rotational increments around the pilot shaft axis. The LCD meter may be rotated in 90 degree increments to accommodate this.

The digital level controller and torque tube arm are attached to the sensor either to the left or right of the displacer, as shown in figure 2-5. This can be changed in the field on the 249 sensors (refer to the appropriate sensor instruction manual). Changing the mounting also changes the effective action, because the torque tube rotation for increasing level, (looking at the protruding shaft), is clockwise when the unit is mounted to the right of the displacer and counter-clockwise when the unit is mounted to the left of the displacer.

All caged 249 sensors have a rotatable head. That is, the digital level controller can be positioned at any of eight alternate positions around the cage as indicated by the position numbers 1 through 8 in figure 2-5. To rotate the head, remove the head flange bolts and nuts and position the head as desired.

Figure 2-5. Typical Mounting Positions for the FIELDVUE DLC3010 Digital Level Controller on Fisher 249 Sensor

SENSOR	LEFT-OF-DISPLACER	RIGHT-OF-DISPLACER
CAGED		
CAGELESS		

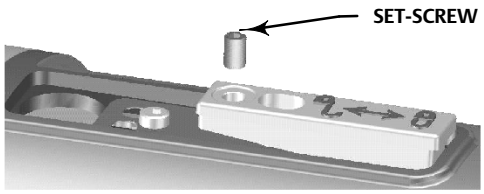
1 Not available for NPS 2 CL300 and 600 249C.

Mounting the Digital Level Controller on a 249 Sensor

Refer to figure 2-4 unless otherwise indicated.

1. If the set-screw in the access handle (figure 2-6) is driven against the spring plate, back it out until the head is flush with the outer surface of the handle, using a 2 mm hex key. Slide the access handle to the locked position to expose the access hole. Press on the back of the handle as shown in figure 2-4 then slide the handle toward the front of the unit. Be sure the locking handle drops into the detent.

Figure 2-6. Close-up of Set-Screw



2. Using a 10 mm deep well socket inserted through the access hole, loosen the shaft clamp (figure 2-4). This clamp will be re-tightened in the Coupling portion of the Initial Setup section.
3. Remove the hex nuts from the mounting studs. Do not remove the adapter ring.

CAUTION

Measurement errors can occur if the torque tube assembly is bent or misaligned during installation.

4. Position the digital level controller so the access hole is on the bottom of the instrument.
5. Carefully slide the mounting studs into the sensor mounting holes until the digital level controller is snug against the sensor.
6. Reinstall the hex nuts on the mounting studs and tighten the hex nuts to 10 N•m (88.5 lbf•in).

Mounting the Digital Level Controller for High Temperature Applications

Refer to figure 2-8 for parts identification except where otherwise indicated.

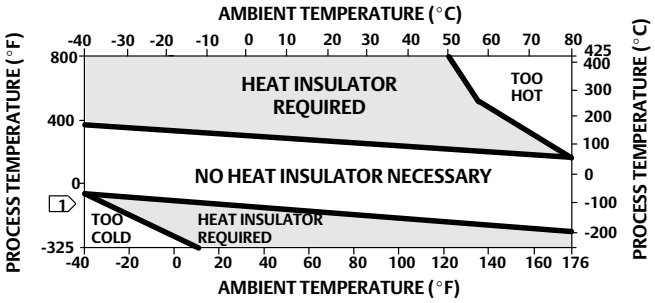
The digital level controller requires an insulator assembly when temperatures exceed the limits shown in figure 2-7.

A torque tube shaft extension is required for a 249 sensor when using an insulator assembly.

CAUTION

Measurement errors can occur if the torque tube assembly is bent or misaligned during installation.

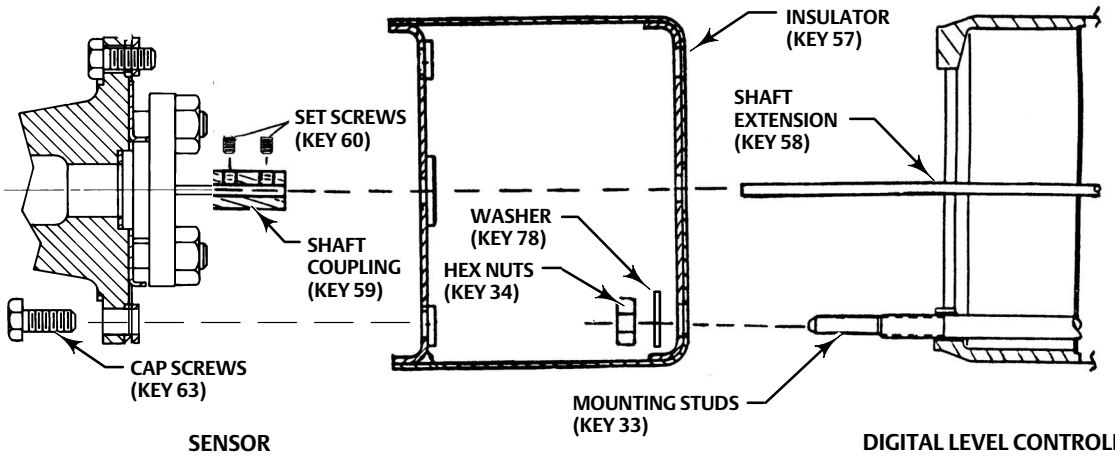
Figure 2-7. Guidelines for Use of Optional Heat Insulator Assembly



NOTES:
1 FOR PROCESS TEMPERATURES BELOW -29°C (-20°F) AND ABOVE 204°C (400°F) SENSOR MATERIALS MUST BE APPROPRIATE FOR THE PROCESS; SEE TABLE 1-4.
2. IF AMBIENT DEW POINT IS ABOVE PROCESS TEMPERATURE, ICE FORMATION MIGHT CAUSE INSTRUMENT MALFUNCTION AND REDUCE INSULATOR EFFECTIVENESS.

39A4070-B
A5494-1

Figure 2-8. Digital Level Controller Mounting on Sensor in High Temperature Applications



MN28800
20A7423-C
B2707

1. For mounting a digital level controller on a 249 sensor, secure the shaft extension to the sensor torque tube shaft via the shaft coupling and set screws, with the coupling centered as shown in figure 2-8.
2. Slide the access handle to the locked position to expose the access hole. Press on the back of the handle as shown in figure 2-4 then slide the handle toward the front of the unit. Be sure the locking handle drops into the detent.
3. Remove the hex nuts from the mounting studs.
4. Position the insulator on the digital level controller, sliding the insulator straight over the mounting studs.
5. Install 4 washers (key 78) over the studs. Install the four hex nuts and tighten.
6. Carefully slide the digital level controller with the attached insulator over the shaft coupling so that the access hole is on the bottom of the digital level controller.
7. Secure the digital level controller and insulator to the torque tube arm with four cap screws.
8. Tighten the cap screws to 10 N•m (88.5 lbf•in).

Electrical Connections

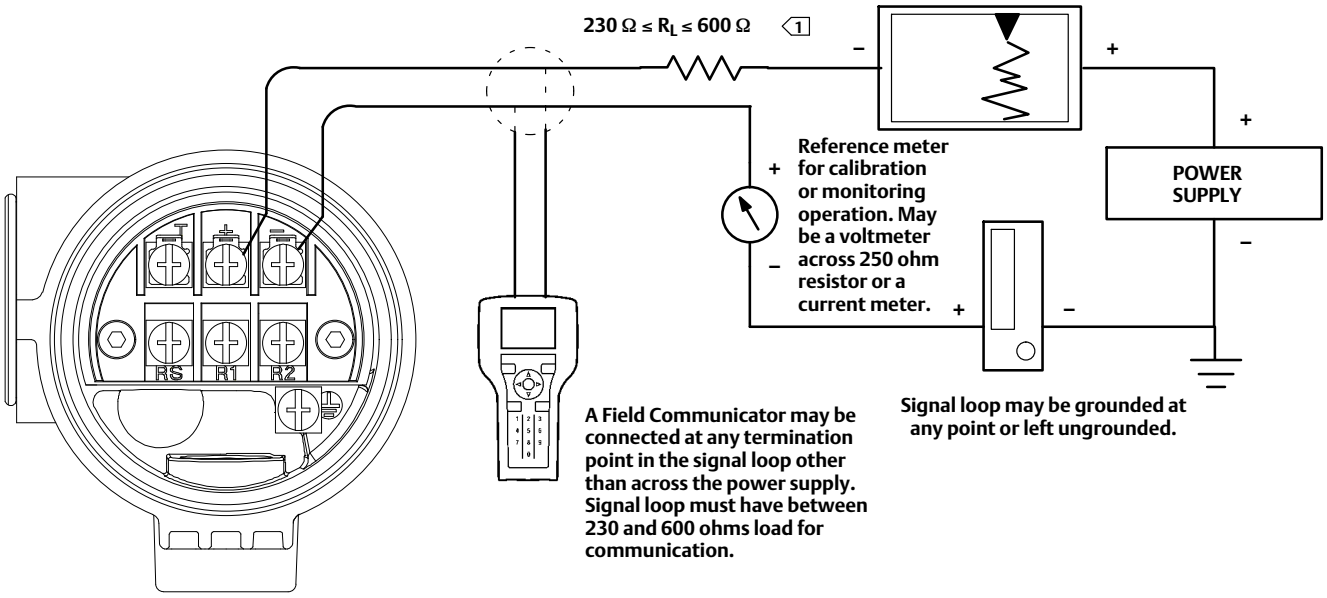
⚠ WARNING

Select wiring and/or cable glands that are rated for the environment of use (such as hazardous area, ingress protection and temperature). Failure to use properly rated wiring and/or cable glands can result in personal injury or property damage from fire or explosion.

Wiring connections must be in accordance with local, regional, and national codes for any given hazardous area approval. Failure to follow the local, regional, and national codes could result in personal injury or property damage from fire or explosion.

Proper electrical installation is necessary to prevent errors due to electrical noise. A resistance between 230 and 600 ohms must be present in the loop for communication with a Field Communicator. Refer to figure 2-9 for current loop connections.

Figure 2-9. Connecting a Field Communicator to the Digital Level Controller Loop



NOTE:
1 THIS REPRESENTS THE TOTAL SERIES LOOP RESISTANCE.

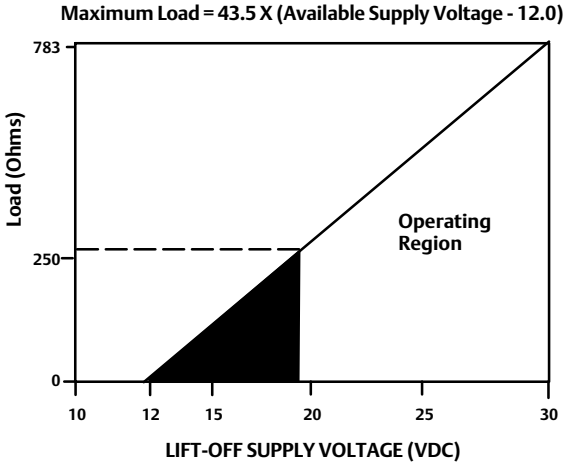
E0363

Power Supply

To communicate with the digital level controller, you need a 17.75 volt DC minimum power supply. The power supplied to the transmitter terminals is determined by the available supply voltage minus the product of the total loop resistance and the loop current. The available supply voltage should not drop below the lift-off voltage. (The lift-off voltage is the minimum “available supply voltage” required for a given total loop resistance). Refer to figure 2-10 to

determine the required lift-off voltage. If you know your total loop resistance you can determine the lift-off voltage. If you know the available supply voltage, you can determine the maximum allowable loop resistance.

Figure 2-10. Power Supply Requirements and Load Resistance



If the power supply voltage drops below the lift-off voltage while the transmitter is being configured, the transmitter may output incorrect information.

The DC power supply should provide power with less than 2% ripple. The total resistance load is the sum of the resistance of the signal leads and the load resistance of any controller, indicator, or related pieces of equipment in the loop. Note that the resistance of intrinsic safety barriers, if used, must be included.

Field Wiring

Note

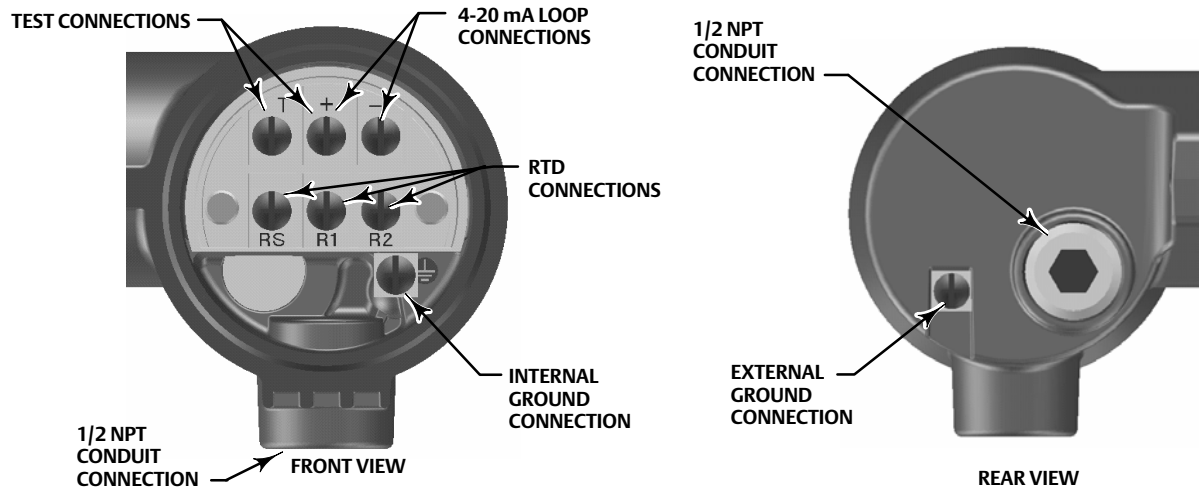
For intrinsically safe applications, refer to the instructions supplied by the barrier manufacturer.

⚠ WARNING

To avoid personal injury or property damage caused by fire or explosion, remove power to the instrument before removing the digital level controller cover in an area which contains a potentially explosive atmosphere or has been classified as hazardous.

All power to the digital level controller is supplied over the signal wiring. Signal wiring need not be shielded, but use twisted pairs for best results. Do not run unshielded signal wiring in conduit or open trays with power wiring, or near heavy electrical equipment. If the digital controller is in an explosive atmosphere, do not remove the digital level controller covers when the circuit is alive, unless in an intrinsically safe installation. Avoid contact with leads and terminals. To power the digital level controller, connect the positive power lead to the + terminal and the negative power lead to the - terminal as shown in figure 2-11.

Figure 2-11. Digital Level Controller Terminal Box



CAUTION

Do not apply loop power across the T and + terminals. This can destroy the 1 Ohm sense resistor in the terminal box. Do not apply loop power across the Rs and — terminals. This can destroy the 50 Ohm sense resistor in the electronics module.

When wiring to screw terminals, the use of crimped lugs is recommended. Tighten the terminal screws to ensure that good contact is made. No additional power wiring is required. All digital level controller covers must be fully engaged to meet explosion proof requirements. For ATEX approved units, the terminal box cover set screw must engage one of the recesses in the terminal box beneath the terminal box cover.

Grounding

⚠ WARNING

Personal injury or property damage can result from fire or explosion caused by the discharge of static electricity when flammable or hazardous gases are present. Connect a 14 AWG (2.1 mm^2) ground strap between the digital level controller and earth ground when flammable or hazardous gases are present. Refer to national and local codes and standards for grounding requirements.

The digital level controller will operate with the current signal loop either floating or grounded. However, the extra noise in floating systems affects many types of readout devices. If the signal appears noisy or erratic, grounding the current signal loop at a single point may solve the problem. The best place to ground the loop is at the negative terminal of the power supply. As an alternative, ground either side of the readout device. Do not ground the current signal loop at more than one point.

Shielded Wire

Recommended grounding techniques for shielded wire usually call for a single grounding point for the shield. You can either connect the shield at the power supply or to the grounding terminals, either internal or external, at the instrument terminal box shown in figure 2-11.

Power/Current Loop Connections

Use ordinary copper wire of sufficient size to ensure that the voltage across the digital level controller terminals does not go below 12.0 volts DC. Connect the current signal leads as shown in figure 2-9. After making connections, recheck the polarity and correctness of connections, then turn the power on.

RTD Connections

An RTD that senses process temperatures may be connected to the digital level controller. This permits the instrument to automatically make specific gravity corrections for temperature changes. For best results, locate the RTD as close to the displacer as practical. For optimum EMC performance, use shielded wire no longer than 3 meters (9.8 feet) to connect the RTD. Connect only one end of the shield. Connect the shield to either the internal ground connection in the instrument terminal box or to the RTD thermowell. Wire the RTD to the digital level controller as follows (refer to figure 2-11):

Two-Wire RTD Connections

1. Connect a jumper wire between the RS and R1 terminals in the terminal box.
2. Connect the RTD to the R1 and R2 terminals.

Note

During Manual Setup, you must specify the connecting wire resistance for a 2-wire RTD. 250 feet of 16 AWG wire has a resistance of 1 ohm.

Three-Wire RTD Connections

1. Connect the 2 wires which are connected to the same end of the RTD to the RS and R1 terminals in the terminal box. Usually these wires are the same color.
2. Connect the third wire to terminal R2. (The resistance measured between this wire and either wire connected to terminal RS or R1 should read an equivalent resistance for the existing ambient temperature. Refer to the RTD manufacturer's temperature to resistance conversion table.) Usually this wire is a different color from the wires connected to the RS and R1 terminals.

Communication Connections

⚠ WARNING

Personal injury or property damage caused by fire or explosion may occur if this connection is attempted in an area which contains a potentially explosive atmosphere or has been classified as hazardous. Confirm that area classification and atmosphere conditions permit the safe removal of the terminal box cap before proceeding.

The Field Communicator interfaces with digital level controller from any wiring termination point in the 4–20 mA loop (except across the power supply). If you choose to connect the HART communicating device directly to the instrument, attach the device to the loop + and - terminals inside the terminal box to provide local communications with the instrument.

Test Connections

⚠ WARNING

Personal injury or property damage caused by fire or explosion may occur if the following procedure is attempted in an area which contains a potentially explosive atmosphere or has been classified as hazardous. Confirm that area classification and atmosphere conditions permit the safe removal of the terminal box cap before proceeding.

Test connections inside the terminal box can be used to measure loop current across an internal 1 ohm resistor.

1. Remove the terminal box cap.
2. Adjust the test meter to measure a range of 0.001 to 0.1 volts.
3. Connect the positive lead of the test meter to the + connection and the negative lead to the T connection inside the terminal box.
4. Measure Loop current as:

Voltage (on test meter) $\times$ 1000 = milliamps

example:

Test meter Voltage X 1000 = Loop Milliamps

0.004 X1000 = 4.0 milliamperes

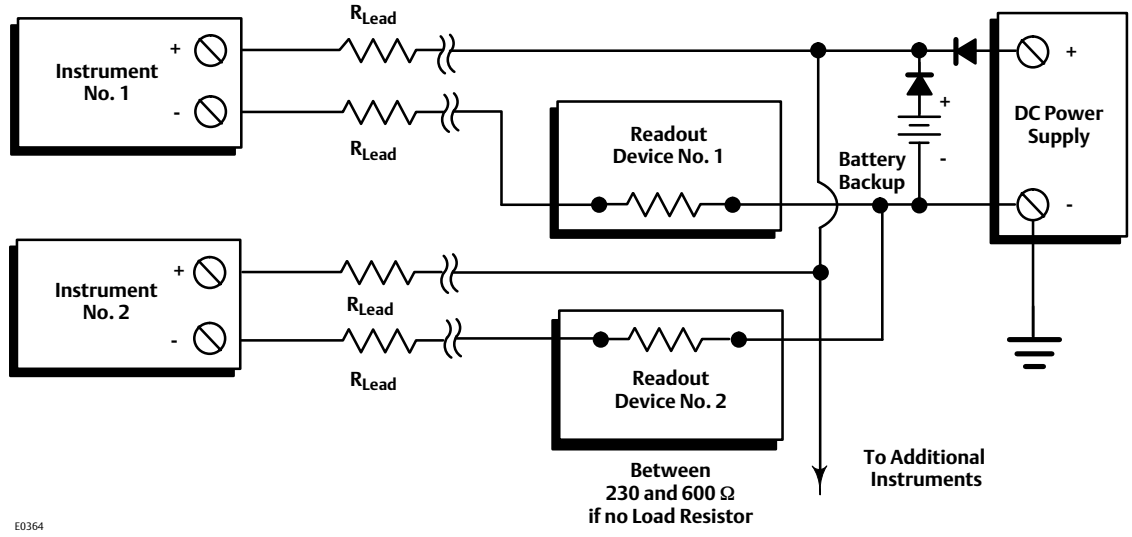
0.020 X 1000 = 20.0 milliamperes

5. Remove test leads and replace the terminal box cover.

Multichannel Installations

You can connect several instruments to a single master power supply as shown in figure 2-12. In this case, the system may be grounded only at the negative power supply terminal. In multichannel installations where several instruments depend on one power supply, and the loss of all instruments would cause operational problems, consider an uninterruptible power supply or a back-up battery. The diodes shown in figure 2-12 prevent unwanted charging or discharging of the back-up battery. If several loops are connected in parallel, make sure the net loop impedance does not reach levels that would prevent communication.

Figure 2-12. Multichannel Installations



Note that to provide a 4-20 mA analog output signal, the DLC3010 must use HART polling address 0. Therefore, if a multichannel installation is used with all transmitters in 4-20 mA output mode, some means must be provided to isolate an individual transmitter for configuration or diagnostic purposes. A multichannel installation is most useful if the instruments are also in multi-drop mode and all signaling is done by digital polling.

Alarm Jumper

Each digital level controller continuously monitors its own performance during normal operation. This automatic diagnostic routine is a timed series of checks repeated continuously. If diagnostics detect a failure in the electronics, the instrument drives its output to either below 3.70 mA or above 22.5 mA, depending on the position (HI/LO) of the alarm jumper.

An alarm condition occurs when the digital level controller self-diagnostics detect an error that would render the process variable measurement inaccurate, incorrect, or undefined, or a user defined threshold is violated. At this point the analog output of the unit is driven to a defined level either above or below the nominal 4-20 mA range, based on the position of the alarm jumper.

On encapsulated electronics 14B5483X042 and earlier, if the jumper is missing, the alarm is indeterminate, but usually behaves as a FAIL LOW selection. On encapsulated electronics 14B5483X052 and later, the behavior will default to FAIL HIGH when the jumper is missing.

Alarm Jumper Locations

Without a meter installed

The alarm jumper is located on the front side of the electronics module on the electronics side of the digital level controller housing, and is labeled FAIL MODE.

With a meter installed

The alarm jumper is located on the LCD faceplate on the electronics module side of the digital level controller housing, and is labeled FAIL MODE.

Changing Jumper Position

⚠ WARNING

Personal injury or property damage caused by fire or explosion may occur if the following procedure is attempted in an area which contains a potentially explosive atmosphere or has been classified as hazardous. Confirm that area classification and atmosphere conditions permit the safe removal of the instrument cover before proceeding.

Use the following procedure to change the position of the alarm jumper:

1. If the digital level controller is installed, set the loop to manual.
2. Remove the housing cover on the electronics side. Do not remove the cover in explosive atmospheres when the circuit is alive.
3. Set the jumper to the desired position.
4. Replace the cover. All covers must be fully engaged to meet explosion proof requirements. For ATEX approved units, the set screw on the transducer housing must engage one of the recesses in the cover.

Loop Test

Field Communicator	Service Tools > Maintenance > Tests > Loop Test (3-3-1-1) or (3-3-1-2) if LCD Configuration is installed

Loop test can be used to verify the controller output, the integrity of the loop, and the operations of any recorders or similar devices installed in the loop. To initiate a loop test, perform the following procedure:

1. Connect a reference meter to the controller. To do so, either connect the meter to the test connections inside the terminal box (see the Test Connections procedure) or connect the meter in the loop as shown in figure 2-9.
2. Access *Loop Test*.
3. Select *OK* after you set the control loop to manual.

The Field Communicator displays the loop test menu.

4. Select a discreet milliamp level for the controller to output. At the “Choose analog output” prompt, select *4 mA*, *20 mA,* or *Other* to manually input a value between 4 and 20 milliamps.
5. Check the reference meter to verify that it reads the value you commanded the controller to output. If the readings do not match, either the controller requires an output trim, or the meter is malfunctioning.

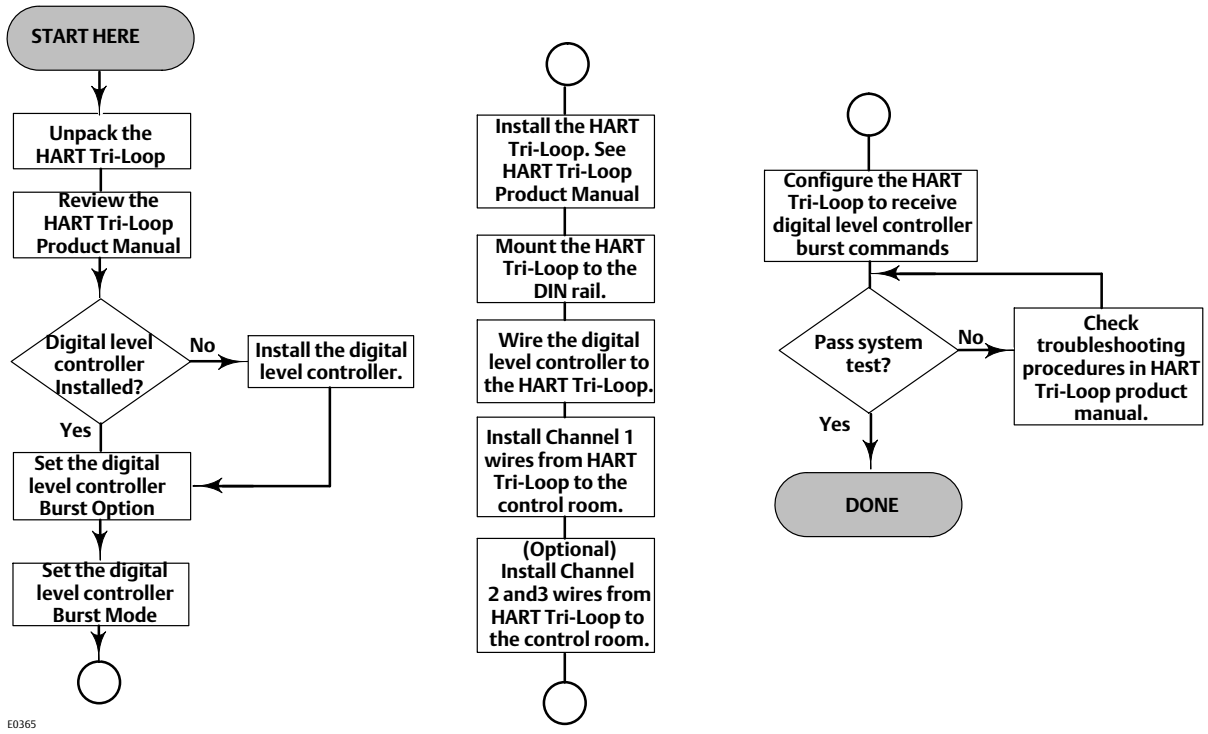
After completing the test procedure, the display returns to the loop test screen and allows you to choose another output value or end the test.

Installation in Conjunction with a Rosemount 333 HART Tri-Loop HART-to-Analog Signal Converter

Use the DLC3010 digital level controller in operation with a Rosemount 333 HART Tri-Loop HART-to-Analog Signal Converter to acquire an independent 4-20 mA analog output signal for the process variable, % range, electronics temperature, and process temperature. The Tri-Loop divides the digital signal and outputs any or all of these variables into as many as three separate 4-20 mA analog channels.

Refer to figure 2-13 for basic installation information. Refer to the 333 HART Tri-Loop HART-to-Analog Signal Converter Product Manual for complete installation information.

Figure 2-13. HART Tri-Loop Installation Flowchart



Commissioning the Digital Level Controller for use with the HART Tri-Loop

To prepare the digital level controller for use with a 333 HART Tri-Loop, you must configure the digital level controller to burst mode, and select the dynamic variables to burst. In burst mode, the digital level controller provides digital information to the HART Tri-Loop HART-to-Analog Signal Converter. The HART Tri-Loop converts the digital information to a 4-20 mA analog signal. The HART Tri-Loop divides the signal into separate 4-20 mA loops for the primary (PV), secondary (SV), tertiary (TV), and quaternary (QV) variables. Depending upon the burst option selected, the digital level controller will burst the variables as shown in table 2-1.

The DLC3010 status words are available in the HART Burst messages. However, the Tri-Loop cannot be configured to monitor them directly.

To commission a DLC3010 digital level controller for use with a HART Tri-Loop, perform the following procedure.

Table 2-1. Burst Variables Sent by the FIELDVUE DLC3010

Burst Option	Variable	Variable Burst(1)	Burst Command
Read PV	Primary	Process variable (EU)	1
Read PV mA and % Range	Primary	Process variable (mA)	2
	Secondary	Percent range (%)	
Read Dynamic Vars	Primary	Process variable (EU)	3
	Secondary	Electronics temperature (EU)	
	Tertiary	Process temperature (EU)	
	Quaternary	Not used	

1. EU—engineering units; mA—current in milliamperes; %—percent

Set the Burst Operation

Field Communicator	Configure > Communications > Burst Option (2-4-2)

1. Access *Burst Option*.
2. Select the desired burst option and press *ENTER*
3. Access *Burst Mode* and select *On* to enable burst mode. Press *ENTER*.
4. Select *SEND* to download the new configuration information to the digital level controller.

Section 3 Overview

Overview

Field Communicator	Overview (1)

Device Status

Good There are no active alerts and instrument is In Service.

Failed The highest severity active alert is in the Failed category.

Maintenance The highest severity active alert is in the Maintenance category.

Advisory The highest severity active alert is in the Advisory category.

Comm Status

Polled Communication with Digital Level Controller is established. Burst mode is turned off.

Burst Provides continuous communication from the digital level controller. Burst mode applies only to the transmission of burst mode data and does not affect the way other data is accessed.

PV is

Indicates the type of measurement either level, interface (the interface of two liquids of different specific gravities), or density (measures the liquid specific gravity). The process variable displayed and measured depends on the entry for “PV is” under PV Setup.

Primary Variable

PV Value Displays the process variable (level, interface, or density) in engineering units.

% Range Displays the process variable as a percent of span (determined by the LRV and URV).

AO

Indicates the current analog output value of the instrument, in milliamperes.

Process Temperature

Proc Temp Source— Manual or RTD

Proc Temp— indicates the process temperature.

Device Information

Identification

Follow the prompts on the Field Communicator display to view the following information.

- HART Tag— a unique name (up to eight characters) that identifies the physical instrument.
- Distributor— identifies the distributor of the instrument.
- Model— identifies the instrument model; ie. DLC3010.
- Device ID— each instrument has a unique Device Identifier. The Device ID provides additional security to prevent this instrument from accepting commands meant for other instruments.
- Date— user-defined variable that provides a place to save the date of the last revision of configuration or calibration information.
- Descriptor— a longer user-defined electronic label to assist with more specific controller identification that is available with the HART tag.
- Message— user-defined means for identifying individual controllers in multi-controller environments.

Revisions

Follow the prompts on the Field Communicator display to view revision information.

- HART Universal Revision— the revision number of the HART Universal Commands which are used as the communications protocol for the instrument.
- Field Device Revision— the revision of the protocol for interfacing to the functionality of the instrument.
- Firmware Revision— the revision number of the Fisher software in the instrument.
- Hardware Revision— the revision number of the Fisher instrument hardware.
- DD Information— the revision level of the Device Description used by the Field Communicator while communicating with the instrument.

Alarm Type and Security

Alarm Type

- Alarm Jumper— displays the position of the hardware alarm jumper, either high current or low current.
- Display Alert/Saturation Level

Security

- Write Lock
- Write Lock Setup

To setup and calibrate the instrument, write lock must be set to *Writes Enabled*. (Write Lock is reset by a power cycle. If you have just powered up the instrument Writes will be enabled by default.) In AMS, go to Device Information in the Overview page. Select the Alarms tab to change the write lock.

Section 4 Configuration and Calibration

Initial Setup

If a DLC3010 digital level controller ships from the factory mounted on a 249 sensor, initial setup and calibration is not necessary. The factory enters the sensor data, couples the instrument to the sensor, and calibrates the instrument and sensor combination.

Note

If you received the digital level controller mounted on the sensor with the displacer blocked, or if the displacer is not connected, the instrument will be coupled to the sensor and the lever assembly unlocked. To place the unit in service, if the displacer is blocked, remove the rod and block at each end of the displacer and check the instrument calibration. (If the "factory cal" option was ordered, the instrument will be precompensated to the process conditions provided on the requisition, and will not appear to be calibrated if checked against room temperature 0 and 100% water level inputs).

If the displacer is not connected, hang the displacer on the torque tube.

If you received the digital level controller mounted on the sensor and the displacer is not blocked (such as in skid mounted systems), the instrument will not be coupled, to the sensor, and the lever assembly will be locked. Before placing the unit in service, couple the instrument to the sensor, then unlock the lever assembly.

When the sensor is properly connected and coupled to the digital level controller, establish the zero process condition and run the appropriate zero calibration procedure under Partial Calibration. The Torque Rate should not need to be re-calibrated.

To review the configuration data entered by the factory, connect the instrument to a 24 VDC power supply as shown in figure 2-9. Connect the Field Communicator to the instrument and turn it on. Go to *Configure* and review the data under Manual Setup, Alert Setup, and Communications. If your application data has changed since the instrument was factory-configured, refer to the Manual Setup section for instructions on modifying configuration data.

For instruments not mounted on a level sensor or when replacing an instrument, initial setup consists of entering sensor information. The next step is coupling the sensor to the digital level controller. When the digital level controller and sensor are coupled, the combination may be calibrated.

Sensor information includes displacer and torque tube information, such as:

- Length units (meters, inches, or centimeters)
- Volume units (cubic inches, cubic millimeters, or milliliters)
- Weight units (kilograms, pounds, or ounce)
- Displacer Length
- Displacer Volume
- Displacer Weight
- Displacer Driver Rod Length (moment arm) (see table 4-1)

- Torque Tube Material

Note

A sensor with an N05500 torque tube may have NiCu on the nameplate as the torque tube material.

- Instrument mounting (right or left of displacer)
- Measurement Application (level, interface, or density)

Configuration Advice

Guided Setup directs you through initialization of configuration data needed for proper operation. When the instrument comes out of the box, the default dimensions are set for the most common Fisher 249 construction, so if any data is unknown, it is generally safe to accept the defaults. The mounting sense - 'instrument left or right of displacer' - is important for correct interpretation of positive motion. The torque tube rotation is clockwise with rising level when the instrument is mounted to the right of the displacer, and counter-clockwise when mounted to the left of the displacer. Use Manual Setup to locate and modify individual parameters when they need to be changed.

Preliminary Considerations

Write Lock

Field Communicator	Overview > Device Information > Alarm Type and Security > Security > Write Lock (1-7-3-2-2)

To setup and calibrate the instrument, write lock must be set to *Writes Enabled*. Write Lock is reset by a power cycle. If you have just powered up the instrument Writes will be enabled by default.

Guided Setup

Field Communicator	Configure > Guided Setup > Instrument Setup (2-1-1)

Note

Place the loop into manual operation before making any changes in setup or calibration.

Instrument Setup is available to aid initial setup. Follow the prompts on the Field Communicator display to enter information for the displacer, torque tube, and digital measurement units. Most of the information is available from the sensor nameplate, shown in figure 4-1. The moment arm is the effective length of the driver rod and depends upon the sensor type. For a 249 sensor, refer to table 4-1 to determine driver rod length. For a special sensor, refer to figure 4-2.

Figure 4-1. Example Sensor Nameplate

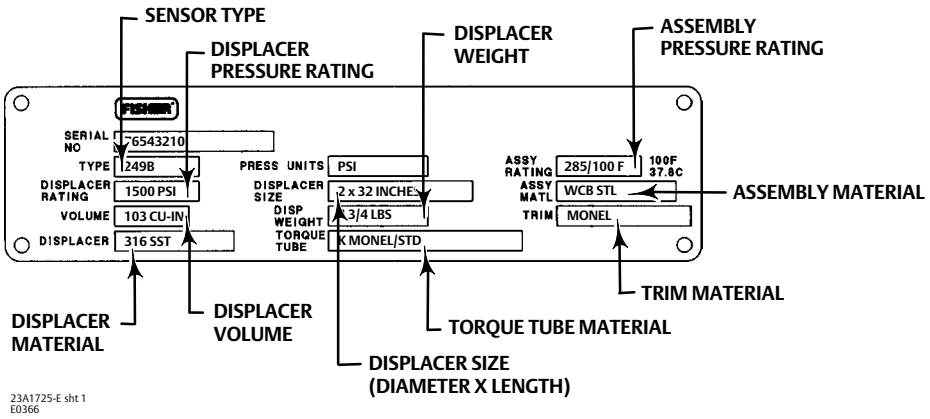


Table 4-1. Moment Arm (Driver Rod) Length(1)

SENSOR TYPE(2)	MOMENT ARM	
	mm	Inch
249	203	8.01
249B	203	8.01
249BF	203	8.01
249BP	203	8.01
249C	169	6.64
249CP	169	6.64
249K	267	10.5
249L	229	9.01
249N	267	10.5
249P (CL125-CL600)	203	8.01
249P (CL900-CL2500)	229	9.01
249VS (Special)(1)	See serial card	See serial card
249VS (Std)	343	13.5
249W	203	8.01

1. Moment arm (driver rod) length is the perpendicular distance between the vertical centerline of the displacer and the horizontal centerline of the torque tube. See figure 4-2. If you cannot determine the driver rod length, contact your Emerson Process Management sales office and provide the serial number of the sensor.
2. This table applies to sensors with vertical displacers only. For sensor types not listed, or sensors with horizontal displacers, contact your Emerson Process Management sales office for the driver rod length. For other manufacturers' sensors, see the installation instructions for that mounting.

1. Enter displacer length, weight, volume units and values, and driver rod (moment arm) length (in the same units chosen for displacer length) when prompted.
2. Choose Instrument Mounting (left or right of displacer, refer to figure 2-5).
3. Choose Torque Tube Material.

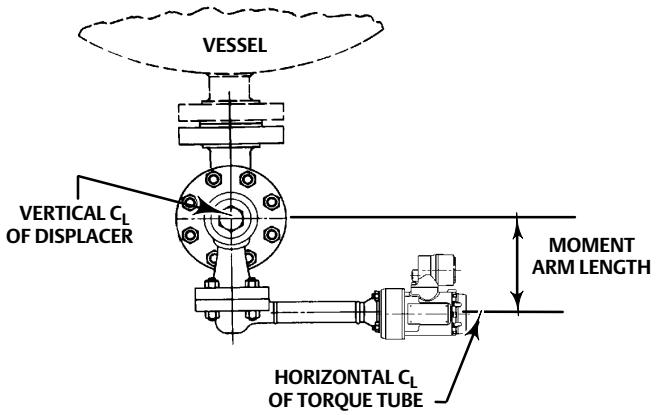
4. Select the measurement application (level, interface, or density).

Note

For interface applications, if the 249 is not installed on a vessel, or if the cage can be isolated, calibrate the instrument with weights, water, or other standard test fluid, in level mode. After calibrating in level mode, the instrument can be switched to interface mode. Then, enter the actual process fluid specific gravity(s) and range values.

If the 249 sensor is installed and must be calibrated in the actual process fluid(s) at operating conditions, enter the final measurement mode and actual process fluid data now.

Figure 4-2. Method of Determining Moment Arm from External Measurements



a. If you choose “Level” or “Interface,” the default process variable units are set to the same units chosen for displacer length. You are prompted to key in the level offset. Range values will be initialized based on Level Offset and displacer size. The default upper range value is set to equal the displacer length and the default lower range value is set to zero when the level offset is 0.

b. If you choose “Density,” the default process variable units are set to “SGU” (Specific Gravity Units). The default upper range value is set to “1.0” and the default lower range value is set to “0.1”.

5. Select the desired output action: Direct or Reverse

Choosing “reverse acting” will swap the default values of the upper and lower range values (the process variable values at 20 mA and 4 mA). In a reverse acting instrument, the loop current will decrease as the fluid level increases.

6. You are given the opportunity to modify the default value for the process variable engineering units.
7. You are then given the opportunity to edit the default values that were entered for the upper range value (PV Value at 20 mA) and lower range value (PV Value at 4 mA).
8. The default values of the alarm variables will be set as follows:

Direct-Acting Instrument (Span = Upper Range Value - Lower Range Value	
Alarm Variable	Default Alarm Value
Hi-Hi Alarm	Upper Range Value
Hi Alarm	95% span + Lower Range Value
Lo Alarm	5% span + Lower Range Value
Lo-Lo Alarm	Lower Range Value

Reverse-Acting Instrument (Span = Lower Range Value - Upper Range Value	
Alarm Variable	Default Alarm Value
Hi-Hi Alarm	Lower Range Value
Hi Alarm	95% span + Upper Range Value
Lo Alarm	5% span + Upper Range Value
Lo-Lo Alarm	Upper Range Value

PV alert thresholds are initialized at 100%, 95%, 5% and 0% span.

PV alert deadband is initialized to 0.5% span.

PV alerts are all disabled. Temperature alerts are enabled.

- If Density mode was chosen, setup is complete.
- If Interface or Density mode was chosen, you are prompted to enter the specific gravity of the process fluid (if interface mode, the specific gravities of the upper and lower process fluids).

Note

If you are using water or weights for calibration, enter a specific gravity of 1.0 SGU. For other test fluids, enter the specific gravity of the fluid used.

For temperature compensation, go to *Manual Setup*. Under *Process Fluid* select *View Fluid Tables*. Temperature compensation is enabled by entering values into the fluid tables. Two data tables are available that may be entered in the instrument to provide specific gravity correction for temperature (see tables 4-2 and 4-3). For interface level applications, both tables are used. For level measurement applications, only the lower specific gravity table is used. Neither table is used for density applications. Both tables may be edited during detailed setup.

Note

The existing tables may need to be edited to reflect the characteristics of the actual process fluid.

- You can accept the current table(s), modify an individual entry, or enter a new table manually. For an interface application, the user can switch between the upper and lower fluid tables.

Coupling

If the digital level controller is not already coupled to the sensor, perform the following procedure to couple the digital level controller to the sensor.

1. Slide the access handle to the locked position to expose the access hole. Press on the back of the handle as shown in figure 2-4 then slide the handle toward the front of the unit. Be sure the locking handle drops into the detent.
2. Set the displacer to the lowest possible process condition, (i.e. lowest water level or minimum specific gravity) or replace the displacer by the heaviest calibration weight.

Note

Interface or density applications with displacer/torque tube sized for a small total change in specific gravity are designed to be operated with the displacer always submerged. In these applications, the torque rod is sometimes resting on a stop while the displacer is dry. The torque tube does not begin to move until a considerable amount of liquid has covered the displacer. In this case, couple with the displacer submerged in the fluid with the lowest density and the highest process temperature condition, or with an equivalent condition simulated by the calculated weights.

If the sizing of the sensor results in a proportional band greater than 100% (total expected rotational span greater than 4.4 degrees), couple the transmitter to the pilot shaft while at the 50% process condition to make maximum use of available transmitter travel ($\pm 6^\circ$). The Capture Zero procedure is still performed at the zero buoyancy (or zero differential buoyancy) condition.

3. Insert a 10 mm deep well socket through the access hole and onto the torque tube shaft clamp nut. Tighten the clamp nut to a maximum torque of 2.1 N•m (18 lbf•in).
4. Slide the access handle to the unlocked position. (Press on the back of the handle as shown in figure 2-4 then slide the handle toward the rear of the unit.) Be sure the locking handle drops into the detent.

Manual Setup

The DLC3010 digital level controller has the capability to communicate via the HART protocol. This section describes the advanced features that can be accessed with the Field Communicator.

Note

Changing setup parameters may require enabling writing to the instrument with the Field Communicator (Overview > Device Information > Alarm Type and Security > Security > Write Lock Setup). Select *Writes Enabled* to enable writing setup and calibration data, or select *Writes Disabled* to disable writing data. Note that cycling power will clear the Write Lock condition to "Writes Enabled".

Sensor

Field Communicator	Configure > Manual Setup > Sensor (2-2-1)

Sensor Units

Follow the prompts on the Field Communicator to enter the desired sensor units.

- Length Units— Permits setting the units of measure for the displacer length (in feet, meters, inches, or centimeters).
- Volume Units— Permits setting the units of measure for the displacer volume (in liters, cubic inches, cubic millimeters, or milliliters).
- Weight Units— Permits setting the units of measure for the displacer weight (in grams, kilograms, pounds, or ounces).
- Torque Rate Units— Permits setting the torque rate units (in lbf-in per deg—pounds-force inches per degree rotation; newton-m per deg—newton-meters per degree rotation; or dyne-cm per deg—dyne-centimeters per degree rotation.
- Temperature Units— Select either *degC* (degrees centigrade) or *degF* (degrees Fahrenheit) to enter the temperature units. Note that when using degF, the Temperature Alert Deadband parameter is incorrectly displayed with a 32° bias.

Sensor Dimensions

Follow the prompts on the Field Communicator to enter the sensor dimensions. Dimensions can be found on the sensor name plate as shown in figure 4-1.

- Displacer Length— Enter the displacer length from the sensor nameplate.
- Displacer Volume— Enter the displacer volume from the sensor nameplate.
- Displacer Weight— Enter the displacer weight from the sensor nameplate.

- Driver Rod Length— Enter the displacer rod length. The displacer rod length depends upon the sensor type. For a 249 sensor, obtain the displacer rod length from table 4-1 or from the Field Communicator Help. Refer to figure 4-2 to physically measure this value.

Torque Tube

Follow the prompts on the Field Communicator to enter torque tube data.

- Torque Rate— Displays the torque rate currently stored in the instrument.

Change Torque Rate— Permits changing the torque rate stored in the instrument.

- TT Material— Displays the torque tube material currently stored in the instrument.

Note

A sensor with an N05500 torque tube may have NiCu on the nameplate as the torque tube material.

TT Comp Selection— Torque Tube Compensation Selection permits changing the torque tube material stored in the instrument.

- TT Comp Table— Torque Tube Compensation Table permits you to load a table with the material temperature coefficients.

Note

In firmware version 07 and 08, the data tables for torque-tube correction are simply stored without implementation. The information may be used to pre-compensate the measured torque-tube rate manually.

Instrument Mounting

Follow the prompts on the Field Communicator display to specify if the instrument is to the right or left of the displacer. See figure 2-5.

Sensor Damping

Follow the prompts on the Field Communicator display to configure the input filter.

Time constant for the input filter, in seconds, for the A/D measurement. The filter is applied before PV processing, after the A/D conversion. Range is 0 to 16 seconds in 0.1 second increments. The default value is 0.0 seconds. To disable the filter, set the time constant to 0 seconds. This filter is provided for extreme input noise situations. Use of this filter normally should not be necessary.

Net instrument response is a combination of analog input filtering and output filtering.

Variables

Field Communicator	Configure > Manual Setup > Variables (2-2-2)

Primary Variables

Follow the prompts on the Field Communicator to view or edit Primary Variable information.

- PV is— Display the PV assignment currently stored in the instrument.

Change PV— Follow the prompts to change the PV assignment. Select Level Units if the PV is level, Interface Units if the PV is Density, or Density Units if the PV is Density.

Note

If the PV assignment is changing to Level or Interface, go to the Process Fluid(s) menu and edit the configuration data for fluid density before returning the loop to Auto.

- PV Units— Permits changing the PV units.

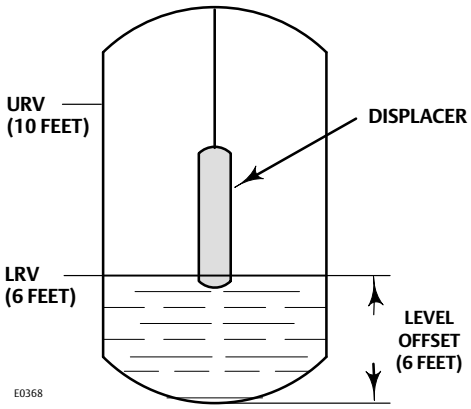
  For density measurement:
  - g/cm^3—grams per cubic centimeter
  - kg/m^3—kilograms per cubic meter
  - lb/gal—pounds per gallon
  - lb/ft^3—pounds per cubic foot
  - g/mL—grams per milliliter
  - kg/L—kilograms per liter
  - g/L—grams per liter
  - lb/in^3—pounds per cubic inch
  - SGU—specific gravity units

  For level and interface measurement:
  - ft—feet
  - m—meters
  - in—inches
  - cm—centimeters
  - mm—millimeters

- Level Offset— The Primary Variable value you want the instrument to report when physical level is at the bottom of displacer.

Set Level Offset— Adding a level offset permits the process variable value in engineering units to be reported with respect to a reference point other than the bottom of the displacer (see figure 4-3). Examples include: bottom of the process vessel, the process set point, or sea level. Set Level Offset is only available in Level or Interface measurement mode. Follow the prompts on the Field Communicator to enter the offset value. The procedure will offer to shift the range values and alert thresholds by the amount of the level offset for you. This will keep the 4-20 mA output aligned with the top and bottom of the displacer. If you have already shifted the range values and alert thresholds to account for the effect of the offset you are adding select No when asked if you want to 'Proceed changing range values and alert thresholds'.

Figure 4-3. Example of the Use of Level Offset



Sensor Limits

Follow the prompts on the Field Communicator to view sensor limit information.

- Upper Sensor Limit— Indicates the maximum usable value for the Upper Range Value.
- Lower Sensor Limit— Indicates the minimum usable value for the Lower Range Value.
- Minimum Span— Difference between the Upper Range Value and the Lower Range Value below which amplification of instrument errors may become a concern. This effect should be considered when sizing displacer / torque tube.

Primary Variable Range

Follow the prompts on the Field Communicator to view or edit range information.

- Upper Range Value— Defines the operational end point from which the Analog Value and the 100% point of the percent range are derived.
- Lower Range Value— Defines the operational end point from which the Analog Value and the 0% point of the percent range are derived.

View/Change AO Action— Follow the prompt and change the output action: Direct/Reverse.

For Reverse action, the Upper Range Value and Lower Range Value will be swapped.

PV Damping

PV Damping changes the response time of the controller to smooth variations in output readings caused by rapid changes in input. Determine the appropriate damping setting based on the necessary response time, signal stability, and other requirements of the loop dynamics of your system. The default damping value is 0.2 seconds. and can be reset to any value between 0 and 16 seconds in 0.1 second increments. When set to 0, the damping function is off.

Net instrument response is a combination of analog input filtering and output filtering.

Process Fluid

Field Communicator	Configure > Manual Setup > Process Fluid (2-2-3)

Note

Process Fluid is only visible if PV is Level or Interface.

Process Fluid

Follow the prompts on the Field Communicator to view or edit process fluid information.

- Upper Fluid Density— Indicates the density of the upper fluid.

Note

Upper Fluid Density is only visible if PV is Interface.

- Lower Fluid Density— Indicates the density of the lower fluid.
- View Fluid Tables

Upper Density Table (only visible if PV is Interface)

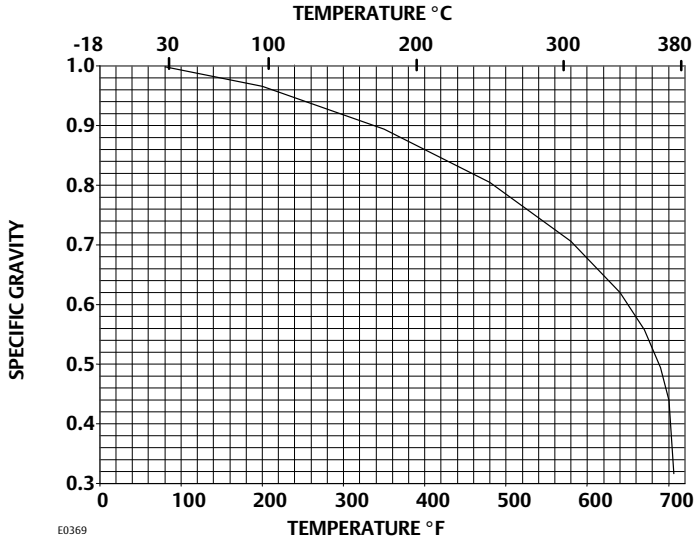
Lower Density Table

Two specific gravity tables are available in the instrument to provide specific gravity correction for temperature. For level measurement applications, only the lower specific gravity table is used. For interface applications, both the upper and lower table can be displayed and edited. For density applications, no specific gravity correction table is presented. Example entries for saturated water are given in table 4-2. Figure 4-4 shows the curve that results when these values are plotted.

Table 4-2. Example Specific Gravity vs Temperature Table for Saturated Water

Data Point	Temperature		Specific Gravity
	°C	°F	
1	26.7	80.0	0.9985
2	93.3	200.0	0.9655
3	176.7	350.0	0.8935
4	248.9	480.0	0.8040
5	304.4	580.0	0.7057
6	337.8	640.0	0.6197
7	354.4	670.0	0.5570
8	365.6	690.0	0.4940
9	371.1	700.0	0.4390
10	374.7	706.5	0.3157

Figure 4-4. Example Saturated Water Curve Plotted with Values from Table 4-2



You can enter up to 10 temperature and specific gravity pairs in the table. The table entry function is terminated by entering zero for the specific gravity. Keep this in mind when setting up a table for a upper fluid, such as steam, whose specific gravity approaches 0 at lower temperatures.

The resolution of the table entry for specific gravity is 5 decimal places. This means the smallest specific gravity value you can enter is 0.00001, which should be sufficient to allow a starting temperature around 15.6 °C (60 °F) for the steam specific gravity table.

The example set of tables given are generated by visually laying linear segments over a reference curve, and are not guaranteed to provide any particular accuracy. They are provided to illustrate the guidelines for developing your own table.

1. Establish a table for the fluid(s) you are using over the expected operating range of process temperature. This allows you to make best use of the maximum of ten points to obtain the accuracy you require. If your fluid specific gravity is very linear over the operating temperature range, two data points may be sufficient. (The correction algorithm provides linear interpolation between data points, and bounds the result at the table end points.)
2. Pick points closer together in regions of higher slope.
3. Pick linear segments that distribute the error equally on each side of the true curve.

Enter values in the specific gravity tables.

Enter Constant Density— Define fluid density/densities by constant values. No temperature compensation is applied.

Measure Density

Note

Measure Density is only available if PV is Level.

If specific gravity information for the process fluid is not available, an instrument and sensor combination that has been previously calibrated can be used to measure the fluid density. You must be able to manipulate the level and externally measure it to have the instrument measure the specific gravity. First capture a new zero reference angle at the zero process condition for the unknown fluid(s), then run this procedure. If the actual process application is Level, use a test level near 100% when measuring SG. If the actual process application is interface, the best differential SG measurement will be obtained at 50% interface level. Follow the prompts on the Field Communicator and the following procedure to measure specific gravity:

1. Set the control loop for manual control.
2. Adjust the liquid level as close as possible to the optimum value discussed above.
3. Enter the externally measured level, in engineering units.

After you press OK on the Field Communicator, the instrument begins calculating the specific gravity. You can then elect to use this value as the specific gravity for all level measurements. If you select *No*, the instrument uses the specific gravity entered under PV Setup, or the values from the specific gravity tables.

4. When finished measuring specific gravity, return the control loop to automatic control.

- Load Steam Tables

Note

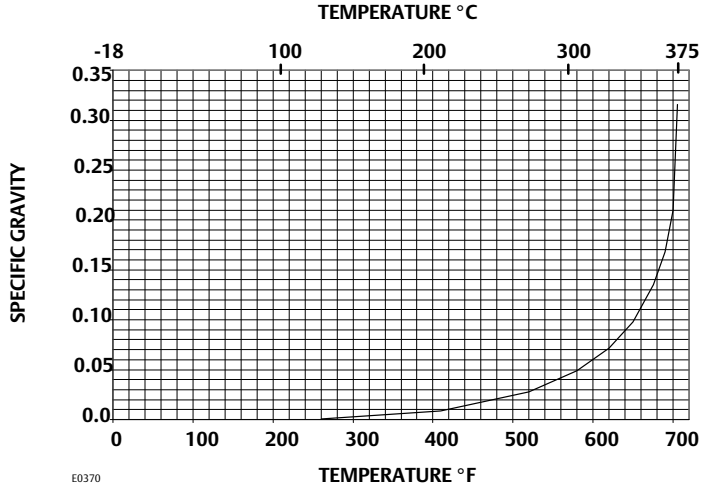
Load Steam Tables is only visible if PV is Interface.

Table 4-3 lists example entries for saturated steam. Figure 4-5 is the curve that results when these values are plotted.

Table 4-3. Example Specific Gravity vs Temperature Table for Saturated Steam

DATA POINT	TEMPERATURE		SPECIFIC GRAVITY
	°C	°F	
1	126.7	260	0.00095
2	210.0	410	0.00850
3	271.1	520	0.02760
4	304.4	580	0.04900
5	326.7	620	0.07200
6	343.3	650	0.09800
7	357.8	676	0.13500
8	365.6	690	0.16800
9	371.1	700	0.21000
10	374.4	706	0.31570

Figure 4-5. Example Saturated Steam Curve Plotted from Values in Table 4-3



Process Temperature

The digital level controller can receive the process temperature from a resistance temperature detector (RTD) connected to the unit or, if no RTD is connected to the unit, you can enter the process temperature directly. The digital level controller uses the process temperature to make specific gravity corrections. Follow the prompts on the Field Communicator to view or edit process temperature information.

- Proc Temp Source— Manual or RTD

Change Proc Temp Source— Select Keep Value, Edit Value, or Install RTD.

You must select the number of wires for an RTD; either 2 or 3.

For a 2-wire RTD, you must specify the connecting wire resistance for one wire of the pair. If you know the resistance, select *Resistance* and enter the resistance of the wire. 250 feet of 16 AWG wire has a resistance of 1 ohm. If you do not know the resistance manually compute the value from a wire resistance table, or temporarily short the two wires at one end of the cable, measure the resistance at the other end, and divide by two.

Note

For DD Rev 3 and earlier, the algorithm provided in this procedure for calculating wire resistance does not compute the correct value for size 16 AWG, hence the need to manually compute the resistance. This issue will be fixed in DD Rev 4.

- Proc Temp— Display the process temperature.
- RTD Wire Resistance— Displays the user estimate of wiring resistance (per lead) when employing a 2-wire RTD connection.

Device Information

Field Communicator	Configure > Manual Setup > Device Information (2-2-4)

Follow the prompts on the Field Communicator display to view or edit information in the following fields.

- HART Tag— The HART tag is the easiest way to identify and distinguish between controllers in multi-controller environments. Use the HART tag to label controllers electronically according to the requirements of your application. The tag you define is automatically displayed when a HART-based communicator establishes contact with the controller at power-up. The tag may be up to eight characters long and has no impact on the primary variable readings of the controller.

- Date— Date is a user-defined variable that provides a place to save the date of the last revision of configuration or calibration information. It has no impact on the operation of the controller or Field Communicator. Enter a date with the format MM/DD/YYYY.

- Descriptor— The Descriptor provides a longer user-defined electronic label to assist with more specific controller identification that is available with the HART tag. The descriptor may be up to 16 characters long and has no impact on the operation of the controller or HART-based communicator.

- Message— Message provides the most specific user-defined means for identifying individual controllers in multi-controller environments. it allows for 32 characters of information and is stored with the other configuration data. Message has no impact on the operation of the controller or the Field Communicator.

- Polling Address— If the digital level controller is used in a point-to-point configuration, the Polling Address is 0. When several devices are connected in the same loop, each device must be assigned a unique polling address. The Polling Address may be set to a value between 0 and 15. A device with polling address greater than 0 will operate in Multi-Drop mode, with output current fixed. Any process information from a device in Multi-Drop mode must be obtained via HART communication.

  For the Field Communicator to be able to communicate with a device whose polling address is not 0, it must be configured to automatically search for all or specific connected devices.

- Serial Numbers— Follow the prompts on the Field Communicator display to enter or view the following serial numbers.

  Instrument Serial Number— Use this field to enter or view the serial number on the instrument nameplate, up to 12 characters.

  Sensor Serial Number— Use this field to enter or view the sensor serial number. The sensor serial number is found on the sensor nameplate.

  Final Assembly Number— A number that can be used to identify the instrument and sensor combination.

Instrument Display

Field Communicator	Configure > Manual Setup > Instrument Display (2-2-5)

Follow the prompts on the Field Communicator display to view or edit what is visible in the instrument display.

- LCD Configuration— Select this parameter to indicate if the meter is installed. If the meter is physically installed, select *Installed*, then send the change to the instrument. When switching the setting from 'Not Installed' to 'Installed', the meter display will be activated immediately. However, if you change the setting to 'Not Installed'

from 'Installed' just to disable the display without physically removing the meter, a device reset or power cycle will be required before the setting takes effect. The meter must be installed before you can set the display type or the decimal places.

- Display Mode—Only visible if the meter is installed.

Change Display Mode— Select the type of information the meter should display and how it should be displayed by selecting 'Change display mode'. You can select for display:

PV— Displays the process variable (level, interface, or density) in engineering units.

PV/Process Temperature— Alternately displays the process variable in engineering units, the process temperature in the units selected under *Temp Units* (PV Setup), and the degrees of torque tube rotation.

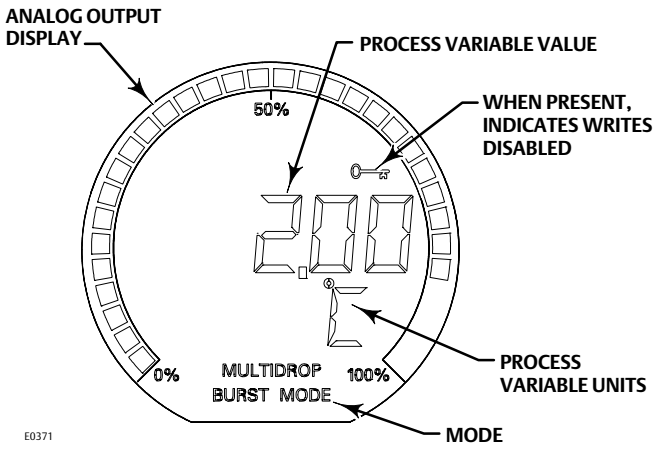
% Range— Displays the process variable as a percent of span (determined by the LRV and URV).

PV/% Range— Alternately displays the process variable in engineering units and the process variable in percent of span.

- Decimal Places—Selects the number of decimal places to display, up to four. Setting the value to zero puts the display in auto-scale mode. It will then display as may decimals places as will fit.

If *PV/Proc Temp* or *PV/% Range* is selected, the display alternates every two seconds between the selected readings. The meter also simultaneously displays the analog output signal using a percent of scale bar graph around the perimeter of the display face as shown in figure 4-6, no matter what display type is selected.

Figure 4-6. LCD Meter Display



After you have selected the desired meter settings, press *SEND* on the Field Communicator to download the meter settings to the instrument.

Alert Setup

The following menus are available for configuring Alerts.

Primary Variable

Field Communicator	Configure > Alert Setup > Primary Variable (2-3-1)

Follow the prompts on the Field Communicator display to view or edit the following primary variable alerts.

Primary Variable Hi

- Hi Alert

  PV Hi Alert Enable— On or Off. PV High Alert Enable activates checking the primary variable against the PV High Alert limit. The High Alert is set if the primary variable rises above the PV High Alert limit. Once the alert is set, the primary variable must fall below the PV High Alert limit by the PV Alerts Threshold Deadband before the alert is cleared. See figure 4-7.

  PV Hi Alert Threshold— Primary Variable Hi Alert Threshold is the value of the process variable, in engineering units, which, when exceeded, sets the Primary Variable High Alert.

  PV Hi Alert Threshold— Method to change the PV Hi Alert Threshold

- Hi Hi Alert

  PV Hi Hi Alert Enable— On or Off. PV High High Alert Enable activates checking the primary variable against the PV High-High Alert limit. The High High Alert is set if the primary variable rises above the PV High High Alert limit Once the alert is set, the primary variable must fall below the PV High High Alert limit by the PV Alerts Threshold Deadband before the alert is cleared. See figure 4-7.

  PV HiHi Alert Threshold— Primary Variable HiHi Alert Threshold is the value of the process variable, in engineering units, which, when exceeded, sets the Primary Variable High-High Alert.

  PV HiHi Alert Threshold— Method to change the PV HiHi Alert Threshold

Note

If the Hi Hi Alert is enabled and set, the digital level controller output will go to below 3.75 mA or above 21.0 mA, depending on the position of the alarm jumper.

Consider the effect of an alarm annunciation on the process, then set alarm jumper position accordingly.

When Output Action is 'Direct':

- A Hi alarm setting will result in an alarm-state output consistent with a very high process.
- A Lo alarm setting will result in an alarm-state output consistent with a very low process.

When Output Action is 'Reverse', these relationships are swapped.

In a Multi-Drop network (device has a non-zero Polling Address) alarm annunciation is disabled and the device is not directly driving any effector, so jumper setting is not a concern.

Primary Variable Lo

- Lo Alert

  PV Lo Alert Enable— On or Off. PV Lo Alert Enable activates checking the primary variable against the PV Lo Alert limit. The Lo Alert is set if the primary variable rises above the PV Lo Alert limit. Once the alert is set, the primary variable must fall below the PV Lo Alert limit by the PV Alerts Threshold Deadband before the alert is cleared. See figure 4-7.

  PV Lo Alert Threshold— Primary Variable Lo Alert Threshold is the value of the primary variable, in engineering units, which, when exceeded, sets the Primary Variable Low Alert.

  PV Lo Alert Threshold— Method to change the PV Lo Alert Threshold

- Lo Lo Alert

  PV LoLo Alert Enable— On or Off. PV Lo Lo Alert Enable activates checking the primary variable against the PV Lo Lo Alert limit. The Lo Lo Alert is set if the primary variable rises above the PV Lo Lo Alert limit. Once the alert is set, the primary variable must fall below the PV Lo Lo Alert limit by the PV Alerts Threshold Deadband before the alert is cleared. See figure 4-7.

  PV LoLo Alert Threshold— Primary Variable LoLo Alert Threshold is the value of the primary variable, in engineering units, which, when exceeded, sets the Primary Variable Low-Low Alert.

  PV LoLo Alert Threshold — Method to change the PV Lo Lo Alert Threshold

Note

If the Lo Lo Alert is enabled and set, the digital level controller output will go to below 3.75 mA or above 21.0 mA, depending on the position of the alarm jumper.

Consider the effect of an alarm annunciation on the process, then set alarm jumper position accordingly.

When Output Action is 'Direct':

- A Hi alarm setting will result in an alarm-state output consistent with a very high process.
- A Lo alarm setting will result in an alarm-state output consistent with a very low process.

When Output Action is 'Reverse', these relationships are swapped.

In a Multi-Drop network (device has a non-zero Polling Address) alarm annunciation is disabled and the device is not directly driving any effector, so jumper setting is not a concern.

PV Value— Current process variable (level, interface, or density) in engineering units.

Upper Range Value— Highest value of the primary variable that the digital level controller is currently configured to measure in the 4 to 20 mA loop.

Lower Range Value — Lowest value of the primary variable that the digital level controller is currently configured to measure in the 4 to 20 mA loop.

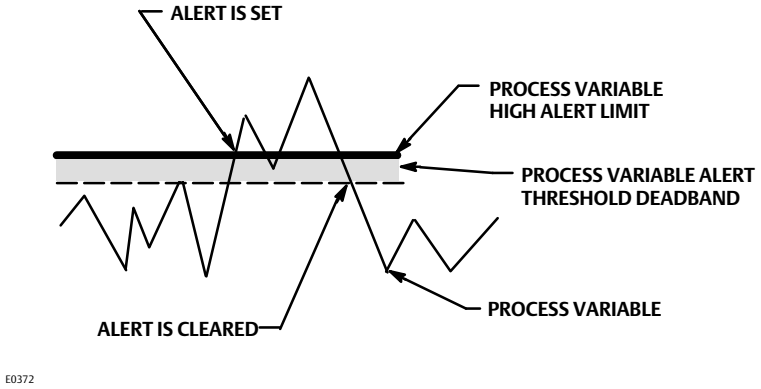
PV Alerts Threshold Deadband — The Primary Variable Alerts Threshold Deadband is the amount the primary variable, in engineering units, must change to clear a primary variable alert, once it has been set. The deadband applies to all the primary variable alarms. See figure 4-7.

Note

For DD Rev 3 and lower, when changing the applied PV Deadband, the echoed value may not be displayed correctly in Length units other than inches and Density units other than pounds per cubic inch. Before editing this parameter, temporarily switch the PV

units to inches (or pounds per cubic inch), then restore the desired PV units after confirming the desired Deadband value. This issue will be fixed in DD Rev 4.

Figure 4-7. Process Variable Alert Threshold Deadband (Process Variable High Alert Example)



Temperature

Field Communicator	Configure > Alert Setup > Temperature (2-3-2)

Follow the prompts on the Field Communicator display to set the following temperature alerts.

Instrument Temperature

- Hi Alert

  Inst Temp Hi Alert Enable— On or Off. Instrument Temperature High Alert Enable activates checking of the instrument temperature against the Instrument Temperature High Alert Threshold. Instrument Temperature High Alert is set if the instrument temperature rises above the Instrument Temperature High Alert Threshold. Once the alarm is set, the instrument must fall below the Instrument Temperature High Alert Threshold by the Temperature Deadband before the alarm is cleared. See figure 4-8.

  Inst Temp Hi Alert Threshold— Instrument Temperature High Alert Threshold is the instrument electronics temperature, in temperature units, which, when exceeded, will set the Electronics High Alert.

- Lo Alert

  Inst Temp Lo Alert Enable— On or Off. Instrument Temperature Low Alert Enable activates checking of the instrument temperature against the Instrument Temperature Low Alert Threshold. Instrument Temperature High Alert is set if the instrument temperature rises above the Instrument Temperature Low Alert Threshold. Once the alarm is set, the instrument must fall below the Instrument Temperature Low Alert Threshold by the Temperature Deadband before the alert is cleared. See figure 4-8.

  Inst Temp Lo Alert Threshold— Instrument Temperature Low Alert Threshold is the instrument electronics temperature, in temperature units, which, when exceeded, will set the Electronics Low Alert.

- Inst Temp— Current Instrument Temperature.

- Inst Temp Offset— Offset to trim instrument temperature output to an independent reference. Factory calibration that may be modified by user.

Process Temperature

- Hi Alert

  Proc Temp Hi Alert Enable— On or Off. Process Temperature High Alert Enable activates checking of the process variable temperature against the Process Temperature High Alert Threshold. The Process Temperature High Alert is set if the process variable temperature rises above the Process Temperature High Alert Threshold. Once the alert is set, the process variable temperature must fall below the Process Temperature High Alert Threshold by the Temperature Deadband before the alert is cleared. See figure 4-8.

  Proc Temp Hi Alert Threshold— Process Temperature High Alert Threshold is the process variable temperature, in temperature units, which, when exceeded, will set the Process Temperature High Alert.

- Lo Alert

  Proc Temp Lo Alert Enable— On or Off. Process Temperature Low Alert Enable activates checking of the process variable temperature against the Process Temperature Low Alert Threshold. The Process Temperature Low Alert is set if the process variable temperature rises above the Process Temperature Low Alert Threshold. Once the alert is set, the process variable temperature must fall below the Process Temperature Low Alert Threshold by the Temperature Deadband before the Alert is cleared. See figure 4-8.

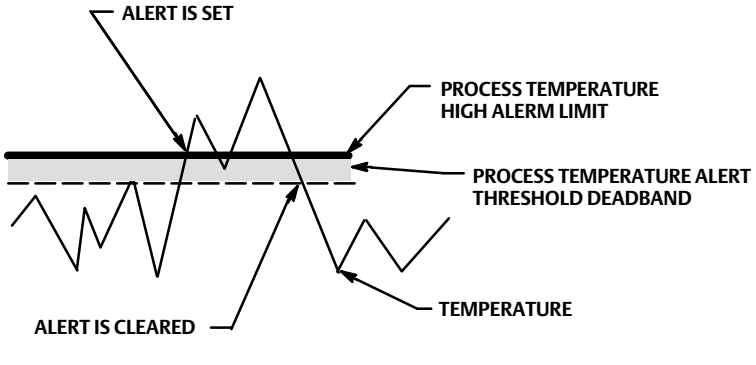
  Proc Temp Lo Alert Threshold— Process Temperature Low Alert Threshold is the process variable temperature, in temperature units, which, when exceeded, will set the Temperature Low Alert.

- Proc Temp— Displays the process temperature stored in the instrument.
- Proc Temp Offset— Bias to improve the accuracy of the (RTD) temperature measurement used to provide compensation for process-temperature-related density changes.
- Temperature Deadband— The Temperature Deadband is the amount the temperature, in temperature units, must change to clear a temperature alert, once it has been set. The deadband applies to all the temperature alerts. See figure 4-8. In firmware revision 8, the Temp Alert Offset is displayed incorrectly when the units are DegF. (The number displayed is 32 more than the actual deadband.)

Note

For DD Rev 3 and earlier, switch temperature units to Deg C before editing this parameter, then switch back to the desired temperature units after confirming the Deadband value.

Figure 4-8. Process Temperature Alert Threshold Deadband (Temperature High Alert Example)



Communications

Field Communicator	Configure > Communications > Burst Mode (2-4-1) or Burst Option (2-4-2)

Burst Mode

Enabling burst mode provides continuous communication from the digital level controller.

Note

It may be difficult to make configuration adjustments to the DLC3010 while it is in burst mode, due to an increase in communication errors. To reconfigure the device, it is advisable to first disable burst mode.

Depending upon the burst option selected, the digital level controller will burst the variables as shown in table 2-1.

Table 4-4. Burst Variables Sent by the FIELDVUE DLC3010

Burst Option	Variable	Variable Burst(1)	Burst Command
Read PV	Primary	Process variable (EU)	1
Read PV mA and % Range	Primary	Process variable (mA)	2
	Secondary	Percent range (%)	
Read Dynamic Vars	Primary	Process variable (EU)	3
	Secondary	Electronics temperature (EU)	
	Tertiary	Process temperature (EU)	
	Quaternary	Not used	

1. EU—engineering units; mA—current in milliamperes; %—percent

Burst Option

1. Select *On* in the Burst Mode menu; press *ENTER* to enable Burst Mode.
2. Select the desired option from the Burst Option menu and press *ENTER*.
3. Press *SEND* to download the new configuration information to the digital level controller.

Calibration

Introduction: Calibration of Smart Instruments

Analog instruments generally have only one interface that can be calibrated by the user. A zero and span output calibration is normally performed at the corresponding two input conditions. Zero/Span calibration is very simple to use, but provides little versatility. If the 0% and 100% input conditions are not available to the user, a calibration can sometimes be accomplished, but the gain and offset adjustments will likely interact, requiring considerable iteration to achieve accuracy. In contrast, intelligent instruments have many interfaces that can be calibrated or scaled by the user, with consequent increased versatility.

Refer to table 4-5 for a list of relationships in the DLC3010 that can be calibrated or configured by the user. Note that not all relationships are listed here.

Table 4-5. Relationships in the FIELVUE DLC3010 that can be User Calibrated or Configured

Torque Tube Rate	The scale factor between the internal digital representation of the measured pilot shaft rotation and the physical torque input to the sensor.
Zero Reference Angle	The angle of pilot shaft rotation associated with the zero buoyancy condition in Interface or Density mode, or the zero differential buoyancy condition in Level mode. (The zero reference for the input of the PV calculation).
Driver Rod Length	The scale factor (moment arm) between a force input to the sensor driver rod and the torque developed as input to the torque tube.
Displacer Volume	The scale factor relating the density of the process fluid to the maximum force that can be produced as an input to the driver rod of the sensor.
SG	The density of the process fluid normalized to the density of water at reference conditions. The scale factor that transforms displacer volume and measured buoyancy into a level signal normalized to displacer length.
Displacer Length	The scale factor to convert normalized level to level on the displacer in engineering units.
Level Offset	The zero reference for the output of the PV calculation, referred to the location of the bottom of the displacer.
URV (Upper Range Value)	The value of computed process variable at which a 20 mA output (100% Range) is desired.
LRV (Lower Range Value)	The value of computed process variable at which a 4 mA output (0% Range) is desired.
D/A Trim	The gain and offset of the D/A converter which executes the digital commands to generate output
Instrument Temperature Offset	Bias to improve the accuracy of the ambient temperature measurement used to provide temperature compensation for the mechanical-to-electronic transducer.
Proc Temp Offset	Bias to improve the accuracy of the (RTD) temperature measurement used to provide compensation for process-temperature-related density changes.

These parameters are factory-set to the most common values for the 249 sensors. Therefore, for the bulk of units sold in simple level applications, it is possible to accept the defaults and run a Min/Max Calibration. If any of the advanced features of the instrument are to be used, accurate sensor and test fluid information should generally be entered before beginning the calibration.

Primary

Guided Calibration

Field Communicator	Configure > Calibration > Primary > Guided Calibration (2-5-1-1)

Guided Calibration recommends an appropriate calibration procedures for use in the field or on the bench based on your input. Answer questions about your process scenario to reach the calibration recommendation. When feasible, the appropriate calibration method will be invoked from within the procedure.

Full Calibration

Field Communicator	Configure > Calibration > Primary > Full Calibration (2-5-1-2)

Full Calibration operations compute the sensor gain and zero reference from two independent observations of process data points. They are appropriate for cases where the two input conditions can be established relatively quickly in one session.

Min/Max Calibration

The following procedure can be useful when process values can't be precisely observed, but the displacer can sequentially be submerged in fluids of known minimum and maximum density. (E.g., no sight glass is available, but the cage can be isolated and drained or flooded.)

Correct displacer information and the SG of the test fluid must be entered before performing this procedure. Capture Zero can be performed at minimum buoyancy (or completely submerged in upper fluid) before performing Min/Max Calibration.

Follow the prompts on the Field Communicator to calibrate the instrument and sensor.

1. Set the control loop for manual control.
2. Enter the specific gravity for the liquid in the system.
3. Adjust the liquid level until the displacer is dry (or completely submerged in upper liquid). Allow the output to settle, then acknowledge establishment of the minimum buoyancy condition to the system.
4. Adjust the liquid level until the displacer is completely submerged in the lower liquid. Allow the output to settle, then acknowledge establishment of the maximum buoyancy condition of the system.

The sensor is calibrated. Verify that the upper and lower range values are correct and return the loop to automatic control.

Two Point Calibration

This procedure uses independent observations of two valid process conditions, together with the hardware dimensional data and SG information, to compute the effective torque rate and zero reference angle for the sensor. The two data points can be separated by any span between a minimum of 5% to 100%, as long as they remain on the displacer. Within this range, the calibration accuracy will generally increase as the data-point separation gets larger. Accuracy is also improved by running the procedure at process temperature, as the temperature effect on torque rate will be captured. (It is possible to use theoretical data to pre-compensate the measured torque rate for a target process condition when the calibration must be run at ambient conditions.)

An external method of measuring the process condition is required.

Follow the prompts on the Field Communicator to calibrate the sensor.

1. Put the control loop in manual control.
2. Adjust the process condition to a value near the top or bottom of the valid range.
3. Enter this externally measured process condition in the current PV units.
4. Adjust the process condition to a value near the bottom or top of the valid range, but at a position that is toward the opposite end of the range relative to the condition used in step 2.
5. Enter this second externally measured process condition in the current PV units.

The sensor is now calibrated. Be sure to verify that the upper and lower range values are correct before returning the loop to automatic control.

Weight Calibration

This procedure may be used on the bench or with a calibration jig that is capable of applying a mechanical force to the driver rod to simulate displacer buoyancy changes. It allows the instrument and sensor to be calibrated using equivalent weights or force inputs instead of using the actual displacer buoyancy changes. If the displacer information has been entered prior to beginning the procedure, the instrument will be able to compute reasonable weight value suggestions for the calibration. However, the only preliminary data essential for the correct calibration of the torque rate is the length of the driver rod being used for the calibration.

Weight equivalent to the net displacer weight at two valid process conditions must be available. The sensor must have been sized properly for the expected service, so that the chosen process conditions are in the free-motion linear range of the sensor. The instrument should normally be physically coupled to the pilot shaft at what is going to be the zero buoyancy weight or the zero differential-buoyancy weight, depending on the calibration approach. (However, if the expected operational travel of the pilot is greater than 5 degrees, it is advisable to couple the transmitter to the pilot shaft at the condition representing mid-travel instead. This will prevent hitting a stop in the transmitter before limiting in the sensor.) A small zero trim correction may be necessary at start-up, since the weight input may not perfectly simulate the actual process fluid(s).

Follow the prompts on the Field Communicator to calibrate the sensor.

1. For interface level or density measurements, enter the specific gravity of the upper fluid and lower fluid as requested.
2. Place a weight on the displacer rod that is approximately equal to that indicated on the prompt. The suggested weight is equivalent to the effective displacer weight when the liquid is at its lowest level or the displacer is suspended in the liquid with the lower specific gravity.
3. After allowing the system to stabilize, enter the actual value of the weight suspended on the displacer rod.
4. Place a weight on the displacer rod that is approximately equal to that indicated on the prompt. The suggested weight is equivalent to the effective displacer weight when the liquid is at its highest level or the displacer is suspended in the liquid with the higher specific gravity.
5. After allowing the system to stabilize, enter the actual value of the weight suspended on the displacer rod.

The sensor is calibrated, but a small zero trim may be required when the actual process fluid(s) are introduced. Check the range values before putting the loop in service.

Theoretical Calibration

In cases where it is not possible to manipulate the input at all, the user may set up a nominal calibration using information available about the hardware and the process. The theoretical torque rate for the installed torque tube may be looked up and compensated for process temperatures. This value is then manually entered in the instrument configuration. (The 'Change Torque Rate procedure under the *Manual Setup* > *Sensor* > *Torque Tube* menu can be used to look up and select theoretical values for common torque tubes if you select the 'Need Assistance' option instead of the 'Edit value directly' approach.) The displacer information and fluid SGs are entered. The desired range values are entered manually. Finally,Trim Zero computes PV to the current value of the process. It should be possible to control the loop with this rough calibration.

Note

The theoretical torque rate for the installed torque tube is available in the Simulation of Process Conditions for Calibration of Fisher Level Controllers and Transmitters instruction manual supplement (D103066X012). Contact your Emerson Process Management sales office for information on obtaining this manual supplement.

Observations of the sight glass or other independent measurements may be logged against DLC3010 outputs over time. The ratio of the independent-observable process changes to the DLC3010 output changes may then be used as a scale factor to modify the theoretical torque rate stored in the instrument. After each gain adjustment, a new zero trim will be required. When a plant-maintenance shutdown occurs, the instrument may be isolated and calibrated in the normal manner.

Partial Calibration

Field Communicator	Configure > Calibration > Primary > Partial Calibration (2-5-1-3)

Partial Calibration operations are useful when it would take too long to establish a second data point in a single session. There are of two types of partial calibrations: capture and trim. The 'capture zero' operation sets the input zero reference angle to the value currently being measured. It is therefore valid only at the defined zero process condition. Trim operations recompute either gain or zero reference angle with one observation of process data. The calibration parameter that is NOT being trimmed is assumed to be correct.

Capture Zero

Capture Zero captures the current value of the torque tube angle as the input zero. The displacer must be loading the torque tube, and not resting on a travel stop. The torque tube must be coupled to the DLC3010 and the coupling access door must be closed. In Level mode, the captured angle represents zero differential buoyancy on displacer, and must be obtained at the actual process zero condition. In Interface and Density mode, the captured angle represents zero absolute buoyancy on displacer, and must be obtained at actual dry condition.

If the displacer is overweight and it is necessary to use the partial calibration methods, select Level mode and enter the differential density before using ‘Capture Zero’ and ‘Trim Gain’. After the gain is correct, switch back to Density or Interface mode, (re-enter individual densities if Interface), then perform a ‘Trim Zero’ procedure to back-compute the required zero buoyancy angle.

The Capture zero procedure prompts you to verify the instrument is coupled to torque tube, coupling access door is closed, and verify that the displacer is completely dry.

Note

If the handle on the coupling access door is in the position towards the front of the transmitter, the coupling access hole is open and the lever is “locked” (pinned in the neutral travel position). In this condition, the true “at-rest” position of the linkage may not be captured correctly. Moving the handle to the rear of the transmitter closes the coupling-access hole and unlocks the lever.

It functions as the pre-calculation zero for the process measurement algorithm. This procedure can be run either before or after other calibration procedures. However, the procedure returns a valid result at only one input condition - zero buoyancy for Interface and zero differential buoyancy for Level mode.

Before calibration, use the *Configure* > *Manual Setup* >*Sensor* menu to verify that all sensor and compensation data match the calibration conditions.

Trim Gain

Trim Gain operations recompute gain with one observation of process data.

Trim Gain trims the torque rate value to align the digital Primary Variable with the user’s observation. This calibration assumes that sensor zero is already accurate and only a gain error exists. Actual process condition must be non-zero and able to be measured independently. Configuration data must contain density of calibration fluid(s), displacer volume, and driver rod length.

Before calibration, use the *Configure* > *Manual Setup* >*Sensor* menu to verify that all sensor and compensation data match the calibration conditions.

Trim Zero

Trim Zero computes the value of the input angle required to align the digital Primary Variable with the user's observation of the process, and corrects the stored input zero reference, assuming that the calibration gain is accurate. Use this procedure when the process cannot be moved to zero for capture, but gain is known to be correct (only a bias error exists).

Before calibration, use the *Configure* > *Manual Setup* >*Sensor* menu to verify that all sensor and compensation data match the calibration conditions.

Follow the prompts on the Field Communicator.

1. Adjust the process condition or simulation to any valid and observable value.
2. Enter the external observation of the measurement in the current PV units.

Secondary

Temperature Calibration

Field Communicator	Configure > Calibration > Secondary > Temperature Calibration (2-5-2-1)

This procedure allows you to display the temperature as measured by the instrument. You can then trim the temperature reading so that it matches the actual temperature more closely in the region of interest. (This is an offset adjustment only. There is no ability to change the gain.)

This calibration is initially performed at the factory. Performing it in the field requires an accurate independent measurement of the instrument housing temperature or process temperature, (as appropriate). The instrument should be at a steady-state condition with respect to that temperature when performing the procedure.

Note

The effectiveness of the instrument electronic temperature compensation depends upon the accuracy of the electronics temperature offset stored in the NVM (non-volatile memory). If the electronics temperature is incorrect, the temperature curve applied to the magnets and Hall sensor will be misaligned, resulting in over- or under-compensation.

Trim Instrument Temperature

Follow the prompts on the Field Communicator to trim the instrument temperature.

Trim Process Temperature

Trim Process Temperature is available if the Process Temperature Source is not Manual. Follow the prompts on the Field Communicator to trim the process temperature.

Manual Entry of Process Temperature

Field Communicator	Configure > Manual Setup > Process Fluid > Process Temperature > Change Proc Temp (2-2-3-2-2)

If a process temperature sensor (RTD) is not installed, it is possible to manually set the Digital Process Temperature variable to the target process temperature. This value will be used by any SG-compensation tables that the user has entered. If no compensation tables are active, the Digital Process Temperature value may be used to document the process temperature at which the instrument was calibrated, or the process temperature for which the stored torque rate is pre-compensated.

Follow the prompts on the Field Communicator to edit the Digital Proc Temp.

Analog Output Calibration

Scaled D/A Trim

Field Communicator	Configure > Calibration > Secondary > Analog Output Calibration > Scaled D/A Trim (2-5-2-2)

This procedure allows trimming the gain and offset of the Digital-to-Analog (D/A) converter to adjust the accuracy at which the output follows 4 to 20 mA current commands from the firmware. This relationship is initially set in the factory, and should not require frequent user adjustment. Reasons for using this procedure include:

- Correction for component aging after the instrument has been in service for an extended period.
- Adjusting D/A calibration to be optimum at the normal operating temperature, when that temperature is considerably removed from room temperature conditions.

The procedure is iterative, and will eventually reach a resolution limit where attempts to improve the result will cycle at a few decimal places to either side of the target.

Follow the prompts on the Field Communicator to trim the D/A output.

1. Scale the output from 4 to 20 mA? If your reference meter is graduated in “mA”, select *Proceed* and go to step 5. If the reference reading is presented in some other unit system, such as “%” or “mm”, select *Change* and continue with step 2.
2. Enter the scale low output value.
3. Enter the scale high output value.
4. If the high and low output values are correct, select *Proceed* and continue to step 5. If they are not correct, select *Change* and return to step 2.
5. Connect a reference meter across the test connections in the terminal box. See the Test Connections procedure in the Installation section. You can also connect a reference meter in the loop as shown in figure 2-9.
6. The Field Communicator commands the instrument to set its output to 4 mA or the low output value.
7. Enter the reading from the reference meter.
8. If the reference meter reading equals 4 mA or the low output value, select *Yes* and continue to step 9. If not, select *No* and return to step 7.
9. The Field Communicator commands the instrument to set its output to 20 mA or the high output value.
10. Enter the reading from the reference meter.
11. If the reference meter reading equals 20 mA or the high output value, select *Yes* and continue to step 12. If not, select *No* and return to step 10.

12. The Field Communicator commands the instrument to set its output back to the original value.

Note

If communications with the device are lost before exit of the procedure, the device may be stuck in fixed output current mode. Be sure to check for the 'Analog Output Fixed' alert after communications are re-established, or disturb the input linkage and confirm output current change before returning the loop to Auto.

Calibration Examples

Calibration—with Standard Displacer and Torque Tube

Run the initial calibration near ambient temperature at design span to take full advantage of the available resolution. This is accomplished by using a test fluid with a specific gravity (SG) close to 1. The value of SG in the instrument memory during the calibration process should match the SG of the test fluid being used in the calibration. After the initial calibration, the instrument may be set up for a target fluid with a given specific gravity, or an interface application, by simple configuration data changes.

1. Run through Guided Setup and verify that all sensor data is correct.
   Procedure:
   Change the PV mode to Level
   If your input observations are going to be made with respect to location of the bottom of the displacer at the lowest process condition, set the Level Offset value to 0.00, and
   Set the Specific Gravity value to the SG of the test fluid being used.

Establish the test fluid level at the desired process zero point. Make sure that the DLC3010 lever assembly has been properly coupled to the torque tube (see coupling procedure on page 38). To unlock the lever assembly and allow it to freely follow the input, close the coupling access door on the instrument. It is often possible to watch the instrument display and/or the analog output to detect when the fluid hits the displacer, because the output will not start moving upward until that point is reached.

Select the Min/Max calibration from the Full Calibration menu, and confirm that you are at the 'Min' condition at the prompt. After the 'Min' point has been accepted, you will be prompted to establish the 'Max' condition. (The 'displacer completely covered' condition should be slightly higher than the 100% level mark to work correctly. for example, 15 inches above the zero mark would generally be enough for a 14 inch displacer on a 249B, because the amount of displacer rise expected for that configuration is about 0.6 inch.)

Accept this as the 'Max' condition. Adjust the test fluid level and check the instrument display and current output against external level at several points distributed across the span to verify the level calibration.

a. To correct bias errors, 'Trim Zero' at a precisely known process condition.

b. To correct gain errors, 'Trim Gain' at a precisely-known high level condition.

Note

If you are able to precisely observe individual input states, the Two-Point calibration may be used instead of Min/Max.

If for some reason you are unable to carry out Min/Max or Two Point Calibration, set the lowest process condition and Capture Zero. Run Trim Gain at a process level of minimum 5% above the Lower Range Value.

If the measured output doesn't come off the low saturation value until the level is considerably above the bottom of the displacer, it is possible that the displacer is overweight. An overweight displacer will rest on the lower travel stop until sufficient buoyancy has developed to allow the linkage to move. In that case, use the calibration procedure for overweight displacers found below.

After the initial calibration:

For a level application— Go to the Sensor Compensation menu and use the 'Enter constant SG' item to configure the instrument for the target process fluid density.

For an interface application— Change the PV mode to Interface, verify or adjust the range values presented by the Change PV mode procedure, and then use 'Enter constant SG' to configure the instrument for the SGs of each of the target process fluids.

For a density application— Change the PV mode to Density, and establish the desired range values in the 'Change PV mode' procedure.

If the target application temperature is considerably elevated or depressed from ambient, refer to pages 37 and 66 for information on temperature compensation.

Note

Information on computing precise simulation of this effect is available in the Simulation of Process Conditions for Calibration of Fisher Level Controllers and Transmitters instruction manual supplement (D103066X012), available from your Emerson Process Management sales office or at www.fisher.com.

Calibration with an Overweight Displacer

When the sensor hardware is sized for greater mechanical gain (as it is in some interface or density measurement applications), the dry displacer weight is often greater than the maximum permissible load on the torque tube. In this situation it is impossible to 'capture' the zero buoyancy rotation of the torque tube, because the linkage is lying on a travel stop at that condition.

The 'Capture Zero' routine in the Partial Calibration menu group will therefore not function correctly in the target PV modes of Interface or Density when the displacer is overweight.

The Full Calibration routines: Min/Max, Two-Point, and Weight, will all work correctly at the actual process conditions when in interface or density mode, because they back-compute the theoretical zero-buoyancy angle instead of capturing it.

If it is necessary to use the Partial Calibration methods when the displacer is overweight, the following transformation may be used:

An interface or density application can be mathematically represented as a level application with a single fluid whose density is equal to the difference between the actual SGs of the fluid covering the displacer at the two process extremes.

The calibration process flows as follows:

- Change the PV mode to Level.
- Set the Level Offset to zero.
- Set the Range Values to:
  LRV = 0.0,
  URV = displacer length.
- Capture Zero at the lowest process condition (that is, with the displacer completely submerged in the fluid of the lowest density - NOT dry).
- Set Specific Gravity to the difference between the SGs of the two fluids (for example, if SG_upper = 0.87 and SG_lower = 1.0, enter a specific gravity value of 0.13).
- Set up a second process condition more than 5% of span above the minimum process condition, and use the Trim Gain procedure at that condition. The gain will now be initialized correctly. (The instrument would work fine in this configuration for an interface application. However, if you have a density application, it won't be possible to report the PV correctly in engineering units if the instrument calibration is concluded at this point.)

Since you now have a valid gain:

- Change the PV mode to Interface or Density,
- reconfigure the fluid SGs or range values to the actual fluid values or extremes, and
- use the Trim Zero procedure in the Partial Calibration menu to back-compute the theoretical zero-buoyancy angle.

The last step above will align the value of the PV in engineering units to the independent observation.

Note

Information on simulating process conditions is available in the Simulation of Process Conditions for Calibration of Fisher Level Controllers and Transmitters instruction manual supplement (D103066X012), available from your Emerson Process Management sales office or at www.fisher.com.

Following are some guidelines on the use of the various sensor calibration methods when the application uses an overweight displacer:

Weight-based: Use two accurately known weights between minimum and maximum buoyancy conditions. The full displacer weight is invalid because it will put the linkage on a stop.

Min/Max: Min now means submerged in the lightest fluid and Max means submerged in the heaviest fluid.

Two point: Use any two interface levels that actually fall on the displacer. Accuracy is better if the levels are farther apart. The result should be close if you can move the level even 10%.

Theoretical: If the level cannot be changed at all, you can enter a theoretical value for torque tube rate manually, then Trim Zero to adjust the output to the current independent observation of the process condition. Gain and bias errors will exist with this approach, but it can provide nominal control capability. Keep records of subsequent observations of

actual process versus instrument output and different conditions and use the ratios between the process and instrument changes to scale the torque rate value. Repeat Zero Trim after each gain change.

Density Applications - with Standard Displacer and Torque Tube

Note

When you change 'PV is' from level or interface to density, the range values will be initialized to 0.1 and 1.0 SGU. You may edit the range values and density units after that initialization. The initialization is performed to clear out irrelevant numerical values from length dimensions that cannot be reasonably converted to density dimensions.

Any of the full sensor calibration methods (Min/Max, Two Point, and Weight) can be used in density mode.

Min/Max: The Min/Max Calibration first asks for the SG of your minimum density test fluid (which could be zero if the displacer is not overweight). Then, it has you set up a completely submerged displacer condition with that fluid. Next it asks for the SG of your maximum density test fluid and directs you to completely submerge the displacer in that fluid. If successful, the computed torque rate and zero reference angle are displayed for reference.

Two Point: The Two Point Calibration requires you to set up two different process conditions with as much difference as possible. You could use two standard fluids with well-known density and alternately submerge the displacer in one or the other. If you are going to try to simulate a fluid by using a certain amount of water, remember that the amount of displacer covered by the water is what counts, not the amount in the cage. The amount in the cage will always need to be slightly more because of the displacer motion. If successful, the computed torque rate and zero reference angle are displayed for reference.

Weight Based: The Weight Calibration asks you for the lowest and highest density you want to use for the calibration points, and computes weight values for you. If you can't come up with the exact values asked for, you are allowed to edit the values to tell it what weights you actually used. If successful, the computed torque rate and zero reference angle are displayed for reference.

Sensor Calibration at Process Conditions (Hot Cut-Over) when input cannot be varied

If the input to the sensor cannot be varied for calibration, you can configure the instrument gain using theoretical information and use Trim Zero to trim the output to the current process condition. This allows you to make the controller operational and to control a level around a setpoint. You can then use comparisons of input changes to output changes over time to refine the gain estimate. A new trim zero will be required after each gain adjustment. This approach is not recommended for a safety-related application, where exact knowledge of the level is important to prevent an overflow or dry sump condition. However, it should be more than adequate for the average level-control application that can tolerate large excursions from a midspan set point.

There are a number of calibration methods available in the DLC3010 Device Description. Two Point Calibration allows you to calibrate the torque tube using two input conditions that put the measured interface anywhere on the displacer. The accuracy of the method increases as the two points are moved farther apart, but if the level can be adjusted up or down a minimum 5% span, it is enough to make a calculation. Most level processes can accept a small, manual adjustment of this nature. If your process cannot, then the theoretical approach is the only method available.

1. Determine all the information you can about the 249 hardware: 249 type, mounting sense (controller to the right or left of displacer), torque tube material and wall thickness, displacer volume, weight, length, and driver rod length. (the driver rod length is not the suspension rod length, but the horizontal distance between the centerline of the displacer and the centerline of the torque tube). Also obtain process information: fluid densities, process temperature, and pressure. (The pressure is used as a reminder to consider the density of an upper vapor phase, which can become significant at higher pressures.)

2. Run Instrument Setup and enter the various data that is requested as accurately as possible In Manual Setup. Set the *Range Values* (LRV, URV) to the PV values where you will want to see 4 mA and 20 mA output, respectively. These might be 0 and 14 inches on a 14 inch displacer.
3. Mount and couple at the current process condition. Do not run the Capture Zero procedure, because it will not be accurate.
4. With the torque tube type and material information, find a theoretical value for the composite or effective torque-tube rate, (Refer to the Entering Theoretical Torque Tube (TT) Rates procedure in this section), and enter it in the instrument memory. The value can be accessed by selecting:
Configure > Manual Setup > Sensor > Torque Tube > Change Torque Rate (2-2-1-3-2)
If you select the 'Need Assistance' option instead of the 'Edit value directly' approach, the procedure can look up values for commonly available torque tubes.
5. If the process temperature departs significantly from room temperature, use a correction factor interpolated from tables of theoretical normalized modulus of rigidity. Multiply the theoretical rate by the correction factor before entering the data. You should now have the gain correct to within perhaps 10%, at least for the standard wall, short length torque tubes. (For the longer torque tubes (249K, L, N) with thin-wall and a heat insulator extension, the theoretical values are much less accurate, as the mechanical path departs considerably from the linear theory.)

Note

Tables containing information on temperature effects on torque tubes can be found in the Simulation of Process Conditions for Calibration of Fisher Level Controllers and Transmitters instruction manual supplement (D103066X012), available from your Emerson Process Management sales office or at www.fisher.com. This document is also available in the device help files linked to some host applications with graphical user interfaces.

6. Using a sight glass or sampling ports, obtain an estimate of the current process condition. Run the Trim Zero calibration and report the value of the actual process in the PV engineering units.
7. You should now be able to go to automatic control. If observations over time show the instrument output exhibits, for example,1.2 times as much excursion as the sight glass input, you could divide the stored torque tube rate by 1.2 and send the new value to the instrument. Then run another Trim Zero calibration and observe results for another extended period to see if further iteration is required.

Entering Theoretical Torque Tube (TT) Rates

The Simulation of Process Conditions for Calibration of Fisher Level Controllers and Transmitters instruction manual supplement (D103066X012) provides the theoretical composite torque tube (TT) rate for 249 sensors with DLC3010 controllers. These numbers are nominal values. They should be within 10% of the values that the instrument would compute when you perform a sensor calibration. They will be less accurate for the long torque tubes (249K, L, N, VS, and P), especially with thin-wall constructions.

If you are unable to perform a sensor calibration during installation, you may enter the values into the instrument at the following menu item in the handheld:
Configure > Manual Setup > Sensor > Torque Tube > Change Torque Rate (2-2-1-3-2)
If you select the 'Need Assistance' option instead of the 'Edit value directly' approach, the procedure can look up values for commonly available torque tubes.

Then, manually set the LRV and URV to the PV values at which you desire 4 and 20 mA output, respectively:
Configure > Manual Setup > Variables > Primary Variable Range > Upper or *Lower Range Value (2-2-2-3-1 or -2)*

Next, perform a *Trim Zero* operation to align the instrument output with the sight glass reading:
Configure > Calibration > Primary > Partial Calibration > Trim Zero (2-5-1-3-3)

These steps will provide an approximate PV calibration to get a system operational. Further refinements can then be made when it is possible to manipulate and observe the level and instrument output.

Excessive Mechanical Gain

If the displacer/torque tube sizing provides more than 4.4 degrees of torque tube rotation for a full span change in process input, It may be difficult to obtain a valid calibration with the normal coupling procedure. In such a case, you can utilize the full mechanical span of the DLC3010 by coupling the instrument to the torque tube at the 50% travel condition, instead of at the lowest process condition. When coupled at the 50% travel condition, the travel limits of the 249 hardware will be the constraining factor. If the 249 travel limit is reached before full process input travel is achieved, the hardware is either improperly sized for the application, improperly assembled, or damaged.

Determining the SG of an Unknown Fluid

If the instrument has been calibrated with weights or by using a test fluid with a well-known SG, it is possible to use the instrument to measure the SG of an unknown fluid, or the differential SG between two fluids. A procedure called 'Measure Density' is provided in the Manual Setup - Process Fluid menu when you are in Level measurement mode. The procedure presents the measured value and allows you either to automatically move it into the instrument configuration, or to manually record it for later use.

Accuracy Considerations

Effect of Proportional Band

If you are operating at low Proportional Band [PB = 100% times (full span torque tube rotation) / (4.4 degrees)], you can expect a degradation factor of about (100%)/(PB%) on the Transmitter accuracy specifications.

Note

This formula is most correct for linearity errors that are relatively steep-sided. If the linearity error curve shape is simple with relatively gradual slope, the net effect of reducing span may be less. Instruments such as the DLC3010, that use a compensation technique to reduce the residual mechanical or electrical non-linearity, will generally have a complex shape for the net-error curve.

If this is too much degradation, an improvement of 2.0 can be obtained by using a thin-wall torque tube. Additional gain can be achieved by increasing the displacer diameter. Available clearance inside the cage, and the need to keep the net displacer weight at the highest and lowest process conditions within the usable range of the torque tube / driver rod combination, place practical limits on how much the sizing can be adjusted.

With an overweight displacer, the calibration process becomes more difficult, (because the zero buoyancy condition will occur with the linkage driven hard into a travel stop). In interface measurement mode it becomes impossible to Capture Zero. One simple and effective solution is to use Level measurement mode. Capture Zero at the lowest process condition instead of zero buoyancy, and enter the differential SG = (SGlowerfluid - SGupperfluid). The algorithm then computes level correctly.

Density Variations in Interface Applications

A high sensitivity to errors in the knowledge of fluid density can develop in some interface applications. For example: Suppose the whole input span is represented by an effective change in SG of 0.18. Then a change in the actual SG of the upper fluid from 0.8 to 0.81 could cause a measurement error of 5.6% of span at the lowest interface level. The sensitivity to the knowledge of a fluid density is maximum at the process condition where that fluid covers all of the displacer, zero at the opposite extreme process condition, and varies linearly between those points.

If the fluid density changes are batch-related or very gradual, it may be practical to keep track of the SG of the fluid and periodically reconfigure the transmitter memory to match the actual process condition. Frequent automatic updates to this variable are not advised, as the NVM location where it is stored has an expected lifetime of about 10,000 write operations. If changes are only a function of temperature, the characteristic of the fluid can be loaded once in the NVM table, and an RTD connected to measure the process temperature and drive the correction table. If temperature is not the driving influence, the best that can be done is to calibrate for the widest potential differential SG. (This will keep the variations as small a percentage of calibrated span as possible.) Then calculate an alarm threshold that will prevent vessel over- or under-flow at the worst case error.

Extreme Process Temperatures

For applications that will run at extreme temperatures, the effect of process temperature on the torque tube must be taken into account. Best results are obtained by running the torque tube calibration at actual process temperature. However, the decrease in spring rate with temperature can be simulated at room temperature by increasing the load on the torque tube during room-temperature calibration. This will produce the same deflection that would occur at actual process conditions. This compensation is theoretical and not perfect, but is still an improvement over ambient calibration with no attempt at compensation.

Note

For additional information, refer to the Simulation of Process Conditions for Calibration of Fisher Level Controllers and Transmitters instruction manual supplement (D103066X012), available from your Emerson Process Management sales office or at www.fisher.com.

Temperature Compensation

If the process temperature departs significantly from calibration temperature, you will need to apply a correction factor. Interpolate the correction factor from the material-specific tables of theoretical normalized modulus of rigidity versus temperature, as described in the Simulation of Process Conditions for Calibration of Fisher Level Controllers and Transmitters instruction manual supplement. Multiply the measured torque tube rate (editable in the review menu under factory settings) by the correction factor and enter the new value. When you cannot calibrate at process temperature this approach allows a better approximation of the actual torque tube behavior at process conditions.

Section 5 Service Tools

Active Alerts

Field Communicator	Service Tools > Active Alerts (3-1)

Visible if an alert is not active

No Active Alerts

Visible if an alert is active

Refresh Alerts— issues a request to the device to update the reported status information for display. This is used to clear displayed alerts after corrective action has been taken. Items in the following list appear only if the associated alert is actve:

- F: Process Temperature Signal Failed - When active, indicates the process temperature sensor (RTD) reading has exceeded the hardcoded limits (<10 ohms or >320 ohms).
  If this status message appears, appears:
  1. Check condition of RTD and its wiring. Ensure RTD is connected.
  2. For temporary remedial action, switch 'Process Temperature Source' to 'Manual Entry' and enter best estimate of current process temperature.
  3. After repair of RTD circuit, restore.
- F: Sensor Drive Failed - The Hall sensor drive current read-back is outside of the hard-coded limits.
  If this message appears:
  1. Confirm integrity of connection between electronics module and transducer board.
  2. If Hall sensor continuity is good, replace electronics module.
  3. If not, replace instrument. (Check warranty status.)
- F: Sensor Signal Failed - The instrumentation amplifier output for the torque tube position is outside of range.
  If this message appears:
  1. Check whether instrument lever assembly is being driven to a mechanical stop by the sensor linkage.
  2. If so, correct the coupling configuration.
  3. Otherwise, replace instrument or electronics module as appropriate.
- M: Non-Primary Variable Out of Limits - When active, indicates the process applied to a sensor, other than that of the Primary Variable, is beyond the operating limits of the device. This indicates Electronics or Process Temperature has reached or exceeded the associated temperature alert limits. This is a summary alert - check the appropriate detail alerts for recommendations.
- M: Analog Output Saturated - The Analog Output value reported by the instrument is beyond the limits (3.8 or 20.5 mA) and no longer represent the true applied process.
  If this message appears:
  1. Check whether the PV range values (and Level Offset, where applicable) are set appropriately.
  2. Confirm that PV is tracking physical process - check calibration.
  3. If temperature compensation is being used on fluid density parameters, check the process temperature signal quality (or manual value), and the compensation table accuracy.
  4. Confirm that the hardware and data configurations are correct for the application.
  5. Check mechanical hardware for damage.

- M: Processor Free Time Depleted - There is insufficient free time remaining in the execution period to complete the scheduled tasks.
  If this message appears:
  1. Reset the processor or cycle power to the instrument.
  2. If the condition repeats, replace the electronics module. (Check warranty status.)
- M: NVM Write Limit Exceeded - When active, indicates the total number of writes to one of the three areas of NVM has exceeded the hardcoded limit. Try cycling power to the instrument and see if it clears.
  If it does not clear:
  1. If the Configuration NVM count is 0, replace the electronics module. Check for system conditions that could cause frequent automatic writes to configuration data.
  2. If the Transducer NVM count is 0, the most likely cause is a circuit failure on the transducer board. Replace and submit the instrument for warranty consideration.

Note
The Buffer NVM is only used during firmware load. It should never deplete its remaining write count.

- A: Analog Output Fixed - The Analog Output is in Fixed Current Mode.
  If this message appears:
  1. If the device is in multi-drop mode (Polling Address is non-zero) or a loop test is in progress, this is an intended state.
  2. If point-to-point network topology is desired, restore polling address to zero
  3. If device was accidentally left in loop test, exit fixed current mode.
- A: Cold Start - A power cycle or device reset has occurred.
  If this message appears:
  1. If event was unexpected, check condition of loop wiring and power supply.
  2. Check the terminal box integrity and instrument function over the range of environmental conditions being experienced.
- A: Instrument Temperature Too Low - When active, indicates that the Instrument Temperature has exceeded the value of the Instrument Temperature Low Alert Threshold.
- A: Instrument Temperature Too High - When active, indicates that the Instrument Temperature has exceeded the value of the Instrument Temperature High Alert Threshold.

  If instrument temperature alert messages appear:
  1. Check accuracy of temperature signal.
  2. Modify mounting/installation of device to maintain the operating temperature within limits.
  3. Check functionality. If degraded, replace the device.
  4. Check for appropriate value of Alert Threshold.
- A: Process Temperature Too Low - When active, indicates that the Process Temperature has exceeded the value of the Process Temperature Low Alert Threshold.
- A: Process Temperature Too High - When active, indicates that the Process Temperature has exceeded the value of the Process Temperature High Alert Threshold.

  If process temperature alert messages appear:
  1. Check accuracy of temperature signal.
  2. Adjust process temperature within limits.
  3. Inspect sensor hardware for any damage caused by temperature extremes. Repair or replace components as required.
  4. Check for appropriate value of Alert Threshold.

- A: PV LoLo Alert - When active, indicates that the Process Variable has exceeded the value of the Process Variable Low Low Alert Threshold. Analog Output set to jumper-selected alarm current, (if in Point-to-Point network).
  1. Take immediate action to stop violation of process limits.
  2. Take remedial action for any process stream quality or drain contamination incurred.
  3. Check calibration of instrument.
  4. Check for appropriate value of Alert Threshold.
- A: PV Lo Alert - When active, indicates that the Process Variable has exceeded the value of the Process Variable Low Alert Threshold.
  If this message appears:
  1. Correct the out-of-limits process condition.
  2. Check calibration of instrument.
  3. Check for appropriate value of Alert Threshold.
- A: PV HiHi Alert - When active, indicates that the Process Variable has exceeded the value of the Process Variable High High Alert Threshold. Analog Output set to jumper-selected alarm current (if in Point-to-Point network).
  1. Take immediate action to stop violation of process limits.
  2. Take remedial action for any process stream quality or overflow incurred.
  3. Check calibration of instrument.
  4. Check for appropriate value of Alert Threshold.
- A: PV Hi Alert - When active, indicates that the Process Variable has exceeded the value of the Process Variable High Alert Threshold.
  If this message appears:
  1. Correct the out-of-limits process condition.
  2. Check calibration of instrument.
  3. Check for appropriate value of Alert Threshold.
- A: PV Out of Limits - Primary Variable value is beyond its operating limit.

Variables

Field Communicator	Service Tools > Variables (3-2)

Follow the prompts on the Field Communicator display to view the following analog output variables.

PV is— Indicates the type of measurement either level, interface (the interface of two liquids of different specific gravities), or density (measures the liquid specific gravity). The process variable displayed and measured depends on the entry for “PV is” under PV Setup.

Primary Variable

- PV Value— Indicates the current process variable (level, interface, or density) in engineering units.
- % Range— Indicates the current process variable in percent of the span determined by the lower range value and the upper range value.

Refer to figure 5-1. If the digital level controller is setup for direct action the lower range value is less than the upper range value. If the digital level controller is setup for reverse action the lower range value is greater than the upper range value. Use the following equation to calculate the % range values:

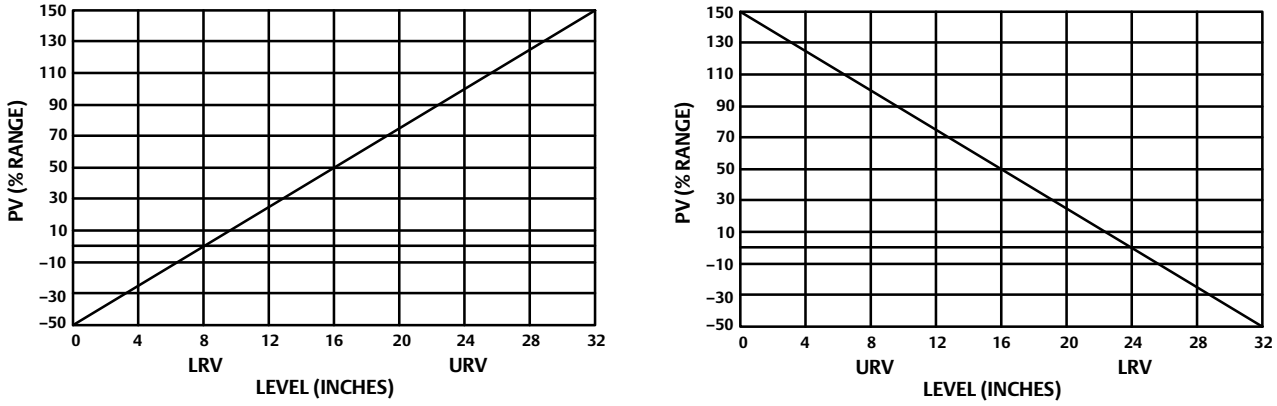
$$\text{PV(\%range)} = \frac{(\text{PV}_{\text{EU}} - \text{LRV})}{(\text{URV} - \text{LRV})} \times 100$$

where:

PV_{EU} = process variable in engineering units

The LRV always represents the 0% range value and the URV always represents the 100% range value.

Figure 5-1. PV % Range Indication for Direct and Reverse Action with a 32-Inch Displacer Ranged for 8 to 24 Inches



AO— Indicates the current analog output value of the instrument, in milliamperes.

Inst Temp— Indicates the current Instrument Temperature.

Process Temperature

- Proc Temp Source— The source of measurement for Process Temperature.
- Proc Temp—- Indicates the current Process Temperature.

Torque Rate— Torque rate of the torque tube applied in PV measurements.

Upper Fluid Density — Density of Upper Fluid applied in PV measurements.

Note

Upper Fluid Density is only visible if PV is Interface

Lower Fluid Density— Density of Lower Fluid applied in PV measurements.

Note

Lower Fluid Density is only visible if PV is Level or Interface

Maintenance

Tests

Field Communicator	Service Tools > Maintenance > Tests (3-3-1-1)

LCD Test— only visible if LCD Configuration is installed

The meter activates all segments immediately after power-up, during a digital level controller self-test, or during a master reset sent by a host supporting HART communications. You can also test the meter by selecting *Turn Cells On* to turn on all display segments, including the analog output bar graph, or select *Turn Cells Off* to turn off all display segments. When finished with the test, press OK to return the meter to normal display mode.

Loop Test— used to verify the controller output, the integrity of the loop, and the operations of any recorders or similar devices installed in the loop. To initiate a loop test, perform the following procedure:

1. Connect a reference meter to the controller. To do so, either connect the meter to the test connections inside the terminal box (see the Test Connections procedure) or connect the meter in the loop as shown in figure 2-9.
2. Access *Loop Test*.
3. Select *OK* after you set the control loop to manual.

The Field Communicator displays the loop test menu.

4. Select a discreet milliamp level for the controller to output. At the “Choose analog output” prompt, select *4 mA*, *20 mA,* or *Other* to manually input a value between 4 and 20 milliamps.
5. Check the reference meter to verify that it reads the value you commanded the controller to output. If the readings do not match, either the controller requires an output trim, or the meter is malfunctioning.

After completing the test procedure, the display returns to the loop test screen and allows you to choose another output value or end the test.

Reset/Restore

Field Communicator	Service Tools > Mainentance > Reset/Restore (3-3-2)

Restore Factory Defaults

- Restore Factory Configuration— Follow the prompts on the Field Communicator display to restore the digital level controller to the factory configuration.
- Restore Factory Compensation— Replaces all calibration and compensation data with factory defaults.

  Both Restore Factory Configuration and Restore Factory are drastic procedures which should be used only as a last resort.

Reset Device— Issues a master reset request to the processor in the DLC3010.

Section 6 Maintenance & Troubleshooting

The DLC3010 digital level controller features a modular design for easy maintenance. If you suspect a malfunction, check for an external cause before performing the diagnostics described in this section.

Sensor parts are subject to normal wear and must be inspected and replaced as necessary. For sensor maintenance information, refer to the appropriate sensor instruction manual.

⚠ WARNING

To avoid personal injury, always wear protective gloves, clothing, and eyewear when performing any maintenance operations.

Personal injury or property damage due to sudden release of pressure, contact with hazardous fluid, fire, or explosion can be caused by puncturing, heating, or repairing a displacer that is retaining process pressure or fluid. This danger may not be readily apparent when disassembling the sensor or removing the displacer. Before disassembling the sensor or removing the displacer, observe the appropriate warnings provided in the sensor instruction manual.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

CAUTION

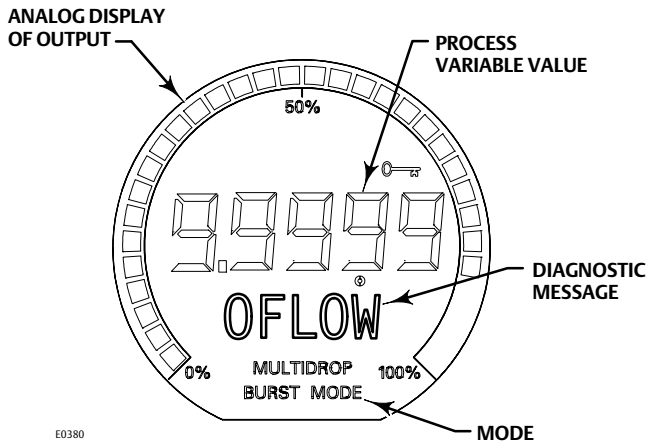
When replacing components, use only components specified by the factory. Always use proper component replacement techniques, as presented in this manual. Improper techniques or component selection may invalidate the approvals and the product specifications, as indicated in table 1-1. It may also impair operations and the intended function of the device.

Diagnostic Messages

In addition to the output, the LCD meter displays abbreviated diagnostic messages for troubleshooting the digital level controller. To accommodate two-word messages, the display alternates between the first and second word. The meter displays messages simultaneously on the Process Variable and Process Variable Unit lines as shown in figure 6-1. Messages on the Process Variable line refer to general device conditions, while messages on the Process Variable Unit line refer to specific causes for these conditions. A description of each diagnostic message follows.

- [BLANK]— If the meter does not appear to function, and the instrument is otherwise functioning correctly, make sure the digital level controller is configured for the LCD meter. The meter will not function if the *LCD Configuration* selection is “Not Installed.” To check this function, connect the Field Communicator to the digital level controller and turn it on. From the Online menu, select:
  Configure > Manual Setup > Instrument Display > LCD Configuration (2-2-5-1)
  For information on setting up the LCD meter see page 47. A diagnostic test for meter function is also detailed later in this section.

Figure 6-1. LCD Meter Diagnostic Display



- FAIL HDWR— This message indicates the existence of one or more of the following conditions:

  —The primary sensor input conversion is out of range.

  —The primary sensor drive current is out of range.

  —The internal reference voltage for controlling the loop current is out of range.

Perform the diagnostic procedures detailed later in this section to isolate the specific failure. If diagnostics indicate a failure of a particular module, replace the indicated module with a new one. Otherwise, correct the mechanical input condition to clear the message.

- OFLOW— The location of the decimal point, as configured in the meter setup, is not compatible with the value to be displayed by the meter. For example, if the meter is measuring a level greater that 99.999 mm, and the meter decimal point is set to 3 digit precision, the meter will display an “OFLOW” message because it is only capable of displaying a maximum value of 99.999 when set to 3 digit precision. The position of the decimal point may be adjusted by using the Field Communicator. From the Online menu, select:
  Configure > Manual Setup > Instrument Display > Decimal Places (2-2-5-4).
  Selecting “0” will put the display in auto-scale mode. (The number of decimal places displayed will be the maximum remaining in the display field for the current value of PV.)

Hardware Diagnostics

If you suspect a malfunction despite the absence of diagnostic messages on the Field Communicator display, follow the procedures described in table 6-1 to verify that the digital level controller hardware and process connections are in good working order. Under each of the major symptoms, specific suggestions are offered for solving problems. Always deal with the most likely and easiest-to-check conditions first.

Table 6-1. Troubleshooting

Symptom	Potential Source	Corrective Action
Analog Output is within valid range but Instrument does not communicate with Field Communicator	Loop Wiring	1. Check resistance between the power supply and the Field Communicator connection. The net resistance in the loop must be between 230 and 1100 Ohms for HART communication. 2. Check for adequate voltage to the digital level controller. Refer to figure 2-10 for requirements. Some models of battery-operated field calibrators do not have sufficient compliance voltage to operate a DLC3010 over the entire output current range. 3. Check for excessive capacitance in the field wiring. (Isolate the instrument from field wiring and try to communicate locally.)
	Terminal Box	4. If the terminal box does not have a 4-digit date-code sticker inside the lower lip, it may have developed a high internal resistance. Try a new terminal box.
	Electronics Module	5. Swap the electronics module with a known good part.
	Transducer Module	6. If the electronics module and terminal box work on a known good transducer module, replace the old transducer module.
Output ≅ 0 mA	Loop Wiring	7. Check for open circuits. 8. Check for proper polarity at the signal terminals. — See item 2. above.
	Terminal Box	9. Check resistance between "Loop+" and "T" terminals of terminal box. If greater than 1.1 Ohm, the internal sense resistor may be damaged. An external jumper may be added for a temporary repair. Replace terminal box and avoid applying loop voltage across "T" and "Loop+" for long term solution. — See item 4. above
	Electronics Module	— See item 5. above.
	Transducer Module	— See item 6. above.
Fixed Output ≅ 3.7 mA	Alarm Condition (Fail-low setting)	Connect the Field Communicator and: 10. Select *LCD Test* (3-3-1-1)to isolate a module failure. 11. Check PV against Hi-Hi and Lo-Lo alarm thresholds and PV alarm deadband setting, if these alarms are enabled.
Fixed Output = 3.8 mA	Low Saturation	Connect the Field Communicator and: 12. Check the PV against the upper and lower range values. Check actual process condition and calibration adjustments.
Fixed Output = 20.5 mA	High Saturation	Connect the Field Communicator and: — see item 12. above.
Fixed Output ≅ 22.5 mA	Alarm Condition (Fail-high setting)	Connect the Field Communicator and: — see items 10. and 11. above.
Fixed Output > 22.5 mA	Loop Wiring	13. Check for short circuits.
	Terminal Box	14. Remove terminal box from the instrument, and apply 24 Volts between Loop+ and Loop- terminals, (with a series resistance of approximately 1200 Ohms to protect power supply). If any current flows, replace terminal box.
	Electronics Module	— See item 5. above.
Output is within 4-20 mA range, but does not track displayed PV value (e.g., a) gain error, b) low saturation occurs at a value higher than 3.8 mA, c) high saturation occurs at a value lower than 20.5 mA)	Electronics Module	Connect the Field Communicator and: 15. Run Loop diagnostic test (3-3-1-1) [(3-3-1-2) if LCD Configuration is installed]. If the forced output does not track commands, attempt *Scaled D/A Trim* procedure (2-5-2-2-1). If D/A calibration cannot be restored, replace Electronics Module.
Output Drifting while at fixed process input.	Sensor	16. Check torque tube spring rate change versus process temperature per figure 1-2. Use appropriate material for process temperature. Pre-compensate the calibration for target process condition.
	Transducer Module	Connect the Field Communicator and: 17. Check *Instrument Temperature* (3-2-4) against an independent measurement of DLC3010 temperature. a) If inaccurate, trim the instrument temperature measurement (2-5-2-1-1) to improve ambient temperature compensation performance. b) If *Instrument Temperature* value is extreme, replace transducer module.
	Electronics Module	Connect the Field Communicator and: 18. Run Loop diagnostic test (3-3-1-1) [(3-3-1-2) if LCD Configuration is installed]). Leave instrument in fixed current mode at 12 mA command and observe analog output variation with ambient temperature. If drift exceeds specifications replace electronics module.
	Configuration Data	Connect the Field Communicator and: 19. Check stored *Specific Gravity* values (2-2-3-1) against independent measurement of process density. If process SG has changed from calibration values, correct configuration data to match process
Erratic Output	Loop Wiring	If output current enters a limit cycle between zero and a value within the 4-20 mA range when level reaches some arbitrary upper threshold, 20. Check for excessive loop resistance or low compliance voltage. (See items 2. and 4. above.)
Scrambled or erratic Display on LCD	Loop Wiring	—see item 20. above. (Insufficient voltage to operate display)
	LCD Assy	21. Swap LCD Assy with known good part.
	Electronics Module	22. Connector solder joint failure in electronics module. Replace module.

Test Terminals

Test connections inside the terminal box can be used to measure loop current. These terminals are across an internal 1 ohm resistor that is in series with the loop.

1. Remove the terminal box cap.
2. Adjust the test meter to measure a range of 0.001 to 0.1 volts.
3. Connect the positive lead of the test meter to the + connection and the negative lead to the T connection inside the terminal box.
4. Measure Loop current as:

Voltage (on test meter) $\times$ 1000 = milliamps

example:

Test meter Voltage X 1000 = Loop Milliamps

0.004 X1000 = 4.0 milliamperes

0.020 X 1000 = 20.0 milliamperes

5. Remove test leads and replace the terminal box cover.

Removing the Digital Level Controller from the Sensor

Because of its modular design, most of the service and maintenance to the digital level controller can be done without removing it from the sensor. However, if necessary to replace sensor to instrument mating parts or parts in the transducer housing, or to perform bench maintenance, perform the following procedures to remove the digital level controller from the sensor.

⚠ WARNING

On an explosion-proof instrument, remove the electrical power before removing the instrument covers in a hazardous area. Personal injury or property damage may result from fire and explosion if power is applied to the instrument with the covers removed.

Tools Required

Table 6-2 lists the tools required for maintaining the DLC3010 digital level controller.

Table 6-2. Tools Required

Tool	Size	Usage	Keys
Hex Key	2 mm	Handle Cover-lock set screws	31 20
Hex Key	2.5 mm	Small cap screws	13
Hex Key	4 mm	Lever assembly mtg cap screw	14
Hex Key	5 mm	Terminal box mtg cap screw	7
Hex Socket	10 mm	Coupling nut	76
Open-end	13 mm	Transmitter mounting nuts	34
Phillips Screwdriver		Terminal screws Electronics module mtg screws	25 36
Small flat blade screwdriver		LCD assy mtg screws	40
Strap wrench		Helpful for removing a display cover that has been over-tightened	3
Large flat blade screwdriver(1)		Flex circuit mtg screws	19
Needle nose pliers(1)		Align/clamp ring extraction	17

1. Needed to remove a flex circuit if date code numbers are requested for warranty information.

Removing the DLC3010 Digital Level Controller from a 249 Sensor

249 Sensor in Standard Temperature Applications

1. Loosen the set screw (key 31) in the terminal box cover assembly (key 6) so that the cover can be unscrewed from the terminal box.
2. After removing the cover (key 6), note the location of field wiring connections and disconnect the field wiring from the wiring terminals.
3. As shown in figure 2-4, locate the access handle on the bottom of the transducer housing. Using a 2 mm hex key, back out the set screw in the depression on the access handle until it is flush with the handle surface. Press on the back of the handle, as shown in the figure, and slide the handle toward the front of the unit, (the locked position), to expose the access hole. Be sure the locking handle drops into the detent.

Note

If the access handle will not slide, the sensor linkage is most likely in an extreme position. When the lever assembly is at a hard stop inside the housing, the locking pin on the access door may not be able to engage the mating slot in the lever assembly. This condition can occur if the displacer has been removed, if the sensor is lying on its side, or if the instrument had been coupled to the sensor while the displacer was not connected. To correct this condition, manipulate the sensor linkage to bring the lever assembly to within approximately 4 degrees of the neutral position before attempting to slide the handle. A probe inserted through the top vent of the 249 head may be required to deflect the driver rod to a position where the lever assembly is free.

4. Using a 10 mm deep well socket inserted through the access hole, loosen the shaft clamp (figure 2-4).
5. Loosen and remove the hex nuts (key 34) from the mounting studs (key 33).
6. Carefully pull the digital level controller straight off the sensor torque tube.

CAUTION

Tilting the instrument when pulling it off of the sensor torque tube can cause the torque tube shaft to bend. To prevent damage to the torque tube shaft, ensure that the digital level controller is level when pulling it off of the sensor torque tube.

7. When re-installing the digital level controller, follow the appropriate procedure outlined in the Installation section. Also setup the digital level controller as described in the Initial Setup section.

249 Sensor in High Temperature Applications

1. Loosen the set screw (key 31) in the terminal box cover assembly (key 6) so that the cover can be unscrewed from the terminal box.
2. After removing the cover (key 6), note the location of field wiring connections and disconnect the field wiring from the wiring terminals.
3. As shown in figure 2-4, locate the access handle on the bottom of the transducer housing. Using a 2 mm hex key, back out the set screw in the depression on the access handle until it is flush with the handle surface. Press on the back of the handle, as shown in the figure, and slide the handle toward the front of the unit, (the locked position), to expose the access hole. Be sure the locking handle drops into the detent.

Note

If the access handle will not slide, the sensor linkage is most likely in an extreme position. When the lever assembly is at a hard stop inside the housing, the locking pin on the access door may not be able to engage the mating slot in the lever assembly. This condition can occur if the displacer has been removed, if the sensor is lying on its side, or if the instrument had been coupled to the sensor while the displacer was not connected. To correct this condition, manipulate the sensor linkage to bring the lever assembly to within approximately 4 degrees of the neutral position before attempting to slide the handle. A probe inserted through the top vent of the 249 head may be required to deflect the driver rod to a position where the lever assembly is free.

4. Using a 10 mm deep well socket inserted through the access hole, loosen the shaft clamp (figure 2-4).
5. While supporting the instrument, loosen and remove the cap screws (key 63).
6. Carefully pull the digital level controller straight off the torque tube shaft extension (key 58).

CAUTION

Tilting the instrument when pulling it off of the sensor torque tube can cause the torque tube shaft to bend. To prevent damage to the torque tube shaft, ensure that the digital level controller is level when pulling it off of the sensor torque tube.

7. Loosen and remove the hex nuts (key 34) from the mounting studs (key 33).
8. Pull the heat insulator (key 57) off the mounting studs.
9. When re-installing the digital level controller, follow the appropriate procedure outlined in the Installation section. Also setup the digital level controller as described in the Setup and Calibration section.

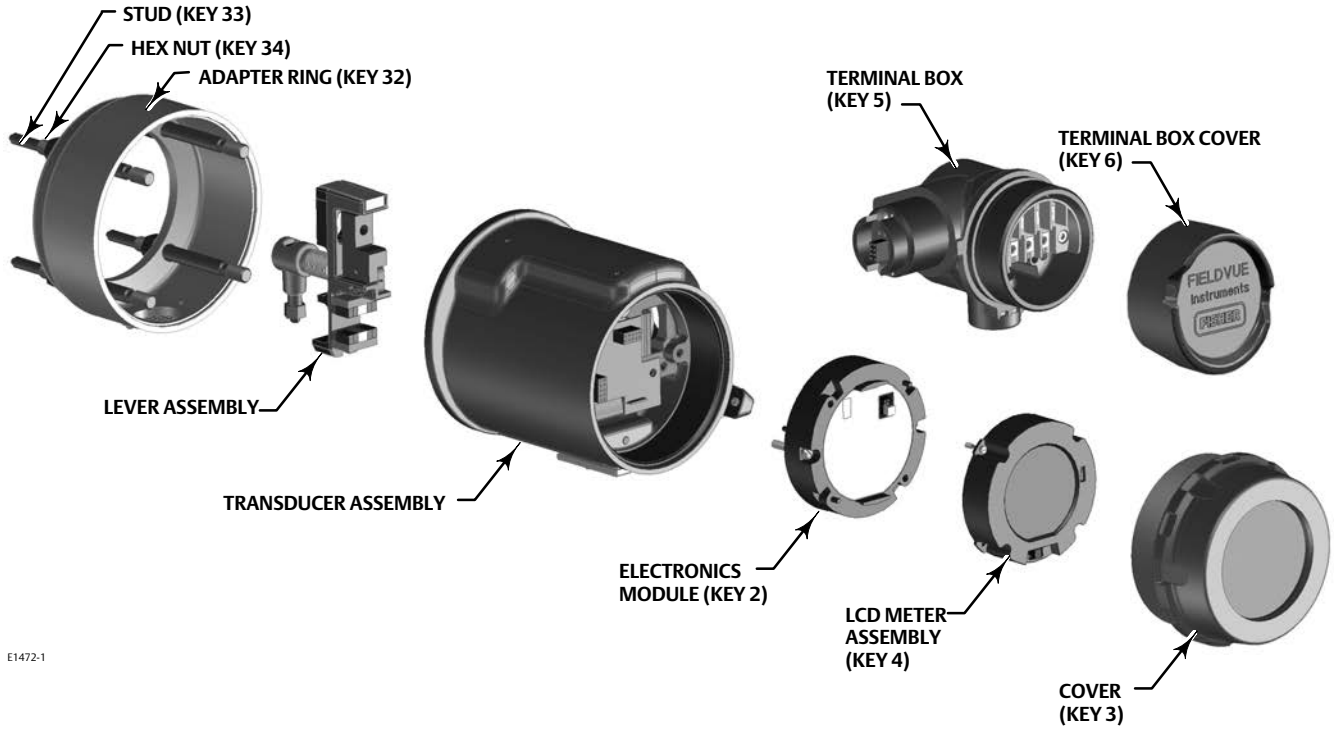
LCD Meter Assembly

⚠ WARNING

In an explosion-proof or flame-proof installation remove the electrical power before removing the instrument covers in a hazardous area. Personal injury or property damage may result from fire and explosion if power is applied to the instrument with the covers removed.

The digital level controller is designed with a dual-compartment housing; one compartment contains the LCD meter and Electronics Module; the other contains all wiring terminals and the communication receptacles. The LCD meter is located in the compartment opposite the wiring terminals, as shown in figure 6-2.

Figure 6-2. DLC3010 Digital Level Controller Assembly



Removing the LCD Meter

Perform the following procedure to remove the LCD meter.

1. Disconnect power to the digital level controller.
2. Remove the cover from the transducer housing. In explosive atmospheres, do not remove the instrument cover when the circuit is alive, unless in an intrinsically safe installation.
3. Loosen the two screws that anchor the LCD meter to the Electronics Module. These screws are captive and should not be removed.
4. Firmly grasp the LCD meter and pull it straight away from the Electronics Module. Retain the six-pin dual header for later reinstallation.

Replacing the LCD Meter

Perform the following procedure to replace the LCD meter.

1. Verify that the interconnection header is in the six-pin socket on the face of the Electronics Module. The longer set of pins should be inserted in the Electronics Module socket.
2. Decide which direction to orient the meter. The meter can be rotated in 90-degree increments for easy viewing. Position one of the four six-pin sockets on the back of the meter to accept the interconnection header, and insert

the long meter screws into the two holes on the meter to coincide with the appropriate holes on the Electronics Module.

3. Attach the meter to the interconnection pins. Thread the long meter screws into the holes on the Electronics Module and tighten to secure the meter.
4. Note the position of the alarm jumper on the LCD meter removed from the digital level controller. Remove the alarm jumper and install it on the replacement meter in the same position.
5. Install the six-pin dual header on the LCD meter. Carefully insert the LCD meter to mate with the interconnecting pins with the receptacles on the Electronics Module .

CAUTION

To prevent damage to the interconnecting pins when installing the LCD Meter, use the guide pins to insert the LCD meter straight onto the Electronics Module, without twisting or turning.

6. Replace the cover. Tighten 1/3 of a revolution after the cover begins to compress the O-ring. Both instrument covers must be fully engaged to meet explosion-proof or flame-proof requirements.

Electronics Module

Removing the Electronics Module

Perform the following procedure to remove the Electronics Module.

Note

The electronics are sealed in a moisture-proof plastic enclosure referred to as the Electronics Module. The assembly is a non-repairable unit; if a malfunction occurs the entire unit must be replaced.

⚠ WARNING

On an explosion-proof instrument, remove the electrical power before removing the instrument covers in a hazardous area. Personal injury or property damage may result from fire and explosion if power is applied to the instrument with the covers removed.

1. Disconnect power to the digital level controller.
2. Remove the cover from the transducer housing. In explosive atmospheres, do not remove the instrument cover when the circuit is alive, unless in an intrinsically safe installation. Remove the LCD meter assembly.
3. Loosen the two screws that anchor the Electronics Module to the transducer housing. These screws are captive and should not be removed.
4. Firmly grasp the Electronics Module and pull it straight out of the housing.

Replacing the Electronics Module

Perform the following procedure to replace the Electronics Module.

1. Carefully insert the Electronics Module to mate the interconnecting pins with the receptacles on the Transducer housing.

CAUTION

To prevent damage to the interconnecting pins when installing the Electronics Module, use the guide pins to insert the Electronics Module straight onto the Transducer housing receptacles without twisting or turning.

2. Tighten the two mounting screws. Replace the LCD meter assembly.
3. Replace the cover. Tighten 1/3 of a revolution after the cover begins to compress the O-ring. Both instrument covers must be fully engaged to meet explosion-proof requirements.

Terminal Box

The terminal box is located on the transducer housing and contains the terminal strip assembly for field wiring connections. Unless indicated otherwise, refer to figure 7-3.

⚠ WARNING

On an explosion-proof instrument, remove the electrical power before removing the instrument covers in a hazardous area. Personal injury or property damage may result from fire and explosion if power is applied to the instrument with the covers removed.

Removing the Terminal Box

1. Loosen the set screw (key 31) in the terminal box cover assembly (key 6) so that the cover can be unscrewed from the terminal box.
2. After removing the cover (key 6), note the location of field wiring connections and disconnect the field wiring from the wiring terminals.
3. Remove the screw (key 7), and pull out the terminal box assembly.

CAUTION

To avoid damaging the terminal box assembly connector, pull the terminal box assembly straight out of the housing, without twisting or turning.

Replacing the Terminal Box

Note

Inspect all O-rings for wear and replace as necessary.

1. Apply sealant to the O-ring (key 27) and install the O-ring over the stem of the terminal box as shown in figure 7-3.
2. Orient the terminal box so that the connectors engage properly, and carefully insert the terminal box into the transducer housing until the O-ring is seated.

CAUTION

To avoid damaging the mating pins in the Transducer housing, ensure that the guiding mechanism is engaged properly before applying force.

3. Fasten the terminal box to the transducer housing with the screw (key 7). Tighten the screw to 6 N•m (53 lbf•in).
4. Apply sealant to the O-ring (key 26) and install the O-ring over the cover threads on the terminal box. Use a tool to prevent cutting the O-ring while installing it over the threads.
5. Reconnect the field wiring as noted in step 2 in the Removing the Terminal Box procedure.
6. Apply lubricant to the threads on the terminal box to prevent seizing or galling while installing the terminal box cover.
7. Screw the terminal box cover assembly (key 6) completely onto the terminal box to seat the O-ring (key 26). Loosen the cover (not more than 1 turn) until the set screw (key 31) aligns with one of the recesses in the terminal box beneath the cover. Tighten the set screw to engage the recesses but no more than 0.88 N•m (7.8 lbf•in).
8. Apply lubricant to the conduit entrance plug (key 28) and install it in the unused conduit entrance.

Removing and Replacing the Inner Guide and Access Handle Assembly

The access handle and inner guide are located on the transducer housing. Unless indicated otherwise, refer to figure 7-2.

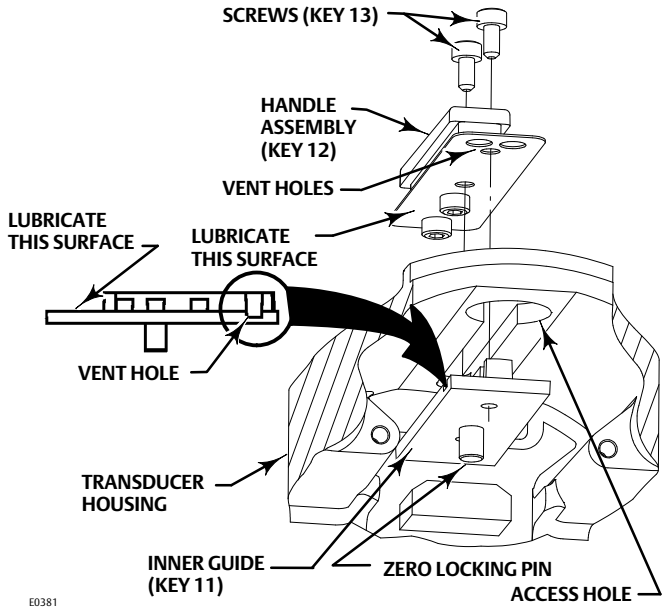
1. Remove the digital level controller from the sensor as described in Removing the Digital Level Controller from the Sensor.
2. Loosen and remove the hex nuts (key 34) from the studs (key 33) and remove the adapter ring (key 32).

Note

In the next step the screws (key 13) will be attracted by the magnets on the lever assembly. Use care to keep the screws from falling beneath the coupling shield.

3. Remove the coupling shield (key 16) by removing the two screws (key 13). Take care not to drop the screws into the lever assembly compartment where they will be attracted by the magnets.
4. Loosen and remove the two screws (key 13) in the handle assembly (key 12). Remove the handle assembly and the inner guide (key 11).
5. Apply thread lock to the internal threads of the replacement inner guide. Also apply a thin coat of a light grade of grease to the zero locking pin on the inner guide and on the surface that is opposite the zero locking pin, as shown in figure 6-3 (this surface contacts the transducer housing when installed).

Figure 6-3. Installing Inner Guide and Access Handle Assembly



6. Place the inner guide in the slot inside the transducer housing so that the vent holes in the inner guide (the milled slots in the inner guide, see figure 6-3) face the exterior of the housing and are over the access hole.
7. Apply a thin coat of a light grade of grease to the surface of the replacement handle assembly (see figure 6-3) where it will contact the transducer housing.
8. Install the handle assembly (key 12) in the slot of the transducer housing over the inner guide (key 11) so that the vent holes in the handle assembly are over the access hole.
9. Install two screws (key 13) to secure the handle assembly (key 12) to the inner guide (key 11). Tighten the screws to 0.48 N•m (4.2 lbf•in).
10. Press down on the handle as shown in figure 2-4 and slide it forward to make sure it works smoothly and that the zero locking pin engages the lever assembly. Also check for free travel of the lever assembly when the handle is in the unlocked position.
11. Install the coupling shield (key 16) and secure with the two screws (key 13). Tighten the screws to 0.48 N•m (4.2 lbf•in).
12. Refer to figure 7-1. Install the adapter ring (key 32) on the studs (key 33) and secure with hex nuts (key 34).
13. When re-installing the digital level controller, follow the appropriate procedure outlined in the Installation section. Also setup the digital level controller as described in the Setup and Calibration section.

Lever Assembly

Removing the Lever Assembly

The lever assembly is located in the transducer housing. Unless indicated otherwise, refer to figure 7-2.

1. Remove the digital level controller from the sensor as described in Removing the Digital Level Controller from the Sensor.

2. Loosen and remove the hex nuts (key 34) from the studs (key 33) and remove the adapter ring (key 32).
3. Remove the coupling shield (key 16) by removing the two screws (key 13). Take care not to drop the screws into the lever assembly compartment where they will be attracted by the magnets.
4. Inspect the lever assembly alignment with the housing. If it is off center or not co-axial with the main housing, continue with the removal procedure.
5. Loosen and remove the mounting screw (key 14) from the lever assembly.
6. Loosen the flexure block from its machined pocket in the housing, by inserting a smooth tool into the hole for the mounting screw, and gently rocking it back and forth in what would be the vertical axis if the transmitter were installed.
7. Lift the lever assembly out of the housing.

Inspect the flexure for damage. If the flexure is bent or torn, replace the lever assembly.

Replacing the Lever Assembly

Replacing the lever assembly in the field may result in a slight degradation in linearity performance, since the factory characterizes the entire transducer module as a unit. For most applications, this degradation should not be noticeable. (If guaranteed restoration to factory specification is desired, the entire transducer module should be replaced.)

1. Move the zero-pin slide to the locking position.
2. Apply a thin coat of a light grade of grease to the internal thread of the hole for the lever mounting bolt.
3. Hold lever assembly by coupling block and guide the flexure block into its aligning slot in the housing without applying any downward force to the sprung parts of the lever assembly.

CAUTION

To prevent damage to the flexure when inserting the flexure block into its aligning slot in the housing, apply pressure to the flexure block only.

A long pin inserted into the bolt-hole in the flexure block may be used to pull it against the inside corner of the aligning slot.

4. Secure the block by reinstalling the M5x20 socket-head cap screw (key 14). Torque to 2.8 N•m (25 lbf•in) ± 10%.
5. Mark bolt head and block with a movement-detecting sealant.
6. Install the coupling shield (key 16) and secure with the two screws (key 13). Tighten the screws to 0.48 N•m (4.2 lbf•in).
7. Refer to figure 7-1. Install the adapter ring (key 32) on the studs (key 33) and secure with hex nuts (key 34). When re-installing the digital level controller, follow the appropriate procedure outlined in the Installation section. Set up the digital level controller as described in the Setup and Calibration section.

Packing for Shipment

If it becomes necessary to return the unit for repair or diagnosis, contact your Emerson Process Management sales office for returned goods information.

CAUTION

Lock the lever assembly when shipping the stand-alone instrument, to prevent damage to the flexure.

Use the original shipping carton if possible.

Section 7 Parts

Parts Ordering

Whenever corresponding with your Emerson Process Management sales office about this equipment, always mention the controller serial number.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management, should not, under any circumstances, be used in any Fisher instrument. The use of components not manufactured by Emerson Process Management may void your warranty, might adversely affect the performance of the instrument, and could cause personal injury and property damage.

Mounting Kits

Contact your Emerson Process Management sales office for the following DLC3010 mounting options:

- Fisher 249 sensors - heat insulator for field mounting the DLC3010
- Masoneilan 12100, 12800 Series
- Masoneilan 12100, 12800 Series with heat insulator
- Masoneilan 12200, 12300 Series
- Masoneilan 12200, 12300 Series with heat insulator
- Yamatake Honeywell™ Type NQP
- Yamatake Honeywell Type NQP with heat insulator
- Foxboro-Eckardt 134LD and 144LD
- Foxboro-Eckardt 134LD and 144LD with heat insulator
- Foxboro-Eckardt LP167
- Foxboro-Eckardt LP167 with heat insulator

Note

Contact your Emerson Process Management sales office for information on the availability of additional mounting kits.

Parts Kits

	Description	Part Number
1*	Small Hardware Spare Parts Kit	19B1643X052
	Includes	Qty/kit
	Screw (key 7)	1
	Screw, hex socket (key 13)	6
	Screw, cap, hex socket (key 14)	1
	Set Screw (key 20)	2
	Set Screw (key 31)	2
	Test Terminal (key 24)	4
	Wire Retainer (key 25)	8
	Nut (key 34)	4
	Alarm Jumper (key 35)	2
	Header Assembly (key 38)	2
2*	Spare O-Rings Kit Includes three each of keys 21, 26, and 27	19B1643X022
3*	Coupling Hardware Spare Parts Kit	19B1643X042
	Includes	Qty/kit
	Clamp Nut (key 76)	1
	Washer, Lock, Spring (key 77)	1
	Bolt, lock, coupling block(key 82)	1

*Recommended spare parts

Parts List

Note

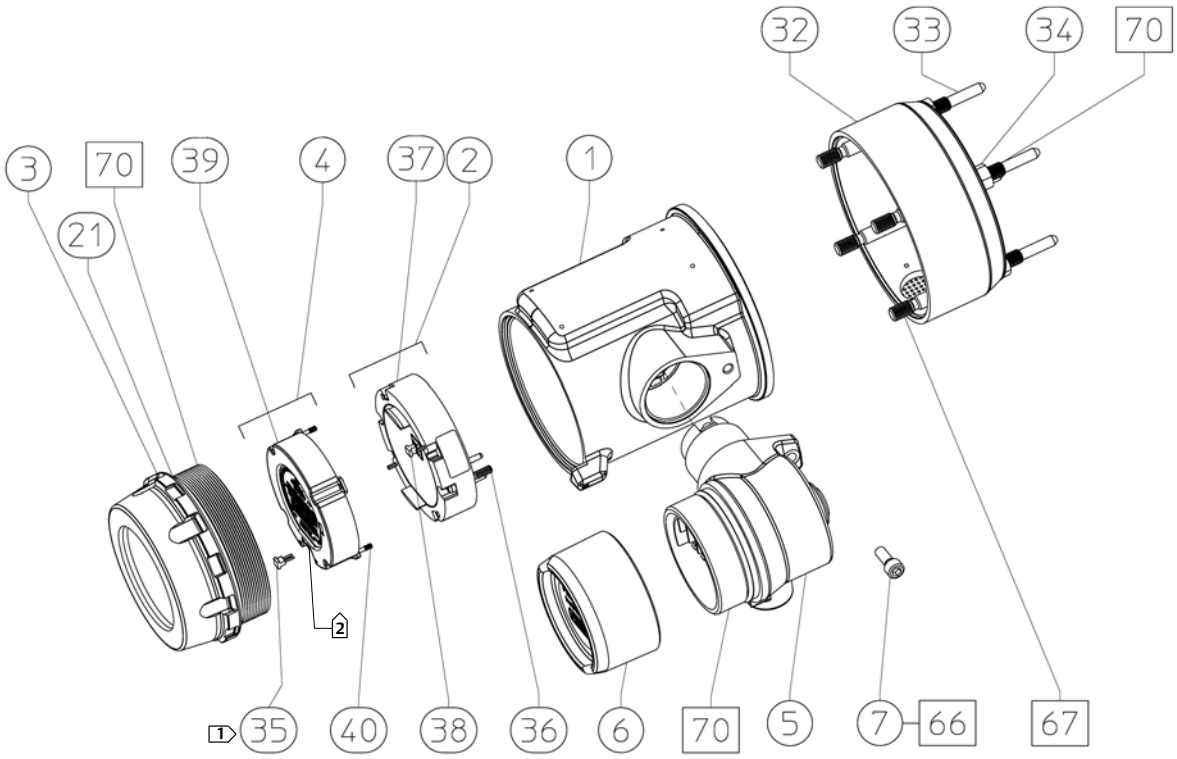
Contact your Emerson Process Management sales office for Part Ordering information.

DLC3010 Digital Level Controllers (figure 7-1)

Key	Description
1	Transducer Module(1)
2*	Electronics Ass'y(1)
3	Cover Assy, includes O-ring (key 21)
4	LCD Meter Ass'y, includes alarm jumper (key 35), header ass'y (key 38) and captive screws (key 40), and LCD Meter ass'y
5*	Terminal Box Ass'y
6	Terminal Box Cover Ass'y, includes labels (key 30 and 64) and set screw (key 31)
7	Screw, hex socket(2)
8	Nameplate
9	Drive Screw, 18-8 SST
21*	O-ring, nitrile(3)
32	Adaptor Ring, A03600
33	Stud, SST (4 req'd)
34	Hex Nut, 304 SST (4 req'd)
35	Alarm Jumper(2)(4)(5)
36	Screw, captive, 18-8 SST For electronics ass'y (2 req'd)(4)
38	Header Assembly, dual row (not shown)(2)(4)(5)
40	Screw, captive, 18-8 SST For LCD meter (2 req'd)(5)
66	Anti-Seize Sealant (not furnished with instrument)
67	Thread locking adhesive (medium strength) (not furnished with instrument)
70	Lithium grease (not furnished with instrument)

Key	Description	Part Number
3	Cover Assy, includes O-ring (key 21)	
4	LCD Meter Ass'y, includes alarm jumper (key 35), header ass'y (key 38) and captive screws (key 40), and LCD Meter ass'y	28B5738X012
5*	Terminal Box Ass'y	28B5740X022

Figure 7-1. DLC3010 Digital Level Controller Assembly



NOTES:
1 INSTALL ALARM JUMPER (KEY 35) ON ELECTRONICS ASSEMBLY (KEY2) WHEN LCD METER (KEY 4) IS NOT INSTALLED.
2 LOCATION OF ALARM JUMPER (KEY 35) WHEN LCD METER (KEY 4) IS INSTALLED.
☐ APPLY LUB/THREADLOCK
58B5510-E

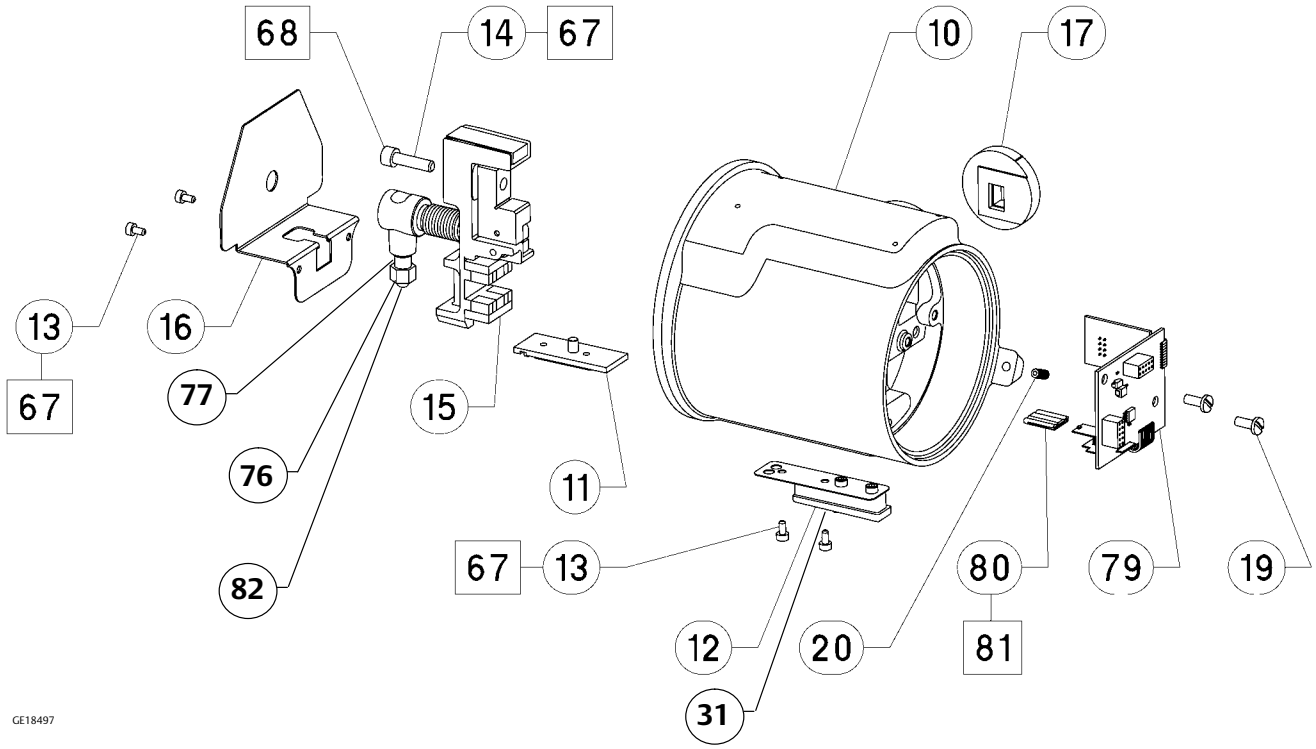
*Recommended spare parts
1. These parts are not replaced in the field due to serialization and characterization issues, but can be replaced at a qualified service center or Fisher Authorized Service Provider (FASP) that can issue nameplate. Contact your Emerson Process Management sales office for additional information.
2. Included in small hardware spare parts kit.
3. Included in spare O-rings kit.
4. Included in the Electronics Ass'y, key 2
5. Included in the LCD Meter Ass'y. key 4

Key	Description	Part Number

Transducer Assembly (figure 7-2)

Key	Description	Part Number
11	Inner Guide, aluminum	
12	Handle Ass'y aluminum/SST	
13	Screw, hex socket, 18-8 SST (4 req'd)	
14	Screw, cap, 18-8 SST	
15*	Lever Assembly, aluminum/SST/NdFeB/CS	38B5509X042
16	Coupling Shield, 18-8 SST	
17	Ring, align/clamp	
19	Machine Screw, pan head	
20	Set Screw, 18-8 SST(2)	
31	Set Screw, hex socket, 18-8 SST(2)	
67	Thread Locking adhesive (medium strength) (not furnished with instrument)	
68	Sealant	
76	Clamp Nut, 18-8 SST(2)(6)	
77	Spring Lock Washer, 18-8 SST(2)(6)	
79	Transducer Board Assembly(1)	
80	Hall Guard	
81	Compound, silicone	
82	Bolt, lock, coupling block, SST(6)	

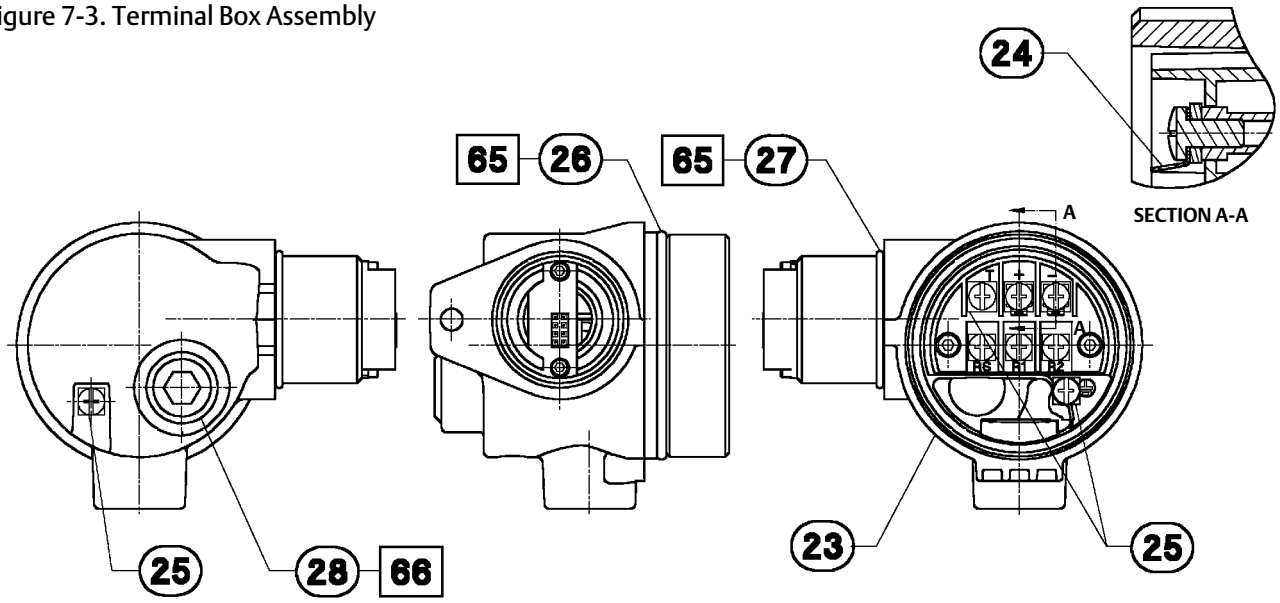
Figure 7-2. DLC3010 Digital Level Controller Transducer Assembly



*Recommended spare parts

1. These parts are not replaced in the field due to serialization and characterization issues, but can be replaced at a qualified service center or Fisher Authorized Service Provider (FASP) that can issue nameplate. Contact your Emerson Process Management sales office for additional information.
2. Included in small hardware spare parts kit.
6. Included in Coupling Hardware Spare Parts Kit

Figure 7-3. Terminal Box Assembly



Key Description

Terminal Box Assembly (figure 7-3)

24 Test Terminal, 18-8 SST (2 req'd)(2)
25 Wire Retainer, 18-8 SST (8 req'd)(2)

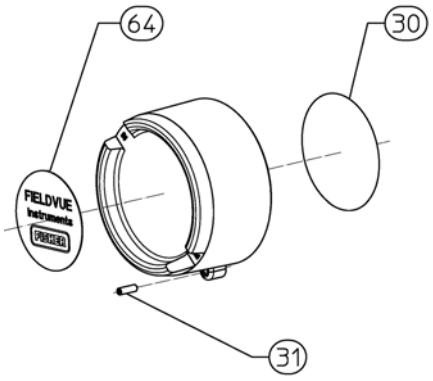
26* O-Ring, nitrile(3)
27* O-Ring, nitrile(3)

28 Pipe Plug, 18-8 SST
65 Lubricant, Silicone (not furnished with instrument)
66 Anti-Seize Sealant (not furnished with instrument)

Terminal Box Cover Assembly (figure 7-4)

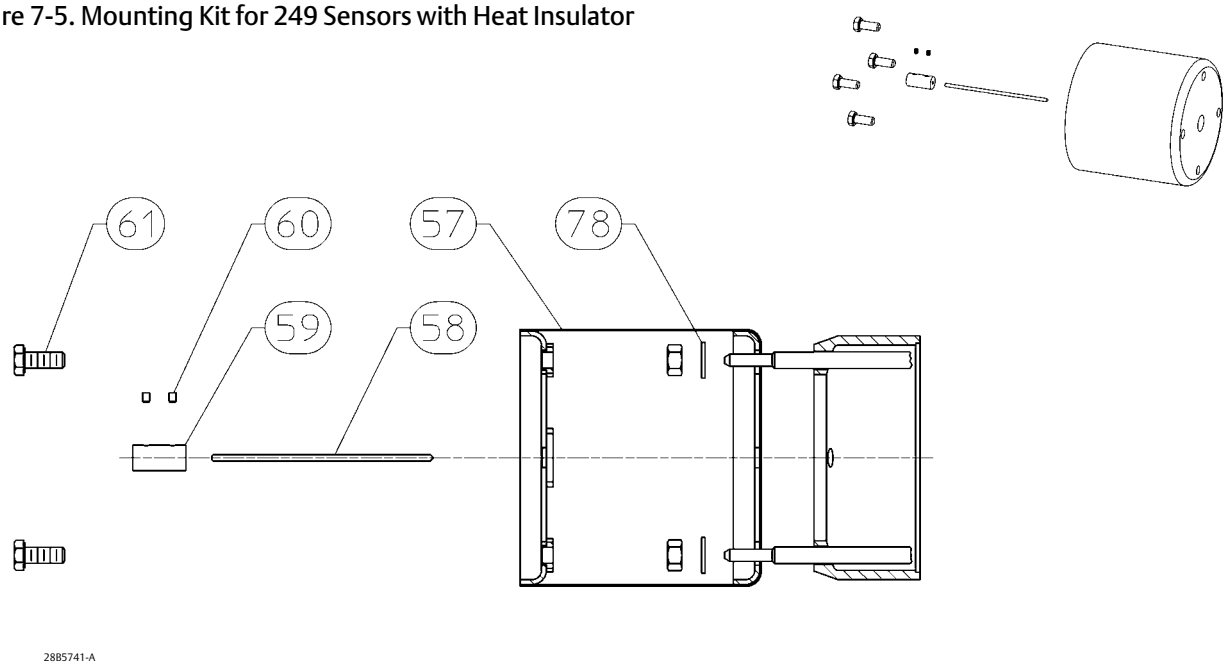
30 Label, internal, plastic
31* Set Screw, hex socket, 18-8 SST(2)
64 Label, external

Figure 7-4. Terminal Box Cover Assembly



*Recommended spare parts
2. Included in small hardware spare parts kit.
3. Included in spare O-rings kit.

Figure 7-5. Mounting Kit for 249 Sensors with Heat Insulator



Mounting Parts

These parts are available as a kit as indicated in the Mounting Kits section. Contact your Emerson Process Management sales office for these mounting options.

Key Description

249 Sensors with Heat Insulator (figure 7-5)

57 Heat Insulator, S30400
58 Shaft Extension, N05500
59 Shaft Coupling, S30300
60 Set Screw, hex socket, SST (2 req'd)
61 Screw, hex hd, SST (4 req'd)
78 Washer, plain (4 req'd)

Key Description

Masoneilan Sensors (figures 7-6 and 7-7)

12100 or 12800 without Heat Insulator

58 Shaft Extension, S31600
59 Shaft Coupling, S30300
60 Set Screw, hex socket, SST (2 req'd)
61 Screw, hex hd, 18-8 SST (4 req'd)
62 Mounting Adapter, A03560
63 Screw, hex socket, (4 req'd)

12100 or 12800 with Heat Insulator

57 Heat Insulator, S30400
58 Shaft Extension, S31600
59 Shaft Coupling, S30300
60 Set Screw, hex socket, SST (2 req'd)
61 Screw, hex hd, SST (4 req'd)
62 Mounting Adapter, A03560
63 Screw, hex socket, steel (4 req'd)
78 Washer, plain (4 req'd)

Figure 7-6. Mounting Kit for Masoneilan 12200 and 12300 Sensor without Heat Insulator

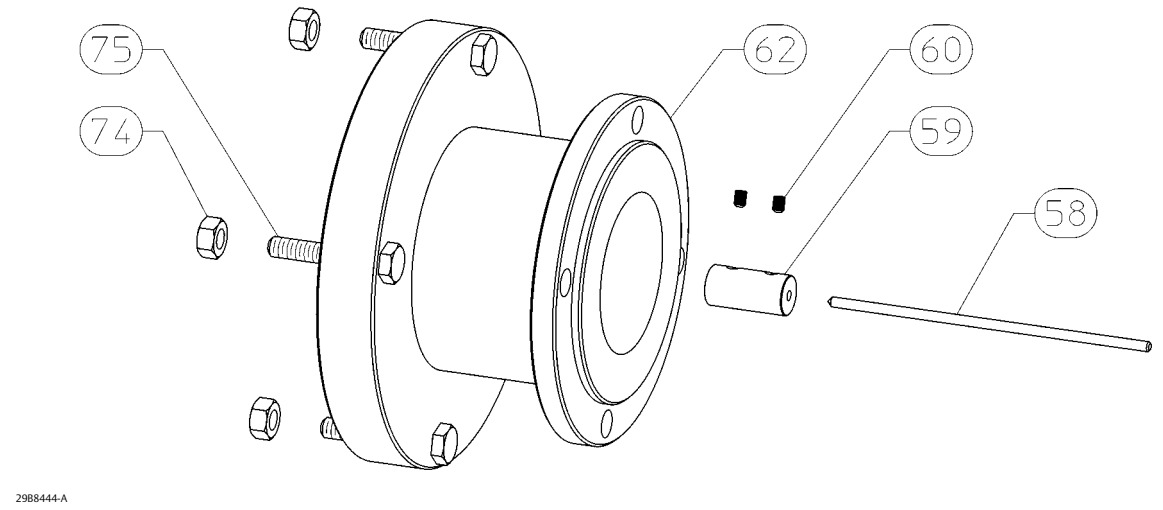
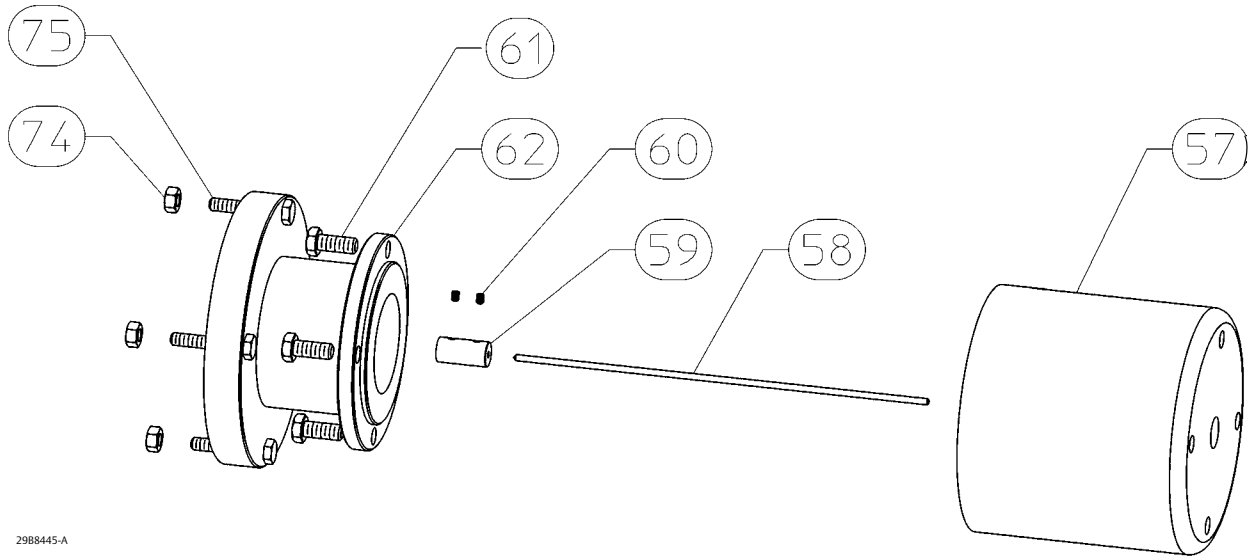


Figure 7-7. Mounting Kit for Masoneilan 12200 and 12300 Sensor with Heat Insulator



Key Description

12200 or 12300 without Heat Insulator

58 Shaft Extension N05500
59 Shaft Coupling, S30300
60 Hex Socket Screw (2 req'd)
62 Mounting Adaptor, A92024
74 Hex Nut, SST (4 req'd)
75 Hex Cap Screw, SST (4 req'd)

Key Description

12200 or 12300 with Heat Insulator

57 Heat Insulator, S30400
58 Shaft Extension, S31600
59 Shaft Coupling, S30300
61 Hex Cap Screw, SST (4 req'd)
60 Hex Socket Screw (2 req'd)
62 Mounting Adaptor, A92024
74 Hex Nut, SST (4 req'd)
75 Hex Cap Screw, SST (4 req'd)
78 Washer, plain (4 req'd) not shown

Key Description

Yamatake NQP Sensor

Without Heat Insulator

58 Shaft Extension, S31600
59 Shaft Retainer, S30400
60 Hex Socket Screw, SST
62 Mounting Adaptor, A96061
63 Hex Socket Screw, SST (3 req'd)
71 Hex Socket Screw, SST (3 req'd)
72 Shaft Adapter, S30400
73 Hex Socket Screw, SST (2 req'd)

With Heat Insulator

57 Heat Insulator, S30400
58 Shaft Extension, S31600
59 Shaft Retainer, S30300
60 Hex Socket Screw, SST
61 Hex Cap Screw, SST (4 req'd)
62 Mounting Adaptor, A96061
63 Hex Socket Screw, SST (3 req'd)
71 Hex Socket Screw, SST (3 req'd)
72 Shaft Adapter, S30400
73 Hex Socket Screw, SST (2 req'd)
78 Washer, plain (4 req'd)

Key Description

Foxboro-Eckardt Sensors

144LD without Heat Insulator

58 Shaft Extension, S31600
59 Shaft Coupling, S30300
60 Set Screw, hex socket, SST (2 req'd)
62 Mounting Adapter, A92024
74 Hex Nut, steel (4 req'd)
75 Hex Cap Screw, steel (4 req'd)

144LD with Heat Insulator

57 Heat Insulator, S30400
58 Shaft Extension, 316 SST
59 Shaft Coupling, S30300
60 Set Screw, hex socket, SST (2 req'd)
61 Screw, hex hd, SST (4 req'd)
62 Mounting Adapter, A92024
74 Hex Nut, steel (4 req'd)
75 Hex Cap Screw, steel (4 req'd)
78 Washer, plain (4 req'd)

LP167 without Heat Insulator

58 Shaft Extension, S31600
59 Shaft Coupling, S30300
60 Set Screw, hex socket, SST (2 req'd)
62 Mounting Adapter, A92024
63 Screw, hex socket, (4 req'd)

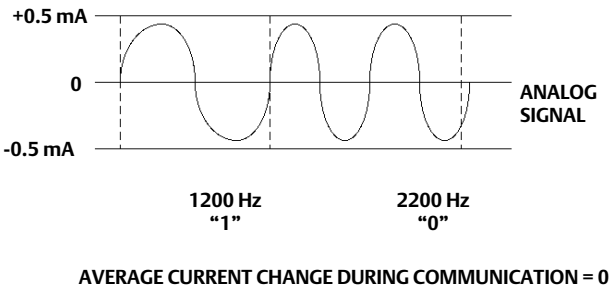
Appendix A Principle of Operation

HART Communication

The HART (Highway Addressable Remote Transducer) protocol gives field devices the capability of communicating instrument and process data digitally. This digital communication occurs over the same two-wire loop that provides the 4-20 mA process control signal, without disrupting the process signal. In this way, the analog process signal, with its faster update rate, can be used for control. At the same time, the HART protocol allows access to digital diagnostic, maintenance, and additional process data. The protocol provides total system integration via a host device.

The HART protocol uses the frequency shift keying (FSK) technique based on the Bell 202 communication standard. By superimposing a frequency signal over the 4-20 mA current, digital communication is attained. Two individual frequencies of 1200 and 2200 Hz are superimposed as a sinewave over the 4-20 mA current loop. These frequencies represent the digits 1 and 0 (see figure A-1). The average value of this sinewave is zero, therefore no DC value is added to the 4-20 mA signal. Thus, true simultaneous communication is achieved without interrupting the process signal.

Figure A-1. HART Frequency Shift Keying Technique



The HART protocol allows the capability of multidropping, networking several devices to a single communications line. This process is well suited for monitoring remote applications such as pipelines, custody transfer sites, and tank farms.

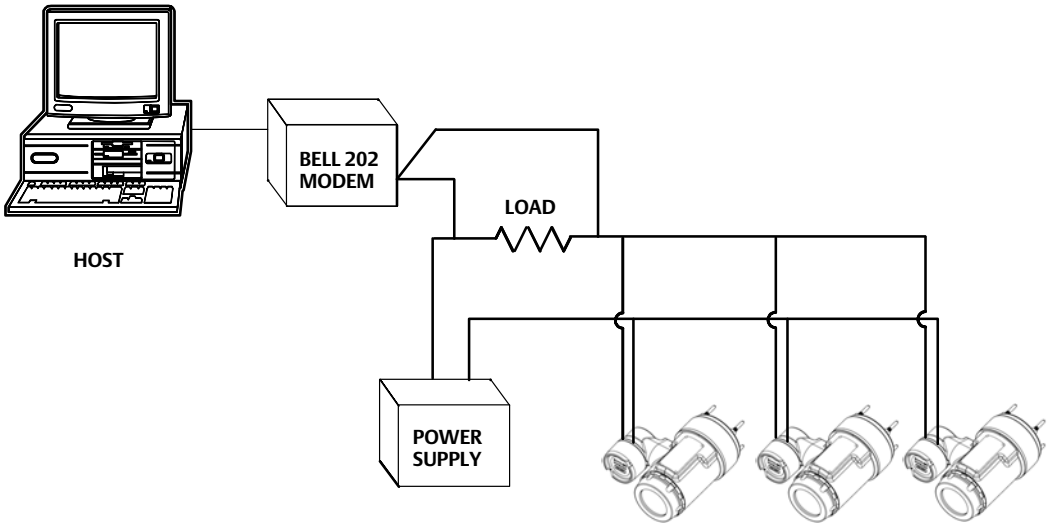
Multidrop Communication

“Multidropping” refers to the connection of several digital level controllers or transmitters to a single communications transmission line. Communication between the host and the field instruments takes place digitally with the analog output of the instruments deactivated. With the HART communications protocol, up to 15 field instruments can be connected on a single twisted pair of wires or over leased phone lines. Multidrop installations are not recommended where intrinsic safety is a requirement.

The application of a multidrop installation requires consideration of the update rate necessary from each instrument, the combination of instrument models, and the length of the transmission line. Communication with the field instruments can be accomplished with commercially available Bell 202 modems and a host implementing the HART protocol. Each instrument is identified by a unique address (1-15) and responds to the commands defined in the HART protocol.

Figure A-2 shows a typical multidrop network. Do not use this figure as an installation diagram. Contact your Emerson Process Management sales office with specific requirements for multidrop applications.

Figure A-2. Typical Multidropped Network



The Field Communicator can test, configure, and format a multidropped DLC3010 digital level controller in the same way as in a standard point-to-point installation, provided that it has been configured to scan for multiple polling addresses.

Note

DLC3010 digital level controllers are set to address 0 at the factory, allowing them to operate in the standard point-to-point manner with a 4-20 mA output signal. To activate multidrop communication, the address must be changed to a number between 1 and 15. This change deactivates the 4-20 mA analog output, sending it to 4 mA. The failure mode current also is disabled.

Digital Level Controller Operation

The DLC3010 digital level controller is a loop-powered instrument that measure changes in liquid level, level of an interface between two liquids, or density of a liquid. Changes in the buoyancy of a displacer suspended in a vessel vary the load on a torque tube. The displacer and torque tube assembly constitute the primary mechanical sensor. The angular deflection of the torque tube is measured by the instrument transducer, which consists of a magnet system moving over a Hall effect device. A liquid crystal display (LCD) meter can display the analog output; process variable (level, interface level, or density); the process temperature, if an RTD (resistance temperature detector) is installed; the degrees of torque tube rotation; and percent range.

The instrument uses a microcontroller and associated electronic circuitry to measure the process variable, provide a current output, drive the LCD meter, and provide HART communications capability. Figure A-3 shows the digital level controller assembly. Figure A-4 is a block diagram of the main components in the instrument electronics; the LCD meter, the processor module, the transducer board, and the terminal board. The processor module contains the microprocessor, the analog-to-digital (A/D) converters, loop interface, signal conditioning, the digital-to-analog (D/A) output, power supply and interfaces to other boards.

Figure A-3. FIELDVUE DLC3010 Digital Level Controller Assembly

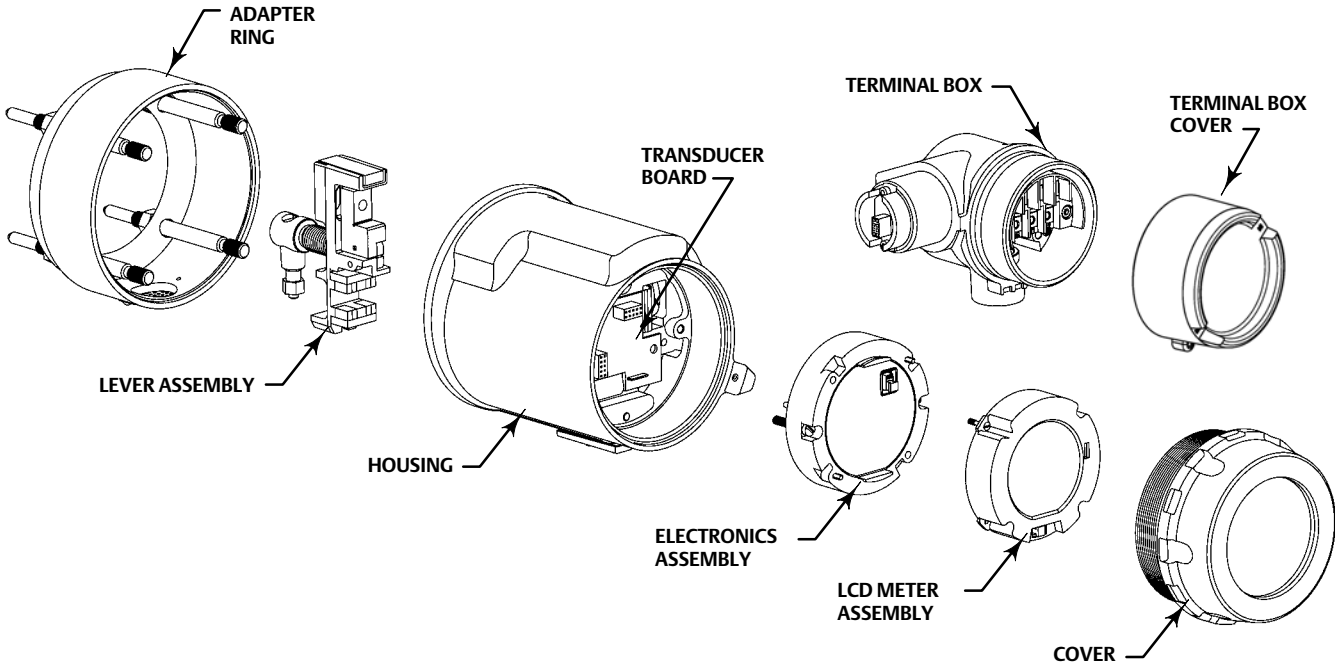
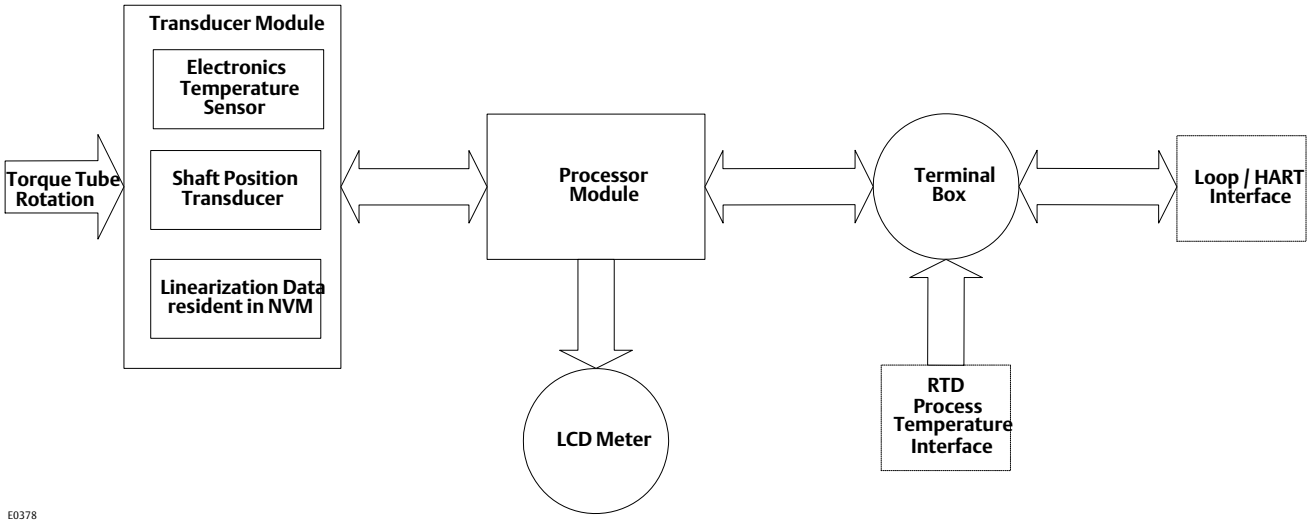


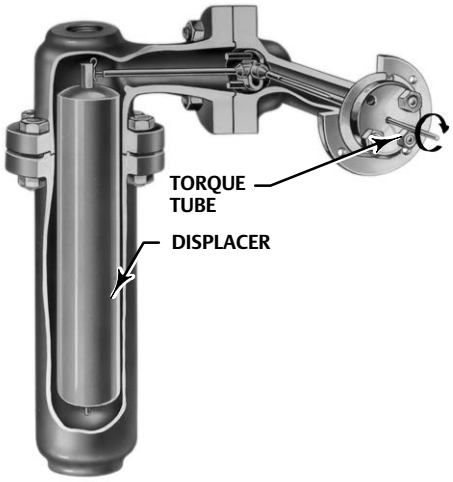
Figure A-4. FIELDVUE DLC3010 Digital Level Controller Principle of Operation



The transducer board contains the Hall sensor, a temperature sensor to monitor the Hall sensor temperature, and an EEPROM to store the coefficients associated with the Hall sensor. The terminal board contains the EMI filters, the loop connection terminals, and the connections for the optional RTD used to measure process temperature.

A level, density, or interface level change in the measured fluid causes a change in the displacer position (figure A-5). This change is transferred to the torque tube assembly. As the measured fluid changes, the torque tube assembly rotates up to 4.4 degrees for a 249 sensor, varying the digital level controller output between 4 and 20 mA.

Figure A-5. Typical Sensor Operation



W1389-1

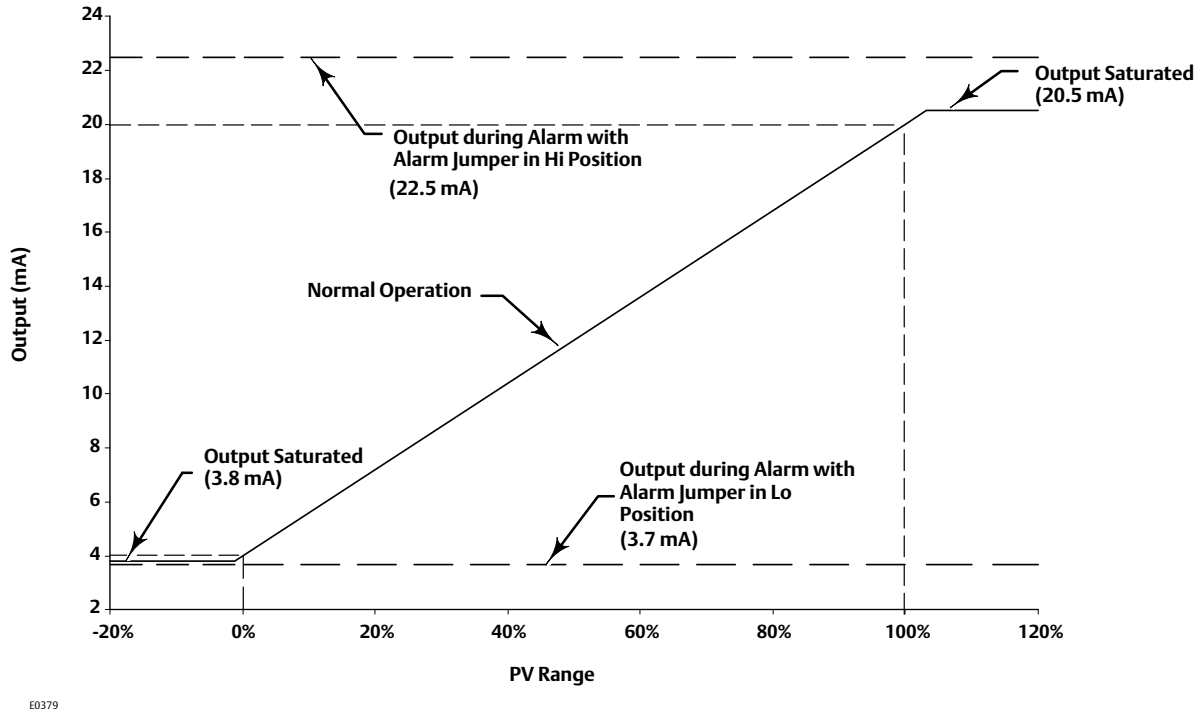
249 SENSOR (SIDE VIEW)

The rotary motion of the torque tube is transferred to the digital level controller lever assembly. The rotary motion moves a magnet attached to the lever assembly, changing the magnetic field that is sensed by the Hall effect sensor. The sensor converts the magnetic field signal to an electronic signal.

The microcontroller accepts the electronic signal, which is ambient-temperature-compensated and linearized. The microcontroller can also actively compensate for changes in liquid specific gravity due to changes in process temperature based on an input via HART protocol or via an optional RTD, if it is connected. The D/A output circuit accepts the microcontroller output and provides a 4 to 20 mA current output signal.

During normal operation, when the input is between the lower and upper range values, the digital level controller output signal ranges between 4 and 20 mA and is proportional to the input. See figure A-6. If the input should exceed the lower and upper range values, the output will continue to be proportional to the input until the output reaches either 3.8 or 20.5 mA. At this time the output is considered saturated and will remain at this value until the input returns to the normal operating range. However, should an alarm occur, the output is driven to either 3.7 or 22.5 mA, depending upon the position of the alarm jumper.

Figure A-6. Digital Level Controller Analog Output Signal



Note

The upper alarm value is compliant with NAMUR NE-43, but the lower alarm value is not.

If using in a system with NAMUR NE-43 compatibility, the high alarm value may be an appropriate choice.

Other circuits in the digital level controller provide reverse polarity protection, transient power surge protection, and electromagnetic interference (EMI) protection.

Appendix B Fast-Key Sequence and Field Communicator Menu Tree

Fast-key sequences are included for common DLC3010 digital level controller functions. Also included are Field Communiator menu trees.

- Fast-key sequences, see table B-1
- Hot Key menu, see figure B-1
- Overview menu, see figure B-2
- Guided Setup menu, see figure B-3
- Manual Setup menu, see figure B-4
- Alert Setup menu, see figure B-5
- Communications menu, see figure B-6
- Calibration menu, see figure B-7
- Service Tools menu, see figure B-8

Table B-1. Fast Key Sequence

Function	Fast-Key Sequence	See Figure
Active Alerts	3-1	B-8
Alarm Jumper	1-7-3-1-1	B-2
Analog Output	1-5	B-2
	3-2-3	B-8
Burst Mode	2-4-1	B-6
Burst Option	2-4-2	B-6
Calibration, Full	2-5-1-2	B-7
Calibration, Partial	2-5-1-3	B-7
Calibration, Temperature	2-5-2-1	B-7
Change Process Temperature	2-2-3-2[1]	B-4
	2-2-3-2-2[2]	B-4
Change Primary Variable	2-2-2-1-2	B-1
Change Torque Rate	2-2-1-3-2	B-4
Comm Status	1-2	B-2
Date	1-7-1-8	B-2
	2-2-4-2	B-4
DD Information	1-7-2-5	B-2
Decimal Places	2-2-5-4	B-4
Descriptor	1-7-1-9	B-2
	2-2-4-3	B-4
Device ID	1-7-1-4	B-2
Device Status	1-1	B-2
Display Alert/Saturation Level	1-7-3-1-2	B-2
Display Mode	2-2-5-2	B-4
Distributor	1-7-1-2	B-2
Enter Constant Density	2-2-3-1-4[2]	B-1
Field Device Revision	1-7-2-2	B-2
Final Assembly Number	1-7-1-7	B-2
	2-2-4-8-3	B-4
Firmware Revision	1-7-2-3	B-2
Guided Setup	2-1	B-3
Hardware Revision	1-7-2-4	B-2
HART Tag	1-7-1-1	B-2
	2-2-4-1	B-4
HART Universal Revision	1-7-2-1	B-2
Instrument Mounting	2-2-1-4	B-4
Instrument Serial Number	1-7-1-5	B-2
	2-2-4-8-1	B-4
Instrument Temperature	3-2-4	B-8
Instrument Temperature Alerts	2-3-2-1	B-5
LCD Configuration	2-2-5-1	B-4
LCD Test	3-3-1-1[3]	B-8
Level Offset	2-2-2-1-4	B-4
Loop Test	3-3-1-1	B-8
	3-3-1-2[3]	B-8
Lower Density Table	2-2-3-1-3-1[4]	B-4
	2-2-3-1-3-2[5]	B-4
Lower Fluid Density	2-2-3-1-1 or 3-2-7[4]	B-4
	2-2-3-1-2 or 3-2-8[5]	B-4
Lower Range Value	2-2-2-3-2	B-4
	2-3-1-4	B-5
Lower Sensor Limit	2-2-2-2-2	B-4
Measure Density	2-2-3-1-4[4]	B-4
Message	2-2-4-4	B-4
Minimum Span	2-2-2-2-3	B-4
Model	1-7-1-3	B-2
Number of Request Preambles	2-2-4-7	B-4
Percent Range	1-4-2	B-2
	3-2-2-2	B-8
Physical Signalling Code	2-2-4-6	B-4
Polling Address	2-2-4-5	B-4
Primary Variable Hi Alerts	2-3-1-1	B-5
Primary Variable Lo Alerts	2-3-1-2	B-5
Process Temperature	1-6-2	B-2
	2-2-3-2-3[2]	B-4
	2-2-3-3[1]	B-4
	3-2-5-2	B-8
Process Temperature Alerts	2-3-2-2	B-5
Process Temperature Source	1-6-1	B-4
	2-2-3-2-1[2]	B-4
	2-2-3-[1]	B-2
	3-2-5-1	B-8
PV Alerts Threshold Deadband	2-3-1-6	B-5
PV is	1-3	B-2
	2-2-2-1-1	B-4
PV Units	2-2-2-1-3	B-4
PV Value	1-4-1	B-2
	3-2-2-1	B-8
Reset Device	3-3-2-2	B-8
Restore Factory Defaults	3-3-2-1	B-8
RTD Wire Resistance	2-2-3-2-4[2]	B-4
	2-2-3-4[1]	B-4
Scaled D/A Trim	2-5-2-2-1	B-7
Sensor Damping	2-2-1-5	B-4
Sensor Serial Number	1-7-1-6	B-2
	2-2-4-8-2	B-4
Sensor Units	2-2-1-1	B-4
	2-2-1-2	B-4
Set Level Offset	2-2-2-1-5	B-4
Temperature Deadband	2-3-2-3	B-5
Torque Rate	2-2-1-3-1	B-4
	3-2-6	B-8
Torque Tube Compensation Selection	2-2-1-3-4	B-4
Torque Tube Compensation Table	2-2-1-3-5	B-4
Torque Tube Material	2-2-1-3-3	B-4
Upper Density Table	2-2-3-1-3-1[4]	B-4
Upper Fluid Density	2-2-3-1-1[4]	B-4
	3-2-7[4]	B-8
Upper Range Value	2-2-2-3-1	B-4
	2-3-1-3	B-5
Upper Sensor Limit	2-2-2-2-1	B-4
Write Lock	1-7-3-2-1	B-1
Write Lock Setup	1-7-3-2-2	B-1

1. If PV is Density
2. If PV is Level or Interface.
3. LCD Configuration is installed
4. If PV is Level
5. If PV is Interface

Figure B-1. Hot Key



Hot Key

1 Write Lock
2 Write Lock Setup
3 Change PV
4 Enter Contstant Density

Figure B-2. Overview

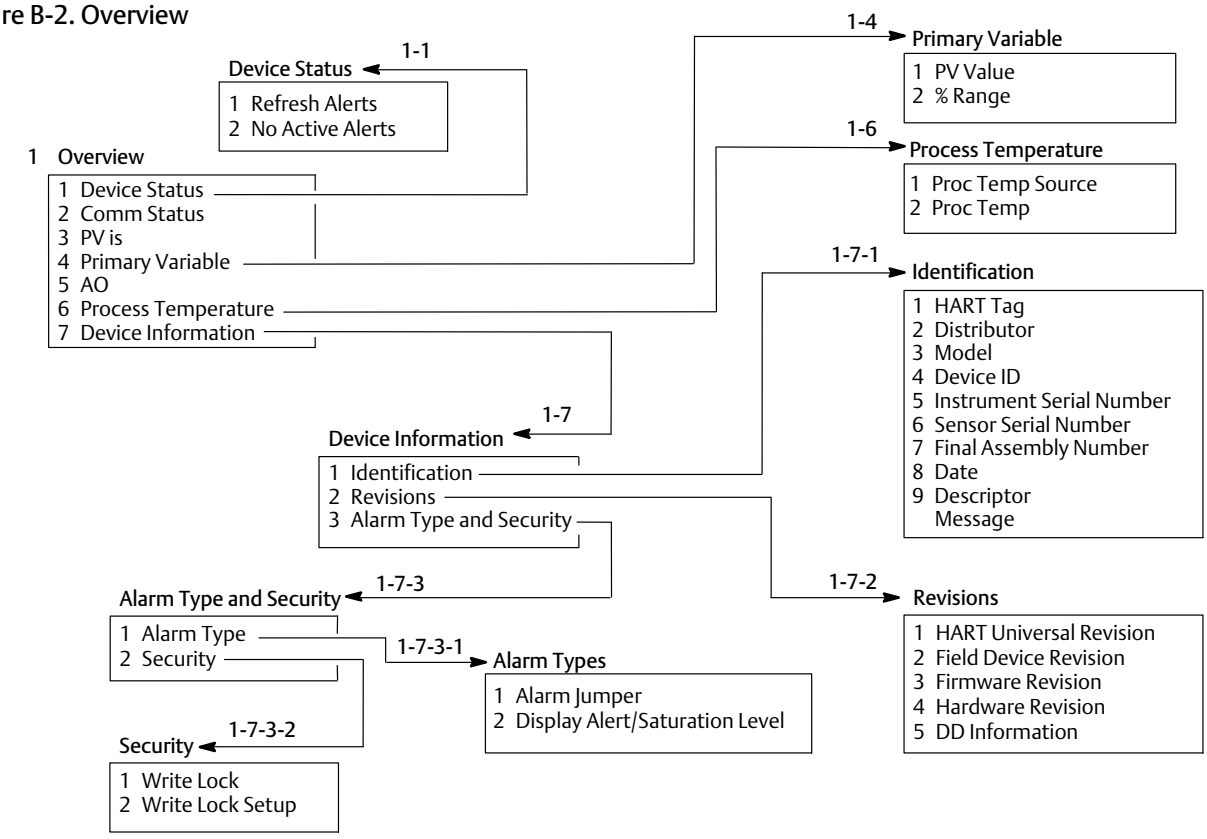


Figure B-3. Configure > Guided Setup



Figure B-4. Configure > Manual Setup

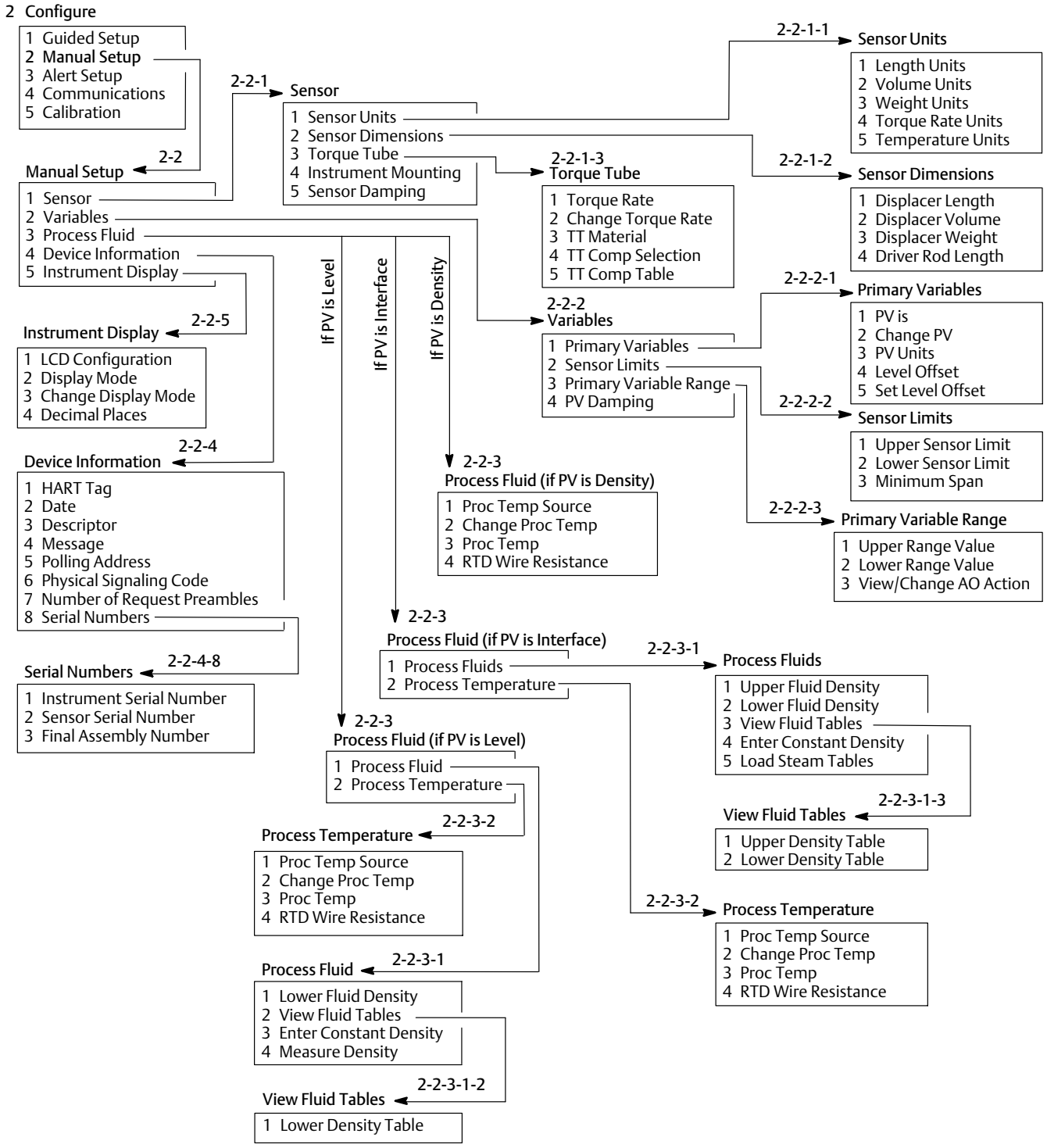


Figure B-5. Configure > Alert Setup

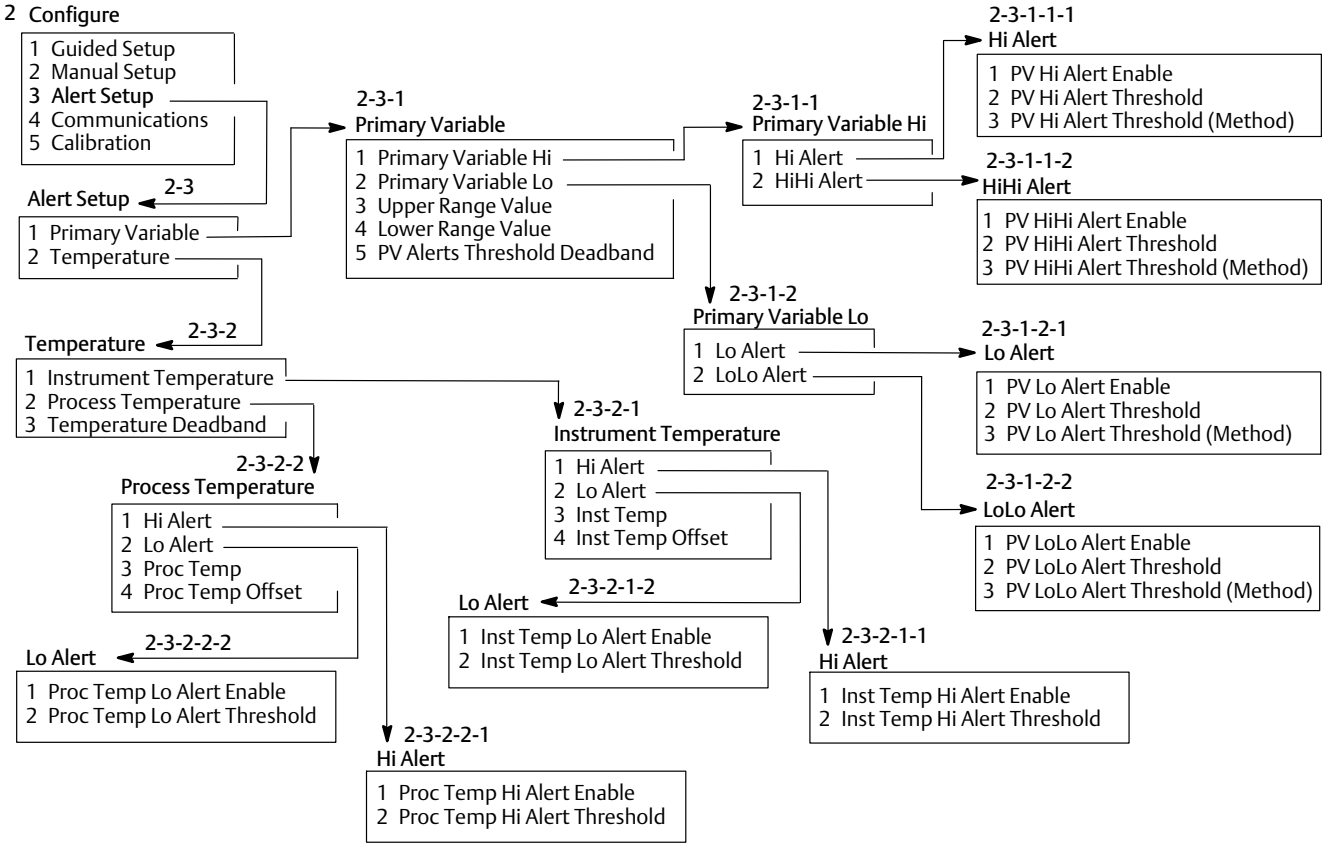


Figure B-6. Field Communicator Menu Tree—Configure > Communications

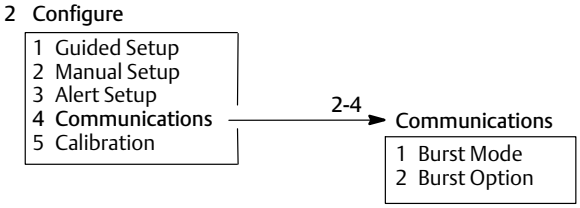


Figure B-7. Configure > Calibration

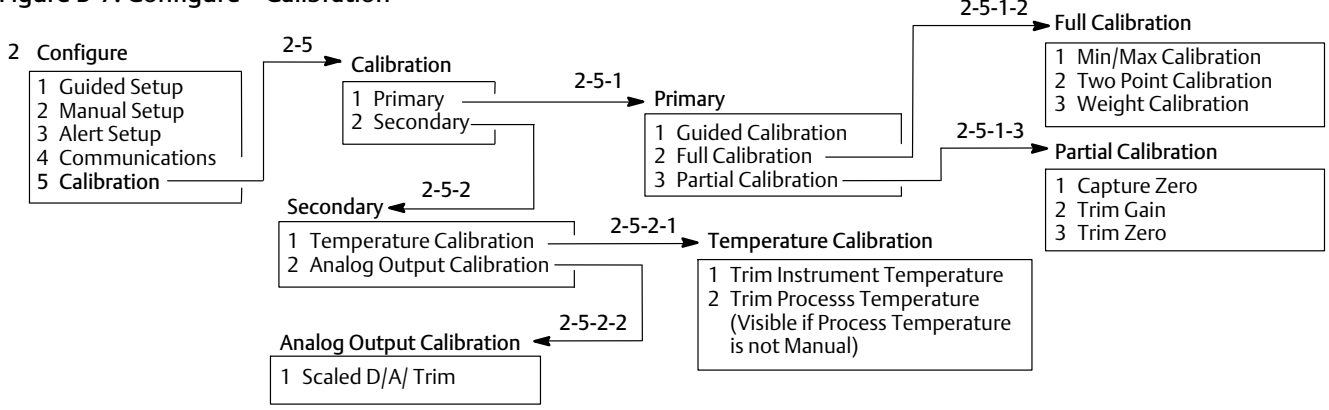
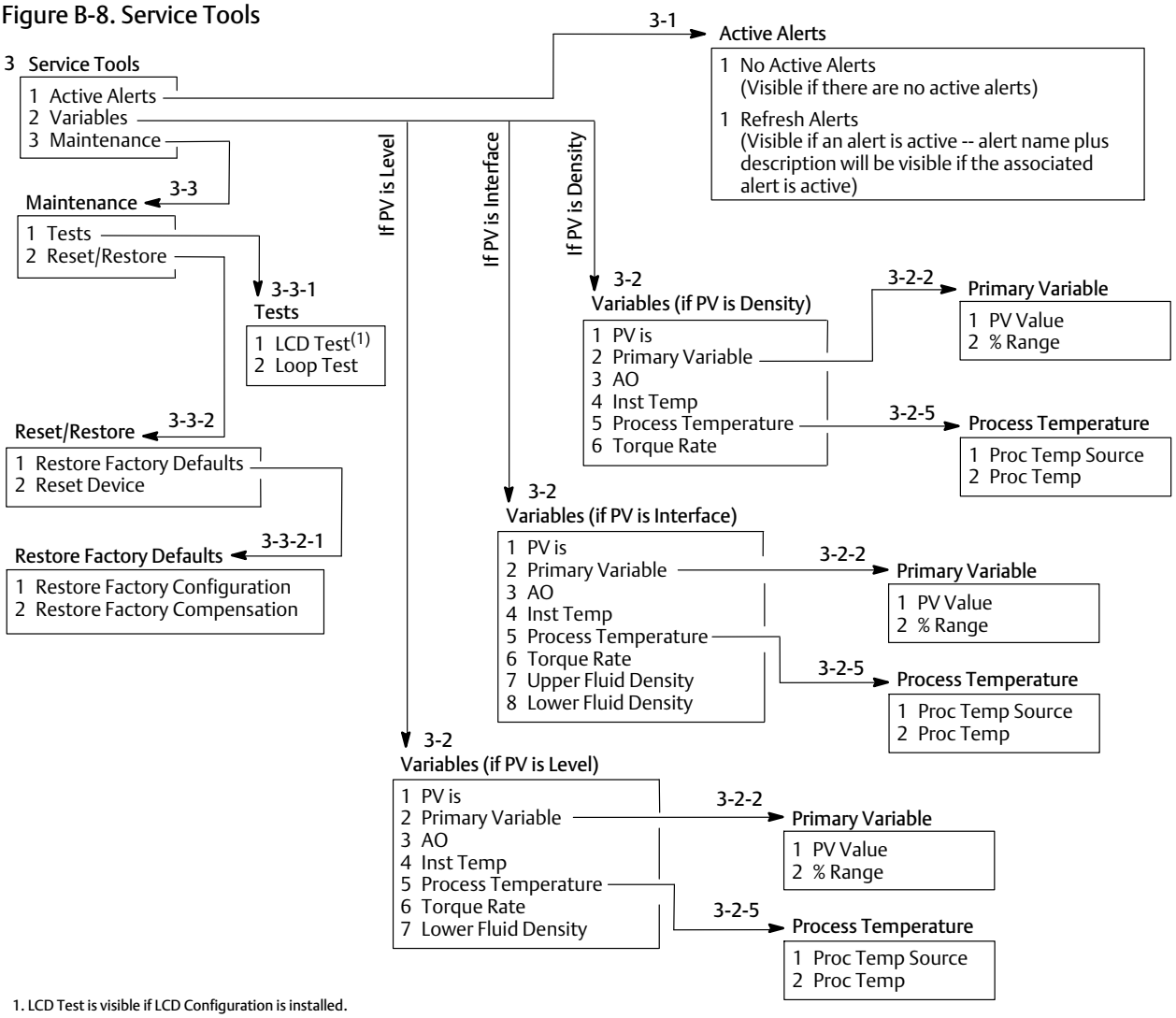


Figure B-8. Service Tools



1. LCD Test is visible if LCD Configuration is installed.

Glossary

Alarm Deadband
The amount by which the process variable must return within normal limits for the alarm to clear.

Alarm Limit
An adjustable value that, when exceeded, activates an alert.

Algorithm
A set of logical steps to solve a problem or accomplish a task. A computer program contains one or more algorithms.

Alphanumeric
Consisting of letters and numbers.

ANSI (acronym)
The acronym ANSI stands for the American National Standards Institute

Burst
Burst mode is an extension to HART protocol that provides the continuous transmission of standard HART command response by a field device.

Byte
A unit of binary digits (bits). A byte consists of eight bits.

Commissioning
Functions performed with a Field Communicator and the digital level controller to test the instrument and loop and verify digital level controller configuration data.

Configuration
Stored instructions and operating parameters for a FIELDVUE Instrument.

Control Loop
An arrangement of physical and electronic components for process control. The electronic components of the loop continuously measure one or more aspects of the process, then alter those aspects as necessary to achieve a desired process condition. A simple control loop measures only one variable. More sophisticated control loops measure many variables and maintain specified relationships among those variables.

Damping
Output function that increases the time constant of the digital level controller output to smooth the output when there are rapid input variations.

Descriptor
Sixteen-character field for additional identification of the digital level controller, its use, or location. The descriptor is stored in the instrument and can be changed using a Field Communicator and the device information function.

Device ID
Unique identifier embedded in the instrument at the factory.

Device Revision
Revision number of the interface software that permits communication between the Field Communicator and the instrument.

Firmware Revision
The revision number of the instrument firmware. Firmware is a program that is entered into the instrument at time of manufacture and cannot be changed by the user.

Free Time
Percent of time that the microprocessor is idle. A typical value is 25%. The actual value depends on the number of functions in the instrument that are enabled and on the amount of communication currently in progress.

Gain
The ratio of output change to input change.

Hardware Revision
Revision number of the Fisher instrument hardware. The physical components of the instrument are defined as the hardware.

HART (acronym)
The acronym HART stands for Highway Addressable Remote Transducer. The communications standard that provides simultaneous analog and digital signal transmission between control rooms and field devices.

HART Tag
An eight-character field for identifying the digital level controller. The HART tag is stored in the instrument and can be changed using a Field Communicator and the device information function.

HART Universal Revision
Revision number of the HART Universal Commands which are the communications protocol for the instrument.

Instrument Serial Number
The serial number assigned to the instrument.

Lower Range Value (LRV)
Lowest value of the process variable that the digital level controller is currently configured to measure in the 4 to 20 mA loop.

Lower Sensor Limit (LSL)
Lowest value of the process variable that the digital level controller can be configured to measure.

Memory
A type of semiconductor used for storing programs or data. FIELDVUE instruments use three types of memory: Random Access Memory (RAM), Read Only Memory (ROM), and Non-Volatile Memory (NVM). See also these listings in this glossary.

Menu
A list of programs, commands, or other activities that you select by using the arrow keys to highlight the item then pressing ENTER, or by entering the numeric value of the menu item.

Message
Thirty-two character field for any additional information the user may want to include.

Multidropping
The connection of several field devices to a single communications transmission line.

Non-Volatile Memory (NVM)
A type of semiconductor memory that retains its contents even though power is disconnected. NVM contents can be changed during configuration unlike ROM which can be changed only at time of instrument manufacture. NVM stores configuration data.

On-Line Configuration
Configuration of the digital level controller operational parameters using a Field Communicator connected to the instrument.

Parallel
Simultaneous: said of data transmission on two or more channels at the same time.

Polling Address
Address of the instrument. If the digital level controller is used in a point-to-point configuration, set the polling address to 0. If it is used in a multidrop configuration, or split range application, set the polling address to a value from 0 to 15.

Process Variable (PV)
A physical quality or quantity which is monitored as part of a control strategy. The digital level controller can measure level, interface level between two liquids of different specific gravity, and liquid density.

Protocol
A set of data formats and transmission rules for communication between electronic devices. Devices that conform to the same protocol can communicate accurately.

Random Access Memory (RAM)

A type of semiconductor memory that is normally used by the microprocessor during normal operation that permits rapid retrieval and storage of programs and data. See also Read Only Memory (ROM) and Non-Volatile Memory (NVM).

Read-Only Memory (ROM)

A memory in which information is stored at the time of instrument manufacture. You can examine but not change ROM contents.

Reranging

Configuration function that changes the digital level controller 4 to 20 mA settings.

RTD

The abbreviation for resistance temperature detector. Temperature is measured by the RTD by correlating the resistance of the RTD element with temperature.

Send Data

A Field Communicator command that transfers configuration data from the Field Communicator's working register to the digital level controller memory.

SI Units

The International System of Units. Includes metric units such as ampere (A), meter (m), kilogram (kg), Kelvin (K), and second (s).

Software

Microprocessor or computer programs and routines that reside in alterable memory (usually RAM), as opposed to firmware, which consists of programs and routines that are programmed into memory (usually ROM) when the instrument is manufactured. Software can be manipulated during normal operation, firmware cannot.

Span

Algebraic difference between the upper and lower range values.

Temperature Sensor

A device within the instrument that measures the instrument's internal temperature.

Upper Range Value (URV)

Highest value of the process variable that the digital level controller is currently configured to measure in the 4 to 20 mA loop.

Upper Sensor Limit (USL)

Highest value of the process variable that the digital level controller can be configured to measure.

Working Register

Memory location in a Field Communicator that temporarily stores data as it is being entered.

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Fisher® FIELDVUE™ DVC6200 Digital Valve Controller

This manual applies to

Instrument Level	HC, AD, PD, ODV	AC
Device Type	03	07
Device Revision	2	2
Hardware Revision	1	1
Firmware Revision	9, 10 & 11	9, 10 & 11
DD Revision	8	1



W9713

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The FIELDVUE DVC6200 Digital Valve Controller is a core component of the PlantWeb™ digital plant architecture. The digital valve controller powers PlantWeb by capturing and delivering valve diagnostic data. Coupled with ValveLink™ software, the DVC6200 provides users with an accurate picture of valve performance, including actual stem position, instrument input signal, and pneumatic pressure to the actuator. Using this information, the digital valve controller diagnoses not only itself, but also the valve and actuator to which it is mounted.

Section 1 Introduction

Scope of Manual

This instruction manual is a supplement to the DVC6200 Series Quick Start Guide (D103556X012) that ships with every instrument. This instruction manual includes product specifications, installation information, reference materials, custom setup information, maintenance procedures, and replacement part details for the FIELDVUE DVC6200 digital valve controller, device revision 2, firmware revision 9, 10, and 11, instrument level AC, HC, AD, PD, and ODV.

Note

Firmware 9, 10, or 11 is required for the DVC6200 digital valve controller. A printed wiring board with earlier versions of firmware must be updated before using with the DVC6200.

Note

All references to the DVC6200 digital valve controller include the DVC6205 base unit unless otherwise indicated.

This instruction manual describes using the 475 Field Communicator with device description revisions 1 and 2 to setup and calibrate the instrument. You can also use Fisher ValveLink software version 10.2 or higher to setup, calibrate, and diagnose the valve and instrument. For information on using ValveLink software with the instrument refer to ValveLink software help or documentation.

Do not install, operate, or maintain a DVC6200 digital valve controller without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all of the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Conventions Used in this Manual

Navigation paths and fast-key sequences are included for procedures and parameters that can be accessed using the Field Communicator.

For example, to access Setup Wizard:

Field Communicator	Configure > Guided Setup > Setup Wizard (1-1-1)

Refer to Appendix B for Field Communicator menu trees.

Note

Field Communicator menu sequences used in this manual are for instrument level HC, AD, PD, and ODV. Refer to the AC menu tree in Appendix B for AC menu sequences.

Description

DVC6200 digital valve controllers (figures 1-1 and 1-2) are communicating, microprocessor-based current-to-pneumatic instruments. In addition to the normal function of converting an input current signal to a pneumatic output pressure, the DVC6200 digital valve controller, using the HART® communications protocol, gives easy access to information critical to process operation. You can gain information from the principal component of the process, the control valve itself, using the Field Communicator at the valve, or at a field junction box, or by using a personal computer or operator's console within the control room.

Using a personal computer and ValveLink software or AMS Suite: Intelligent Device Manager, or a Field Communicator, you can perform several operations with the DVC6200 digital valve controller. You can obtain general information concerning software revision level, messages, tag, descriptor, and date.

Figure 1-1. FIELDVUE DVC6200 Digital Valve Controller Mounted on a Fisher Sliding-Stem Valve Actuator



W9643

Figure 1-2. FIELDVUE DVC6200 Digital Valve Controller Integrally Mounted to a Fisher GX Control Valve



W9616

Diagnostic information is available to aid you when troubleshooting. Input and output configuration parameters can be set, and the digital valve controller can be calibrated. Refer to table 1-1 for details on the capabilities of each diagnostic tier.

Table 1-1. Instrument Level Capabilities

CAPABILITY	DIAGNOSTIC LEVEL				
	AC	HC	AD	PD	ODV
Auto Calibration	X	X	X	X	X
Custom Characterization	X	X	X	X	X
Burst Communication		X	X	X	X
Alerts		X	X	X	X
Step Response, Drive Signal Test & Dynamic Error Band			X	X	X
Advanced Diagnostics (Valve Signature)			X	X	X
Performance Tuner			X	X	X
Travel Control - Pressure Fallback			X	X	X
Supply Pressure Sensor			X	X	X
Performance Diagnostics				X	X
Solenoid Valve Testing					X
Lead/Lag Set Point Filter(1)					X

1. Refer to brochure part # D351146X012/D351146X412 for information on Fisher optimized digital valves for compressor antisurge applications.

Using the HART protocol, information from the field can be integrated into control systems or be received on a single loop basis.

The DVC6200 digital valve controller is designed to directly replace standard pneumatic and electro-pneumatic valve mounted positioners.

Specifications

⚠ WARNING

Refer to table 1-2 for specifications. Incorrect configuration of a positioning instrument could result in the malfunction of the product, property damage or personal injury.

Specifications for DVC6200 digital valve controllers are shown in table 1-2. Specifications for the Field Communicator can be found in the product manual for the Field Communicator.

Table 1-2. Specifications

Available Mounting

DVC6200 digital valve controller or DVC6215 feedback unit: ■ Integral mounting to the Fisher GX Control Valve and Actuator System ■ Window mounting to Fisher rotary actuators ■ Sliding-stem linear applications ■ Quarter-turn rotary applications

DVC6205 base unit for 2 inch pipestand or wall mounting (for remote-mount)

The DVC6200 digital valve controller or DVC6215 feedback unit can also be mounted on other actuators that comply with IEC 60534-6-1, IEC 60534-6-2, VDI/VDE 3845 and NAMUR mounting standards.

Input Signal

Point-to-Point:

Analog Input Signal: 4-20 mA DC, nominal; split ranging available
Minimum Voltage Available at Instrument Terminals must be 10.5 VDC for analog control, 11 VDC for HART communication
Minimum Control Current: 4.0 mA
Minimum Current w/o Microprocessor Restart: 3.5 mA
Maximum Voltage: 30 VDC
Overcurrent protected
Reverse Polarity protected

Multi-drop:

Instrument Power: 11 to 30 VDC at 8 mA
Reverse Polarity protected

Supply Pressure(1)

Minimum Recommended: 0.3 bar (5 psig) higher than maximum actuator requirements
Maximum: 10.0 bar (145 psig) or maximum pressure rating of the actuator, whichever is lower
Medium: Air or Natural Gas

Air: Supply pressure must be clean, dry air that meets the requirements of ISA Standard 7.0.01.

Natural Gas: Natural gas must be clean, dry, oil-free, and noncorrosive. H_2S content should not exceed 20 ppm.

A maximum 40 micrometer particle size in the air system is acceptable. Further filtration down to 5 micrometer particle size is recommended. Lubricant content is not to exceed 1 ppm weight (w/w) or volume (v/v) basis. Condensation in the air supply should be minimized.

Output Signal

Pneumatic signal, up to full supply pressure
Minimum Span: 0.4 bar (6 psig)
Maximum Span: 9.5 bar (140 psig)
Action: ■ Double, ■ Single Direct or ■ Reverse

Steady-State Air Consumption(2)(3)

Standard Relay:
At 1.4 bar (20 psig) supply pressure: Less than 0.38 normal m^3/hr (14 scfh)
At 5.5 bar (80 psig) supply pressure: Less than 1.3 normal m^3/hr (49 scfh)

Low Bleed Relay:
At 1.4 bar (20 psig) supply pressure: Average value 0.056 normal m^3/hr (2.1 scfh)
At 5.5 bar (80 psig) supply pressure: Average value 0.184 normal m^3/hr (6.9 scfh)

Maximum Output Capacity(2)(3)

At 1.4 bar (20 psig) supply pressure:
10.0 normal m^3/hr (375 scfh)
At 5.5 bar (80 psig) supply pressure:
29.5 normal m^3/hr (1100 scfh)

Operating Ambient Temperature Limits(1)(4)

-40 to 85°C (-40 to 185°F)
-52 to 85°C (-62 to 185°F) for instruments utilizing the Extreme Temperature option (fluorosilicone elastomers)
-52 to 125°C (-62 to 257°F) for remote-mount feedback unit

Independent Linearity(5)

Typical Value: ±0.50% of output span

Electromagnetic Compatibility

Meets EN 61326-1 (First Edition)
Immunity—Industrial locations per Table 2 of the EN 61326-1 standard. Performance is shown in table 1-3 below.
Emissions—Class A
ISM equipment rating: Group 1, Class A

Lightning and Surge Protection—The degree of immunity to lightning is specified as Surge immunity in table 1-3. For additional surge protection commercially available transient protection devices can be used.

-continued-

Table 1-2. Specifications (continued)

Vibration Testing Method

Tested per ANSI/ISA-S75.13.01 Section 5.3.5. A resonant frequency search is performed on all three axes. The instrument is subjected to the ISA specified 1/2 hour endurance test at each major resonance.

Input Impedance

The input impedance of the DVC6200 active electronic circuit is not purely resistive. For comparison to resistive load specifications, an equivalent impedance of 550 ohms may be used. This value corresponds to 11V @ 20 mA.

Humidity Testing Method

Tested per IEC 61514-2

Electrical Classification

Hazardous Area Approvals:

CSA— Intrinsically Safe, Explosion-proof, Division 2, Dust Ignition-proof

FM— Intrinsically Safe, Explosion-proof, Non-incendive, Dust Ignition-proof

ATEX— Intrinsically Safe, Flameproof, Type n

IECEx— Intrinsically Safe, Flameproof, Type n

Electrical Housing:

CSA— Type 4X, IP66

FM— Type 4X, IP66

ATEX— IP66

IECEx— IP66

Other Classifications/Certifications

Natural Gas Certified, Single Seal Device— CSA, FM, ATEX, and IECEx

FSETAN—Federal Service of Technological, Ecological and Nuclear Inspectorate (Russia)

GOST-R— Russian GOST-R

INMETRO— National Institute of Metrology, Quality and Technology (Brazil)

KGS— Korea Gas Safety Corporation (South Korea)

NEPSI— National Supervision and Inspection Centre for Explosion Protection and Safety of Instrumentation (China)

PESO CCOE— Petroleum and Explosives Safety Organisation - Chief Controller of Explosives (India)

TIIS— Technology Institution of Industrial Safety (Japan)

Contact your Emerson Process Management sales office for classification/certification specific information.

Connections

Supply Pressure: 1/4 NPT internal and integral pad for mounting 67CFR regulator
Output Pressure: 1/4 NPT internal
Tubing: 3/8-inch recommended
Vent: 3/8 NPT internal
Electrical: 1/2 NPT internal, M20 adapter optional

Actuator Compatibility

Stem Travel (Sliding-Stem Linear):
Minimum: 6.5 mm (0.25 inch)
Maximum: 606 mm (23.875 inches)

Shaft Rotation (Quarter-Turn Rotary):
Minimum: 45°
Maximum: 90°

Weight

DVC6200: 3.5 kg (7.7 lbs)

DVC6205: 4.1 kg (9 lbs)

DVC6215: 1.4 kg (3.1 lbs)

Construction Materials

Housing, module base and terminal box: A03600 low copper aluminum alloy (standard)
Cover: Thermoplastic polyester
Elastomers: Nitrile (standard)
Fluorosilicone (extreme temperature)

Options

■ Supply and output pressure gauges or ■ Tire valves ■ Integral mounted filter regulator ■ Low-Bleed Relay ■ Extreme Temperature ■ Natural Gas Certified, Single Seal Device ■ Remote Mount(6)

Contact your Emerson Process Management sales office, or go to www.FIELDVUE.com for additional information.

-continued-

Table 1-2. Specifications (continued)

Declaration of SEP	
Fisher Controls International LLC declares this product to be in compliance with Article 3 paragraph 3 of the Pressure Equipment Directive (PED) 97 / 23 / EC. It was designed and manufactured in accordance with Sound Engineering Practice (SEP) and cannot bear the CE marking related to PED compliance. However, the product *may* bear the CE marking to indicate compliance with *other* applicable European Community Directives.	

NOTE: Specialized instrument terms are defined in ANSI/ISA Standard 51.1 - Process Instrument Terminology.
1. The pressure/temperature limits in this document and any other applicable code or standard should not be exceeded.
2. Normal m^3/hour - Normal cubic meters per hour at 0°C and 1.01325 bar, absolute. Scfh - Standard cubic feet per hour at 60°F and 14.7 psia.
3. Values at 1.4 bar (20 psig) based on a single-acting direct relay; values at 5.5 bar (80 psig) based on double-acting relay.
4. Temperature limits vary based on hazardous area approval.
5. Not applicable for travels less than 19 mm (0.75 inch) or for shaft rotation less than 60 degrees. Also not applicable for digital valve controllers in long-stroke applications.
6. 4-conductor shielded cable, 18 to 22 AWG minimum wire size, in rigid or flexible metal conduit, is required for connection between base unit and feedback unit. Pneumatic tubing between base unit output connection and actuator has been tested to 91 meters (300 feet). At 15 meters (50 feet) there was no performance degradation. At 91 meters there was minimal pneumatic lag.

Table 1-3. EMC Summary Results—Immunity

Port	Phenomenon	Basic Standard	Test Level	Performance Criteria(1)	
				Point-to-Point	Multi-drop
Enclosure	Electrostatic discharge (ESD)	IEC 61000-4-2	4 kV contact 8 kV air	A(2)	A
	Radiated EM field	IEC 61000-4-3	80 to 1000 MHz @ 10V/m with 1 kHz AM at 80% 1400 to 2000 MHz @ 3V/m with 1 kHz AM at 80% 2000 to 2700 MHz @ 1V/m with 1 kHz AM at 80%	A	A
	Rated power frequency magnetic field	IEC 61000-4-8	30 A/m at 50/60Hz	A	A
I/O signal/control	Burst	IEC 61000-4-4	1 kV	A(2)	A
	Surge	IEC 61000-4-5	1 kV	B	B
	Conducted RF	IEC 61000-4-6	150 kHz to 80 MHz at 3 Vrms	A	A

Performance criteria: +/- 1% effect.
1. A = No degradation during testing. B = Temporary degradation during testing, but is self-recovering.
2. Excluding auxiliary switch function, which meets Performance Criteria B.

Related Documents

This section lists other documents containing information related to the DVC6200 digital valve controller. These documents include:

- Bulletin 62.1:DVC6200 - Fisher FIELDVUE DVC6200 Digital Valve Controller (D103415X012)
- Bulletin 62.1:DVC6200 HC - Fisher FIELDVUE DVC6200 Digital Valve Controller (D103423X012)
- Bulletin 62.1:DVC6200(S1) Fisher FIELDVUE DVC6200 Digital Valve Controller Dimensions (D103543X012)
- Fisher FIELDVUE DVC6200 Series Digital Valve Controller Quick Start Guide (D103556X012)
- FIELDVUE Digital Valve Controller Split Ranging - Supplement to HART Communicating Fisher FIELDVUE Digital Valve Controller Instruction Manuals (D103262X012)
- Using FIELDVUE Instruments with the Smart HART Loop Interface and Monitor (HIM) - Supplement to HART Communicating Fisher FIELDVUE Instrument Instruction Manuals (D103263X012)
- Using FIELDVUE Instruments with the Smart Wireless THUM™ Adapter and a HART Interface Module (HIM) - Supplement to HART Communicating Fisher FIELDVUE Instrument Instruction Manuals
- Audio Monitor for HART Communications - Supplement to HART Communicating Fisher FIELDVUE Instrument Instruction Manuals (D103265X012)

- HART Field Device Specification - Supplement to Fisher FIELDVUE DVC6000 and DVC6200 HW1 Digital Valve Controller Instruction Manuals (D103649X012)
- Using the HART Tri-Loop HART-to-Analog Signal Converter with FIELDVUE Digital Valve Controllers - Supplement to HART Communicating FIELDVUE Instrument Instruction Manuals (D103267X012)
- Lock-in-Last Strategy - Supplement to Fisher FIELDVUE DVC6000 or DVC6200 Digital Valve Controller Instruction Manual (D103261X012)
- Fisher HF340 Filter Instruction Manual (D102796X012)
- 475 Field Communicator User's Manual
- ValveLink Software Help or Documentation

All documents are available from your Emerson Process Management sales office. Also visit our website at www.FIELDVUE.com.

Educational Services

For information on available courses for the DVC6200 digital valve controller, as well as a variety of other products, contact:

Emerson Process Management
Educational Services - Registration
P.O. Box 190
Marshalltown, IA 50158-2823
Phone: 800-338-8158 or 641-754-3771
FAX: 641-754-3431
e-mail: education@emerson.com

Section 2 Installation

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before proceeding with any Installation procedures:

- **Always wear protective clothing, gloves, and eyewear to prevent personal injury or property damage.**
- **If installing into an existing application, also refer to the WARNINGS at the beginning of the Maintenance section of this instruction manual.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

⚠ WARNING

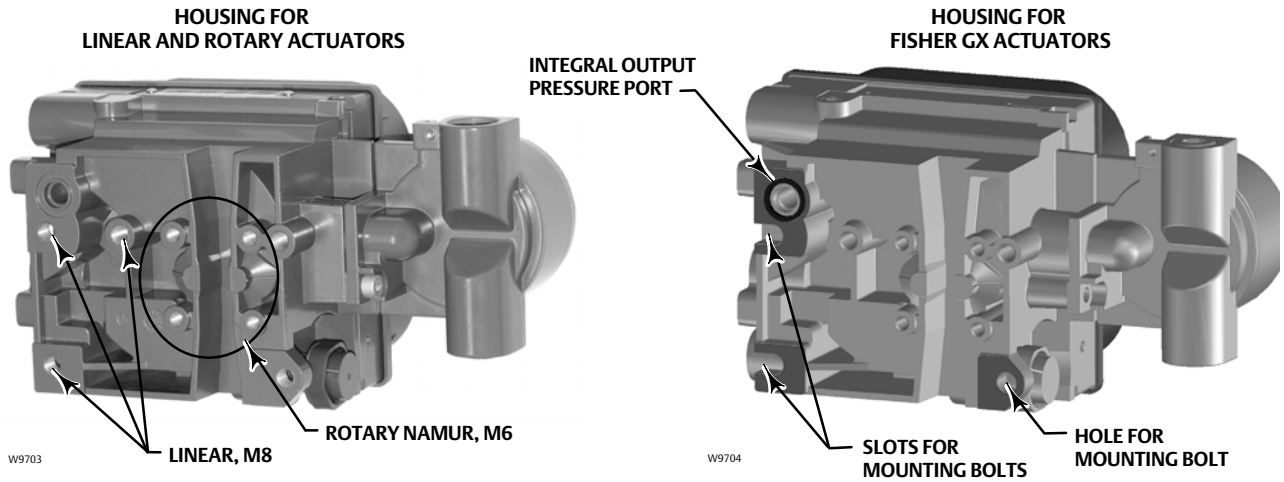
To avoid static discharge from the plastic cover when flammable gases or dust are present, do not rub or clean the cover with solvents. To do so could result in a spark that may cause the flammable gases or dust to explode, resulting in personal injury or property damage. Clean with a mild detergent and water only.

Refer to the quick start guide that ships with the instrument (D103556X012) for Hazardous Area Approvals and Special Instructions for "Safe Use" and Installations in Hazardous Locations.

Mounting the DVC6200 Digital Valve Controller

The DVC6200 housing is available in two different configurations, depending on the actuator mounting method. Figure 2-1 shows the available configurations.

Figure 2-1. Housing Configurations



The feedback system for the DVC6200 digital valve controller utilizes a magnetic assembly for linkage-less, non-contacting position measurement. In order to prevent inadvertent stem movement while the instrument is in operation, magnetic tools (such as a magnetic-tipped screwdriver) should not be used.

Note

The magnet assembly may be referred to as a magnetic array in user interface tools.

CAUTION

The magnet assembly material has been specifically chosen to provide a long-term stable magnetic field.

However, as with any magnet, care must be taken when handling the magnet assembly. Another high powered magnet placed in close proximity (less than 25 mm) can cause permanent damage. Potential sources of damaging equipment include, but are not limited to: transformers, DC motors, stacking magnet assemblies.

CAUTION

General Guidelines for use of High Power Magnets with Positioners

Use of high power magnets in close proximity to <u>any positioner</u> which is operating a process should be avoided. <u>Regardless of the positioner model</u>, high power magnets can affect the positioner's ability to control the valve. Technicians should avoid the use of high power magnets in close proximity with any positioner.

Use of Magnetic Tools with the DVC6200

- **<u>Magnetic Tip Screw Drivers</u> – Magnetic tip screw drivers can be used to work on the DVC6200. However, they should not be brought in close proximity to the magnet assembly (located at the back of the instrument) during process operations.**
- **<u>Calibrator Strap Magnets</u> – These are high power magnets used to hold 4-20 ma calibrators. Normally, these calibrators would not be used while an instrument is controlling the process. High power magnets should be kept at least 15 cm (6 inches) from the DVC6200.**

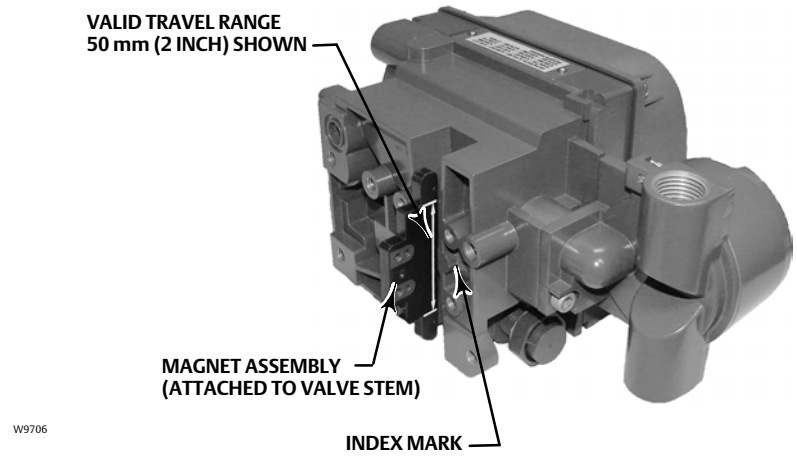


Note

As a general rule, do not use less than 60% of the magnet assembly travel range for full travel measurement. Performance will decrease as the assembly is increasingly subranged.

The linear magnet assemblies have a valid travel range indicated by arrows molded into the piece. This means that the hall sensor (on the back of the DVC6200 housing) has to remain within this range throughout the entire valve travel. See figure 2-2. The linear magnet assemblies are symmetrical. Either end may be up.

Figure 2-2. Travel Range



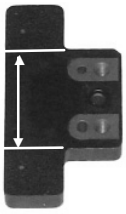
Note

Mounting the instrument vertically, with the vent at the bottom of the assembly, or horizontally, with the vent pointing down, is recommended to allow drainage of moisture that may be introduced via the instrument air supply.

There are a variety of mounting brackets and kits that are used to mount the DVC6200 to different actuators. Depending on the actuator, there will be differences in fasteners, brackets, and connecting linkages.

Each mounting kit will include one of the magnet assemblies illustrated in figure 2-3.

Figure 2-3. Magnet Assemblies



AVAILABLE CONSTRUCTIONS:
SSTEM #7 ASSEMBLY (7 mm / 1/4 INCH)
SSTEM #19 ASSEMBLY (19 mm / 3/4 INCH)
SSTEM #25 ASSEMBLY (25 mm / 1 INCH)



AVAILABLE CONSTRUCTIONS:
SSTEM #38 ASSEMBLY (38 mm / 1-1/2 INCH)
SSTEM #50 ASSEMBLY (50 mm / 2 INCH)
SSTEM #100 ASSEMBLY (100 mm / 4 INCH)
SSTEM #210 ASSEMBLY (210 mm / 8-1/4 INCH)



AVAILABLE CONSTRUCTIONS:
SSTEM #1 ROLLER ASSEMBLY
RSHAFT #1 WINDOW ASSEMBLY
(FISHER 2052 SIZE 2 & 3, 1051/1052 SIZE 40-70, 1061 SIZE 30-100, SLIDING-STEM > 210 mm (8.25 INCHES)
RSHAFT #2 WINDOW ASSEMBLY
(2052 SIZE 1, 1051/1052 SIZE 20-33)



RSHAFT END ASSEMBLY 90 DEG

If ordered as part of a control valve assembly, the factory will mount the digital valve controller on the actuator and calibrate the instrument. If purchased separately, you will need a mounting kit to mount the digital valve controller on the actuator. Each mounting kit includes detailed information on mounting the digital valve controller to a specific actuator. Refer to table 2-1 for the more common Fisher actuator mounting instructions, available at www.fisher.com or your Emerson Process Management sales office.

For general mounting guidelines, refer to the DVC6200 Series quick start guide (D103556X012), available at www.fisher.com or your Emerson Process Management sales office.

Table 2-1. DVC6200 Mounting Instructions

Instructions for Mounting:	Part Number
585C/585CR Size 25 Actuator with or without Handjack	D103439X012
585C/585CR Size 50 Actuator with or without Handjack	D103440X012
657 and 667 Size 30-60 Actuators	D103441X012
657 and 667 Size 34-60 Actuators with Handwheel	D103442X012
657 and 667 Size 70, 76, and 87 Actuators (up to 2 inch travel)	D103443X012
657 and 667 Size 70, 76, and 87 Actuators (4 inch travel)	D103444X012
657 and 667 Size 80 Actuators (up to 2 inch travel)	D103445X012
657 and 667 Size 80 Actuators (4 inch travel)	D103446X012
1051 Size 33 and 1052 Size 20 and 33 Actuators (Window Mount)	D103447X012
1051 and 1052 Size 33 Actuators (End Mount)	D103448X012
1051 and 1052 Size 40-70 Actuators (Window Mount)	D103449X012
1051 and 1052 Size 40-70 Actuators (End Mount)	D103450X012
1052 Size 20 Actuator (End Mount)	D103451X012
1061 Size 30-68 Actuator (Window Mount)	D103453X012
1061 Size 80-100 Actuator (Window Mount)	D103452X012
2052 Size 1, 2, 3 Actuator (End Mount)	D103454X012
2052 Size 1, 2, 3 Actuator with Spacer (Window Mount)	D103455X012
Baumann Sliding-Stem Actuators	D103456X012
GX Control Valve and Actuator System	D103457X012
IEC60534-6-1 (NAMUR) Sliding Stem Actuators	D103458X012
IEC60534-6-2 (NAMUR) Rotary Actuators	D103459X012

Mounting the DVC6205 Base Unit

For remote-mounted digital valve controllers, the DVC6205 base unit ships separately from the control valve and does not include tubing, fittings or wiring. See the instructions that come with the mounting kit for detailed information on mounting the feedback unit to a specific actuator model.

Mount the DVC6205 base unit on a 50.8 mm (2 inch) pipestand or wall. The included bracket is used for either mounting method.

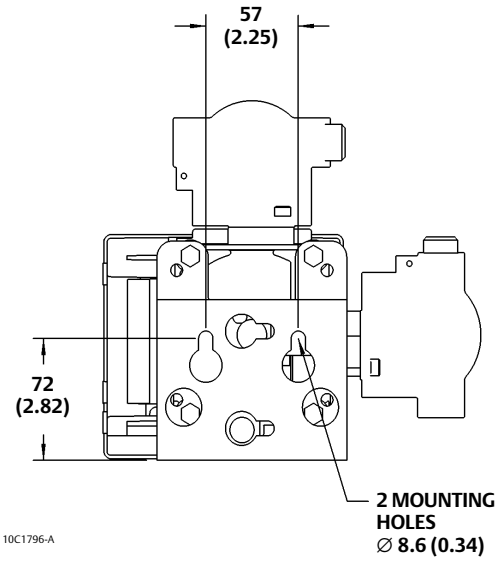
Wall Mounting

Refer to figures 2-4 and 2-5. Drill two holes in the wall using the dimensions shown in figure 2-4. Attach the mounting bracket to the base unit using four spacers and 25.4 mm (1-inch) 1/4-20 hex head screws. Attach the base unit to the wall using suitable screws or bolts.

Pipestand Mounting

Refer to figure 2-6. Position a standoff on the back of the base unit. Using two 101.6 mm (4-inch) 1/4-20 hex head screws loosely attach the base unit to the pipestand with the mounting bracket. Position the second standoff, then using the remaining 101.6 mm (4-inch) hex head screws, securely fasten the base unit to the pipe stand.

Figure 2-4. FIELDVUE DVC6205 Base Unit with Mounting Bracket (Rear View)



MM
(INCH)

Figure 2-5. FIELDVUE DVC6205 Base Unit Wall Mounting

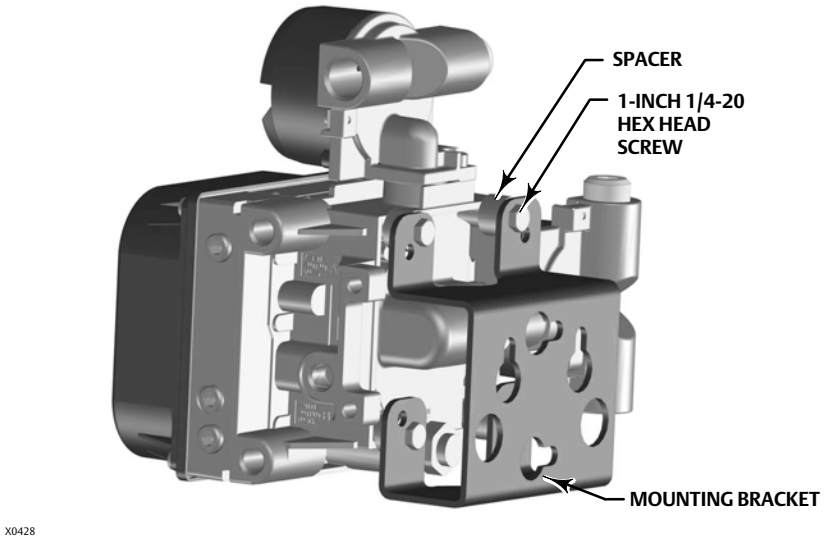
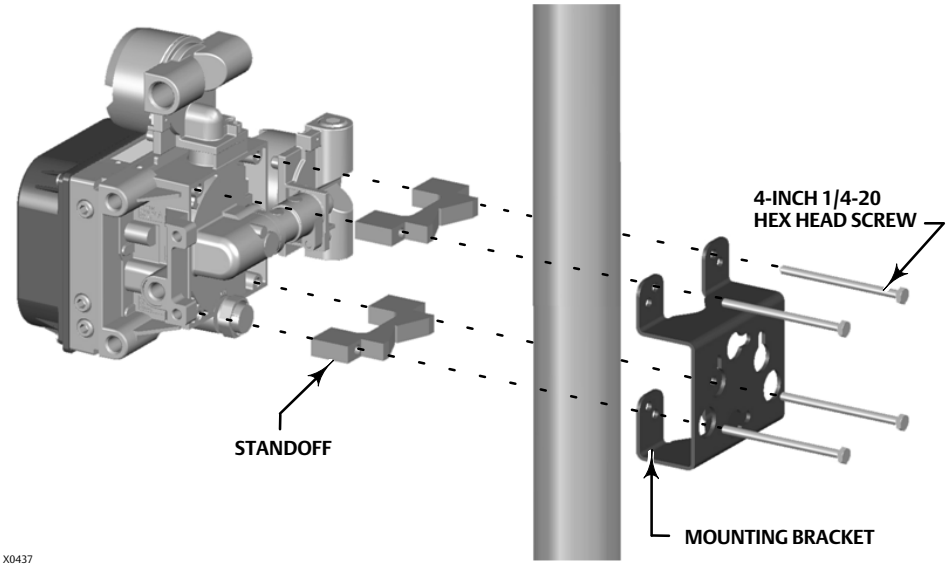


Figure 2-6. FIELDVUE DVC6205 Base Unit Pipestand Mounting

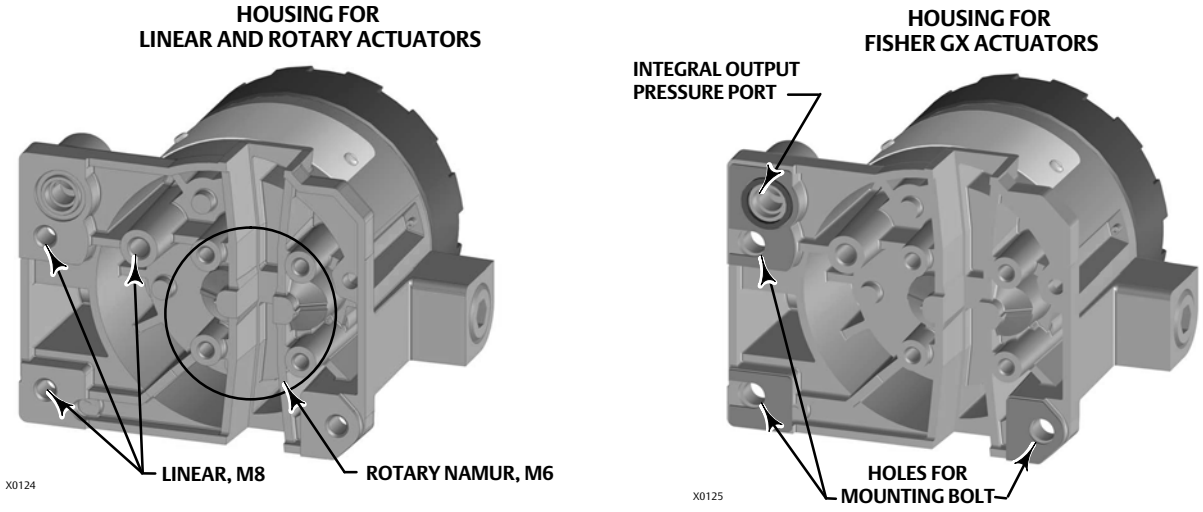


Mounting the DVC6215 Feedback Unit

If ordered as part of a control valve assembly, the factory mounts the feedback unit on the actuator, makes pneumatic connections to the actuator, sets up, and calibrates the instrument. If you purchased the feedback unit separately, you will need a mounting kit to mount the feedback unit on the actuator. See the instructions that come with the mounting kit for detailed information on mounting the feedback unit to a specific actuator model.

The DVC6215 housing is available in two different configurations, depending on the actuator mounting method. Figure 2-7 shows the available configurations. The feedback system for the DVC6215 feedback unit utilizes a magnetic assembly for true linkage-less, non-contacting position measurement. In order to prevent inadvertent stem movement while the instrument is in operation, magnetic tools (such as a magnetic-tipped screwdriver) should not be used.

Figure 2-7. Feedback Unit Housing Configurations



CAUTION

The magnet assembly material has been specifically chosen to provide a long-term stable magnetic field.

However, as with any magnet, care must be taken when handling the magnet assembly. Another high powered magnet placed in close proximity (less than 25 mm) can cause permanent damage. Potential sources of damaging equipment include, but are not limited to: transformers, DC motors, stacking magnet assemblies.

CAUTION

General Guidelines for use of High Power Magnets with Positioners

Use of high power magnets in close proximity to any positioner which is operating a process should be avoided. Regardless of the positioner model, high power magnets can affect the positioner's ability to control the valve. Technicians should avoid the use of high power magnets in close proximity with any positioner.

Use of Magnetic Tools with the DVC6215

- **Magnetic Tip Screw Drivers – Magnetic tip screw drivers can be used to work on the DVC6215. However, they should not be brought in close proximity to the magnet assembly (located at the back of the instrument) during process operations.**
- **Calibrator Strap Magnets – These are high power magnets used to hold 4-20 ma calibrators. Normally, these calibrators would not be used while an instrument is controlling the process. High power magnets should be kept at least 15 cm (6 inches) from the DVC6215.**

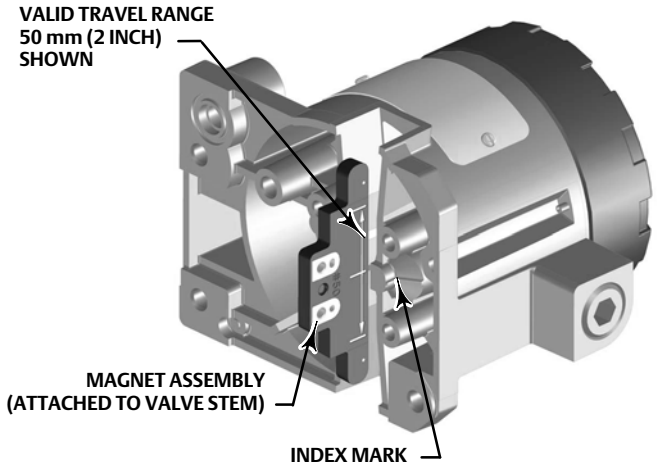


Note

As a general rule, do not use less than 60% of the magnet assembly travel range for full travel measurement. Performance will decrease as the assembly is increasingly subranged.

The linear magnet assemblies have a valid travel range indicated by arrows molded into the piece. This means that the hall sensor (on the back of the DVC6215 housing) has to remain within this range throughout the entire valve travel. See figure 2-8. The linear magnet assemblies are symmetrical. Either end may be up.

Figure 2-8. Travel Range



There are a variety of mounting brackets and kits that are used to mount the DVC6215 to different actuators.

Note

The DVC6215 feedback unit uses the same mountings as the DVC6200 digital valve controller.

However, despite subtle differences in fasteners, brackets, and connecting linkages, the procedures for mounting can be categorized as follows:

- Sliding-stem linear actuators
- Fisher rotary actuators
- GX actuator
- Quarter-turn actuators

See figure 2-3 for examples of the different travel feedback magnet assemblies.

Sliding-Stem Linear Actuators up to 210 mm (8.25 Inches) of Travel

The DVC6215 feedback unit has linkage-less, non-contact feedback on sliding-stem actuators with up to 210 mm (8.25 inches) travel. Figure 2-9 shows a typical mounting on a sliding stem actuator. For actuators with greater than 210 mm (8.25 inches) travel, see the guidelines on page 20.

1. Isolate the control valve from the process line pressure and release pressure from both sides of the valve body. Shut off all pressure lines to the actuator, releasing all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
2. Attach the mounting bracket to the actuator.

Figure 2-9. Mounting Parts for Sliding-Stem Actuator with up to 210 mm (8.25 Inches) Travel



3. Loosely attach the feedback pieces and magnet assembly to the valve stem connector. Do not tighten the fasteners because fine adjustment is required.

CAUTION

Do not install a magnet assembly that is shorter than the physical travel of the actuator. Loss of control will result from the magnet assembly moving outside the range of the index mark in the feedback slot of the DVC6215 housing.

4. Using the alignment template (supplied with the mounting kit), position the magnet assembly inside the retaining slot.
5. Align the magnet assembly as follows:

For air-to-open actuators (e.g. Fisher 667) vertically align the magnet assembly so that the center line of the alignment template is lined up as close as possible with the upper extreme of the valid travel range on the magnet assembly. The magnet assembly should be positioned so that the index mark in the feedback slot of the DVC6215 housing is within the valid range on the magnet assembly throughout the range of travel. See figure 2-10.

For air-to-close actuators (e.g. Fisher 657) vertically align the magnet assembly so that the center line of the alignment template is lined up as close as possible with the lower extreme of the valid travel range on the magnet assembly. The magnet assembly should be positioned so that the index mark in the feedback slot of the DVC6215 housing is within the valid range on the magnet assembly throughout the range of travel. See figure 2-11.

Figure 2-10. Air-to-Open Magnet Assembly Alignment

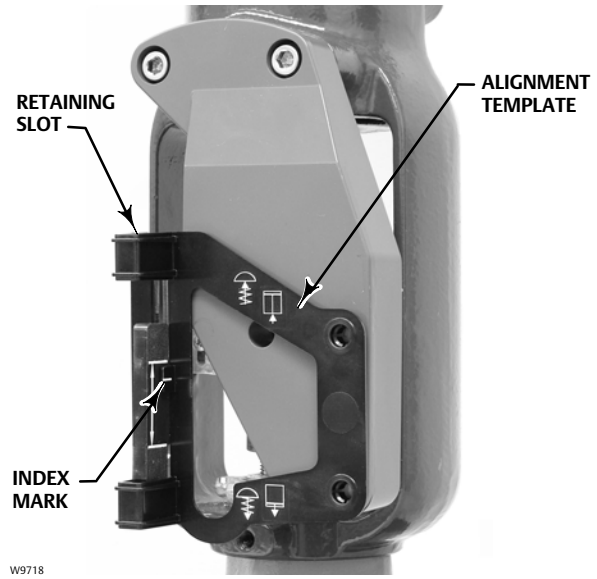
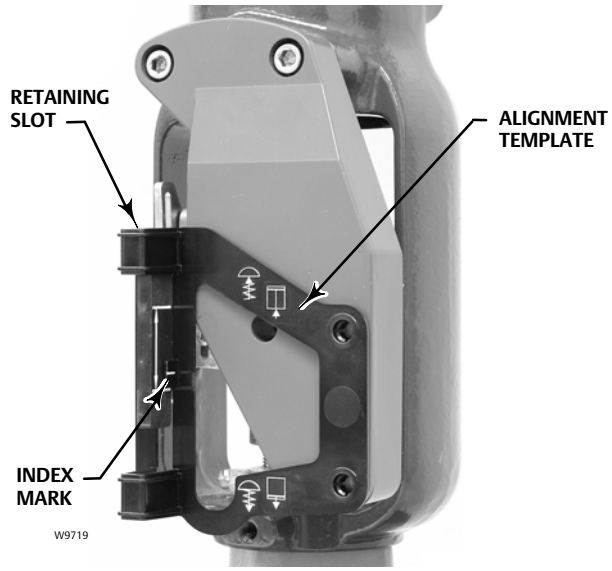


Figure 2-11. Air-to-Close Magnet Assembly Alignment



6. Tighten the fasteners and remove the alignment template.

Note

Use a flat end hex key to tighten the mounting assembly fasteners to a torque of 2.37 N•m (21 in•lbf) for 4 mm screws, and 5.08 N•m (45 in•lbf) for 5 mm screws. While tightening the fasteners using the hex key should be sufficient, blue (medium) thread locker may be used for additional security.

7. Mount the feedback unit to the mounting bracket, using the mounting bolts.
8. Check for clearance between the magnet assembly and the DVC6215 feedback slot.

Note

Ensure that there is clearance between the magnet assembly and the DVC6215 housing slot throughout the full range of travel.

Fisher Rotary Actuators and Sliding-Stem Linear Actuators over 210 mm (8.25 Inches) Travel

The DVC6215 feedback unit uses a cam (designed for linear response) and roller as the feedback mechanism. See figures 2-12 and 2-13.

Figure 2-12. Mounting on Rotary Actuators

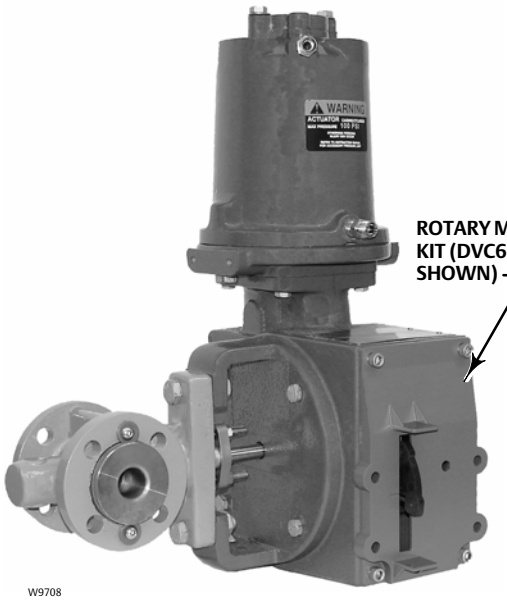
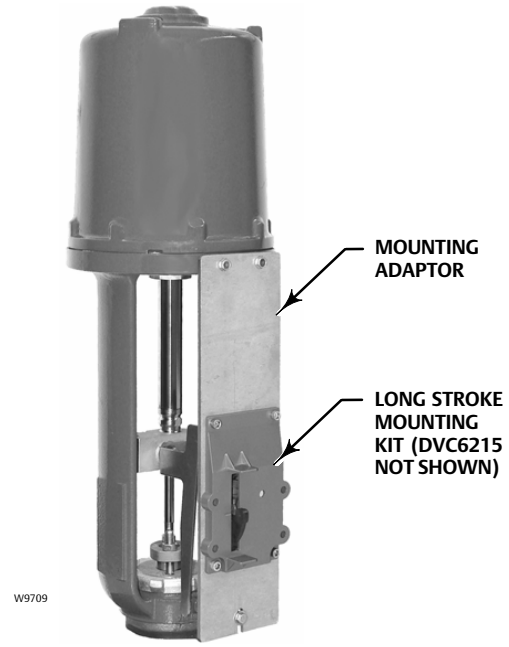


Figure 2-13. Mounting on Sliding-Stem (Linear) Actuators over 210 mm (8.25 Inches) Travel



Note

All cams supplied with FIELDVUE mounting kits are characterized to provide a linear response.

There are three different mounting adaptions, based on the actuator design (see figure 2-14).

Fisher Rotary Actuators

Refer to the following guidelines when mounting on rotary actuators.

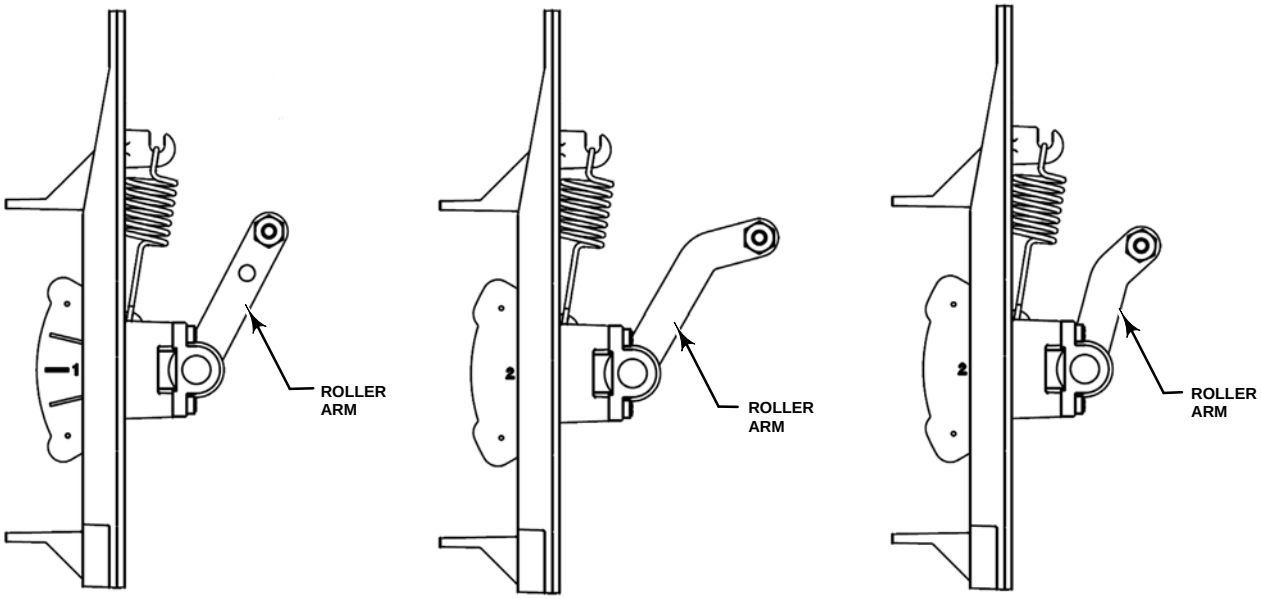
1. Isolate the control valve from the process line pressure and release pressure from both sides of the valve body. Shut off all pressure lines to the pneumatic actuator, releasing all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while working on the equipment.

2. Verify that the appropriate cam is installed on the actuator as described in the instructions included with the mounting kit.
3. Mount the DVC6215 on the actuator as follows:

- If required, a mounting adaptor is included in the mounting kit. Attach the adaptor to the feedback unit, then attach the feedback unit assembly to the actuator. The roller on the feedback arm will contact the actuator cam as it is being attached.

- If no mounting adaptor is required, attach the feedback unit and mounting kit assembly to the actuator. The roller on the feedback arm will contact the actuator cam as it is being attached.

Figure 2-14. Mounting Variations



VARIATION A **VARIATION B** **VARIATION C**

VARIATION	ACTUATOR
A	2052 Size 2 and 3
	1051/1052 size 40-70
	1061 Size 30-100
	Sliding-Stem > 210 mm (8.25 Inches)
B	2052 Size 1
C	1052 Size 20-33
	1051 Size 33

NOTE THE DIFFERENCE IN THE SHAPE AND LENGTH OF THE ROLLER ARM
E1229

Sliding-Stem Linear Actuators over 210 mm (8.25 Inches) Travel

Refer to the following guidelines when mounting on sliding-stem linear actuators over 210 mm (8.25 inches) travel (see figure 2-13).

1. Isolate the control valve from the process line pressure and release pressure from both sides of the valve body. Shut off all pressure lines to the pneumatic actuator, releasing all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while working on the equipment.
2. Install the cam to the valve stem connector as described in the instructions included with the mounting kit.
3. Install the mounting adaptor to the actuator.
4. Attach the feedback unit and mounting kit assembly to the mounting adaptor. The roller on the feedback arm will contact the actuator cam as it is being attached.

GX Actuators

The DVC6215 feedback unit mounts directly on the GX actuator without the need for a mounting bracket.

Identify the yoke side to mount the DVC6215 feedback unit based on the actuator fail mode. Refer to the GX Control Valve and Actuator System instruction manual (D103175X012).

1. Isolate the control valve from the process line pressure and release pressure from both sides of the valve body. Shut off all pressure lines to the actuator, releasing all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
2. Loosely attach the feedback pieces and magnet assembly to the valve stem connector. Do not tighten the fasteners because fine adjustment is required.

CAUTION

Do not install a magnet assembly that is shorter than the physical travel of the actuator. Loss of control will result from the magnet assembly moving outside the range of the index mark in the feedback slot of the DVC6215 housing.

3. Using the alignment template (supplied with the mounting kit), position the feedback assembly inside the retaining slot.
4. Align the magnet assembly as follows:

For air-to-open GX actuators vertically align the magnet assembly so that the center line of the alignment template is lined up as close as possible with the upper extreme of the valid travel range on the magnet assembly. The magnet assembly should be positioned so that the index mark in the feedback slot of the DVC6215 housing is within the valid range on the magnet assembly throughout the range of travel. See figure 2-15.

For air-to-close GX actuators vertically align the magnet assembly so that the center line of the alignment template is lined up as close as possible with the lower extreme of the valid travel range on the magnet assembly. The magnet assembly should be positioned so that the index mark in the feedback slot of the DVC6215 housing is within the valid range on the magnet assembly throughout the range of travel. See figure 2-16.

Figure 2-15. Air-to-Open Fisher GX Magnet Assembly Alignment

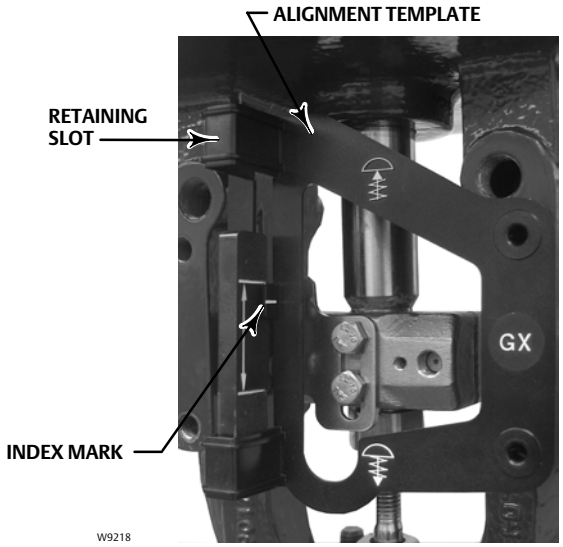
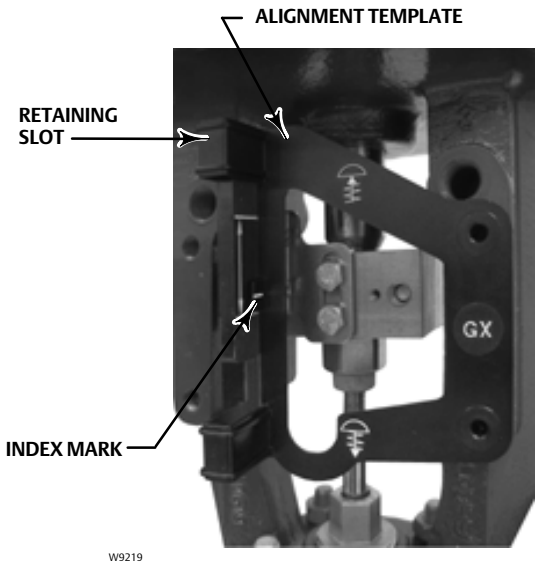


Figure 2-16. Air-to-Close Fisher GX Magnet Assembly Alignment



5. Tighten the fasteners and remove the alignment template. Continue on with the appropriate step 6 below.

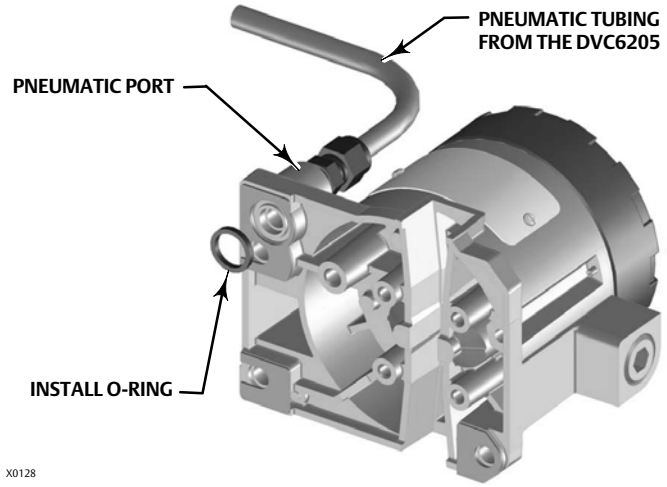
Note

Use a flat end hex key to tighten the mounting assembly fasteners to a torque of 2.37 N•m (21 in•lbf) for 4 mm screws, and 5.08 N•m (45 in•lbf) for 5 mm screws. While tightening the fasteners using the hex key should be sufficient, blue (medium) thread locker may be used for additional security.

Air-to-Open GX Actuators

6. The pneumatic output port on the DVC6215 lines up with the integral GX actuator pneumatic port. See figure 2-17.
7. Using a 5 mm hex wrench, attach the feedback unit to the GX actuator mounting pad on the side that has the open pneumatic port. Be sure to place the O-ring between the feedback units pneumatic output and the actuator mounting pad. Pneumatic tubing between the feedback unit and the actuator is not required because the air passages are internal to the actuator.
8. Connect the pneumatic tubing from the DVC6205 to the feedback units pneumatic port provided on the front of the DVC6215 as shown in figure 2-17.
9. Check for clearance between the magnet assembly and the DVC6215 feedback slot.
10. If not already installed, install a vent in the port on the upper diaphragm casing's air supply connection on the actuator yoke leg.

Figure 2-17. Modifications for Fisher GX Actuator; Air-to-Open Construction Only



Air-to-Close GX Actuators

6. Using a 5 mm hex wrench, attach the feedback unit to the GX actuator mounting pad.
7. Check for clearance between the magnet assembly and the DVC6215 feedback slot.
8. Install tubing between the actuator casing and the appropriate DVC6215 pneumatic output port.
9. If not already installed, install a vent in the port on the lower diaphragm casing.

Note

- To convert to air-to-open, install an O-ring between the feedback units pneumatic output and the actuator mounting pad. Connect pneumatic tubing from the DVC6205 to the DVC6215. Refer to figure 2-17.

- To convert to air-to-close, remove the O-ring between the feedback units pneumatic output and the actuator mounting pad. Disconnect the pneumatic tubing from the DVC6205 to the DVC6215. Install tubing between the pneumatic output connection of the DVC6205 to the pneumatic port on top of the actuator casing.

Quarter-Turn Rotary Actuators

The DVC6215 feedback unit can be mounted to any quarter-turn rotary actuator, as well as those that comply with the NAMUR guidelines. A mounting bracket and associated hardware are required. Refer to figure 2-18.

1. Isolate the control valve from the process line pressure and release pressure from both sides of the valve body. Shut off all pressure lines to the actuator, releasing all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
2. Attach the magnet assembly to the actuator shaft. At mid-travel, the flats on the magnet assembly should be approximately parallel to the channel on the back of the DVC6215 housing, as shown in figure 2-19.
3. Install the mounting bracket on the actuator.
4. Attach the feedback unit to the mounting bracket using the 4 mounting bolts, as shown in figure 2-18.
5. Check for clearance between the magnet assembly and the DVC6215 feedback slot.
6. Install tubing between the actuator casing and the appropriate DVC6215 pneumatic output port.

Figure 2-18. Mounting on Quarter-Turn Actuators

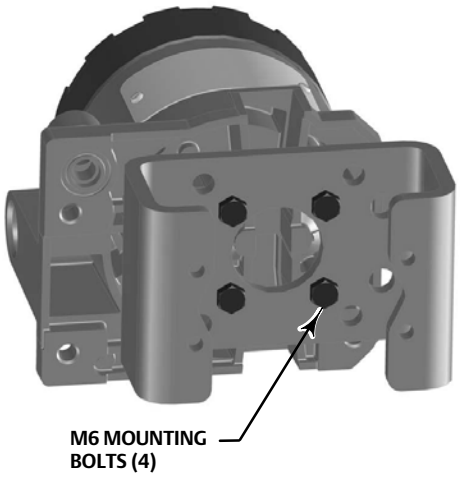
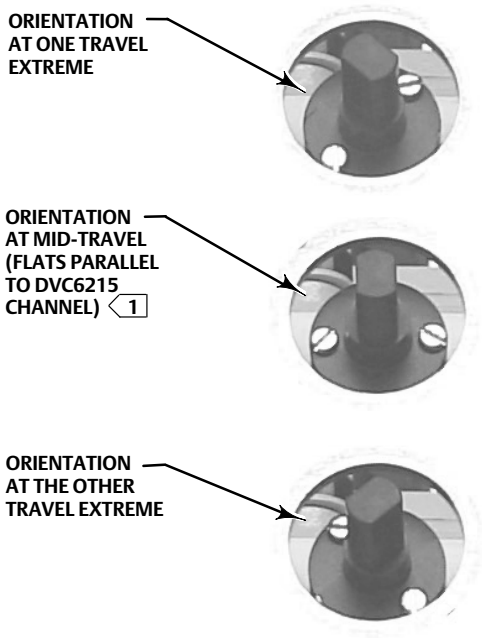


Figure 2-19. Magnet Assembly Orientation on Quarter-Turn Actuators



1 THIS EXAMPLE SHOWS AN ACTUATOR WITH 90° TRAVEL. ON AN ACTUATOR THAT HAS LESS THAN 90° TRAVEL THE MAGNET ASSEMBLY MAY NOT BE PARALLEL AT THE MID-TRAVEL POINT. TO VERIFY THE MAGNET ASSEMBLY POSITION IS IN WORKING RANGE, CONFIRM TRAVEL COUNTS ARE WITHIN THE EXPECTED RANGE OF 175-3800 USING VALVELINK SOFTWARE OR A FIELD COMMUNICATOR.

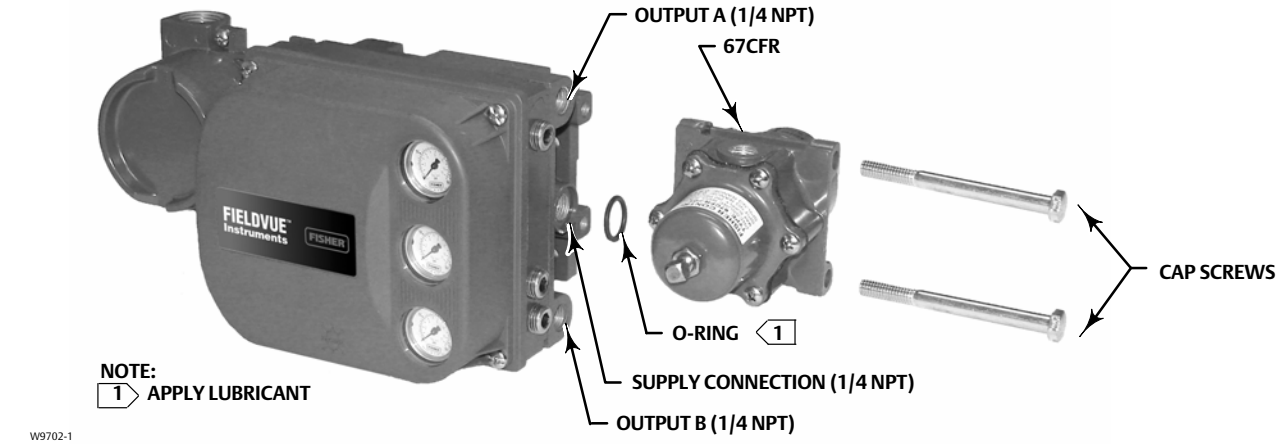
Mounting Fisher 67CFR Filter Regulator

A 67CFR filter regulator, when used with a DVC6200 digital valve controller, can be mounted one of three ways.

Integral-Mounted Regulator

Refer to figure 2-20. Lubricate an O-ring and insert it in the recess around the SUPPLY connection on the digital valve controller. Attach the 67CFR filter regulator to the side of the digital valve controller. Thread a 1/4-inch socket-head pipe plug into the unused outlet on the filter regulator. This is the standard method of mounting the filter regulator.

Figure 2-20. Mounting the Fisher 67CFR Regulator on a FIELDVUE DVC6200 Digital Valve Controller



Yoke-Mounted Regulator

Mount the filter regulator with two cap screws to the pre-drilled and tapped holes in the actuator yoke. Thread a 1/4-inch socket-head pipe plug into the unused outlet on the filter regulator. No O-ring is required.

Casing-Mounted Regulator

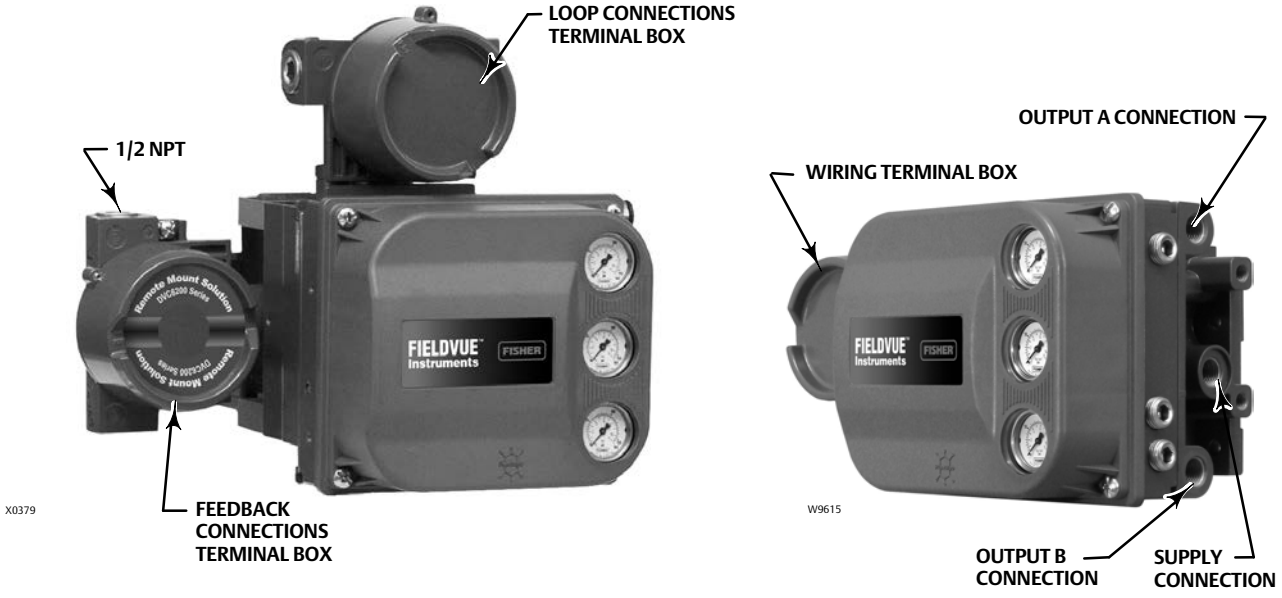
Use the separate 67CFR filter regulator casing mounting bracket provided with the filter regulator. Attach the mounting bracket to the 67CFR and then attach this assembly to the actuator casing. Thread a 1/4-inch socket-head pipe plug into the unused outlet on the filter regulator. No O-ring is required.

Pneumatic Connections

Pressure

Pressure connections are shown in figure 2-21. All pressure connections on the digital valve controller are 1/4 NPT internal connections. Use at least 10 mm (3/8-inch) tubing for all pressure connections. If remote venting is required a minimum of 12.7 mm (1/2-inch) tubing should be used. Refer to the vent subsection for remote venting information.

Figure 2-21. Pressure Connections



Supply

⚠ WARNING

To avoid personal injury or property damage resulting from bursting of parts, do not exceed maximum supply pressure.

Personal injury or property damage may result from fire or explosion if natural gas is used as the supply medium and appropriate preventive measures are not taken. Preventive measures may include, but are not limited to, one or more of the following: Remote venting of the unit, re-evaluating the hazardous area classification, ensuring adequate ventilation, and the removal of any ignition sources. For information on remote venting of this controller, refer to page 30.

Severe personal injury or property damage may occur from an uncontrolled process if the instrument supply medium is not clean, dry, oil-free, and noncorrosive. While use and regular maintenance of a filter that removes particles larger than 40 micrometers in diameter will suffice in most applications, check with an Emerson Process Management field office and industry instrument air quality standards for use with corrosive air or if you are unsure about the amount of air filtration or filter maintenance.

⚠ WARNING

When using natural gas as the supply medium, or for explosion proof applications, the following warnings also apply:

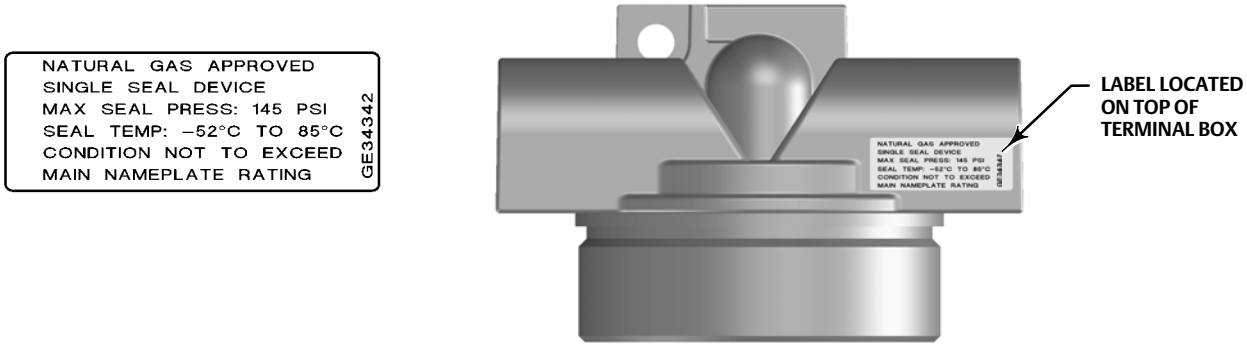
- **Remove electrical power before removing the housing cap. Personal injury or property damage from fire or explosion may result if power is not disconnected before removing the cap.**
- **Remove electrical power before disconnecting any of the pneumatic connections.**
- **When disconnecting any of the pneumatic connections or any pressure retaining part, natural gas will seep from the unit and any connected equipment into the surrounding atmosphere. Personal injury or property damage may result from fire or explosion if natural gas is used as the supply medium and appropriate preventive measures are not taken. Preventive measures may include, but are not limited to, one or more of the following: ensuring adequate ventilation and the removal of any ignition sources.**

- **Ensure that the cover is correctly installed before putting this unit back into service. Failure to do so could result in personal injury or property damage from fire or explosion.**

The DVC6200 can be used with air or natural gas as the supply medium. If using natural gas as the pneumatic supply medium, natural gas will be used in the pneumatic output connections of the DVC6200 to any connected equipment. In normal operation the unit will vent the supply medium into the surrounding atmosphere unless it is remotely vented.

Natural Gas Certified, Single Seal instruments can be identified by the natural gas approval label shown in figure 2-22. The Natural Gas Certified, Single Seal device option simplifies conduit sealing requirements. Read and follow all local, regional, and federal wiring requirements for natural gas installations. Contact your Emerson Process Management sales office for information on obtaining a Natural Gas Certified, Single Seal DVC6200 digital valve controller.

Figure 2-22. Gas Certified Label



Supply pressure must be clean, dry air that meets the requirements of ISA Standard 7.0.01.

Alternatively, natural gas must be clean, dry, oil-free, and noncorrosive. H_2S content should not exceed 20 ppm.

A maximum 40 micrometer particle size in the air system is acceptable. Further filtration down to 5 micrometer particle size is recommended. Lubricant content is not to exceed 1 ppm weight (w/w) or volume (v/v) basis. Condensation in the air supply should be minimized.

If you are using a 67CFR filter regulator with standard 5 micrometer filter, connect the supply line to the 1/4 NPT IN connection and attach tubing from the output connection on the filter regulator to the SUPPLY connection on the instrument. If you are using an integral mounted 67CFR filter regulator, connect the supply to the IN connection on the regulator.

Output Connection

A factory mounted digital valve controller has its output piped to the supply connection on the actuator. If mounting the digital valve controller in the field, connect the 1/4 NPT digital valve controller output connection to the pneumatic actuator input connection.

Single-Acting Actuators

When using a single-acting direct digital valve controller (relay A or C) on a single-acting actuator, connect OUTPUT A to the actuator pneumatic input. When using a single-acting reverse digital valve controller (relay B) on a single-acting actuator, connect OUTPUT B to the actuator diaphragm casing.

Double-Acting Actuators

DVC6200 digital valve controllers on double-acting actuators always use relay A. With no input current, OUTPUT A is at 0 pressure and OUTPUT B is at full supply pressure when the relay is properly adjusted. To have the actuator stem extend from the cylinder with increasing input signal, connect OUTPUT A to the upper actuator cylinder connection. Connect OUTPUT B to the lower cylinder connection. To have the actuator stem retract into the cylinder with increasing input signal, connect OUTPUT A to the lower actuator cylinder connection. Connect OUTPUT B to the upper cylinder connection.

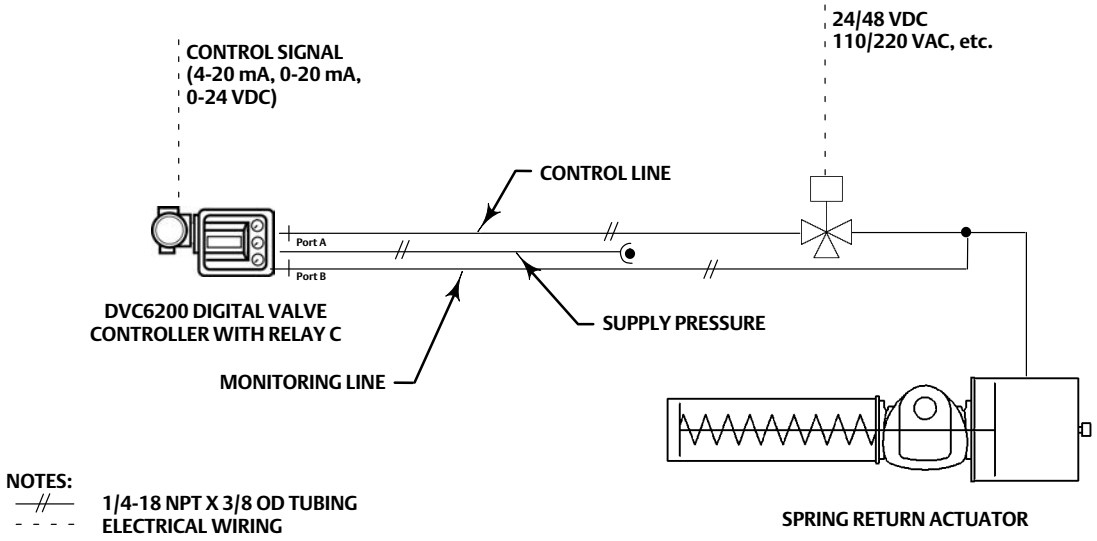
Special Construction to Support Solenoid Valve Testing

Note

Solenoid valve testing is only available for instrument level ODV.

In single-acting actuator applications with a solenoid valve installed, the DVC6200 can be configured to test the operation of the solenoid valve. This is accomplished by connecting the “unused” output port from the DVC6200 to the pneumatic line between the solenoid valve and the actuator, as shown in figure 2-23. When single-acting, direct relay C is installed, the “unused” output port is port B. When single-acting, reverse relay B is used, the unused port is port A.

Figure 2-23. Pneumatic Hookup for Solenoid Testing (Instrument Level ODV only)



Note

This application is called “special application” in the Setup Wizard relay selection.

This configuration is not possible with a double-acting actuator or when using relay A in single-acting mode.

Vent

⚠ WARNING

Personal injury or property damage can occur from cover failure due to overpressure. Ensure that the housing vent opening is open and free of debris to prevent pressure buildup under the cover.

⚠ WARNING

This unit vents the supply medium into the surrounding atmosphere. When installing this unit in a non-hazardous (non-classified) location in a confined area, with natural gas as the supply medium, you must remotely vent this unit to a safe location. Failure to do so could result in personal injury or property damage from fire or explosion, and area re-classification.

When installing this unit in a hazardous (classified) location remote venting of the unit may be required, depending upon the area classification, and as specified by the requirements of local, regional, and federal codes, rules and regulations. Failure to do so when necessary could result in personal injury or property damage from fire or explosion, and area re-classification.

Vent line piping should comply with local and regional codes, should be as short as possible with a minimum inside diameter of 12.7 mm (1/2-inch), and few bends to reduce case pressure buildup.

In addition to remote venting of the unit, ensure that all caps and covers are correctly installed. Failure to do so could result in personal injury or property damage from fire or explosion, and area re-classification.

The relay constantly bleeds a small amount of supply medium into the area under the cover. The vent opening, located below the wiring terminal box on the side of the housing, should be left open to prevent pressure buildup under the cover. If a remote vent is required, the vent lines must be as short as possible with a minimum number of bends and elbows.

To connect a remote vent, remove the plastic vent. The vent connection is 3/8 NPT. At a minimum, 12.7 mm (1/2-inch) tubing should be used when installing a remote vent to prevent excessive pressure from building up under the cover.

Wiring and Electrical Connections

⚠ WARNING

To avoid personal injury resulting from electrical shock, do not exceed maximum input voltage specified in table 1-2 of this quick start guide, or on the product nameplate. If the input voltage specified differs, do not exceed the lowest specified maximum input voltage.

⚠ WARNING

Select wiring and/or cable glands that are rated for the environment of use (such as hazardous area, ingress protection and temperature). Failure to use properly rated wiring and/or cable glands can result in personal injury or property damage from fire or explosion.

Wiring connections must be in accordance with local, regional, and national codes for any given hazardous area approval. Failure to follow the local, regional, and national codes could result in personal injury or property damage from fire or explosion.

Personal injury or property damage caused by fire or explosion may occur if this connection is attempted in a potentially explosive atmosphere or in an area that has been classified as hazardous. Confirm that area classification and atmosphere conditions permit the safe removal of the terminal box cover before proceeding.

The valve may move in an unexpected direction when power is applied to the DVC6200 digital valve controller. To avoid personal injury and property damage caused by moving parts, keep hands, tools, and other objects away from the valve/actuator assembly when applying power to the instrument.

4-20 mA Loop Connections

The digital valve controller is normally powered by a control system output channel. The use of shielded cable will ensure proper operation in electrically noisy environments.

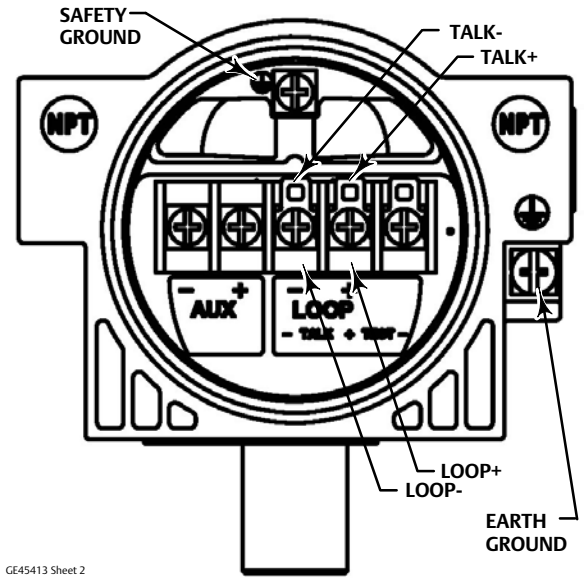
Note

Connect the digital valve controller to a 4-20 mA current source for operation in the point-to-point wiring mode. In the point-to-point wiring mode, the digital valve controller will not operate when connected to a voltage source.

Wire the digital valve controller as follows, refer to figure 2-24:

1. Remove the wiring terminal box cap (refer to figure 2-21).
2. Bring the field wiring into the terminal box. When applicable, install conduit using local and national electrical codes which apply to the application.
3. Connect the control system output channel positive wire “current output” to the LOOP + screw terminal in the terminal box. Connect the control system output channel negative (or return) wire to the LOOP - screw terminal in the terminal box.

Figure 2-24. Loop Connections Terminal Box



⚠ WARNING

Personal injury or property damage, caused by fire or explosion, can result from the discharge of static electricity. Connect a 14 AWG (2.08 mm^2) ground strap between the digital valve controller and earth ground when flammable or hazardous gases are present. Refer to national and local codes and standards for grounding requirements.

4. As shown in figure 2-24, two ground terminals are available for connecting a safety ground, earth ground, or drain wire. The safety ground is electrically identical to the earth ground. Make connections to these terminals following national and local codes and plant standards.

⚠ WARNING

To avoid static discharge from the plastic cover when flammable gases or dust are present, do not rub or clean the cover with solvents. To do so could result in a spark that may cause the flammable gases or dust to explode, resulting in personal injury or property damage. Clean with a mild detergent and water only.

5. Replace and hand tighten the terminal box cap. To secure the terminal box cap engage the lock screw. When the loop is ready for startup, apply power to the control system output channel.

Remote Travel Sensor Connections

The DVC6205 base unit is designed to receive travel information via the Emerson Process Management supplied DVC6215 feedback unit.

⚠ WARNING

Personal injury or property damage, caused by wiring failure, can result if the feedback wiring connecting the base unit with the remote feedback unit shares a conduit with any other power or signal wiring.

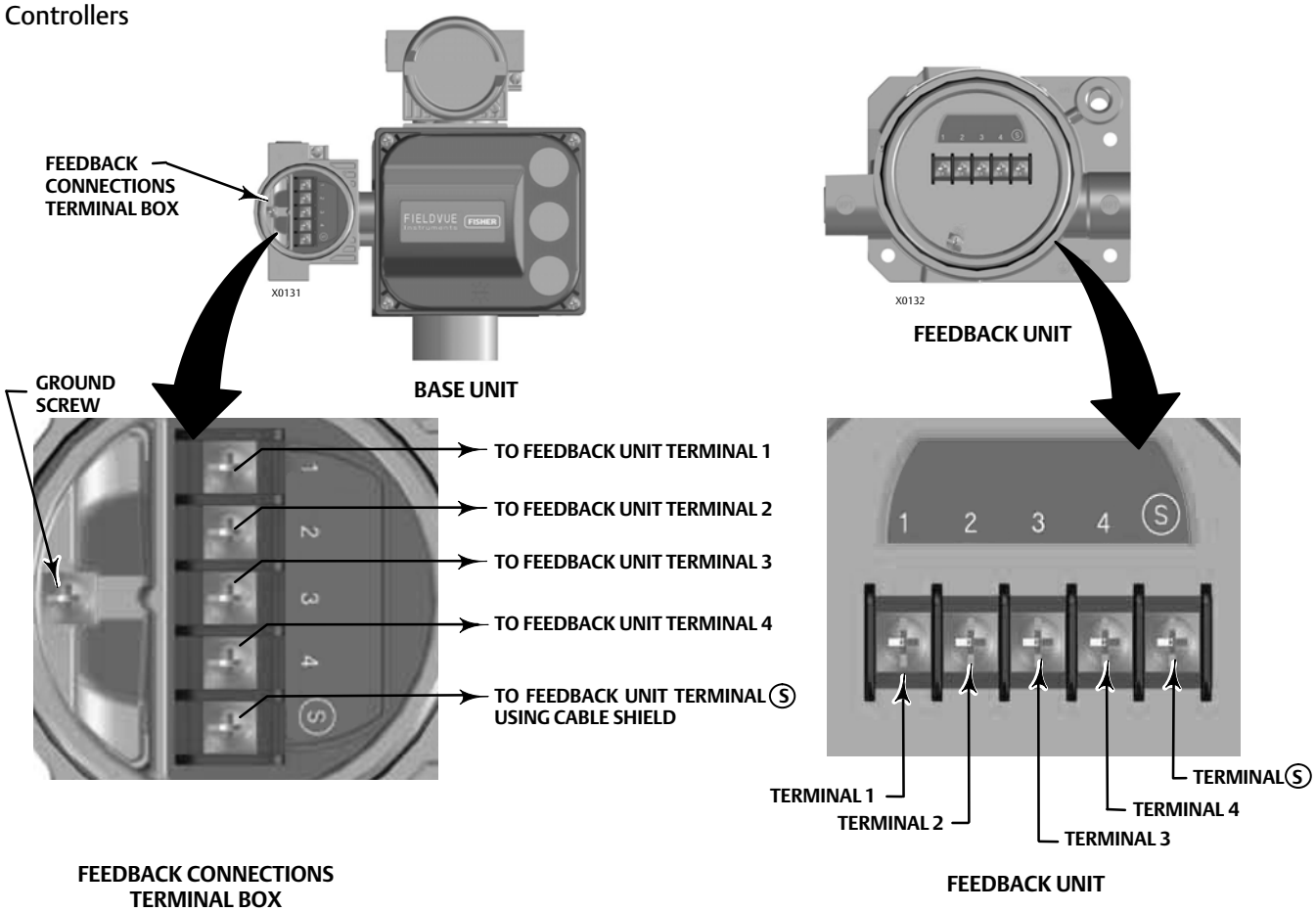
Do not place feedback wiring in the same conduit as other power or signal wiring.

Note

4-conductor shielded cable, 18 to 22 AWG minimum wire size, in rigid or flexible metal conduit, is required for connection between base unit and feedback unit. Pneumatic tubing between base unit output connection and actuator has been tested to 91 meters (300 feet). At 15 meters (50 feet) there was no performance degradation. At 91 meters there was minimal pneumatic lag.

1. On the feedback unit, remove the housing cap.
2. On the base unit, remove the feedback connections terminal box cap (see figure 2-21).
3. Install conduit between the feedback unit and the base unit following applicable local and national electrical codes. Route the 4-conductor shielded cable between the two units (refer to figure 2-25).
4. Connect one wire of the 4-conductor shielded cable between terminal 1 on the feedback unit and terminal 1 on the base unit.
5. Connect the second wire of the 4-conductor shielded cable between terminal 2 on the feedback unit and terminal 2 on the base unit.

Figure 2-25. Terminal Details for Connecting the Base Unit and Feedback Unit for Remote-Mounted Digital Valve Controllers



6. Connect the third wire of the 4-conductor shielded cable between terminal 3 on the feedback unit and terminal 3 on the base unit.
7. Connect the fourth wire of the 4-conductor shielded cable between terminal 4 on the feedback unit and terminal 4 on the base unit.

⚠ WARNING

The cable shield is typically not insulated. It is required that you insulate the cable shield prior to installation.

When connecting the cable shield in step 8 ensure that the uninsulated shield wiring does not contact the DVC6215 housing. Failure to do so can result in ground loop issues.

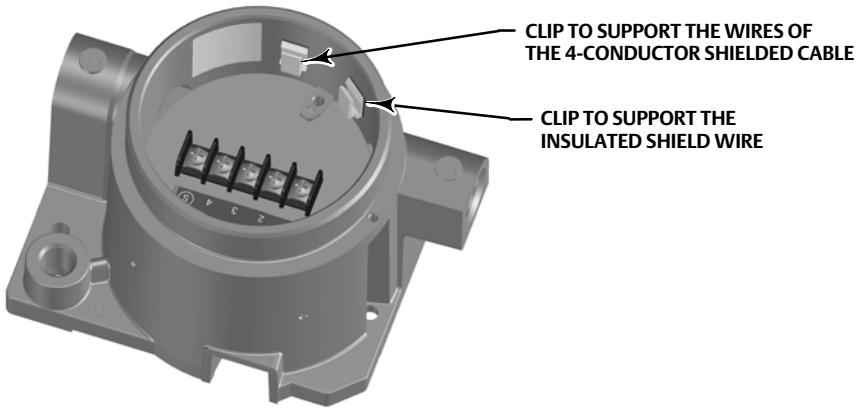
8. Connect the cable shield between terminal S on the feedback unit and terminal S on the base unit.

CAUTION

Failure to secure the cable wires in the support clips in step 9 can result in broken wires in applications with high levels of vibration.

9. Secure the cable wires, using the support clips in the DVC6215 feedback unit (as shown in figure 2-26), to help prevent shifting and movement of the wires.
10. Replace and hand-tighten all covers.

Figure 2-26. Secure Wires in Clips



Wiring Practices

Control System Requirements

There are several parameters that should be checked to ensure the control system is compatible with the DVC6200 digital valve controller.

HART Filter

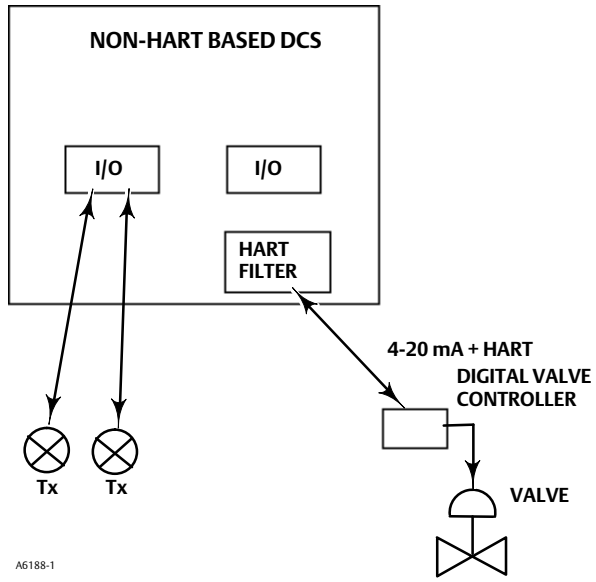
Depending on the control system you are using, a HART filter may be needed to allow HART communication. The HART filter is a passive device that is inserted in field wiring from the HART loop. The filter is normally installed near the field wiring terminals of the control system I/O (see figure 2-27). Its purpose is to effectively isolate the control system output from modulated HART communication signals and raise the impedance of the control system to allow HART communication. For more information on the description and use of the HART filter, refer to the appropriate HART filter instruction manual.

To determine if your system requires a filter contact your Emerson Process Management sales office.

Note

A HART filter is typically NOT required for any of the Emerson Process Management control systems, including PROVOX™, RS3™, and DeltaV™ systems.

Figure 2-27. HART Filter Application



Voltage Available

The voltage available at the DVC6200 digital valve controller must be at least 11 volts DC. The voltage available at the instrument is not the actual voltage measured at the instrument when the instrument is connected. The voltage measured at the instrument is limited by the instrument and is typically less than the voltage available.

As shown in figure 2-28, the voltage available at the instrument depends upon:

- the control system compliance voltage
- if a filter, wireless THUM adapter, or intrinsic safety barrier is used, and
- the wire type and length.

The control system compliance voltage is the maximum voltage at the control system output terminals at which the control system can produce maximum loop current.

The voltage available at the instrument may be calculated from the following equation:

Voltage Available = [Control System Compliance Voltage (at maximum current)] - [filter voltage drop (if a HART filter is used)] - [total cable resistance $\times$ maximum current] - [barrier resistance x maximum current].

The calculated voltage available should be greater than or equal to 11 volts DC.

Table 2-2 lists the resistance of some typical cables.

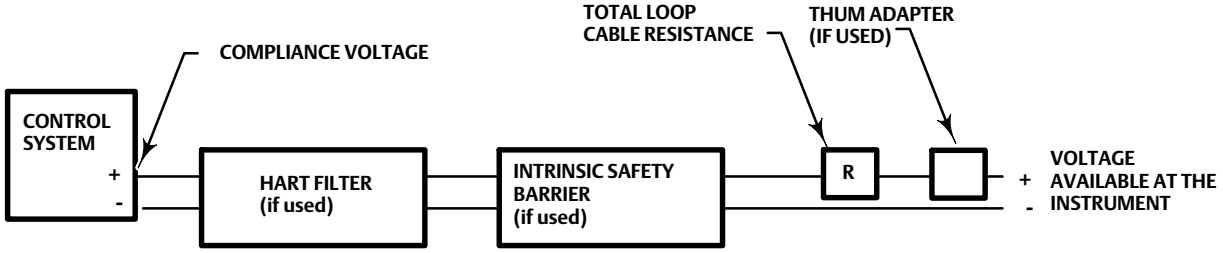
The following example shows how to calculate the voltage available for a Honeywell™ TDC2000 control system with a HF340 HART filter, and 1000 feet of Belden™ 9501 cable:

Voltage available = [18.5 volts (at 21.05 mA)] - [2.3 volts] - [48 ohms $\times$ 0.02105 amps]

Voltage available = [18.5] - [2.3] - [1.01]

Voltage available = 15.19 volts

Figure 2-28. Determining Voltage Available at the Instrument



Calculate Voltage Available at the Instrument as follows:	**Example Calculation**
Control system compliance voltage	**18.5 volts (at 21.05 mA)**
– Filter voltage drop (if used) 1	**– 2.3 volts (for HF300 filter)**
– Intrinsic safety barrier resistance (if used) x maximum loop current	**– 2.55 volts (121 ohms x 0.02105 amps)**
– Smart Wireless THUM adapter voltage drop (if used) 2	
– Total loop cable resistance x maximum loop current	**– 1.01 volts (48 ohms x 0.02105 amps for 1000 feet of Belden 9501 cable)**
= Voltage available at the instrument 3	**= 15.19 volts, available—if safety barrier (2.55 volts) is not used**

NOTES:

1 **Obtain filter voltage drop. The measured drop will be different than this value. The measured filter voltage drop depends upon control system output voltage, the intrinsic safety barrier (if used), and the instrument. See note 3.**

2 **The voltage drop of the THUM adapter is linear from 2.25 volts at 3.5 mA to 1.2 volts at 25 mA.**

3 **The voltage available at the instrument is not the voltage measured at the instrument terminals. Once the instrument is connected, the instrument limits the measured voltage to approximately 9.0 to 10.5 volts.**

Table 2-2. Cable Characteristics

Cable Type	Capacitance(1) pF/Ft	Capacitance(1) pF/m	Resistance(2) Ohms/ft	Resistance(2) Ohms/m
BS5308/1, 0.5 sq mm	61.0	200	0.022	0.074
BS5308/1, 1.0 sq mm	61.0	200	0.012	0.037
BS5308/1, 1.5 sq mm	61.0	200	0.008	0.025
BS5308/2, 0.5 sq mm	121.9	400	0.022	0.074
BS5308/2, 0.75 sq mm	121.9	400	0.016	0.053
BS5308/2, 1.5 sq mm	121.9	400	0.008	0.025
BELDEN 8303, 22 awg	63.0	206.7	0.030	0.098
BELDEN 8441, 22 awg	83.2	273	0.030	0.098
BELDEN 8767, 22 awg	76.8	252	0.030	0.098
BELDEN 8777, 22 awg	54.9	180	0.030	0.098
BELDEN 9501, 24 awg	50.0	164	0.048	0.157
BELDEN 9680, 24 awg	27.5	90.2	0.048	0.157
BELDEN 9729, 24 awg	22.1	72.5	0.048	0.157
BELDEN 9773, 18 awg	54.9	180	0.012	0.042
BELDEN 9829, 24 awg	27.1	88.9	0.048	0.157
BELDEN 9873, 20 awg	54.9	180	0.020	0.069

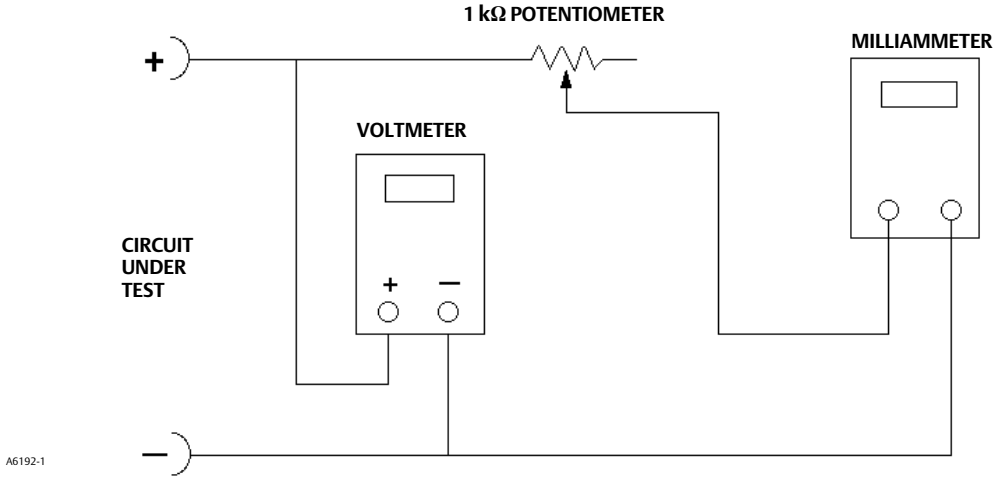
1. The capacitance values represent capacitance from one conductor to all other conductors and shield. This is the appropriate value to use in the cable length calculations.
2. The resistance values include both wires of the twisted pair.

Compliance Voltage

If the compliance voltage of the control system is not known, perform the following compliance voltage test.

1. Disconnect the field wiring from the control system and connect equipment as shown in figure 2-29 to the control system terminals.

Figure 2-29. Voltage Test Schematic



2. Set the control system to provide maximum output current.
3. Increase the resistance of the 1 kΩ potentiometer, shown in figure 2-29, until the current observed on the milliammeter begins to drop quickly.
4. Record the voltage shown on the voltmeter. This is the control system compliance voltage.

For specific parameter information relating to your control system, contact your Emerson Process Management sales office.

Maximum Cable Capacitance

The maximum cable length for HART communication is limited by the characteristic capacitance of the cable. Maximum length due to capacitance can be calculated using the following formulas:

Length(ft) = [160,000 - C_{master}(pF)] ÷ [C_{cable}(pF/ft)]

Length(m) = [160,000 - C_{master}(pF)] ÷ [C_{cable}(pF/m)]

where:

160,000 = a constant derived for FIELDVUE instruments to ensure that the HART network RC time constant will be no greater than 65 µs (per the HART specification).

C_{master} = the capacitance of the control system or HART filter

C_{cable} = the capacitance of the cable used (see table 2-2)

The following example shows how to calculate the cable length for a Foxboro™ I/A control system (1988) with a C_{master} of 50, 000 pF and a Belden 9501 cable with characteristic capacitance of 50pF/ft.

Length(ft) = [160,000 - 50,000pF] ÷ [50pF/ft]

Length = 2200 ft.

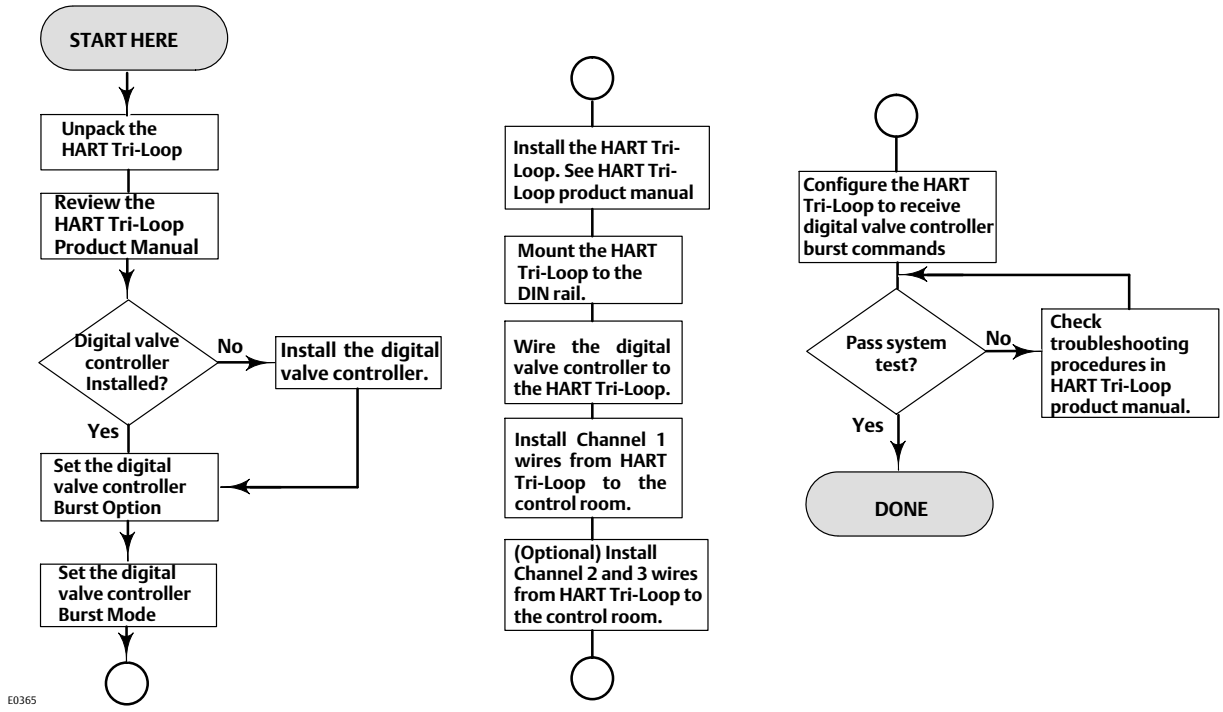
The HART communication cable length is limited by the cable characteristic capacitance. To increase cable length, select a wire with lower capacitance per foot. Contact your Emerson Process Management sales office for specific information relating to your control system.

Installation in Conjunction with a Rosemount 333 HART Tri-Loop HART-to-Analog Signal Converter

Use the DVC6200 digital valve controller in operation with a Rosemount 333 HART Tri-Loop HART-to-Analog Signal Converter to acquire an independent 4-20 mA analog output signal for the analog input, travel target, pressure, or travel. The HART Tri-Loop accepts any three of these digital signals and converts them into three separate 4-20 mA analog channels.

Refer to figure 2-30 for basic installation information. Refer to the 333 HART Tri-Loop HART-to-Analog Signal Converter Product Manual for complete installation information.

Figure 2-30. HART Tri-Loop Installation Flowchart



Commissioning the Digital Valve Controller for use with the HART Tri-Loop Signal Converter

To prepare the digital valve controller for use with a 333 HART Tri-Loop, you must configure the digital valve controller to burst mode, and select Burst Command 3. In burst mode, the digital valve controller provides digital information to the HART Tri-Loop HART-to-Analog Signal Converter. The HART Tri-Loop converts the digital information to a 4 to 20 mA analog signal. Each burst message contains the latest value of the primary (analog input), secondary (travel target), tertiary (configured output pressure), and quaternary (travel) variables.

To commission a DVC6200 for use with a HART Tri-Loop, perform the following procedures.

Note

Instrument level AC does not support HART Command 3 or Burst Mode communications.

Set the Burst Operation

Field Communicator	Configure > Detailed Setup > Mode and Protection > Burst Mode (1-2-1-4)

1. Select *Change Burst Enable.* Select *Enable* then press ENTER and SEND.
2. Select *Change Burst Command.* Select the desired command (HART Univ Command 3).
3. Select *Cmd 3 Configured Pressure*. Select the pressure you desire the HART Tri-Loop to use as the tertiary variable.

Command 3 provides the following variables:

Primary variable—analog input in % off mA,

Secondary variable—travel target in % of ranged travel,

Tertiary variable—supply or output pressure in psig, bar, kPa, or kg/cm^2. Select *Cmd 3 Press* from the *Burst* menu to select if the output A, output B, differential (A-B), or supply pressure is sent.

Quaternary variable—travel in % of ranged travel.

Section 3 Basic Setup

Instrument Mode

Field Communicator	Hot Key > Instrument Mode (Hot Key-1)
	Configure > Detailed Setup > Mode and Protection > Instrument Mode (1-2-1-1)

To setup and calibrate the instrument, the instrument mode must be *Out Of Service*.

If the mode is not *Out Of Service*, select *Out Of Service* from the *Instrument Mode* menu and press ENTER.

Configuration Protection

Field Communicator	Hot Key > Protection (Hot Key-3)
	Configure > Detailed Setup > Mode and Protection > Protection (1-2-1-5)

To setup and calibrate the instrument, the protection must be set to *None* with the Field Communicator. If the protection is not *None*, changing the protection requires placing a jumper across the Auxiliary terminals in the terminal box.

To remove protection:

1. Connect a 4-20 mA source to the instrument.
2. Connect the Field Communicator to the instrument and turn it on.
3. Press the Hot Key on the Field Communicator and select *Protection.*

Note

If the Aux Terminal Mode is configured for Auto Calibration, be sure the jumper remains across the auxiliary terminals until the Field Communicator prompts you to remove it. Removing the jumper too soon will cause the instrument to begin auto calibration.

Auto calibration can be terminated by shorting the Aux Terminals for one second.

⚠ WARNING

If the jumper is removed too soon, and auto calibration begins, the valve will move full stroke. To avoid personal injury and property damage caused by the release of pressure or process fluid, isolate the valve from the process and equalize pressure on both sides of the valve or bleed off the process fluid.

4. From the *Protection* menu, select *None.* When prompted by the Field Communicator, temporarily attach the jumper to the AUX + and AUX - terminals in the instrument terminal box.
5. Remove the jumper from the AUX terminals when prompted.

Basic Setup

Field Communicator	Configure > Guided Setup (1-1)

⚠ WARNING

Changes to the instrument setup may cause changes in the output pressure or valve travel. Depending on the application, these changes may upset process control, which may result in personal injury or property damage.

Note

To setup and calibrate the instrument, the protection must be *None* and the Instrument Mode must be *Out Of Service*. See Configuration Protection and Instrument Mode at the beginning of this section for information on removing instrument protection and changing the instrument mode.

If you are operating in burst mode, we recommend that you disable burst before continuing with calibration. Once calibration is complete, burst mode may then be turned back on.

When the DVC6200 digital valve controller is ordered as part of a control valve assembly, the factory mounts the digital valve controller and sets up the instrument as specified on the order. When mounting to a valve in the field, the instrument needs to be set up to match the instrument to the valve and actuator.

Before beginning Basic Setup, be sure the instrument is correctly mounted as described in the Installation section.

Setup Wizard

Field Communicator	Configure > Guided Setup > Setup Wizard (1-1-1)

Follow the prompts on the Field Communicator display to automatically setup the instrument using specified actuator information. Table 4-4 provides the actuator information required to setup and calibrate the instrument.

1. Enter the instrument family; select DVC6200.
2. Select travel or pressure control. Travel control is the typical mode of operation. Refer to page 56 for additional information on setting Travel/Pressure Control.
3. Enter the pressure units: psi, bar, kPa, or kg/cm^2.
4. Enter the maximum instrument supply pressure.

After entering the maximum instrument supply pressure, the Setup Wizard prompts you for actuator information.

5. Enter the manufacturer of the actuator on which the instrument is mounted. If the actuator manufacturer is not listed, select Other.
6. Enter the actuator model or type. If the actuator model is not listed, select Other.
7. Enter the actuator size.
8. Select whether the valve is open or closed under the zero power condition.
9. Specify if a volume booster or quick release valve is present.
10. Specify if factory defaults should be used for Basic Setup. If you select YES for factory default, the Field Communicator sets the setup parameters to the values listed in table 3-1. If you select NO for the factory defaults, the setup parameters listed in the table remain at their previous settings.

Table 3-1. Factory Default Settings

Setup Parameter	Default Setting
Analog Input Units Analog In Range High Analog In Range Low Control Mode Restart Control Mode	mA 20.0 mA 4.0 mA Analog (Digital if Multidrop) Resume Last
Self-Test Shutdown Setpoint Filter Time (Lag Time) Input Characteristic Travel Limit High Travel Limit Low	All Failures Disabled Filter Off Linear 125% -25%
Travel Cutoff High Travel Cutoff Low Set Point Rate Open Set Point Rate Close Polling Address	99.5% 0.5% 0%/sec 0%/sec 0
Command 3 Pressure For double-acting actuators For single-acting actuators	 differential output pressure actuator pressure

Typically the Setup Wizard determines the required setup information based upon the actuator manufacturer and model specified. However, if you enter *other* for the actuator manufacturer or the actuator model, then you will be prompted for setup parameters such as:
Actuator style (spring & diaphragm, piston double-acting without spring, piston single-acting with spring, piston double-acting with spring),
Valve style (rotary or sliding-stem),
On Loss of Instrument Signal (valve opens or closes), see Zero Power Condition on page 70.

⚠ WARNING

If you answer YES to the prompt for permission to move the valve when the Setup Wizard is determining the travel sensor motion, the instrument will move the valve through its full travel range. To avoid personal injury and property damage caused by the release of pressure or process fluid, isolate the valve from the process and equalize pressure on both sides of the valve or bleed off the process fluid.

Travel Sensor motion (increasing or decreasing air pressure causes the magnet assembly to move up or down or the rotary shaft to turn clockwise or counterclockwise) The Setup Wizard asks if it can move the valve to determine travel sensor motion. If you answer Yes, the instrument will stroke the valve the full travel span to determine travel sensor motion. If you answer No, then you must specify the direction of travel movement. For quarter-turn actuators determine rotation by viewing the rotation of the magnet assembly from the back of the instrument (see Travel Sensor Motion on page 71).
Volume booster (indicate if volume booster or quick release valve is present)
Tuning set (see Tuning Set in the Detailed Setup section).

Note

Travel Sensor Motion in this instance refers to the motion of the magnet assembly. Note that the magnet assembly may be referred to as a magnetic array in user interface tools.

After completing the setup information, you will be prompted to run auto calibration. Follow the prompts on the Field Communicator display. The calibration procedure uses the valve and actuator stops as the 0% and 100% calibration points. For additional information, refer to Auto Calibration on page 78.

If a double-acting relay is used, you will be prompted to run the relay adjustment when auto calibration is selected. Select Yes to adjust the relay. For additional information refer to Relay Adjustment on page 83.

If after completing the Setup Wizard the valve seems slightly unstable or unresponsive, you can improve operation by selecting either *Performance Tuner* or *Stabilize/Optimize*.

Performance Tuner

Field Communicator	Configure > Guided Setup > Performance Tuner (1-1-2)

Note

The Performance Tuner is available for instrument level AD, PD, and ODV.

⚠ WARNING

During performance tuning the valve may move, causing process fluid or pressure to be released. To avoid personal injury and property damage caused by the release of process fluid or pressure, isolate the valve from the process and equalize pressure on both sides of the valve or bleed off the process fluid.

The Performance Tuner is used to optimize digital valve controller tuning. It can be used with digital valve controllers mounted on most sliding-stem and rotary actuators, including Fisher and other manufacturers' products. Moreover, because the Performance Tuner can detect internal instabilities before they become apparent in the travel response, it can generally optimize tuning more effectively than manual tuning. Typically, the Performance Tuner takes 3 to 5 minutes to tune an instrument, although tuning instruments mounted on larger actuators may take longer.

Access Performance Tuner by selecting *Performance Tuner* from the *Guided Setup* menu. Follow the prompts on the Field Communicator display to optimize digital valve controller tuning.

Stabilizing/Optimizing Valve Response

Field Communicator	Hot Key > Stabilize/Optimize (Hot Key-4)
	Instrument level HC only Configure > Guided Setup > Stabilize/Optimize (1-1-2)

Note

Stabilize/Optimize is available for instrument level HC, AD, PD, and ODV.

⚠ WARNING

During Stabilize/Optimize the valve may move, causing process fluid or pressure to be released. To avoid personal injury and property damage caused by the release of process fluid or pressure, isolate the valve from the process and equalize pressure on both sides of the valve or bleed off the process fluid.

If after completing setup and calibration the valve seems slightly unstable or unresponsive, you can improve operation by pressing the Hot Key and selecting *Stabilize/Optimize,* or select *Stabilize/Optimize* from the *Guided Setup* menu (for instrument level HC only). *Stabilize/Optimize* can be accessed through the *Detailed Setup* menu for instrument level AD, PD, and ODV.

Stabilize/Optimize permits you to adjust valve response by changing the digital valve controller

If the valve is unstable, select *Decrease Response* to stabilize valve operation. This selects the next lower tuning set (e.g., F to E). If the valve response is sluggish, select *Increase Response* to make the valve more responsive. This selects the next higher tuning set (e.g., F to G).

If after selecting *Decrease Response* or *Increase Response* the valve travel overshoot is excessive select *Decrease Damping* to select a damping value that allows more overshoot. Select *Increase Damping* to select a damping value that will decrease the overshoot. When finished, select *Done*.

Section 4 Detailed Setup

Detailed Setup

Field Communicator	Configure > Detailed Setup (1-2)

Note

Detailed Setup is available for instrument level HC, AD, PD, and ODV.

Detailed Setup allows you to configure the digital valve controller to your application. Table 4-1 lists the default settings for a standard factory configuration. You can adjust actuator response, set the various modes, alerts, ranges, travel cutoffs and limits. You can also restart the instrument and set the protection.

Table 4-1. Default Detailed Setup Parameters

Setup Parameter		Default Setting(1)
Instrument Configuration	Control Mode	Analog
	Restart Control Mode	Resume Last
	Zero Power Condition	Valve Open(2)
	Analog In Range Low	4 mA
	Analog In Range High	20 mA
	Analog Input Units	mA
	Feedback Connection	Rotary - All(2)
	Travel Sensor Motion	CW/To Bottom Inst.(2)
	Auxiliary Terminal Action	Disabled
	Max Supply Pressure	20(2)
	Pressure Units	PSI(3)
	Temperature Units	F(3)
	Polling Address	0
	Burst Mode Enable	No
	Burst Command	3
	Cmd 3 Configured Pressure	A-B
Dynamic Response and Tuning	Tuning Set	F(2)
	Input Characterization	Linear
	Travel Limit High	125%
	Travel Limit Low	-25%
	Travel/Pressure Cutoff High	99.46%
	Travel/Pressure Cutoff Low	0.50%
	Set Point Rate Open	0%/sec
	Set Point Rate Close	0%/sec
	Set Point Filter Time (Lag Time)	0 sec
	Integrator Enable	Yes
	Integral Gain	9.4 repeats/minute
	Integral Deadzone	0.26%

-continued on next page-

Table 4-1. Default Detailed Setup Parameters (continued)

Setup Parameter		Default Setting[1]
Travel History Alerts	Cycle Counter Alert Enable	No
	Cycle Counter Alert Deadband	1%
	Cycle Counter Alert Point	1000000
	Travel Accumulator Alert Enable	No
	Travel Accumulator Deadband	1%
	Travel Accumulator Alert Point	1000000
Deviation & Other Alerts	Travel Deviation Alert Enable	Yes
	Travel Deviation Alert Point	5%
	Travel Deviation Time	9.99 sec
	Pressure Deviation Alert Enable	Yes
	Pressure Deviation Alert Point	5 psi[3]
	Pressure Deviation Alert Time	9.99 sec
	Drive Signal Alert Enable	Yes
	Supply Pressure Alert Enable	Yes
	Supply Pressure Alert Point	19 psi[3]
Travel Alerts	Travel Alert Lo Enable	No
	Lo Point	-25%
	Travel Alert Hi Enable	No
	Hi Point	125%
	Travel Alert Lo Lo Enable	No
	Lo Lo Point	-25%
	Travel Alert Hi Hi Enable	No
	Hi Hi Point	125%
	Deadband	5%
Electronics Alerts	Shutdown Activated	Yes
	Non-Critical NVM Alert Enable	No
Informational Status	Instrument Time Invalid Enable	Yes
	Calibration in Progress Enable	No
	Autocalibration in Progress Enable	No
	Diagnostics in Progress Enable	No
	Diagnostics Data Available Enable	Yes
	Integrator Saturated Hi Enable	Yes
	Integrator Saturated Lo Enable	Yes
	Pressure Control Active Enable	Yes
	Multi-Drop Alert Enable	No
Alert Record	Valve Alerts Enable	Yes
	Failure Alerts Enable	Yes
	Miscelleneous Alerts Enable	No
	Alert Record has Entries Enable	Yes
	Alert Record Full Enable	Yes

1. The settings listed are for standard factory configuration. DVC6200 instruments can also be ordered with custom configuration settings. For the default custom settings, refer to the order requisition.
2. If the instrument is shipped mounted on an actuator, these values depend upon the actuator on which the instrument is mounted.
3. U.S. Factory defaults only.

Mode and Protection

Mode

Instrument Mode

Field Communicator	Hot Key > Instrument Mode (Hot Key-1)
	Configure > Detailed Setup > Mode and Protection > Instrument Mode (1-2-1-1)

Instrument Mode allows you to either take the instrument Out Of Service or place it In Service. Taking the instrument Out Of Service allows you to perform instrument calibration and also allows you to change setup variables that affect control, provided the calibration/configuration protection is properly set. See Setting Protection.

Note

Some changes that require the instrument to be taken Out Of Service will not take effect until the instrument is placed back In Service or the instrument is restarted.

Control Mode

Field Communicator	Hot Key > Instrument Mode (Hot Key-2)
	Configure > Detailed Setup > Mode and Protection > Instrument Mode (1-2-1-2)

Control Mode lets you define where the instrument reads its set point. Follow the prompts on the Field Communicator display to choose one of the following control modes: Analog or Digital.

Choose Analog if the instrument is to receive its set point over the 4-20 mA loop. Normally the instrument control mode is Analog.

Choose Digital if the instrument is to receive its set point digitally, via the HART communications link.

A third mode, Test, is also displayed. Normally the instrument should not be in the Test mode. The Field Communicator automatically switches to this mode whenever it needs to stroke the valve during calibration or stroke valve, for example. However, if you abort from a procedure where the instrument is in the Test mode, it may remain in this mode. To take the instrument out of the Test mode, select *Control Mode* then select either Analog or Digital.

Restart Control Mode

Field Communicator	Configure > Detailed Setup > Mode and Protection > Restart Control Mode (1-2-1-3)

Restart Control Mode lets you choose which operating mode you want the instrument to be in after a restart. Follow the prompts on the Field Communicator display to define the restart control mode as Resume Last, Analog, or Digital.

Burst Mode

Field Communicator	Configure > Detailed Setup > Mode and Protection > Burst Mode (1-2-1-4)

Enabling burst mode provides continuous communication from the digital valve controller. Burst mode applies only to the transmission of burst mode data (analog input, travel target, pressure, and travel) and does not affect the way other data is accessed.

Access to information in the instrument is normally obtained through the poll/response of HART communication. The Field Communicator or the control system may request any of the information that is normally available, even while

the instrument is in burst mode. Between each burst mode transmission sent by the instrument, a short pause allows the Field Communicator or control system to initiate a request. The instrument receives the request, processes the response message, and then continues "bursting" the burst mode data.

- *Burst Enable*—Yes or no. Burst mode must be enabled before you can change the burst mode command.
- *Change Burst Enable*— Turns Burst Mode on and off. Actual values are Burst Enable = Disabled(Polled), Enabled.
- *Burst Command*—There are four burst mode commands. Command 3 is recommended for use with the 333 HART Tri-Loop HART-to-analog signal converter. The other three are not used at this time.
- *Change Burst Command*— Allows you to pick the command to be sent from the instrument when Burst Mode is on. Select HART Univ Cmd 1, HART Univ Cmd 2, HART Univ Cmd 3, or DVC6000 Cmd 148.
- *Cmd 3 Configured Pressure*—Command 3 provides the following variables:

Primary variable—analog input in % or mA,

Secondary variable—travel target in % of ranged travel,

Tertiary variable—supply or output pressure in psig, bar, kPa, or kg/cm^2. Select *Cmd 3 Configured Pressure* from the *Burst* menu to select if the output A, output B, differential (A-B), or supply pressure is sent.

Quaternary variable—travel in % of ranged travel.

Protection

Protection

Field Communicator	Hot Key > Protection (Hot Key-3)
	Configure > Detailed Setup > Mode and Protection > Protection (1-2-1-5)

Some setup parameters may require changing the protection with the Field Communicator. To remove protection (change protection to *None*) requires placing a jumper across the auxiliary terminals in the terminal box in order to change protection.

Note

If the Auxiliary Terminal Action is configured for Auto Calibration, be sure the jumper remains across the auxiliary terminals until the Field Communicator prompts you to remove it. Removing the jumper too soon will cause the instrument to begin auto calibration.

Auto calibration can be terminated by shorting the auxiliary terminals for one second.

⚠ WARNING

If the jumper is removed too soon, and auto calibration begins, the valve will move full stroke. To avoid personal injury and property damage caused by the release of pressure or process fluid, isolate the valve from the process and equalize pressure on both sides of the valve or bleed off the process fluid.

Two levels of protection are available:

- *Config & Calib*—Both setup and calibration are protected. Prohibits changing calibration and protected setup parameters.
- *None*—Neither setup nor calibration is protected. Allows changing calibration and setup parameters.

Table 4-2 lists configurable parameters in the instrument and the requirements for modifying these parameters, in terms of instrument mode and protection.

Select the desired level of protection. Follow the prompts on the Field Communicator display to set the protection level. If necessary, temporarily attach the jumper to the AUX + and AUX - terminals in the instrument terminal box when prompted by the Field Communicator.

Table 4-2. Conditions for Modifying FIELDVUE DVC6200 Digital Valve Controller Parameters

Parameters	In Service/ Config Protected	In Service/ Config Unprotected	Out of Service/ Config Protected	Out of Service/ Config Unprotected
Control Mode	✓	✓	✓	✓
Restart Ctrl Mode	---	---	---	✓
Burst Mode Enable	✓	✓	✓	✓
Burst Mode Command	---	✓	---	✓
Protection	✓	✓	✓	✓
HART Tag	---	✓	---	✓
Message	---	✓	---	✓
Descriptor	---	✓	---	✓
Date	---	✓	---	✓
Valve Serial Num	---	✓	---	✓
Inst Serial Num	---	✓	---	✓
Polling Address	---	---	---	✓
Relay Type	---	---	---	✓
Max Supply Pressure	---	---	---	✓
Actuator Style	---	---	---	✓
Feedback Connection	---	---	---	✓
Travel Sensor Motion	---	---	---	✓
Valve Style	---	---	---	✓
Zero Ctrl Signal	---	---	---	✓
Analog In Units	---	---	---	✓
Input Range High	---	---	---	✓
Input Range Low	---	---	---	✓
Pressure Units	---	---	---	✓
Temp Units	✓	✓	✓	✓
Tuning Set	---	✓	---	✓
Prop Gain	---	✓	---	✓
Velocity Gain	---	✓	---	✓
MLFB Gain	---	✓	---	✓
Input Char	---	---	---	✓
Define Custom Char	---	---	---	✓
Set Point Filter Time (Lag Time)	---	---	---	✓
Tvl Limit High	---	---	---	✓
Tvl Limit Low	---	---	---	✓
Tvl Cutoff High	---	---	---	✓
Tvl Cutoff Low	---	---	---	✓
Set Point Rate Open	---	---	---	✓
Set Point Rate Close	---	---	---	✓
Tvl Hi/Lo Enab	✓	✓	✓	✓
Tvl HH/LL Enab	✓	✓	✓	✓
Tvl Alert Hi Pt	✓	✓	✓	✓
Tvl Alert Lo Pt	✓	✓	✓	✓
Tvl Alert HiHi Pt	✓	✓	✓	✓
Tvl Alert LoLo Pt	✓	✓	✓	✓
Tvl Alrt DB	✓	✓	✓	✓

✓—indicates parameter may be modified for instrument mode and protection shown.

-Continued-

Table 4-2. Conditions for Modifying FIELDVUE DVC6200 Digital Valve Controller Parameters (continued)

Parameters	In Service/ Config Protected	In Service/ Config Unprotected	Out of Service/ Config Protected	Out of Service/ Config Unprotected
Tvl Dev Alrt Enab	✓	✓	✓	✓
Tvl Dev Alrt Pt	✓	✓	✓	✓
Tvl Dev Time	✓	✓	✓	✓
Cycl Cnt Alrt Enab	✓	✓	✓	✓
Cycl Count Alrt Pt	✓	✓	✓	✓
Cycl Count DB	✓	✓	✓	✓
Cycl Count	✓	✓	✓	✓
Tvl Acum Alrt Enab	✓	✓	✓	✓
Tvl Acum Alrt Pt	✓	✓	✓	✓
Tvl Acum DB	✓	✓	✓	✓
Tvl Acum	✓	✓	✓	✓
Aux Terminal Action	---	---	---	✓
Aux In Alrt Enab	✓	✓	✓	✓
Aux In Alrt State	✓	✓	✓	✓
Drive Alrt Enab	✓	✓	✓	✓
Supply Press Alrt	✓	✓	✓	✓
Flash ROM Fail	---	---	---	✓
Ref Voltage Fail	---	---	---	✓
Drive Current Fail	---	---	---	✓
Critical NVM Fail	---	---	---	✓
Temp Sensor Fail	---	---	---	✓
Press Sensor Fail	---	---	---	✓
Tvl Sensor Fail	---	---	---	✓

✓—indicates parameter may be modified for instrument mode and protection shown.

Response Control

Field Communicator	Configure > Detailed Setup > Response Control (1-2-2)

Follow the prompts on the Field Communicator display to configure the following response control parameters: *Tuning, Travel/Pressure Control, Input Characterization, Custom Characterization Table,* and *Dynamic Response*.

Tuning

Field Communicator	Configure > Detailed Setup > Response Control > Tuning (1-2-2-1)

Travel Tuning

⚠ WARNING

Changes to the tuning set may cause the valve/actuator assembly to stroke. To avoid personal injury and property damage caused by moving parts, keep hands, tools, and other objects away from the valve/actuator assembly.

- Travel Tuning Set—There are eleven tuning sets to choose from. Each tuning set provides a preselected value for the digital valve controller gain settings. Tuning set C provides the slowest response and M provides the fastest response.

Table 4-3 lists the proportional gain, velocity gain and minor loop feedback gain values for preselected tuning sets.

Table 4-3. Gain Values for Preselected Travel Tuning Sets

Tuning Set	Proportional Gain	Velocity Gain	Minor Loop Feedback Gain
C	4.4	3.0	35
D	4.8	3.0	35
E	5.5	3.0	35
F	6.2	3.1	35
G	7.2	3.6	34
H	8.4	4.2	31
I	9.7	4.85	27
J	11.3	5.65	23
K	13.1	6.0	18
L	15.5	6.0	12
M	18.0	6.0	12
X (Expert)	User Adjusted	User Adjusted	User Adjusted

In addition, you can specify Expert tuning and individually set the proportional gain, velocity gain, and minor loop feedback gain. Individually setting or changing any tuning parameter or running the Performance Tuner or Stabilize/Optimize will automatically change the tuning set to X (expert).

Note

Use Expert tuning only if standard tuning has not achieved the desired results.

Stabilize/Optimize or Performance Tuner may be used to achieve the desired results more rapidly than Expert tuning.

Table 4-4 provides tuning set selection guidelines for Fisher and Baumann actuators. These tuning sets are only recommended starting points. After you finish setting up and calibrating the instrument, you may have to select either a higher or lower tuning set to get the desired response. You can use the Performance Tuner to optimize tuning.

- Integral Enable—Yes or No. Enable the integral setting to improve static performance by correcting for error that exists between the travel target and actual travel. Travel Integral Control is enabled by default.

- Integral Gain—Travel Integral Gain is the ratio of the change in output to the change in input, based on the control action in which the output is proportional to the time integral of the input.

- Stabilize/Optimize—Stabilize/Optimize permits you to adjust valve response by changing the digital valve controller tuning. During this routine, the instrument must be out of service; however, the instrument will respond to setpoint changes.

If the valve is unstable, select *Decrease Response* to stabilize valve operation. This selects the next lower tuning set (e.g., F to E). If the valve response is sluggish, select *Increase Response* to make the valve more responsive. This selects the next higher tuning set (e.g., F to G).

If after selecting *Decrease Response* or *Increase Response* the valve travel overshoot is excessive, select *Decrease Damping* to select a damping value that allows more overshoot. Select *Increase Damping* to select a damping value that will decrease the overshoot. When finished, select *done.*

Table 4-4. Actuator Information for Initial Setup

Actuator Manufacturer	Actuator Model	Actuator Size	Actuator Style	Starting Tuning Set	Travel Sensor Motion[2] Relay A or C[3]	
Fisher	585C & 585CR	25 50 60 68, 80 100, 130	Piston Dbl w/ or w/o Spring. See actuator instruction manual and nameplate.	E I J L M	User Specified	
	657	30 34, 40 45, 50 46, 60, 70, 76, & 80-100	Spring & Diaphragm	H K L M	Away from the top of the instrument	
	667	30 34, 40 45, 50 46, 60, 70, 76, & 80-100	Spring & Diaphragm	H K L M	Towards the top of the instrument	
	1051 & 1052	20, 30 33 40 60, 70	Spring & Diaphragm (Window-mount)	H I K M	Away from the top of the instrument	
	1061	30 40 60 68, 80, 100, 130	Piston Dbl w/o Spring	J K L M	Depends upon pneumatic connections. See description for Travel Sensor Motion	
	1066SR	20 27, 75	Piston Sgl w/Spring	G L	Mounting Style	Travel Sensor Motion
					A	Away from the top of the instrument
					B	Towards the top of the instrument
					C	Towards the top of the instrument
					D	Away from the top of the instrument
	2052	1 2 3	Spring & Diaphragm (Window-mount)	H J M	Away from the top of the instrument	
	3024C	30, 30E 34, 34E, 40, 40E 45, 45E	Spring & Diaphragm	E H K	For P_O operating mode (air opens): Towards the top of the instrument For P_S operating mode (air closes): Away from the top of the instrument	
	GX	225	Spring & Diaphragm	X[1]	Air to Open Towards the top of the instrument	Air to Close Away from the top of the instrument
		750		K		
		1200		M		
Baumann	Air to Extend	16 32 54	Spring & Diaphragm	C E H	Towards the top of the instrument	
	Air to Retract				Away from the top of the instrument	
	Rotary	10 25 54		E H J	Specify	

NOTE: Refer to figure 2-3 and table 4-8 for feedback connection (magnet assembly) information.
1. X = Expert Tuning. Proportional Gain = 4.2; Velocity Gain = 3.0; Minor Loop Feedback Gain = 18.0
2. Travel Sensor Motion in this instance refers to the motion of the magnet assembly.
3. Values shown are for Relay A and C. Reverse for Relay B.

- Performance Tuner

Note

The Performance Tuner is available for instrument level AD, PD, and ODV, and can only be run while in Travel control mode.

The Performance Tuner is used to determine digital valve controller tuning. It can be used with digital valve controllers mounted on most sliding-stem and rotary actuators, including Fisher and other manufacturers' products. Moreover, because the performance tuner can detect internal instabilities before they become apparent in the travel response, it can generally optimize tuning more effectively than manual tuning. Typically, the performance tuner takes 3 to 5 minutes to tune an instrument, although tuning instruments mounted on larger actuators may take longer.

Integral Settings

- Integral Dead Zone—A window around the Primary Setpoint in which integral action is disabled. This feature is used to eliminate friction induced limit cycles around the Primary Setpoint when the integrator is active. The Dead Zone is configurable from 0% to 2%, corresponding to a symmetric window from 0% to +/-2% around the Primary Setpoint. Default value is 0.25%.

- Integral Limit—The Integral Limit provides an upper limit to the integrator output. The high limit is configurable from 0 to 100% of the I/P drive signal.

Pressure Tuning

⚠ WARNING

Changes to the tuning set may cause the valve/actuator assembly to stroke. To avoid personal injury and property damage caused by moving parts, keep hands, tools, and other objects away from the valve/actuator assembly.

- Pressure Tuning Set—There are twelve Pressure Tuning Sets to choose from. Each tuning set provides a preselected value for the digital valve controller gain settings. Tuning set C provides the slowest response and M provides the fastest response.

Tuning set B is appropriate for controlling a pneumatic positioner. Table 4-5 lists the proportional gain, pressure integrator gain and minor loop feedback gain values for preselected tuning sets.

Table 4-5. Gain Values for Preselected Pressure Tuning Sets

Tuning Set	Proportional Gain	Integrator Gain	Minor Loop Feedback Gain
B	0.5	0.3	35
C	2.2	0.1	35
D	2.4	0.1	35
E	2.8	0.1	35
F	3.1	0.1	35
G	3.6	0.1	34
H	4.2	0.1	31
I	4.8	0.1	27
J	5.6	0.1	23
K	6.6	0.1	18
L	7.8	0.1	12
M	9.0	0.1	12
X (Expert)	User Adjusted	User Adjusted	User Adjusted

In addition, you can specify Expert tuning and individually set the pressure proportional gain, pressure integrator gain, and pressure minor loop feedback gain. Individually setting or changing any tuning parameter will automatically change the tuning set to X (expert).

Note

Use Expert tuning only if standard tuning has not achieved the desired results.

Stabilize/Optimize or Performance Tuner may be used to achieve the desired results more rapidly than Expert tuning.

- Integral Enable—Yes or No. Enable the pressure integral setting to improve static performance by correcting for error that exists between the pressure target and actual pressure. Pressure Integral Control is disabled by default.
- Integral Gain—Pressure Integral Gain (also called reset) is the gain factor applied to the time integral of the error signal between desired and actual pressure. Changing this parameter will also change the tuning set to Expert.

Travel/Pressure Control

Field Communicator	Configure > Detailed Setup > Response Control > Travel/Pressure Control (1-2-2-2)

- Travel/Pressure Select

Travel/Pressure Select determines if the instrument is set up for position or pressure control. Select Travel, Pressure, Travel with Pressure Fallback/Auto recovery or Travel with Pressure Fallback/Manual Recovery. If the travel sensor fails, and Travel with Pressure Fallback/Auto Recovery is selected, it will return to travel control when the travel sensor starts working again. Travel with Pressure Fallback/Manual recovery will stay in pressure control until Travel Pressure Select is changed to Travel or Travel with Pressure Fallback/Auto recovery. It is not necessary to enable the Travel Sensor Alert for Pressure Fallback to occur.

Note

Travel / Pressure Select must be set to Travel for double-acting actuators

Cutoffs and Limits

- *Cutoff Hi*

  Travel Cutoff High defines the high cutoff point for the travel in percent (%) of ranged input current. Above this cutoff, the travel target is set to 123.0% of the ranged input current. When a Travel Cutoff High is set, the Travel Limit High is deactivated, since only one of these parameters can be active. Travel Cutoff Hi is deactivated by setting it to 125.0%.

  Pressure Cutoff Hi defines the high cutoff point for the pressure in percent (%) of pre-characterized setpoint. Above this cutoff, the pressure target is set to 123.0%. A Pressure Cutoff Hi of 99.5% is recommended to ensure valve goes fully open. Pressure Cutoff Hi is deactivated by setting it to 125%.

- *Cutoff Lo*

  Travel Cutoff Low defines the low cutoff point for the travel set point. Travel Cutoff Low can be used to ensure proper seat load is applied to the valve. When below the travel cutoff low, the output is set to zero or to full supply

pressure, depending upon the zero power condition. A Travel Cutoff Low of 0.5% is recommended to help ensure maximum shutoff seat loading. When a Travel Cutoff Low is set, the Travel Limit Low is deactivated, since only one of these parameters can be active. Travel Cutoff Low is deactivated by setting it to -25%.

Pressure Cutoff Lo defines the low cutoff point for the pressure in percent (%) of pre-characterized setpoint. Below this cutoff, the pressure target is set to -23%. A Pressure Cutoff Lo of 0.5% is recommended to help ensure maximum shutoff seat loading. Pressure Cutoff Lo is deactivated by setting it to -25.0%

- *Change Cutoffs*—Allows you to set hi and lo cutoffs. When a cutoff is set the corresponding travel or pressure limit will be disabled.
- *Travel Limit Hi*—Defines the high limit for the travel in percent (%) of ranged travel. It is the maximum allowable travel (in percent of ranged travel) for the valve. During operation, the travel target will not exceed this limit. When a Travel Limit High is set, the Travel Cutoff High is deactivated, since only one of these parameters can be active. Travel Limit High is deactivated by setting it to 125.0%
- *Travel Limit Lo*—Defines the low limit for the travel in percent (%) of ranged travel. It is the minimum allowable travel (in percent of ranged travel) for the valve. During operation, the travel target will not exceed this limit. When a Travel Limit Low is set, the Travel Cutoff Low is deactivated, since only one of these parameters can be active. Travel Limit Low is deactivated by setting it to -25.0%.
- *Change Travel Limits*—Allows you to set hi and lo travel limits. Setting a travel limit will eliminate the corresponding Tvl/Press Cutoff.

Pressure Control

- *Pressure Range Hi*—The high end of output pressure range. Enter the pressure that corresponds with 100% valve travel when Zero Power Condition is closed, or 0% valve travel when Zero Power Condition is open. This pressure *must be greater* than the Pressure Range Lo.
- *Pressure Range Lo*—The low end of the output pressure range. Enter the pressure that corresponds to 0% valve travel when Zero Power Condition is closed, or 100% valve travel when Zero Power Condition is open. This pressure *must be less* than the Pressure Range Hi.

End Point Pressure Control (Instrument Level ODV)

Note
End Point Pressure Control is available for instrument level ODV.

- *End Pt Control Enab*— Select Yes or No. End Point Pressure Control allows the digital valve controller to pull back from saturation of the pneumatic output after reaching the travel extreme. Rather than having the instrument provide full supply pressure (saturation) continuously at the travel extreme, the digital valve controller switches to an End Point Pressure Control where the output pressure (pressure controller set point) to the actuator is maintained at a certain value. This value is configured through the Upper Operating Pressure feature. Because the digital valve controller is constantly in control and not allowed to reach a dormant or saturated state, it is constantly testing its own pneumatic system. If there is an output pressure deviation, for example, the instrument will issue an alert. To ensure there is an alert when an output pressure deviation occurs, setup the alert as described under Pressure Deviation Alert.
- *PST Start Pt*—Defines the travel stop the valve needs to be at before a partial stroke test can be initiated. Also defines the travel stop for end point pressure control. Setting this value to Not Configured will disable partial stroke tests and end point pressure control.

- *Press Set Point*—Used in conjunction with End Point Pressure Control, Pressure Set Point allows the user to select a pressure to be delivered by the instrument at the travel extreme. For a fail-closed valve, this pressure must be sufficient to maintain the fully open position. For a fail-open valve, this pressure (which is automatically set to supply pressure) must be sufficient to fully close the valve and maintain its rated shutoff classification. For double-acting spring return actuators, this is the differential pressure required to either maintain the fully open or fully closed position, depending on the valve and actuator configuration. For a double-acting actuator without springs with a fail-close valve, this is 95% of the supply pressure. If the valve is fail-open, the upper operating pressure for all actuator is set to the supply pressure.

- *Press Sat Time*— Pressure Saturation Time is the time the digital valve controller stays in hard cutoff before switching to pressure control. Default is 45 seconds.

Input Characterization

Field Communicator	Configure > Detailed Setup > Response Control > Input Characterization (1-2-2-3)

Input Characterization defines the relationship between the travel target and ranged set point. Ranged set point is the input to the characterization function. If the zero power condition equals closed, then a set point of 0% corresponds to a ranged input of 0%. If the zero power condition equals open, a set point of 0% corresponds to a ranged input of 100%. Travel target is the output from the characterization function.

To select an input characterization, select *Input Characterization* from the *Response Control* menu. You can select from the three fixed input characteristics shown in figure 4-1 or you can select a custom characteristic. Figure 4-1 shows the relationship between the travel target and ranged set point for the fixed input characteristics, assuming the Zero Power Condition is configured as closed.

You can specify 21 points on a custom characteristic curve. Each point defines a travel target, in % of ranged travel, for a corresponding set point, in % of ranged set point. Set point values range from -6.25% to 106.25%. Before modification, the custom characteristic is linear.

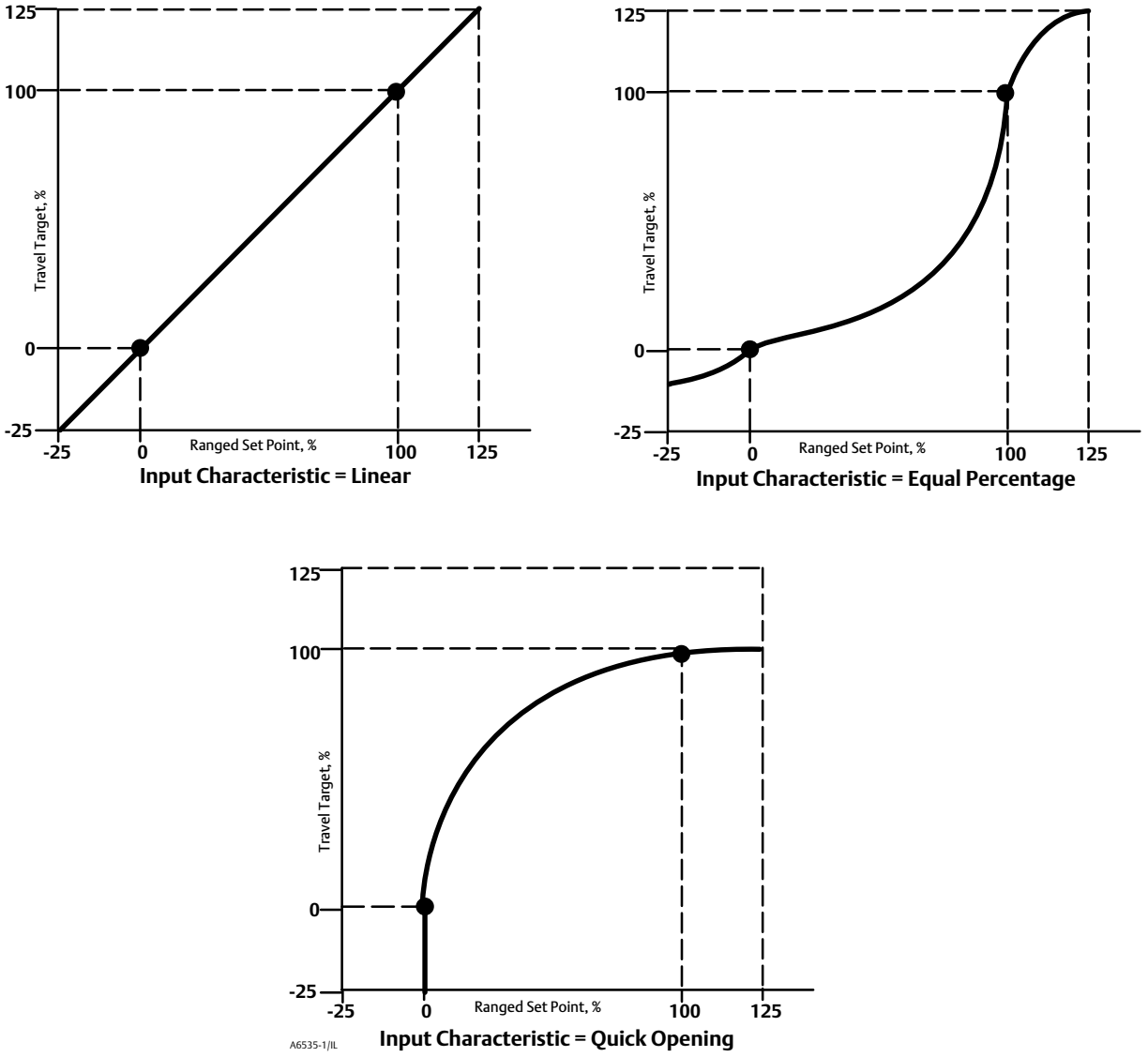
Custom Characterization Table

Field Communicator	Configure > Detailed Setup > Response Control > Custom Characterization Table (1-2-2-4)

To define a custom input character select *Custom Characterization Table* from the *Response Control* menu. Select the point you wish to define (1 to 21), then enter the desired set point value. Press Enter then enter the desired travel target for the corresponding set point. When finished, select point 0 to return to the *Response Control* menu.

With input characterization you can modify the overall characteristic of the valve and instrument combination. Selecting an equal percentage, quick opening, or custom (other than the default of linear) input characteristic modifies the overall valve and instrument characteristic. However, if you select the linear input characteristic, the overall valve and instrument characteristic is the characteristic of the valve, which is determined by the valve trim (i.e., the plug or cage).

Figure 4-1. Travel Target Versus Ranged Set Point, for Various Input Characteristics (Zero Power Condition = Closed)



Dynamic Response

Field Communicator	Configure / Setup > Detailed Setup > Response Control > Dynamic Response (1-2-2-5)

- SP Rate Open—Maximum rate (% of valve travel per second) at which the digital valve controller will move to the open position regardless of the rate of input current change. A value of 0 will deactivate this feature and allow the valve to stroke open as fast as possible. In firmware 9 and 10 this parameter should be set to 0.

- SP Rate Close—Maximum rate (% of valve travel per second) at which the digital valve controller will move to the close position regardless of the rate of input current change. A value of 0 will deactivate this feature and allow the valve to stroke close as fast as possible. In firmware 9 and 10 this parameter should be set to 0.

- Set Point Filter Time (Lag Time)—The Set Point Filter Time (Lag Time) slows the response of the digital valve controller. A value ranging from 0.2 to 10.0 can be used for noisy or fast processes to improve closed loop process control. Entering a value of 0.0 will deactivate the lag filter. In firmware 9 and 10 this parameter should be set to 0.

Note
Set Point Filter Time (Lag Time) is available for instrument level HC, AD, and PD.

- Lead/Lag Set Point Filter—ODV devices have access to a lead-lag set point filter that can be used to improve a valve's dynamic response. The lead-lag filter is part of the set point processing routine that reshapes the input signal before it becomes travel set point. Lead-lag filters are characterized by lead and lag time constants.

Note
Lead/Lag is only available for instrument level ODV.

When the valve is in its active control region (off the seat), the lead-lag filter improves small amplitude response by momentarily overdriving the travel set point. This is useful when the actuator is large and equipped with accessories. As a result, any volume boosters that are present will be activated. The longer the lag time, the more pronounced the overdrive. Since the lead-lag input filter is used to enhance the dynamic response of a control valve, filter parameters should be set after the tuning parameters have been established.

When the valve is at its seat, the lead-lag filter also has a boost function that sets the initial conditions of the filter artificially low so that small amplitude signal changes appear to be large signal changes to the filter. The boost function introduces a large spike that momentarily overdrives the instrument and activates any external volume boosters that may be present. The lead-lag boost function is normally disabled except for those cases where the valve must respond to small command signals off the seat. By setting the lead/lag ratio in the opening and closing directions to 1.0, the boost function can be enabled without introducing lead-lag dynamics in the active control region. See table 4-6 for typical lead-lag filter settings.

Table 4-6. Typical Lead/Lag Filter Settings for Instrument Level ODV

Parameter	Description	Typical Value
Lag Time	First order time constant. A value of 0.0 will disable the lead-lag filter.	0.2 sec
Opening Lead/Lag Ratio	Initial response to the filter in the opening direction.	2.0
Closing Lead/Lag Ratio	Initial response to the filter in the closing direction.	2.0
Lead-Lag Boost	Initial conditions of the lead-lag filter when the lower travel cutoff is active.	Off

Alert Setup

Field Communicator	Configure > Detailed Setup > Alert Setup (1-2-3)

The following menus are available for configuring Alerts. Items on the menus may be changed with the instrument In Service. Protection does not need to be removed (no need to set to *None*). Alerts are not processed when a Diagnostic is in progress. Follow the prompts on the Field Communicator display to configure the following alerts: *Electronics Alerts, Sensor Alerts, Environment Alerts, Travel Alerts, Travel History Alerts, SIS Alerts* (instrument level ODV), and *Alert Record.*

Note
The Alerts section covers alerts and shutdowns. An alert, if enabled, can provide information on operation and performance issues. A shutdown, if enabled, and upon the occurrence of the associated failure alert, will cause the instrument air output to go to the

Zero Power Condition as per figure 4-6. It will remain latched in that condition until power to the instrument is cycled and the failure alert has cleared. While in shutdown condition the instrument will remain powered up and able to communicate via HART. Shutdown alerts are turned off by default.

Electronics Alerts

Field Communicator	Configure > Detailed Setup > Alert Setup > Electronics Alerts (1-2-3-1)

Drive Current Shutdown

When enabled, the instrument shuts down whenever the drive current does not read as expected.

Drive Signal Alert—Drive Signal Alert checks the drive signal and calibrated travel. If one of the following conditions exists for more than 20 seconds, the Drive Signal Alert is set.

For the case where Zero Power Condition is defined as closed:

Drive Signal < 10% and Calibrated Travel > 3%

Drive Signal > 90% and Calibrated Travel < 97%

For the case where Zero Power Condition is defined as open:

Drive Signal < 10% and Calibrated Travel < 97%

Drive Signal > 90% and Calibrated Travel > 3%

- *Drive Signal Alert Enable*—Yes or No. Drive Signal Alert Enable activates checking of the relationship between the Drive Signal and the calibrated travel. Factory default is Yes.
- *Drive Signal*—Shows the value of the instrument drive signal in % (percent) of maximum drive.

Processor Impaired Alerts

- *Offline/Failed Alert Enab*—If enabled, set when the device is in a failed state and not controlling the input.
- *Low Power Write Fail Enab*—When enabled, an alert is generated if a write to the instrument is attempted and fails when the loop current is less than 3.5 mA.
- *Non-Critical NVM Alrt Enab*—When enabled, an alert is generated whenever there is a failure associated with non-critical NVM (non-volatile memory).
- *Critical NVM Shutdown*—When enabled, the instrument shuts down whenever there is a failure associated with critical NVM (non-volatile memory).
- *Flash ROM Shutdown*—When enabled, the instrument shuts down whenever there is a failure associated with flash ROM (read only memory).
- *Reference Voltage Shutdown*—When enabled, the instrument shuts down whenever there is a failure associated with the internal voltage reference.

Sensor Alerts

Field Communicator	Configure > Detailed Setup > Alert Setup > Sensor Alerts (1-2-3-2)

Travel Sensor Shutdown—When enabled, the instrument shuts down whenever there is a failure associated with the travel sensor.

Temp Sensor Shutdown—When enabled, the instrument shuts down whenever there is a failure associated with the temperature sensor.

Pressure Sensor Shutdown—When enabled, the instrument shuts down whenever there is a failure associated with the pressure sensor.

Environment Alerts

Field Communicator	Configure > Detailed Setup > Alert Setup > Environment Alerts (1-2-3-3)

Auxiliary Terminal Alert

- *Auxiliary Terminal Alert Enable*—Yes or No. Auxiliary Input Alert Enable activates checking the status of the auxiliary input when the Auxiliary Terminal Mode is Aux Input Alert. When enabled, the Auxiliary Input Alert is set when the auxiliary input terminals are either open or closed, depending upon the selection for the Aux In Alrt State. Factory default is No.
- *Auxiliary Input*—The auxiliary input is a contact or discrete input, which may be open or closed.
- *Auxiliary Terminal Action*—Disabled, Alert on Open Contact, Alert on Close Contact, or Auto Travel Calibration. Selecting Alert on Open or Closed Contact activates checking the status of the auxiliary input contacts. Selecting Auto Travel Calibration permits starting an automatic travel calibration procedure by placing a jumper across the auxiliary input terminals for 3 to 5 seconds.

Supply Pressure Lo Alert

Note
The Supply Pressure Lo alert is available for instrument level AD, PD, and ODV.

- *Supply Pressure Lo Alert Enable*—When enabled, the instrument sends an alert when the supply pressure falls below the supply pressure alert point. Factory default is Yes.
- *Supply*—Displays the instrument supply pressure in kPa,bar, psi, or kg/cm^2.
- *Supply Pressure Lo Alert Point*—When the supply pressure falls below the supply pressure alert point, the supply pressure alert is active. To disable the supply pressure alert, set Supply Pressure Alert Point to zero.

Loop Current Validation Enable—When enabled, the instrument shuts down whenever there is a failure associated with the measured loop current being out-of-range.

Note
Loop Current Validation Enable is available for instrument level AD, PD, and ODV.

Travel Alerts

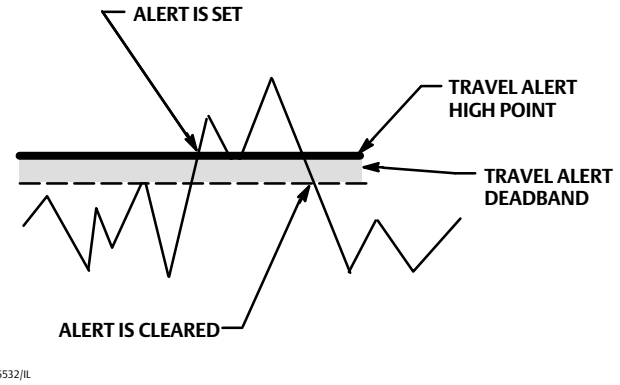
Field Communicator	Configure > Detailed Setup > Alert Setup > Travel Alerts (1-2-3-4)

Travel—Travel displays the actual position of the valve in percent (%) of calibrated travel.

Setpoint—Setpoint is the input to the characterization function.

Travel Alert DB—Travel Alert Deadband is the travel, in percent (%) of ranged travel, required to clear a travel alert, once it has been set. The deadband applies to both Travel Alert Hi/Lo and Travel Alert Hi Hi/Lo Lo. See figure 4-2.

Figure 4-2. Travel Alert Deadband



Travel Deviation Alert—If the difference between the travel target and the actual target exceeds the Travel Deviation Alert Point for more than the Travel Deviation Time, the Travel Deviation Alert is set. It remains set until the difference between the travel target and the actual travel is less than the Travel Deviation Alert Point minus the Travel Alert Deadband.

- *Travel Deviation Alert Enable*—Select Yes or No. When enabled, the Travel Deviation Alert checks the difference between the travel target and the actual travel. Factory default is Yes.
- *Travel Deviation Alert Point*—Travel Deviation Alert Point is the alert point for the difference, expressed in percent (%), between the travel target and the actual travel. When the difference exceeds the alert point for more than the Travel Deviation Time, the Travel Deviation Alert is set.
- *Travel Deviation Time*—Travel Deviation Time is the time, in seconds, that the travel deviation must exceed the Travel Deviation Alert Point before the alert is set.

Travel Limit Alerts—Travel Alert Hi Hi is set if the ranged travel rises above the alert high point. Once the alert is set, the ranged travel must fall below the alert high high point by the Travel Alert Deadband before the alert is cleared. See figure 4-2.

Travel Alert Lo Lo is set if the ranged travel falls below the alert low low point. Once the alert is set, the ranged travel must rise above the alert low low point by the Travel Alert Deadband before the alert is cleared.

- *Travel Alert Hi Hi Enable*—Yes or No. Activates checking of the ranged travel against the Travel Alert Hi Hi points. Factory default is No.
- *Travel Alert Lo Lo Enable*—Yes or No. Activates checking of the ranged travel against the Travel Alert Lo Lo points. Factory default is No.

- *Travel Alert Hi Hi Point*—The value of the travel, in percent (%) of ranged travel, which, when exceeded, sets the Travel Alert Hi Hi alert.

- *Travel Alert Lo Lo Point*— The value of the travel, in percent (%) of ranged travel, which, when exceeded, sets the Travel Alert Lo Lo alert.

Travel Limit Hi/Lo Alerts—Travel Alert Hi is set if the ranged travel rises above the alert high point. Once the alert is set, the ranged travel must fall below the alert high point by the Travel Alert Deadband before the alert is cleared. See figure 4-2.

Travel Alert Lo is set if the ranged travel falls below the alert low point. Once the alert is set, the ranged travel must rise above the alert low point by the Travel Alert Deadband before the alert is cleared.

- *Travel Alert Hi Enable*—Yes or No. Activates checking of the ranged travel against the Travel Alert High Point. Factory default is No.

- *Travel Alert Lo Enable*—Yes or No. Activates checking of the ranged travel against the Travel Alert Lo Point. Factory default is No.

- *Travel Alert Hi Point*— The value of the travel, in percent (%) of ranged travel, which, when exceeded, sets the Travel Alert Hi alert.

- *Travel Alert Lo Point*—The value of the travel, in percent (%) of ranged travel, which, when exceeded, sets the Travel Alert Lo alert.

Travel Limit / Cutoff Alerts

- *Travel Limit/Cutoff Hi Alert Enable*—Yes or No. Activates the Travel Limit / Cutoff Hi alert.

- *Travel Limit/Cutoff Lo Alert Enable*—Yes or No. Activates the Travel Limit/Cutoff Lo alert.

- *Cutoff Hi*

  Travel Cutoff Hi defines the high cutoff point for the travel in percent(%) of pre-characterized set point. Above this cutoff, the travel target is set to 123.0% of the ranged travel. Travel Cutoff Hi is deactivated by setting it to 125.0%.

  Pressure Cutoff Hi defines the high cutoff point for the pressure in percent (%) of pre-characterized set point. Above this cutoff,the pressure target is set to 123.0%. A Pressure Cutoff Hi of 99.5% is recommended to ensure valve goes fully open. Pressure Cutoff Hi is deactivated by setting it to 125%

- *Cutoff Lo*

  Travel Cutoff Lo defines the low cutoff point for the travel in percent (%)of pre-characterized set point. Below this cutoff, the travel target is set to -23%. A Travel Cutoff Lo of 0.5% is recommended to help ensure maximum shutoff seat loading. Travel Cutoff Lo is deactivated by setting it to-25.0%

  Pressure Cutoff Lo defines the low cutoff point for the pressure in percent (%) of pre-characterized set point. Below this cutoff,the pressure target is set to -23%. A Pressure Cutoff Lo of 0.5% is recommended to help ensure maximum shutoff seat loading. Pressure Cutoff Lo is deactivated by setting it to -25.0%

- *Change Cutoffs*—Allows you to set Cutoff Hi and Cutoff Lo. When a cutoff is set the corresponding travel or pressure limit is disabled.

- *Travel Limit High*—Defines the high limit for the travel in percent (%) of ranged travel. It is the maximum allowable travel (in percent of ranged travel) for the valve. During operation, the travel target will not exceed this limit. When a Travel Limit High is set, the Travel Cutoff High is deactivated, since only one of these parameters can be active. Travel Limit High is deactivated by setting it to 125.0%.

- *Travel Limit Lo*—Defines the low limit for the travel in percent (%) of ranged travel. It is the minimum allowable travel (in percent of ranged travel) for the valve. During operation, the travel target will not exceed this limit. When a Travel Limit Low is set, the Travel Cutoff Low is deactivated, since only one of these parameters can be active. Travel Limit Low is deactivated by setting it to -25.0%.

- *Change Travel Limits*— Allows you to set hi and lo travel limits. Setting a travel limit will eliminate the corresponding Tvl/Press Cutoff.

Travel History Alerts

Field Communicator	Configure > Detailed Setup > Alerts > Travel History Alerts (1-2-3-5)

Cycle Counter

- *Cycle Count Alert Enable*—Yes or No. Activates checking of the difference between the Cycle Counter and the Cycle Counter Alert point. The Cycle Counter Alert is set when the value exceeds the Cycle Counter Alert point. It is cleared after you reset the Cycle Counter to a value less than the alert point. Factory default is No.

- *Cycle Counter*—Records the number of times the travel changes direction. The change in direction must occur after the deadband has been exceeded before it can be counted as a cycle. See figure 4-3. You can reset the Cycle Counter by configuring it as zero.

- *Cycle Count Alert Point*—The value of the Cycle Counter, in cycles, which, when exceeded, sets the Cycle Counter Alert.

Cycle Count/Travel Accumulator Deadband

- *Deadband*—Cycle Counter Deadband is the area around the travel reference point, in percent (%) of ranged travel, that was established at the last increment of the Cycle Counter. This area must be exceeded before a change in travel direction can be counted as a cycle. See figure 4-3.

  Travel Accumulator Deadband is the area around the travel reference point, in percent (%) of ranged travel, that was established at the last increment of the accumulator. This area must be exceeded before a change in travel can be accumulated. See figure 4-4.

Table 4-3. Cycle Counter Deadband (set at 10%)

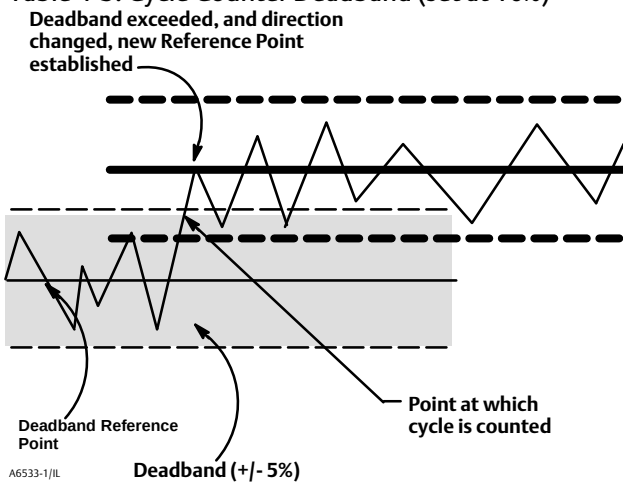
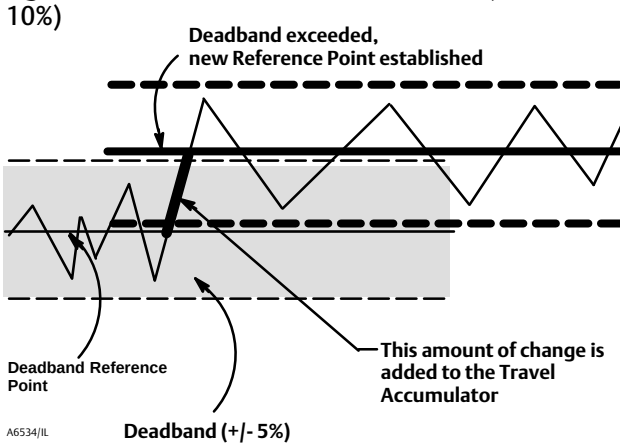


Figure 4-4. Travel Accumulator Deadband (set at 10%)



Travel Accumulator

- *Travel Accumulator Alert Enable*—Yes or No. Activates checking of the difference between the Travel Accumulator value and the Travel Accumulator Alert Point. The Travel Accumulation Alert is set when the Travel Accumulator value exceeds the Travel Accumulator Alert Point. It is cleared after you reset the Travel Accumulation to a value less than the alert point. Factory default is No.

- *Travel Accumulator*—Records the total change in travel, in percent (%) of ranged travel, since the accumulator was last cleared. The value of the Travel Accumulator increments when the magnitude of the change exceeds the Travel Accumulator Deadband. See figure 4-4. You can reset the Travel Accumulator by configuring it to zero.

- *Travel Accumulator Alert Point*—The value of the Travel Accumulator, in percent (%) of ranged travel, which, when exceeded, sets the Travel Accumulator Alert.

SIS Alerts (Instrument Level ODV)

Field Communicator	Configure > Detailed Setup > Alert Setup > SIS Alerts (1-2-3-6)

Note

SIS Alerts are only available for instrument level ODV.

- *PST Press Limit*—Partial Stroke Test Pressure Limit defines the output pressure that will cause the partial stroke test to stop. For actuators that vent from the test starting point, the pressure limit will be a minimum value. For actuators that fill from the test starting point, the pressure limit will be a maximum value.

- *Press Dev Alrt Enab*—Select Yes or No. This alert notifies a monitoring system when a deviation in the actuator pressure has occurred. This is used when the instrument is controlling via pressure (Pressure Control Mode is enabled) to the actuator (rather than valve position) to prevent saturation of the pneumatic output. When enabled, this alert checks the difference between the target pressure and the actual pressure. If the difference exceeds the Pressure Deviation Alert Point for more than the pressure deviation time, the Pressure Deviation Alert is set. It remains set until the difference between the target pressure and the actual pressure is less than the Pressure Deviation Alert Point. The pressure deviation alert point and deviation alert time are configurable and can be disabled altogether. Factory default is Yes.

- *Press Dev Alrt Point*—The alert point for the difference between the pressure target and the actual pressure. When the difference exceeds the alert point for more than the Pressure Deviation Time, the Pressure Deviation Alert is set. After completion of the Setup Wizard or Auto Travel calibration a default value of 2 psi is set. This will generate an alert when the actuator pressure is not within $\pm$ 2 psi of the target pressure.

- *Press Dev Time*—The time, in seconds, that the pressure deviation must exceed the Pressure Deviation Alert Point before the alert is set. The Pressure Deviation Time is set to 30 seconds by default.

Alert Record

Field Communicator	HC, AD and PD Configure > Detailed Setup > Alert Setup > Alert Record (1-2-3-6)
	ODV Configure > Detailed Setup > Alert Setup > Alert Record (1-2-3-7)

To be recorded, an alert must both be enabled for reporting, and the group in which it resides must be enabled for recording. Table 4-7 lists the alerts included in each of the groups. When any alert from an enabled group becomes active, active alerts in all enabled groups are stored.

Table 4-7. Alerts Included in Alert Groups for Alert Record

Alert Group	Alerts Include in Group
Valve Alerts	Travel Lo Alert Travel Hi Alert Travel Lo Lo Alert Travel Hi Hi Alert Travel Deviation Alert Drive Signal Alert
Failure Alerts	Flash ROM Fail No Free Time Reference Voltage Fail Drive Current Fail Critical NVM Fail Temperature Sensor Fail Pressure Sensor Fail Travel Sensor Fail
Miscellaneous Alerts	Auxiliary input

Alert Record has Entries Enable—Yes or No. When enabled indicates when an alert has been recorded. Factory default is Yes.

Alert Record Full Enable—Yes or No. When enabled indicates when the Alert Record is full. Factory default is Yes.

View Alert Records—Displays all recorded alerts and the date and time the alerts were recorded.

Clear ALL Records—Clears the alert record. To clear the alert record, all alerts in enabled groups must be inactive.

Alert Groups

- *Failure Group Enable*—Permits enabling the Failure Alert group. Table 4-7 lists the alerts included in each of the groups. Factory default is Yes.
- *Valve Group Enable*—Permits enabling the Valve Alert group. Table 4-7 lists the alerts included in each of the groups. Factory default is Yes.
- *Miscellaneous Group Enable*—Permits enabling the Miscellaneous Alert group. Table 4-7 lists the alerts included in each of the groups. Factory default is No.

Status

Field Communicator	Configure > Detailed Setup > Status (1-2-4)

Follow the prompts on the Field Communicator display to configure the following parameters: *Instrument Time, Calibration and Diagnostics, Operational,* and *Integrator.*

Instrument Time

- *Inst Time Invalid Enable*—Yes or No. When enabled indicates if the Instrument Time Invalid alert is active. Factory default is Yes.

- *Instrument Date and Time*—Permits setting the instrument clock. When alerts are stored in the alert record, the record includes the time and date. The instrument clock uses a 24-hour format.

Calibration and Diagnostics

- *Calibration in Progress Enable*—Yes or No. When enabled indicates that calibration is in progress. Factory default is No.

- *AutoCal in Progress Enable*—Yes or No. When enabled indicates that auto calibration is in progress. Factory default is No.

- *Diagnostic in Progress Enable*—Yes or No. When enabled indicates that a diagnostic test is in progress. Factory default is No.

- *Diagnostic Data Avail Enable*—Yes or No. When enabled indicates when there is diagnostic data available. Factory default is Yes.

Operational

- *Pressure Control Active Enable*—Yes or No. When enabled indicates when Pressure Control is active. Factory default is Yes.

- *Multi-Drop Enable*—Yes or No. When enabled indicates the digital valve controller is operating in a multi-drop loop. Factory default is No.

Integrator Saturation

- *Integrator Sat Hi Enable*—Yes or No. When enabled indicates when the Integrator Saturated High alert is active. Factory default is Yes.

- *Integrator Sat Lo Enable*—Yes or No. When enabled indicates when the Integrator Saturated Lo alert is active. Factory default is Yes.

- *Integral Limit*—The Integral Limit provides an upper limit to the integrator output. The high limit is configurable from 0 to 100% of the I/P drive signal.

- *Integral Dead Zone*—Integral Dead Zone is the window around the Primary Setpoint in which integral action is disabled. This feature is used to eliminate friction induced limit cycles around the Primary Setpoint when the integrator is active. The Dead Zone is configurable from 0% to 2%, corresponding to a symmetric window from 0% to +/-2% around the Primary Setpoint. Default value is 0.25%.

Instrument

Field Communicator	Configure > Detailed Setup > Instrument (1-2-5)

Follow the prompts on the Field Communicator display to configure the following Instrument parameters: *General, Units, Analog Input Range, Relay Type, Zero Power Condition, Maximum Supply Pressure*, *Auxiliary Terminal Mode*, *Instrument Date and Time*, and *Calibration Status and Type*.

General

- *HART Tag*—Enter an up to 8 character HART tag for the instrument. The HART tag is the easiest way to distinguish between instruments in a multi-instrument environment. Use the HART tag to label instruments electronically according to the requirements of your application. The tag you assign is automatically displayed when the Field Communicator establishes contact with the digital valve controller at power-up.
- *Message*—Enter any message with up to 32 characters. Message provides the most specific user-defined means for identifying individual instruments in multi-instrument environments.
- *Descriptor*—Enter a descriptor for the application with up to 16 characters. The descriptor provides a longer user-defined electronic label to assist with more specific instrument identification than is available with the HART tag.
- *Date*—Enter a date with the format MM/DD/YY. Date is a user-defined variable that provides a place to save the date of the last revision of configuration or calibration information.
- *Valve Serial Number*—Enter the serial number for the valve in the application with up to 12 characters.
- *Instrument Serial Number*—Enter the serial number on the instrument nameplate, up to 12 characters.
- *Polling Address*—If the digital valve controller is used in point-to-point operation, the Polling Address is 0. When several devices are connected in the same loop, such as for split ranging, each device must be assigned a unique polling address. The Polling Address is set to a value between 0 and 15. To change the polling address the instrument must be Out Of Service.

  For the Field Communicator to be able to communicate with a device whose polling address is not 0, it must be configured to automatically search for all or specific connected devices.

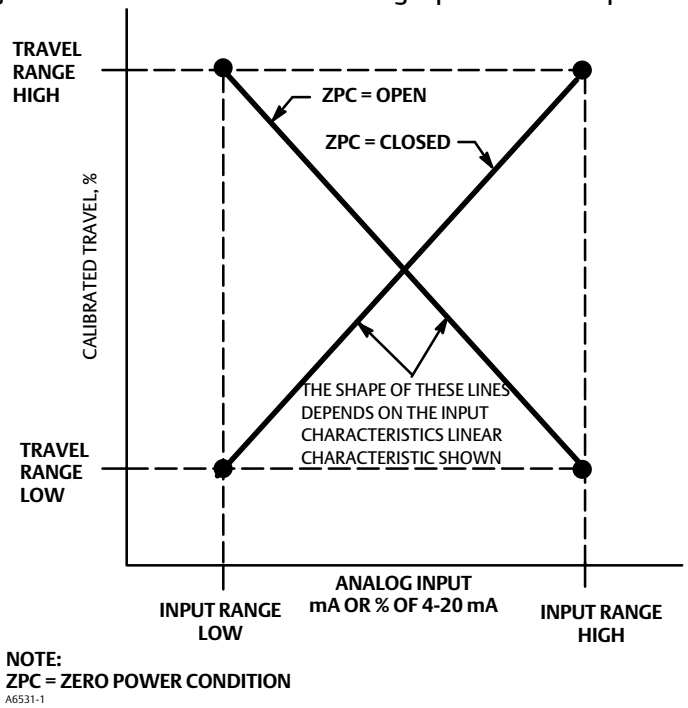
Units

- *Pressure Units*—Defines the output and supply pressure units in either psi, bar, kPa, or kg/cm^2.
- *Temperature Units*—Degrees Fahrenheit or Celsius. The temperature measured is from a sensor mounted on the digital valve controller's printed wiring board.
- *Analog In Units*—Permits defining the Analog Input Units in mA or percent of 4-20 mA range.

Analog Input Range

- *Input Range Hi*—Permits setting the Input Range High value. Input Range High should correspond to Travel Range High, if the Zero Power Condition is configured as closed. If the Zero Power Condition is configured as open, Input Range High corresponds to Travel Range Low. See figure 4-5.
- *Input Range Lo*—Permits setting the Input Range Low value. Input Range Low should correspond to Travel Range Low, if the Zero Power Condition is configured as closed. If the Zero Power Condition is configured as open, Input Range Low corresponds to Travel Range High. See figure 4-5.

Figure 4-5. Calibrated Travel to Analog Input Relationship



Relay Type—There are three categories of relays that result in combinations from which to select.

Relay Type: The relay type is printed on the label affixed to the relay body.

A = double-acting or single-acting

B = single-acting, reverse

C= single-acting, direct

Special App: This is used in single-acting applications where the "unused" output port is configured to read the pressure downstream of a solenoid valve. See page 29 for additional information.

Lo Bleed: The label affixed to the relay body indicates whether it is a low bleed version.

Zero Power Condition—The position of the valve (open or closed) when the electrical power to the instrument is removed. Zero Power Condition (ZPC) is determined by relay type, as shown in figure 4-6.

Figure 4-6. Zero Power Condition



Relay Type	Loss of Electrical Power
Single-Acting Direct (Relay C)	Port A pressure to zero.
Double-Acting (Relay A)	Port A pressure to zero. Port B pressure to full supply.
Single-Acting Reverse (Relay B)	Port B pressure to full supply.

Maximum Supply Pressure—Enter the maximum supply pressure in psi, bar, kPa, or kg/cm^2, depending on what was selected for pressure units.

Auxiliary Terminal Action —Disabled, Alert on Open Contact, Alert on Close Contact, or Auto Travel Calibration. Selecting Alert on Open or Closed Contact activates checking the status of the auxiliary input contacts. Selecting Auto Travel Calibration permits starting an automatic travel calibration procedure by placing a jumper across the auxiliary input terminals for 3 to 5 seconds.

Instrument Date and Time—Permits setting the instrument clock. When alerts are stored in the alert record, the record includes the time and date. The instrument clock uses a 24-hour format.

Calib Status and Type

- *Last AutoCal Status*—Indicates the status of the last instrument calibration.
- *Last Calibration Type* —Indicates the type of the last instrument calibration.

Valve and Actuator

Field Communicator	Configure > Detailed Setup > Valve & Actuator (1-2-6)

Follow the prompts on the Field Communicator display to configure the following instrument parameters: *Manufacturer, Valve Serial Number*, *Valve Style, Actuator Style*, *Travel Sensor Motion,* and *View / Edit Feedback Connection.*

Manufacturer—Enter the manufacturer of the actuator on which the instrument is mounted. If the actuator manufacturer is not listed, select Other.

Valve Serial Number—Enter the serial number for the valve in the application with up to 12 characters.

Valve Style—Enter the valve style, rotary or sliding-stem

Actuator Style—Enter the actuator style, spring and diaphragm, piston double-acting without spring, piston single-acting with spring, or piston double-acting with spring.

Travel Sensor Motion

⚠ WARNING

If you answer YES to the prompt for permission to move the valve when determining travel sensor motion, the instrument will move the valve through a significant portion of its travel range. To avoid personal injury and property damage caused by the release of process fluid or pressure, isolate the valve from the process and equalize pressure on both sides of the valve or bleed off the process fluid.

Select Clockwise/Toward Bottom, or Counterclockwise/Toward Top. Travel Sensor Motion establishes the proper travel sensor rotation. For quarter-turn actuators determine rotation by viewing the rotation of the magnet assembly from the back of the instrument.

Note

Travel Sensor Motion in this instance refers to the motion of the magnet assembly. Note that the magnet assembly may be referred to as a magnetic array in user interface tools.

- For instruments with Relay A and C: If increasing air pressure at output A causes the magnet assembly to move down or the rotary shaft to turn clockwise, enter CW/To Bottom Inst. If it causes the magnet assembly to move up, or the rotary shaft to turn counterclockwise, enter CCW/To Top Inst.

- For instruments with Relay B: If decreasing air pressure at output B causes the magnet assembly to down, or the rotary shaft to turn clockwise, enter CW/To Bottom Inst. If it causes the magnet assembly to move up, or the rotary shaft to turn counterclockwise, enter CCW/To Top Inst.

View / Edit Feedback Connection—Refer to table 4-8 for Feedback Connection options. Choose the assembly that matches the actuator travel range.

Note

As a general rule, do not use less than 60% of the magnet assembly travel range for full travel measurement. Performance will decrease as the assembly is increasingly subranged.

The linear magnet assemblies have a valid travel range indicated by arrows molded into the piece. This means that the hall sensor (on the back of the DVC6200 housing) has to remain within this range throughout the entire valve travel. See figure 2-2. The linear magnet assemblies are symmetrical. Either end may be up.

Table 4-8. Feedback Connection Options

Magnet Assembly	Travel Range		
	mm	Inch	Degrees
Sstem #7	4.2-7	0.17-0.28	-
SStem #19	8-19	0.32-0.75	-
SStem #25	20-25	0.76-1.00	-
SStem #38	26-38	1.01-1.50	-
SStem #50	39-50	1.51-2.00	-
SStem #100	51-100	2.01-4.00	-
SStem #210	101-210	4.01-8.25	
SStem #1 Roller	-	-	60-90°
RShaft Window #1	-	-	60-90°
RShaft Window #2	-	-	60-90°
RShaft End Mount	-	-	60-90°

Assembly Specification Sheet— Allows you to view and edit the Specification Sheet used by ValveLink software.

SIS/Partial Stroke (Instrument Level ODV)

Field Communicator	Configure / Setup > Detailed Setup > SIS/Partial Stroke (1-2-7)

Note

Partial Stroke is only available for instrument level ODV.

Follow the prompts on the Field Communicator display to configure the following partial stroke parameters: *PST Enable*, and *View/Edit PST Variables*.

PST Enable—Yes or No. Enables or disables the Partial Stroke Test.

PST Vars View/Edit—Follow the prompts on the Field Communicator display to enter or view information for following PST Variables: *Max Travel Movement*, *Stroke Speed*, *Pause Time*, *PST Press Limit*, *PST Mode Enable*, *Pressure Set Point*, and *End Pt Control Enable*.

Max Travel Movement—The default value for Max Travel Movement is 10%. It may be set to a value between 1 and 30% in 0.1% increments.

Note

The Max Travel Movement is the percentage of total span that the valve moves away from its operating state towards its fail state during a Partial Stroke Test.

Stroke Speed—The stroke speed can be set for 1%/second, 0.5%/second, 0.25%/second, 0.12%/second, or 0.06%/second. The default value for Partial Stroke Speed is 0.25%/second.

Pause Time—The Setup Wizard sets the Partial Stroke Pause Time to 5 seconds. This is the pause time between the up and down strokes of the test. It can be set for 5, 10, 15, 20 or 30 seconds.

PST Press Limit (single acting actuators)—During the Setup Wizard, or Auto Calibration, the Partial Stroke Pressure Limit value will be set to a positive value. For single acting actuators that vent from the test starting point, the pressure limit will be a minimum value. For those actuators that fill from the test starting point, the pressure limit will be a maximum value. The pressure signal used for this threshold depends on relay type and is summarized below.

Relay Type	Pressure Signal
A or C	Port A - Port B
B	Port B - Port A
B Special App.	Port B
C Special App.	Port A

PST Press Limit (double-acting actuators)— During the Setup Wizard or Auto Calibration, the Partial Stroke Pressure Limit value will be set to a negative value for actuators where the Partial Stroke Start Point is opposite of the Zero Power Condition (e.g., Partial Stroke Start Point= Open and Zero Power Condition = Closed) and to a positive valve for actuators where the Partial Stroke Start Point is the same as the Zero Power Condition.

To set the partial stroke pressure limit manually for single acting actuators select *min pressure.* Select *min diff press* for double acting actuators.

Note

In order to manually set the partial stroke pressure limit with the correct value, you must be able to run a valve signature test using ValveLink software. It is then possible to set the partial stroke pressure limit with the Field Communicator, using the information generated by the valve signature test.

To manually set the partial stroke pressure limit, disable the travel deviation alert by setting Travel Dev Alert Pt to 125%. Also disable "end point pressure control" and disable the partial stroke pressure limit by setting the values shown in table 4-9.

Table 4-9. Values for Disabling Partial Stroke Pressure Limit

Actuator Type	Relay Type	Zero Power Condition	Partial Stroke Start Point	Partial Stroke Pressure Limit (Disabled)
Single Acting	A or C	Closed	Open	0.0
			Closed	Psupply
		Open	Open	Psupply
			Closed	0.0
	B	Closed	Open	Psupply
			Closed	0.0
		Open	Open	0.0
			Closed	Psupply
Double Acting	A	Closed	Open	-Psupply
			Closed	Psupply
		Open	Open	Psupply
			Closed	-Psupply

Run the partial stroke test using the Field Communicator. Once the test is completed download the partial stroke test results using ValveLink software.

Select the Press/Time radio button from the partial stroke valve signature graph. If actuator pressure starts high and moves low, find the minimum actuator pressure, Pmin. Otherwise, find the maximum actuator pressure, Pmax. Use table 4-10 to estimate the partial stroke pressure limit.

The default value is 0.

For double acting valves, the differential pressure is used.

Table 4-10. Estimates for Partial Stroke Pressure Limits

Actuator Style	Relay Type	Zero Power Condition	PST Starting Point	Partial Stroke Pressure Limit(1)
Spring and Diaphragm	A or C	Closed	Open	Pmin - 0.25 * (Bench Set High - Bench Set Low)
			Closed	Pmax + 0.25 * (Bench Set High - Bench Set Low)
		Open	Open	Pmax + 0.25 * (Bench Set High - Bench Set Low)
			Closed	Pmin - 0.25 * (Bench Set High - Bench Set Low)
	B	Closed	Open	Pmax + 0.25 * (Bench Set High - Bench Set Low)
			Closed	Pmin - 0.25 * (Bench Set High - Bench Set Low)
		Open	Open	Pmin - 0.25 * (Bench Set High - Bench Set Low)
			Closed	Pmax + 0.25 * (Bench Set High - Bench Set Low)
Single Acting Piston	A or C	Closed	Open	0.5 * Pmin
			Closed	Pmax + 0.5 * (Psupply - Pmax)
		Open	Open	Pmax + 0.5 * (Psupply - Pmax)
			Closed	0.5 * Pmin
	B	Closed	Open	Pmax + 0.5 * (Psupply - Pmax)
			Closed	0.5 * Pmin
		Open	Open	0.5 * Pmin
			Closed	Pmax + 0.5 * (Psupply - Pmax)
Double Acting Piston	A	Closed	Open	Pmin - 0.5 * (Psupply + Pmin)
			Closed	Pmax + 0.5 * (Psupply - Pmax)
		Open	Open	Pmax + 0.5 * (Psupply - Pmax)
			Closed	Pmin - 0.5 * (Psupply + Pmin)

Section 5 Calibration

Calibration Overview

When a DVC6200 digital valve controller is ordered as part of a control valve assembly, the factory mounts the digital valve controller on the actuator and connects the necessary tubing, then sets up and calibrates the controller.

For digital valve controllers that are ordered separately, recalibration of the analog input or pressure sensors generally is unnecessary. However, after mounting on an actuator, perform the initial setup then calibrate travel by selecting *Configure* > *Calibrate* > *Travel Calibration* > *Auto Calibration*. For more detailed calibration information, refer to the following calibration procedures.

Calibrate

Field Communicator	Configure > Calibrate (1-3)

Travel Calibration

- Auto Travel Calibration —This procedure automatically calibrates the travel. The calibration procedure uses the valve and actuator stops as the 0% and 100% calibration points.
- Manual Travel Calibration —This procedure permits manual calibration of the travel. This calibration procedure allows you to determine the 0% and 100% calibration points.

Sensor Calibration

- Pressure Sensors—This procedure permits calibrating the three pressure sensors. Normally the sensors are calibrated at the factory and should not need calibration.
- Analog In Calibration—This procedure permits calibrating the analog input sensor. Normally the sensor is calibrated at the factory and should not need calibration.

Relay Adjustment—This procedure permits adjustment of the pneumatic relay.

Restore Factory Settings—This procedure permits you to restore the calibration settings back to the factory settings.

Note

The Instrument Mode must be Out Of Service and the Protection set to None before the instrument can be calibrated.

If you are operating in burst mode, we recommend that you disable burst before continuing with calibration. Once calibration is complete, burst mode may then be turned back on.

⚠ WARNING

During calibration the valve will move full stroke. To avoid personal injury and property damage caused by the release of pressure or process fluid, isolate the valve from the process and equalize pressure on both sides of the valve or bleed off the process fluid.

Travel Calibration

Field Communicator	Configure > Calibrate > Travel Calibration (1-3-1)

If a double-acting relay is used, you will be prompted to run the relay adjustment when auto or manual calibration is selected. Select Yes to adjust the relay, select No to proceed with calibration. For additional information, refer to Relay Adjustment in this section.

Note

Relay Adjustment is only available for the double-acting relay (Relay A).

Auto Travel Calibration

1. The auto calibration procedure is automatic. It is completed when the *Calibrate* menu appears.

During calibration, the instrument seeks the high and low end points and the minor loop feedback (MLFB) and output bias. By searching for the end points, the instrument establishes the limits of physical travel, i.e. the actual travel 0 and 100% positions. This also determines how far the relay beam swings to calibrate the sensitivity of the MLFB sensor.

2. Place the instrument In Service and verify that the travel properly tracks the current source.

If the unit does not calibrate, refer to table 5-1 for error messages and possible remedies.

Table 5-1. Auto Calibrate Travel Error Messages

Error Message	Possible Problem and Remedy
Power failure occurred during Auto Calib	The analog input signal to the instrument must be greater than 3.8 mA. Adjust the current output from the control system or the current source to provide at least 4.0 mA.
Auto Calib did not complete within the time limit.	The problem may be one or the other of the following: 1. The tuning set selected is too low and the valve does not reach an end point in the allotted time. Press the Hot Key, select *Stabilize/Optimize* then *Increase Response* (selects next higher tuning set). 2. The tuning set selected is too high, valve operation is unstable and does not stay at an end point for the allotted time. Press the Hot Key, select *Stabilize/Optimize* then *Decrease Response* (selects next lower tuning set).
Insufficient travel	Prior to receiving this message, did the instrument output go from zero to full supply? If not, verify instrument supply pressure by referring to the specifications in the appropriate actuator instruction manual. If supply pressure is correct, check instrument pneumatic components (I/P converter and relay). If the instrument output did go from zero to full supply prior to receiving this message, then verify proper mounting by referring to the appropriate mounting procedure in the Installation section and checking the magnet array for proper alighment.
Drive signal exceed low limit; check supply pressure	1. Check supply pressure (reverse-acting relay) 2. Friction is too high.
Drive signal exceed high limit; check supply pressure	1. Check supply pressure (direct-acting relay) 2. Friction is too high

Manual Travel Calibration

Two procedures are available to manually calibrate travel:

- Analog Adjust
- Digital Adjust

Analog Calibration Adjust

Connect a variable current source to the instrument LOOP + and LOOP - terminals. The current source should be capable of generating 4 to 20 mA.

Follow the prompts on the Field Communicator display to calibrate the instrument's travel in percent.

Note
0% Travel = Valve Closed
100% Travel = Valve Open

1. Adjust the input current until the valve is near mid-travel. Press OK.

Note
In steps 2 through 7 the accuracy of the current source adjustment affects the position accuracy.

2. Adjust the current source until the valve is at 0% travel, then press OK.
3. Adjust the current source until the valve is at 100% travel, then press OK.
4. Adjust the current source until the valve is at 0% travel, then press OK.
5. Adjust the current source until the valve is at 100% travel, then press OK.
6. Adjust the current source until the valve is at 5% travel, then press OK.
7. Adjust the current source until the valve is at 95% travel, then press OK.
8. Place the instrument In Service and verify that the travel properly tracks the current source.

Digital Calibration Adjust

Connect a variable current source to the instrument LOOP + and LOOP - terminals. The current source should be set between 4 and 20 mA.

Follow the prompts on the Field Communicator display to calibrate the instrument's travel in percent.

1. Adjust the input current until the valve is near mid-travel. Press OK.

Note
0% Travel = Valve Closed
100% Travel = Valve Open

2. From the adjustment menu, select the direction and size of change required to set the travel at 0%.

Selecting large, medium, and small adjustments causes changes of approximately 10.0%, 1.0%, and 0.1%, respectively.

If another adjustment is required, repeat step 2. Otherwise, select Done and go to step 3.

3. From the adjustment menu, select the direction and size of change required to set the travel to 100%.

If another adjustment is required, repeat step 3. Otherwise, select Done and go to step 4.

4. From the adjustment menu, select the direction and size of change required to set the travel at 0%.

If another adjustment is required, repeat step 4. Otherwise, select Done and go to step 5.

5. From the adjustment menu, select the direction and size of change required to set the travel to 100%.

If another adjustment is required, repeat step 5. Otherwise, select Done and go to step 6.

6. From the adjustment menu, select the direction and size of change required to set the travel to 5%.

If another adjustment is required, repeat step 6. Otherwise, select Done and go to step 7.

7. From the adjustment menu, select the direction and size of change required to set the travel to 95%.

If another adjustment is required, repeat step 7. Otherwise, select Done and go to step 8.

8. Place the instrument In Service and verify that the travel properly tracks the current source.

Calibration using the Aux Terminal Connections

Note
Pressure range is not captured during this procedure.

Travel calibration can also be accomplished by shorting the auxiliary terminal connections for 3 to 5 seconds. You can abort the procedure by shorting the auxiliary terminals for 1 second.

To enable this calibration *Auxiliary Terminal Action* must be set to *Auto Calibration*. The instrument *Operational Status* during calibration is *Calibration in Progress*.

Use this calibration procedure to calibrate the digital valve controller travel whenever the I/P converter or relay is replaced. Do not use this calibration for initial calibration when mounting the instrument on an actuator, or if the printed wiring board assembly was replaced.

You can use the auxiliary terminal connections to calibrate the digital valve controller if you suspect calibration has changed due to drift. However, prior to initiating calibration for this reason, perform a Valve Signature diagnostic test, using ValveLink software. This will capture the as-found data for future root cause analysis.

Sensor Calibration

Field Communicator	Configure > Calibrate > Sensor Calibration (1-3-2)

Pressure Sensors

Note
The pressure sensor is calibrated at the factory and should not require calibration.

Output Pressure Sensor

To calibrate the output pressure sensor, connect an external reference gauge to the output being calibrated. The gauge should be capable of measuring maximum instrument supply pressure. Depending upon the sensor you wish to calibrate, select either *Output A Sensor* or *Output B Sensor.* Follow the prompts on the Field Communicator display to calibrate the instrument's output pressure sensor.

1. Adjust the supply pressure regulator to the maximum instrument supply pressure. Press OK.
2. The instrument reduces the output pressure to 0. The following message appears.

> Use the Increase and Decrease selections until the displayed pressure matches the output x pressure.

Press OK when you have read the message.

3. The value of the output pressure appears on the display. Press OK to display the adjustment menu.
4. From the adjustment menu, select the direction and size of adjustment to the displayed value.

Selecting large, medium, and small adjustments causes changes of approximately 3.0 psi/0.207 bar/20.7 kPa, 0.30 psi/0.0207 bar/2.07 kPa, and 0.03 psi/0.00207 bar/0.207 kPa, respectively.

If the displayed value does not match the output pressure, press OK, then repeat this step (step 4) to further adjust the displayed value. When the displayed value matches the output pressure, select Done and go to step 5.

5. The instrument sets the output pressure to full supply. The following message appears.

> Use the Increase and Decrease selections until the displayed pressure matches the output x pressure.

Press OK when you have read the message.

6. The value of the output pressure appears on the display. Press OK to display the adjustment menu.
7. From the adjustment menu, select the direction and size of adjustment to the displayed value. If the displayed value does not match the output pressure, press OK, then repeat this step (step 7) to further adjust the displayed value. When the displayed value matches the output pressure, select Done and go to step 8.
8. Place the instrument In Service and verify that the displayed pressure matches the measured output pressure.

Supply Pressure Sensor

Note
Supply Pressure Sensor Calibration is not available for instrument level HC.

To calibrate the supply pressure sensor, connect an external reference gauge to the output side of the supply regulator. The gauge should be capable of measuring maximum instrument supply pressure. Follow the prompts on the Field Communicator display to calibrate the instrument's supply pressure sensor.

1. Select a) Zero Only, or b) Zero and Span (gauge required).

   a. If Zero Only calibration is selected, adjust the supply pressure regulator to remove supply pressure from the instrument. Press OK. Once calibration is complete, go to step 5.

   b. If Zero and Span calibration is selected, adjust the supply pressure regulator to remove supply pressure from the instrument. Press OK. Adjust the supply regulator to the maximum instrument supply pressure. Press OK. Proceed with step 2.

2. The following message appears:

   > Use the Increase and Decrease selections until the displayed pressure matches the instrument supply pressure.

Press OK when you have read this message.

3. The value of the pressure appears on the display.
4. From the adjustment menu, select the direction and size of adjustment to the displayed value.

Selecting large, medium, and small adjustments causes changes of approximately 3.0 psi/0.207 bar/20.7 kPa, 0.30 psi/0.0207 bar/2.07 kPa, and 0.03 psi/0.00207 bar/0.207 kPa, respectively.

Adjust the displayed value until it matches the supply pressure, select Done and go to step 5.

5. Place the instrument In Service and verify that the displayed pressure matches the measured supply pressure.

Analog Input Calibration

To calibrate the analog input sensor, connect a variable current source to the instrument LOOP+ and LOOP- terminals. The current source should be capable of generating an output of 4 to 20 mA. Follow the prompts on the Field Communicator display to calibrate the analog input sensor.

1. Set the current source to the target value shown on the display. The target value is the Input Range Low value. Press OK.
2. The following message appears:

   > Use Increase and Decrease selections until the displayed current matches the target.

Press OK when you have read this message.

3. The value of the Analog Input appears on the display. Press OK to display the adjustment menu.
4. From the adjustment menu, select the direction and size of adjustment to the displayed value.

Selecting large, medium, and small adjustments causes changes of approximately 0.4 mA, 0.04 mA, and 0.004 mA, respectively.

If the displayed value does not match the current source, press OK, then repeat this step (step 4) to further adjust the displayed value. When the displayed value matches the current source, select Done and go to step 5.

5. Set the current source to the target value shown on the display. The target value is the Input Range High value. Press OK.
6. The following message appears:

> Use Increase and Decrease selections until the displayed current matches the target.

Press OK when you have read this message.

7. The value of the Analog Input appears on the display. Press OK to display the adjustment menu.
8. From the adjustment menu, select the direction and size of adjustment to the displayed value. If the displayed value does not match the current source, press OK, then repeat this step (step 8) to further adjust the displayed value. When the displayed value matches the current source, select Done and go to step 9.
9. Place the instrument In Service and verify that the analog input displayed matches the current source.

Relay Adjustment

Field Communicator	Configure > Calibrate > Sensor Calibration > Relay Adjust (1-3-3)

Before beginning travel calibration, check the relay adjustment. Replace the digital valve controller cover when finished.

Note

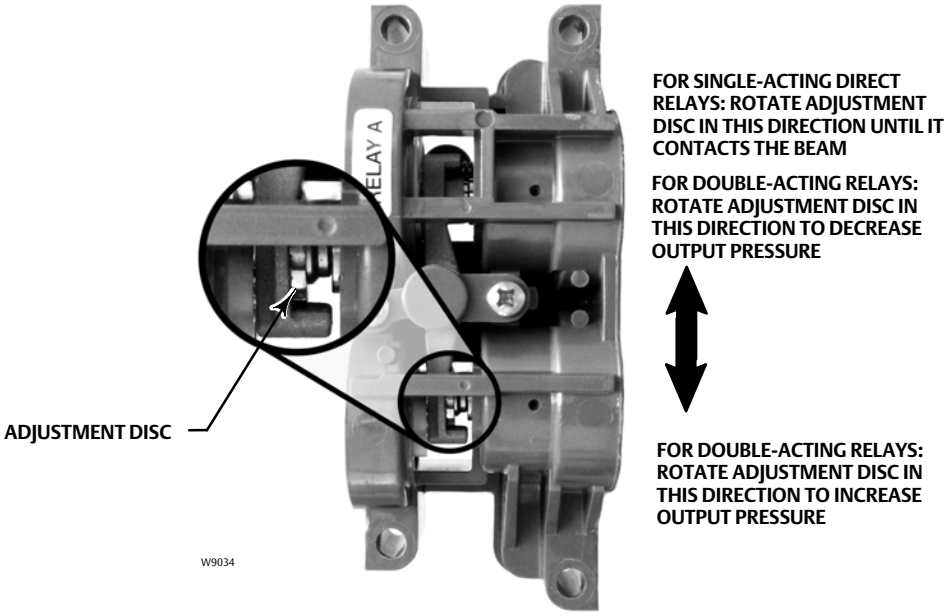
Relay B and C are not user-adjustable.

Double-Acting Relay

The double-acting relay is designated by “Relay A” on a label affixed to the relay itself. For double-acting actuators, the valve must be near mid-travel to properly adjust the relay. The Field Communicator will automatically position the valve when *Relay Adjust* is selected.

Rotate the adjustment disc, shown in figure 5-1, until the output pressure displayed on the Field Communicator is between 50 and 70% of supply pressure. This adjustment is very sensitive. Be sure to allow the pressure reading to stabilize before making another adjustment (stabilization may take up to 30 seconds or more for large actuators).

Figure 5-1. Relay A Adjustment (Shroud Removed for Clarity)



If the low bleed relay option has been ordered stabilization may take approximately two minutes longer than the standard relay.

Relay A may also be adjusted for use in single-acting- direct applications. Rotate the adjustment disc as shown in figure 5-1 for single-acting direct operation.

CAUTION

Care should be taken during relay adjustment as the adjustment disc may disengage if rotated too far.

Single-Acting Relays

⚠ WARNING

For Instrument Level ODV only:

If the unused port is monitoring pressure, ensure that the pressure source conforms to ISA Standard 7.0.01 and does not exceed the pressure supplied to the instrument.

Failure to do so could result in personal injury or property damage caused by loss of process control.

Single-Acting Direct Relay

The single-acting direct relay is designated by “Relay C” on a label affixed to the relay itself. Relay C requires no adjustment.

Single-Acting Reverse Relay

The single-acting reverse relay is designated by “Relay B” on a label affixed to the relay itself. Relay B is calibrated at the factory and requires no further adjustment.

Restoring Factory Settings

Field Communicator	Configure > Calibrate > Restore Factory Settings (1-3-4)

Note

After restoring factory settings you will need to re-configure and calibrate the instrument.

Follow the prompts on the Field Communicator display to restore calibration and all parameters to the factory settings. You should only restore the calibration if it is not possible to calibrate an individual sensor. Restoring calibration returns the calibration of all of the sensors and the tuning set to their factory settings. Following restoration of the factory calibration, the individual sensors should be recalibrated.

Section 6 Viewing Device Variables and Diagnostics

Service Tools

Note

Service Tools are not available for instrument level AC.

Alert Conditions

Field Communicator	Service Tools > Alert Conditions (2-1)

Instrument Alert Conditions, when enabled, detect many operational and performance issues that may be of interest. To view these alerts navigate to *Alert Conditions*. The alert conditions for each group of alerts are listed below. If there are no alerts active for a particular group the group will not be displayed on the Field Communicator. See table 6-1 for alert groups.

Table 6-1. Alerts Included in Alert Groups for Alert Record

Alert Group	Alerts Include in Group
Valve Alerts	Travel Alert Lo Travel Alert Hi Travel Alert Lo Lo Travel Alert Hi Hi Travel deviation Drive signal
Failure Alerts	Flash ROM fail Drive current fail Ref Voltage fail NVM fail Temperature sensor fail Pressure sensor fail Travel sensor fail
Miscellaneous Alerts	Auxiliary input

- Electronics— If an electronics alert is active it will appear under ELECT ALERTS.

Drive Current

Drive Current Alert—This alert is indicated when the drive current does not read as expected. If this alert occurs, check the connection between the I/P converter and the printed wiring board assembly. Try removing the I/P converter and re-installing it. If the failure does not clear, replace the I/P converter or the printed wiring board assembly.

Drive Signal

Drive Signal Alert—This alert is indicated when the Drive Signal is greater or less than the expected maximum or minimum.

Processor Impaired

Offline/Failed Alert—This alert is indicated if a failure, enabled from the Self Test Shutdown menu, caused an instrument shutdown. Press Enter to see which of the specific failures caused the Offline/Failed indication.

Low Power Write Alert— This alert is activated if a write to the instrument is attempted when the loop current is less than approximately 3.5 mA.

Non-Critical NVM Alert—This alert is indicated if the checksum for data, which are not critical for instrument operation, has failed.

Critical NVM Alert—This alert is indicated when the Non-Volatile Memory integrity test fails. Configuration data is stored in NVM. If this failure is indicated, restart the instrument and see if it clears. If it does not clear, replace the printed wiring board assembly.

Flash ROM Alert—This alert indicates that the Read Only Memory integrity test failed. If this alert is indicated, restart the instrument and see if it clears. If it does not clear, replace the printed wiring board assembly.

Reference Voltage Alert—This failure is indicated whenever there is a failure associated with the internal voltage reference. If this alert is indicated replace the printed wiring board assembly.

Internal Sensor Out of Limits—This alert is indicated if there is a possible problem with either the pressure sensor or the printed wiring board assembly submodule.

Variable Out of Range—This alert is indicated if one or more of the measured analog sensor readings (loop current, pressure, temperature, or travel) is saturated or reading out of its configured range. The condition may be due to improper configuration or physical setup and not be due to a sensor malfunction.

Field device malfunction—The alert is indicated if the pressure, position, or temperature sensors are providing invalid readings.

- Sensor— If a sensor alert is active it will appear under *SENSOR ALERTS*.

Travel Sensor

Travel Sensor Alert—This alert is indicated if the sensed travel is outside the range of -25.0 to 125.0% of calibrated travel. If this alert is indicated, check the instrument mounting. Also, check that the electrical connection from the travel sensor is properly plugged into the printed wiring board assembly. After restarting the instrument, if the alert does not clear, troubleshoot the printed wiring board assembly or travel sensor.

Pressure Sensors

Pressure Sensor Alert—This alert is indicated if the actuator pressure is outside the range of -24.0 to 125.0% of the calibrated pressure for more than 60 seconds. If this alert is indicated, check the instrument supply pressure. If the failure persists, ensure the printed wiring board assembly is properly mounted onto the Module Base Assembly, and the pressure sensor O-rings are properly installed. If the alert does not clear after restarting the instrument, replace the printed wiring board assembly.

Note

The pressure sensor alert is used for output A, output B, and the supply pressure sensor. Check the pressure values to see which sensor is causing the alert.

Temperature Sensor

Temperature Sensor Alert—This alert is indicated when the instrument temperature sensor fails, or the sensor reading is outside of the range of -40 to 85°C (-40 to 185°F). The temperature reading is used internally for temperature compensation of inputs. If this alert is indicated, restart the instrument and see if it clears. If it does not clear, replace the printed wiring board assembly.

- Environment— If an environment alert is active it will appear under ENVIRO ALERTS.

Supply Pressure

Supply Pressure Lo Alert—This alert is indicated when supply pressure is lower than the configured limit.

Aux Terminal Alert
Aux Terminal Alert—This alert is set when the auxiliary input terminals are either open or closed, depending upon the selection for the Auxiliary Input Alert State.

Loop Current Validation Alert— This alert is activated if the loop current is out of valid range. If the control system is known to output currents outside of this range, the loop current shutdown should not be enabled. If this alert is indicated, clear the alert by restarting the instrument with the loop current verified to be in the valid range. If the alert does not clear, replace the printed wiring board.

- Travel— If a travel alert is active it will appear under TRAVEL ALERTS.

Travel Deviation
Travel Deviation Alert—The difference between Setpoint and Travel is greater than the configured limits.

Travel Limit
Travel Alert Hi Hi—This alert is indicated if the Travel is greater than the configured limit.

Travel Alert Lo Lo—This alert is indicated if the Travel is lower than the configured limit.

Travel Limit Hi/Lo
Travel Alert Hi—This alert is indicated if the Travel is greater than the configured limit.

Travel Alert Lo—This alert is indicated if the Travel is lower than the configured limit.

Travel Limit / Cutoff
Travel Limit/Cutoff Hi—This alert is indicated if the Travel is limited high or the high cutoff is in effect.

Travel Limit/Cutoff Lo—This alert is indicated if the Travel is limited low or the low cutoff is in effect.

- Travel History— If a travel history alert is active it will appear under TVL HIST ALERTS.

Cycle Count
Cycle Count Alert—This alert is indicated if the Cycle Counter exceeds the Cycle Count Alert Point.

Travel Accumulator
Travel Accumulator Alert—This alert is indicated if the Travel Accum exceeds the Travel Accumulator Alert Point.

- SIS (ODV only)— If an SIS alert is active it will appear under SIS ALERTS.

Partial Stroke Test (PST)
Valve Stuck or Pressure/Travel Path Obstructed—This alert is indicated if the valve is stuck or the pressure/travel path is obstructed.

End Point Pressure Deviation
Pressure Deviation Alert—The alert is indicated if the difference between the target pressure and the actual pressure exceeds the Pressure Deviation Alert Point for a period of time greater than the Pressure Deviation Time.

Locked in Safety Alert—This alert is indicated if the ODV unit is locked in the safety position.

- Alert Record

Alert Record has Entries Enable—This alert indicates that an alert has been saved to the alert record.

Alert Record Full—This alert indicates that the alert record is full.

Viewing Instrument Status

Field Communicator	Service Tools > Status (2-2)

Status displays the status of the Operational items listed below. The status of more than one operational item may be indicated.

Instrument Time

Inst Time Invalid

Calibration and Diagnostics

Cal in Progress, Autocal in Progress, Diag in Progress, Diag Data Avail

Operational

Press Ctrl Active, Multi-Drop

Integrator

Integrator Sat Hi, Integrator Sat Lo

Device Record

Field Communicator	Service Tools > Device Record (2-3)

Follow the prompts on the Field Communicator display to view the following Device Record parameters: *Maximum Recorded Temperature*, *Minimum Recorded Temperature*, *View Number of Days Powered Up,* and *Number of Power Ups*.

- *Maximum Temperature Recorded*—Shows the maximum temperature the instrument has experienced since installation.
- *Minimum Temperature Recorded*—Shows the minimum temperature the instrument has experienced since installation.
- *View Number of Days Powered Up*—Indicates in hours or days the total elapsed time the instrument has been powered up.
- *Number of Power Ups*—Indicates how many times the instrument has cycled power.

Stroking the Digital Valve Controller Output

Field Communicator	Service Tools > Stroke Valve (2-4)

Follow the prompts on the Field Communicator display to select from the following:

- *Done*—Select this if you are done. All ramping is stopped when DONE is selected.
- *Ramp Open*—ramps the travel toward open at the rate of 1.0% per second of the ranged travel.
- *Ramp Closed*—ramps the travel toward closed at the rate of 1.0% per second of the ranged travel.

- *Ramp to Target*—ramps the travel to the specified target at the rate of 1.0% per second of the ranged travel.
- *Step to Target*—steps the travel to the specified target.

Partial Stroke Test (ODV only)

Field Communicator	Service Tools > Partial Stroke Test (2-5)

Note
Partial Stroke Test is only available for instrument level ODV.

The Partial Stroke Test allows DVC6200 digital valve controllers with instrument level ODV to perform a Valve Signature type of test while the instrument is in service and operational. In some applications, it is important to be able to exercise and test the valve to verify that it will operate when commanded. This feature allows the user to partially stroke the valve while continually monitoring the input signal. If a demand arises, the test is aborted and the valve moves to its commanded position. The partial stroke valve travel is configurable between 1 and 30% maximum travel, in 0.1% increments. Data from the last partial stroke test is stored in the instrument memory for retrieval by ValveLink software.

The Partial Stroke Test allows you to perform a partial, 10%, stroke test (standard) or a custom stroke test. With the custom stroke test, the stroke may be extended up to 30%. Be sure to check plant guidelines before performing a custom stroke test. The purpose of this test is to ensure that the valve assembly moves upon demand.

A partial stroke test can be initiated when the valve is operating at either 4 or 20 mA (point-to-point mode). In applications where a spurious trip is to be minimized, 4 mA is the normal operating position.

When enabled, a partial stroke test may be initiated by the device (as a scheduled, auto partial stroke test), a remote push button located in the field or at the valve, a Field Communicator, or ValveLink software.

Device (Digital Valve Controller)

The Auto Partial Stroke Test allows the partial stroke test to be scheduled by the DVC6200. The test is scheduled in number of hours between tests. Any power cycle will reset the test clock timer.

Auxiliary Terminal

The auxiliary terminal can be used for different applications. The default configuration is for a partial stroke test initiated by shorting the contacts wired to the auxiliary +/- terminals of the DVC6200. Refer to Auxiliary Terminal Wiring Length Guidelines below.

- Local Push Button

A partial stroke test command may be sent to the digital valve controller using a set of contacts wired to the auxiliary +/- terminals. To perform a test, the contacts must be closed for 3 to 5 seconds and then opened. To abort the test, close the contacts for 1 second. The last set of diagnostic data is stored in the instrument memory for later retrieval via ValveLink software.

- Local DI

When configured by the user interface, the Auxiliary Terminal can be used as a discrete input from a pressure switch, temperature switch etc., to provide an alert.

Auxiliary Terminal Wiring Length Guidelines

The Auxiliary Input Terminals of a DVC6200 with instrument level ODV can be used with a locally-mounted switch for initiating a partial stroke test. Some applications require that the partial stroke test be initiated from a remote location.

The length for wiring connected to the Auxiliary Input Terminals is limited by capacitance. For proper operation of the Auxiliary Input Terminals capacitance should not exceed 18000 pF. As with all control signal wiring, good wiring practices should be observed to minimize adverse effect of electrical noise on the Aux Switch function.

Example Calculation: Capacitance per foot or per meter is required to calculate the length of wire that may be connected to the Aux switch input. The wire should not exceed the capacitance limit of 18000 pF. Typically the wire manufacturer supplies a data sheet which provides all of the electrical properties of the wire. The pertinent parameter is the highest possible capacitance. If shielded wire is used, the appropriate number is the “Conductor to Other Conductor & Shield” value.

Example — 18AWG Unshielded Audio, Control and Instrumentation Cable

Manufacturer's specifications include:

Nom. Capacitance Conductor to Conductor @ 1 KHz: 26 pF/ft
Nom. Conductor DC Resistance @ 20 Deg. C: 5.96 Ohms/1000 ft
Max. Operating Voltage - UL 200 V RMS (PLTC, CMG),150 V RMS (ITC)
Allowable Length with this cable = 18000pF /(26pF/ft) = 692 ft

Example — 18AWG Shielded Audio, Control and Instrumentation Cable

Manufacturer's specifications include:

Nom. Characteristic Impedance: 29 Ohms
Nom. Inductance: .15 µH/ft
Nom. Capacitance Conductor to Conductor @ 1 KHz: 51 pF/ft
Nom. Cap. Cond. to other Cond. & Shield @ 1 KHz 97 pF/ft
Allowable Length with this cable = 18000pF /(97pF/ft) = 185 ft

The AUX switch input passes less than 1 mA through the switch contacts, and uses less than 5V, therefore, neither the resistance nor the voltage rating of the cable are critical. Ensure that switch contact corrosion is prevented. It is generally advisable that the switch have gold-plated or sealed contacts.

Field Communicator

1. Connect the Field Communicator to the LOOP terminals on the digital valve controller.
2. Turn on the Field Communicator.
3. From the *Online* menu, select *Service Tools* > *Partial Stroke Test*.
4. Select either *Standard (10%)* or *Custom*. With the Custom Stroke Test, the stroke may be entered up to 30% with configurable stroking speed and pause time.
5. The currently configured Stroke, Stroking Speed, and Pause Time is displayed. Choose “Yes” to run the test using these values. Choose “No” to modify the values. The default value for Stroke Speed is 0.25%/second.
6. The valve begins to move and the actual travel reported by the digital valve controller is displayed on the Field Communicator.
7. Once the valve has reached the endpoint, check that the valve has reached the desired set point. The valve should return to its original position.

For information on configuring the Partial Stroke Test, see Partial Stroke Variables in the Detailed Setup section.

Overview

Field Communicator	Overview (3)

The following menus are available to define and/or view information about the instrument.

Note
Overview is not available for instrument level AC.

Analog In

Analog Input shows the value of the instrument analog input in mA (milliamperes) or % (percent) of ranged input.

Setpoint

Setpoint shows the requested valve position in % of ranged travel post characterization.

Travel

Travel shows the value of the DVC6200 digital valve controller travel in % (percent) of ranged travel. Travel always represents how far the valve is open.

Drive Signal

Drive Signal shows the value of the instrument drive signal in % (percent) of maximum drive.

Pressure

Shows the value of the instrument supply and output pressures in psi, bar, kPa, or kg/cm^2. Also shows the output pressure differential. To display pressures may require selecting the variable; a detail display of that variable with its values will appear.

- *Pressure A*— Shows the value of Output Pressure A in psi, bar, kPa, or kg/cm^2.
- *Pressure B*— Shows the value of Output Pressure B in psi, bar, kPa, or kg/cm^2.
- *A Minus B*—Shows the value of the output pressure differential in psi, bar, kPa, or kg/cm^2.
- *Supply* —Displays the instrument supply pressure in psi ,bar, kPa, or kg/cm^2. Not available in instrument level HC.

Variables

The *Variables* menu is available to view additional variables, including; *Auxiliary Input*, *Temperature, Maximum Recorded Temperature*, *Minimum Recorded Temperature*, *Cycle Counter, Travel Accumulator*, *Raw Travel Input*, *View Numbers of Days Powered Up,* and *Number of Power Ups*.

If a value for a variable does not appear on the display, select the variable and a detailed display of that variable with its value will appear. A variable's value does not appear on the menu if the value becomes too large to fit in the allocated space on the display, or if the variable requires special processing, such as Aux Input.

- *Auxiliary Input*—A discrete input that can be used with an independent limit or pressure switch. Its value is either open or closed.

- *Temperature*—The internal temperature of the instrument is displayed in either degrees Fahrenheit or Celsius.
- *Maximum Recorded Temperature*—Shows the maximum temperature the instrument has experienced since installation.
- *Minimum Recorded Temperature*—Shows the minimum temperature the instrument has experienced since installation.
- *Cycle Counter*—Displays the number of times the valve travel has cycled. Only changes in direction of the travel after the travel has exceeded the deadband are counted as a cycle. Once a new cycle has occurred, a new deadband around the last travel is set. The value of the Cycle Counter can be reset from the *Cycle Count Alert* menu. See page 65 for additional information.
- *Travel Accumulator*—Contains the total change in travel, in percent of ranged travel. The accumulator only increments when travel exceeds the deadband. Then the greatest amount of change in one direction from the original reference point (after the deadband has been exceeded) will be added to the Travel Accumulator. The value of the Travel Accumulator can be reset from the *Travel Accumulator* menu. See page 66 for additional information.

Note

The following should only be used for a relative indication to be sure the travel sensor is working and that it is detecting movement of the magnet assembly.

- *Raw Travel Input*—Indicates the magnet assembly position in analog-to-digital converter counts. When the travel sensor is operating correctly, this number changes as the valve strokes.
- *View Number of Days Powered Up*—Indicates in hours or days the total elapsed time the instrument has been powered up.
- *Number of Power Ups*—Indicates how many times the instrument has cycled power.

Device Information

The *Device Information* menu is available to view information about the instrument, including; *HART Tag, Device ID*, *Manufacturer*, *Model, Device Revision, Firmware Revision, Hardware Revision, Instrument Level*, and *HART Universal Revision*.

- *Hart Tag*—A HART tag is a unique name (up to eight characters) that identifies the physical instrument.
- *Device ID*—Each instrument has a unique Device Identifier. The device ID provides additional security to prevent this instrument from accepting commands meant for other instruments.
- *Manufacturer*—Identifies the manufacturer of the instrument.
- *Model*—Identifies the instrument model.
- *Device Revision*—Device Revision is the revision number of the software for communication between the Field Communicator and the instrument.
- *Firmware Revision*—The revision number of the firmware in the instrument.

- *Hardware Revision*—The revision number of the electrical circuitry within the instrument printed wiring board.

- *Instrument Level*—Indicates the instrument level
  AC—Auto Calibrate
  HC—HART Communicating
  AD—Advanced Diagnostics
  PD—Performance Diagnostics
  ODV—Optimized Digital Valve

Table 6-2 lists the functions available for each instrument level.

Table 6-2. Functions Available for Instrument Level

Instrument Level	Functions Available
AC	Communicates with the Field Communicator. Provides Basic Setup and calibration.
HC	Communicates with the Field Communicator and ValveLink software. In addition, HC provides: travel cutoffs and limits, minimum opening and closing times, input characterization (linear, equal percentage, quick opening, and custom), trending with ValveLink Solo, and the following alerts: travel deviation; travel alert high, low, high high, and low low; drive signal; auxiliary terminal; cycle counter; and travel accumulation.
AD	Includes all functions listed above plus (with ValveLink software) all offline diagnostic tests (dynamic error band, drive signal, step response, and valve signature) plus online trending
PD	Includes all functions listed above plus all Performance Diagnostics online/in-service valve testing (valve friction, electronics, and mechanical condition)
ODV	Includes all functions listed above plus partial stroke test and lead/lag set point filter.

- *HART Universal Revision*—The revision number of the HART Universal Commands which are used as the communications protocol for the instrument.

- DD Information

DD Information contains the device description in the Field Communicator.

Section 7 Maintenance and Troubleshooting

The DVC6200 digital valve controller enclosure is rated Type 4X and IP66, therefore periodic cleaning of internal components is not required. If the DVC6200 is installed in an area where the exterior surfaces tend to get heavily coated or layered with industrial or atmospheric contaminants, however, it is recommended that the vent (key 52) be periodically inspected to ensure it is fully open. If the vent appears to be clogged, it can be removed, cleaned and replaced. Lightly brush the exterior of the vent to remove contaminants and run a mild water/detergent solution through the vent to ensure it is fully open. Allow the vent to dry before reinstalling.

⚠ WARNING

Personal injury or property damage can occur from cover failure due to overpressure. Ensure that the housing vent opening is open and free of debris to prevent pressure buildup under the cover.

⚠ WARNING

To avoid static discharge from the plastic cover when flammable gases or dust are present, do not rub or clean the cover with solvents. To do so could result in a spark that may cause the flammable gases or dust to explode, resulting in personal injury or property damage. Clean with a mild detergent and water only.

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance procedures on the DVC6200 digital valve controller:

- **Always wear protective clothing, gloves, and eyewear.**
- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**
- **Vent the pneumatic actuator loading pressure and relieve any actuator spring precompression so the actuator is not applying force to the valve stem; this will allow for the safe removal of the stem connector.**

⚠ WARNING

When using natural gas as the supply medium, or for explosion proof applications, the following warnings also apply:

- **Remove electrical power before removing the housing cap. Personal injury or property damage from fire or explosion may result if power is not disconnected before removing the cap.**
- **Remove electrical power before disconnecting any of the pneumatic connections.**
- **When disconnecting any of the pneumatic connections or any pressure retaining part, natural gas will seep from the unit and any connected equipment into the surrounding atmosphere. Personal injury or property damage may result**

from fire or explosion if natural gas is used as the supply medium and appropriate preventive measures are not taken. Preventive measures may include, but are not limited to, one or more of the following: ensuring adequate ventilation and the removal of any ignition sources.

- **Ensure that the cover is correctly installed before putting this unit back into service. Failure to do so could result in personal injury or property damage from fire or explosion.**

CAUTION

When replacing components, use only components specified by the factory. Always use proper component replacement techniques, as presented in this manual. Improper techniques or component selection may invalidate the approvals and the product specifications, as indicated in table 1-2, and may also impair operations and the intended function of the device.

Because of the diagnostic capability of the DVC6200, predictive maintenance is available through the use of ValveLink software. Using the digital valve controller, valve and instrument maintenance can be enhanced, thus avoiding unnecessary maintenance. For information on using ValveLink software, refer to the ValveLink software online help.

Removing the Magnetic Feedback Assembly

To remove the magnet assembly from the actuator stem, perform the following basic steps.

1. Make sure that the valve is isolated from the process.
2. Remove the instrument terminal box cover.
3. Disconnect the field wiring from the terminal board.
4. Shut off the instrument air supply.
5. Disconnect the pneumatic tubing and remove the DVC6200 or the DVC6215 from the actuator.
6. Remove the screws holding the magnet assembly to the connector arm.

When replacing the instrument, be sure to follow the mounting guidelines in the Installation section. Setup and calibrate the instrument prior to returning to service.

Module Base Maintenance

The digital valve controller contains a module base consisting of the I/P converter, printed wiring board assembly, and pneumatic relay. The module base may be easily replaced in the field without disconnecting field wiring or tubing.

Tools Required

Table 7-1 lists the tools required for maintaining the DVC6200 digital valve controller.

Table 7-1. Tools Required

Tool	Size	Component
Phillips Screwdriver		Relay, printed wiring board assembly, and cover screws
Hex key	5 mm	Terminal box screw
Hex key	1.5 mm	Terminal box cover screw
Hex key	2.5 mm	I/P converter screws
Hex key	6 mm	Module base screws

Component Replacement

When replacing any of the components of the DVC6200, the maintenance should be performed in an instrument shop whenever possible. Make sure that the electrical wiring and pneumatic tubing is disconnected prior to disassembling the instrument.

Removing the Module Base

Refer to figure 8-2 or 8-4 for key number locations.

⚠ WARNING

To avoid personal injury or equipment damage from bursting of parts, turn off the supply pressure to the digital valve controller and bleed off any excess supply pressure before attempting to remove the module base assembly from the housing.

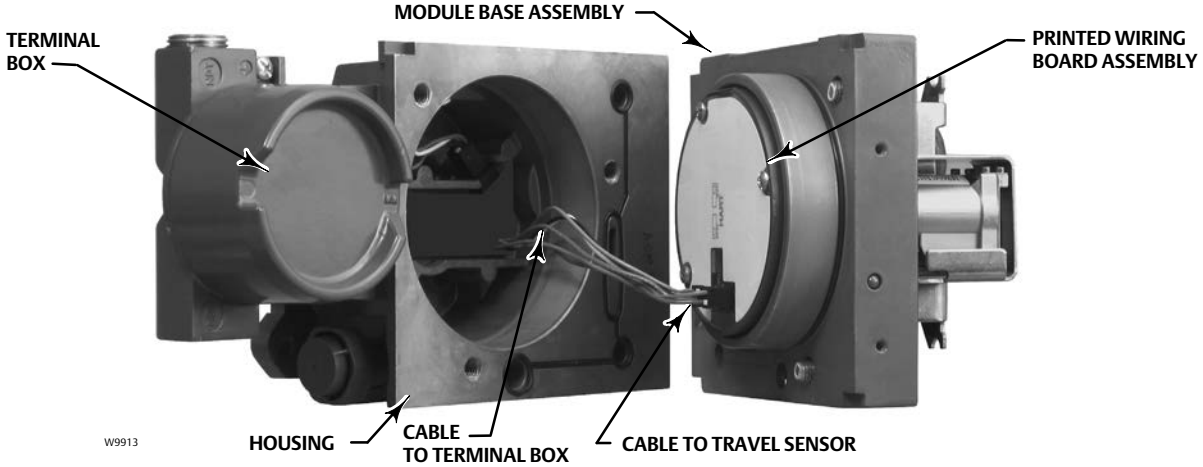
1. Unscrew the four captive screws in the cover (key 43) and remove the cover from the module base (key 2).
2. Using a 6 mm hex socket wrench, loosen the three-socket head screws (key 38). These screws are captive in the module base by retaining rings (key 154).

Note

The module base is linked to the housing by two cable assemblies. Disconnect these cable assemblies after you pull the module base out of the housing.

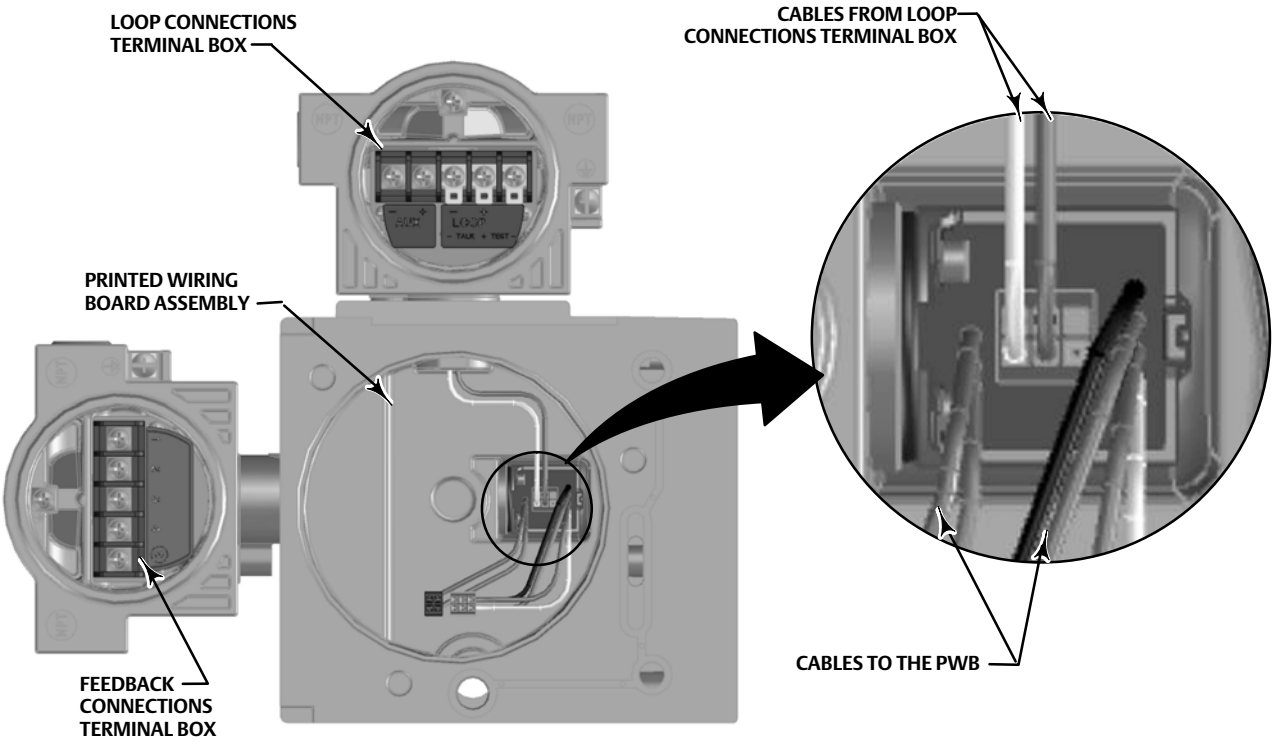
3. Pull the module base straight out of the housing (key 1). Once clear of the housing, swing the module base to the side of the housing to gain access to the cable assemblies.
4. The digital valve controller/base unit has two cable assemblies, shown in figure 7-1, which connect the module base, via the printed wiring board assembly, to the output of the travel feedback sensor board and the travel feedback sensor. Disconnect these cable assemblies from the printed wiring board assembly on the back of the module base.

Figure 7-1. Printed Wiring Board Cable Connections



5. For the DVC6205 only, disconnect the cable assembly from the LOOP connections terminal box, as shown in figure 7-2.

Figure 7-2. FIELDVUE DVC6205 Cable Connections



Replacing the Module Base

Refer to figure 8-2 or 8-4 for key number locations.

CAUTION

To avoid affecting performance of the instrument, take care not to damage the module base seal or guide surface. Do not bump or damage the bare connector pins on the PWB assembly. Damaging either the module base or guide surface may result in material damage, which could compromise the instruments ability to maintain a pressure seal.

Note

To avoid affecting performance of the instrument, inspect the guide surface on the module and the corresponding seating area in the housing before installing the module base assembly. These surfaces must be free of dust, dirt, scratches, and contamination.

Ensure the module base seal is in good condition. Do not reuse a damaged or worn seal.

1. Ensure the module base seal (key 237) is properly installed in the housing (key 1). Ensure the O-ring (key 12) is in place on the module base assembly.

2. Connect the two cable assemblies from the sensor board to the PWB assembly (key 50). Orientation of the connector is required.
3. For DVC6205 only, connect the cable assembly from the LOOP connections terminal box to the Feedback Connections Terminal Box (see figure 7-2).
4. Insert the module base (key 2) into the housing (key 1).
5. Install three socket head screws (key 38) in the module base into the housing. If not already installed, press three retaining rings (key 154) into the module base. Evenly tighten the screws in a crisscross pattern to a final torque of 16 N•m (138 lbf•in).

CAUTION

Personal injury, property damage, or disruption of process control can result if the cable assemblies/wiring are damaged when attaching the cover to the module base assembly

Ensure that the cable assemblies/wiring are positioned in the cavity of the module base so they do not get compressed or damaged when attaching the cover to the module base assembly in step 6.

6. Attach the cover (key 43) to the module base assembly.

Submodule Maintenance

The module base of the DVC6200 contains the following submodules: I/P converter, PWB assembly, and pneumatic relay. If problems occur, these submodules may be removed from the module base and replaced with new submodules. After replacing a submodule, the module base may be put back into service.

CAUTION

Exercise care when performing maintenance on the module base. Reinstall the cover to protect the I/P converter and gauges when servicing other submodules.

In order to maintain accuracy specifications, do not strike or drop the I/P converter during submodule maintenance.

I/P Converter

Refer to figure 8-2 or 8-4 for key number locations. The I/P converter (key 41) is located on the front of the module base.

Note

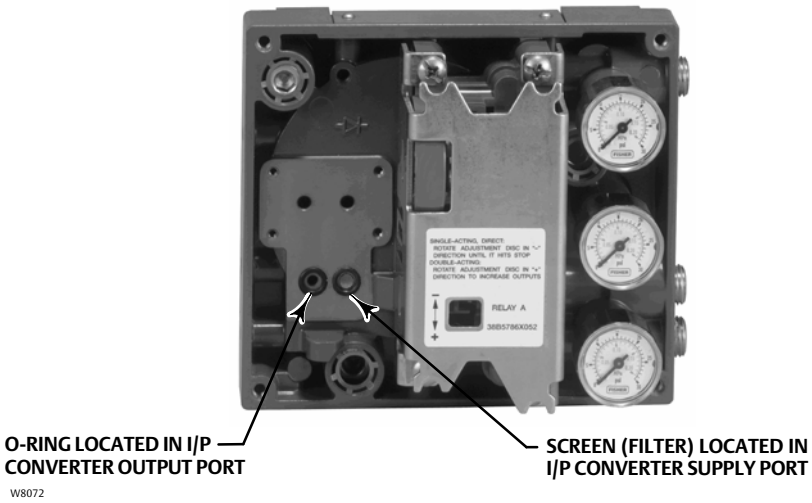
After I/P converter submodule replacement, calibrate the digital valve controller to maintain accuracy specifications.

Replacing the I/P Filter

A screen in the supply port beneath the I/P converter serves as a secondary filter for the supply medium. To replace this filter, perform the following procedure:

1. Remove the I/P converter (key 41) and shroud (key 169) as described in the Removing the I/P Converter procedure.
2. Remove the screen (key 231) from the supply port.
3. Install a new screen in the supply port as shown in figure 7-3.

Figure 7-3. I/P Filter Location



4. Inspect the O-ring (key 39) in the I/P output port. if necessary, replace it.
5. Reinstall the I/P converter (key 41) and shroud (key 169) as described in the Replacing the I/P Converter procedure.

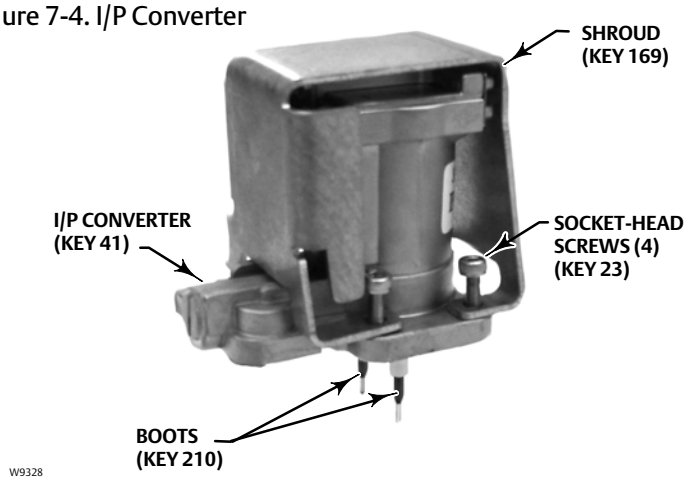
Removing the I/P Converter

1. Remove the front cover (key 43), if not already removed.
2. Refer to figure 7-4. Using a 2.5 mm hex socket wrench, remove the four socket-head screws (key 23) that attach the shroud (key 169) and I/P converter (key 41) to the module base (key 2).
3. Remove the shroud (key 169); then pull the I/P converter (key 41) straight out of the module base (key 2). Be careful not to damage the two electrical leads that come out of the base of the I/P converter.
4. Ensure that the O-ring (key 39) and screen (key 231) stay in the module base and do not come out with the I/P converter (key 41).

Replacing the I/P Converter

1. Refer to figure 7-3. Inspect the condition of the O-ring (key 39) and screen (key 231) in the module base (key 2). Replace them, if necessary. Apply silicone lubricant to the O-rings.
2. Ensure the two boots (key 210) shown in figure 7-4 are properly installed on the electrical leads.

Figure 7-4. I/P Converter



3. Install the I/P converter (key 41) straight into the module base (key 2), taking care that the two electrical leads feed into the guides in the module base. These guides route the leads to the printed wiring board assembly submodule.
4. Install the shroud (key 169) over the I/P converter (key 41).
5. Install the four socket-head screws (key 23) and evenly tighten them in a crisscross pattern to a final torque of 1.6 N•m (14 lbf•in).
6. After replacing the I/P converter, calibrate travel or perform touch-up calibration to maintain accuracy specifications.

Printed Wiring Board (PWB) Assembly

Refer to figure 8-2 or 8-4 for key number locations. The PWB assembly (key 50) is located on the back of the module base assembly (key 2).

Note
The PWB assembly must be firmware revision 9 or later.

Note
If the PWB assembly submodule is replaced, calibrate and configure the digital valve controller to maintain accuracy specifications.

Removing the Printed Wiring Board Assembly

1. Separate the module base from the housing by performing the Removing the Module Base procedure.
2. Remove three screws (key 33).
3. Lift the PWB assembly (key 50) straight out of the module base (key 2).
4. Ensure that the O-rings (key 40) remain in the pressure sensor bosses on the module base assembly (key 2) after the PWB assembly (key 50) has been removed.

Replacing the Printed Wiring Board Assembly and Setting the DIP Switch

1. Apply silicone lubricant to the pressure sensor O-rings (key 40) and install them on the pressure sensor bosses in the module base assembly.

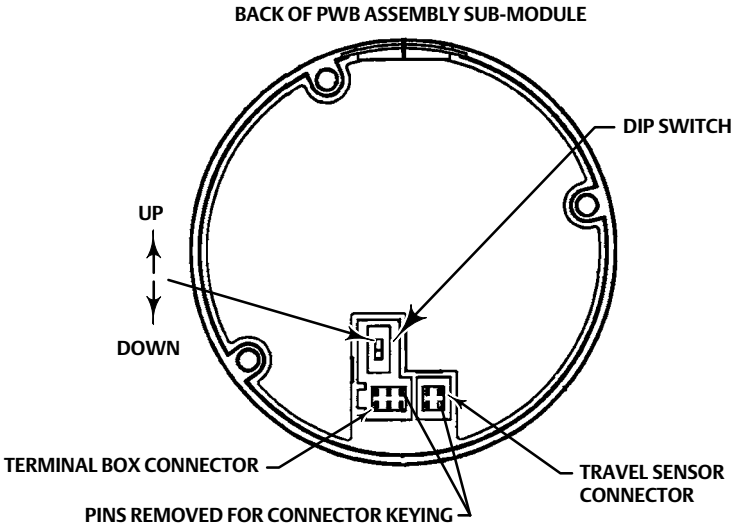
2. Properly orient the PWB assembly (key 50) as you install it into the module base. The two electrical leads from the I/P converter (key 41) must guide into their receptacles in the PWB assembly and the pressure sensor bosses on the module base must fit into their receptacles in the PWB assembly.
3. Push the PWB assembly (key 50) into its cavity in the module base.
4. Install and tighten three screws (key 33) to a torque of 1 N•m (10.1 lbf•in).
5. Set the DIP switch on the PWB assembly according to table 7-2.

Table 7-2. DIP Switch Configuration(1)

Operational Mode	Switch Position
Multidrop Loop	UP
Point-to-Point Loop	DOWN

1. Refer to figure 7-5 for switch location.

Figure 7-5. DIP Switch Location



Note

For the digital valve controller to operate with a 4 to 20 mA control signal, be sure the DIP switch is in the point-to-point loop position, i.e., switch in down position.

6. Reassemble the module base to the housing by performing the Replacing the Module Base procedure.
7. Setup and calibrate the digital valve controller.

Pneumatic Relay

Refer to figure 8-2 or 8-4 for key number locations. The pneumatic relay (key 24) is located on the front of the module base.

Note

After relay submodule replacement, calibrate the digital valve controller to maintain accuracy specifications.

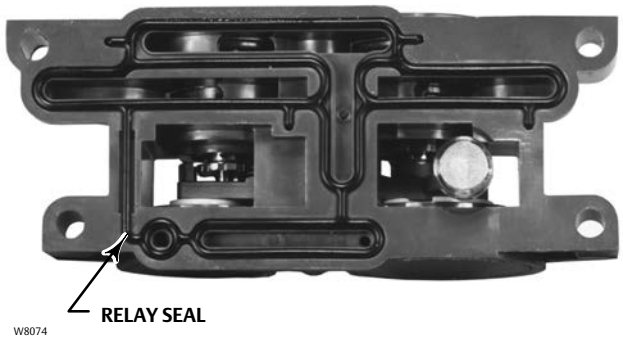
Removing the Pneumatic Relay

1. Loosen the four screws that attach the relay (key 24) to the module base. These screws are captive in the relay.
2. Remove the relay.

Replacing the Pneumatic Relay

1. Visually inspect the holes in the module base to ensure they are clean and free of obstructions. If cleaning is necessary, do not enlarge the holes.
2. Apply silicone lubricant to the relay seal and position it in the grooves on the bottom of the relay as shown in figure 7-6. Press small seal retaining tabs into retaining slots to hold relay seal in place.

Figure 7-6. Pneumatic Relay Assembly



3. Position the relay (with shroud) on the module base. Tighten the four screws, in a crisscross pattern, to a final torque of 2 N•m (20.7 lbf•in).
4. Using the Field Communicator, verify that the value for Relay Type parameter matches the relay type installed.
5. After replacing the relay and verifying the relay type, calibrate travel or perform touch-up calibration to maintain accuracy specifications

Gauges, Pipe Plugs, or Tire Valves

Depending on the options ordered, the DVC6200 or DVC6205 will be equipped with either gauges (key 47), pipe plugs (key 66), or tire valves (key 67). Single-acting direct instruments will also have a screen (key 236, figure 8-3). These are located on the top of the module base next to the relay.

Perform the following procedure to replace the gauges, tire valves, or pipe plugs. Refer to figure 8-2 and 8-3 for key number locations.

1. Remove the front cover (key 43).
2. Remove the gauge, pipe plug, or tire valve as follows:

For gauges (key 47), the flats are on the gauge case. Use a wrench on the flats of the gauge to remove the gauge from the module base. For double-acting instruments, to remove the supply gauge remove one of the output gauges.

For pipe plugs (key 66) and tire valves (key 67), use a wrench to remove these from the module base.

3. Apply zinc based anti-seize sealant (key 64) to the threads of the replacement gauges, pipe plugs, or tire valves.
4. Using a wrench, screw the gauges, pipe plugs, or tire valves into the module base.

Terminal Box

⚠ WARNING

Refer to the Maintenance WARNING at the beginning of this section.

Refer to figure 8-2 or 8-4 for key number locations.

The terminal box is located on the housing and contains the terminal strip assembly for field wiring connections.

Note
The DVC6205 feedback connections terminal box (shown in figure 7-7) is not a replaceable part. Do not remove the tamper proof paint on the screw.

Figure 7-7. FIELDVUE DVC6205 Feedback Connections Terminal Box



Removing the Terminal Box

⚠ WARNING

To avoid personal injury or property damage caused by fire or explosion, remove power to the instrument before removing the terminal box cover in an area which contains a potentially explosive atmosphere or has been classified as hazardous.

1. Loosen the set screw (key 58) in the cap (key 4) so that the cap can be unscrewed from the terminal box.
2. After removing the cap (key 4), note the location of field wiring connections and disconnect the field wiring from the terminal box.
3. Separate the module base from the housing by performing the Removing the Module Base procedure.
4. Disconnect the terminal box wiring connector from the sensor board in the housing assembly (key 50).
5. Remove the screw (key 72). Pull the terminal box assembly straight out of the housing.

Replacing the Terminal Box

Note

Inspect all O-rings for wear and replace as necessary.

1. Apply lubricant, silicone sealant to the O-ring (key 34) and install the O-ring over the stem of the terminal box.
2. Insert the terminal box assembly stem into the housing until it bottoms out. Position the terminal box assembly so that the hole for the screw (key 72) in the terminal box aligns with the threaded hole in the housing. Install the screw (key 72).
3. Connect the terminal box wiring connector to the sensor board in the housing assembly (key 50). Orientation of the connector is required.
4. Reassemble the module base to the housing by performing the Replacing the Module Base procedure.
5. Reconnect the field wiring as noted in step 2 in the Removing the Terminal Box procedure.
6. Apply lubricant, silicone sealant to the O-ring (key 36) and install the O-ring over the 2-5/8 inch threads of the terminal box. Use of a tool is recommended to prevent cutting the O-ring while installing it over the threads.
7. Apply lithium grease (key 63) to the 2-5/8 inch threads on the terminal box to prevent seizing or galling when the cap is installed.
8. Screw the cap (key 4) onto the terminal box.
9. Install a set screw (key 58) into the cap (key 4). Loosen the cap (not more than 1 turn) to align the set screw over one of the recesses in the terminal box. Tighten the set screw (key 58).

Troubleshooting

If communication or output difficulties are experienced with the instrument, refer to the troubleshooting chart in table 7-3. Also see the DVC6200 Technical Support Checklist on page 111.

Checking Voltage Available

⚠ WARNING

Personal injury or property damage caused by fire or explosion may occur if this test is attempted in an area which contains a potentially explosive atmosphere or has been classified as hazardous.

To check the Voltage Available at the instrument, perform the following:

1. Connect the equipment in figure 2-29 to the field wiring in place of the FIELDVUE instrument.
2. Set the control system to provide maximum output current.
3. Set the resistance of the 1 kilohm potentiometer shown in figure 2-29 to zero.
4. Record the current shown on the milliammeter.
5. Adjust the resistance of the 1 kilohm potentiometer until the voltage read on the voltmeter is 11.0 volts.
6. Record the current shown on the milliammeter.
7. If the current recorded in step 6 is the same as that recorded in step 4 (± 0.08 mA), the voltage available is adequate.
8. If the voltage available is inadequate, refer to Wiring Practices in the Installation section.

Checking the Loop Current Without Disturbing the Loop Wiring

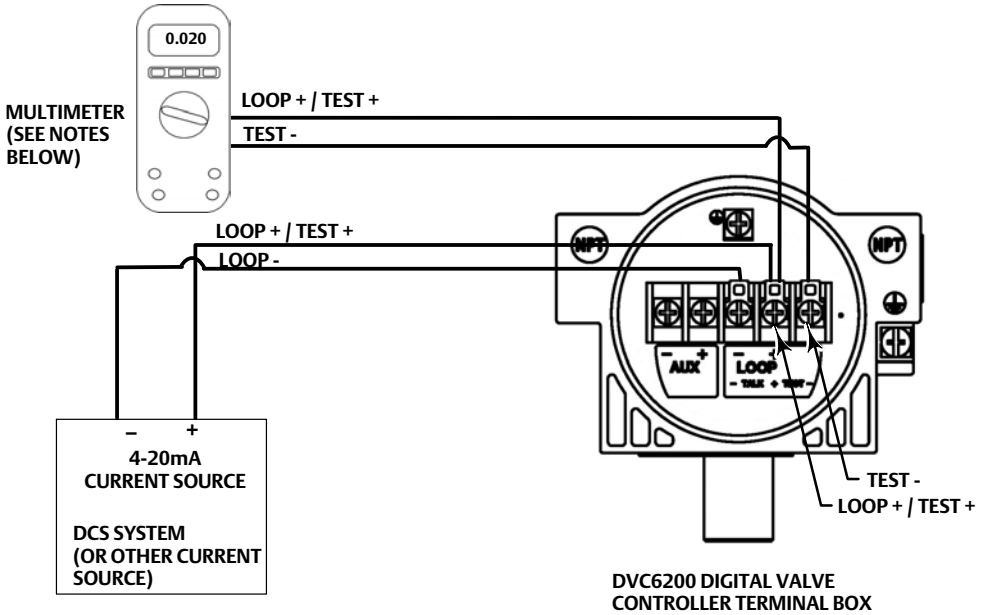
⚠ WARNING

Personal injury or property damage caused by fire or explosion may occur if this test is attempted in an area which contains a potentially explosive atmosphere or has been classified as hazardous.

To check the loop current without disturbing the loop wiring perform the following procedure.

1. With the FIELDVUE instrument connected to a current source connect a digital multimeter reading Volts DC (0 to 1 VDC or mV scale) to the TEST terminals as shown in figure 7-8.
2. The reading at the test terminals is proportional to the loop current [0.004 V = 0.004 A (4 MA)] mA of loop current). Refer to Specifications, table 1-2, to determine if the current is sufficient.

Figure 7-8. Check the Loop Current using the TEST Terminals



NOTES:
1. MULTIMETER MEASURING 0.000 TO 1.0000 VDC
2. TYPICAL READINGS 0.004 VDC TO 0.020 VDC
3. OHM'S LAW—V = I x R, WHERE R = PRECISION 1 OHM RESISTOR, V = I x 1, SO V= I

Table 7-3. Instrument Troubleshooting

Symptom	Possible Cause	Action
1. Analog input reading at instrument does not match actual current provided.	1a. Control mode not Analog.	1a. Check the control mode using the Field Communicator. If in the Digital or Test mode, the instrument receives its set point as a digital signal. Control is not based on input current. Change Control Mode to Analog.
	1b. Low control system compliance voltage.	1b. Check system compliance voltage (see Wiring Practices in the Installation section.
	1c. Instrument shutdown due to self test failure.	1c. Check instrument status using the Field Communicator (see Viewing Instrument Status in the Viewing Device Information section).
	1d. Analog input sensor not calibrated.	1d. Calibrate the analog input sensor (see Analog Input Calibration in the Calibration section).
	1e. Current leakage.	1e. Excessive moisture in the terminal box can cause current leakage. Typically the current will vary randomly if this is the case. Allow the inside of the terminal box to dry, then retest.
2. Instrument will not communicate.	2a. Insufficient Voltage Available.	2a. Calculate Voltage Available (see Wiring Practices in the Installation section). Voltage Available should be greater than or equal to 11 VDC.
	2b. Controller output Impedance too low.	2b. Install a HART filter after reviewing Control System Compliance Voltage requirements (see Wiring Practices in the Installation section).
	2c. Cable capacitance too high.	2c. Review maximum cable capacitance limits (see Wiring Practices in the Installation section).
	2d. HART filter improperly adjusted.	2d. Check filter adjustment (see the appropriate HART filter instruction manual).
	2e. Improper field wiring.	2e. Check polarity of wiring and integrity of connections. Make sure cable shield is grounded only at the control system.
	2f. Controller output providing less than 4 mA to loop.	2f. Check control system minimum output setting, which should not be less than 3.8 mA.
	2g. Disconnected loop wiring cable at PWB.	2g. Verify connectors are plugged in correctly.
	2h. PWB DIP switch not set properly.	2h. Check for incorrect setting or broken DIP switch on the back of the PWB. Reset switch or replace PWB, if switch is broken. See table 7-2 for switch setting information
	2j. PWB failure.	2j. Use a 4-20 mA current source to apply power to the instrument. Terminal voltage across the LOOP+ and LOOP- terminals should be 9 to 10.5 VDC. If the terminal voltage is not 9 to 10.5 VDC, replace the PWB.
	2k. Polling address incorrect.	2k. Use the Field Communicator to set the polling address (refer to the Detailed Setup section). From the *Utility* menu, select *Configure Communicator* > *Polling* > *Always Poll*. Set the instrument polling address to 0.
	2l. Defective terminal box.	2l. Check continuity from each screw terminal to the corresponding PWB connector pin. If necessary, replace the terminal box assembly.
	2m. Defective Field Communicator or ValveLink modem cable.	2m. If necessary, repair or replace cable.
	2n. ValveLink modem defective or not compatible with PC.	2n. Replace ValveLink modem.
	2p. ValveLink hardlock defective or not programmed.	2p. Replace if defective or return to factory for programming.
3. Instrument will not calibrate, has sluggish performance or oscillates.	3a. Configuration errors.	3a. Verify configuration: If necessary, set protection to None. If Out of Service, place In Service. Check: Travel Sensor Motion Tuning set Zero control signal Feedback Connection Control mode (should be Analog) Restart control mode (should be Analog)

Table 7-3. Instrument Troubleshooting (Continued)

Symptom	Possible Cause	Action
	3b. Restricted pneumatic passages in I/P converter.	3b. Check screen in I/P converter supply port of the module base. Replace if necessary. If passages in I/P converter restricted, replace I/P converter.
	3c. O-ring(s) between I/P converter ass'y missing or hard and flattened losing seal.	3c. Replace O-ring(s).
	3d. I/P converter ass'y damaged/corroded/clogged.	3d. Check for bent flapper, open coil (continuity), contamination, staining, or dirty air supply. Coil resistance should be between 1680 - 1860 ohms. Replace I/P assembly if damaged, corroded, clogged, or open coil.
	3e. I/P converter ass'y out of spec.	3e. I/P converter ass'y nozzle may have been adjusted. Verify drive signal (55 to 80% for double-acting; 60 to 85% for single-acting) with the valve off the stops. Replace I/P converter assembly if drive signal is continuously high or low.
	3f. Defective module base seal.	3f. Check module base seal for condition and position. If necessary, replace seal.
	3g. Defective relay.	3g. Depress relay beam at adjustment location in shroud, look for increase in output pressure. Remove relay, inspect relay seal. Replace relay seal or relay if I/P converter assembly is good and air passages not blocked. Check relay adjustment.
	3h. Defective 67CFR regulator, supply pressure gauge jumps around.	3h. Replace 67CFR regulator.
4. ValveLink diagnostic tests provide erroneous results.	4a. Defective pressure sensor.	4a. Replace PWB.
	4b. Pressure sensor O-ring missing.	4b. Replace O-ring.
5. Field Communicator does not turn on.	5a. Battery pack not charged.	5a. Charge battery pack. Note: Battery pack can be charged while attached to the Field communicator or separately. The Field Communicator is fully operable while the battery pack is charging. Do not attempt to charge the battery pack in a hazardous area.

DVC6200 Technical Support Checklist

Have the following information available prior to contacting your Emerson Process Management sales office for support.

1. Instrument serial number as read from nameplate _____
2. Is the digital valve controller responding to the control signal? Yes _____ No _____

   If not, describe _____
3. Measure the voltage across the "Loop -" and Loop +" terminal box screws when the commanded current is 4.0 mA and 20.0 mA: _____V @ 4.0 mA _____V @ 20.0 mA.
   (These values should be around 9.6 V @ 4.0 mA and 10.3 V @ 20 mA).
4. Is it possible to communicate via HART to the digital valve controller? Yes _____ No _____
5. What is the Diagnostic Tier of the digital valve controller? AC ____ HC ____ AD ____ PD ____ ODV____
6. What is the firmware version of the digital valve controller? _____
7. What is the hardware version of the digital valve controller? _____
8. Is the digital valve controller's Instrument Mode "In Service"? Yes _____ No _____
9. Is the digital valve controller's Control Mode set to "Analog"? Yes _____ No _____
10. Is it on Travel or Pressure control?
11. What are the following parameter readings?

    Input Signal _____ Drive Signal _____%

    Supply Pressure _____ Pressure A _____ Pressure B _____

    Travel Target _____% Travel _____%
12. What are the following alert readings?

    Fail alerts _____

    Valve alerts _____

    Operational status _____

    Alert event record entries _____
13. Export ValveLink data (if available) for the device (Status Monitor, Detailed Setup, etc.).

Mounting

1. Which digital valve controller do you have? DVC6200 _____ DVC6205/DVC6215 _____
2. What Make, Brand, Style, Size, etc. actuator is the DVC6200 mounted on? _____
3. What is the full travel of the valve? _____
4. What is the Mounting Kit part number? _____
5. If mounting kits are made by LBP/Customer, please provide pictures of installation.
6. Is the Mounting kit installed per the instructions? Yes _____ No _____
7. What is the safe position of the valve? Fail closed _____ Fail open _____

Section 8 Parts

Parts Ordering

Whenever corresponding with your Emerson Process Management sales office about this equipment, always mention the controller serial number. When ordering replacement parts, refer to the 11-character part number of each required part as found in the following parts list. Part numbers are shown for kits and recommended spares only. For part numbers not shown, contact your Emerson Process Management sales office.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management should not, under any circumstances, be used in any Fisher instrument. Use of components not supplied by Emerson Process Management may void your warranty, might adversely affect the performance of the instrument, and could cause personal injury and property damage.

Parts Kits

Kit	Description	Part Number
1*	Elastomer Spare Parts Kit (kit contains parts to service one digital valve controller)	
	Standard	19B5402X012
	Extreme Temperature option (fluorosilicone elastomers)	19B5402X022
2*	Small Hardware Spare Parts Kit (kit contains parts to service one digital valve controller)	19B5403X012
3*	Seal Screen Kit [kit contains 25 seal screens (key 231) and 25 O-rings (key 39)]	
	Standard and Extreme Temperature option (fluorosilicone elastomers)	14B5072X182
4*	Terminal Box Kit, aluminum	
	Standard	19B5401X012
	Standard, Natural Gas approved	19B5401X032
	Extreme Temperature option (fluorosilicone elastomers)	19B5401X022
	Extreme Temperature option (fluorosilicone elastomers) Natural Gas Approved	19B5401X042
5*	I/P Converter Kit	
	Standard	38B6041X152
	For Extreme Temperature option (fluorosilicone elastomers)	38B6041X132
6*	Spare Module Base Assembly Kit, Aluminum [kit contains module base (key 2); drive screws, qty. 2, (key 11); shield/label (key 19); hex socket cap screw, qty. 3, (key 38); self tapping screw, qty. 2 (key 49); pipe plug, qty. 3 (key 61); retaining ring, qty. 3 (key 154); screen (key 236); and flame arrestors, qty. 3 (key 243)]	GE18654X012
7*	Spare Housing Assembly Kit, aluminum [kit contains housing (key 1); vent assembly (key 52); seal (only included in Housing A kits) (key 288); seal (key 237); O-ring (key 34); O-ring (only used with integrally mounted regulator) (key 5)]	
	Housing A (used for GX actuator)	
	Standard (nitrile elastomers)	GE48798X012
	Extreme Temperature option (fluorosilicone elastomers)	GE48798X022
	Housing B (used for all actuators except GX)	
	Standard (nitrile elastomers)	GE48798X052
	Extreme Temperature option (fluorosilicone elastomers)	GE48798X062
8*	Spare I/P Shroud Kit [kit contains shroud (key 169) and hex socket cap screw, qty. 4 (key 23)]	GE29183X012
9*	Remote Mount Feedback Unit Kit (see figure 8-5) [remote housing assembly (key25); hex socket set screw (key 58); 1/2 NPT pipe plug (key 62); wire retainer, qty 2 (key 131); terminal cover (key 255); o-ring (key 256); gasket (Housing A only, used for GX actuator) (key 287); seal (Housing A only, used for GX actuator) (key 288)	
	Housing A (used for GX actuator)	GE46670X012
	Housing B (used for all actuators except GX)	GE40178X012

*Recommended spare parts

Kit	Description	Part Number
10*	Feedback Array Kit, Aluminum	
	Sliding Stem (Linear) [kit contains feedback array and hex socket cap screws, qty. 2, with hex key and alignment template. 210 mm (8-1/4 inch) kit also contains insert]. Stainless steel kits only for use with stainless steel mounting kits.	
	7 mm (1/4-inch)	
	Aluminum	GG20240X012
	19 mm (3/4-inch)	
	Aluminum	GG20240X022
	Stainless steel	GG13199X012
	25 mm (1-inch)	
	Aluminum	GG20240X032
	Stainless steel	GG13199X022
	38 mm (1-1/2 inch)	
	Aluminum	GG20240X042
	Stainless steel	GG13199X032
	50 mm (2-inch)	
	Aluminum	GG20240X052
	Stainless steel	GG13199X042
	100 mm (4-inch)	
	Aluminum	GG20240X062
	Stainless steel	GG13199X052
	210 mm (8-1/4 inch)	
	Aluminum	GG20243X012
	Stainless steel	GG13199X072
	Rotary [kit contains feedback assembly, pointer, and travel indicator scale]. Stainless steel kits only for use with stainless steel mounting kits.	
	Aluminum	GG10562X012
	Stainless steel	GG10562X022

Parts List

Note

Part numbers are shown for recommended spares only. For part numbers not shown, contact your Emerson Process Management sales office.
Parts with footnote numbers shown are available in parts kits; see footnote information at the bottom of the page.

Key	Description	Part Number

Housing (see figure 8-2 and 8-4)

DVC6200 and DVC6205

Key	Description	Part Number
1	Housing(7)	
11	Drive Screw (2 req'd) (DVC6205 only)	
20	Shield (DVC6205 only)	
52	Vent, plastic(2)	
74	Mounting Bracket (DVC6205 only)	
248	Screw, hex head (4 req'd) (DVC6205 only)	
249	Screw, hex head (4 req'd) (DVC6205 only)	
250	Spacer (4 req'd) (DVC6205 only)	
267	Standoff (2 req'd) (DVC6205 only)	
271	Screen(7)	
287	Gasket, Housing A only (used for GX actuator) (DVC6200 only)	
288	Seal, Housing A only (used for GX actuator) (DVC6200 only)	

Common Parts (see figure 8-2, 8-3, and 8-4)

DVC6200 and DVC6205

Key	Description	Part Number
16*	O-ring(1) (3 req'd)	
29	Warning label, for use only with LCIE hazardous area classifications	
33	Mach Screw, pan head, SST(2) (3 req'd)	
38	Cap Screw, hex socket, SST(2)(6) (3 req'd)	
43*	Cover Assembly (includes cover screws)	
	Standard	38B9580X022
	Extreme temperature option (fluorosilicone elastomers)	38B9580X032
48	Nameplate	
49	Screw, self tapping (2 req'd)(6)	
61	Pipe Plug, hex socket(6)	
	Housing A with relay C (2 req'd) (used for GX actuator)	
	Housing A with relay B (1 req'd) (used for GX actuator)	
	Housing B with relay B and C (1 req'd) (used for all actuators except GX)	
	Not required for relay A	
63	Lithium grease (not furnished with the instrument)	
64	Zinc based anti-seize compound (not furnished with the instrument)	
65	Lubricant, silicone sealant (not furnished with the instrument)	
154	Retaining Ring(2) (3 req'd)	
236	Screen (required for relay B and C only)(7)	
237	Module Base Seal(1)	

Module Base (see figure 8-2 and 8-4)

DVC6200 and DVC6205

Key	Description	Part Number
2	Module Base(6)	
11	Drive Screw(6) (2 req'd)	
12	O-ring(1)	
19	Shield(6)	
61	Pipe Plug, hex socket(6) (3 req'd)	
243	Slotted Pin (flame arrestor)(6) (3 req'd)	

*Recommended spare

1. Available in the Elastomer Spare Parts Kit
2. Available in the Small Hardware Spare Parts Kit
6. Available in the Spare Module Base Assembly Kit
7. Available in the Spare Housing Assembly Kit

Key	Description	Part Number

I/P Converter Assembly (see figure 8-2 and 8-4)

DVC6200 and DVC6205

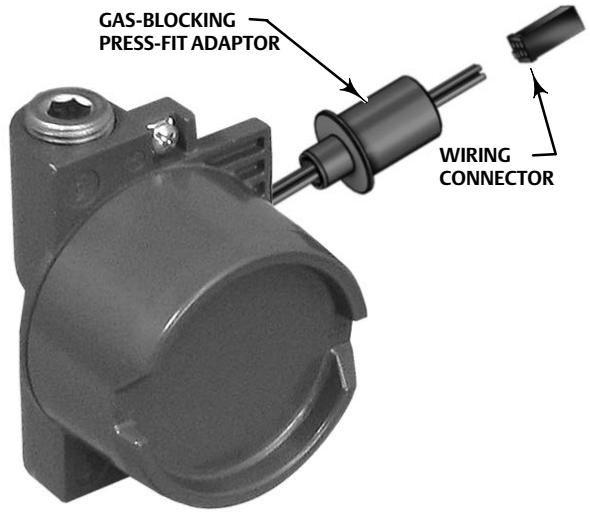
23	Cap Screw, hex socket, SST(2)(8) (4 req'd)	
39*	O-ring(1)(3)(5)	
41	I/P Converter(5)	
169	Shroud(5)(8) (see figure 7-4)	
210*	Boot, nitrile(1)(5) (2 req'd) (see figure 7-4)	
231*	Seal Screen(1)(3)(5)	

Relay (see figure 8-2 and 8-4)

DVC6200 and DVC6205

24*	Relay Assembly, (includes shroud, relay seal, mounting screws)	
	Standard (nitrile elastomers)	
	Standard Bleed	
	Housing A (used for GX actuator)	
	Single-/acting direct (relay C)	38B5786X182
	Single-acting reverse (relay B)	38B5786X172
	Housing B (used for all actuators except GX)	
	Single-acting direct (relay C)	38B5786X132
	Double-acting (relay A)	38B5786X052
	Single-acting reverse (relay B)	38B5786X092
	Low Bleed	
	Housing A (used for GX actuator)	
	Single-acting direct (relay C)	38B5786X202
	Single-acting reverse (relay B)	38B5786X192
	Housing B (used for all actuators except G)	
	Single-acting direct (relay C)	38B5786X152
	Double-acting (relay A)	38B5786X072
	Single-acting reverse (relay B)	38B5786X112
	Extreme Temperature option (fluorosilicone elastomers)	
	Standard Bleed	
	Single-acting direct (relay C)	38B5786X142
	Double-acting (relay A)	38B5786X032
	Single-acting reverse (relay B)	38B5786X102
	Low Bleed	
	Single-acting direct (relay C)	38B5786X162
	Double-acting (relay A)	38B5786X082
	Single-acting reverse (relay B)	38B5786X122

Figure 8-1. Terminal Box of Natural Gas Certified FIELDVUE DVC6200 Digital Valve Controller



Key	Description	Part Number

Loop Connections Terminal Box (see figure 8-2 and 8-4)

DVC6200 and DVC6205

4	Terminal Box Cap	
34*	O-ring(1)(4)	
36*	O-ring(1)(4)	
58	Set Screw, hex socket, SST(2)	
72	Cap Screw, hex socket, SST(2)	
164	Terminal Box Assembly	

Feedback Connections Terminal Box (see figure 8-4)

DVC6205

4	Terminal Box Cap	
34*	O-ring(1)(4)	
36*	O-ring(1)(4)	
58	Set Screw, hex socket, SST(2)	
62	Pipe Plug, hex hd, SST	
262	Adapter	
263*	O-ring	
	Standard	1F463606992
	Extreme temperature option, (fluorosilicone)	1F4636X0092

*Recommended spare parts

1. Available in the Elastomer Spare Parts Kit
2. Available in the Small Hardware Spare Parts Kit
3. Available in the Seal Screen Kit
4. Available in the Terminal Box Kit
5. Available in the I/P Converter Kit
8. Available in the Spare Shroud Kit

Key	Description	Part Number

PWB Assembly (see figure 8-2 and 8-4)

DVC6200 and DVC6205

Note
Contact your Emerson Process Management sales office for PWB Assembly FS numbers.

50* PWB Assembly
Standard
For instrument level AC
For instrument level HC
For instrument level AD
For instrument level PD
For instrument level ODV

Extreme Temperature option (fluorosilicone elastomers)
For instrument level AC
For instrument level HC
For instrument level AD
For instrument level PD
For instrument level ODV

Key	Description	Part Number

Pressure Gauges, Pipe Plugs, or Tire Valve Assemblies (see figure 8-3)

DVC6200 and DVC6205

47* Pressure Gauge, nickel-plated brass case, brass connection
Double-acting (3 req'd); Single-acting (2 req'd)
PSI/MPA Gauge Scale
To 60 PSI, 0.4 MPa 18B7713X042
To 160 PSI, 1.1 MPa 18B7713X022
PSI/bar Gauge Scale
To 60 PSI, 4 bar 18B7713X032
To 160 PSI, 11 bar 18B7713X012
PSI/KG/CM^2 Gauge Scale
To 60 PSI, 4 KG/CM^2 18B7713X072
To 160 PSI, 11 KG/CM^2 18B7713X082

66 Pipe Plug, hex head
For double-acting and single-acting direct w/gauges (none req'd)
For single-acting reverse w/gauges (1 req'd)
For all units w/o gauges (3 req'd)

67 Tire Valve, used with Tire Valve Option only
Double-acting (3 req'd); Single-acting (2 req'd)

DVC6215 Feedback Unit (see figure 8-5)

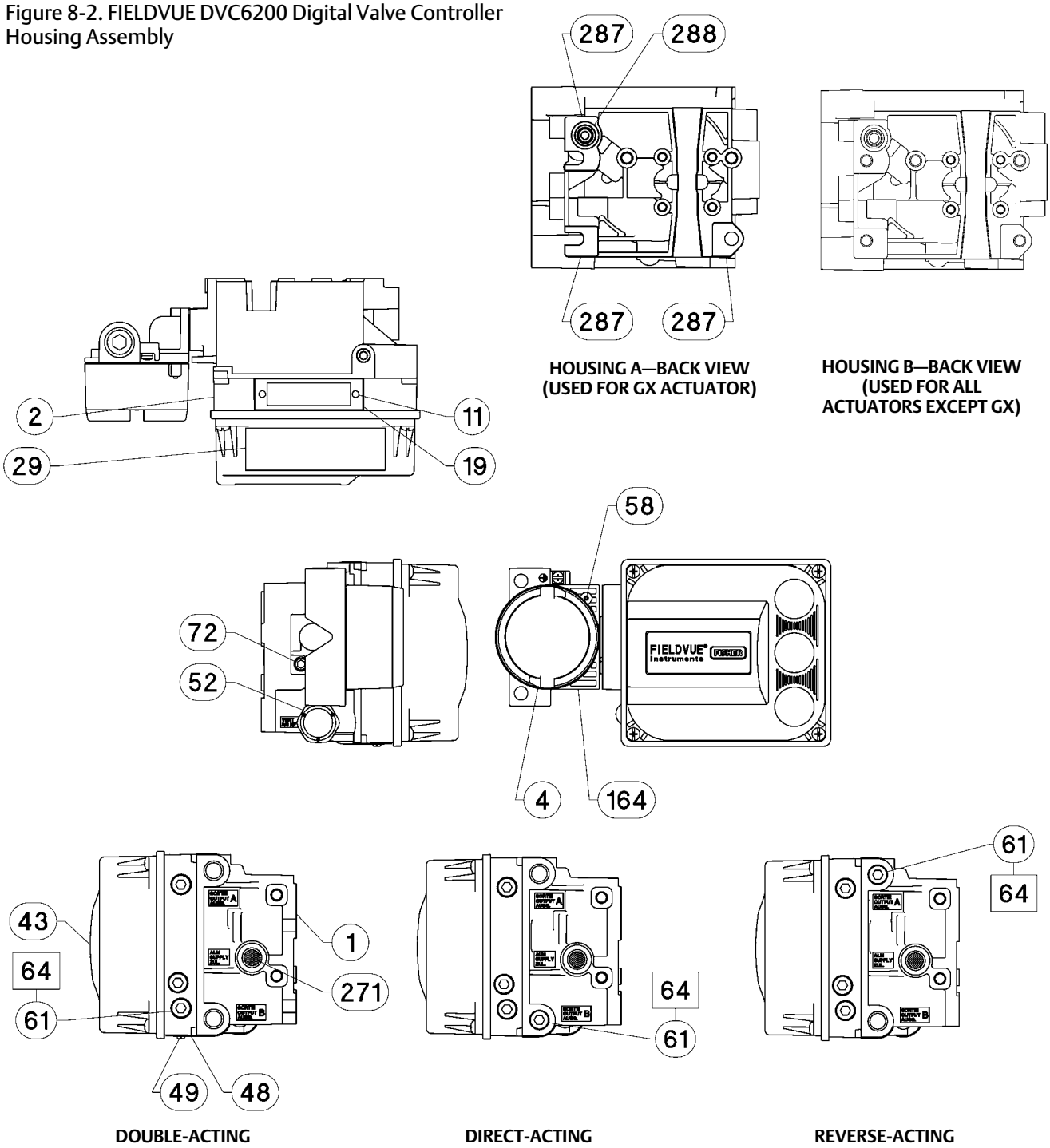
65 Lubricant, silicone sealant (not furnished with the instrument)
256* O-Ring, fluorosilicone 1K1810X0122

HART Filters

HF340, DIN rail mount 39B5411X022
HF341, DIN rail Mount, pass through (no filter) 39B5412X012

*Recommended spare parts

Figure 8-2. FIELDVUE DVC6200 Digital Valve Controller Housing Assembly



HOUSING A—BACK VIEW (USED FOR GX ACTUATOR)

HOUSING B—BACK VIEW (USED FOR ALL ACTUATORS EXCEPT GX)

DOUBLE-ACTING

DIRECT-ACTING

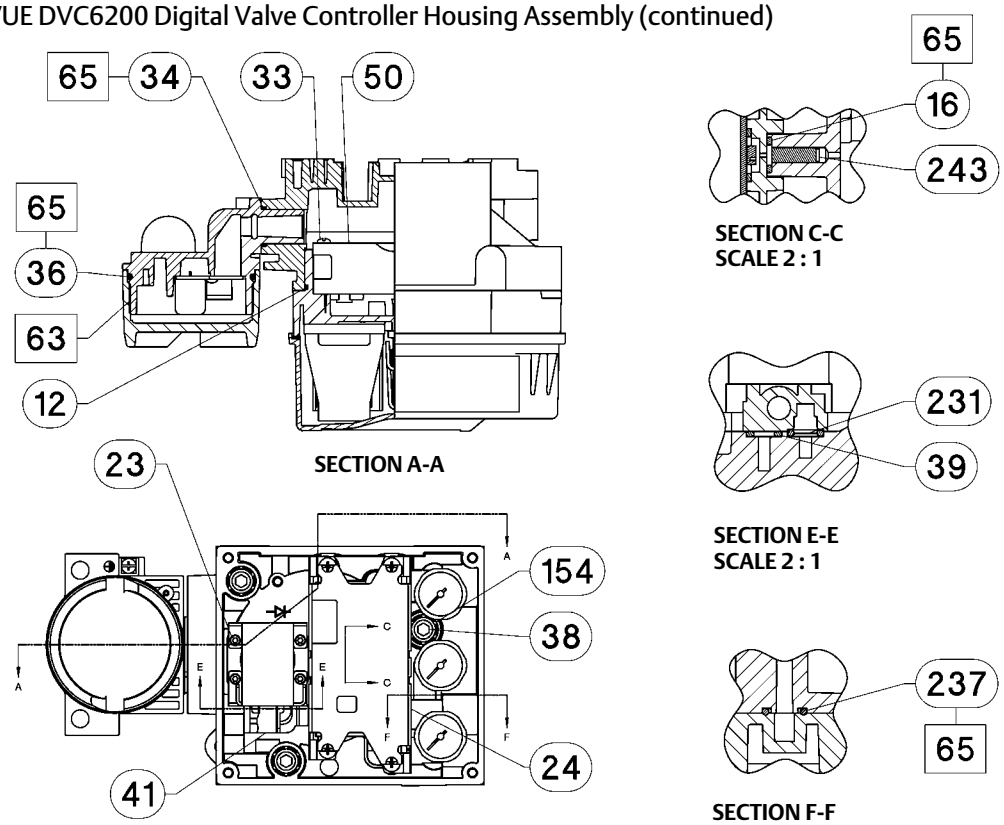
REVERSE-ACTING

APPLY LUBRICANT, SEALANT, OR THREAD LOCK

65 **APPLY LUBRICANT ON ALL O-RINGS UNLESS OTHERWISE SPECIFIED**

GE40185 sheet 1 of 3

Figure 8-2. FIELDVUE DVC6200 Digital Valve Controller Housing Assembly (continued)

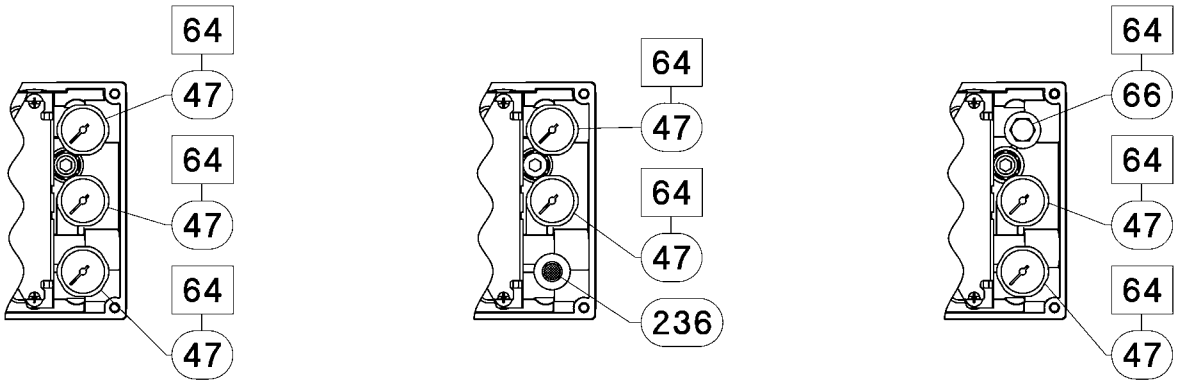


☐ APPLY LUBRICANT, SEALANT, OR THREAD LOCK

65 APPLY LUBRICANT ON ALL O-RINGS UNLESS OTHERWISE SPECIFIED

GE40185 sheet 2 of 3

Figure 8-3. Gauge Configuration



FOR PIPE PLUG OPTION REPLACE (47) WITH (66)

FOR TIRE VALVE OPTION REPLACE (47) WITH (67)

☐ APPLY LUBRICANT, SEALANT, OR THREAD LOCK

65 APPLY LUBRICANT ON ALL O-RINGS UNLESS OTHERWISE SPECIFIED

GE40185 sheet 3 of 3

Figure 8-4. FIELDVUE DVC6205 Base Unit Housing Assembly

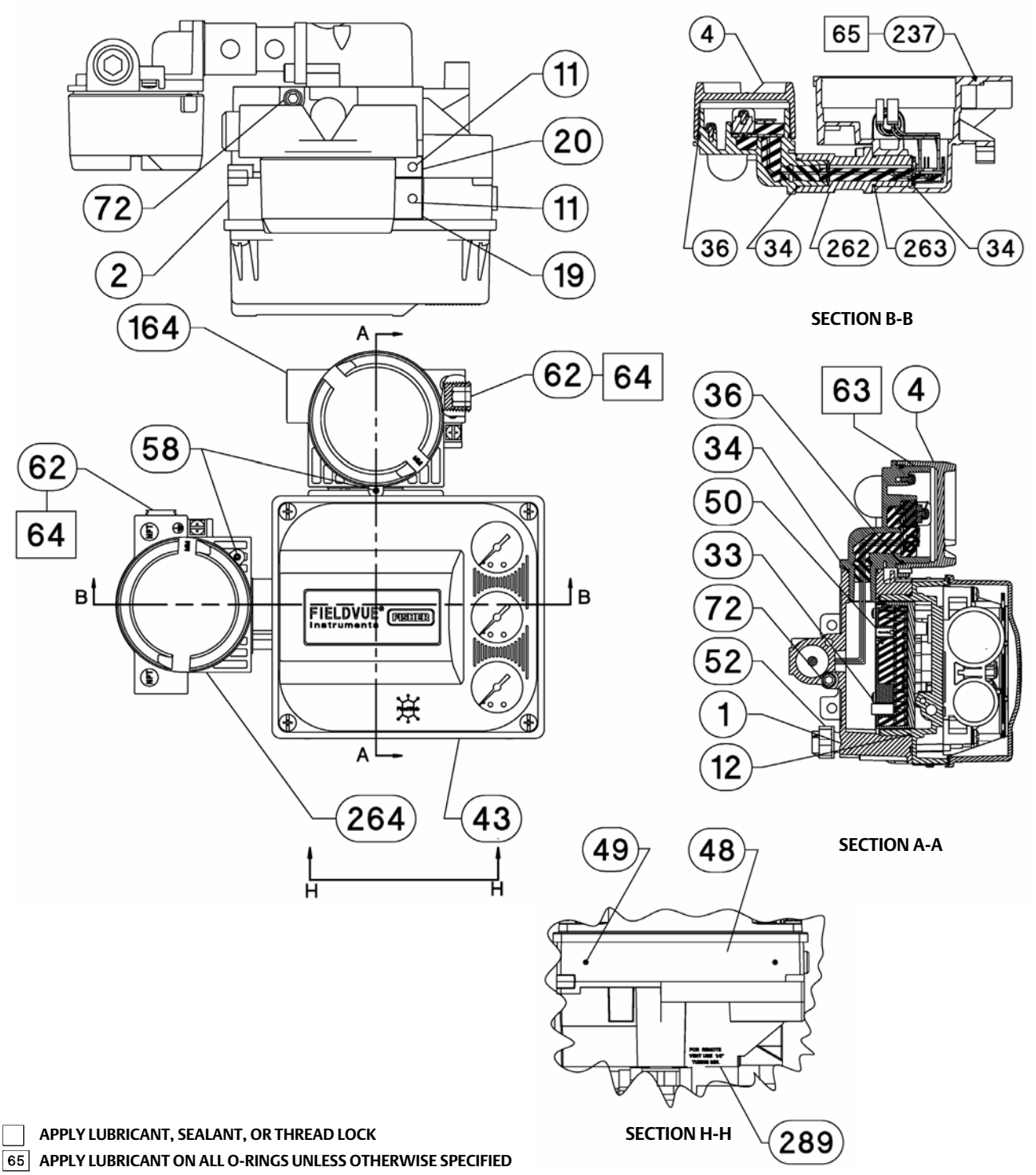
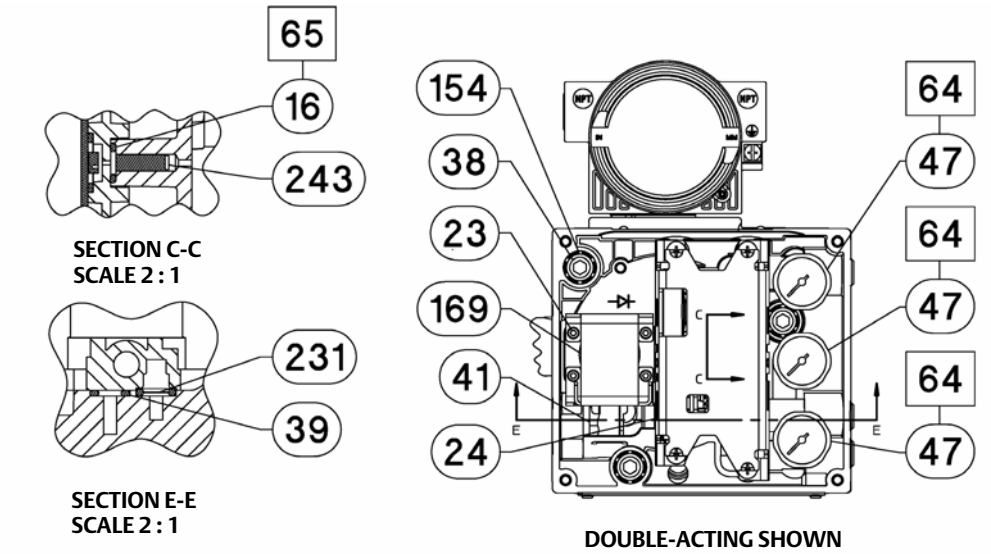
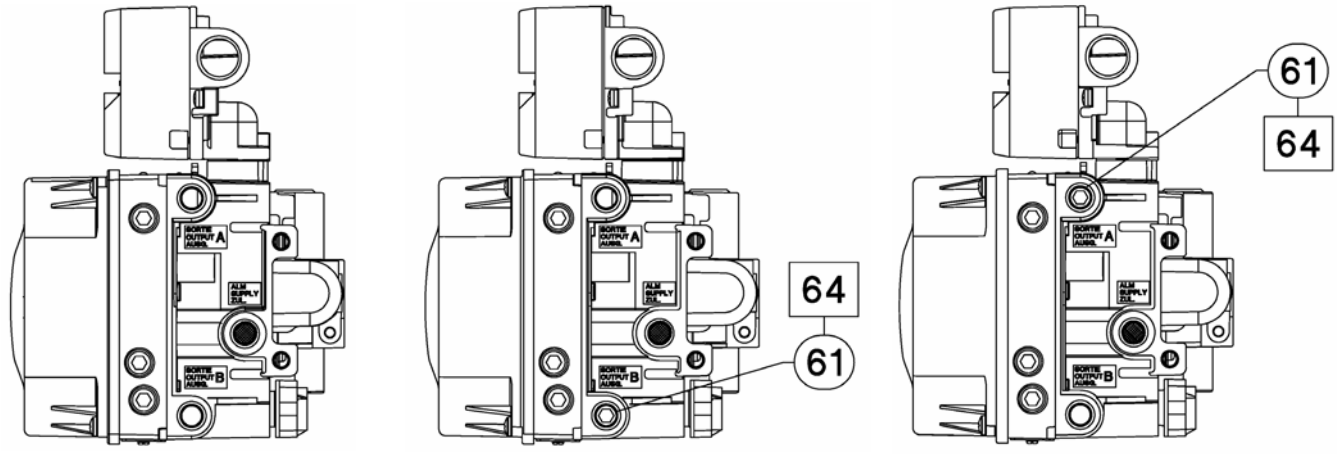


Figure 8-4. FIELDVUE DVC6205 Base Unit Housing Assembly (continued)



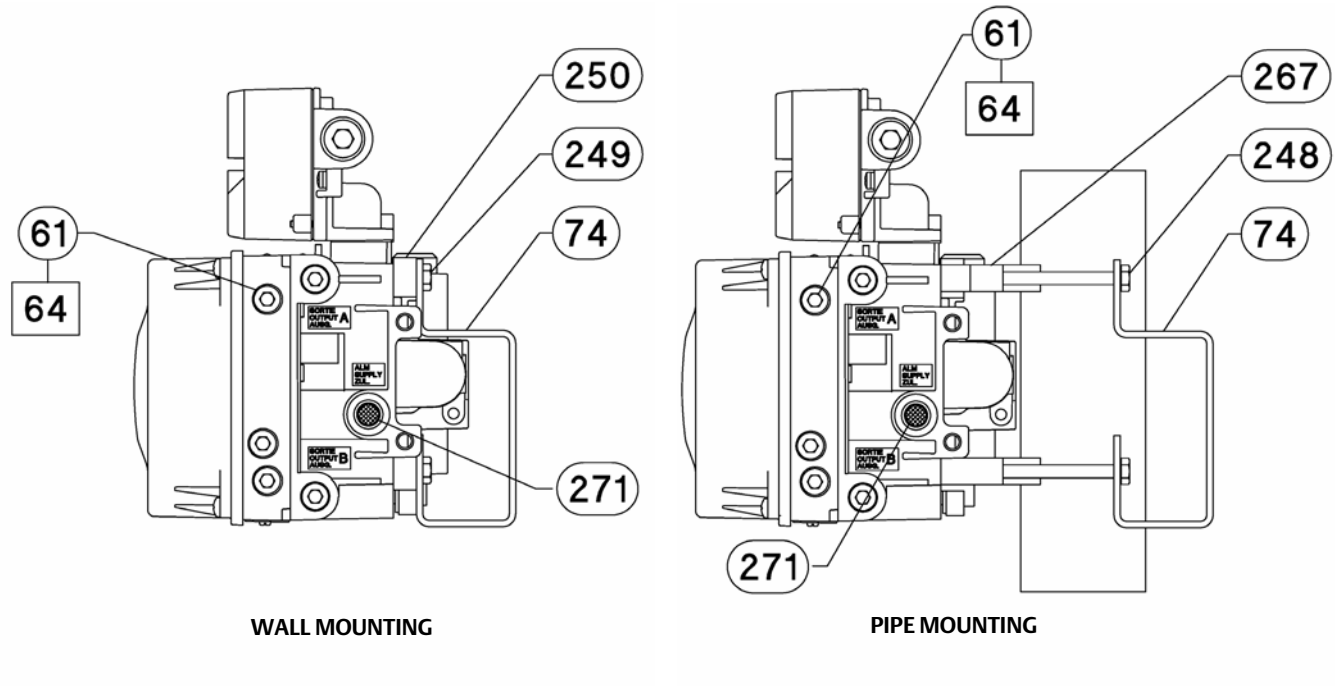


☐ **APPLY LUBRICANT, SEALANT, OR THREAD LOCK**

65 **APPLY LUBRICANT ON ALL O-RINGS UNLESS OTHERWISE SPECIFIED**

GE40181

Figure 8-4. FIELDVUE DVC6205 Base Unit Housing Assembly (continued)

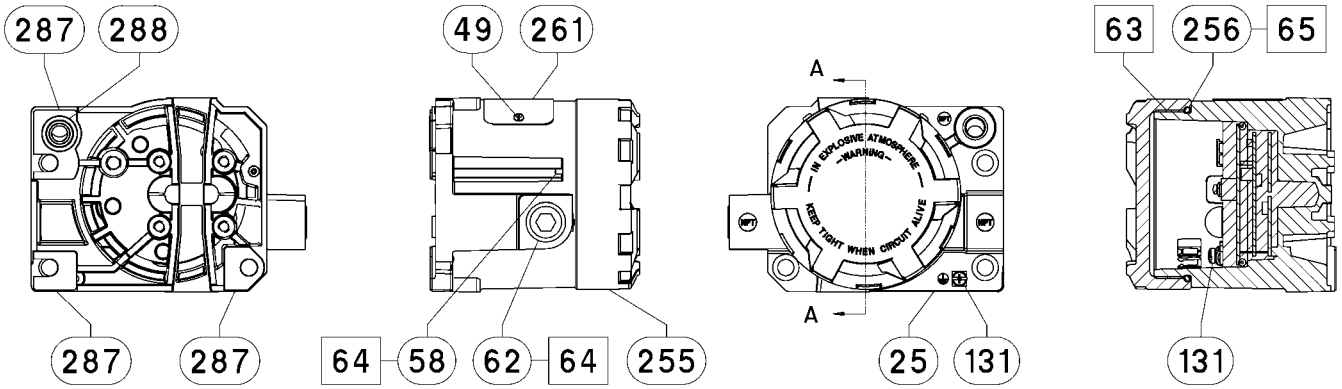


☐ **APPLY LUBRICANT, SEALANT, OR THREAD LOCK**

65 **APPLY LUBRICANT ON ALL O-RINGS UNLESS OTHERWISE SPECIFIED**

GE40181

Figure 8-5. FIELDVUE DVC6215 Remote Feedback Assembly



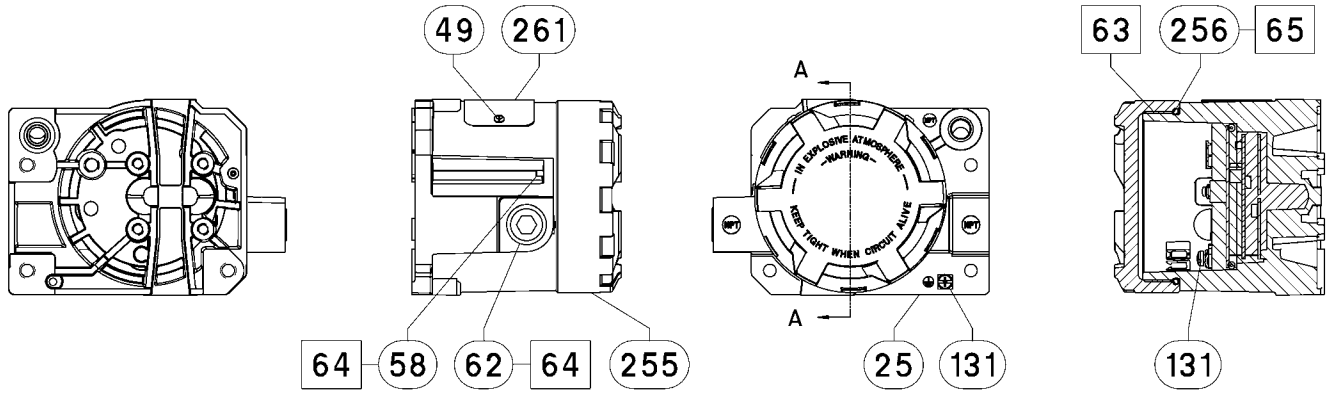
PARTS NOT SHOWN: 158

☐ **APPLY LUBRICANT/SEALANT**

GE46670-B

SECTION A-A

HOUSING A
(USED FOR GX ACTUATOR)



PARTS NOT SHOWN: 158

☐ **APPLY LUBRICANT/SEALANT**

GE40178-B

SECTION A-A

HOUSING B
(USED FOR ALL ACTUATORS EXCEPT GX)

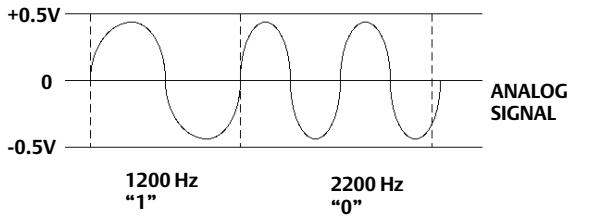
Appendix A Principle of Operation

HART Communication

The HART (Highway Addressable Remote Transducer) protocol gives field devices the capability of communicating instrument and process data digitally. This digital communication occurs over the same two-wire loop that provides the 4-20 mA process control signal, without disrupting the process signal. In this way, the analog process signal, with its faster update rate, can be used for control. At the same time, the HART protocol allows access to digital diagnostic, maintenance, and additional process data. The protocol provides total system integration via a host device.

The HART protocol uses frequency shift keying (FSK). Two individual frequencies of 1200 and 2200 Hz are superimposed over the 4-20 mA current signal. These frequencies represent the digits 1 and 0 (see figure A-1). By superimposing a frequency signal over the 4-20 mA current, digital communication is attained. The average value of the HART signal is zero, therefore no DC value is added to the 4-20 mA signal. Thus, true simultaneous communication is achieved without interrupting the process signal.

Figure A-1. HART Frequency Shift Keying Technique

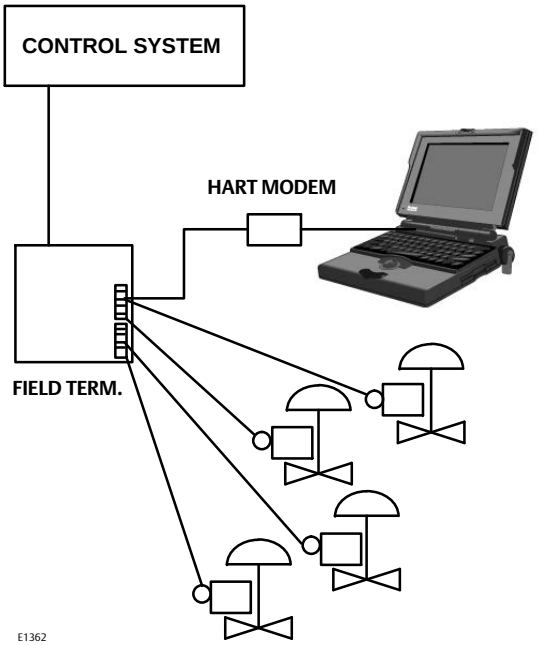


The HART protocol allows the capability of multidropping, i.e., networking several devices to a single communications line. This process is well suited for monitoring remote applications such as pipelines, custody transfer sites, and tank farms. See table 7-2 for instructions on changing the printed wiring board DIP switch configuration to multidrop.

DVC6200 Digital Valve Controller

The DVC6200 digital valve controller housing contains the travel sensor, terminal box, pneumatic input and output connections and a module base that may be easily replaced in the field without disconnecting field wiring or tubing. The module base contains the following submodules: I/P converter, printed wiring board (pwb) assembly, and pneumatic relay. The relay position is detected by sensing the magnet on the relay beam via a detector on the printed wiring board. This sensor is used for the minor loop feedback (MLFB) reading. The module base can be rebuilt by replacing the submodules. See figures A-3 and A-4.

Figure A-2. Typical FIELDVUE Instrument to Personal Computer Connections for ValveLink Software



DVC6200 digital valve controllers are loop-powered instruments that provide a control valve position proportional to an input signal from the control room. The following describes a double-acting digital valve controller mounted on a piston actuator.

The input signal is routed into the terminal box through a single twisted pair of wires and then to the printed wiring board assembly submodule where it is read by the microprocessor, processed by a digital algorithm, and converted into an analog I/P drive signal.

As the input signal increases, the drive signal to the I/P converter increases, increasing the I/P output pressure. The I/P output pressure is routed to the pneumatic relay submodule. The relay is also connected to supply pressure and amplifies the small pneumatic signal from the I/P converter. The relay accepts the amplified pneumatic signal and provides two output pressures. With increasing input (4 to 20 mA signal), the output A pressure always increases and the output B pressure decreases. The output A pressure is used for double-acting and single-acting direct applications. The output B pressure is used for double-acting and single-acting reverse applications. As shown in figure A-3 the increased output A pressure causes the actuator stem to move downward. Stem position is sensed by the non-contact travel feedback sensor. The stem continues to move downward until the correct stem position is attained. At this point the printed wiring board assembly stabilizes the I/P drive signal. This positions the flapper to prevent any further increase in nozzle pressure.

As the input signal decreases, the drive signal to the I/P converter submodule decreases, decreasing the I/P output pressure. The pneumatic relay decreases the output A pressure and increases the output B pressure. The stem moves upward until the correct position is attained. At this point the printed wiring board assembly stabilizes the I/P drive signal. This positions the flapper to prevent any further decrease in nozzle pressure.

Figure A-3. FIELDVUE DVC6200 Digital Valve Controller Block Diagram

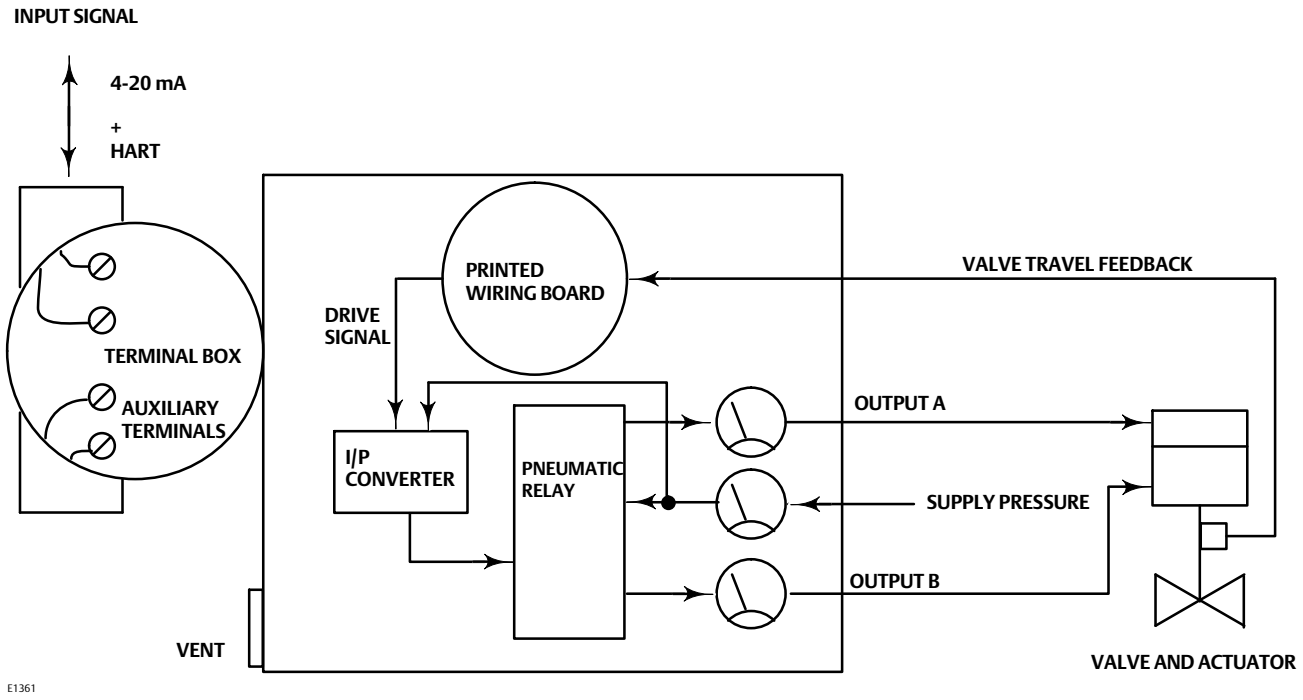
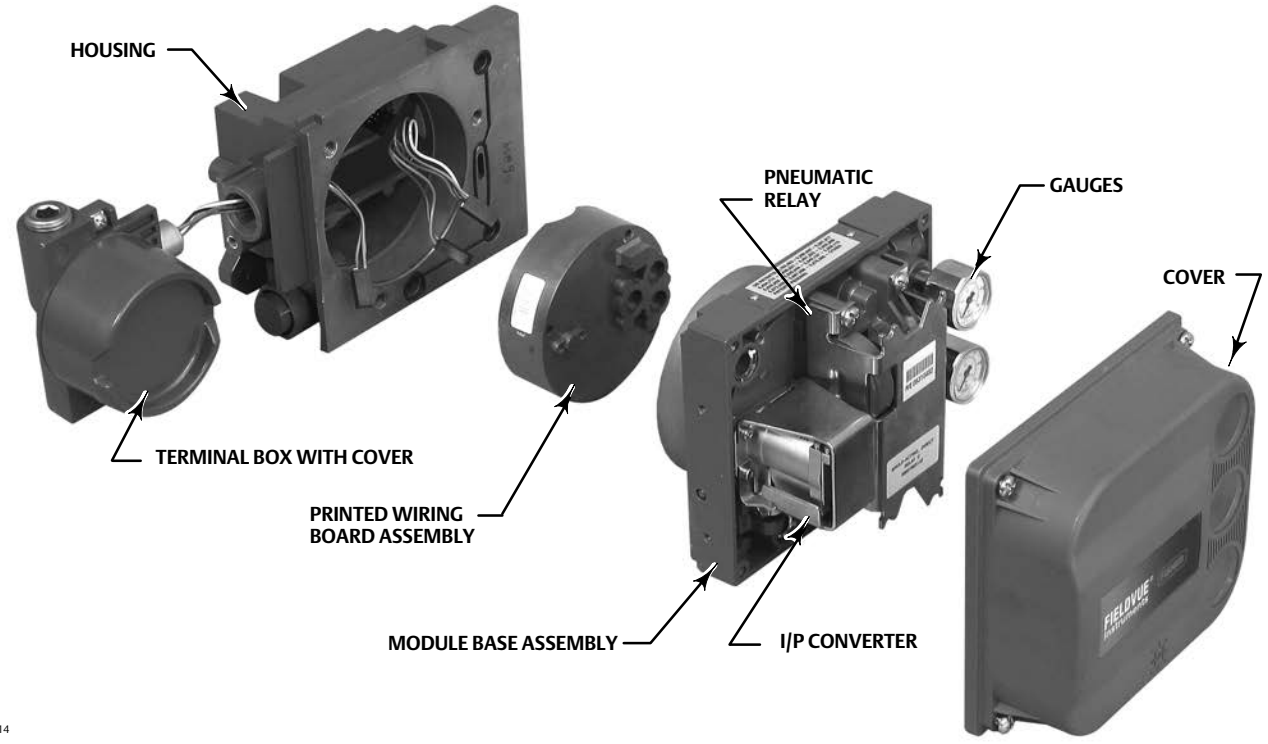


Figure A-4. FIELDVUE DVC6200 Digital Valve Controller Assembly



Appendix B Field Communicator Menu Trees

This section contains the Field Communicator menu trees for instrument level HC, AD, PD, and ODV and instrument level AC. It also contains Fast Key Sequence tables with coordinates to help locate the function/variable on the appropriate menu tree.

Instrument Level HC, AD, PD, and ODV

Function/Variable	Fast-Key Sequence	Coordinates(1)
A minus B	3-5-3	4-G
Actuator Style	1-2-6-4	3-D
Alert Conditions	2-1	2-F
Alert Record Full Enable	1-2-3-6-1	10-H
	1-2-3-7-1	
Alert Record has Entries Enable	1-2-3-6-2	10-H
	1-2-3-7-2	
Analog Input	3-1	2-G
Analog Input Calibration	1-3-2-2	4-E
Analog Input Range Hi	1-2-5-3-1	6-H
Analog Input Range Lo	1-2-5-3-2	6-H
Analog Input Units	1-2-5-2-3	6-G
Auto Calibration	1-3-1-1	4-E
Autocalibration in Progress Enable	1-2-4-2-2	8-H
Auxiliary Input	3-6-1	4-H
	1-2-3-3-1-2	12-D
Auxiliary Terminal Action	1-2-3-3-1-3	12-D
	1-2-5-7	4-G
Auxiliary Terminal Alert Enable	1-2-3-3-1-1	12-D
Burst Command	1-2-1-4-3	6-B
Burst Enable	1-2-1-4-1	6-B
Calibration in Progress Enable	1-2-4-2-1	8-H
Change Cutoffs	1-2-3-4-7-5	12-G
	1-2-2-2-2-3	10-C
Change Travel Limits	1-2-3-4-7-8	12-G
	1-2-2-2-2-6	10-C
Clear ALL Records	1-2-3-6-4	10-H
	1-2-3-7-4	
Command 3 Configured Pressure	1-2-1-4-3	5-A
Control Mode	Hot Key-2	1-A
	1-2-1-2	4-B
Critical NVM Shutdown	1-2-3-1-3-4	12-C
Cutoff Hi	1-2-3-4-7-3	12-F
	1-2-2-2-2-1	10-B
Cutoff Lo	1-2-3-4-7-4	10-F
	1-2-2-2-2-2	10-B
Custom Characteriztion Table	1-2-2-4	4-C
Cycle Counter	1-2-3-5-1-2	12-H
Cycle Counter	3-6-5	4-H
Cycle Count Alert Enable	1-2-3-5-1-1	12-H
Cycle Count Alert Point	1-2-3-5-1-3	12-H
Date	1-2-5-1-4	6-G
Dead Band (Cycle Count / Travel Accumulator)	1-2-3-5-3-1	12-H
Descriptor	1-2-5-1-3	6-F
Device Description Information	3-8	2-G
Device ID	3-7-2	2-H

Function/Variable	Fast-Key Sequence	Coordinates(1)
Device Revision	3-7-5	2-H
Diagnostic Data Available Enable	1-2-4-2-4	8-H
Diagnostic in Progress Enable	1-2-4-2-3	8-H
Drive Current Shutdown	1-2-3-1-1	8-D
Drive Signal Alert Enable	1-2-3-1-2-1	10-D
Drive Signal	3-4	2-G
	1-2-3-1-2-2	10-D
End Point Control Enable(3)	*1-2-2-2-4-1*	8-D
Failure Group Enable	1-2-3-6-5-1	10-I
	1-2-3-7-5-1	
Firmware Revision	3-7-6	2-H
Flash ROM Shutdown	1-2-3-1-3-5	12-C
Hardware Revision	3-7-7	2-H
HART Tag	1-2-5-1-1	6-F
	3-7-1	2-H
HART Universal Revision	3-7-9	2-H
Input Characterization	1-2-2-3	4-C
Instrument Date and Time	1-2-4-1-2	8-G
	1-2-5-8	4-G
Instrument Level	3-7-8	2-H
Instrument Mode	Hot Key-1	1-A
	1-2-1-1	4-B
Instrument Serial Number	1-2-5-1-6	6-G
Instrument Time Invalid Enable	1-2-4-1-1	8-G
Integral Dead Zone	1-2-4-4-4	8-I
	1-2-2-1-2-1	8-B
Integral Enable (Pressure)	1-2-2-1-3-2	8-C
Integral Enable (Travel)	1-2-2-1-1-2	8-A
Integral Gain (Pressure)	1-2-2-1-3-3	8-C
Integral Gain (Travel)	1-2-2-1-1-3	8-A
Integral Limit	1-2-4-4-3	8-I
	1-2-2-1-2-2	8-B
Integrator Saturated Hi Enable	1-2-4-4-1	8-I
Integrator Saturated Lo Enable	1-2-4-4-2	8-I
Last AutoCal Status	1-2-5-9-1	6-H
Last Calibration Type	1-2-5-9-2	6-H
Lead/Lag(3)	*1-2-2-5-3*	5-D
Loop Current Validation Enable(2)	1-2-3-3-3	9-E
Low Power Write Fail Enable	1-2-3-1-3-2	12-B
Manual Calibration	1-3-1-2	4-E
Manufacturer	3-7-3	2-H
	1-2-6-1	3-D
Maximum Recorded Temperature	2-3-1	3-F
	3-6-3	4-H
Maximum Supply Pressure	1-2-5-6	4-G
Message	1-2-5-1-2	6-F

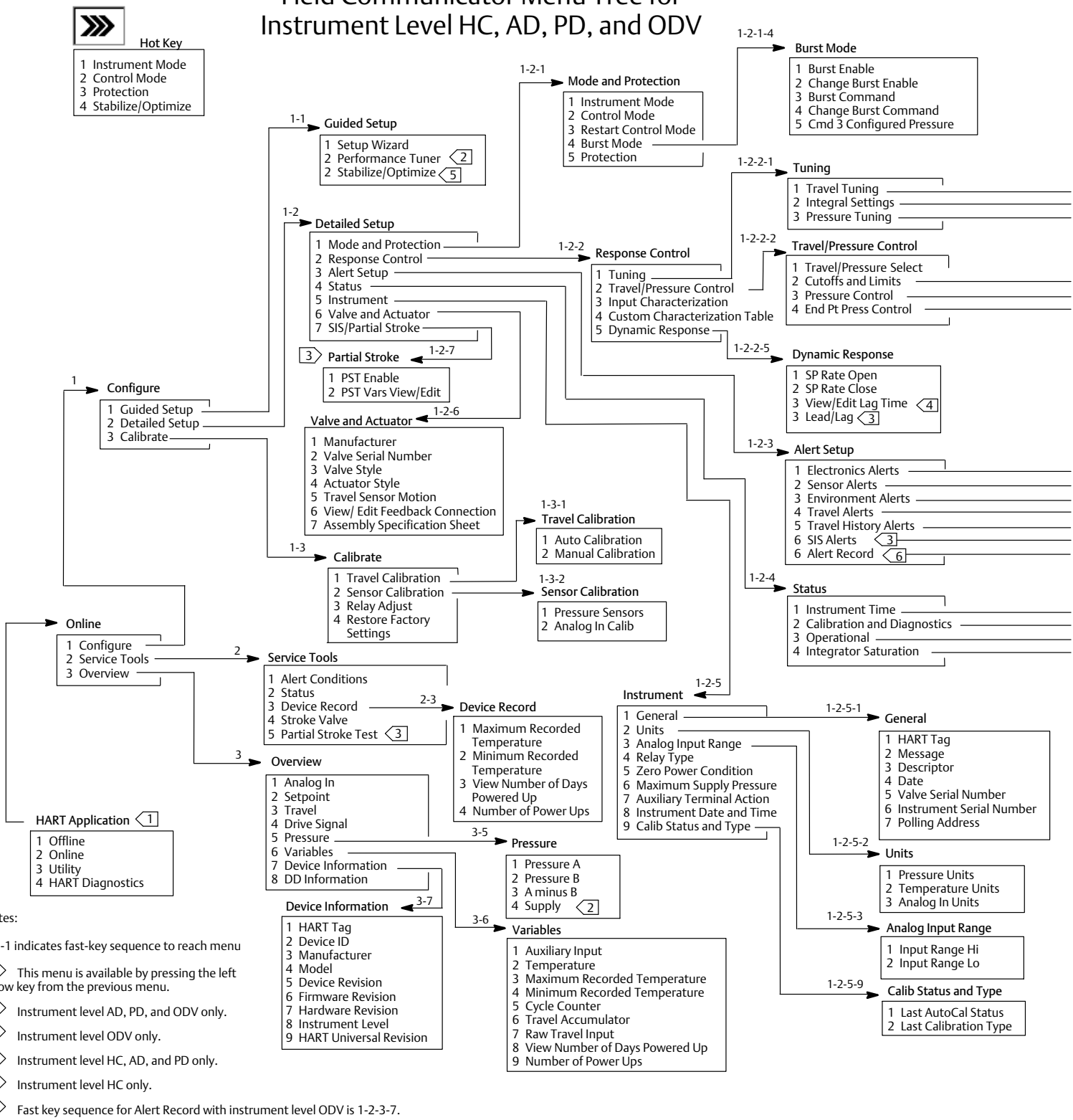
NOTE: *Italicized Fast-Key Sequence* indicates fast-key sequence is applicable only for instrument level ODV.
1. Coordinates are to help locate the item on the menu tree on page 130 and 131.
2. Instrument level AD, PD, and ODV only.
3. Instrument level ODV only.
4. Instrument level HC, AD, and PD only.
5. Instrument level HC only.

Function/Variable	Fast-Key Sequence	Coordinates(1)
Minimum Recorded Temperature	2-3-2	3-F
	3-6-4	4-H
Miscellaneous Group Enable	1-2-3-6-5-3	10-I
	1-2-3-7-5-3	
Model	3-7-4	2-H
Multi-Drop Alert Enable	1-2-4-3-2	8-H
Non-Critical NVM Alert Enable	1-2-3-1-3-3	12-C
Number of Power Ups	2-3-4	4-G
Number of Power Ups	3-6-9	4-H
Offline/Failed Alert Enable	1-2-3-1-3-1	12-B
Partial Stroke Test(3)	*2-5*	2-F
Partial Stroke Test Enable(3)	*1-2-7-1*	3-D
Partial Stroke Test Pressure Limit(3)	*1-2-3-6-1*	10-G
Partial Stroke Test Start Point(3)	*1-2-2-2-5-2*	8-D
Partial Stroke Test Variables View/Edit(3)	*1-2-7-2*	3-D
Performance Tuner(2)	1-1-2	2-B
	1-2-2-1-1-5	8-A
Polling Address	1-2-5-1-7	6-G
Pressure A	3-5-1	4-G
Pressure B	3-5-2	4-G
Pressure Control Active Enable	1-2-4-3-1	8-H
Pressure Deviation Alert Enable(3)	*1-2-3-6-2*	10-G
Pressure Deviation Alert Point(3)	*1-2-3-6-3*	10-G
Pressure Deviation Time(3)	*1-2-3-6-4*	10-G
Pressure Range Hi	1-2-2-2-3-1	10-D
Pressure Range Lo	1-2-2-2-3-2	10-D
Pressure Sat Time(3)	*1-2-2-2-4-4*	8-D
Pressure Sensor Shutdown(2)	1-2-3-2-3	12-C
Pressure Sensors—Calibration	1-3-2-1	4-E
Pressure Set Point(3)	*1-2-2-2-5-3*	8-D
Pressure Tuning Set	1-2-2-1-3-1	10-B
Pressure Units	1-2-5-2-1	6-G
Protection	Hot Key-3	1-A
	1-2-1-5	4-B
Raw Travel Input	3-6-7	4-H
Reference Voltage Shutdown	1-2-3-1-3-7	12-C
Relay Adjust	1-3-3	3-E
Relay Type	1-2-5-4	4-F
Restart Control Mode	1-2-1-3	4-B
Restore Factory Settings	1-3-4	3-E
Setpoint (Travel)	1-2-3-4-2	9-E
	3-2	2-G
Set Point Rate Close	1-2-2-5-2	5-D
Set Point Rate Open	1-2-2-5-1	5-D
Setup Wizard	1-1-1	2-B
Stabilize/Optimize	Hot Key-4	1-A
	1-1-2(5)	2-B
	1-2-2-1-1-4	8-A

Function/Variable	Fast-Key Sequence	Coordinates(1)
Status	2-2	2-F
Stroke Valve	2-4	2-F
Supply(2)	3-5-4	4-G
	1-2-3-3-2-2	12-D
Supply Pressure Lo Alert Enable(2)	1-2-3-3-2-1	12-D
Supply Pressure Lo Alert Point(2)	1-2-3-3-2-3	12-D
Temperature	3-6-2	4-H
Temperature Sensor Shutdown	1-2-3-2-2	12-C
Temperature Units	1-2-5-2-2	6-G
Travel	3-3	2-G
	1-2-3-4-1	9-E
Travel / Pressure Select	1-2-2-2-1	5-C
Travel Accumulator	3-6-6	4-H
	1-2-3-5-3-2	12-H
Travel Accumulator Alert Enable	1-2-3-5-3-1	12-I
Travel Accumulator Alert Point	1-2-3-5-3-3	12-I
Travel Alert Dead Band	1-2-3-4-3	9-E
Travel Alert Hi Enable	1-2-3-4-6-1	10-F
Travel Alert Hi Hi Enable	1-2-3-4-5-1	12-E
Travel Alert Hi Hi Point	1-2-3-4-5-3	12-F
Travel Alert Hi Point	1-2-3-4-6-3	10-F
Travel Alert Lo Enable	1-2-3-4-6-2	10-F
Travel Alert Lo Lo Enable	1-2-3-4-5-2	12-E
Travel Alert Lo Lo Point	1-2-3-4-5-4	12-F
Travel Alert Lo Point	1-2-3-4-6-4	10-F
Travel Deviation Alert Enable	1-2-3-4-4-1	10-E
Travel Deviation Alert Point	1-2-3-4-4-2	10-E
Travel Deviation Time	1-2-3-4-4-3	10-E
Travel Limit/Cutoff Hi Alert Enable	1-2-3-4-7-1	12-F
Travel Limit/Cutoff Lo Alert Enable	1-2-3-4-7-2	12-F
Travel Limit Hi	1-2-3-4-7-6	12-G
	1-2-2-2-2-4	10-C
Travel Limit Lo	1-2-3-4-7-7	12-G
	1-2-2-2-2-3	10-C
Travel Sensor Motion	1-2-6-5	3-E
Travel Sensor Shutdown	1-2-3-2-1	12-C
Travel Tuning Set	1-2-2-1-1-1	10-A
Valve Group Enable	1-2-3-6-5-2	10-I
	1-2-3-7-5-2	
Valve Serial Number	1-2-5-1-5	6-F
	1-2-6-2	3-D
Valve Style	1-2-6-3	3-D
View Alert Records	1-2-3-6-3	10-H
	1-2-3-7-3	
View/Edit Feedback Connection	1-2-6-6	3-E
View/Edit Lag Time(4)	1-2-2-5-3	5-D
View Number of Days Powered Up	2-3-3	3-F
	3-6-8	4-I
Zero Power Condition	1-2-5-5	4-G

NOTE: *Italicized Fast-Key Sequence* indicates fast-key sequence is applicable only for instrument level ODV.
1. Coordinates are to help locate the item on the menu tree on page 130 and 131.
2. Instrument level AD, PD, and ODV only.
3. Instrument level ODV only.
4. Instrument level HC, AD, and PD only.
5. Instrument level HC only.

Field Communicator Menu Tree for Instrument Level HC, AD, PD, and ODV



Notes:

1-1-1 indicates fast-key sequence to reach menu

1 This menu is available by pressing the left arrow key from the previous menu.

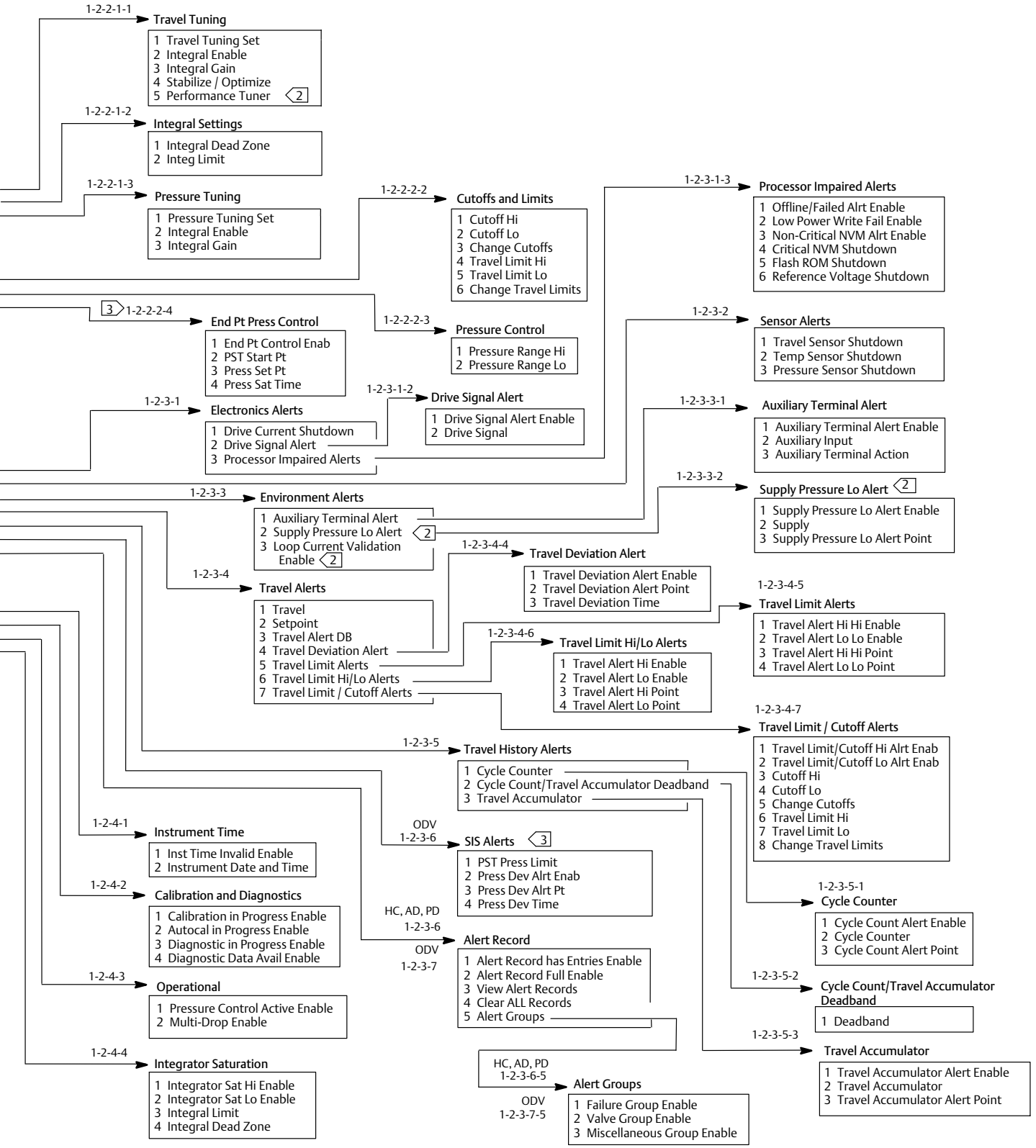
2 Instrument level AD, PD, and ODV only.

3 Instrument level ODV only.

4 Instrument level HC, AD, and PD only.

5 Instrument level HC only.

6 Fast key sequence for Alert Record with instrument level ODV is 1-2-3-7.

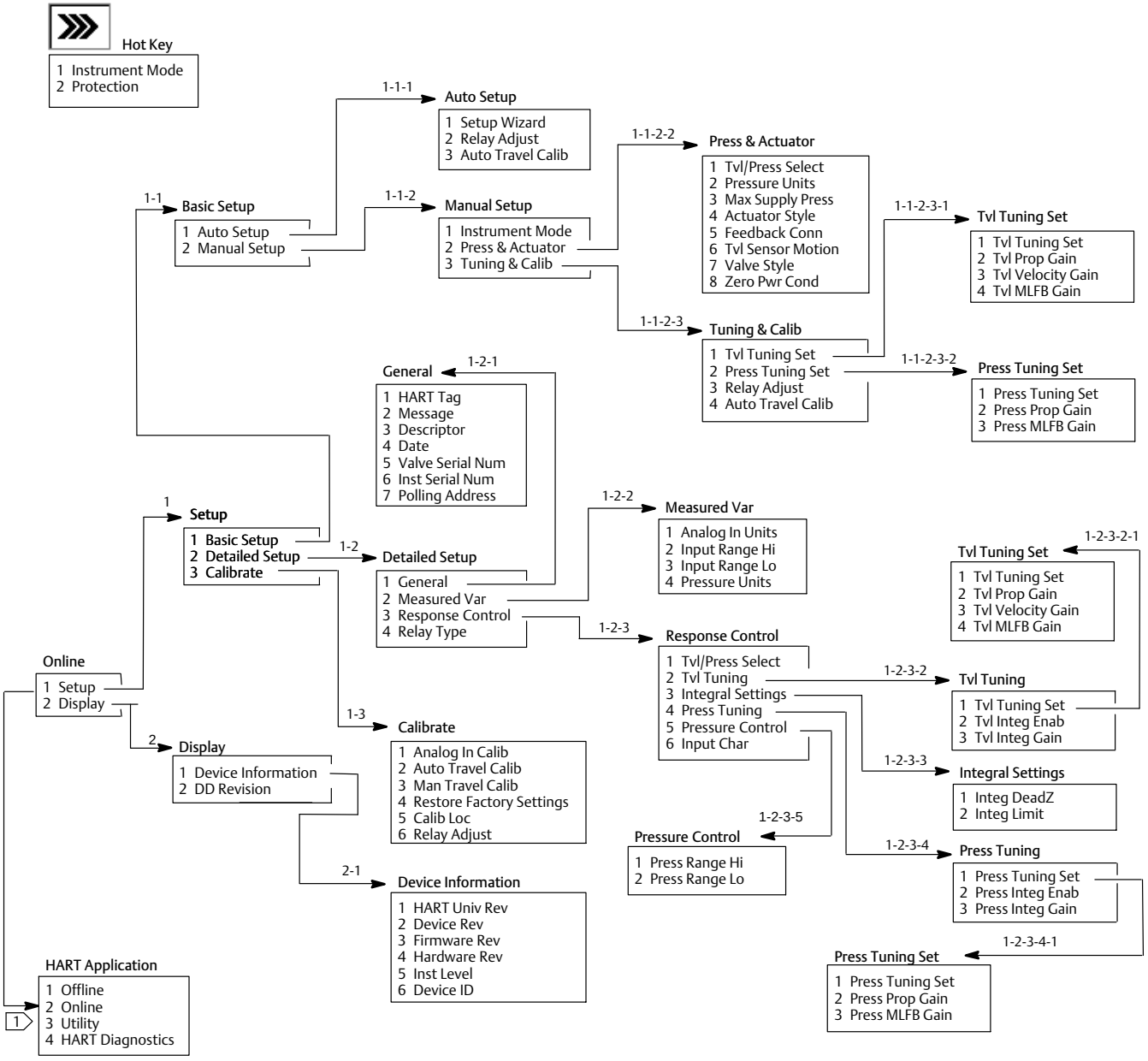

1-2-2-1-1
Travel Tuning
1 Travel Tuning Set
2 Integral Enable
3 Integral Gain
4 Stabilize / Optimize
5 Performance Tuner 2
1-2-2-1-2
Integral Settings
1 Integral Dead Zone
2 Integ Limit
1-2-2-1-3
Pressure Tuning
1 Pressure Tuning Set
2 Integral Enable
3 Integral Gain
1-2-2-2-2
Cutoffs and Limits
1 Cutoff Hi
2 Cutoff Lo
3 Change Cutoffs
4 Travel Limit Hi
5 Travel Limit Lo
6 Change Travel Limits
1-2-3-1-3
Processor Impaired Alerts
1 Offline/Failed Alrt Enable
2 Low Power Write Fail Enable
3 Non-Critical NVM Alrt Enable
4 Critical NVM Shutdown
5 Flash ROM Shutdown
6 Reference Voltage Shutdown
3 1-2-2-2-4
End Pt Press Control
1 End Pt Control Enab
2 PST Start Pt
3 Press Set Pt
4 Press Sat Time
1-2-2-2-3
Pressure Control
1 Pressure Range Hi
2 Pressure Range Lo
1-2-3-2
Sensor Alerts
1 Travel Sensor Shutdown
2 Temp Sensor Shutdown
3 Pressure Sensor Shutdown
1-2-3-1-2
Drive Signal Alert
1 Drive Signal Alert Enable
2 Drive Signal
1-2-3-1
Electronics Alerts
1 Drive Current Shutdown
2 Drive Signal Alert
3 Processor Impaired Alerts
1-2-3-3-1
Auxiliary Terminal Alert
1 Auxiliary Terminal Alert Enable
2 Auxiliary Input
3 Auxiliary Terminal Action
1-2-3-3-2
Supply Pressure Lo Alert 2
1 Supply Pressure Lo Alert Enable
2 Supply
3 Supply Pressure Lo Alert Point
1-2-3-3
Environment Alerts
1 Auxiliary Terminal Alert
2 Supply Pressure Lo Alert 2
3 Loop Current Validation Enable 2
1-2-3-4-4
Travel Deviation Alert
1 Travel Deviation Alert Enable
2 Travel Deviation Alert Point
3 Travel Deviation Time
1-2-3-4
Travel Alerts
1 Travel
2 Setpoint
3 Travel Alert DB
4 Travel Deviation Alert
5 Travel Limit Alerts
6 Travel Limit Hi/Lo Alerts
7 Travel Limit / Cutoff Alerts
1-2-3-4-5
Travel Limit Alerts
1 Travel Alert Hi Hi Enable
2 Travel Alert Lo Lo Enable
3 Travel Alert Hi Hi Point
4 Travel Alert Lo Lo Point
1-2-3-4-6
Travel Limit Hi/Lo Alerts
1 Travel Alert Hi Enable
2 Travel Alert Lo Enable
3 Travel Alert Hi Point
4 Travel Alert Lo Point
1-2-3-4-7
Travel Limit / Cutoff Alerts
1 Travel Limit/Cutoff Hi Alrt Enab
2 Travel Limit/Cutoff Lo Alrt Enab
3 Cutoff Hi
4 Cutoff Lo
5 Change Cutoffs
6 Travel Limit Hi
7 Travel Limit Lo
8 Change Travel Limits
1-2-3-5
Travel History Alerts
1 Cycle Counter
2 Cycle Count/Travel Accumulator Deadband
3 Travel Accumulator
1-2-4-1
Instrument Time
1 Inst Time Invalid Enable
2 Instrument Date and Time
ODV
1-2-3-6
SIS Alerts 3
1 PST Press Limit
2 Press Dev Alrt Enab
3 Press Dev Alrt Pt
4 Press Dev Time
1-2-3-5-1
Cycle Counter
1 Cycle Count Alert Enable
2 Cycle Counter
3 Cycle Count Alert Point
1-2-4-2
Calibration and Diagnostics
1 Calibration in Progress Enable
2 Autocal in Progress Enable
3 Diagnostic in Progress Enable
4 Diagnostic Data Avail Enable
HC, AD, PD
1-2-3-6
ODV
1-2-3-7
Alert Record
1 Alert Record has Entries Enable
2 Alert Record Full Enable
3 View Alert Records
4 Clear ALL Records
5 Alert Groups
1-2-3-5-2
Cycle Count/Travel Accumulator Deadband
1 Deadband
1-2-4-3
Operational
1 Pressure Control Active Enable
2 Multi-Drop Enable
1-2-3-5-3
Travel Accumulator
1 Travel Accumulator Alert Enable
2 Travel Accumulator
3 Travel Accumulator Alert Point
1-2-4-4
Integrator Saturation
1 Integrator Sat Hi Enable
2 Integrator Sat Lo Enable
3 Integral Limit
4 Integral Dead Zone
HC, AD, PD
1-2-3-6-5
Alert Groups
ODV
1-2-3-7-5
1 Failure Group Enable
2 Valve Group Enable
3 Miscellaneous Group Enable

Instrument Level AC

Function/Variable	Fast-Key Sequence	Coordinates(1)
Actuator Style	1-1-2-2-4	4-C
Analog Input Calibration	1-3-1	3-F
Analog Input Range Hi	1-2-2-2	4-E
Analog Input Range Lo	1-2-2-3	4-E
Analog Input Units	1-2-2-1	4-E
Auto Travel Calibration	1-1-2-3-4	4-D
	1-3-2	3-F
	1-1-1-3	3-C
Calibration Location	1-3-5	3-G
Date	1-2-1-4	3-D
Descriptor	1-2-1-3	3-D
Device Description Revision	2-2	2-F
Device Identification	2-1-6	3-H
Device Revision	2-1-2	3-G
Feedback Connection	1-1-2-2-5	4-C
Firmware Revision	2-1-3	3-G
Hardware Revision	2-1-4	3-G
HART Tag	1-2-1-1	3-D
HART Universal Revision	2-1-1	3-G
Input Characterization	1-2-3-6	4-F
Instrument Level	2-1-5	3-H
Instrument Mode	Hot Key-1	1-B
	1-1-2-1	3-C
Instrument Serial Number	1-2-1-6	3-D
Integral Dead Zone	1-2-3-3-1	6-F
Integral Limit	1-2-3-3-2	6-F
Manual Travel Calibration	1-3-3	3-F
Maximum Supply Pressure	1-1-2-2-3	4-C
Message	1-2-1-2	3-D
Polling Address	1-2-1-7	3-E
Pressure Integral Control Enable	1-2-3-4-2	6-G
Pressure Integral Gain	1-2-3-4-3	6-G
Pressure MLFB Gain	1-1-2-3-2-3	6-D
	1-2-3-4-1-3	5-H
Pressure Proportional Gain	1-1-2-3-2-2	6-D
	1-2-3-4-1-2	5-H
Pressure Range Hi	1-2-3-5-1	4-G
Pressure Range Lo	1-2-3-5-2	4-G
Pressure Tuning Set	1-1-2-3-2-1	6-D
	1-2-3-4-1-1	6-G
Pressure Units	1-1-2-2-2	4-C
	1-2-2-4	4-E
Protection	Hot Key-2	1-B
Relay Adjust	1-1-1-2	3-B
	1-1-2-3-3	4-D
	1-3-6	3-G
Relay Type	1-2-4	3-E
Restore Factory Settings	1-3-4	3-F
Setup Wizard	1-1-1-1	3-D
Travel Integral Gain	1-2-3-2-3	6-F
Travel Integral Enable	1-2-3-2-2	6-F
Travel MLFB Gain	1-1-2-3-1-4	6-C
	1-2-3-2-1-4	6-E
Travel / Pressure Select	1-1-2-2-1	4-C
	1-2-3-1	4-F
Travel Proportional Gain	1-1-2-3-1-2	6-C
Travel Sensor Adjust	1-3-7	3-G
Travel Sensor Motion	1-1-2-2-6	4-C
Travel Tuning Set	1-1-2-3-1-1	6-C
	1-2-3-2-1-1	6-E
Travel Velocity Gain	1-1-2-3-1-3	6-C
	1-2-3-2-1-3	6-E
Valve Serial Number	1-2-1-5	3-D
Valve Style	1-1-2-2-7	4-C
Zero Power Condition	1-1-2-2-8	4-C

1. Coordinates are to help locate the item on the menu tree on page 133.

Field Communicator Menu Tree for Instrument Level AC



Notes:

1-1-1 indicates fast-key sequence to reach menu

1 This menu is available by pressing the left arrow key from the previous menu.

Glossary

Alert Point
An adjustable value that, when exceeded, activates an alert.

Algorithm
A set of logical steps to solve a problem or accomplish a task. A computer program contains one or more algorithms.

Alphanumeric
Consisting of letters and numbers.

Analog Input Units
Units in which the analog input is displayed and maintained in the instrument.

ANSI (acronym)
The acronym ANSI stands for the American National Standards Institute

ANSI Class
Valve pressure/temperature rating.

Auxiliary Input Alert
Checks the status of the auxiliary input; a discrete input. When enabled, the Auxiliary Input Alert is active when the auxiliary input terminals are open or closed (shorted), depending upon the selection for Auxiliary Input Alert State.

Auxiliary Terminal (Indicator)
Indicates whether auxiliary wiring terminals are open or closed (such as by an external switch contact).

Bench Set
Pressure, supplied to an actuator, required to drive the actuator through rated valve travel. Expressed in pounds per square inch.

Byte
A unit of binary digits (bits). A byte consists of eight bits.

Calibration Location
Where the instrument was last calibrated; either in the factory or in the field.

Configuration
Stored instructions and operating parameters for a FIELDVUE Instrument.

Control Loop
An arrangement of physical and electronic components for process control. The electronic components of the loop continuously measure one or more aspects of the process, then alter those aspects as necessary to achieve a desired process condition. A simple control loop measures only one variable. More sophisticated control loops measure many variables and maintain specified relationships among those variables.

Control Mode
Defines where the instrument reads its set point. The following control modes are available for a FIELDVUE Instrument:
Analog The instrument receives its travel set point over the 4-20 mA loop.
Digital The instrument receives its set point digitally, via the HART communications link.
Test This is not a user-selectable mode. The Field Communicator or ValveLink software places the instrument in this mode whenever it needs to move the valve, such as for calibration or diagnostic tests.

Control Mode, Restart
Determines the instrument control mode after a restart. See Control Mode for the available restart control modes.

Controller
A device that operates automatically to regulate a controlled variable.

Current-to-Pressure (I/P) Converter

An electronic component or device that converts a milliamp signal to a proportional pneumatic pressure output signal.

Cycle Counter

The capability of a FIELDVUE instrument to record the number of times the travel changes direction. The change in direction must occur after the deadband has been exceeded before it can be counted as a cycle.

Cycle Counter Alert

Checks the difference between the Cycle Counter and the Cycle Counter Alert Point. Cycle Counter Alert is active when the cycle counter value exceeds the Cycle Counter Alert Point. It clears after you reset the Cycle Counter to a value less than the alert point.

Cycle Counter Alert Point

An adjustable value which, when exceeded, activates the Cycle Counter Alert. Valid entries are 0 to 4 billion cycles.

Cycle Counter Deadband

Region around the travel reference point, in percent of ranged travel, established at the last increment of the Cycle Counter. The deadband must be exceeded before a change in travel can be counted as a cycle. Valid entries are 0% to 100%. Typical value is between 2% and 5%.

Deviation

Usually, the difference between set point and process variable. More generally, any departure from a desired or expected value or pattern.

Device ID

Unique identifier embedded in the instrument at the factory.

Device Revision

Revision number of the interface software that permits communication between the Field Communicator and the instrument.

Drive Signal

The signal to the I/P converter from the printed wiring board. It is the percentage of the total microprocessor effort needed to drive the valve fully open.

Drive Signal Alert

Checks the drive signal and calibrated travel. If one of the following conditions exists for more than 20 seconds, the Drive Signal Alert is active. If none of the conditions exist, the alert is cleared.
If Zero Power Condition = Closed

The alert is active when:

drive signal <10% and calibrated travel >3%

drive signal >90% and calibrated travel <97%

If Zero Power Condition = Open

The alert is active when:

drive signal <10% and calibrated travel <97%

drive signal >90% and calibrated travel >3%

Equal Percentage

A valve flow characteristic where equal increments of valve stem travel produce equal percentage changes in existing flow. One of the input characteristics available for a FIELDVUE Instrument. See also, Linear and Quick Opening.

Feedback Signal

Indicates to the instrument the actual position of the valve. The travel sensor provides the feedback signal to the instrument printed wiring board assembly.

Firmware Revision

The revision number of the instrument firmware. Firmware is a program that is entered into the instrument at time of manufacture and cannot be changed by the user.

Free Time

Percent of time that the microprocessor is idle. A typical value is 25%. The actual value depends on the number of functions in the instrument that are enabled and on the amount of communication currently in progress.

Full Ranged Travel
Current, in mA, that corresponds with the point where ranged travel is maximum, i.e., limited by the mechanical travel stops.

Gain
The ratio of output change to input change.

Hardware Revision
Revision number of the Fisher Controls instrument hardware. The physical components of the instrument are defined as the hardware.

HART (acronym)
The acronym HART stands for Highway Addressable Remote Transducer.

HART Tag
An eight-character name that identifies the physical instrument.

HART Universal Revision
Revision number of the HART Universal Commands which are the communications protocol for the instrument.

Input Characteristic
The relationship between the ranged travel and ranged input. Possible values include: linear, equal percentage, and quick opening.

Input Current
The current signal from the control system that serves as the analog input to the instrument. See also Input Signal.

Input Range
The analog input signal range that corresponds to the travel range.

Input Signal
The current signal from the control system. The input signal can be displayed in milliamperes or in percent of ranged input.

Instrument Level
Determines the functions available for the instrument. See table 6-2, page 95.

Instrument Mode
Determines if the instrument responds to its analog input signal. There are two instrument modes:
In Service: For a fully functioning instrument, the instrument output changes in response to analog input changes. Typically changes to setup or calibration cannot be made when the instrument mode is In Service.
Out of Service: The instrument output does not change in response to analog input changes when the instrument mode is Out of Service. Some setup parameters can be changed only when the instrument mode is Out of Service.

Instrument Protection
Determines if commands from a HART device can calibrate and/or configure certain parameters in the instrument. There are two types of instrument protection:
Configuration and Calibration: Prohibits changing protected setup parameters; prohibits calibration.
None: Permits both configuration and calibration. The instrument is "unprotected."

Instrument Serial Number
The serial number assigned to the printed wiring board by the factory but can be changed during setup. The instrument serial number should match the serial number on the instrument nameplate.

Leak Class
Defines the allowable leakage by a valve when it is closed. Leak class numbers are listed in two standards: ANSI/FCI 70-2 and IEC 534-4.

Linear
A valve flow characteristic where changes in flow rate are directly proportional to changes in valve stem travel. One of the input characteristics available for a FIELDVUE Instrument. See also, Equal Percentage and Quick Opening.

Linearity, dynamic
Linearity (independent) is the maximum deviation from a straight line best fit to the opening and closing curves and a line representing the average value of those curves.

Memory
A type of semiconductor used for storing programs or data. FIELDVUE instruments use three types of memory: Random Access Memory (RAM), Read Only Memory (ROM), and Non-Volatile Memory (NVM). See also these listings in this glossary.

Menu
A list of programs, commands, or other activities that you select by using the arrow keys to highlight the item then pressing ENTER, or by entering the numeric value of the menu item.

Minimum Closing Time
Minimum time, in seconds, for the travel to decrease through the entire ranged travel. This rate is applied to any travel decrease. Valid entries are 0 to 400 seconds. Deactivate by entering a value of 0 seconds.

Minimum Opening Time
Minimum time, in seconds, for the travel to increase through the entire ranged travel. This rate is applied to any travel increase. Because of friction, actual valve travel may not respond in exactly the same time frame. Valid entries are 0 to 400 seconds. Deactivate by entering a value of 0 seconds.

Non-Volatile Memory (NVM)
A type of semiconductor memory that retains its contents even though power is disconnected. NVM contents can be changed during configuration unlike ROM which can be changed only at time of instrument manufacture. NVM stores configuration restart data.

Parallel
Simultaneous: said of data transmission on two or more channels at the same time.

Polling Address
Address of the instrument. If the digital valve controller is used in a point-to-point configuration, set the polling address to 0. If it is used in a multidrop configuration, or split range application, set the polling address to a value from 0 to 15.

Pressure Sensor
A FIELDVUE instrument internal device that senses pneumatic pressure. The DVC6200 has three pressure sensors: one to sense supply pressure and two to sense the output pressures.

Primary Master
Masters are communicating devices. A primary master is a communicating device permanently wired to a field instrument. Typically, a HART-compatible control system or a computer running ValveLink software is the primary master.

In contrast, a secondary master is not often permanently wired to a field instrument. The Field Communicator or a computer running ValveLink software communicating through a HART modem could be considered a secondary master.

Note: If one type of master takes an instrument Out Of Service, the same type must put it In Service. For example, if a device set up as a primary master takes an instrument Out Of Service, a device set up as a primary master must be used to place the instrument In Service.

Quick Opening
A valve flow characteristic where most of the change in flow rate takes place for small amounts of stem travel from the closed position. The flow characteristic curve is basically linear through the first 40 percent of stem travel. One of the input characteristics available for a FIELDVUE Instrument. See also, Equal Percentage and Linear.

Random Access Memory (RAM)
A type of semiconductor memory that is normally used by the microprocessor during normal operation that permits rapid retrieval and storage of programs and data. See also Read Only Memory (ROM) and Non-Volatile Memory (NVM).

Rate
Amount of change in output proportional to the rate of change in input.

Read-Only Memory (ROM)
A memory in which information is stored at the time of instrument manufacture. You can examine but not change ROM contents.

Seat Load
Force exerted on the valve seat, typically expressed in pounds force per lineal inch of port circumference. Seat load is determined by shutoff requirements.

Set Point Filter Time (Lag Time)
The time constant, in seconds, for the first-order input filter. The default of 0 seconds will bypass the filter.

Software
Microprocessor or computer programs and routines that reside in alterable memory (usually RAM), as opposed to firmware, which consists of programs and routines that are programmed into memory (usually ROM) when the instrument is manufactured. Software can be manipulated during normal operation, firmware cannot.

Stroking Time
The time, in seconds, required to move the valve from its fully open position to fully closed, or vice versa.

Temperature Sensor
A device within the FIELDVUE instrument that measures the instrument's internal temperature.

Travel
Movement of the valve stem or shaft which changes the amount the valve is open or closed.

Travel Accumulator
The capability of a FIELDVUE instrument to record total change in travel. The value of the Travel Accumulator increments when the magnitude of the change exceeds the Travel Accumulator Deadband. To reset the Travel Accumulator, set it to zero.

Travel Accumulator Alert
Checks the difference between the Travel Accumulator value and the Travel Accumulator Alert Point. The Travel Accumulator Alert is active when the Travel Accumulator value exceeds the Travel Accumulator Alert Point. It clears after you reset the Travel Accumulator to a value less than the alert point.

Travel Accumulator Alert Point
An adjustable value which, when exceeded, activates the Travel Accumulator Alert. Valid entries are 0% to 4 billion %.

Travel Accumulator Deadband
Region around the travel reference point established at the last increment of the accumulator. This region must be exceeded before a change in travel can be accumulated. Valid entries are 0% to 100%.

Travel Alert
Checks the ranged travel against the travel high and low alert points. The travel alert is active if either the high or low point is exceeded. Once a high or low point is exceeded, the ranged travel must clear that point by the Travel Alert Deadband before the alert clears. Four travel alerts are available: Travel Alert Hi, Travel Alert Lo, Travel Alert Hi Hi, and Travel Alert Lo Lo.

Travel Alert Deadband
Travel, in percent of ranged travel, required to clear a travel alert, once it is active. Valid entries are -25% to 125%.

Travel Alert High Point
Value of the travel, in percent of ranged travel, which, when exceeded, sets the Travel Alert Hi alert. Valid entries are -25% to 125%.

Travel Alert High High Point

Value of the travel, in percent of ranged travel, which, when exceeded, sets the Travel Alert Hi Hi alert. Valid entries are -25% to 125%.

Travel Alert Low Point

Value of the travel, in percent of ranged travel, which, when exceeded, sets the Travel Alert Lo alert. Valid entries are -25% to 125%.

Travel Alert Low Low Point

Value of the travel, in percent of ranged travel, which, when exceeded, sets the Travel Alert Lo Lo alert. Valid entries are -25% to 125%.

Travel Cutoff

Defines the cutoff point for the travel, in percent of ranged travel. There are two travel cutoffs: high and low. Once travel exceeds the cutoff, the drive signal is set to either maximum or minimum, depending on the Zero Control Signal and if the cutoff is high or low. Minimum opening time or minimum closing time are not in effect while the travel is beyond the cutoff. Use the travel cutoff to obtain the desired seat load or to be sure the valve is fully open.

Travel Deviation

The difference between the analog input signal (in percent of ranged input), the “target” travel, and the actual “ranged” travel.

Travel Deviation Alert

Checks the difference between the target and the ranged travel. If the difference exceeds the Travel Deviation Alert Point for more than the Travel Deviation Time, the Travel Deviation Alert is active. It remains active until the difference is less than the Travel Deviation Alert Point.

Travel Deviation Alert Point

An adjustable value for the target travel and the ranged travel difference, expressed in percent, When this value is exceeded by the travel deviation for more than the Travel Deviation Time, the Travel Deviation Alert is active. Valid entries are 0% to 100%. Typically this is set to 5%.

Travel Deviation Time

The time, in seconds. that the travel deviation must exceed the Travel Deviation Alert Point before the alert is active. Valid entries are 1 to 60 seconds.

Travel Limit

A setup parameter that defines the maximum allowable travel (in percent of ranged travel) for the valve. During operation, the travel target will not exceed this limit. There are two travel limits: high and low. Typically the travel limit low will be used to keep the valve from going completely closed.

Travel Range

Travel, in percent of calibrated travel, that corresponds to the input range.

Travel Sensor

A device within the FIELDVUE instrument that senses valve stem or shaft movement. The travel sensor in the DVC6200 is the Hall Effect sensor that measures the position of the magnetic assembly.

Travel Sensor Motion

Increasing or decreasing air pressure causes the magnet assembly to move up or down or the rotary shaft to turn clockwise or counterclockwise. The Setup Wizard asks if it can move the valve to determine travel.

Tuning

The adjustment of control terms or parameter values to produce a desired control effect.

Tuning Set

Preset values that identify gain settings for a FIELDVUE instrument. The tuning set and supply pressure together determine an instrument's response to input signal changes.

Watch Dog Timer

A timer that the microprocessor must rearm periodically. If the microprocessor is unable to rearm the timer, the instrument goes through reset.

Zero Power Condition

The position of the valve (open or closed) when the electrical power to the instrument is removed. Zero Power Condition (ZPC) is determined by relay and actuator action as follows:

Single Acting Direct (Relay C) Upon loss of electrical power instrument goes to zero air output at port A.

Double Acting (Relay A) Upon loss of electrical power instrument goes to full supply air output at port B. A goes to zero air output.

Single Acting Reverse (Relay B) Upon loss of electrical power instrument goes to full supply air output at Port B.

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Fisher® ET and EAT easy-e™ Valves CL125 through CL600

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Figure 1. Fisher ET Control Valve with 667 Actuator



W1916-3

Introduction

Scope of Manual

This instruction manual includes installation, maintenance, and parts information for NPS 1 through 8 Fisher ET valves, and NPS 1 through 6 EAT valves, through CL600 ratings. Refer to separate manuals for instructions covering the actuator and accessories.

Do not install, operate, or maintain ET valves without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Table 1. Specifications

End Connection Styles

Cast Iron Valves
Flanged: CL125 flat-face or 250 raised-face flanges per ASME B16.1
Steel and Stainless Steel Valves
Flanged: CL150, 300, and 600 raised-face or ring-type joint flanges per ASME B16.5
Screwed or Socket Welding: All available ASME B16.11 schedules that are consistent with CL600 per ASME B16.34
Buttwelding: Consistent with ASME B16.25

Maximum Inlet Pressure(1)

Cast Iron Valves
Flanged: Consistent with CL125B or 250B pressure-temperature ratings per ASME B16.1
Steel and Stainless Steel Valves
Flanged: Consistent with CL150, 300, and 600(2) pressure-temperature ratings per ASME B16.34
Screwed or Welding: Consistent with CL600 pressure-temperature ratings per ASME B16.34

Shutoff Classifications

See table 2

Flow Characteristics

Linear (all cages), quick-opening (all except Whisper Trim™, WhisperFlo™, and Cavitrol™ cages), or equal percentage (all except Whisper Trim, WhisperFlo, and Cavitrol cages)

Flow Directions

Linear, Quick Opening, or Equal Percentage Cage: Normally down
Whisper Trim and WhisperFlo Cages: Always up
Cavitrol Cage: Always down

Approximate Weights

VALVE SIZE, NPS	WEIGHT	
	kg	Pounds
1 and 1-1/4	14	30
1-1/2	20	45
2	39	67
2-1/2	45	100
3	54	125
4	77	170
6	159	350
8	408	900

1. The pressure/temperature limits in this manual and any applicable standard or code limitation for valve should not be exceeded.
2. Certain bonnet bolting material selections may require a CL600 easy-e valve assembly to be derated. Contact your Emerson Process Management sales office.

Table 2. Available Shutoff Classifications per ANSI/FCI 70-2 and IEC 60534-4

Valve	Seating	Shutoff Class
All except those with Cavitrol III cages	PTFE (standard)	V - air test
		V - water test (optional)
	Metal	IV
		V (optional)(2)
ET with Cavitrol III one-stage cage	Metal	IV (standard)
		V (optional)
ET with Cavitrol III two-stage cages	Metal	V
ET w/PEEK Anti-Extrusion Rings	Metal	V to 316°C (600°F)
ET w/ 3.4375 to 7-inch port	Soft or Metal	VI
ET and EAT w/ TSO (Tight Shutoff Trim)	Replaceable, protected soft seat	TSO(1)

1. This is a special non-ANSI/FCI leakage class.
2. Class V shutoff requires spring-loaded seal ring, radiused-seat plug, and wide-bevel seat ring (not available with 8-inch port, quick-opening cage). Not available with trims 4, 29, and 85.

Description

These single-port valves have cage guiding, quick-change trim, and balanced push-down-to-close valve plug action. Valve configurations are as follows:

ET--Globe-style valve (figure 1) with metal-to-PTFE seating (standard for all except Cavitrol III cages) for stringent shutoff requirements, or metal-to-metal seating (standard for Cavitrol III cages, optional for all others) for higher temperatures.

EAT--Angle version of ET, used to facilitate piping or in applications which require a self-draining valve.

Specifications

Typical specifications for these valves are shown in table 1.

Educational Services

For information on available courses for Fisher ET and ETA valves, as well as a variety of other products, contact:

Emerson Process Management
Educational Services - Registration
Phone: 1-641-754-3771 or 1-800-338-8158
E-mail: education@emerson.com
http://www.emersonprocess.com/education

Installation

⚠ WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

Personal injury or equipment damage caused by sudden release of pressure may result if the valve assembly is installed where service conditions could exceed the limits given in table 1 or on the appropriate nameplates. To avoid such injury or damage, provide a relief valve for over-pressure protection as required by government or accepted industry codes and good engineering practices.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

CAUTION

When ordered, the valve configuration and construction materials were selected to meet particular pressure, temperature, pressure drop, and controlled fluid conditions. Responsibility for the safety of process media and compatibility of valve materials with process media rests solely with the purchaser and end-user. Since some valve body/trim material combinations are limited in their pressure drop and temperature ranges, do not apply any other conditions to the valve without first contacting your Emerson Process Management sales office.

Before installing the valve, inspect the valve and pipelines for any damage and any foreign material which may cause product damage.

1. Before installing the valve, inspect the valve and associated equipment for any damage and any foreign material.
2. Make certain the valve body interior is clean, that pipelines are free of foreign material, and that the valve is oriented so that pipeline flow is in the same direction as the arrow on the side of the valve.

3. The control valve assembly may be installed in any orientation unless limited by seismic criteria. However, the normal method is with the actuator vertical above the valve. Other positions may result in uneven valve plug and cage wear, and improper operation. With some valves, the actuator may also need to be supported when it is not vertical. For more information, consult your Emerson Process Management sales office.
4. Use accepted piping and welding practices when installing the valve in the line. For flanged valves, use a suitable gasket between the valve and pipeline flanges.

CAUTION

Depending on valve body materials used, post weld heat treating may be required. If so, damage to internal elastomeric and plastic parts, as well as internal metal parts is possible. Shrink-fit pieces and threaded connections may also loosen. In general, if post weld heat treating is to be performed, all trim parts should be removed. Contact your Emerson Process Management sales office for additional information.

5. With a leak-off bonnet construction, remove the pipe plugs (keys 14 and 16, figure 14) to hook up the leak-off piping. If continuous operation is required during inspection or maintenance, install a three-valve bypass around the control valve assembly.
6. If the actuator and valve are shipped separately, refer to the actuator mounting procedure in the appropriate actuator instruction manual.

⚠ WARNING

Personal injury could result from packing leakage. Valve packing was tightened prior to shipment; however, the packing might require some readjustment to meet specific service conditions. Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

Valves with ENVIRO-SEAL live-loaded packing or HIGH-SEAL live-loaded packing will not require this initial readjustment. See the Fisher instruction manuals, ENVIRO-SEAL Packing System for Sliding-Stem Valves or HIGH-SEAL Live-Loaded Packing System (as appropriate), for packing instructions. If you wish to convert your present packing arrangement to ENVIRO-SEAL packing, refer to the retrofit kits listed in the Parts Kits section.

Maintenance

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. This section includes instructions for packing lubrication, packing maintenance, trim maintenance, and ENVIRO-SEAL bellows seal bonnet replacement. All maintenance operations may be performed with the valve in the line.

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**

- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the pneumatic actuator loading pressure and relieve any actuator spring precompression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline*. Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

CAUTION

Follow instructions carefully to avoid damaging the product surfaces, which could result in damage to the product.

Note

Whenever a gasket seal is disturbed by removing or shifting gasketed parts, install a new gasket during reassembly. This ensures a good gasket seal because the used gasket may not seal properly.

Packing Lubrication

Note

ENVIRO-SEAL and HIGH-SEAL packing do not require lubrication.

⚠ WARNING

To avoid personal injury or property damage resulting from fire or explosion, do not lubricate packing used in oxygen service or in processes with temperatures over 260°C (500°F).

If a lubricator or lubricator/isolating valve (figure 2) is provided for PTFE/composition or other packings that require lubrication, it will be installed in place of the pipe plug (key 14, figure 14). Use a good quality silicon-base lubricant. Do not lubricate packing used in oxygen service or in processes with temperatures over 260°C (500°F). To operate the lubricator, simply turn the cap screw clockwise to force the lubricant into the packing box. The lubricator/isolating valve operates the same way except open the isolating valve before turning the cap screw and then close the isolating valve after lubrication is completed.

Packing Maintenance

Note

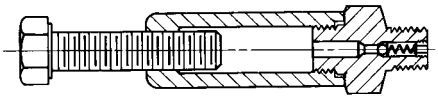
For valves with ENVIRO-SEAL packing, see the Fisher instruction manual, ENVIRO-SEAL Packing System for Sliding-Stem Valves, D101642X012, for packing instructions.

For valves with HIGH-SEAL packing, see the Fisher instruction manual, HIGH-SEAL Live-Loaded Packing System, D101453X012, for packing instructions.

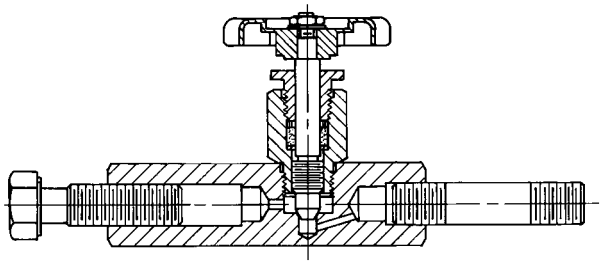
Key numbers refer to figure 3 for PTFE V-ring packing and to figure 4 for PTFE/composition packing, unless otherwise indicated.

For spring-loaded single PTFE V-ring packing, the spring (key 8) maintains a sealing force on the packing. If leakage is noted around the packing follower (key 13), check to be sure the shoulder on the packing follower is touching the bonnet. If the shoulder is not touching the bonnet, tighten the packing flange nuts (key 5, figure 14) until the shoulder is against the bonnet. If leakage cannot be stopped in this manner, proceed to the Replacing Packing procedure.

Figure 2. Lubricator and Lubricator/Isolating Valve (Optional)



LUBRICATOR



10A9421-A
AJ5428-D
A0832-2

LUBRICATOR/ISOLATING VALVE

If there is undesirable packing leakage with other than spring-loaded packing, first try to limit the leakage and establish a stem seal by tightening the packing flange nuts.

If the packing is relatively new and tight on the stem, and if tightening the packing flange nuts does not stop the leakage, the valve stem may be worn or nicked so that a seal cannot be made. The surface finish of a new valve stem is critical for making a good packing seal. If the leakage comes from the outside diameter of the packing, the leakage may be caused by nicks or scratches around the packing box wall. If performing any of the following procedures, inspect the valve stem and packing box wall for nicks and scratches.

Replacing Packing

⚠ WARNING

Refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve, and drain the process media from both sides of the valve. If using a power actuator, also shut off all pressure lines to the power actuator, and release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
2. Disconnect the operating lines from the actuator and any leak-off piping from the bonnet. Disconnect the stem connector, then remove the actuator from the valve by unscrewing the yoke locknut (key 15, figure 14) or the hex nuts (key 26, figure 14).

3. Loosen the packing flange nuts (key 5, figure 14) so that the packing is not tight on the valve stem. Remove any travel indicator parts and stem locknuts from the valve stem threads.

⚠ WARNING

To avoid personal injury or property damage caused by uncontrolled movement of the bonnet, loosen the bonnet by following the instructions in the next step. Do not remove a stuck bonnet by pulling on it with equipment that can stretch or store energy in any other manner. The sudden release of stored energy can cause uncontrolled movement of the bonnet.

Figure 3. PTFE V-Ring Packing Arrangements for Plain and Extension Bonnets

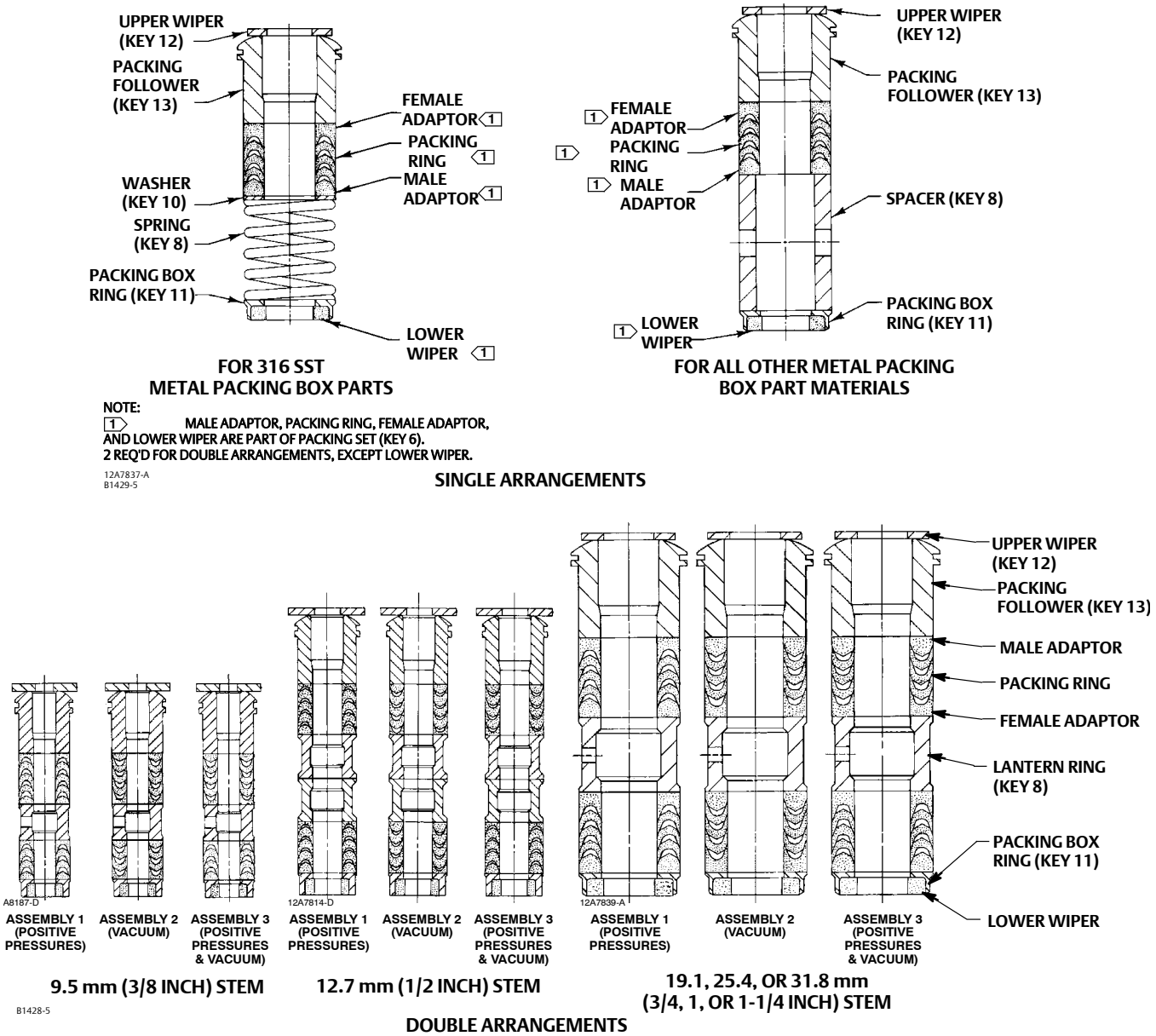


Figure 4. Detail of PTFE/Composition Packing Arrangements for Plain and Extension Bonnets

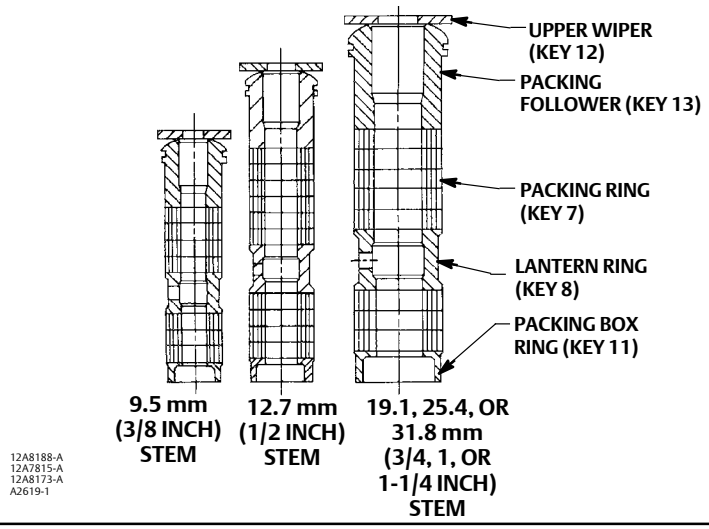


Table 3. Body-to-Bonnet Bolt Torque Guidelines

VALVE SIZE, NPS		BOLT TORQUES(1)			
ET	EAT	SA193-B7, SA193-B8M(3, 4)		SA193-B8M(2, 4)	
		N•m	Lbf•ft	N•m	Lbf•ft
1-1/4 or less	1	129	95	64	47
1-1/2, 1-1/2 x 1, 2, or 2 x 1	2 or 2 x 1	96	71	45	33
2-1/2 or 2-1/2 x 1-1/2	3 or 3 x 1-1/2	129	95	64	47
3, 3 x 2, or 3 x 2-1/2	4 or 4 x 2	169	125	88	65
4, 4 x 2-1/2, or 4 x 3	6 or 6 x 2-1/2	271	200	156	115
6	– – –	549	405	366	270
8	– – –	746	550	529	390

1. Determined from laboratory tests.
2. SA193-B8M annealed.
3. SA193-B8M strain hardened.
4. For other materials, contact your Emerson Process Management sales office.

Note

The following step also helps to provide additional assurance that the valve body fluid pressure has been relieved.

CAUTION

Avoid damaging the seating surface caused by the valve plug and stem assembly dropping from the bonnet (key 1, figure 14) after being lifted part way out. When lifting the bonnet, temporarily install a valve stem locknut on the valve stem. The locknut will prevent the valve plug and stem assembly from dropping out of the bonnet.

4. Hex nuts (key 16, figure 16, 17, or 20) or cap screws (not shown) attach the bonnet (key 1, figure 14) to the valve body (key 1, figure 16, 17, or 20). Loosen these nuts or cap screws approximately 3 mm (1/8 inch). Then loosen the body-to-bonnet gasketed joint by either rocking the bonnet or prying between the bonnet and valve. Work the

prying tool around the bonnet until the bonnet loosens. If no fluid leaks from the joint, remove the nuts or cap screws completely and carefully lift the bonnet off the valve.

Table 4. Recommended Torque for Packing Flange Nuts

VALVE STEM DIAMETER		PRESSURE RATING	GRAPHITE TYPE PACKING				PTFE TYPE PACKING			
			Minimum Torque		Maximum Torque		Minimum Torque		Maximum Torque	
mm	Inches		N•m	Lbf•in	N•m	Lbf•in	N•m	Lbf•in	N•m	Lbf•in
9.5	3/8	CL125, 150	3	27	5	40	1	13	2	19
		CL250, 300	4	36	6	53	2	17	3	26
		CL600	6	49	8	73	3	23	4	35
12.7	1/2	CL125, 150	5	44	8	66	2	21	4	31
		CL250, 300	7	59	10	88	3	28	5	42
		CL600	9	81	14	122	4	39	7	58
19.1	3/4	CL125, 150	11	99	17	149	5	47	8	70
		CL250, 300	15	133	23	199	7	64	11	95
		CL600	21	182	31	274	10	87	15	131
25.4	1	CL300	26	226	38	339	12	108	18	162
		CL600	35	310	53	466	17	149	25	223
31.8	1-1/4	CL300	36	318	54	477	17	152	26	228
		CL600	49	437	74	655	24	209	36	314

5. Remove the locknut and separate the valve plug and stem from the bonnet. Set the parts on a protective surface to prevent damage to gasket or seating surfaces.

CAUTION

To prevent possible product damage, cover the opening in the valve in the following procedure to prevent foreign material from getting into the valve body cavity.

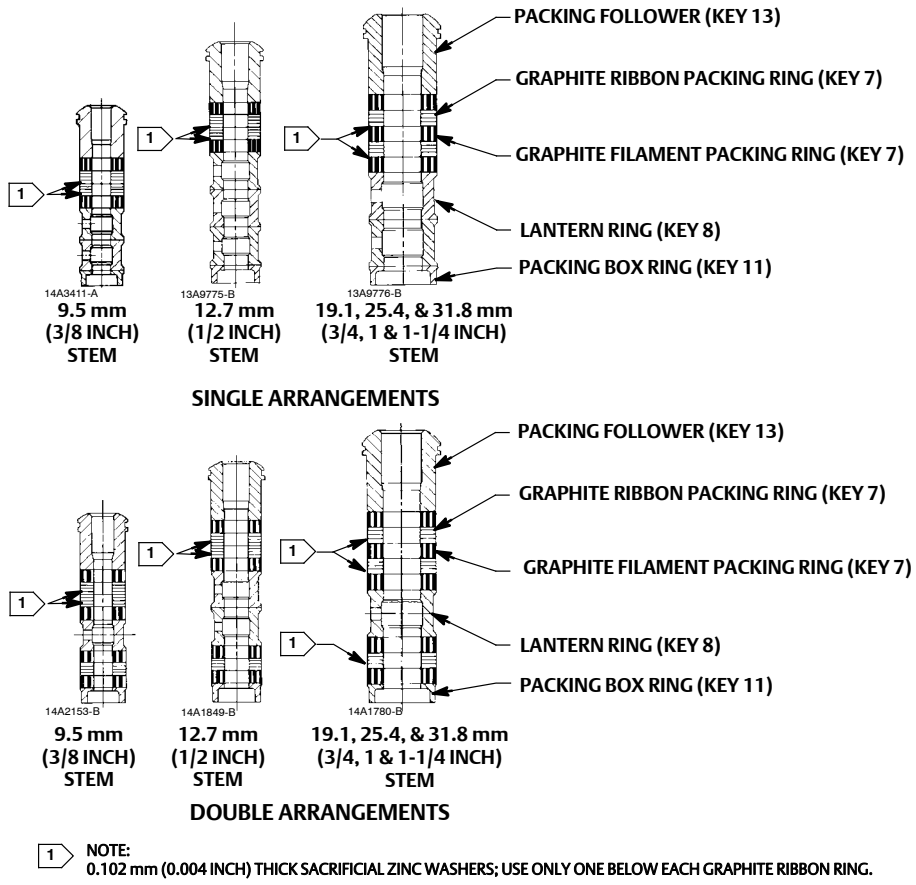
6. Remove the bonnet gasket (key 10, figure 16, 17, or 20) and cover the opening in the valve to protect the gasket surface and prevent foreign material from getting into the valve body cavity.
7. Remove the packing flange nuts, packing flange, upper wiper, and packing follower (keys 5, 3, 12, and 13, figure 14). Carefully push out all the remaining packing parts from the valve side of the bonnet using a rounded rod or other tool that will not scratch the packing box wall. Clean the packing box and the metal packing parts.
8. Inspect the valve stem threads and packing box surfaces for any sharp edges which might cut the packing. Scratches or burrs could cause packing box leakage or damage to the new packing. If the surface condition cannot be improved by light sanding, replace the damaged parts by following the appropriate steps in the Trim Maintenance procedure.
9. Remove the covering protecting the valve body cavity and install a new bonnet gasket (key 10, figure 16, 17, or 20), making sure the gasket seating surfaces are clean and smooth. Then slide the bonnet over the stem and onto the stud bolts (key 15, figure 16, 17, or 20) or onto the valve body cavity if cap screws (not shown) will be used instead.

Note

Proper performance of the bolting procedures in step 10 compresses the spiral wound gasket (key 12, figure 16 or 17) or load ring (key 26, figure 20) enough to both load and seal the seat ring gasket (key 13, figure 16, 17 or 20). It also compresses the outer edge of the bonnet gasket (key 10, figure 16 through 20) enough to seal the body-to-bonnet joint.

The proper bolting procedures in step 10 include--but are not limited to--ensuring that bolting threads are clean, and evenly tightening the cap screws, or the nuts onto the studs, in a crisscross pattern. Tightening one cap screw or nut may loosen an adjacent cap screw or nut. Repeat the crisscross tightening pattern several times until each cap screw or nut is tight and the body-to-bonnet seal is made. When the operating temperature has been reached, perform this torquing procedure once again.

Figure 5. Detail of Graphite Ribbon/Filament Packing for Plain and Extension Bonnets



Note

Stud(s) and nut(s) should be installed such that the manufacturer's trademark and material grade marking is visible, allowing easy comparison to the materials selected and documented in the Emerson/Fisher serial card provided with this product.

⚠ WARNING

Personal injury or damage to equipment could occur if improper stud and nut materials or parts are used. Do not operate or assemble this product with stud(s) and nut(s) that are not approved by Emerson/Fisher engineering and/or listed on the serial card provided with this product. Use of unapproved materials and parts could lead to stresses exceeding the design or code limits intended for this particular service. Install studs with the material grade and manufacturer's identification mark visible. Contact your Emerson Process Management representative immediately if a discrepancy between actual parts and approved parts is suspected.

10. Lubricate the bolting (not necessary if factory pre-lubricated stud bolt nuts are used) and install it, using accepted bolting procedures during tightening, so that the body-to-bonnet joint will withstand test pressures and application service conditions. Use the bolt torques in table 3 as guidelines.
11. Install new packing and the metal packing box parts according to the appropriate arrangement in figure 3, 4, or 5. Place a smooth-edged pipe over the valve stem and gently tap each soft packing part into the packing box.

12. Slide the packing follower, upper wiper, and packing flange (keys 13, 12, and 3, figure 14) into position. Lubricate the packing flange studs (key 4, figure 14) and the faces of the packing flange nuts (key 5, figure 14). Install the packing flange nuts.
13. **For spring-loaded PTFE V-ring packing,** tighten the packing flange nuts until the shoulder on the packing follower (key 13, figure 14) contacts the bonnet.

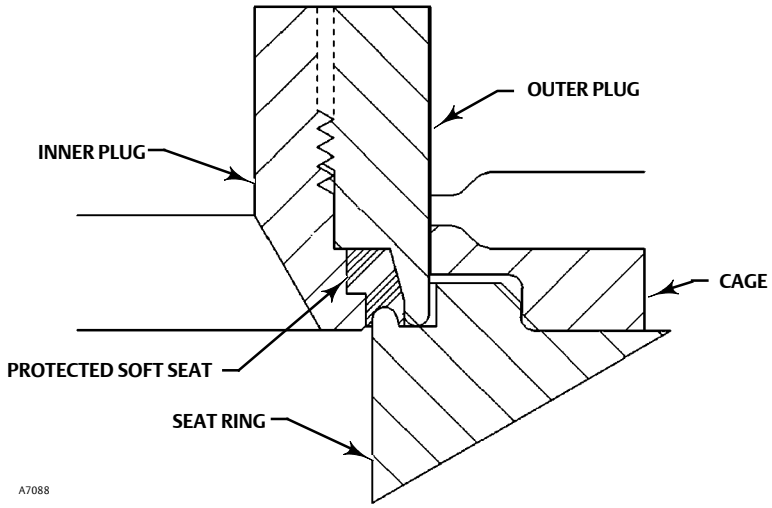
For graphite packing, tighten the packing flange nuts to the maximum recommended torque shown in table 4. Then, loosen the packing flange nuts, and retighten them to the recommended minimum torque shown in table 4.

For other packing types, tighten the packing flange nuts alternately in small equal increments until one of the nuts reaches the minimum recommended torque shown in table 4. Then, tighten the remaining flange nut until the packing flange is level and at a 90-degree angle to the valve stem.

For ENVIRO-SEAL or HIGH-SEAL live-loaded packing, refer to the note at the beginning of Packing Maintenance.

14. Mount the actuator on the valve assembly and reconnect the actuator and valve stem according to the procedure in the appropriate actuator instruction manual.

Figure 6. TSO (Tight Shutoff Trim), Detail of Protected Soft Seat



Trim Maintenance

⚠ WARNING

Refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

Except where indicated, key numbers in this section are referenced in figure 16 for standard NPS 1 through 6 constructions, figure 17 for Whisper Trim III detail, figures 18 and 19 for WhisperFlo trim, and figure 20 for Cavitrol III detail and the NPS 8 ET valve.

Disassembly

1. Remove the actuator and the bonnet according to steps 1 through 6 of the Replacing Packing procedure in the Maintenance section.

⚠ WARNING

To avoid personal injury due to leaking fluid, avoid damaging gasket sealing surfaces. The surface finish of the valve stem (key 7) is critical for making a good packing seal. The inside surface of the cage or cage/baffle assembly (key 3), or cage retainer (key 31), is critical for smooth operation of the valve plug. The seating surfaces of the valve plug (key 2) and seat ring (key 9) are critical for proper shutoff. Unless inspection reveals otherwise, assume all these parts are in good condition and protect them accordingly.

2. Remove the packing flange nuts, packing flange, upper wiper, and packing follower (keys 5, 3, 12, and 13 in figure 14). Carefully push out all the remaining packing parts from the valve side of the bonnet using a rounded rod or other tool that will not scratch the packing box wall. Clean the packing box and the metal packing parts.
3. Inspect the valve stem threads and packing box surfaces for any sharp edges which might cut the packing. Scratches or burrs could cause packing box leakage or damage to the new packing. If the surface condition cannot be improved by light sanding, replace the damaged parts.
4. Remove the load ring (key 26) from an NPS 8 ET valve, or the cage adaptor (key 4) from any restricted-trim valve through NPS 4, and wrap it for protection.
5. On an NPS 6 ET valve with Whisper Trim III or WhisperFlo cage, also remove the bonnet spacer (key 32) and bonnet gasket (key 10) on top of the spacer. Then on any construction with a cage retainer (key 31), remove the cage retainer and its associated gaskets. A Whisper Trim III and WhisperFlo cage retainer has two 3/8-inch-16 UNC tappings in which screws or bolts can be installed for lifting.
6. Remove the cage or cage/baffle assembly (key 3), the associated gaskets (keys 10, 11, and 12), and shim (key 51). If the cage is stuck in the valve, use a rubber mallet to strike the exposed portion of the cage at several points around its circumference.
7. For constructions other than TSO (tight shutoff) trim, remove the seat ring or liner (key 9) or disk seat (key 22), seat ring gasket (key 13), and the seat ring adaptor (key 5) and adaptor gasket (key 14) where used in a restricted-trim seat ring construction. PTFE-seat constructions use a disk (key 23) sandwiched between the disk seat and disk retainer (key 21).
8. For TSO (tight shutoff) trim constructions, perform the following steps (refer to figures 6 and 7):

- Remove the retainer, backup ring, anti-extrusion rings, and piston ring.
- Remove the set screws that lock the outer plug to the inner plug.
- Using a strap wrench or similar tool, unscrew the outer plug from the inner plug. Do not damage the outer plug guide surfaces.
- Remove the protected soft seat seal.
- Inspect the parts for damage and replace if needed.

9. For all constructions, inspect parts for wear or damage which would prevent proper operation of the valve. Replace or repair trim parts according to the following procedure for Lapping Metal Seats or other valve plug maintenance procedures as appropriate.

Lapping Metal Seats

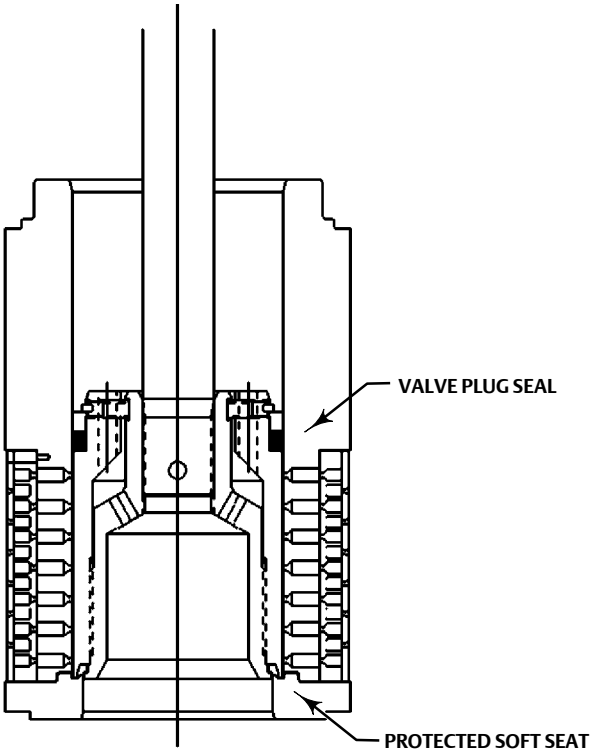
CAUTION

To avoid damaging the ENVIRO-SEAL Bellows Seal Bonnet assembly, do not attempt to lap the metal seating surfaces. The design of the assembly prevents rotation of the stem and any forced lapping rotation will damage internal components of the ENVIRO-SEAL Bellows Seal bonnet.

Except with respect to the ENVIRO-SEAL Bellows Seal Bonnet assembly, with metal-seat constructions, lapping seating surfaces of the valve plug and seat ring or liner (keys 2 and 9, figure 16, 17, or 20) can improve shutoff. (Deep nicks should be machined out rather than ground out.) Use a good quality lapping compound of a mixture of 280 to 600-grit. Apply the compound to the bottom of the valve plug.

Assemble the valve to the extent that the cage and the cage retainer and bonnet spacer (if used) are in place and the bonnet is bolted to the valve body. A simple handle can be made from a piece of strap iron locked to the valve plug stem with nuts. Rotate the handle alternately in each direction to lap the seats. After lapping, remove the bonnet and clean the seat surfaces. Completely assemble as described in the Assembly portion of the Trim Maintenance procedure and test the valve for shutoff. Repeat the lapping procedure if leakage is still excessive.

Figure 7. Typical Balanced TSO Trim



Valve Plug Maintenance

Except where indicated, key numbers in this section are referenced in figure 16 for standard NPS 1 through 6 constructions, figure 17 for Whisper Trim III, figures 18 and 19 for WhisperFlo trim, and figure 20 for Cavitrol III detail and the NPS 8 ET valve.

CAUTION

To avoid the valve plug seal ring (key 28) not sealing properly, be careful not to scratch the surfaces of the ring groove in the valve plug or any of the surfaces of the replacement ring.

1. With the valve plug (key 2) removed according to the Disassembly portion of the Trim Maintenance procedure, proceed as appropriate:

For the two-piece seal ring, The ring cannot be reused because it is a closed ring which must be pried and/or cut from the groove. Once the seal ring is removed, the elastomeric backup ring (key 29), which is also a closed ring, can be pried from the groove.

CAUTION

To avoid damaging the seal ring, slowly and gently stretch it for the following procedure. Avoid jerking sharply on the ring.

To install a new two-piece seal ring, apply a general purpose silicone-base lubricant to both the backup ring and seal ring (keys 29 and 28). Place the backup ring over the stem (key 7) and into the groove. Place the seal ring over the top edge of the valve plug (key 2) so that it enters the groove on one side of the valve plug. Slowly and gently stretch the seal ring and work it over the top edge of the valve plug. The PTFE material in the seal ring must be permitted time to cold-flow during the stretching procedure, so avoid jerking sharply on this ring. Stretching the seal ring over the valve plug may make it seem unduly loose when in the groove, but it will contract to its original size after insertion into the cage.

For the spring-loaded seal ring, the ring used on a valve plug having a 136.5 mm (5.375 inch) or less port diameter may be removed undamaged by first working the retaining ring (key 27) off with a screwdriver. Then carefully slide the metal backup ring (key 29) and seal ring (key 28) off the valve plug (key 2). The spring-loaded seal ring used on a valve plug having a 178 mm (7-inch) or greater port diameter must be carefully pried and/or cut from its groove. Therefore, it cannot be reused.

A spring-loaded seal ring must be installed so that its open side faces toward the valve stem, or toward the seat of the plug depending on flow direction, as shown in view A of figure 16 or 20. To install a spring-loaded seal ring on a valve plug with a 136.5 mm (5.375 inch) or less port diameter, slide the seal ring (key 28) onto the valve plug followed by the metal backup ring (key 29). Then install the retaining ring (key 27) by inserting one end in the groove and, while turning the plug, press the ring into the groove. Again, be careful not to scratch any surfaces of the ring or plug.

CAUTION

To avoid damaging the seal ring, slowly and gently stretch it for the following procedure. Avoid jerking sharply on the ring.

To install the seal ring on a valve plug with 178 mm (7-inch) or greater port diameter, lubricate it with a general purpose silicone-base lubricant. Then gently stretch the seal ring and work it over the top edge of the valve plug. The PTFE material in the seal ring must be permitted time to cold-flow during the stretching procedure, so avoid jerking sharply on the ring. Stretching the seal ring over the valve plug may make it seem unduly loose when in the groove, but it will contract to its original size after insertion into the cage.

CAUTION

Never reuse an old stem or adaptor with a new valve plug. Using an old stem or adaptor with a new plug requires drilling a new pin hole in the stem (or adaptor, in case an ENVIRO-SEAL bellows seal bonnet is being used). This drilling weakens the stem or adaptor and may cause failure in service. However, a used valve plug may be reused with a new stem or adaptor, except with Cavitrol III trim.

Note

The valve plug and valve plug stem for 2-stage Cavitrol III trim are a matched set and must be ordered together. If the 2-stage Cavitrol III valve plug or valve plug stem is damaged, replace the entire assembly (key 2, figure 20).

Note

For plain bonnets and style 1 extension bonnets, the valve plug (key 2), valve stem (key 7), and pin (key 8) are available completely assembled. Refer to the Key 2, 7, and 8 Valve Plug and Stem Assembly tables in the Parts List.

2. To replace the valve stem (key 7), drive out the pin (key 8). Unscrew the valve plug from the stem or adaptor.
3. To replace the adaptor (key 24, figure 14) on ENVIRO-SEAL bellows seal bonnets, place the plug stem assembly and valve plug in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug that is not a seating surface. Drive out the pin (key 36, figure 14). Reverse the plug stem assembly in the soft-jaw chuck or vise. Grip the flat areas on the valve stem just below the threads for the actuator/stem connection. Unscrew the valve plug/adaptor assembly (key 24, figure 14) from the valve stem assembly (key 20, figure 14).
4. Screw the new stem or adaptor into the valve plug. Tighten to the torque value given in table 5. Refer to table 5 to select the proper hole size. Drill through the stem or adaptor, using the hole in the valve plug as a guide. Remove any chips or burrs and drive in a new pin to lock the assembly.

Table 5. Valve Stem Connection Assembly Torque and Pin Replacement

VALVE STEM DIAMETER		TORQUE, MINIMUM TO MAXIMUM		HOLE SIZE	
mm	Inches	N•m	Lbf•ft	mm	Inch
9.5	3/8	40-47	25-35	2.41 - 2.46	0.095 - 0.097
12.7	1/2	81-115	60-85	3.20 - 3.25	0.126 - 0.128
19.1	3/4	237-339	175-250	4.80 - 4.88	0.189 - 0.192
25.4	1	420-481	310-355	6.38 - 6.45	0.251 - 0.254
31.8	1-1/4	827-908	610-670	6.38 - 6.45	0.251 - 0.254

5. For ENVIRO-SEAL bellows seal bonnets, grip the flats of the stem extending out of the top of the bellows shroud with a soft-jaw chuck or other type of vise. Screw the valve plug/adaptor assembly onto the valve stem. Tighten as necessary to align the pin hole in the stem with one of the holes in the adaptor. Secure the adaptor to the stem with a new pin.

Assembly

Except where indicated, key numbers are referenced in figure 16 for standard NPS 1 through 6 constructions, figure 17 for Whisper Trim III detail, figures 18 and 19 for WhisperFlo detail, and figure 20 for Cavitrol III detail and the NPS 8 ET valve.

1. With a restricted-trim seat ring construction, install the adaptor gasket (key 14) and seat ring adaptor (key 5).
2. Install the seat ring gasket (key 13), seat ring or liner (key 9), or disk seat (key 22). With a PTFE-seat construction, install the disk and disk retainer (keys 21 and 23).
3. Install the cage or cage/baffle assembly (key 3). Any rotational orientation of the cage or assembly with respect to the valve body is acceptable. A Whisper Trim III cage designated by level A3, B3, or C3 may be installed with either end up. The level D3 cage/baffle assembly or Cavitrol III cage assembly, however, must be installed with the hole pattern end next to the seat ring. If a cage retainer (key 31) is to be used, place it on top of the cage.
4. **For constructions other than TSO (tight shutoff) trim**, slide the valve plug (key 2) and stem assembly, or valve plug and ENVIRO-SEAL bellows seal assembly, into the cage. Make sure the seal ring (key 28) is evenly engaged in the entrance chamfer at the top of the cage (key 3) or cage retainer (key 31) to avoid damaging the ring.
5. **For TSO (tight shutoff) trim constructions**, perform the following steps (refer to figures 6 and 7).

- Thread the outer plug onto the inner plug until the parts seat metal to metal, using a strap wrench or similar tool that will not damage the outer plug guide surfaces.
- Mark the top of the inner plug and outer plug with alignment marks in the assembled position.

- Disassemble the outer plug from the inner plug and install the seal over the inner plug, so that the seal rests below the threaded area.
- Thread the outer plug onto the inner plug and tighten with a strap wrench or similar tool until the alignment marks line up. This will ensure that the plug parts are metal to metal and the seal is compressed properly. Do not damage the outer plug guide surfaces.
- Install set screws centering the inner plug in the outer plug and torque to 11 N•m (8 lbf•ft).
- Assemble the piston ring, anti-extrusion rings, backup ring, and retainer.

6. For all constructions, place the gaskets (keys 12, 11 or 14 if used, and 10) and the shim (key 51) on top of the cage or cage retainer. If there is a cage adaptor (key 4) or a bonnet spacer (key 32), set it on the cage or cage retainer gaskets and place another flat sheet gasket (key 10) on top of the adaptor or spacer. If there is only a cage retainer, place another flat sheet gasket on the retainer.
7. With an NPS 8 ET valve, install the load ring (key 26).
8. Mount the bonnet on the valve body and complete assembly according to steps 10 through 14 of the Replacing Packing procedure. Be sure to observe the note prior to step 10.

ENVIRO-SEAL Bellows Seal Bonnet

Replacing a Plain or Extension Bonnet with an ENVIRO-SEAL Bellows Seal Bonnet (Stem/Bellows Assembly)

1. Remove the actuator and bonnet according to steps 1 through 5 of the Replacing Packing procedure in the Maintenance section.
2. With care, remove the valve plug and stem assembly from the valve body. If necessary, also lift out the cage.

CAUTION

To prevent possible product damage, cover the opening in the valve in the following procedure to protect the sealing surfaces and to prevent foreign material from getting into the valve body cavity.

3. Remove and discard the existing bonnet gasket. Cover the valve body opening to protect sealing surfaces and to prevent foreign material from entering the valve body cavity.

Note

The ENVIRO-SEAL stem/bellows assembly for easy-e valves is available only with a threaded and drilled plug/adaptor/stem connection. The existing valve plug can be reused with the new stem/bellows assembly or a new plug can be installed.

4. Inspect the existing valve plug. If the plug is in good condition, it can be reused with the new ENVIRO-SEAL stem/bellows assembly. To remove the existing valve plug from the stem, first, place the existing plug stem assembly and valve plug in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug that is not a seating surface. Drive out or drill out the pin (key 8).
5. Reverse the plug stem assembly in the soft-jaw chuck or vise. Grip the valve stem in an appropriate place and unscrew the existing plug from the valve stem.

Table 6. Recommended Torque for ENVIRO-SEAL Bellows Seal Packing Flange Nuts

VALVE SIZE, NPS	VALVE STEM DIAMETER THROUGH PACKING	MINIMUM TORQUE		MAXIMUM TORQUE	
		N•m	Lbf•in	N•m	Lbf•in
1 - 2	1/2	2	22	4	33
3 - 8	1	5	44	8	67

CAUTION

When installing a valve plug on the ENVIRO-SEAL stem/bellows assembly, the valve stem must not be rotated. Damage to the bellows may result.

To avoid product damage, do not grip the bellows shroud or other parts of the stem/bellows assembly. Grip only the flat areas on the stem where it extends out of the top of the bellows shroud.

Note

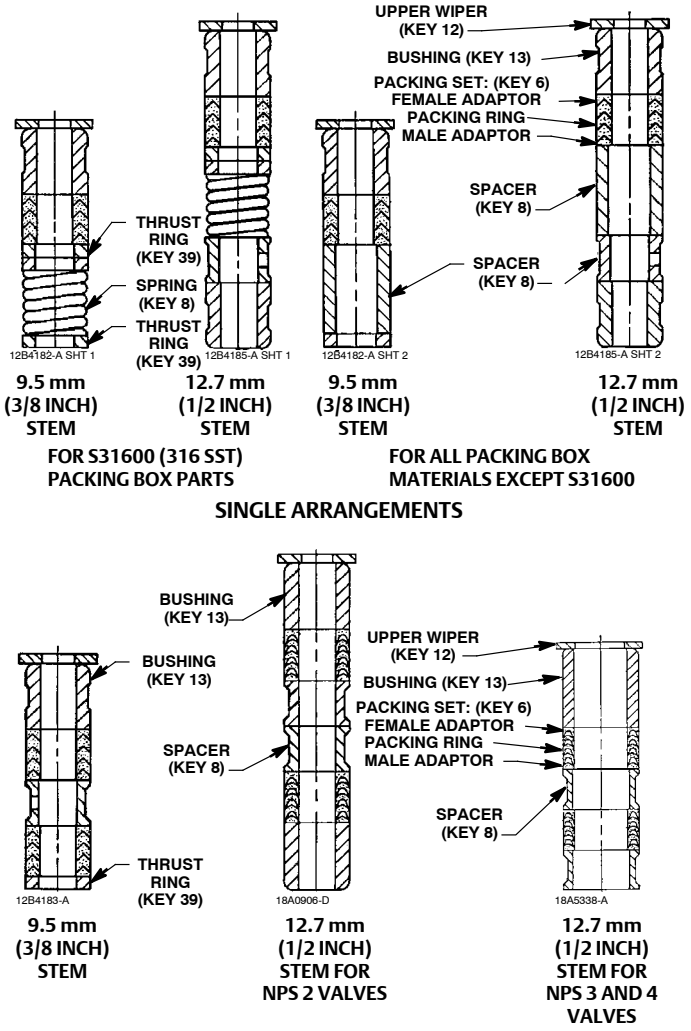
The ENVIRO-SEAL stem/bellows assembly has a one-piece stem.

CAUTION

To avoid damaging parts, do not grip the valve plug on any seating surface in the following procedure.

6. To attach the valve plug to the stem of the new ENVIRO-SEAL stem/bellows assembly, first attach the plug to the adaptor (key 24). Locate the adaptor. Notice that a hole has not been drilled in the threads where the plug screws onto the adaptor. Secure the valve plug in a soft-jaw chuck or other type of vise. Do not grip the plug on any seating surface. Position the plug in the chuck or vise for easy threading of the adaptor. Thread the adaptor into the valve plug and tighten to the appropriate torque value.
7. Select the proper size of drill bit and drill through the adaptor using the hole in the valve plug as a guide. Remove any metal chips or burrs and drive in a new pin to lock the plug/adaptor assembly together.
8. Attach the plug/adaptor assembly to the ENVIRO-SEAL stem/bellows assembly by first securing the stem/bellows assembly in a soft-jaw chuck or other type of vise so that the jaws of the chuck or vise grip the flats of the stem extending out of the top of the bellows shroud. Screw the valve plug/adaptor assembly onto the valve stem. Tighten as necessary to align the pin hole in the stem with one of the holes in the adaptor. Secure the adaptor to the stem with a new pin.
9. Inspect the seat ring (key 9) and soft seat parts (keys 21, 22, and 23); replace, if necessary.
10. Place a new gasket (key 10) into the valve body in place of the bonnet gasket. Install the new stem/bellows assembly with valve plug/adaptor by placing it into the valve body on top of the new bellows gasket.
11. Place a new gasket (key 22) over the stem/bellows assembly. Place the new ENVIRO-SEAL bonnet over the stem/bellows assembly.

Figure 8. PTFE Packing Arrangements for Use in ENVIRO-SEAL Bellows Seal Bonnets



Note

Stud(s) and nut(s) should be installed such that the manufacturer's trademark and material grade marking is visible, allowing easy comparison to the materials selected and documented in the Emerson/Fisher serial card provided with this product.

⚠ WARNING

Personal injury or damage to equipment could occur if improper stud and nut materials or parts are used. Do not operate or assemble this product with stud(s) and nut(s) that are not approved by Emerson/Fisher engineering and/or listed on the serial card provided with this product. Use of unapproved materials and parts could lead to stresses exceeding the design or code limits intended for this particular service. Install studs with the material grade and manufacturer's identification mark visible. Contact your Emerson Process Management representative immediately if a discrepancy between actual parts and approved parts is suspected.

12. Properly lubricate the bonnet stud bolts. Install and tighten the bonnet hex nuts to the proper torque.
13. Install new packing and the metal packing box parts according to the appropriate arrangement in figure 8 or 9.
14. Install the packing flange. Properly lubricate the packing flange stud bolts and the faces of the packing flange nuts.

For graphite packing, tighten the packing flange nuts to the maximum recommended torque shown in table 6. Then, loosen the packing flange nuts, and retighten them to the recommended minimum torque shown in table 6.

For other packing types, tighten the packing flange nuts alternately in small equal increments until one of the nuts reaches the minimum recommended torque shown in table 6. Then, tighten the remaining flange nut until the packing flange is level and at a 90-degree angle to the valve stem.

15. Install travel indicator parts and stem locknuts; mount the actuator on the valve body according to the procedure in the appropriate actuator instruction manual.

Replacement of an Installed ENVIRO-SEAL Bellows Seal Bonnet (Stem/Bellows Assembly)

1. Remove the actuator and bonnet according to steps 1 through 5 of the Replacing Packing procedure in the Maintenance section.

CAUTION

To prevent possible product damage, cover the opening in the valve in the following procedure to protect the sealing surfaces and to prevent foreign material from getting into the valve body cavity.

2. Carefully remove the ENVIRO-SEAL stem/bellows assembly. If necessary, also lift out the cage. Remove and discard the existing bonnet gasket and bellows gasket. Cover the valve body opening to protect sealing surfaces and to prevent foreign material from entering the valve body cavity.

CAUTION

The ENVIRO-SEAL stem/bellows assembly for easy-e valves is available only with a threaded and drilled plug/adaptor/stem connection. The existing valve plug can be reused with the new stem/bellows assembly or a new plug can be installed. If the existing valve plug is reused, and the adaptor is in good condition, it may be also reused. However, never reuse an old adaptor with a new valve plug. Using an old adaptor with a new valve plug requires drilling a new pin hole in the adaptor. This drilling weakens the adaptor and may cause failure in service. However, a used valve plug may be reused with a new adaptor, except with Cavitrol III trim.

3. Inspect the existing valve plug and adaptor. If they are in good condition, they can be reused with the new stem/bellows assembly and they do not need to be separated.

CAUTION

When removing/installing a valve plug on the ENVIRO-SEAL stem/bellows assembly, the valve stem must not be rotated. Damage to the bellows may result.

To avoid product damage, do not grip the bellows shroud or other parts of the stem/bellows assembly. Grip only the flat areas on the stem where it extends out of the top of the bellows shroud.

Note

The ENVIRO-SEAL stem/bellows assembly has a one-piece stem.

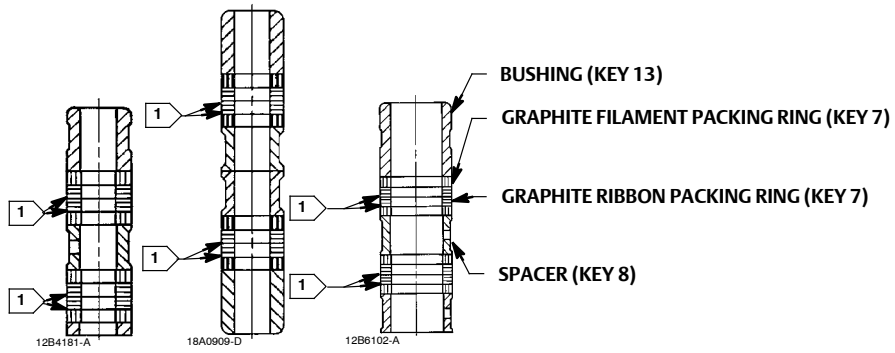
4. If the valve plug and adaptor are not in good condition and must be replaced, first remove the valve plug/adaptor assembly from the stem/bellows assembly; then remove the valve plug from the adaptor. First, place the stem/bellows assembly and valve plug in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug that is not a seating surface. Drive out or drill out the pin (key 8, figure 16, 17, or 20). Drive out the pin (key 36, figure 14).
5. Reverse the stem/bellows and plug/adaptor assembly in the soft-jaw chuck or vise. Grip the flat areas on the valve stem just below the threads for the actuator/stem connection. Unscrew the plug/adaptor assembly from the stem/bellows assembly. Unscrew the valve plug from the adaptor.
6. To attach either the existing valve plug or a new one to the stem of the new ENVIRO-SEAL stem/bellows assembly, first attach the plug to the adaptor (if the valve plug was removed from the adaptor) as follows:

- Locate the adaptor. Notice that a hole has not been drilled in the threads where the plug screws onto the adaptor.

CAUTION

To avoid damaging parts, do not grip the valve plug on any seating surface in the following procedure.

Figure 9. Double Graphite Ribbon/Filament Arrangements for Use in ENVIRO-SEAL Bellows Seal Bonnets



A5870

NOTE:
1 0.102 mm (0.004 INCH) THICK SACRIFICIAL ZINC WASHERS; USE ONLY ONE BELOW EACH GRAPHITE RIBBON RING.

- Secure the valve plug in a soft-jaw chuck or other type of vise. Do not grip the plug on any seating surface. Position the plug in the chuck or vise for easy threading of the adaptor.
- Thread the adaptor into the valve plug and tighten to the appropriate torque value.

7. Complete the installation by following steps 7 through 9 and steps 12 through 15 of the ENVIRO-SEAL Bellows Seal Bonnet installation instructions found on pages 14 and 15.

Purging the ENVIRO-SEAL Bellows Seal Bonnet

The ENVIRO-SEAL bellows seal bonnet can be purged or leak tested. Refer to figure 14 for an illustration of an ENVIRO-SEAL bellows seal bonnet, and perform the following steps for purging or leak testing.

1. Remove the two diametrically opposed pipe plugs (key 16).
2. Connect a purging fluid to one of the pipe plug connections.
3. Install appropriate piping or tubing in the other pipe plug connection to pipe away the purging fluid or to make a connection to an analyzer for leak testing.

4. When purging or leak testing has been completed, remove the piping or tubing and reinstall the pipe plugs (key 16).

Table 7. Standard Material Designations

Standard Designation	Common Name or Tradename
CoCr-A Hardfacing Alloy R30006 S17400 SST S31600 SST	CoCr-A Alloy 6 Casting 17-4PH Stainless Steel 316 Stainless Steel
S41000 SST S41600 SST WCC Carbon Steel Casting	410 Stainless Steel 416 Stainless Steel WCC

Parts Ordering

Each body-bonnet assembly is assigned a serial number which can be found on the valve. This same number also appears on the actuator nameplate when the valve is shipped from the factory as part of a control valve assembly. Refer to the serial number when contacting your Emerson Process Management sales office for technical assistance. When ordering replacement parts, refer to the serial number and to the eleven-character part number for each part required from the following parts kit or parts list information.

Refer to table 7 for standard and common material designations.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management should not, under any circumstances, be used in any Fisher valve, because they may void your warranty, might adversely affect the performance of the valve, and could cause personal injury and property damage.

Parts Kits

Gasket Kits

Gasket Kits (includes keys 10, 11, 12, 13, and 51; plus 14 and 20 on some restricted capacity valves)

DESCRIPTION	Standard Trim Cage Whisper Trim I Cage Cavitrol III - 1 Stage Cage	Cavitrol III - 2 Stage Cage Whisper Trim III Cage WhisperFlo Cage
	-198 to 593°C (-325 to 1100°F)	-198 to 593°C (-325 to 1100°F)
Full Capacity Valves	**Part Number**	**Part Number**
NPS 1 & 1-1/4	RGASKETX162	RGASKETX422
NPS 1-1/2 (NPS 2 EAT)	RGASKETX172	RGASKETX432
NPS 2	RGASKETX182	RGASKETX442
NPS 2-1/2 (NPS 3 EAT)	RGASKETX192	RGASKETX452
NPS 3 (NPS 4 EAT)	RGASKETX202	RGASKETX462
NPS 4 (NPS 6 EAT)	RGASKETX212	RGASKETX472
NPS 6	RGASKETX222	RGASKETX482
NPS 8	RGASKETX232	10A3265X152
Restricted Capacity Valves w/ Metal Seating		
NPS 1-1/2 x 1 (NPS 2 x 1 EAT)	RGASKETX242	---
NPS 2 x 1	RGASKETX252	---
NPS 2-1/2 x 1-1/2 (NPS 3 x 1-1/2 EAT)	RGASKETX262	---
NPS 3 x 2 (NPS 4 x 2 EAT)	RGASKETX272	---
NPS 4 x 2-1/2 (NPS 6 x 2-1/2 EAT)	RGASKETX282	---

Packing Kits

Standard Packing Repair Kits (Non Live-Loaded)

Standard Packing Repair Kits (Non Live-Loaded)

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)	25.4 (1) 127 (5)	31.8 (1-1/4) 127 (5, 5H)
PTFE (Contains keys 6, 8, 10, 11, and 12)	RPACKX00012	RPACKX00022	RPACKX00032	RPACKX00342	RPACKX00352
Double PTFE (Contains keys 6, 8, 11, and 12)	RPACKX00042	RPACKX00052	RPACKX00062	RPACKX00362	RPACKX00372
PTFE/Composition (Contains keys 7, 8, 11, and 12)	RPACKX00072	RPACKX00082	RPACKX00092	---	---
Single Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring], 8, and 11)	RPACKX00102	RPACKX00112	RPACKX00122	---	---
Single Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring], and 11)	---	---	---	RPACKX00532	RPACKX00542
Single Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring])	RPACKX00132	RPACKX00142	RPACKX00152	---	---
Double Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring], 8, and 11)	RPACKX00162	RPACKX00172	RPACKX00182	---	---

ENVIRO-SEAL Packing Retrofit Kits

Retrofit kits include parts to convert valves with existing standard bonnets to the ENVIRO-SEAL packing box construction. Refer to figure 11 for key numbers for PTFE packing, to figure 12 for key numbers for Graphite ULF packing, and to figure 13 for key numbers for duplex packing. PTFE kits include keys 200, 201, 211, 212, 214, 215, 216, 217, 218, tag, and cable tie. Graphite ULF kits include keys 200, 201, 207, 208, 209, 210, 211, 212, 214, 217, tag, and cable tie. Duplex kits include keys 200, 201, 207, 209, 211, 212, 214, 215, 216, 217, tag, and cable tie.

Stems and packing box constructions that do not meet Emerson Process Management stem finish specifications, dimensional tolerances, and design specifications, may adversely alter the performance of this packing kit.

For part numbers of individual components in the ENVIRO-SEAL packing kits, refer to instruction manual ENVIRO-SEAL Packing System for Sliding-Stem Valves, D101642X012.

ENVIRO-SEAL Packing Retrofit Kits

PACKING MATERIAL	STEM DIAMETER AND YOKE BOSS DIAMETER, mm (INCH)				
	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)	25.4 (1) 127 (5)	31.8 (1-1/4) 127 (5, 5H)
Double PTFE	RPACKXRT012	RPACKXRT022	RPACKXRT032	RPACKXRT042	RPACKXRT052
Graphite ULF	RPACKXRT262	RPACKXRT272	RPACKXRT282	RPACKXRT292	RPACKXRT302
Duplex	RPACKXRT212	RPACKXRT222	RPACKXRT232	RPACKXRT242	RPACKXRT252

ENVIRO-SEAL Packing Repair Kits

Repair kits include parts to replace the “soft” packing materials in valves that already have ENVIRO-SEAL packing arrangements installed or in valves that have been upgraded with ENVIRO-SEAL retrofit kits. Refer to figure 11 for key numbers for PTFE packing, to figure 12 for key numbers for Graphite ULF packing, and to figure 13 for key numbers for duplex packing. PTFE repair kits include keys 214, 215, and 218. Graphite ULF repair kits include keys 207, 208, 209, 210, and 214. Duplex repair kits include keys 207, 209, 214, and 215.

Stems and packing box constructions that do not meet Emerson Process Management stem finish specifications, dimensional tolerances, and design specifications, may adversely alter the performance of this packing kit.

For part numbers of individual components in the ENVIRO-SEAL packing kits, refer to instruction manual ENVIRO-SEAL Packing System for Sliding-Stem Valves, D101642X012.

ENVIRO-SEAL Packing Repair Kits

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)	25.4 (1) 127 (5)	31.8 (1-1/4) 127 (5, 5H)
Double PTFE (contains keys 214, 215, & 218)	RPACKX00192	RPACKX00202	RPACKX00212	RPACKX00222	RPACKX00232
Graphite ULF (contains keys 207, 208, 209, 210, and 214)	RPACKX00592	RPACKX00602	RPACKX00612	RPACKX00622	RPACKX00632
Duplex (contains keys 207, 209, 214, and 215)	RPACKX00292	RPACKX00302	RPACKX00312	RPACKX00322	RPACKX00332

Figure 10. Typical HIGH-SEAL Graphite ULF Packing System

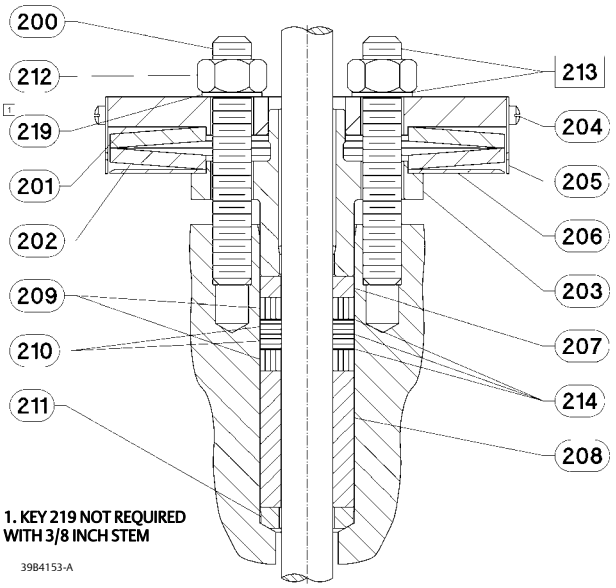


Figure 11. Typical ENVIRO-SEAL Packing System with PTFE Packing

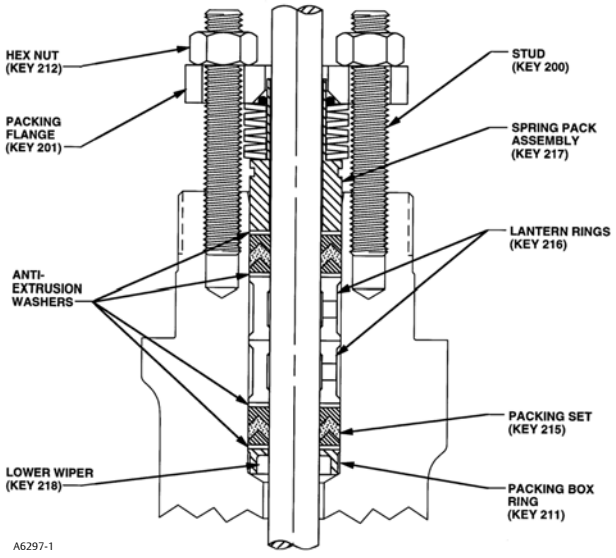


Figure 12. Typical ENVIRO-SEAL Packing System with Graphite ULF Packing

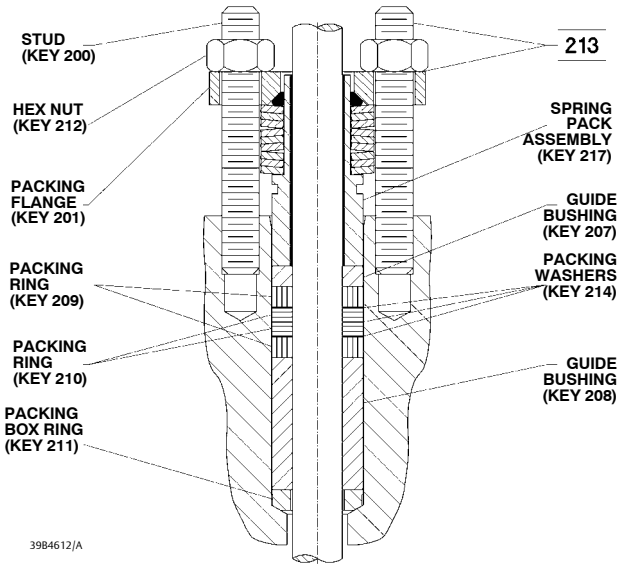
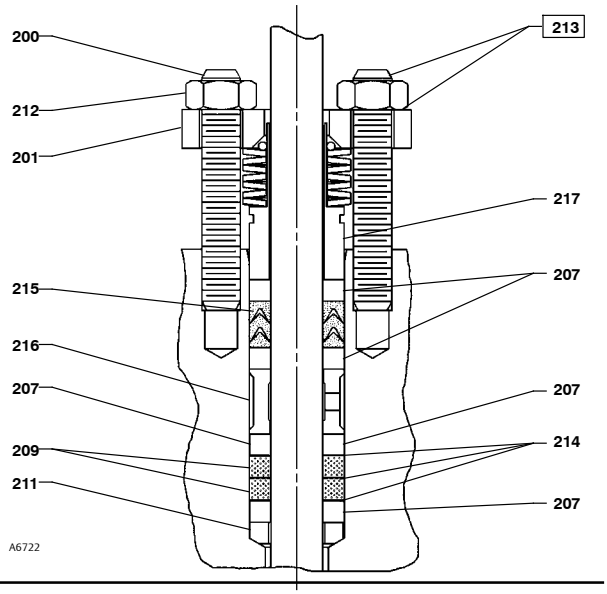


Figure 13. Typical ENVIRO-SEAL Packing System with Duplex Packing



Parts List

Note
Part numbers are shown for recommended spares only. For part numbers not shown, contact your Emerson Process Management sales office.

Bonnet (figures 3 through 9 and figure 14)

Key	Description	Part Number
1	Bonnet/ENVIRO-SEAL bellows seal bonnet If you need a bonnet or an ENVIRO-SEAL bellows seal bonnet as a replacement part, order by valve size and stem diameter, serial number, and desired material.	
2	Extension Bonnet Baffle	
3	Packing Flange	
3	ENVIRO-SEAL bellows seal packing flange	
4	Packing Flange Stud	
4	ENVIRO-SEAL bellows seal stud bolt	
5	Packing Flange Nut	
5	ENVIRO-SEAL bellows seal hex nut	
6*	Packing set, PTFE	see following table
6*	ENVIRO-SEAL bellows seal packing set	
	PTFE for 9.5 mm (3/8 inch) stem (1 req'd for single packing, 2 req'd for double packing)	12A9016X012
	PTFE for NPS 2 with 12.7 mm (1/2 inch) stem (2 req'd for double packing)	12A9016X012
	PTFE for NPS 3 and 4 with 12.7 mm (1/2 inch) stem (2 req'd for double packing)	12A8832X012
7*	Packing ring, PTFE composition	see following table
7*	ENVIRO-SEAL bellows seal packing ring	
	for low chloride graphite ribbon/filament packing arrangement	
	Ribbon packing ring for 9.5 mm (3/8 inch) and NPS 2 with 12.7 mm (1/2 inch) stem (4 req'd)	18A0908X012
	Filament packing ring for 9.5 mm (3/8 inch) and NPS 2 with 12.7 mm (1/2 inch) stem (4 req'd)	1P3905X0172
	Ribbon packing ring for NPS 3 and 4 with 12.7 mm (1/2 inch) stem (4 req'd)	18A0918X012
	Filament packing ring for NPS 3 and 4 with 12.7 mm (1/2 inch) stem (4 req'd)	14A0915X042
8	Spring	
8	Lantern ring	
8	ENVIRO-SEAL bellows seal spring	
8	ENVIRO-SEAL bellows seal spacer	
10	Special washer	
11*	Packing Box Ring, S31600	
	9.5 mm (3/8 inch) stem,	1J873135072
	12.7 mm (1/2 inch) stem,	1J873235072
	19.1 mm (3/4 inch) stem,	1J873335072
	25.4 mm (1-inch) stem,	1J873435072
	31.8 mm (1-1/4 inch) stem,	1J873535072
12*	Upper Wiper, felt	
	9.5 mm (3/8 inch) stem	1J872606332
	12.7 mm (1/2 inch) stem	1J872706332
	19.1 mm (3/4 inch) stem	1J872806332
	25.4 mm (1-inch) stem	1J872906332
	31.8 mm (1-1/4 inch) stem	1J873006332
12*	ENVIRO-SEAL bellows seal upper wiper	
	For 9.5 mm (3/8 inch) and NPS 2 with 12.7 mm (1/2 inch) stem	18A0868X012
	For NPS 3 and 4 with 12.7 mm (1/2 inch) stem	18A0870X012
13	Packing Follower	
13*	ENVIRO-SEAL bellows seal bushing	
	For 9.5 mm (3/8 inch) stem (1 req'd), for NPS 2 with 12.7 mm (1/2 inch) stem (2 req'd)	
	S31600/PTFE	18A0820X012
	R30006	18A0819X012
	S31600/Cr Coated	11B1155X012
	For NPS 3 and 4 with 12.7 mm (1/2 inch) stem (1 req'd)	
	S31600/PTFE	18A0824X012
	R30006	18A0823X012
	S31600/Cr Coated	11B1157X012
13*	ENVIRO-SEAL bellows seal bushing/liner	
	For 9.5 mm (3/8 inch) stem (1 req'd), for NPS 2 with 12.7 mm (1/2 inch) stem (2 req'd)	
	N10276 bushing, PTFE/glass liner	12B2713X012
	N10276 bushing, PTFE/carbon liner	12B2713X042
	For NPS 3 and 4 with 12.7 mm (1/2 inch) stem (1 req'd)	
	N10276 bushing, PTFE/glass liner	12B2715X012
	N10276 bushing, PTFE/carbon liner	12B2715X042
14	Pipe Plug	
14	Lubricator	
14	Lubricator/Isolating Valve	
15	Yoke Locknut	
15	ENVIRO-SEAL bellows seal Locknut	
16	Pipe Plug	
16	ENVIRO-SEAL bellows seal pipe plug	
20*	ENVIRO-SEAL bellows seal stem/bellows assembly	
	1 Ply Bellows	
	S31600 trim mat'l, N06625 bellows mat'l	
	NPS 1 w/ 9.5 mm (3/8 inch) stem	32B4224X012
	NPS 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X012
	NPS 2 w/ 12.7 mm (1/2 inch) stem	32B4226X012
	NPS 3 w/ 12.7 mm (1/2 inch) stem	32B4227X012
	NPS 4 w/ 12.7 mm (1/2 inch) stem	32B4228X012
	N06022 trim mat'l, N06022 bellows mat'l	
	NPS 1 w/ 9.5 mm (3/8 inch) stem	32B4224X022
	NPS 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X022
	NPS 2 w/ 12.7 mm (1/2 inch) stem	32B4226X022
	NPS 3 w/ 12.7 mm (1/2 inch) stem	32B4227X022
	NPS 4 w/ 12.7 mm (1/2 inch) stem	32B4228X022
	2 Ply Bellows	
	S31600 trim mat'l, N06625 bellows mat'l	
	NPS 1 w/ 9.5 mm (3/8 inch) stem	32B4224X032
	NPS 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X032
	NPS 2 w/ 12.7 mm (1/2 inch) stem	32B4226X032
	NPS 3 w/ 12.7 mm (1/2 inch) stem	32B4227X032

*Recommended spare parts

Keys 6*, 7*, 8, and 10 Packing Box Parts(1)

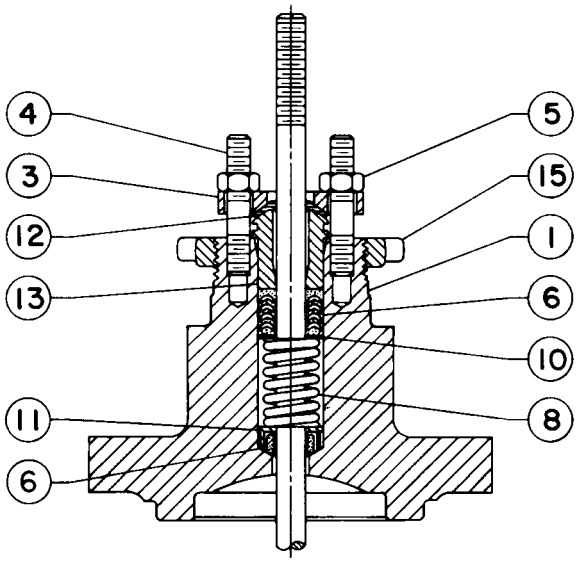
DESCRIPTION			KEY NO.	STEM DIAMETER, mm (INCHES)				
				9.5 (3/8)	12.7 (1/2)	19.1 (3/4)	25.4 (1)	31.8 (1-1/4)
PTFE V-Ring Packing	Packing Set, PTFE (1 req'd for single, 2 req'd for double)(2)		6	1R290001012	1R290201012	1R290401012	1R290601012	1R290801012
	Spring, Stainless Steel (for single only)		8	1F125437012	1F125537012	1F125637012	1D582937012	1D387437012
	Lantern Ring, Stainless Steel (for double only)		8	1F364135072	1J962335072	0N028435072	0U099735072	0W087135072
	Quantity required	Double	– – –	1	2	1	1	1
	Special Washer, Stainless Steel (for single only)		10	1F125236042	1F125136042	1F125036042	1H982236042	1H995936042
PTFE/ Composition Packing	Packing Ring, PTFE composition		7	1F3370X0012	1E319001042	1E319101012	1D7518X0012	1D7520X0012
	Quantity required	Double	– – –	7	10	8	8	8
	Lantern Ring, Stainless Steel (1 required)		8	1F364135072	1J962335072	0N028435072	0U099735072	0W087135072
Graphite Ribbon/ Filament	Graphite Ribbon Ring		7	1V3160X0022	1V3802X0022	1V2396X0022	1U6768X0022	1V5666X0022
	Quantity required	Single	– – –	2	2	2	2	2
		Double	– – –	3	3	3	3	3
	Graphite Filament Ring		7	1F3370X0322	1E3190X0222	1E3191X0282	1D7518X0132	1D7520X0162
	Quantity required	Single	– – –	2	2	3	3	3
		Double	– – –	4	4	5	5	5
	Lantern Ring		8	1F364135072	1J962335072	0N028435072	0U099735072	0W087135072
	Quantity required	Single	– – –	2	3	2	2	2
		Double	– – –	1	2	1	1	1
	Warning Tag			11B9513X012	11B9513X012	11B9513X012	11B9513X012	11B9513X012

1. For ENVIRO-SEAL or HIGH-SEAL packing box parts, see instruction manual ENVIRO-SEAL Packing System for Sliding-Stem Valves, D101642X012 or HIGH-SEAL Live-Loaded Packing System, D101453X012.
2. Key 6 for double construction contains one extra packing ring for the 9.5 mm (3/8 inch) stem and one extra lower wiper for all sizes. Discard upon assembly.

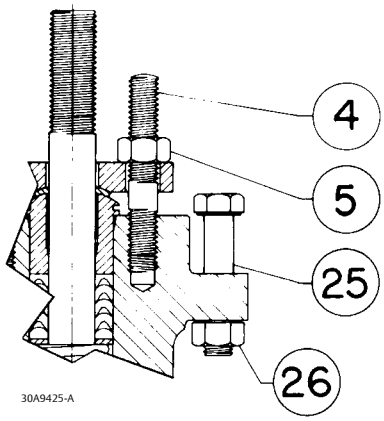
Key	Description	Part Number
	NPS 4 w/ 12.7 mm (1/2 inch) stem N06022 trim mat'l, N06022 bellows mat'l	32B4228X032
	NPS 1 w/ 9.5 mm (3/8 inch) stem	32B4224X042
	NPS 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X042
	NPS 2 w/ 12.7 mm (1/2 inch) stem	32B4226X042
	NPS 3 w/ 12.7 mm (1/2 inch) stem	32B4227X042
	NPS 4 w/ 12.7 mm (1/2 inch) stem	32B4228X042
22*	ENVIRO-SEAL bellows seal bonnet gasket (graphite/S31600)	
	NPS 1/2 through 1-1/4	12B6316X022
	NPS 1-1/2	12B6317X022
	NPS 2	12B6318X022
	NPS 3	12B6319X022
	NPS 4	12B6320X022
24	ENVIRO-SEAL bellows seal adaptor	
25	Cap Screw	
26	Hex Nut	
27	Pipe Nipple for lubricator/isolating valve	
28	ENVIRO-SEAL bellows seal nameplate, warning	
29	ENVIRO-SEAL bellows seal drive screw	
34	Lubricant, Anti-Seize (not included with valve)	
36*	ENVIRO-SEAL bellows seal pin	12B3951X012
37	ENVIRO-SEAL bellows seal warning tag	
38	ENVIRO-SEAL bellows seal tie	
39	ENVIRO-SEAL bellows seal thrust ring	

*Recommended spare parts

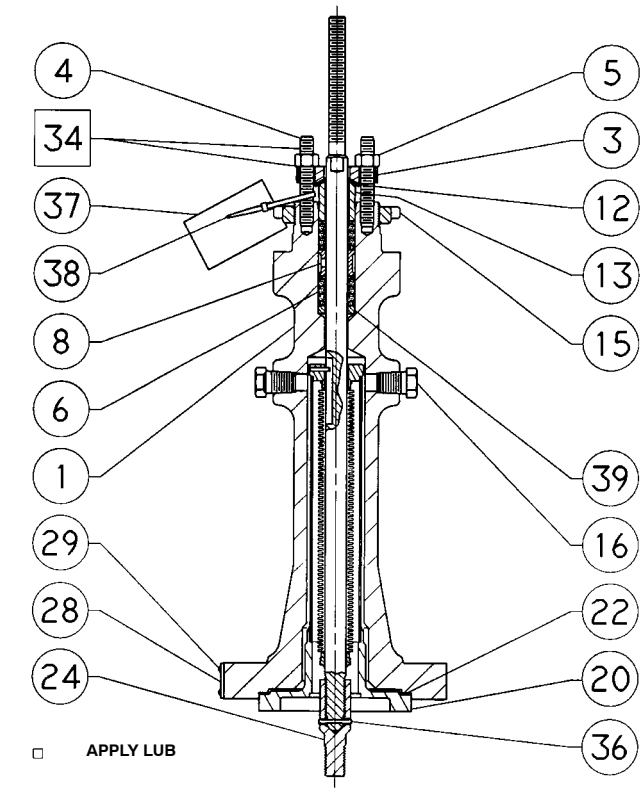
Figure 14. Typical Bonnets



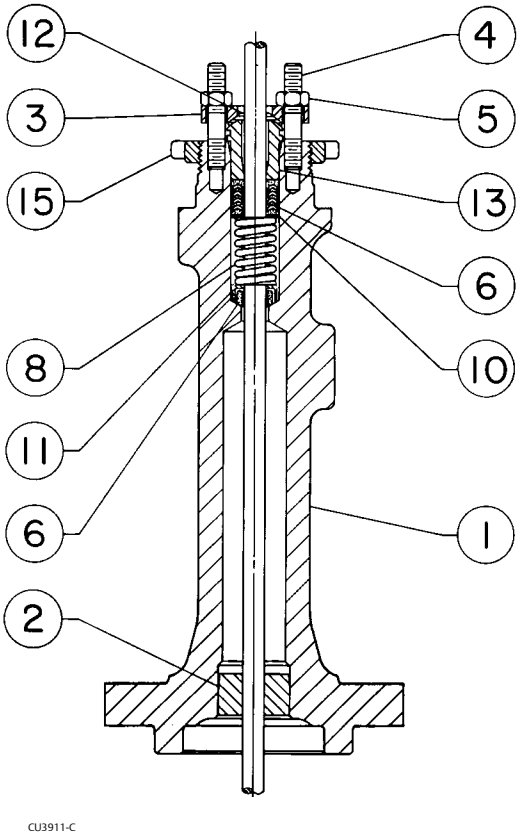
PLAIN BONNET



DETAIL OF 127 mm (5-INCH) YOKE BOSS ACTUATOR BOLTING

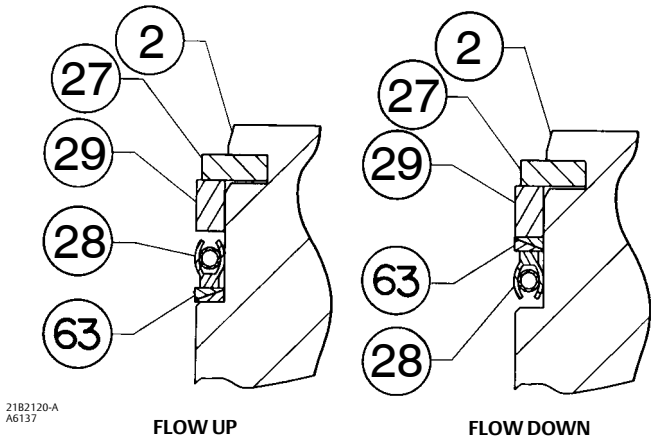


ENVIRO-SEAL BELLOWS SEAL BONNET



STYLE 1 OR 2 EXTENSION BONNET

Figure 15. Alternate Configurations



NPS 1 TO 8 ET USING PEEK ANTI-EXTRUSION RINGS

Key	Description	Part Number
	Valve Body (figures 16 through 21)	
1	Valve Body If you need a valve body as a replacement part, order by valve size, serial number, and desired material.	
2*	Valve plug	see following table
3*	Cage	see following table
4	Trim adaptor	
5	Trim adaptor	
7*	Valve plug stem	see following table
8*	Pin, 316 Stainless Steel	
	9.5 mm (3/8 inch) stem	1V322635072
	12.7 mm (1/2 inch) stem	1V322735072
	19.1 mm (3/4 inch) stem	1V326035072
	25.4 mm (1 inch) or 31.8 mm (1-1/4 inch) stem	1V334035072
9*	Liner	see following table
9*	Seat Ring	see following table
10*	Bonnet Gasket	see following table
11*	Cage Gasket	see following table
12*	Spiral-Wound Gasket	see following table
13*	Seat Ring or Liner Gasket	see following table
14*	Adaptor Gasket	see following table
15	Cap Screw	
15	Stud	
16	Nut	
17	Pipe Plug, for use in valves with drain tapping only	
18	Flow Direction Arrow	
19	Drive Screw, Stainless Steel	
20*	Adaptor Gasket	see following table
21*	Seat Disk Retainer	see following table
22*	Disk Seat	see following table
23*	Disk	see following table
24*	Seal Ring (EAT)	see following table
25*	Backup Ring (EAT)	see following table
26	Load Ring (for NPS 8 ET only)	
27*	Retaining Ring	see following table
27*	Shim (EAT)	see following table
28*	Seal Ring (ET)	see following table
29*	Backup Ring (ET)	see following table
31*	Whisper Trim III Cage Retainer for Levels A3, B3 & C3 (NPS 6 ET only)	
	410 Stainless steel	22A3255X012
	WCC steel (ENC)	22A3256X012
	316 Stainless Steel (ENC)	22A3256X022
	316 Stainless Steel w/CoCr-A bore	22A3257X012
	316 Stainless Steel (Cr Cr)	31A9792X012
31*	Whisper Trim III Cage Retainer & Baffle Ass'y for Level D3 (NPS 6 ET only)	
	410 Stainless Steel retainer & steel baffle	22A3258X012
	WCC steel (ENC) retainer & steel baffle	22A3258X022
	316 Stainless Steel (ENC) retainer & steel baffle	22A3258X052
	316 Stainless Steel w/CoCr-A retainer & steel baffle	22A3258X032
	316 Stainless steel (ENC) retainer & 316 stainless steel baffle	22A3258X042
	316 Stainless Steel (Cr Cr) retainer & 316 Stainless Steel baffle	22A3258X062
32	Cavitrol III Bonnet Spacer	
32	Whisper Trim III Bonnet Spacer (NPS 6 ET only)	
51*	Shim	see following table
54	Wire	
63*	Anti-Extrusion Ring	see following table

*Recommended spare parts

Figure 16. NPS 1 Through 6 Fisher ET and EAT Valves

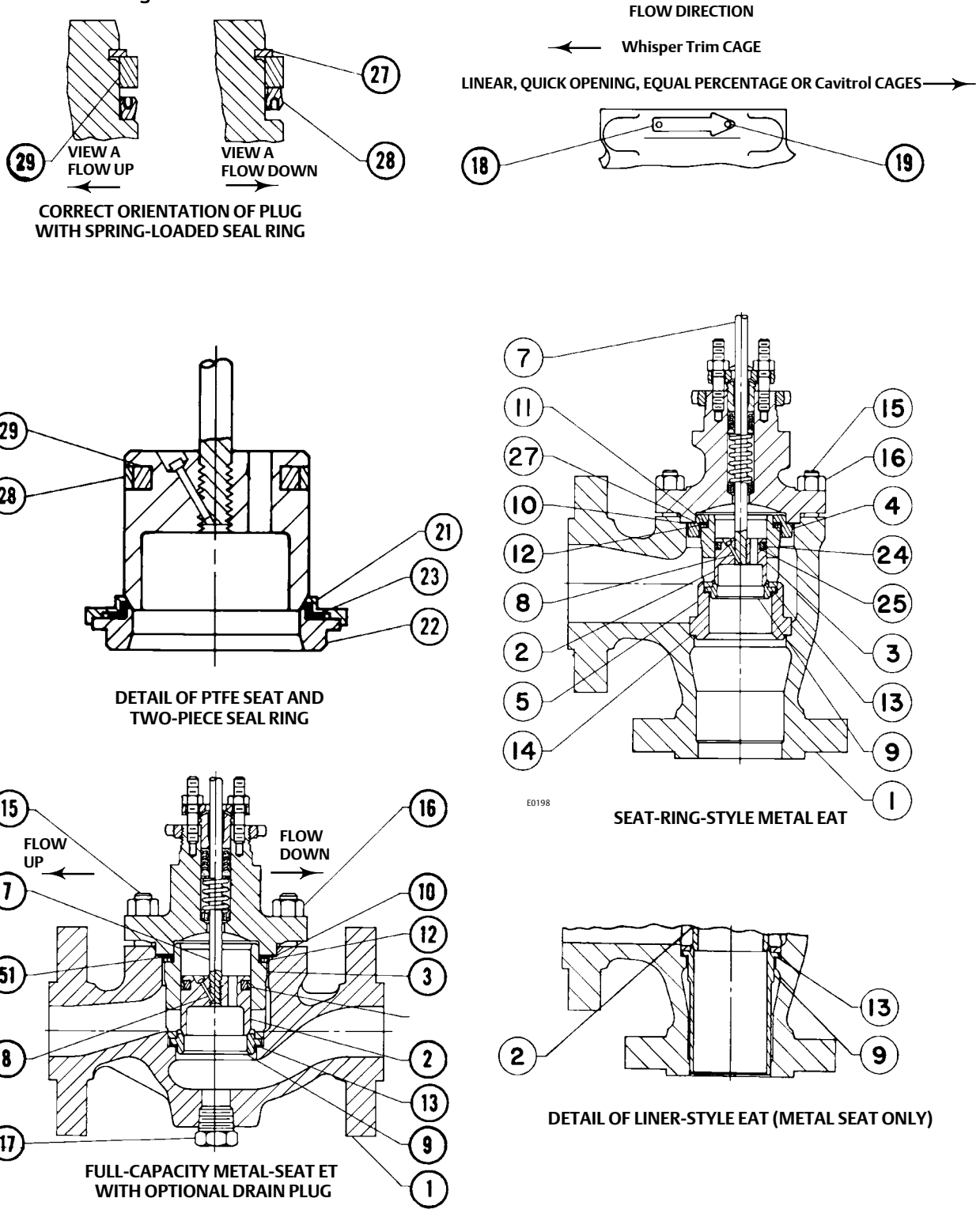


Figure 17. Fisher ET Valve Assembly with Whisper Trim III Cage and Optional Drain Plug

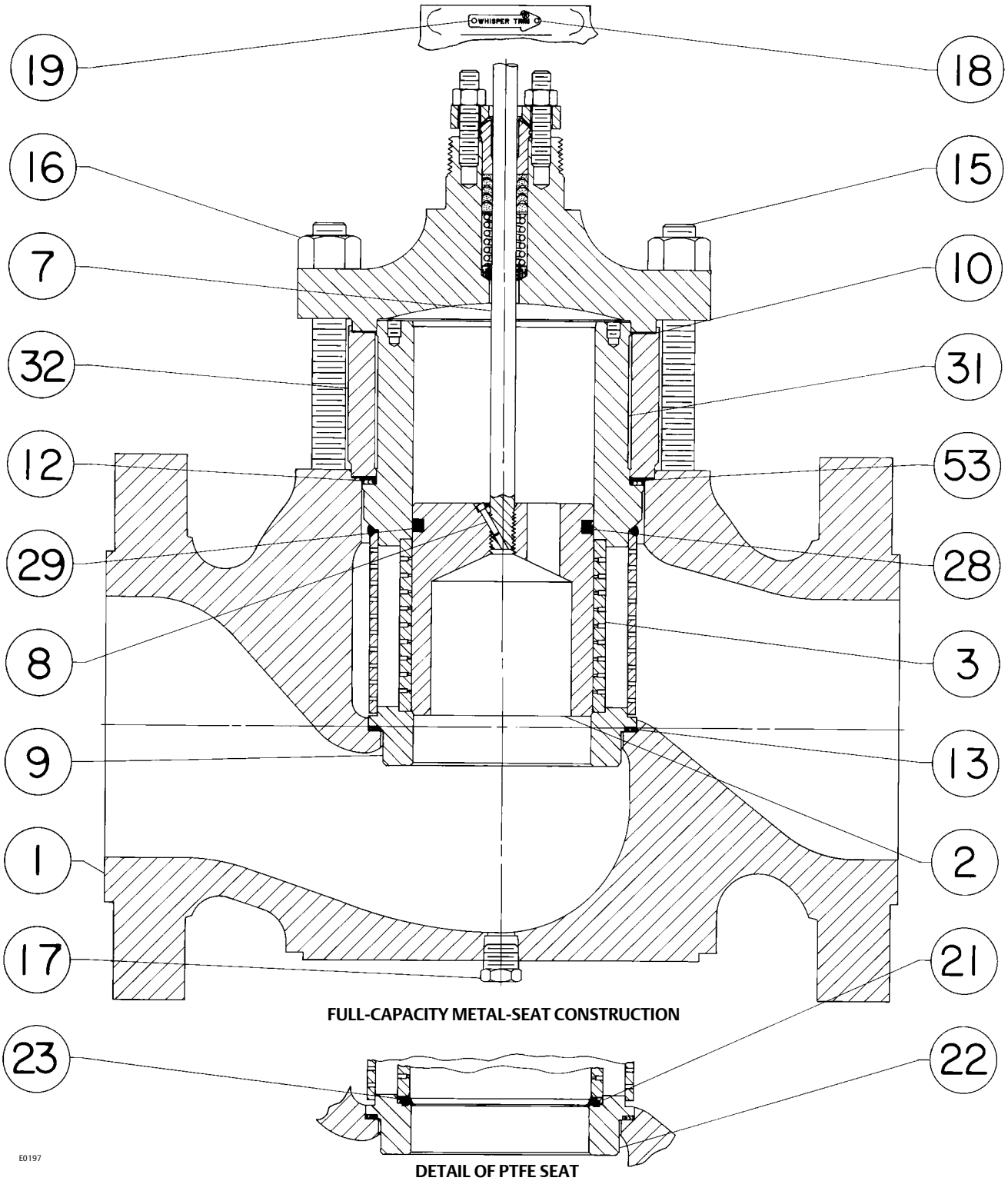


Figure 18. Fisher ET Valve Assembly with WhisperFlo Cage and Optional Drain Plug

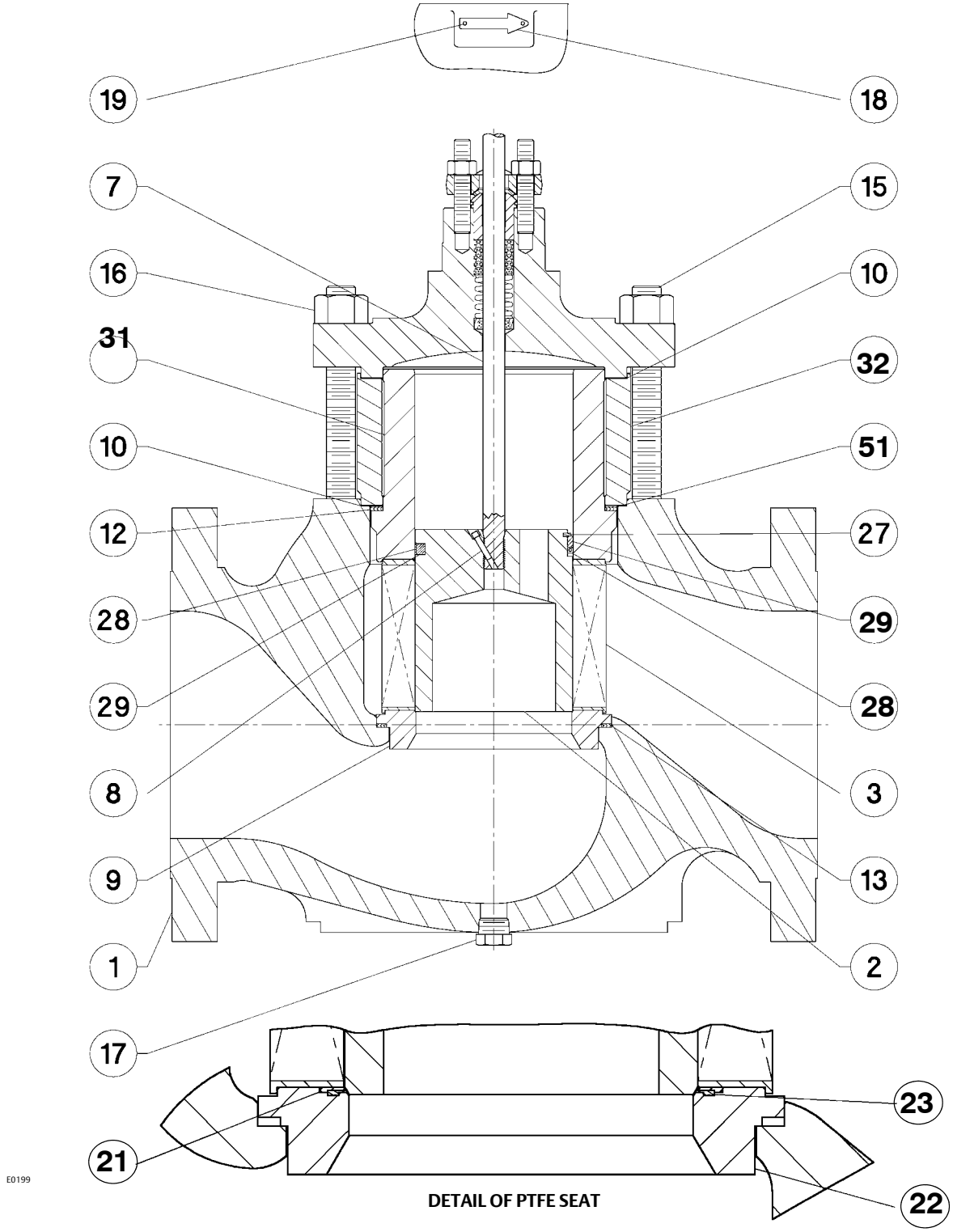


Figure 19. NPS 8 Fisher ET Valve Assembly with WhisperFlo Cage and Optional Drain Plug

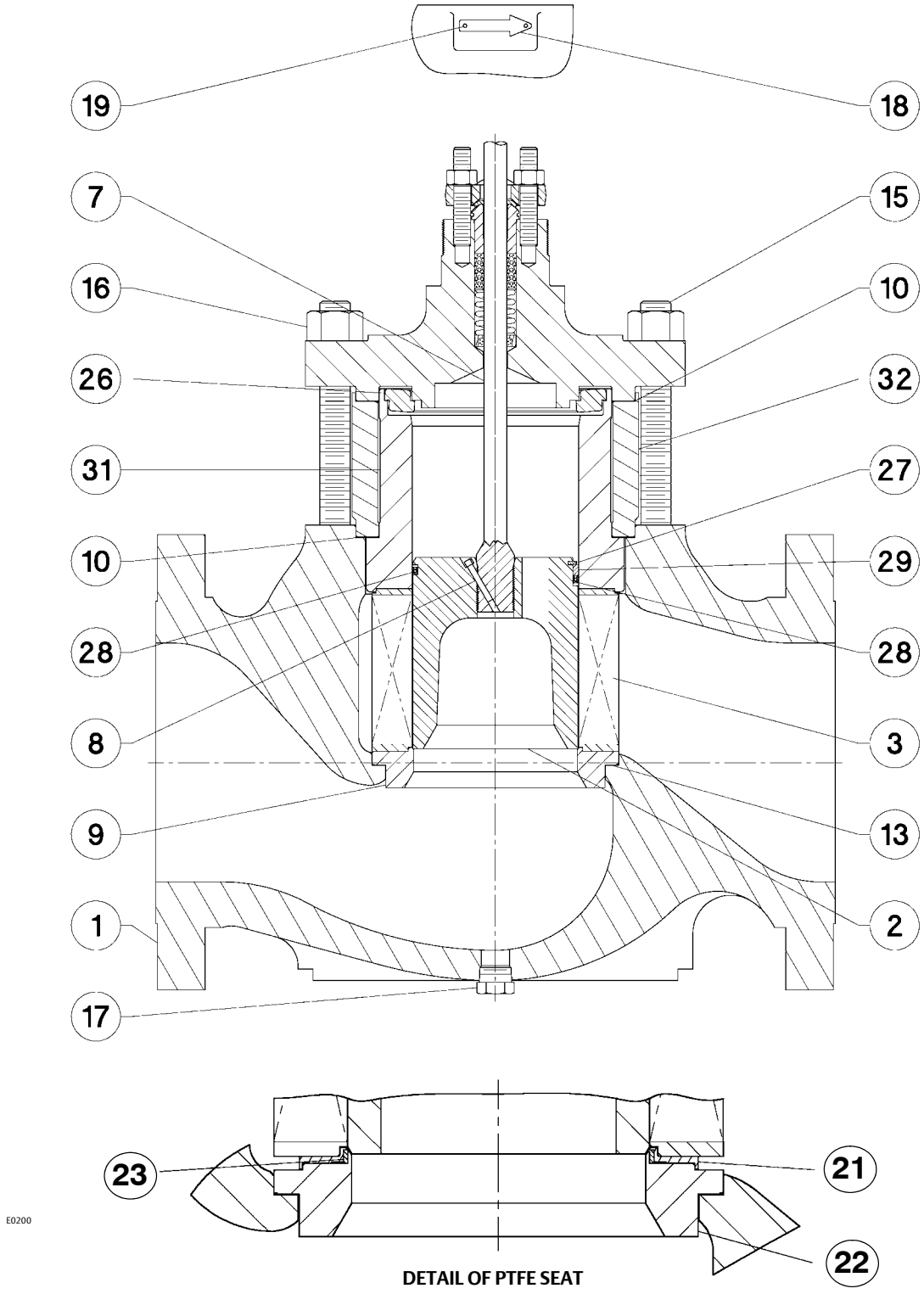
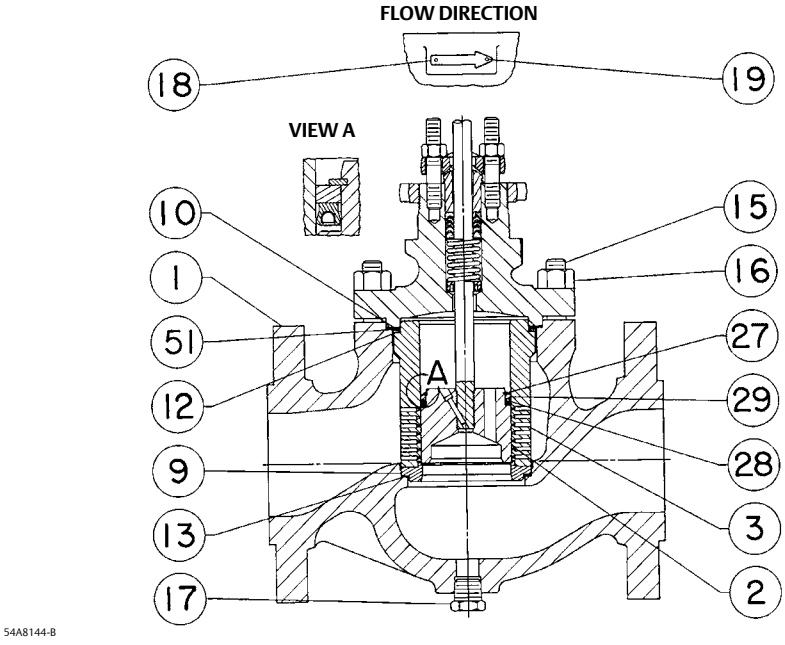
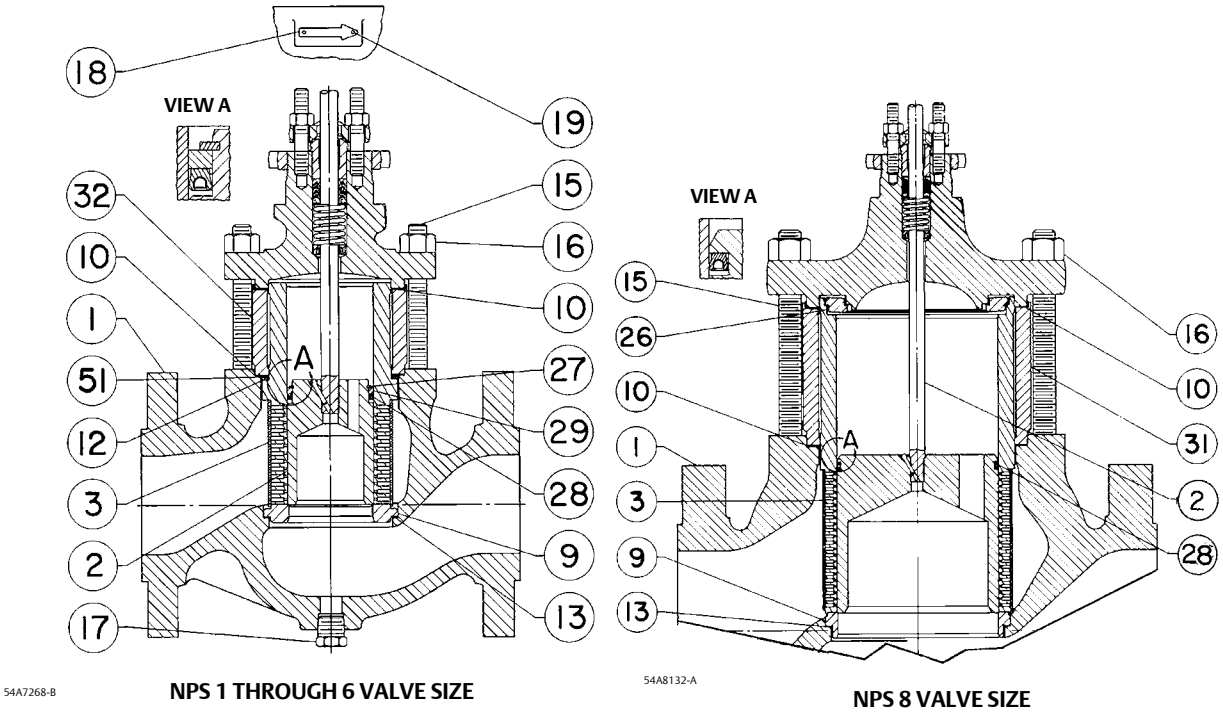


Figure 20. Details of Cavitrol III and NPS 8 Fisher ET Valves with Optional Drain Plug



1-STAGE Cavitrol III CONSTRUCTIONS THRU NPS 6 SHOWING CORRECT ORIENTATION OF PLUG WITH SPRING-LOADED SEAL RING

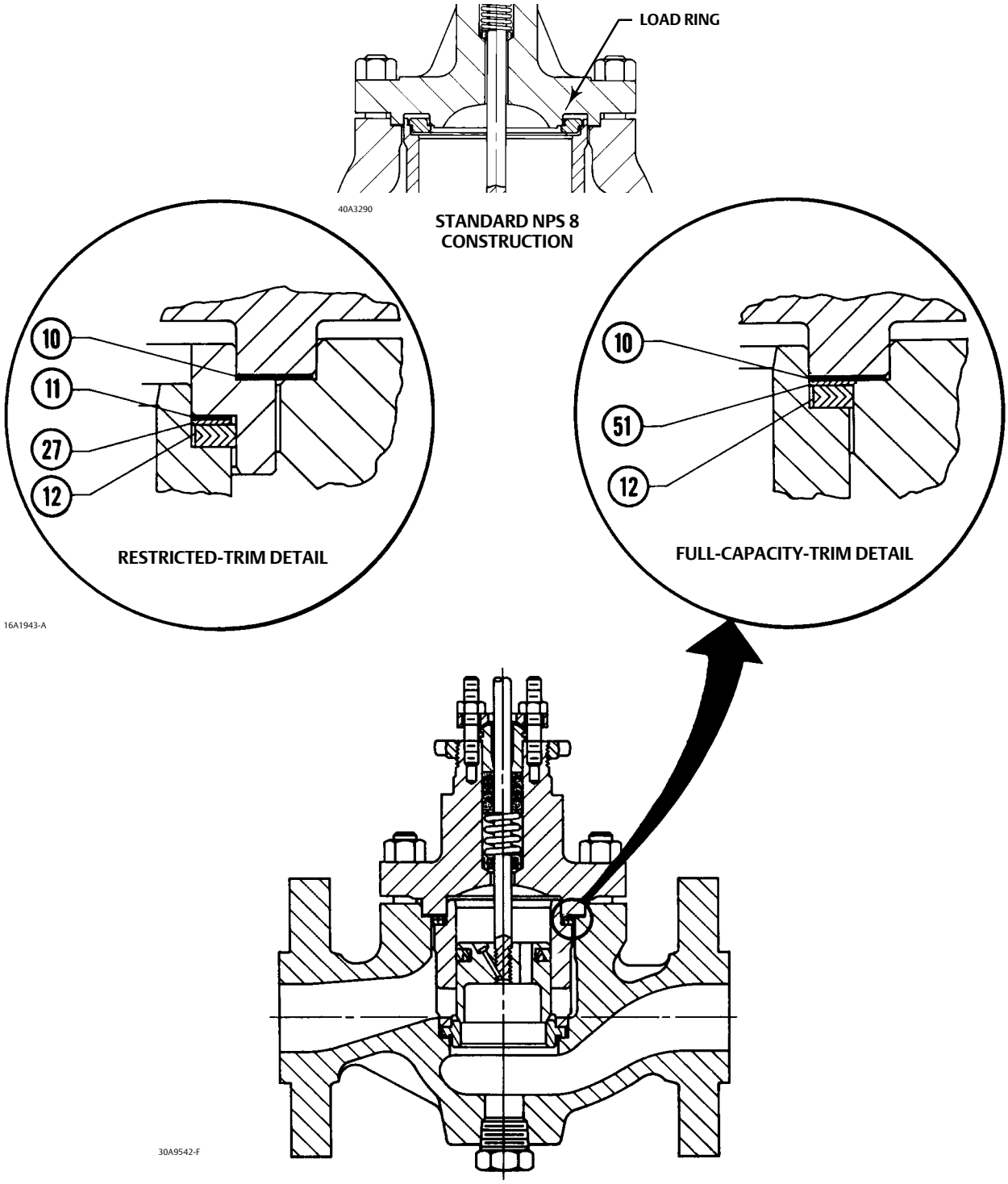


NPS 1 THROUGH 6 VALVE SIZE

NPS 8 VALVE SIZE

PLUG AND SEAL RING WITH SPRING LOADING SHOWN IN CORRECT ORIENTATION FOR 2-STAGE Cavitrol III CAGE

Figure 21. Gasket Set Detail shown with Optional Drain Plug



Actuator Groups

<table>
<tr><td rowspan="11">Group 1
54 mm (2-1/8 inches),
71 mm (2-13/16 inches),
or 90 mm (3-9/16 inches) Yoke Boss

585C

1B

618

644 & 645

657 & 667—76.2 mm (3 inches) maximum travel

1008—71.4 mm (2-13/16 inches) Yoke Boss</td><td rowspan="3">Group 100
127 mm (5 inches) Yoke Boss
3 inches maximum travel

585C
657
1008</td><td rowspan="4">657
657 MO
657-4
657-4 MO
667
667 MO
667-4
667-4 MO</td><td>667
667-4</td></tr>
<tr><td>Group 405
127 mm (5 inches) Yoke Boss
4 inches maximum travel</td></tr>
<tr><td>657 MO
657-4 MO</td></tr>
<tr><td>Group 402
90.5 mm (3-9/16 inches) Yoke Boss
4 inches maximum travel</td><td>Group 406
127 mm (5 inches) Yoke Boss
4 inches maximum travel</td></tr>
<tr><td>Group 101
127 mm (5 inches) Yoke Boss
3 inches maximum travel</td><td>457-7
585C</td><td>667 MO
667-4 MO</td></tr>
<tr><td>667</td><td>Group 403
90.5 mm (3-9/16 inches) Yoke Boss
4 inches maximum travel</td><td>Group 407
127 mm (5 inches) Yoke Boss
4 inches maximum travel</td></tr>
<tr><td>Group 400
71.4 mm (2-13/16 inches)
Yoke Boss
4 inches maximum travel</td><td>585C
1008</td><td>585C
657</td></tr>
<tr><td rowspan="2">585C</td><td>Group 801
90.5 mm (3-9/16 inches) Yoke Boss
8 inches maximum travel</td><td>Group 802
127 mm (5 inches) Yoke Boss
8 inches maximum travel</td></tr>
<tr><td>585C</td><td>585C</td></tr>
</table>

Key 2* Valve Plug for Constructions with Two-Piece Seal Ring

VALVE SIZE, NPS		STEM DIAMETER		416 STAINLESS STEEL HARDENED (STD)	316 STAINLESS STEEL[1]	316 STAINLESS STEEL w/CoCr-A ON SEAT[1]	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE[1]
ET	EAT	mm	Inches				
1, 1-1/4, or 1-1/2 x 1	1 or 2 x 1	9.5 12.7	3/8 1/2	1V657146172 1V657246172	1V657135072 1V657235072	11A5315X012 11A5316X012	11A5317X012 11A5318X012
1-1/2	2	9.5 12.7	3/8 1/2	1V657346172 1V657446172	1V657335072 1V657435072	11A5321X012 10A4439X012	10A4438X012 10A4611X012
2 or 3 x 2	4 x 2	12.7 19.1	1/2 3/4	1V657546172 1V657646172	1V657535072 1V657635072	11A5324X012 11A5325X012	11A5326X012 11A5327X012
2 x 1	- - -	12.7	1/2	1V657246172	1V657235072	11A5316X012	11A5318X012
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	12.7 19.1	1/2 3/4	1V657746172 1V657846172	1V657735072 1V657835072	11A5330X012 11A5331X012	11A5332X012 11A5333X012
2-1/2 x 1-1/2	3 x 1-1/2	12.7	1/2	1V657446172	1V657435072	10A4439X012	10A4611X012
3	4	12.7 19.1	1/2 3/4	1V657946172 1V658046172	1V657935072 1V658035072	11A5336X012 11A5014X012	11A5337X012 11A5338X012
4	6	12.7 19.1 25.4	1/2 3/4 1	1V658146172 1V6582X0022 1V658346172	1V658135072 1V6582X0072 1V658335072	11A5341X012 11A5342X012 11A5343X012	11A5344X012 11A5345X042 11A5346X012
6	- - -	19.1 25.4 31.8	3/4 1 1-1/4	1V658446172 1V658546172 1V658646172	1V658435072 1V658535072 1V658635072	11A5350X012 10A5107X012 10A5108X012	11A5351X012 20A0103X012 20A4608X012

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F).

*Recommended spare parts

Keys 2*, 7*, and 8* Valve Plug and Stem Assembly for Plain Bonnet with Two-Piece Seal Ring

VALVE SIZE, NPS		STEM DIAMETER		416 STAINLESS STEEL HARDENED (STD)	316 STAINLESS STEEL(1)	316 STAINLESS STEEL w/CoCr-A ON SEAT(1)	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE(1)
ET	EAT	mm	Inches				
1 or 1-1/4	1	9.5 12.7	3/8 1/2	1V6571X0032 1V6572X0022	1V6571X0052 1V6572X0062	11A5315X032 11A5316X022	11A5317X042 11A5318X042
1-1/2	2	9.5 12.7	3/8 1/2	1V6573X0042 1V6574X0012	1V6573X0052 1V6574X0032	11A5321X022 ---	10A4438X022 10A4611X042
1-1/2 x 1	2 x 1	9.5 12.7	3/8 1/2	1V6571X0042 1V6572X0042	1V6571X0092 ---	--- ---	11A5317X072 11A5318X032
2 or 3 x 2	4 x 2	12.7 19.1	1/2 3/4	1V6575X0052 1V6576X0012	1V6575X0062 ---	11A5324X022 ---	11A5326X022 11A5327X032
2 x 1	---	12.7	1/2	1V6572X0022	1V6572X0062	11A5316X022	11A5318X042
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	12.7 19.1	1/2 3/4	1V6577X0042 1V6578X0012	1V6577X0062 1V6578X0022	11A5330X022 11A5331X022	11A5332X022 ---
2-1/2 x 1-1/2	3 x 1-1/2	12.7	1/2	1V6574X0012	1V6574X0032	---	10A4611X112
3	4	12.7	1/2	1V6579X0092	1V6579X0112	11A5336X032	11A5337X082
4	6	12.7 19.1	1/2 3/4	1V6581X0042 1V6582X0022	1V6581X0052 1V6582X0072	11A5341X032 ---	11A5344X022 11A5345X042
6	---	19.1	3/4	1V6584X0042	1V6584X0062	11A5350X032	21A5351X062

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F).

Keys 2*, 7*, and 8* Valve Plug and Stem Assembly for Style 1 Extension Bonnet with Two-Piece Seal Ring

VALVE SIZE, NPS		STEM DIAMETER		416 STAINLESS STEEL HARDENED (STD)	316 STAINLESS STEEL(1)	316 STAINLESS STEEL w/CoCr-A ON SEAT(1)	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE(1)
ET	EAT	mm	Inches				
1 or 1-1/4	1	9.5 12.7	3/8 1/2	1V6571X0072 1V6572X0032	1V6571X0062 ---	--- 11A5316X032	11A5317X082 ---
1-1/2	2	9.5 12.7	3/8 1/2	1V6573X0072 1V6574X0052	--- ---	11A5321X042 ---	10A4438X032 10A4611X112
1-1/2 x 1	2 x 1	9.5 12.7	3/8 1/2	1V6571X0102 1V6572X0152	--- ---	--- ---	11A5317X052 ---
2 or 3 x 2	4 x 2	12.7	1/2	1V6575X0182	1V6575X0122	11A5324X042	11A5326X062
2 x 1	---	12.7	1/2	1V6572X0032	---	11A5316X032	---
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	12.7	1/2	1V6577X0052	---	---	11A5332X202
2-1/2 x 1-1/2	3 x 1-1/2	12.7	1/2	1V6574X0052	---	---	10A4611X112
3	4	12.7	1/2	1V6579X0082	1V6579X0072	---	11A5337X062
4	6	12.7	1/2	1V6581X0072	1V6581X0062	---	11A5344X052
6	---	19.1	3/4	1V6584X0052	1V6584X0112	---	21A5351X052

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F).

Key 2* Valve Plug for Spring-Loaded Seal Ring Constructions

VALVE SIZE, NPS		STEM DIAMETER		416 STAINLESS STEEL HARDENED	316 STAINLESS STEEL[1]	316 STAINLESS STEEL w/CoCr-A SEAT & GUIDE[1]
ET	EAT	mm	Inches			
1, 1-1/4, or 1-1/2 x 1	1	9.5	3/8	20A4103X012	20A4103X022	20A4104X012
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	9.5 12.7	3/8 1/2	20A6711X012 20A4150X012	20A6711X022 20A4150X022	22A5941X012 20A4151X012
2 or 3 x 2	4 x 2	12.7 19.1	1/2 3/4	20A4097X012 20A4098X012	20A4097X022 20A4098X022	20A4099X012 20A4100X012
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	12.7 19.1	1/2 3/4	20A9533X012 20A4144X012	20A9533X022 20A4144X022	20A9534X012 20A4146X012
3	4	12.7 19.1	1/2 3/4	20A5414X012 20A5342X012	20A5414X022 20A5342X022	22A3458X012 20A5344X012
4	6	12.7 19.1 25.4	1/2 3/4 1	20A2641X012 20A4194X012 20A4195X012	20A2641X022 20A4194X0A2 20A4195X032	21A0187X012 20A4197X012 20A4198X012
6	- - -	19.1 25.4	3/4 1	20A2642X012 20A5621X012	20A2642X022 20A5621X022	21A8443X012 20A6706X012
8	- - -	19.1 25.4 31.8	3/4 1 1-1/4	21A5356X012 21A5357X012 21A5358X012	21A5356X022 21A5357X022 21A5358X022	21A5362X012 21A5363X012 21A5364X012

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F).

Keys 2*, 7*, and 8* Valve Plug and Stem Assembly for Plain Bonnet for Spring-Loaded Seal Ring Constructions

VALVE SIZE, NPS		STEM DIAMETER		416 STAINLESS STEEL HARDENED	316 STAINLESS STEEL[1]	316 STAINLESS STEEL w/CoCr-A SEAT & GUIDE[1]
ET	EAT	mm	Inches			
1, 1-1/4	1	9.5	3/8	20A4103X052	- - -	- - -
1-1/2	2	9.5 12.7	3/8 1/2	20A6711X032 20A4150X062	20A6711X042 - - -	22A5941X022 - - -
1-1/2 x 1	2 x 1	9.5	3/8	20A4103X042	- - -	- - -
2 or 3 x 2	4 x 2	12.7	1/2	20A4097X062	20A4097X182	20A4099X102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	12.7	1/2	20A9533X052	20A9533X062	20A9534X092
2-1/2 x 1-1/2	3 x 1-1/2	12.7	1/2	20A4150X062	- - -	- - -
3	4	12.7 19.1	1/2 3/4	20A5414X062 20A5342X082	20A5414X052 - - -	22A3458X022 20A5344X042
4	6	12.7 19.1	1/2 3/4	20A2641X042 20A4194X052	20A2641X162 - - -	- - - - - -
6	- - -	19.1	3/4	20A2642X052	20A2642X062	21A8443X032
8	- - -	19.1	3/4	21A5356X052	21A5356X132	21A5362X062

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F).

Key 2* 1-Stage Cavitrol III Valve Plug (Fisher ET only)

VALVE SIZE, NPS	STEM DIAMETER		420 STAINLESS STEEL	316 STAINLESS STEEL w/CoCr-A ON SEAT & GUIDE[1]
	mm	Inches		
1	12.7	1/2	28A1001X012	28A2226X012
1-1/2	12.7	1/2	28A1002X012	28A2227X012
2	12.7 19.1	1/2 3/4	28A1003X012 28A1004X012	28A2228X012 28A2229X012
2-1/2	12.7 19.1	1/2 3/4	28A1005X012 28A1006X012	28A2230X012 28A2231X012
3	12.7 19.1	1/2 3/4	28A1007X012 28A1008X012	28A2232X012 28A2233X012
4	19.1 25.4	3/4 1	28A1010X012 28A1011X012	28A2234X012 28A2235X012
6	25.4 31.8	1 1-1/4	28A1013X012 28A1014X012	28A2236X012 28A2237X012
8	25.4 31.8	1 1-1/4	28A1016X012 28A1017X012	28A2238X012 28A2239X012

1. Not for use with 17-4PH stainless steel cages above 210°C (410°F).

*Recommended spare parts

Key 2* 2-Stage Cavitrol III Valve Plug & Stem Ass'y (Fisher ET only)

VALVE SIZE, NPS	TRAVEL		ACTUATOR GROUP (FROM PRECEDING TABLE)	STEM DIAMETER		316 STAINLESS STEEL STEM		17-4PH STAINLESS STEEL STEM	
	mm	Inches		mm	Inches	420 HT Valve Plug	316 Stainless Steel Valve Plug w/CoCr-A Seat & Guide	420 HT Valve Plug	316 Stainless Steel Valve Plug w/CoCr-A Seat & Guide
1	25	1	1	12.7	1/2	24A5265X022	24A5519X022	– – –	– – –
1-1/2	38	1.5	1	12.7	1/2	24A5266X022	24A5286X022	– – –	– – –
2	51	2	1	12.7 19.1	1/2 3/4	24A3038X022 24A5550X022	24A5287X022 24A5551X022	24A3038X032 – – –	24A5287X032 – – –
2-1/2	64	2.5	1 400 1, 402, 403	12.7 12.7 19.1	1/2 1/2 3/4	24A5267X022 24A5267X032 24A5268X022	24A5288X022 24A5288X032 24A5289X022	24A5267X042 24A5267X052 – – –	24A5288X042 24A5288X052 – – –
3	76	3	1, 400 1, 402, 403	12.7 19.1	1/2 3/4	24A5269X022 23A9452X012	24A5290X022 24A5291X022	24A5269X032 – – –	24A5290X032 – – –
4	76 102 76	3 4 3	1, 402, 403 401, 402, 403 100, 101	19.1 19.1 25.4	3/4 3/4 1	23A5818X022 23A5818X032 24A5270X022	24A5292X022 24A5292X032 24A5293X022	– – – – – – – – –	– – – – – – – – –
	102 102 102	4 4 4	404 405, 406 407	25.4 25.4 25.4	1 1 1	24A5270X022 24A5270X042 24A5270X032	24A5293X022 24A5293X042 24A5293X032	– – – – – – – – –	– – – – – – – – –
6	76 102 102	3 4 4	1 401, 403 402	19.1 19.1 19.1	3/4 3/4 3/4	23A5803X022 23A5803X022 23A5803X042	24A5294X022 24A5294X022 24A5294X042	23A5803X032 23A5803X032 23A5803X052	24A5294X032 24A5294X032 24A5294X052
	76 102 102	3 4 4	100, 101 405, 406 407	25.4 25.4 25.4	1 1 1	24A3028X042 24A3028X052 24A3028X062	24A5295X022 24A5295X032 24A5295X042	– – – – – – – – –	– – – – – – – – –
8	76 102 102 153 76	3 4 4 6 3	1 401, 403 402 801 100, 101	19.1 19.1 19.1 19.1 25.4	3/4 3/4 3/4 3/4 1	24A1141X092 24A1141X092 24A1141X042 24A1141X032 24A5273X022	34A4269X042 34A4269X042 34A4269X062 34A4269X022 34A4270X022	24A1141X072 24A1141X072 24A1141X082 24A1141X062 24A5273X032	34A4269X052 34A4269X052 34A4269X072 34A4269X032 34A5270X032
	102 153	4 6	404 802	25.4 25.4	1 1	24A5273X022 24A5273X022	34A4270X022 34A4270X022	24A5273X032 24A5273X032	34A4270X032 34A4270X032
	102 102 76	4 4 3	407 405, 406 100, 101	25.4 25.4 31.8	1 1 1-1/4	24A5273X042 24A5273X062 24A7259X022	34A4270X042 34A4270X062 34A7260X022	24A5273X052 24A5273X072 – – –	34A4270X052 34A4270X072 – – –
	102 153 102 102	4 6 4 4	404 802 407 405, 406	31.8 31.8 31.8 31.8	1-1/4 1-1/4 1-1/4 1-1/4	24A7259X022 24A7259X022 24A7259X032 24A7259X042	34A7260X022 34A7260X022 34A7260X032 34A7260X042	– – – – – – – – – – – –	– – – – – – – – – – – –

Key 2* Whisper Trim III Valve Plug with Two-Piece Seal Ring (NPS 6 Fisher ET only)

STEM DIAMETER		17-4PH STAINLESS STEEL (H900)	316 STAINLESS STEEL	316 STAINLESS STEEL W/CoCr-A ON SEAT	316 STAINLESS STEEL W/CoCr-A ON SEAT AND GUIDE	316 STAINLESS STEEL W/CoCr-A ON SEAT AND GUIDE(1)
mm	Inches					
19.1 25.4	3/4 1	22A3259X012 22A3262X012	22A3259X022 22A3262X022	22A3260X012 22A3263X012	22A3261X012 22A3264X012	22A3267X012 22A3268X012

1. High temperature.

Key 2* Whisper Trim III Valve Plug for Spring Loaded Seal Ring (NPS 6 Fisher ET only)

STEM DIAMETER		17-4PH (H900)	316 STAINLESS STEEL	316 STAINLESS STEEL W/CoCr-A ON SEAT	316 STAINLESS STEEL W/CoCr-A ON SEAT AND GUIDE
mm	Inches				
19.1 25.4	3/4 1	22A3269X012 22A3272X012	22A3269X022 22A3272X022	22A3270X012 22A3273X012	22A3271X012 22A3274X012

*Recommended spare parts

Key 3* Quick Opening Cage

VALVE SIZE, NPS		17-4PH STAINLESS STEEL (H900)	316 STAINLESS STEEL		ALLOY 6
ET	EAT		Chrome Plated	ENC	
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	2U215033272	2U691146102	2U740348932	2U215039102
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	2U219233272	2U691846102	2U725448932	2U219239102
2 or 3 x 2	4 x 2	2U223433272	2U692146102	2U740448932	2U223439102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	2U227633272	2U692446102	2U740548932	2U227639102
3	4	2U231833272	2U692746102	2U740648932	2U231839102
4	6	2U236033272	2U693046102	2U740748932	2U236039102
6	---	2U506333272	2U693546102	2U806948932	2U506339102
8	---	20A3249X012	20A4350X012	20A5469X012	20A3249X092

Key 3* Linear Cage

VALVE SIZE, NPS		17-4PH STAINLESS STEEL (H900)	316 STAINLESS STEEL		ALLOY 6
ET	EAT		Chrome Plated	ENC	
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	2U215633272	2U691746102	2U741448932	2U215639102
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	2U219833272	2U692046102	2U741548932	2U219839102
2 or 3 x 2	4 x 2	2U224033272	2U692346102	2U741648932	2U224039102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	2U228233272	2U692646102	2U741748932	2U228239102
3	4	2U232433272	2U692946102	2U741848932	2U232439102
4	6	2U236633272	2U693346102	2U741948932	2U236639102
6	---	2U506133272	2U693846102	2U806848932	2U506139102
8	---	20A3247X012	20A4349X012	20A5468X012	20A3247X092

Key 3* Equal Percentage Cage

VALVE SIZE, NPS		17-4PH STAINLESS STEEL (H900)	316 STAINLESS STEEL		ALLOY 6
ET	EAT		Chrome Plated	ENC	
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	2U215333272	2U691346102	2U740848932	2U215339102
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	2U219533272	2U691946102	2U740948932	2U219539102
2 or 3 x 2	4 x 2	2U223733272	2U692246102	2U741048932	2U223739102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	2U227933272	2U692546102	2U741148932	2U227939102
3	4	2U232133272	2U692846102	2U741248932	2U232139102
4	6	2U236333272	2U693146102	2U741348932	2U236339102
6	---	2U505933272	2U693746102	2U806748932	2U505939102
8	---	20A3245X012	20A4348X012	20A5467X012	20A3245X092

Key 3* Whisper Trim I Cage

VALVE SIZE, NPS		17-4PH STAINLESS STEEL (H900)
ET	EAT	
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	2V502333272
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	2V502433272
2 or 3 x 2	4 x 2	2V502533272
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	2V502633272
3	4	2V502733272
4	6	23A8915X032
6	---	23A8913X032

Key 3* Whisper Trim III Cage (NPS 6 Fisher ET only)

LEVEL	416 STAINLESS STEEL	316 STAINLESS STEEL (ENC)	316 STAINLESS STEEL (Cr Cr)
A3	32A3248X012	32A3251X012	32A3336X012
B3	32A3249X012	32A3252X012	32A3337X012
C3	32A3250X012	32A3253X012	32A3338X012
D3	32A6217X012	32A6220X012	32A6741X012

*Recommended spare parts

Key 3* Cavitrol III Cage Assembly, 17-4PH stainless steel (H900)

ET VALVE SIZE, NPS	STAGE		
	1	2	Characterized 2
1	38A1018X012	24A5558X012	24A5558X022
1-1/2	38A1019X012	24A5559X012	24A5559X022
2	38A1020X012	24A3031X032	24A3031X022
2-1/2	38A1021X012	24A5560X012	24A5560X022
3	38A1023X012	23A9453X022	23A9453X012
4	38A1025X012	23A5817X032	23A5817X022
6	38A1027X012	23A5804X012	23A5804X022
8	38A1029X012	24A3020X032	24A3020X042

Key 7* Fisher ET Valve Plug Stem, 316 stainless steel (not for Cavitrol III or Whisper Trim III cage)

VALVE SIZE, NPS		STEM DIAMETER & VSC(1) SIZE		PLAIN BONNET(3)			EXTENSION BONNET					
				Stem Length		Part Number	Style 1(4)			Style 2		
							Stem Length		Part Number	Stem Length		Part Number
		mm	Inches	mm	Inches		mm	Inches		mm	Inches	
Full Capacity	1, 1-1/4, or 1-1/2	9.5 12.7	3/8 1/2	225 300	8.875 11.8125	1U388835162 1U389035162	311 402	12.25 15.8125	1U217735162 1U217935162	405 473	15.9375 18.625	10A8823X022 1U218035162
	2	12.7 19.1	1/2 3/4	311 372	12.25 14.625	1K586935162 1U226535162	413 483	16.25 19	1U226335162 1L400135162	614 ---	24.1875 ---	1U226435162 ---
	2-1/2 or 3	12.7 19.1	1/2 3/4	321 381	12.625 15	1U230535162 1U230835162	421 502	16.5625 19.75	1U230635162 1U444635162	624 ---	24.5625 ---	1U230735162 ---
	4	12.7 19.1 25.4(1) 25.4(2)	1/2 3/4 1(1) 1(2)	321 394 464 489	12.625 15.5 18.25 19.25	1U230535162 1K587735162 1K759035162 1U217535162	421 502 --- ---	16.5625 19.75 --- ---	1U230635162 1U444635162 --- ---	624 694 --- ---	24.5625 27.3125 --- ---	1U230735162 1U240035162 --- ---
	6	19.1 25.4 31.8	3/4 1 1-1/4	403 499 508	15.875 19.625 20	1L996435162 1N704735162 1K415435162	511 630 656	20.125 24.8125 25.8125	1U507135162 1K785135162 1R562435162	699 --- ---	27.5 --- ---	1U524435162 --- ---
	8	19.1 25.4 31.8	3/4 1 1-1/4	492 614 705	19.375 24.1875 27.4375	1K588035162 1K7891X0012 1L268835162	533 614 705	21 24.1875 29.4375	1U928235162 1K7891X0012 1L268835162	--- --- ---	--- --- ---	--- --- ---
Restricted Capacity	1-1/2 x 1	9.5 12.7	3/8 1/2	241 311	9.375 12.25	1U223635162 1K586935162	324 413	12.75 16.25	1U227035162 1U226335162	418 486	16.4375 19.125	1U227235162 1U227335162
	2 x 1 or 2-1/2 x 1-1/2	12.7	1/2	300	11.8125	1U389035162	402	15.8125	1U217935162	605	23.8125	1U3893X0012
	3 x 2	12.7 19.1	1/2 3/4	311 372	12.25 14.625	1K586935162 1U226535162	413 483	16.25 19	1U226335162 1L400135162	614 ---	24.1875 ---	1U226435162 ---
	4 x 2-1/2	12.7 19.1	1/2 3/4	321 381	12.625 15	1U230535162 1U230835162	421 502	16.5625 19.75	1U230635162 1U444635162	624 681	24.5625 26.8125	1U230735162 1U232335162

1. 667 actuator.
2. 657 or 585C Series actuator.
3. Plain bonnet is standard for NPS 8 cast iron and WCC valve bodies.
4. Style 1 extension bonnet is standard for NPS 8 316 SST valve bodies.

Key 7* Whisper Trim III Valve Plug Stem, 316 stainless steel (NPS 6 Fisher ET only)

STEM DIAMETER		PLAIN BONNET	EXTENSION BONNET	
mm	Inches		Style 1	Style 2
19.1	3/4	1U294135162	1U928235162	1U6276X0012
25.4	1	1P847635162	1U627735162	– – –

Key 7* 1-Stage Cavitrol III Valve Plug Stem (Fisher ET only)

VALVE SIZE, NPS	TRAVEL		ACTUATOR GROUP (FROM PRECEDING TABLE)	STEM DIAMETER		316 STAINLESS STEEL	17-4PH STAINLESS STEEL STEM
	mm	Inches		mm	Inches		
1	19, 25	0.75, 1	1	12.7	1/2	1U389035162	1U3890X0062
1-1/2	19, 22	0.75, 0.875	1	12.7	1/2	1U389035162	1U3890X0062
2	26	1.125	1 1	12.7 19.1	1/2 3/4	1K586935162 1U226535162	10A8840XC82 1U226535382
2-1/2	38	1.5	1 1	12.7 19.1	1/2 3/4	1U230535162 1U230835162	1U2305X0012 1U2308X0082
3	38, 41	1.5, 1.625	1 1	12.7 19.1	1/2 3/4	1U230535162 1U230835162	1U2305X0012 1U2308X0082
4	51, 54 54 54	2, 2.125 2.125 2.125	1 402 403	19.1 19.1 19.1	3/4 3/4 3/4	1K587735162 1V142235162 1U293835162	1K5877X0022 1V1422X0042 1U2938X0062
	51, 54	2, 2.125	100 101	25.4 25.4	1 1	1U217535162 1K759035162	1U217550372 1K7590X0012
6	51 57 51 57	2 2.25 2 2.25	100 100 100 100	25.4 25.4 31.8 31.8	1 1 1-1/4 1-1/4	1P847635162 1N704735162 1K415435162 1N920935162	11A3429X252 1N7047X0012 1K415435382 1N9209X0052
	51, 57	2, 2.25	101 101	25.4 31.8	1 1-1/4	1P405135072 1K775335162	1P4051X0032 1K7753X0012
8	76, 86	3, 3.375	100, 101, 404 100, 101, 404	25.4 31.8	1 1-1/4	10A3282X012 1R489535162	10A3282X012 1R4895X0022
	86	3.375	407 407	25.4 31.8	1 1-1/4	11A3429X012 1U9886X0012	1K7783X0052 1U9886X0152

Key 7* Valve Plug Stem for Bellows Seal Bonnet, 316 Stainless Steel

VALVE SIZE, NPS		STEM DIAMETER		STEM LENGTH		PART NUMBER
ET	EAT	mm	Inches	mm	Inches	
1, 1-1/4, 1-1/2, or 1-1/2 X 1	1, 2, or 2 x 1	9.5 12.7	3/8 1/2	222 286	8.75 11.25	1R288535162 1R288835162
2, 2-1/2, 2-1/2 X 1-1/2, or 3	3 or 4	12.7	1/2	314	12.375	1U389235162
– – –	3 x 1-1/2	12.7	1/2	295	11.625	1U388935162
2 x 1 or 3 x 2	4 x 2	12.7	1/2	305	12	1U389135162
4	6	12.7 19.1	1/2 3/4	327 387	12.875 15.25	2R369335072 1K587635162
4 x 2-1/2	6 x 2-1/2	12.7 19.1	1/2 3/4	327 375	12.875 14.75	2R369335072 1U389435162
6	– – –	19.1	3/4	387	15.25	1K587635162

*Recommended spare parts

Key 9* Fisher EAT Liner

Liner Material	Valve Size, NPS	CL150 Raised Face	CL300 Raised Face	CL600 Raised Face	Socket Weld	Schedule 40 or 80 Butt Weld
416 stainless steel (hardened)	1	1V560146172	1U384246172	1V560246172	1V560146172	1V560146172
	2	1V560346172	1U384346172	1V560546172	1V560346172	1V560346172
	2 x 1	1V560646172	1U385146172	1V387646172	1V560646172	1V560646172
	3	2V561346172	2U384546172	2V561646172	---	2V561346172
	3 x 1-1/2	2V560946172	2U385346172	2V545946172	---	2V560946172
	4	2V562246172	2U384746172	2V561946172	---	2V562246172
	4 x 2	2V561846172	2U385546172	2V561246172	---	2V561846172
	6	2V563146172	2U384946172	2V562846172	---	2U384946172
	6 x 2-1/2	2V562646172	2U385746172	2V562346172	---	2U385746172
316 stainless steel	1	1V560135072	1U384235072	1V560235072	1V560135072	1V560135072
	2	1V560335072	1U384335072	1V560535072	1V560335072	1V560335072
	2 x 1	1V560635072	1U385135072	1V387635072	1V560635072	1V560635072
	3	2V561335072	2U384535072	2V561635072	---	2V561335072
	3 x 1-1/2	2V560935072	2U385335072	2V545935072	---	2V560935072
	4	2V562235072	2U384735072	2V561935072	---	2V562235072
	4 x 2	2V561835072	2U385535072	2V561235072	---	2V561835072
	6	2V563135072	2U384935072	2V562835072	---	2U384935072
	6 x 2-1/2	2V562635072	2U385735072	2V562335072	---	2U385735072

Key 9* Metal-Seat Seat Ring (not for Whisper Trim III or Cavitrol III Cage)

VALVE SIZE, NPS		416 STAINLESS STEEL (HARDENED)(1)	316 STAINLESS STEEL	R30006
ET	EAT			
1, 1-1/4, or 2 x 1	1	1U222546172	1U222535072	1U222539102
1-1/2 x 1	2 x 1	1U222046172	1U222035072	1U222039102
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	1U221946172	1U221935072	1U221939102
2 or 3 x 2	4 x 2	1U222646172	1U222635072	1U222639102
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	1U222746172	1U222735072	1U222739102
3	4	1U222846172	1U222835072	1U222839102
4	6	1U222946172	1U222933092	1U222939102
6	---	1U508046172	1U508033092	1U508039102
8	---	20A3260X012	20A3260X022	20A3260X152

1. 410 stainless steel (CA15) is used for NPS 6 and 8 full-sized and restricted-trim valves.

Key 9* Cavitrol III Seat Ring (Fisher ET only)

VALVE SIZE, NPS	1-STAGE CAGE		2-STAGE CAGE	
	17-4PH Stainless Steel	Alloy 6 (Cast)	17-4PH Stainless Steel	316 Stainless Steel w/CoCr-A Seat & Bore
1	23A7567X012	23A7567X022	24A5231X012	24A5239X012
1-1/2	23A7568X012	23A7568X022	24A5232X012	24A5240X012
2	23A7569X012	23A7569X022	24A3039X012	24A5241X012
2-1/2	24A1586X012	24A1586X022	24A5233X012	24A5242X012
3	24A3016X012	24A3016X022	23A9450X012	24A5243X012
4	24A1135X012	24A1135X022	23A5813X012	24A5244X012
6	23A5820X032	23A5820X012	23A5802X022	24A5245X012
8	23A9445X022	23A9445X032	24A3021X022	24A5246X012

Key 9* Whisper Trim III Seat Ring (NPS 6 Fisher ET only)

410 Stainless Steel	316 Stainless Steel	316 Stainless Steel w/ CoCr-A Seat
21A9794X012	21A9794X022	21A9795X012

*Recommended spare parts

Gasket Descriptions

KEY NUMBER	DESCRIPTION	MATERIAL
		FGM -198° to 593°C (-325° to 1100°F)
10[1]	Bonnet Gasket	Graphite/S31600
11	Cage Gasket	
13	Seat Ring or Liner Gasket	
14 or 20	Adapter Gasket	
12	Spiral-Wound Gasket	N06600/Graphite
27 or 51	Shim	S31600 (316 SST)

1. 2 req'd for 2-stage Cavitrol III cage.

Keys 10*, 11*, 12*, 13*, 14*, 20*, 27*, and 51* Gaskets and Shims

Valve Size, NPS		Standard Trim Cage Whisper Trim I Cage Cavitrol III - 1 Stage Cage		Cavitrol III - 2 Stage Cage Whisper Trim III Cage WhisperFlo Cage		VALVE SIZE, NPS		Standard Trim Cage Whisper Trim I Cage Cavitrol III - 1 Stage Cage		Cavitrol III - 2 Stage Cage Whisper Trim III Cage WhisperFlo Cage	
ET	EAT	Key Number	-198 to 593°C (-325 to 1100°F)	Key Number	-198 to 593°C (-325 to 1100°F)	ET	EAT	Key Number	-198 to 593°C (-325 to 1100°F)	Key Number	-198 to 593°C (-325 to 1100°F)
1 or 1-1/4	1	Set 10 12 13 27 or 51	RGASKETX162 1R2859X0042 1R286099442 1R2862X0062 16A1936X012	Set 10 12 13 51	RGASKETX422 1R2859X0042(qty 2) 1R286099442 1R2862X0062 16A1936X012	3	4	Set 10 12 13 27 or 51	RGASKETX202 1R3484X0042 1R348299442 1R3481X0052 16A1940X012	Set 10 12 13 51	RGASKETX462 1R3484X0042(qty 2) 1R348299442 1R3481X0052 16A1940X012
1-1/2	2	Set 10 12 13 27 or 51	RGASKETX172 1R3101X0032 1R309999442 1R3098X0052 16A1937X012	Set 10 12 13 51	RGASKETX432 1R3101X0032(qty 2) 1R309999442 1R3098X0052 16A1937X012	3 x 2	4 x 2	Set 10 11 12 13 14 27 or 51	RGASKETX272 1R3484X0042 1R3298X0032 1R329799442 1R3296X0042 1R3481X0052 16A1938X012	---	---
1-1/2 x 1	2 x 1	Set 10 11 12 13 20 27 or 51	RGASKETX242 1R3101X0032 1R2861X0042 1R286099442 1R3098X0052 1U2152X0042 16A1936X012	---	---	4	6	Set 10 12 13 27 or 51	RGASKETX212 1R3724X0042 1R372299442 1J5047X0062 16A1941X012	Set 10 12 13 51	RGASKETX472 1R3724X0042(qty 2) 1R372299442 1J5047X0062 16A1941X012
2	---	Set 10 12 13 51	RGASKETX182 1R3299X0042 1R329799442 1R3296X0042 16A1938X012	Set 10 12 13 51	RGASKETX442 1R3299X0042(qty 2) 1R329799442 1R3296X0042 16A1938X012	4 x 2-1/2	6 x 2-1/2	Set 10 11 12 13 14 27 or 51	RGASKETX282 1R3724X0042 1R3846X0042 1R384599442 1R3844X0052 1J5047X0062 16A1939X012	---	---
2 x 1	---	Set 10 11 12 13 14 51	RGASKETX252 1R3299X0042 1R2861X0042 1R286099442 1R2862X0062 1R3296X0042 16A1936X012	---	---	6	---	Set 10 12 13 51	RGASKETX222 1U5081X0052 1U508599442 1U5086X0032 16A1942X012	Set 10 12 13 51	RGASKETX482 1U5081X0052(qty 2) 1U508599442 1U5086X0032 16A1942X012
2-1/2	3	Set 10 12 13 27 or 51	RGASKETX192 1R3847X0032 1R384599442 1R3844X0052 16A1939X012	Set 10 12 13 51	RGASKETX452 1R3847X0032(qty 2) 1R384599442 1R3844X0052 16A1939X012	8	---	Set 10 13	RGASKETX232 10A3265X112 10A3266X082	Set 10 13	10A3265X152 10A3265X112(qty 2) 10A3266X082
2-1/2 x 1-1/2	3 x 1-1/2	Set 10 11 12 13 14 27 or 51	RGASKETX262 1R3847X0032 1R3100X0032 1R309999442 1R3098X0052 1R3844X0052 16A1937X012	---	---						

*Recommended spare parts

Key 21*, 22*, and 23* PTFE Seat Disk Retainer, Disk Seat, and Disk

VALVE SIZE, NPS		KEY 21 DISK RETAINER, 316 STAINLESS STEEL	KEY 22 DISK SEAT		KEY 23 DISK, PTFE -73 TO 204°C (-100 TO 400°F)
ET	EAT		316 Stainless Steel	Alloy 6 (Cast)	
1, 1-1/4, or 2 x 1	1	1V710035072	1V710235072	1V710239102	1V710106242
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	1V710335072	1V710535072	1V710539102	1V710406242
1-1/2 x 1	2 x 1	1V712135072	1V712235072	1V712239102	1V710106242
2 or 3 x 2	4 x 2	1V710835072	1V710635072	1V710639102	1V710706242
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	1V710935072	1V711135072	1V711139102	1V711006242
3	4	1V711235072	1V711435072	1V711439102	1V711306242
4	6	1V711533092	1V711733092	1V711739102	1V711606242
6 All except Whisper Trim III cage	– – –	1V711833092	1V712033092	1V7120X0012	1V711906242
6 Whisper Trim III cage	– – –	23A4937X012	23A4938X012	– – –	13A4936X012
8	– – –	10A4466X012	20A4467X012	20A4467X022	20A4468X012

Key 27* Retaining Ring for Spring-Loaded Seal Ring, 302 SST

VALVE SIZE, NPS		PART NUMBER
ET	EAT	
1, 1-1/4 1-1/2 x 1, or 2 x 1	1 or 2 x 1	10A4211X012
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	10A4220X012
2 or 3 x 2	4 x 2	10A4210X012
2-1/2 or 4 x 2-1/2	3 or 6 x 2-1/2	10A4219X012
3	4	10A5350X012
4	6	10A4225X012
6 (Whisper Trim III only)	– – –	10A5410X012

Key 27* Cavitrol III Retaining Ring for NPS 1 through 6 Fisher ET only, 302 SST

VALVE SIZE, NPS	1-STAGE CAGE	2-STAGE CAGE
1	10A4211X012	11A3405X012
1-1/2	10A4220X012	10A4211X012
2	10A4210X012	10A4220X012
2-1/2	10A4219X012	10A4210X012
3	10A5350X012	10A4219X012
4	10A4225X012	10A4219X012
6	None required	10A5410X012

Key 24* Seal Ring (Fisher EAT)
Key 28* Seal Ring (Fisher ET) (not for Cavitrol III or Whisper Trim III Construction)

VALVE SIZE, NPS		STANDARD, CARBON FILLED PTFE	SPRING-LOADED
ET	EAT		PTFE -73 to 232°C (-100 to 450°F)
1, 1-1/4, 1-1/2 x 1, or 2 x 1	1 or 2 x 1	1V659105092	10A4207X012
1-1/2 or 2-1/2 x 1-1/2	2 or 3 x 1-1/2	1V659305092	10A4216X012
2 or 3 x 2	4 x 2	1V550805092	10A4206X012
2-1/2 or 4 x 2-1/2	3 x 2 or 6 x 2-1/2	1V659505092	10A4215X012
3	4	1V659705092	10A5351X022
4	6	1V659905092	10A4223X012
6	– – –	1V660105092	10A2643X022
8	– – –	– – –	10A3261X012

*Recommended spare parts

Key 28* Cavitrol III Seal Ring for Fisher ET only, spring loaded PTFE

VALVE SIZE, NPS	1-STAGE CAGE	2-STAGE CAGE
1	10A4207X012	11A3407X042
1-1/2	10A4216X012	10A4207X012
2	10A4206X012	10A4216X012
2-1/2	10A4215X012	10A4206X012
3	10A5351X022	10A4215X012
4	10A4223X012	10A4215X012
6	10A2643X022	10A5411X022
8	10A3261X012	10A2643X022

Key 28* Whisper Trim III Seal (NPS 6 Fisher ET only)

CARBON FILLED PTFE	SPRING LOADED PTFE
11A9729X012	10A5411X022

Key 25* Backup Ring (Fisher EAT)
Key 29* Backup Ring (Fisher ET) (not for Cavitrol III or NPS 8 ET)

VALVE SIZE, NPS			STANDARD CONSTRUCTION			SPRING LOADED SEAL CONSTRUCTION	
ET		EAT	Nitrile -34 to 93°C (-30 to 200°F)	Fluorocarbon(1) -18 to 204°C (-0 to 400°F)	Ethylene Propylene -40 to 232°C (-40 to 450°F)	416 Stainless Steel	316 Stainless Steel
1, 1-1/4, 1-1/2 x 1, or 2 x 1		1 or 2 x 1	1V659003052	1V659005292	1V6590X0042	10A4209X012	10A4209X022
1-1/2 or 2-1/2 x 1-1/2		2 or 3 x 1-1/2	1V659203052	1V659205292	1V6592X0032	10A4218X022	10A4218X012
2 or 3 x 2		4 x 2	1V550703052	1V550705292	1V5507X0042	10A4208X012	10A4208X022
2-1/2 or 4 x 2-1/2		3 or 6 x 2-1/2	1V659403052	1V659405292	1V6594X0032	10A4217X012	10A4217X022
3		4	1V659603052	1V659605292	1V6596X0032	10A5349X012	10A5349X022
4		6	1V659803052	1V659805292	1V6598X0022	10A4224X012	10A4224X022
6	All except Whisper Trim III cage	– – –	1V660003052	1V660005292	1V6600X0022	– – –	– – –
	Whisper Trim III cage	– – –	11A9728X022	11A9728X012	11A9728X042	12A3332X012	12A3332X022

1. Not for use with steam or ammonia. Not recommended for water above 82°C (180°F).

Key 29* Cavitrol III Backup Ring, 416 Stainless Steel (not for NPS 8 Fisher ET)

VALVE SIZE, NPS	1-STAGE CAGE	2-STAGE CAGE
1	10A4209X012	11A3404X012
1-1/2	10A4218X022	10A4209X022
2	10A4208X012	10A4218X022
2-1/2	10A4217X012	10A4208X012
3	10A5349X012	10A4217X012
4	10A4224X012	10A4217X012
6	None required	10A5409X012

*Recommended spare parts

Keys 3*, 9*, 2*, 28*, 63*, 29*, and 27* TSO Trim Parts for Fisher ET Valves

VALVE SIZE, NPS	PORT, INCH	TRAVEL, INCH	TRIM	STEM DIAMETER		ACTUATOR GROUP	CHARAC-TERISTIC	KEY 3	KEY 3	KEY 9	KEY 2
				mm	Inch			Cage Full 2-Stage	Cage Characterized 2-Stage	Seat Ring	Plug / Stem Assembly
3	2.6875	3	810 816	12.7	1/2	1 & 400	Cavitrol III	23A9453X022	23A9453X012	28B1302X012 28B1303X012	28B1306X012 28B1306X022
			810 816	19.1	3/4	100 & 101		23A9453X022	23A9453X012	28B1302X012 28B1303X012	27B6604X112 27B6604X122
4	2.6875	3	810	19.1	3/4	1, 402, 403	Cavitrol III	23A5817X032	23A5817X022	28B1307X012	28B1310X012
		4				401, 403					
		4				402					28B1310X022
VALVE SIZE, NPS	PORT, INCH	TRAVEL, INCH	TRIM	STEM DIAMETER		ACTUATOR GROUP	CHARAC-TERISTIC	KEY 28	KEY 63	KEY 29	KEY 27
				mm	Inch			Seal Ring	Anti-Extrusion Ring	Back-Up Ring	Retaining Ring
3	2.6875	3	810 816	12.7	1/2	1 & 400	Cavitrol III	10A4215X102	22B2617X012	10A4217X012 10A4217X022	10A4219X012 10A4219X082
			810 816	19.1	3/4	100 & 101				10A4217X012 10A4217X022	10A4219X012 10A4219X052
4	2.6875	3	810	19.1	3/4	1, 402, 403	Cavitrol III	10A4215X102	22B2617X012	10A4217X012	10A4219X012
		4				401, 403					
		4				402					

Keys 3*, 7*, 24*, 63*, 25*, and 27* TSO Trim Parts for Fisher ET and EAT Valves(1)

VALVE SIZE, NPS		PORT	TRAVEL	STEM DIAMETER		CHARAC-TERISTIC	KEY 3	KEY 7	KEY 24	KEY 63	KEY 25	KEY 27
ET	EAT	Inch	Inch	mm	Inch		Cage	Plug/Stem Assembly	Seal Ring	Anti-Extrusion Ring	Back-Up Ring	Retaining Ring
3	4	3.25	1.5	12.7	1/2	Linear Equal % Quick Open	2U232433272 2U232133272 2U231833272	27B9567X012	10A5351X112	23B6126X012	10A5349X012	10A5350X012
4	6	4.1875	2	19.1	3/4	Linear Equal % Quick Open	2U236633272 2U236333272 2U236033272	38B0282X012	10A4223X142	21B9341X012	10A4224X012	10A4225X012

1. Trim is 812.

Key 9* TSO Trim Parts for Fisher ET and EAT Valves(1)

VALVE SIZE, NPS		PORT, INCH	KEY 9				
			Seat Ring	Seat and Liner			
ET	EAT			CL150 Raised Face	CL300 Raised Face	CL600 Raised Face	Schedule 40 or 80 ButtWeld
3	4	3.25	37B9563X012	38B0273X012	38B0273X022	38B0273X032	38B0273X012
4	6	4.1875	38B0276X012	38B0277X012	38B0276X022	38B0276X032	38B0276X022

1. Trim is 812.

Keys 63*, 28*, 29*, 27*, 2*, and 9* Fisher ET Full Capacity Trim above 232°C (450°F) using PEEK Anti-Extrusion Rings

VALVE SIZE, NPS	PORT	Use w/ Cage/See Footnote	KEY 63 Anti-Extrusion Ring	KEY 28 Seal Ring	KEY 29 Back-Up Ring	KEY 27 Retaining Ring	KEY 2 Plug(1)	STEM CONN DIAMETER, INCHES	KEY 9 Seat Ring(1)
1	1.3125	A	23B6125X012	10A4207X032	10A4209X012	10A4211X012	33B6091X012	0.375	21B3686X012
1-1/2	1.875	A	22B4694X012	10A4216X032	10A4218X022	10A4220X012	33B6093X012 33B6094X012	0.375 0.5	21B6970X012
2	2.3125	A	21B9340X012	10A4206X032	10A4208X012	10A4210X012	33B6097X012 33B6098X012	0.5 0.75	10B8254X012
2-1/2	2.875	A	22B2617X012	10A4215X032	10A4217X012	10A4219X012	33B6109X012 33B6110X012	0.5 0.75	21B3687X012
3	3.4375	A	23B6126X012	10A5351X062	10A5349X012	10A5350X012	33B6105X012 33B6106X012	0.5 0.75	23B6127X012
4	4.375	A	21B9341X012	10A4223X032	10A4224X012	10A4225X012	33B6101X012 33B6102X012 33B6111X012	0.5 0.75 1	23B6128X012
6	7	A	22B5998X012	10A2643X032	12B5997X012	14A4652X012	33B6115X012 33B6116X012	0.75 1	29A9703X012
6	5.375	C	21B9342X012	10A5411X032	12A3332X012	10A5410X012	33B6134X012 33B6136X012	0.75 1	33B6146X012
8	8	B	22B9203X012	10A3261X032	11B8325X022	11B8322X012	33B6119X012 33B6120X012 33B6121X012	0.75 1 1.25	29A9704X012

A—Cages - Quick opening, equal percentage, linear, Whisper I.
B—Cages - Equal percentage, linear - plug & seat ring material CA15 (cast 410).
C—Cages - Whisper III - plug material 17-4PH H900 - seat ring material forged F6A (SST).
1. Seat rings with wide bevel seat and plugs with radius seat.

Keys 63*, 28*, 29*, 27*, 2*, and 9* Fisher ET Restricted Trim above 232°C (450°F) using PEEK Anti-Extrusion Rings

VALVE SIZE, NPS	PORT	KEY 63 Anti-Extrusion Ring	KEY 28 Seal Ring	KEY 29 Back-Up Ring	KEY 27 Retaining Ring	KEY 2 Plug(1)	STEM CONN DIAMETER, INCHES	KEY 9 Seat Ring(1)
1-1/2 x 1	1.3125	23B6125X012	10A4207X032	10A4209X012	10A4211X012	33B6091X012	0.375	22B3550X012
2-1/2 x 1-1/2	1.875	22B4694X012	10A4216X032	10A4218X022	10A4220X012	33B6094X012	0.5	21B6970X012
3 x 2	2.3125	21B9340X012	10A4206X032	10A4208X012	10A4210X012	33B6097X012 33B6098X012	0.5 0.75	10B8254X012
4 x 2-1/2	2.875	22B2617X012	10A4215X032	10A4217X012	10A4219X012	33B6109X012 33B6110X012	0.5 0.75	21B3687X012

Cages - Quick opening, equal percentage, linear, Whisper I.
1. Seat rings with wide bevel seat and plugs with radius seat.

*Recommended spare parts

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Fisher® EZ easy-e™ Control Valve

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Figure 1. Fisher EZ Valve with 657 Actuator and DVC6000 Digital Valve Controller



W8120A-1

Introduction

Scope of Manual

This instruction manual includes installation, maintenance, and parts information for NPS 1/2 through 4 Fisher EZ valves through CL600 ratings. Refer to separate manuals for instructions covering the actuator and accessories.

Do not install, operate, or maintain an EZ valve without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Description

EZ valves (figure 1) are globe-style with integral end connections, post guiding, and quick-change trim. These valves are used in chemical or hydrocarbon processing applications or in applications that require control of nonlubricating, viscous, or other hard-to-handle fluids.

Table 1. Specifications

End Connection Styles

Cast Iron Valves
Flanged: CL125 flat-face or 250 raised-face flanges per ASME B16.1
Steel and Stainless Steel Valves
Flanged: CL150, 300, and 600 raised-face or ring-type joint flanges per ASME B16.5
Screwed or Socket Welding: Consistent with ASME B16.11
Buttwelding: All available ASME B16.25 schedules that are consistent with ASME B16.34

Maximum Inlet Pressure(1)

Cast Iron Valves
Flanged: Consistent with CL125B or 250B per ASME B16.1
Steel and Stainless Steel Valves
Flanged: Consistent with CL150, 300, or 600 per ASME B16.34
Screwed or Welding: Consistent with CL600 per ASME B16.34

Shutoff Classifications per ANSI/FCI 70-2 and IEC 60534-4

Metal Seats: Class IV is standard, Class V is optional
PTFE Composition Seats: Class VI

Flow Characteristics

■ Equal percentage, ■ quick opening, and ■ linear

Flow Direction

Up through the seat ring

Approximate Weights

NPS 1/2 and 3/4 Valves: 9.1 kg (20 pounds)
NPS 1 Valve: 11 kg (25 pounds)
NPS 1-1/2 Valve: 18 kg (40 pounds)
NPS 2 Valve: 36 kg (80 pounds)
NPS 3 Valve: 54 kg (120 pounds)
NPS 4 Valve: 75 kg (165 pounds)

1. The pressure/temperature limits in this manual and any applicable standard or code limitation for valve should not be exceeded.

Specifications

Typical specifications for these valves are shown in table 1.

Educational Services

For information on available courses for the Fisher EZ valve, as well as a variety of other products, contact:

Emerson Process Management
Educational Services - Registration
Phone: 1-641-754-3771 or 1-800-338-8158
E-mail: education@emerson.com
http://www.emersonprocess.com/education

Installation

⚠ WARNING

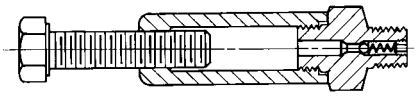
Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

Personal injury or equipment damage caused by sudden release of pressure may result if the valve assembly is installed where service conditions could exceed the limits given in table 1 or on the appropriate nameplates. To avoid such injury or damage, provide a relief valve for overpressure protection as required by government or accepted industry codes and good engineering practices.

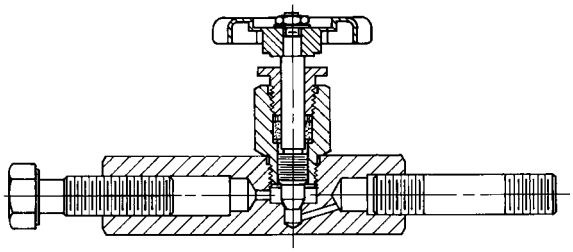
Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

Figure 2. Optional Packing Lubricator and Lubricator/Isolating Valve



LUBRICATOR



10A9421-A
AJ5428-D
A0832-2

LUBRICATOR/ISOLATING VALVE

CAUTION

When ordered, the valve configuration and construction materials were selected to meet particular pressure, temperature, pressure drop, and controlled fluid conditions. Responsibility for the safety of process media and compatibility of valve materials with process media rests solely with the purchaser and end-user. Since some body/trim material combinations are limited in their pressure drop and temperature ranges, do not apply any other conditions to the valve without first contacting your Emerson Process Management sales office.

1. Before installing the valve, inspect it and any associated equipment for damage and any foreign material. Make certain the valve interior is clean, that pipelines are free of foreign material, and that the valve is oriented so that pipeline flow is in the same direction as the arrow on the side of the valve.
2. The control valve assembly may be installed in any orientation unless limited by seismic criteria. However, the normal method is with the actuator vertical above the valve. Other positions may result in uneven valve plug and seat ring retainer wear, and improper operation. With some valves, the actuator may also need to be supported when it is not vertical. For more information, consult your Emerson Process Management sales office.
3. Use accepted piping and welding practices when installing the valve in the line. Internal elastomeric parts may stay in place during the welding procedure. For flanged valves, use a suitable gasket between the valve body flange and pipeline flanges.

CAUTION

Depending on valve body materials used, post weld heat treating may be required. If so, damage to internal elastomeric and plastic parts, as well as internal metal parts is possible. Shrunk-fit pieces and threaded connections may also loosen. In general, if post weld heat treating is to be performed, all trim parts should be removed. Contact your Emerson Process Management sales office for additional information.

4. With a leak-off bonnet construction, remove the pipe plugs (key 14) to hook up the leak-off piping. If continuous operation is required during inspection or maintenance, install a three-valve bypass around the control valve assembly.
5. If the actuator and valve are shipped separately, refer to the actuator mounting procedure in the appropriate actuator instruction manual.

⚠ WARNING

Personal injury could result from packing leakage. Valve packing was tightened before shipment; however, the packing might require some readjustment to meet specific service conditions. Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

Valves with ENVIRO-SEAL live-loaded packing or HIGH-SEAL Heavy-Duty live-loaded packing will not require this initial re-adjustment. See the Fisher instruction manuals titled ENVIRO-SEAL Packing System for Sliding-Stem Valves or Heavy-Duty Live-Loaded Packing System (as appropriate) for packing instructions. If you wish to convert your present packing arrangement to ENVIRO-SEAL packing, refer to the retrofit kits listed in the Parts Kits sub-section near the end of this manual.

Maintenance

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. This section includes instructions for packing lubrication, packing maintenance, trim maintenance, and ENVIRO-SEAL bellows seal replacement. All maintenance operations may be performed with the valve in the line.

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure or bursting of parts. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the pneumatic actuator loading pressure and relieve any actuator spring precompression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline.* Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

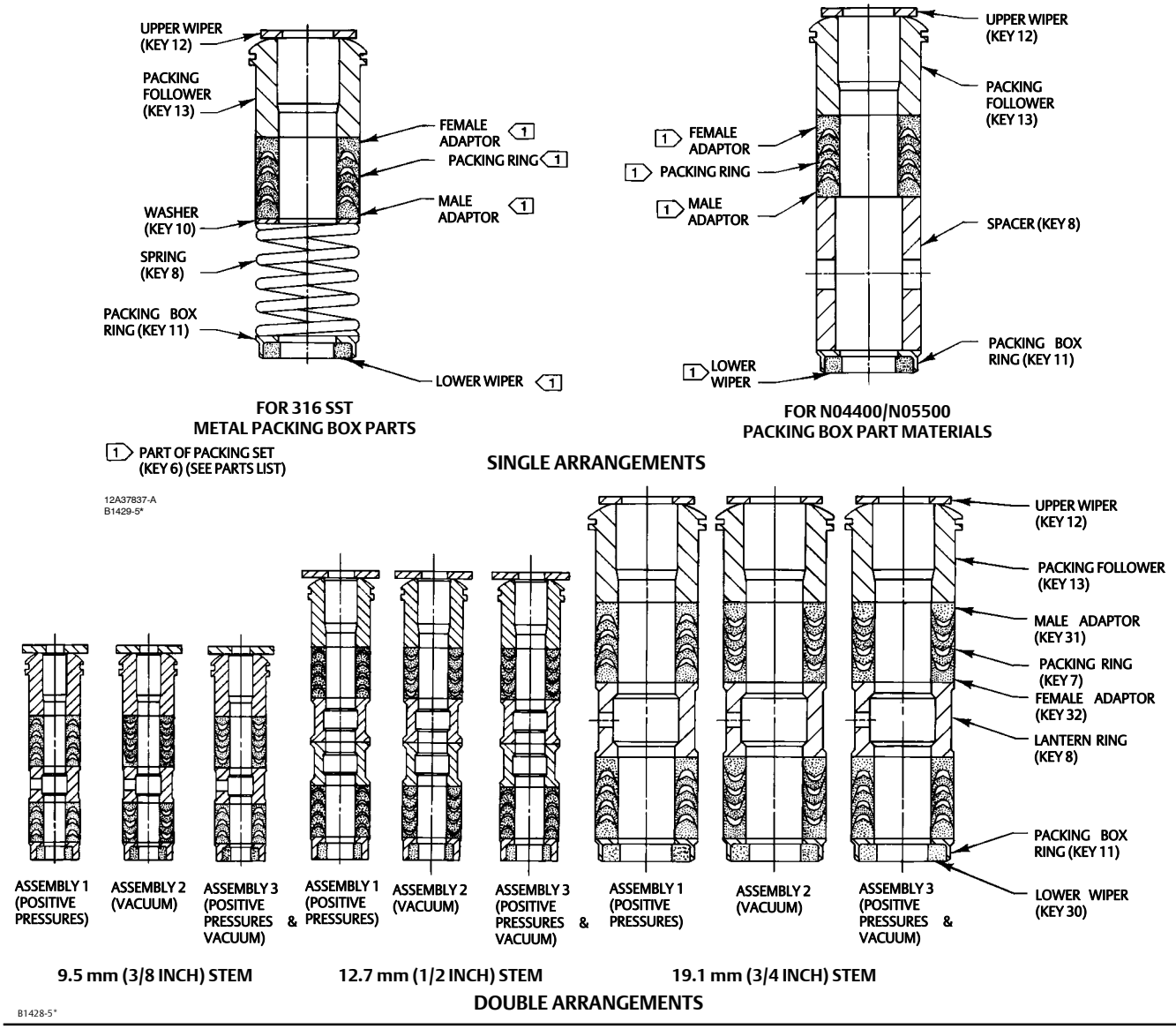
Note

Whenever a gasket seal is disturbed by removing or shifting gasketed parts, a new gasket should be installed upon reassembly. This is necessary to ensure a good gasket seal since the used gasket may not seal properly.

Note

If the valve has ENVIRO-SEAL or HIGH-SEAL live-loaded packing installed, refer to instruction manuals ENVIRO-SEAL Packing System for Sliding Stem Valves, D101642X012, or HIGH-SEAL Live Loaded Packing System, D101453X012, for packing instructions. Figure 6 shows a typical HIGH-SEAL packing system. Figures 7 and 8 show typical ENVIRO-SEAL systems.

Figure 3. PTFE V-Ring Packing Arrangements for Plain and Extension Bonnets

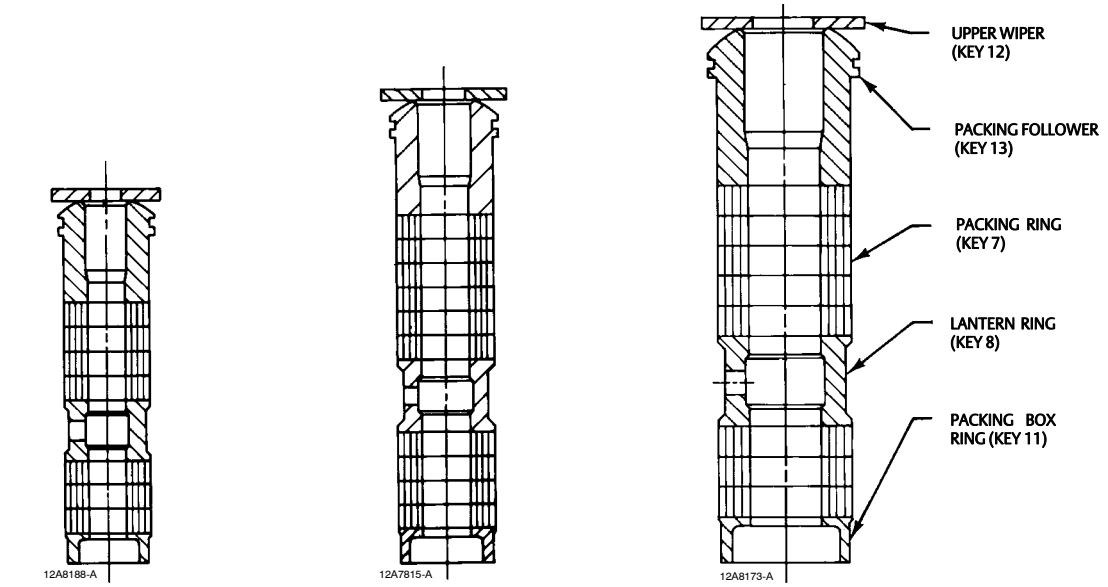


Packing Lubrication

Note
ENVIRO-SEAL or HIGH-SEAL packing does not require lubrication.

If an optional lubricator or lubricator/isolating valve (figure 2) is provided for PTFE/composition or other packings that require lubrication, it will be installed in an optional tapped hole in the bonnet. Use a good quality silicon-base lubricant. Packing used in oxygen service or in processes with temperatures over 260°C (500°F) should not be lubricated. To operate the lubricator, simply turn the cap screw clockwise to force the lubricant into the packing box. The lubricator/isolating valve must first be opened and then closed after lubrication is completed.

Figure 4. PTFE/Composition Packing Arrangements for Plain and Extension Bonnets



Packing Maintenance

This section covers PTFE V-ring, PTFE/composition, and graphite/ribbon packing as used in plain and extension bonnets. Unless otherwise indicated, key numbers refer to figure 3 for PTFE V-ring packing, figure 4 for PTFE/composition packing, and figure 5 for graphite ribbon/filament packing.

For spring-loaded single PTFE V-ring packing, the spring (key 8, figure 3) maintains a sealing force on the packing. If leakage is noted around the packing follower (key 13, figure 3), check to be sure the shoulder on the packing follower is touching the bonnet. If the shoulder is not touching the bonnet, tighten the packing flange nuts (key 5, figure 11), until the shoulder is against the bonnet. If leakage cannot be stopped in this manner, proceed to the Replacing Packing procedure.

If there is unacceptable packing leakage with other than spring-loaded packing, first try to limit the leakage and establish a stem seal by tightening the packing flange nuts.

If the packing is relatively new and tight on the stem, and if tightening the packing flange nuts does not stop the leakage, the valve stem may be worn or nicked so that a seal cannot be made. The surface finish of a valve stem is critical for making a good packing seal. If the leakage comes from the outside diameter of the packing, the leakage may be caused by nicks or scratches around the packing box wall. If performing any of the following procedures, inspect the valve stem and packing box wall for nicks and scratches.

An illustration of a HIGH-SEAL live-loaded packing system is shown in figure 6. Illustrations of ENVIRO-SEAL live-loaded packing systems are shown in figures 7, 8, and 9.

Figure 5. Graphite Ribbon/Filament Packing Arrangements for Plain and Extension Bonnets

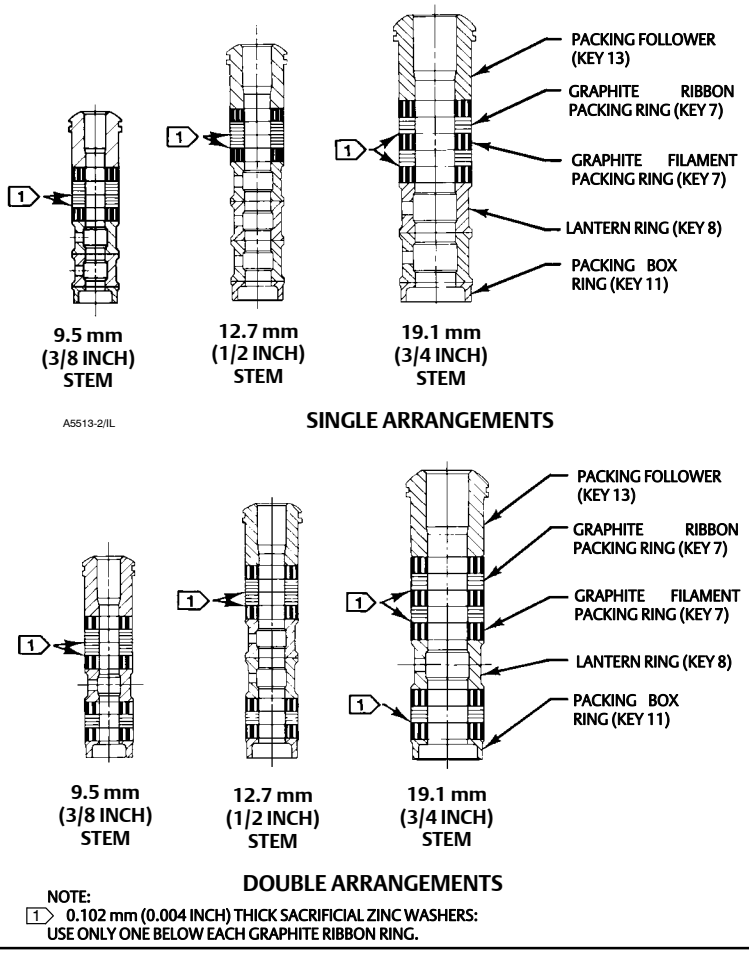
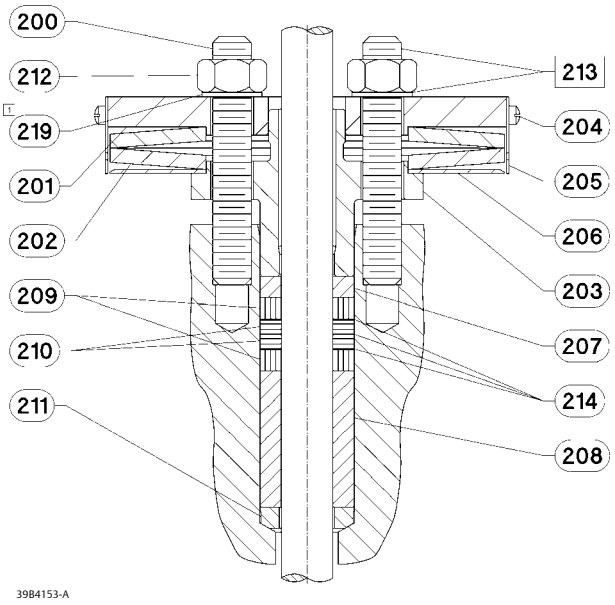


Table 2. Body-to-Bonnet Torque Guidelines

VALVE SIZE, NPS	TORQUES(1, 3)			
EZ	Bolt Material			
	SA193-B7		SA193-B8M(2)	
	N•m	Lbf•ft	N•m	Lbf•ft
1 or smaller	129	95	64	47
1-1/2 or 2	96	71	45	33
3	169	125	88	65
4	271	200	156	115

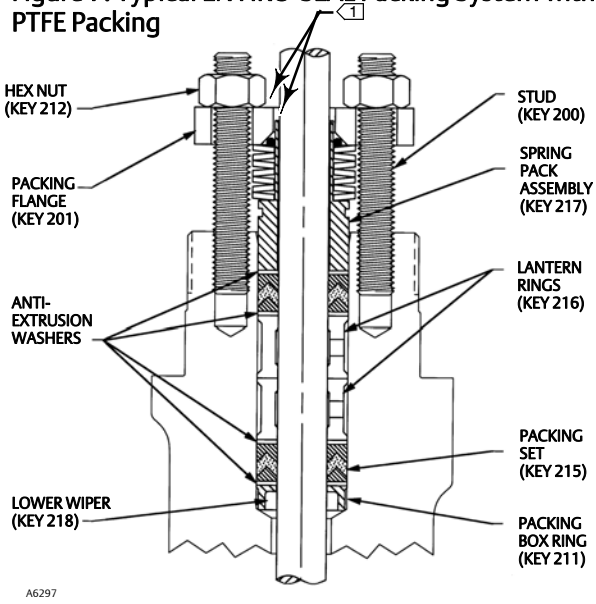
1. Determined from laboratory tests.
2. SA193-B8M annealed.
3. For other materials, contact your Emerson Process Management sales office for torques.

Figure 6. Typical HIGH-SEAL Graphite ULF Packing System



1. Find number 219 not required with 3/8-inch stem

Figure 7. Typical ENVIRO-SEAL Packing System with PTFE Packing



Note:
1 For PTFE packing, tighten the packing box hex nuts until the top of the flange is even with the top of the sleeve on the follower (spring pack assembly).

Figure 8. Typical ENVIRO-SEAL Packing System with Graphite ULF Packing

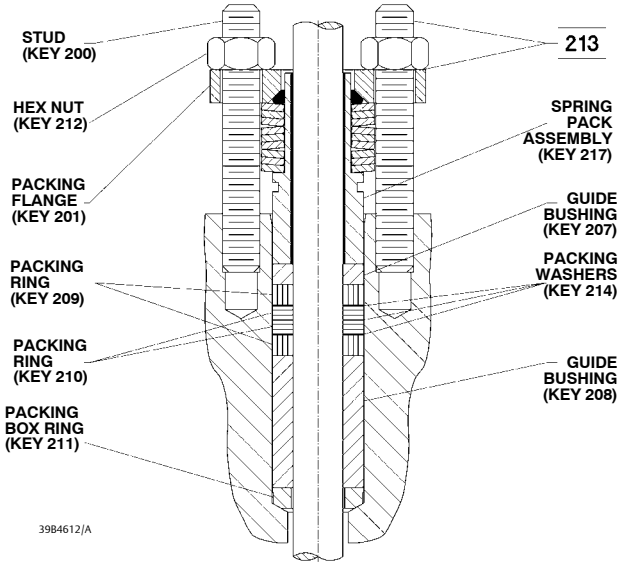
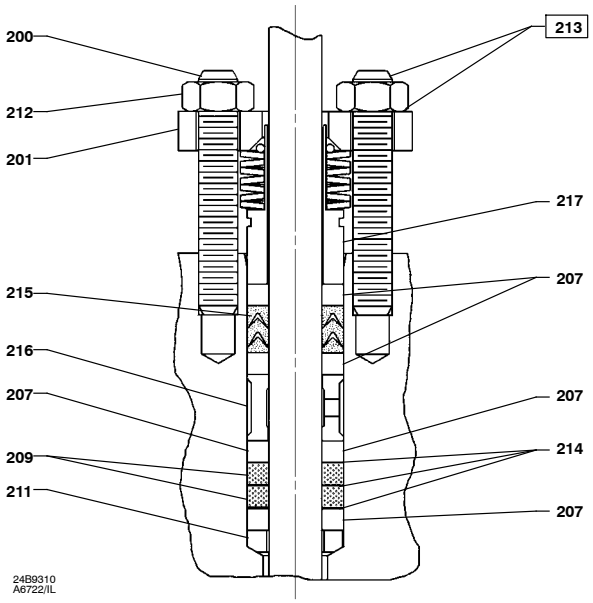


Figure 9. Typical ENVIRO-SEAL Packing System with Duplex Packing



Replacing Packing

⚠ WARNING

Observe the warning at the start of the Maintenance section.

This section covers replacing packing used in plain and extension bonnets. PTFE V-ring packing is shown in figure 3, PTFE/composition packing is shown in figure 4, and graphite/ribbon packing is shown in figure 5.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. If using a power actuator, also shut off all pressure lines to the power actuator, and release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
2. Disconnect the operating lines from the actuator and any leak-off piping from the bonnet. Disconnect the stem connector and then remove the actuator from the valve by unscrewing the yoke locknut (key 15, figure 11).

⚠ WARNING

To avoid personal injury or property damage caused by uncontrolled movement of the bonnet, loosen the bonnet by following the instructions in the next step. Do not remove a stuck bonnet by pulling on it with equipment that can stretch or store energy in any other manner. The sudden release of stored energy can cause uncontrolled movement of the bonnet. If the seat ring retainer sticks to the bonnet, proceed carefully with bonnet removal.

Note

The following step also provides additional assurance that the valve body fluid pressure has been relieved.

3. Hex nuts (key 16, figure 11) attach the bonnet to the valve. Loosen these nuts or cap screws approximately 3 mm (1/8-inch). Then loosen the body-to-bonnet gasketed joint by either rocking the bonnet or prying between the bonnet and valve body. Work the prying tool around the bonnet until the bonnet loosens.
4. Loosen the packing flange nuts (key 5, figure 11) so that the packing is not tight on the valve stem. Remove any travel indicator parts and stem locknuts from the valve stem threads.

CAUTION

Avoid damaging the seating surface caused by the valve plug and stem assembly dropping from the bonnet after being lifted part way out. When lifting the bonnet, temporarily install a valve stem locknut on the valve stem. This locknut will prevent the valve plug and stem assembly from dropping out of the bonnet.

5. Completely remove the cap screws (not shown) or hex nuts (key 16, figure 12) that bolt the bonnet and valve body together and carefully lift the bonnet off.
6. Remove the locknut and separate the valve plug and stem from the bonnet. Set the parts on a protective surface to prevent damage to gasket or seating surfaces.
7. Remove the bonnet gasket (key 10, figure 12) and cover the opening in the valve to protect the gasket surface and to prevent foreign material from getting into the valve body cavity.
8. Remove the packing flange nuts, packing flange, upper wiper, and packing follower (keys 5, 3, 12, and 13, figure 11). Carefully push out all the remaining packing parts from the valve side of the bonnet using a rounded rod or other tool that will not scratch the packing box wall. Clean the packing box and the metal packing parts.
9. Inspect the valve stem threads and the packing box surfaces for any sharp edges which might cut the packing. Scratches or burrs could cause packing box leakage or damage to the new packing. If the surface condition cannot be improved by light sanding, replace the damaged parts.
10. Remove the covering protecting the valve cavity and install a new bonnet gasket (key 10, figure 12), making sure the gasket seating surfaces are clean and smooth. Then slide the bonnet over the stem and onto the stud bolts (key 15, figure 12), or onto the valve cavity if cap screws (not shown) are used instead.

Note

Proper performance of the tightening procedures in step 11 compresses the spiral wound gasket (key 12, figure 12) enough to both load and seal the seat ring gasket (key 13, figure 12). The tightening procedures also compresses the outer edge of the bonnet gasket (key 10, figure 12) enough to seal the body-to-bonnet joint.

The accepted bolting procedures referred to in step 11 include--but are not limited to--ensuring that bolting threads are clean, and evenly tightening the cap screws, or the nuts onto the studs, in a crisscross pattern. Because of the boltup characteristics of spiral wound gaskets, tightening one cap screw or nut may loosen an adjacent cap screw or nut. Repeat the crisscross tightening pattern several times until each cap screw or nut is tight and the body-to-bonnet seal is made. When the operating temperature has been reached, perform this torquing procedure once again.

Note

Stud(s) and nut(s) should be installed such that the manufacturer's trademark and material grade marking is visible, allowing easy comparison to the materials selected and documented in the Emerson/Fisher serial card provided with this product.

⚠ WARNING

Personal injury or damage to equipment could occur if improper stud and nut materials or parts are used. Do not operate or assemble this product with stud(s) and nut(s) that are not approved by Emerson/Fisher engineering and/or listed on the

serial card provided with this product. Use of unapproved materials and parts could lead to stresses exceeding the design or code limits intended for this particular service. Install studs with the material grade and manufacturer's identification mark visible. Contact your Emerson Process Management representative immediately if a discrepancy between actual parts and approved parts is suspected.

11. Install bolting, using accepted bolting procedures during tightening so that the body-to-bonnet joint can withstand test pressures and application service conditions. The bolt torques in table 2 may be used as guidelines unless accepted bolting procedures dictate otherwise.
12. Install new packing and the metal packing box parts according to the appropriate arrangement in figure 3, 4, or 5. If split-ring packing is being added, alternate the position of the splits to avoid a leak path. Place a smooth-edged pipe over the valve stem and gently tap each soft packing part into the packing box, being sure that air is not trapped between adjacent soft parts.

Installation of graphite ribbon packing requires special care to avoid trapping air between the rings. Start with only one ring at a time without forcing the top of the packing ring below the bottom of the entrance chamfer of the packing box. Thus, when a ring is added, the stack should not be pushed into the cavity more than the thickness of the added ring.

13. Slide the packing follower, upper wiper, and packing flange (keys 13, 12, and 3, figure 11) into position. Lubricate the packing flange studs (key 4, figure 11) and the faces of the packing flange nuts (key 5, figure 11). Install the packing flange nuts.

Note

The torque values discussed in step 14 and shown in table 3 are recommended guidelines only and are presented as a starting point for this procedure. Tightening the packing flange nuts to a torque value that exceeds the table guidelines, in order to obtain a seal, may indicate other problems.

14. **For spring-loaded PTFE V-ring packing,** tighten the packing flange nuts until the shoulder on the packing follower (key 13, figure 11) contacts the bonnet.

For graphite packing, tighten the packing flange nuts to the maximum recommended torque shown in table 3. Then, loosen the packing flange nuts, and retighten them to the recommended minimum torque shown in table 3.

For other packing types, tighten the packing flange nuts alternately in small equal increments until one of the nuts reaches the minimum recommended torque shown in table 3. Then, tighten the remaining flange nuts until the packing flange is level and at a 90-degree angle to the valve stem.

For ENVIRO-SEAL or HIGH-SEAL live-loaded packing, refer to the note at the beginning of the Maintenance section on page 5 of this manual.

15. Mount the actuator on the valve body and reconnect the actuator and valve stem according to the procedure in the appropriate actuator instruction manual.

Table 3. Recommended Torque for Packing Flange Nuts (Not for Spring-Loaded Packing)

VALVE STEM DIAMETER		PRESSURE RATING	GRAPHITE TYPE PACKING				PTFE TYPE PACKING			
			Minimum Torque		Maximum Torque		Minimum Torque		Maximum Torque	
mm	Inches		N•m	Lbf•in	N•m	Lbf•in	N•m	Lbf•in	N•m	Lbf•in
9.5	3/8	CL125, CL150	3	27	5	40	1	13	2	19
		CL250 CL300	4	36	6	53	2	17	3	26
		CL600	6	49	8	73	3	23	4	35
12.7	1/2	CL125, CL150	5	44	8	66	2	21	4	31
		CL250 CL300	7	59	10	88	3	28	5	42
		CL600	9	81	14	122	4	39	7	58
19.1	3/4	CL125, CL150	11	99	17	149	5	47	8	70
		CL250 CL300	15	133	23	199	7	64	11	95
		CL600	21	182	31	274	10	87	15	131

Trim Maintenance

⚠ WARNING

Observe the warning at the start of the Maintenance section.

This procedure describes how the valve trim can be completely disassembled. When inspection or repairs are required, perform only those steps necessary to accomplish the task.

Disassembly

Except where indicated, key numbers referenced in the following steps are found in figure 12.

1. Remove the actuator and the bonnet according to steps 1 through 6 of the Replacing Packing procedure of the Maintenance section.

⚠ WARNING

Avoid personal injury or property damage from valve or packing leakage.

Any damage to the gasket sealing surfaces could cause the valve to leak.

The surface finish of the valve stem (key 7) is critical for making a good packing seal. The inside surface of the seat ring retainer is critical for smooth operation of the valve plug.

The seating surfaces of the valve plug and seat ring (keys 2 and 9) are critical for proper shutoff.

Protect these parts accordingly while disassembling the trim. Gasket selection criteria is provided on page 38 of this instruction manual.

2. Packing parts can be removed if desired. Replace these parts as described in the Replacing Packing procedure.

Valves with Plain or Extension Bonnets

Perform the following steps to remove the valve trim.

1. Lift the valve plug and stem assembly [or the plug guide, disk retainer, and disk (keys 27, 28, and 29, figure 13) if used], out of the valve body and set it on a protective surface.

Note

With some valve plug sizes and configurations, the seat ring retainer and bushing assembly (keys 3 and 26, figures 12 and 13) will come out of the valve body with the valve plug and stem assembly, and in other valve plug sizes and configurations, the valve plug or tip will slide through the seat ring retainer and bushing assembly, leaving the retainer and bushing assembly in the valve body.

2. With the valve plug and stem assembly out of the valve, either slide the seat ring retainer and bushing assembly (keys 3 and 26), and gaskets and shim (keys 10, 12, and 25) up over the valve plug and stem or lift the seat ring retainer and bushing assembly and associated gaskets and shim out of the valve body. If the valve plug is to be reused, protect the valve plug seating surface to prevent scratches.
3. **For valves with metal seats,** drive out the pin (key 8) and unscrew the valve stem (key 7) from the valve plug (key 2).
4. **For valves with 0.25 and 0.375-inch ports and composition seats,** refer to figure 13. Drive out the pin (key 8) and unscrew the valve stem (key 7) from the valve plug guide (key 27). Unscrew the disk retainer (key 28) from the valve plug guide. Remove the disk (key 29) from the valve plug tip (key 30).

For valves with 0.5 through 2-inch ports and composition seats, refer to figure 13. Drive out the pin (key 8) and unscrew the valve stem (key 7) from the valve plug guide (key 27). Drive out pin (key 31) and unscrew the tip (key 30) from the valve plug guide. Remove the disk (key 29) from the valve plug guide.

For valves with 3 and 4-inch ports and composition seats, refer to figure 13. Drive out the pin (key 8) and unscrew the valve stem from the valve plug guide (key 27). Remove the cap screw (key 32) to remove the tip (key 30) from the valve plug guide. Remove the disk (key 29).

5. Remove the seat ring and seat ring gasket (keys 9 and 13).
6. Inspect parts for wear or damage that would prevent proper operation of the valve. Replace or repair trim parts according to the following Lapping Metal Seats or Assembly procedure as appropriate.

Valves with Overtravel (EZ-OVT) Trim

Perform the following steps to remove the valve trim.

1. Lift the bonnet flat sheet gasket, gasket shim, and spiral wound gasket (keys 10, 25, and 12) from the valve body. Discard the old gaskets.
2. Lift the valve plug and stem assembly (key 30, figure 13) out of the valve body and set it on a protective surface.

Note

The seat ring retainer and bushing assembly (keys 3 and 26) will come out of the valve body with the valve plug and stem assembly.

3. Lift the seat ring (key 9) out of the valve body. There will be a flat sheet gasket located between the seat ring and valve body shelf (key 13). If the gasket does not come out of the valve body with the seat ring, be sure to remove the gasket from the valve body. Discard the gasket and tape or otherwise protect the seating surface of the seat ring to prevent damage.
4. Inspect all parts for wear and damage which would prevent proper operation of the valve. All gasket surfaces on the trim parts and in the valve body must be cleaned of any graphite residue and must be free from nicks and scratches.

The seating surfaces of the valve plug post and seat ring must be free from nicks, scratches, or any other damage which could affect the proper shutoff. Replace or repair trim parts as appropriate.

Note

If the soft seat disk is damaged, the entire plug assembly must be replaced.

Valves with ENVIRO-SEAL Bellows Seal Bonnets

Perform the following steps to remove the valve trim.

1. Lift the stem/bellows assembly with valve plug attached [or the plug guide, disk retainer, and disk (keys 27, 28, and 29, figure 13) if used], seat ring retainer and gaskets out of the valve body and set them on a protective surface.

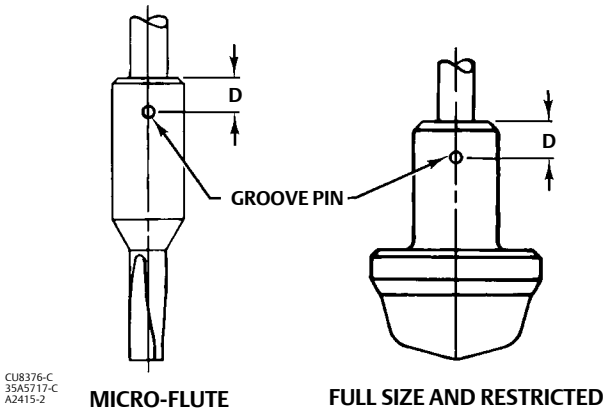
Note

With some valve plug sizes and configurations, the seat ring retainer and bushing assembly (keys 3 and 26, figures 12 and 13) will come out of the valve body with the stem/bellows, and in other valve plug sizes and configurations, the valve plug or tip will slide through the seat ring retainer and bushing assembly, leaving the retainer and bushing assembly in the valve body.

2. If the seat ring retainer and bushing assembly (keys 3 and 26) stayed in the valve, lift them out along with gaskets and shim (keys 10, 12, and 25).
3. If the seat ring retainer and bushing assembly (keys 3 and 26) came out of the valve with the stem/bellows assembly, move the seat ring retainer and bushing assembly against the shoulder of the valve plug (key 2) or valve plug guide (key 27, figure 13) to provide access to the pin (key 36, figure 11).

VALVE STEM		BOLT TORQUE		DRILL SIZE, INCH	D DIMENSION	
mm	Inch	N•m	Lbf•ft		mm	Inch
9.5	3/8	40-47	25-35	3/32	16	0.625
12.7	1/2	81-115	60-85	1/8	19	0.75
19.0	3/4	237-339	175-250	3/16	25	1

Figure 10. Bolt Torque for Plug/Stem Connection and Plug/Adaptor Connection and Pin Replacement



4. Place the stem/bellows assembly and valve plug or valve plug guide in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug or valve plug guide that is not a seating or guiding surface. Drive out the pin (key 36, figure 11).

5. Remove the stem/bellows assembly from the soft-jaw chuck or vise. Place a wrench on the flat areas on the valve stem just below the threads for the actuator/stem connection to keep the stem from turning. Then, unscrew the adaptor (key 24, figure 11), which also includes the valve plug (key 2) or valve plug guide (key 27, figure 13), from the stem/bellows assembly (key 20, figure 11).
6. Remove the seat ring retainer and bushing assembly (keys 3 and 26) by sliding it over the adaptor. If the valve plug is to be reused, protect the valve plug seating surface to prevent scratches.
7. **For valves with metal seats,** drive out the pin (key 8) and unscrew the adaptor (key 24, figure 11) from the valve plug (key 2).
8. **For valves with 0.25 and 0.375-inch ports and composition seats, refer to figure 13.** Drive out the pin (key 8) and unscrew the adaptor (key 24, figure 11) from the valve plug guide (key 27). Unscrew the disk retainer (key 28) from the valve plug guide. Remove the disk (key 29) from the valve plug tip (key 30).

For valves with 0.5 through 2-inch ports and composition seats, refer to figure 13. Drive out the pin (key 8) and unscrew the adaptor (key 24, figure 11) from the valve plug guide (key 27). Drive out the pin (key 31) and unscrew the tip (key 30) from the valve plug guide. Remove the disk (key 29) from the valve plug guide.

For valves with 3 and 4-inch ports and composition seats, refer to figure 13. Drive out the pin (key 8) and unscrew the adaptor (key 24, figure 11) from the valve plug guide (key 27). Remove the cap screw (key 32) to remove the tip (key 30) from the valve plug guide. Remove the disk (key 29).

9. Remove the seat ring and seat ring gasket (keys 9 and 13).
10. Inspect parts for wear or damage that would prevent proper operation of the valve. Replace or repair trim parts according to the following Assembly procedure as appropriate.

Lapping Metal Seats on Valves with Plain and Extension Bonnets

CAUTION

To avoid damaging the ENVIRO-SEAL Bellows Seal Bonnet assembly, do not attempt to lap the metal seating surfaces on valves with ENVIRO-SEAL bellows seal bonnets. The design of the bonnet assembly prevents rotation of the stem and any forced lapping rotation will damage internal components of the ENVIRO-SEAL Bellows Seal bonnet.

With metal-seat constructions, seating surfaces of the valve plug and seat ring (key 2, figure 12) can be lapped for improved shutoff. (Deep nicks should be machined out rather than ground out.) Use a good quality lapping compound of a mixture of 280 to 600-grit. Apply the compound to the bottom of the valve plug.

Assemble the valve to the extent that the seat ring retainer is in place and the bonnet is bolted to the valve body. A simple handle can be made from a piece of strap iron locked to the valve plug stem with nuts. Rotate the handle alternately in each direction to lap the seats. After lapping, remove the bonnet and clean the seat surfaces. Completely assemble as described in the assembly portion of the Trim Maintenance procedure and test the valve for shutoff. Repeat the lapping procedure if leakage is still excessive.

Note

EZ valves with Overtravel (EZ-OVT) trim should not be lapped.

Assembly

This procedure assumes that all the trim and associated gaskets were removed from the valve body. If these parts were not all removed, start the assembly procedure at the appropriate step. Except where indicated, key numbers referenced in the following steps are found in figure 12.

Valves with Plain or Extension Bonnets

Perform the following steps to assemble and install the trim.

CAUTION

To avoid weakening the stem that may cause failure in service, never reuse an old stem with a new valve plug. Using an old stem with a new plug requires drilling a new pin hole in the stem,which will weaken the stem. However, a used valve plug may be reused with a new stem.

1. For valves with metal seats, screw the valve stem (key 7) into the valve plug (key 2). Tighten to the torque value given in figure 10. Refer to figure 10 to select the proper drill size. Drill through the stem using the hole in the valve plug as a guide. Remove any chips or burrs and drive in a new pin (key 8) to lock the assembly.
2. For valves with 0.25 and 0.375-inch ports and composition seats, refer to figure 13. Place the disk (key 29) on the valve plug tip (key 30). Place the disk retainer (key 28) over the disk, and then thread the disk retainer onto the valve plug guide (key 27).

CAUTION

To avoid failure in service for valves with 0.5 through 1-inch ports and composition seats, never reuse an old valve plug guide with a new valve plug tip. Using an old valve plug guide with a new plug tip requires drilling a new pin hole in the valve plug guide, which will weaken the guide. However, a used valve plug tip may be reused with a new valve plug guide.

For valves with 0.5 through 1-inch ports and composition seats, refer to figure 13. Insert the disk (key 29) in the valve plug guide (key 27). Screw the tip (key 30) onto the valve plug guide to clamp the disk in place. Using a 3/32-inch bit, drill through the valve plug guide using the hole in the tip as a drilling guide. Remove any chips or burrs and drive in a new pin (key 31).

CAUTION

To avoid failure in service for valves with 1.5 and 2-inch ports and composition seats, never reuse an old valve plug tip with a new valve plug guide. Using an old valve plug tip with a new valve plug guide requires drilling a new pin hole in the valve plug tip which will weaken the tip. However, a used valve plug guide may be reused with a new valve plug tip.

For valves with 1.5 and 2-inch ports and composition seats, refer to figure 13. Insert the disk (key 29) in the valve plug guide (key 27). Screw the tip (key 30) into the valve plug guide to clamp the disk in place. Using a 3/32-inch bit, drill through the valve plug tip using the hole in the valve plug guide as a drilling guide. Remove any chips or burrs and drive in a new pin (key 31).

For valves with 3 and 4-inch ports and composition seats, refer to figure 13. Insert the disk (key 29) in the valve plug guide (key 27). Place the tip (key 30) against the valve plug guide to clamp the disk in place. Insert the cap screw (key 32) through the tip and thread it into valve plug guide to secure the tip to the valve plug guide.

CAUTION

To avoid failure in service, never reuse an old stem with a new valve plug guide. Using an old stem with a new valve plug guide requires drilling a new pin hole in the stem, which will weaken the stem. However, a used valve plug guide may be

reused with a new stem except for valves with 0.5 through 1-inch ports and composition seats (see to figure 13). For these constructions, a used valve plug guide should only be used if the tip is reused.

3. **For all valves with composition seats,** screw the valve stem (key 7) into the valve plug guide (key 27, figure 13). Tighten to the torque value given in figure 10. Refer to figure 10 to select the proper drill size. Drill through the stem, using the hole in the valve plug guide as a drilling guide. Remove any chips or burrs and drive in a new pin (key 8) to lock the assembly.
4. Install the seat ring gasket (key 13), and replace the seat ring (key 9).

Note

With some valve plug sizes and configurations, the valve plug or tip will slide through the seat ring retainer and bushing assembly (keys 3 and 26), and in other configurations it won't.

5. If the valve plug (key 2) or valve plug tip (key 30, figure 13) will not slide through the seat ring retainer and bushing assembly (keys 3 and 26), proceed as follows:
   a. Place the seat ring retainer and bushing assembly (keys 3 and 26) over the stem of valve plug and stem assembly or over the stem of the valve plug guide and stem assembly.
   b. Install the seat ring retainer and bushing assembly, which also includes the valve plug and stem assembly or valve plug guide and stem assembly, on the top of the seat ring, ensuring that the seat ring retainer slips onto the seat ring properly. Any rotation orientation of the seat ring retainer with respect to the valve body is acceptable.
   c. Place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10) on the shoulder of the seat ring retainer.
6. If the valve plug (key 2) or the valve plug tip (key 30, figure 13) will slide through the seat ring retainer and bushing assembly (keys 3 and 26), proceed as follows:
   a. Install the seat ring retainer and bushing assembly on the top of the seat ring, ensuring that the seat ring retainer slips onto the seat ring properly. Any rotation orientation of the seat ring retainer with respect to the valve body is acceptable.
   b. Place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10) on the shoulder of the seat ring retainer.
   c. Slide the valve plug and stem assembly or the valve plug guide and stem assembly into the seat ring retainer and bushing assembly (keys 3 and 26).
7. Mount the bonnet on the valve body and complete the assembly according to steps 10 through 15 of the Replacing Packing procedure, omitting steps 12 and 13 if new packing is not being installed, and being sure to observe the note prior to step 11.

Valves with Overtravel (EZ-OVT) Trim

Perform the following steps to assemble and install the trim

1. Install the seat ring gasket (key 13) and replace the seat ring (key 9).
2. Place the seat ring retainer and bushing assembly (key 3) over the stem of the valve plug and stem assembly (key 30, figure 13).
3. Install the seat ring retainer and bushing assembly, which also includes the valve plug and stem assembly, on top of the seat ring. Ensure that the seat ring retainer slips onto the seat ring properly. Any rotation orientation of the seat ring retainer with respect to the valve body is acceptable.

4. Place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, 10) on the shoulder of the seat ring retainer.
5. Mount the bonnet on the valve body and complete the assembly according to steps 10 through 15 of the Replacing Packing procedure, omitting steps 12 and 13 if new packing is not being installed. Be sure to observe the note prior to step 11.

Note

When connecting the valve stem to the stem connecting block on the actuator, extra stem force is required on the valve plug to ensure proper seating of the plug to the seat ring. This is required to deform the soft seat disk ensuring a backup metal-to-metal mating surface between the valve plug guide post and the seat ring.

Valves with ENVIRO-SEAL Bellows Seal Bonnets

Perform the following steps to assemble and install the trim.

1. **For valves with 0.25 and 0.375-inch ports and composition seats, refer to figure 13.** Place the disk (key 29) on the valve plug tip (key 30). Place the disk retainer (key 28) over the disk, and then thread the disk retainer onto the valve plug guide (key 27).

CAUTION

To avoid failure in service of valves with 0.5 through 1-inch ports and composition seats, never reuse an old valve plug guide with a new valve plug tip. Using an old valve plug guide with a new plug tip requires drilling a new pin hole in the valve plug guide, which will weaken the guide. However, a used valve plug tip may be reused with a new valve plug guide.

For valves with 0.5 through 1-inch ports and composition seats, refer to figure 13. Insert the disk (key 29) in the valve plug guide (key 27). Screw the tip (key 30) onto the valve plug guide to clamp the disk in place. Using a 3/32-inch bit, drill through the valve plug guide using the hole in the tip as a drilling guide. Remove any chips or burrs and drive in a new pin (key 31).

CAUTION

To avoid failure in service of valves with 1.5 and 2-inch ports and composition seats, never reuse an old valve plug tip with a new valve plug guide. Using an old valve plug tip with a new valve plug guide requires drilling a new pin hole in the valve plug tip, which will weaken the tip. However, a used valve plug guide may be reused with a new valve plug tip.

For valves with 1.5 and 2-inch ports and composition seats, refer to figure 13. Insert the disk (key 29) in the valve plug guide (key 27). Screw the tip (key 30) into the valve plug guide to clamp the disk in place. Using a 3/32-inch bit, drill through the valve plug tip using the hole in the valve plug guide as a drilling guide. Remove any chips or burrs and drive in a new pin (key 31).

For valves with 3 and 4-inch ports and composition seats, refer to figure 13. Insert the disk (key 29) in the valve plug guide (key 27). Place the tip (key 30) against the valve plug guide to clamp the disk in place. Insert the cap screw (key 32) through the tip and thread it into valve plug guide to secure the tip to the valve plug guide.

CAUTION

To avoid weakening the adaptor that may cause failure in service, never reuse an old adaptor with a new valve plug or valve plug guide. Using an old adaptor with a new valve plug or valve plug guide requires drilling a new pin hole in the adaptor, which will weaken the adaptor. However, a used valve plug or valve plug guide may be reused with a new adaptor.

2. Thread the valve plug (key 2) or, the valve plug guide (key 27, figure 13) if the valve has composition seats, onto the adaptor (key 24, figure 11). Tighten to the torque valve given in figure 10.

Note

Valve plugs may not be pre-drilled. Follow the procedure in the following step.

3. If the valve plug is not pre-drilled, drill a hole according to figure 10. Otherwise, select the proper drill size (figure 10) and drill through the adaptor using the hole in the valve plug as a guide. Remove any chips or burrs and drive in a new pin (key 8) to lock the assembly.

Note

With some valve plug sizes and configurations, the valve plug or tip will slide through the seat ring retainer and bushing assembly, and in other configurations it won't.

4. If the valve plug (key 2) or valve plug tip (key 30, figure 13) will not slide through the seat ring retainer and bushing assembly (keys 3 and 26), proceed as follows:

   a. Slide the seat ring retainer and bushing assembly (keys 3 and 26) over the adaptor (key 24, figure 11) so that the bushing rests on the shoulder of the valve plug or valve plug guide.

   b. Place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10) on the shoulder of the seat ring retainer.

   c. Place a wrench on the flat areas of the stem just below the threads for the actuator/stem connection to keep the stem from turning.

   d. Screw the adaptor (key 24, figure 11), which also includes the valve plug or valve plug guide and seat ring retainer and bushing assembly and gaskets, onto the stem/bellows assembly (key 20, figure 11). Tighten the adaptor until it is snug. Then, turn the adaptor until the valve stem hole lines up with the next adaptor pin hole. Drive in a new pin (key 36) to lock the assembly.

   e. Install the seat ring gasket (key 13), and replace the seat ring (key 9).

   f. Install the seat ring retainer and bushing assembly, which also contains the valve plug/adaptor assembly or valve plug guide/adaptor assembly, on the top of the seat ring, ensuring that the seat ring retainer slips onto the seat ring properly. Any rotation orientation of the seat ring retainer with respect to the valve body is acceptable.

   g. Place a new gasket (key 22, figure 11) over the stem and bellows assembly.

5. If the valve plug (key 2) or the valve plug tip (key 30, figure 13) will slide through the seat ring retainer and bushing assembly (keys 3 and 26), proceed as follows:

   a. Place a wrench on the flat areas of the stem just below the threads for the actuator/stem connection to keep the stem from turning.

   b. Screw the adaptor (key 24, figure 11), which also includes the valve plug or valve plug guide onto the stem/bellows assembly (key 20, figure 11). Tighten the adaptor until it is snug. Then, turn the adaptor until the valve stem hole lines up with the next adaptor pin hole. Drive in a new pin (key 36) to lock the assembly.

   c. Install the seat ring gasket (key 13), and replace the seat ring (key 9).

d. Install the seat ring retainer and bushing assembly on the top of the seat ring, ensuring that the seat ring retainer slips onto the seat ring properly. Any rotation orientation of the seat ring retainer with respect to the valve body is acceptable.

e. Place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10) on the shoulder of the seat ring retainer.

f. Slide the valve plug/adaptor assembly or the valve plug guide/adaptor assembly and the connected stem and bellows assembly into the seat ring retainer and bushing assembly (keys 3 and 26).

g. Place a new gasket (key 22, figure 11) over the stem and bellows assembly.

6. Mount the bonnet on the valve body and complete the assembly according to steps 10 through 15 of the Replacing Packing procedure, omitting steps 12 and 13 if new packing is not being installed, and being sure to observe the note prior to step 11.

ENVIRO-SEAL Bellows Seal and Bonnet

Replacing a Plain or Extension Bonnet with an ENVIRO-SEAL Bellows Seal (Stem/Bellows Assembly) and Bonnet

Instructions are provided for replacing a plain or extension bonnet with an ENVIRO-SEAL bellows seal bonnet when the existing valve has a metal seat. If the valve has a composition seat, refer to figure 13 and to composition seat information in the Valves with ENVIRO-SEAL Bellows Seal Bonnet procedure of the Trim Maintenance section.

1. Remove the actuator and bonnet according to steps 1 through 6 of the Replacing Packing procedure of the Maintenance section.

Note

With some valve plug sizes and configurations, the valve plug will slide through the seat ring retainer and bushing assembly, and in other configurations it won't. If the valve plug will not slide through the seat ring retainer and bushing assembly, then the valve plug and stem assembly and the seat ring retainer and bushing assembly must be removed together.

2. Using care, remove the valve plug and stem assembly, and, if necessary, the seat ring retainer and bushing assembly from the valve body.
3. Remove and discard the existing bonnet gasket (key 10, figure 12). Cover the valve body opening to protect sealing surfaces and to prevent foreign material from entering the valve body cavity.

Note

The ENVIRO-SEAL stem/bellows assembly for easy-e valves is available only with a threaded and drilled plug/adaptor connection. The existing valve plug can be reused with the new stem/bellows assembly or a new plug can be installed.

4. Inspect the existing valve plug. If the plug is in good condition, it can be reused with the new ENVIRO-SEAL stem/bellows assembly. To remove the existing valve plug from the stem, first, place the existing plug stem assembly in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug that is not a seating surface. Drive out or drill out the pin (key 8, figure 12).
5. Place a wrench on the flat areas on the existing valve stem just below the threads for the actuator/stem connection. Then, unscrew the stem from the valve plug (key 2, figure 12).

CAUTION

When installing a valve plug on the ENVIRO-SEAL stem/bellows assembly, the valve stem must not be rotated. Damage to the bellows may result.

Do not grip the bellows shroud or other parts of the stem/bellows assembly. Grip only the flat areas on the stem where it extends out of the top of the bellows shroud.

Note

The ENVIRO-SEAL stem/bellows assembly has a one-piece stem.

Table 4. Recommended Torque for ENVIRO-SEAL Bellows Seal Packing Flange Nuts

VALVE SIZE, NPS	VALVE STEM DIAMETER THROUGH PACKING	MINIMUM TORQUE		MAXIMUM TORQUE	
		N•m	Lbf•in	N•m	Lbf•in
1/2 - 2	1/2	2	22	4	33
3 -4	1	5	44	8	67

6. To attach the valve plug to the stem of the new ENVIRO-SEAL stem/bellows assembly, it is necessary to first attach the valve plug to the adaptor (key 24, figure 11). Locate the adaptor. Notice that a hole has not been drilled in the adaptor threads where the valve plug screws onto the adaptor.

Secure the valve plug in a soft-jaw chuck or other type of vise. Do not grip the plug on any seating surface. Position the plug in the chuck or vise for easy threading of the adaptor. Thread the adaptor into the valve plug and tighten to the torque value given in figure 10.

Note

Valve plugs may not be pre-drilled. Follow the procedure in the following step.

7. If the valve plug is not pre-drilled, drill a hole according to figure 10. Otherwise, select the proper size of drill bit (figure 10) and drill through the adaptor using the hole in the valve plug as a guide. Remove any metal chips or burrs and drive in a new pin (key 8, figure 12) to lock the valve plug/adaptor assembly together.

Note

For some valve plug configurations, you must place the valve plug/adaptor assembly inside the seat ring retainer and bushing assembly before attaching the adaptor to the stem extending from the bottom of the ENVIRO-SEAL stem/bellows assembly. If this task is necessary, then place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10, figure 12) on the shoulder of the seat ring retainer. Check the existing seat ring retainer and bushing assembly for clearances. If necessary, use appropriate procedures to support the seat ring retainer while screwing the valve plug/adaptor assembly onto the valve stem extending from the ENVIRO-SEAL stem/bellows assembly.

8. Place a wrench on the flat areas of the valve stem just below the threads for the actuator/stem connection to keep the stem from turning.
9. Screw the adaptor (key 24, figure 11), which also includes the valve plug or valve plug guide and may include the seat ring retainer and bushing assembly and gaskets, onto the valve stem. Tighten the adaptor until it is

finger-tight. Then, tighten the adaptor with a wrench until the valve stem hole lines up with the next adaptor pin hole. Drive in a new pin (key 36, figure 11) to lock the assembly. Make certain the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10, figure 12) are located on the shoulder of the seat ring retainer.

10. Inspect the seat ring. Replace, if necessary.
11. Install the new stem/bellows assembly with valve plug/adaptor by placing it into the valve body.
12. Place a new gasket (key 22, figure 11) over the stem/bellows assembly. Place the new ENVIRO-SEAL bonnet over the stem/bellows assembly.

Note

Stud(s) and nut(s) should be installed such that the manufacturer's trademark and material grade marking is visible, allowing easy comparison to the materials selected and documented in the Emerson/Fisher serial card provided with this product.

⚠ WARNING

Personal injury or damage to equipment could occur if improper stud and nut materials or parts are used. Do not operate or assemble this product with stud(s) and nut(s) that are not approved by Emerson/Fisher engineering and/or listed on the serial card provided with this product. Use of unapproved materials and parts could lead to stresses exceeding the design or code limits intended for this particular service. Install studs with the material grade and manufacturer's identification mark visible. Contact your Emerson Process Management representative immediately if a discrepancy between actual parts and approved parts is suspected.

13. Properly lubricate the bonnet stud bolts. Install and tighten the bonnet hex nuts to the proper torque.
14. Install new packing and the metal packing box parts according to the appropriate arrangement in figure 14 or 15.
15. Install the packing flange. Properly lubricate the packing flange stud bolts and the faces of the packing flange nuts.

For graphite packing, tighten the packing flange nuts to the maximum recommended torque shown in table 4. Then, loosen the packing flange nuts, and retighten them to the recommended minimum torque shown in table 4.

For other packing types, tighten the packing flange nuts alternately in small equal increments until one of the nuts reaches the minimum recommended torque shown in table 4. Then, tighten the remaining flange nuts until the packing flange is level and at a 90-degree angle to the valve stem.

16. Install travel indicator parts, stem locknuts, and mount the actuator on the valve body according to the procedure in the appropriate actuator instruction manual.

Replacing an Installed ENVIRO-SEAL Bellows Seal (Stem/Bellows Assembly)

Instructions are provided for replacing an ENVIRO-SEAL bellows seal (stem/bellows assembly) when the existing valve has a metal seat. If the valve has a composition seat, refer to figure 13 and to composition seat information in the Valves with ENVIRO-SEAL Bellows Seal Bonnet procedure of the Trim Maintenance section.

1. Remove the actuator and bonnet according to steps 1 through 5 of the Replacing Packing procedure of the Maintenance section.

Note

With some valve plug sizes and configurations, the valve plug will slide through the seat ring retainer and bushing assembly, and in other configurations it won't. If the valve plug will not slide through the seat ring retainer and bushing assembly, then the valve plug and stem assembly and the seat ring retainer and bushing assembly must be removed together.

2. Using care, remove the valve plug and stem assembly, and, if necessary, the seat ring retainer and bushing assembly from the valve body. Remove and discard the existing bonnet gasket (key 10, figure 12) and gasket (key 22, figure 11). Cover the valve body opening to protect sealing surfaces and to prevent foreign material from entering the valve body cavity.

CAUTION

The ENVIRO-SEAL stem/bellows assembly for easy-e valves is available only with a threaded and pinned adaptor/stem connection. The existing valve plug can be reused with the new stem/bellows assembly or a new plug can be installed. If the existing valve plug is reused, and the adaptor is in good condition, it may be reused also. However, to avoid weakening the adaptor that may cause failure in service, never reuse an old adaptor with a new valve plug. Using an old adaptor with a new plug requires drilling a new pin hole in the adaptor, which will weaken the adaptor. However, a used valve plug may be reused with a new adaptor.

3. Inspect the existing valve plug and adaptor. If they are in good condition, they can be reused with the new stem/bellows assembly, and they do not need to be separated.

CAUTION

When removing/installing a valve plug on the ENVIRO-SEAL stem/bellows assembly, the valve stem must not be rotated. Damage to the bellows may result.

Do not grip the bellows shroud or other parts of the stem/bellows assembly. Grip only the flat areas on the stem where it extends out of the top of the bellows shroud.

Note

The ENVIRO-SEAL stem/bellows assembly has a one-piece stem.

4. If the existing valve plug and adaptor are not in good condition and must be replaced, first, place the existing stem/bellows assembly and valve plug and adaptor assembly in a soft-jaw chuck or other type of vise so that the jaws grip a portion of the valve plug that is not a seating surface. Drive out or drill out pin (key 8, figure 12). Drive out pin (key 36, figure 11).
5. Use a wrench on the flat areas on the valve stem just below the threads for the actuator/stem connection in a soft-jaw chuck or vice to keep the stem from turning. Then, unscrew the valve plug from the adaptor and the adaptor from the stem/bellows assembly.
6. To attach either the existing valve plug or a new one to the stem of the new ENVIRO-SEAL stem/bellows assembly, it is necessary to first attach the valve plug to the adaptor (key 24, figure 11), if the valve plug was removed from the adaptor. Locate the adaptor. Notice that a hole has not been drilled in the new adaptor threads where the valve plug screws onto the adaptor.

If installing either a new valve plug and/or a new adaptor, secure the valve plug in a soft-jaw chuck or other type of vise. Do not grip the plug on any seating surface. Position the plug in the chuck or vise for easy threading of the adaptor. Thread the adaptor into the valve plug and tighten to the torque values given in figure 10.

7. Complete the installation by following steps 7 through 16 of the Replacing a Plain or Extension Bonnet with an ENVIRO-SEAL Bellows Seal and Bonnet procedure provided in the previous section.

Purging the ENVIRO-SEAL Bellows Seal Bonnet

The ENVIRO-SEAL bellows seal bonnet has been designed so that it can be purged or leak tested. Refer to figure 11 for an illustration of an ENVIRO-SEAL bellows seal bonnet, and perform the following steps for purging or leak testing.

1. Remove the two diametrically opposed pipe plugs (key 16).
2. Connect a purging fluid to one of the pipe plug connections.
3. Install appropriate piping or tubing in the other pipe plug connection to pipe away the purging fluid or to make a connection to an analyzer for leak testing.
4. When purging or leak testing has been completed, remove the piping or tubing and reinstall the pipe plugs (key 16).

Parts Ordering

Each valve is assigned a serial number which can be found on the valve body. This same number also appears on the actuator nameplate when the valve is shipped from the factory as part of a control valve assembly. Refer to the serial number when contacting your Emerson Process Management sales office for technical assistance. When ordering replacement parts, refer to the serial number and to the 11-character part number for each part required from the following parts list.

Parts Kits

Gasket parts kits are in key 10 table.

Packing Kits (non-live-loaded)

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)
PTFE (Contains keys 6, 8, 10, 11, and 12)	RPACKX00012	RPACKX00022	RPACKX00032
Double PTFE (Contains keys 6, 8, 11, and 12)	RPACKX00042(1)(2)	RPACKX00052(1)	RPACKX00062(1)
PTFE/Composition (Contains keys 7, 8, 11, and 12)	RPACKX00072	RPACKX00082	RPACKX00092
Single Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring], 8, and 11)	RPACKX00102	RPACKX00112	RPACKX00122
Double Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring], 8, and 11)	RPACKX00162	RPACKX00172	RPACKX00182

1. These parts kits contain one extra lower wiper (key 30). Discard this extra part upon assembly.
2. This parts kit contains one extra packing ring (key 7). Discard this extra part upon assembly.

Packing Kits (ENVIRO-SEAL) Repair

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)
Double PTFE (Contains keys 214, 215, and 218)	RPACKX00192	RPACKX00202	RPACKX00212
Graphite ULF (Contains keys 207, 208, 209, 210, and 214)	RPACKX00592	RPACKX00602	RPACKX00612
Duplex (Contains keys 207, 209, 214, and 215)	RPACKX00292	RPACKX00302	RPACKX00312

Packing Kits (ENVIRO-SEAL) Retrofit

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)
Double PTFE (Contains keys 200, 201, 211, 212, 214, 215, 216, 217, and 218)	RPACKXRT012	RPACKXRT022	RPACKXRT032
Graphite ULF (Contains keys 200, 201, 207, 208, 209, 210, 211, 212, 214, and 217)	RPACKXRT262	RPACKXRT272	RPACKXRT282
Duplex (Contains keys 200, 201, 207, 209, 211, 212, 214, 215, 216, and 217)	RPACKXRT212	RPACKXRT222	RPACKXRT232

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management should not, under any circumstances, be used in any Fisher valve, because they may void your warranty, might adversely affect the performance of the valve, and could cause personal injury and property damage.

Parts List

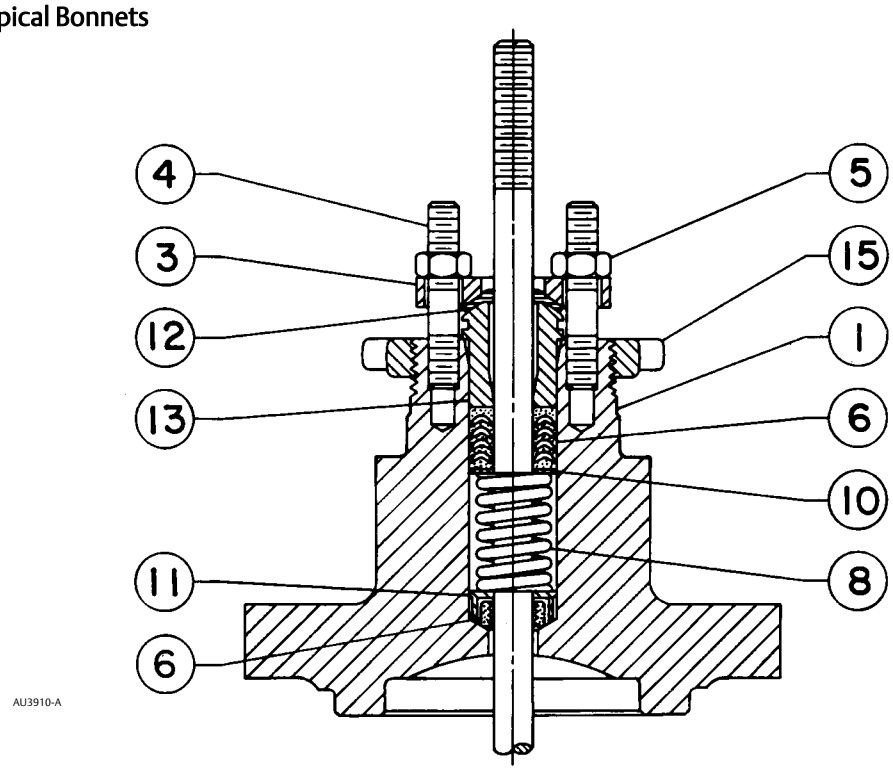
Bonnet

Note
Part numbers are shown for recommended spares only. For part numbers not shown, contact your Emerson Process Management sales office.

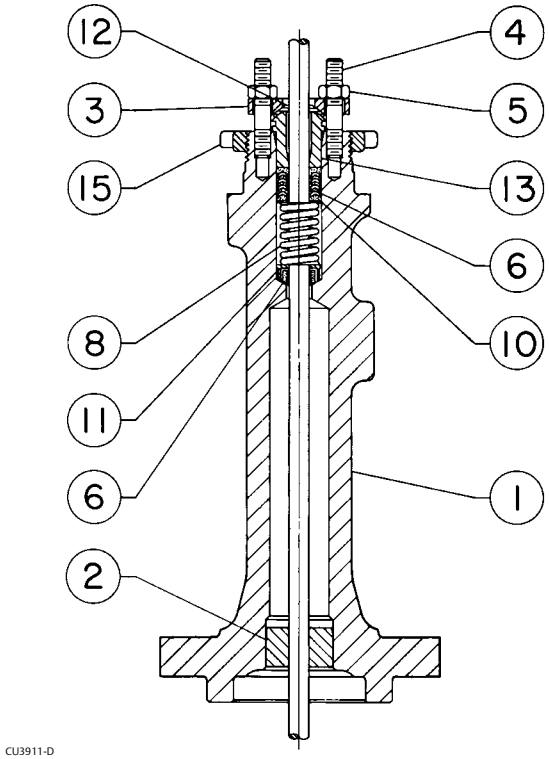
Key	Description	Part Number
1	Bonnet/ENVIRO-SEAL bellows seal bonnet	
	If you need a bonnet or an ENVIRO-SEAL bellows seal bonnet as a replacement part, order by valve size and stem diameter, serial number, and desired material.	
2	Baffle,(for extension bonnets only)	
3	Packing Flange, S31600 (316 SST)	
3	ENVIRO-SEAL Bellows Seal Packing Flange	
4	Packing Flange Stud, S31600 (2 req'd)	
4	ENVIRO-SEAL Bellows Seal Stud Bolt	
5	Packing Flange Nut, S31600 (2 req'd)	
5	ENVIRO-SEAL Bellows Seal Hex Nut	
6*	Packing Set, PTFE (2 req'd for double packing)	
	9.5 mm (3/8-inch) stem	1R290001012
	12.7 mm (1/2-inch) stem	1R290201012
	19.1 mm (3/4-inch) stem	1R290401012
6*	ENVIRO-SEAL Bellows Seal Packing Set	
	PTFE for 9.5 mm (3/8-inch) stem (1 req'd for single packing, 2 req'd for double packing)	12A9016X012
	PTFE for size 2 with 12.7 mm (1/2 inch) stem (2 req'd for double packing)	12A9016X012
	PTFE for size 3 and 4 with 12.7 mm (1/2 inch) stem (2 req'd for double packing)	12A8832X012
7*	Packing Ring, PTFE/comp (for double packing)	
	9.5 mm (3/8-inch) stem PTFE/comp (7 req'd)	1F3370X0012
	12.7 mm (1/2-inch) stem PTFE/comp (10 req'd)	1E319001042
	19.1 mm (3/4-inch) stem PTFE/comp (8 req'd)	1E319101042
7*	Packing Ring, graphite ribbon ring (2 req'd for single packing, 3 req'd for double packing)	
	9.5 mm (3/8-inch) stem	1V3160X0022
	12.7 mm (1/2-inch) stem	1V3802X0022
	19.1 mm (3/4-inch) stem	1V2396X0022
7*	Packing Ring, graphite filament ring	
	9.5 mm (3/8-inch) stem (2 req'd for single packing, 4 req'd for double packing)	1F3370X0322
	12.7 mm (1/2-inch) stem (3 req'd for single packing, 5 req'd for double packing)	1E3190X0222
	19.1 mm (3/4-inch) stem (2 req'd for single packing, 4 req'd for double packing)	1E3191X0282
7*	ENVIRO-SEAL Bellows Seal Packing Ring for low chloride graphite ribbon/filament packing arrangement	
	Ribbon packing ring for 9.5 mm (3/8 inch) and size 2 with 12.7 mm (1/2 inch) stem (4 req'd)	18A0908X012
	Filament packing ring for 9.5 mm (3/8 inch) and size 2 with 12.7 mm (1/2 inch) stem (4 req'd)	1P3905X0172
	Ribbon packing ring for size 3 and 4 with 12.7 mm (1/2 inch) stem (4 req'd)	18A0918X012
	Filament packing ring for size 3 and 4 with 12.7 mm (1/2 inch) stem (4 req'd)	14A0915X042
8	Spring, S31600 (for single PTFE packing only)	
8	Spacer, N04400 (for single PTFE packing only)	
8	Lantern Ring (for double PTFE packing)	
8	ENVIRO-SEAL Bellows Seal Spring	
8	ENVIRO-SEAL Bellows Seal Spacer	
10	Special Washer, S31600 (for single PTFE packing)	
11*	Packing Box Ring	
	Single PTFE packing	
	9.5 mm (3/8-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873135072
	N05500 (std for N05500 trim)	1J873146222
	12.7 mm (1/2-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873235072
	N05500 (std for N05500 trim)	1J873246222
	19.1 mm (3/4-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873335072
	N05500 (std for N05500 trim)	1J873346222
	Double PTFE packing	
	9.5 mm (3/8-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873135072
	Glass-filled PTFE (std for N05500 trim)	17A6872X012
	12.7 mm (1/2-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873235072
	Glass-filled PTFE (std for N05500 trim)	17A6873X012
	Double PTFE packing (cont'd)	
	19.1 mm (3/4-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873335072
	Glass-filled PTFE (std for N05500 trim)	17A6874X012
	PTFE/composition packing	
	9.5 mm (3/8-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873135072
	Glass-filled PTFE (std for N05500 trim)	17A6872X012
	12.7 mm (1/2-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873235072
	N05500 (std for N05500 trim)	1J873246222
	19.1 mm (3/4-inch) stem	
	S31600 (std for S31600 and S41600 trims)	1J873335072
	Glass-filled PTFE (std for N05500 trim)	17A6874X012
12*	Upper Wiper, felt	
	9.5 mm (3/8-inch) stem	1J872606332
	12.7 mm (1/2-inch) stem	1J872706332
	19.1 mm (3/4-inch) stem	1J872806332
12*	ENVIRO-SEAL Bellows Seal Upper Wiper	
	For 9.5 mm (3/8 inch) and size 2 with 12.7 mm (1/2 inch) stem	18A0868X012
	For size 3 & 4 with 12.7 mm (1/2 inch) stem	18A0870X012
13	Packing Follower	

*Recommended spare parts

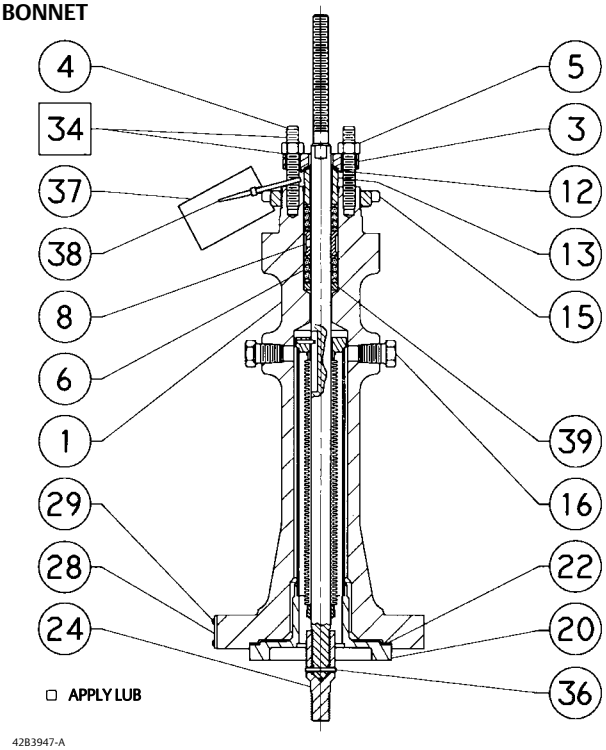
Figure 11. Typical Bonnets



PLAIN BONNET



EXTENSION BONNET



ENVIRO-SEAL BELLOWS SEAL BONNET

Key	Description	Part Number
13*	ENVIRO-SEAL Bellows Seal Bushing	
	For 9.5 mm (3/8 inch) stem (1 req'd),	
	for size 2 with 12.7 mm (1/2 inch) stem, (2 req'd)	
	S31600/PTFE	18A0820X012
	R30006	18A0819X012
	S31600/Cr Ct	11B1155X012
	For size 3 and 4 with 12.7 mm (1/2 inch)	
	stem (1 req'd)	
	S31600/PTFE	18A0824X012
	R30006	18A0823X012
	S31600/Cr Ct	11B1157X012
13*	ENVIRO-SEAL Bellows Seal Bushing/Liner	
	For 9.5 mm (3/8 inch) stem (1 req'd),	
	for size 2 with 12.7 mm (1/2 inch) stem (2 req'd)	
	N10276 bushing, PTFE/glass liner	12B2713X012
	N10276 bushing, PTFE/carbon liner	12B2713X042
	For size 3 and 4 with 12.7 mm (1/2 inch)	
	stem (1 req'd)	
	N10276 bushing, PTFE/glass liner	12B2715X012
	N10276 bushing, PTFE/carbon liner	12B2715X042
14	Pipe Plug (not shown)	
14	Lubricator	
14	Lubricator/Isolating Valve	
15	Yoke Locknut	
15	ENVIRO-SEAL Bellows Seal Yoke Locknut	
16	Pipe Plug (not shown)	
16	ENVIRO-SEAL Bellows Seal Pipe Plug (2 req'd)	
20*	ENVIRO-SEAL Bellows Seal Stem/Bellows	
	Assembly	
	1 Ply Bellows	
	S31603 trim mat'l, N06625 bellows mat'l	
	Size 1 w/ 9.5 mm (3/8 inch) stem	32B4224X012
	Size 1-1/2 w/ 9.5 mm (0.375 inch) stem	32B4225X012
	Size 2 w/ 12.7 mm (1/2 inch) stem	32B4226X012
	Size 3 w/ 12.7 mm (1/2 inch) stem	32B4227X012
	Size 4 w/ 12.7 mm (1/2 inch) stem	32B4228X012
	N06022 trim mat'l, N06022 bellows mat'l	
	Size 1 w/ 9.5 mm (3/8 inch) stem	32B4224X022
	Size 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X022
	Size 2 w/ 12.7 mm (1/2 inch) stem	32B4226X022
	Size 3 w/ 12.7 mm (1/2 inch) stem	32B4227X022
	Size 4 w/ 12.7 mm (1/2 inch) stem	32B4228X022
	2 Ply Bellows	
	S31603 trim mat'l, N06625 bellows mat'l	
	Size 1 w/ 9.5 mm (3/8 inch) stem	32B4224X032
	Size 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X032
	Size 2 w/ 12.7 mm (1/2 inch) stem	32B4226X032
	Size 3 w/ 12.7 mm (1/2 inch) stem	32B4227X032
	Size 4 w/ 12.7 mm (1/2 inch) stem	32B4228X032
	N06022 trim mat'l, N06022 bellows mat'l	
	Size 1 w/ 9.5 mm (3/8 inch) stem	32B4224X042
	Size 1-1/2 w/ 9.5 mm (3/8 inch) stem	32B4225X042
	Size 2 w/ 12.7 mm (1/2 inch) stem	32B4226X042
	Size 3 w/ 12.7 mm (1/2 inch) stem	32B4227X042
	Size 4 w/ 12.7 mm (1/2 inch) stem	32B4228X042
22*	ENVIRO-SEAL Bellows Seal Bonnet Gasket	
	(graphite/S31600)	
	Size 1/2 through 1-1/4	12B6316X022
	Size 1-1/2	12B6317X022
	Size 2	12B6318X022
	Size 3	12B6319X022
	Size 4	12B6320X022
24	ENVIRO-SEAL Bellows Seal Adaptor	
27	Pipe Nipple, for lub/isolating valve,steel	
28	ENVIRO-SEAL Bellows Seal Nameplate, Warning	
29	ENVIRO-SEAL Bellows Seal Drive Screw (2 req'd)	
34	Lubricant, anti-seize (not furnished with valve)	
36*	ENVIRO-SEAL Bellows Seal Pin	12B3951X012
37	ENVIRO-SEAL Bellows Seal Warning Tag	
38	ENVIRO-SEAL Bellows Seal Tie	
39	ENVIRO-SEAL Bellows Seal Thrust Ring	
200	Stud (2 req'd)	
201	Packing Flange	
202	Spring, (2 req'd)	
203	Spring guide packing follower	
204	Screw, 18-8 SST (4 req'd)	
205	Load Scale, 18-8 SST (2 req'd)	
206	Indicator Disk, 18-8 SST	
207*	Guide Bushing, white (2 req'd)	
	For ENVIRO-SEAL and HIGH-SEAL	
	packing	
	Carbon-graphite	
	for graphite packing	
	9.5 mm (3/8-inch) stem	12B5780X012
	12.7 mm (1/2-inch) stem	12B5782X012
	19.1 mm (3/4-inch) stem	12B5784X012
208*	Guide Bushing, no color	
	For ENVIRO-SEAL and HIGH-SEAL packing	
	Carbon-Graphite for graphite packing	
	9.5 mm (3/8-inch) stem	12B5781X012
	12.7 mm (1/2-inch) stem	12B5783X012
	19.1 mm (3/4-inch) stem	12B5785X012
209*	Packing Ring[1] (3 req'd)	
	For ENVIRO-SEAL and HIGH-SEAL	
	packing	
	Graphite Composite	
	for graphite packing	
	9.5 mm (3/8-inch) stem	12B5798X012
	12.7 mm (1/2-inch) stem	12B5799X012
	19.1 mm (3/4-inch) stem	12B5800X012
210*	Packing Ring (2 req'd)	
	For ENVIRO-SEAL and HIGH-SEAL	
	packing	
	Graphite Ribbon	
	for graphite packing	
	9.5 mm (3/8-inch) stem	1V3160X0022
	12.7 mm (1/2-inch) stem	1V3802X0022
	19.1 mm (3/4-inch) stem	1V2396X0022
211*	Packing Box Ring	
	For ENVIRO-SEAL packing	
	S31600	
	For PTFE Packing	
	9.5 mm (3/8-inch) stem	1J873135072
	12.7 mm (1/2-inch) stem	1J873235072
	19.1 mm (3/4-inch) stem	1J873335072
	For ENVIRO-SEAL and HIGH-SEAL	
	packing	
	S31600	
	For Graphite packing and Duplex packing	
	9.5 mm (3/8-inch) stem	12B5774X012
	12.7 mm (1/2-inch) stem	12B5775X012
	19.1 mm (3/4-inch) stem	12B5776X012
212	Hex Nut (2 req'd)	

*Recommended spare parts
1. Part number is stamped on part.

Key	Description	Part Number
213	Lubricant, anti-seize	
214*	Anti-Extrusion washer (4 req'd)	
	For ENVIRO-SEAL packing	
	PTFE filled (off-white)	
	For PTFE packing	
	9.5 mm (3/8-inch) stem	12B6336X022
	12.7 mm (1/2-inch) stem	12B6335X022
	19.1 mm (3/4-inch) stem	12B6660X012
214*	Packing Washer (5 req'd)	
	For ENVIRO-SEAL packing	
	PTFE	
	For Graphite packing and Duplex packing	
	9.5 mm (3/8-inch) stem	12B6936X012
	12.7 mm (1/2-inch) stem	12B6937X012
	19.1 mm (3/4-inch) stem	12B6938X012
215*	Packing Set (2 req'd)	
	For ENVIRO-SEAL packing	
	PTFE-carbon/PTFE	
	9.5 mm (3/8-inch) stem	12B6663X012
	12.7 mm (1/2-inch) stem	12B6667X012
	19.1 mm (3/4-inch) stem	12B6671X012
216	Lantern Ring	
217	Spring Pack Assembly	
218*	Lower wiper	
	For ENVIRO-SEAL packing	
	PTFE	
	For PTFE packing	
	9.5 mm (3/8-inch) stem	1J872106992
	12.7 mm (1/2-inch) stem	1J872206992
	19.1 mm (3/4-inch) stem	1J872306992

Valve Body

Key	Description	Part Number
1	Valve Body	
	If you need a valve body as a replacement part, order by valve size, serial number, and desired material.	
2*	Valve Plug	See following table
3*	Seat Ring Retainer (part numbers for the seat ring retainer/bushing assy are provided in a following table)	
	NPS 1/2, 3/4, & 1 valve	
	CB7Cu-1 (17-4PH SST)	25A6683X012
	CF8M (316 SST)	25A6683X022
	M35-1	25A6683X052
	NPS 1-1/2 valve	
	CB7Cu-1	25A6685X012
	NPS 1-1/2 valve	
	CF8M	25A6685X022
	M35-1	25A6685X052
	NPS 2 valve	
	CB7Cu-1	25A6687X012
	CF8M	25A6687X022
	M35-1	25A6687X052
	NPS 3 valve	
	CB7Cu-1	25A6689X012
	CF8M	25A6689X022
	M35-1	25A6689X052
	NPS 4 valve	
	CB7Cu-1	35A6691X012
	CF8M	35A6691X022
	M35-1	35A6691X052
7*	Stem	See following table
8*	Pin	See following table
9*	Seat Ring	See following table
10*	Bonnet Gasket	See following table
12*	Spiral Wound Gasket	See following table
13*	Seat Ring Gasket	See following table
15	Cap Screw or Stud Bolt	
16	Nut	
17	Pipe Plug, for use in valve bodies with drain tapping only	
18	Flow Arrow, SST	
19	Drive Screw, SST (4 req'd)	
25*	Shim	See following table
26*	Bushing	See following table
	(See additional table for part numbers of assemblies that include both the seat ring retainer and the bushing)	
27*	Valve Plug Guide (for composition seats only)	See following table
28*	Disk Retainer, (composition seats only)	
	6.4 mm (0.25-inch) port diameter	
	S31600	16A3441X012
	N05500	16A3441X042
	S41600	16A3441X052
	9.5 mm (0.375-inch) port diameter	
	S31600	16A5706X012
	N05500	16A5706X042
	S41600	16A5706X052
29*	Disk, PTFE (composition seats only)	
	6.4 mm (0.25-inch) port diameter	13A1226X062
	9.5 mm (0.375-inch) port diameter	13A5125X042
	12.7 mm (0.5-inch) port diameter	1P696806242
	19.1 mm (0.75-inch) port diameter	1P696106242
	25.4 mm (1-inch) port diameter	1P696906242
	38.1 mm (1.5 inch) port diameter	1U279606242
	50.8 mm (2-inch) port diameter	1U279906242
	76.2 mm (3-inch) port diameter	1F5653X0012
	101.6 mm (4-inch) port diameter	16A3462X012
30*	Tip (composition seats only)	See following table
31*	Pin (composition seats only)	
	12.7 mm (0.5-inch) port diameter	
	S31600 and S41600	1B599038992
	N05500	1B5990X0032
	19.1 mm (0.75-inch) port diameter	
	S31600 and S41600	1P730438992
	N05500	1P7304X0032
	25.4 mm (1-inch) and 38.1 mm (1.5 inch) port diameter	
	S31600 and S41600	1B599335072
	N05500	1B5993X00B2
	50.8 mm (2-inch) port diameter	
	S31600 and S41600	1B599538992
	N05500	1B599540032
32	Cap Screw (composition seat only)	
33	Nameplate, stainless steel	
34	Wire, lead	

*Recommended spare parts

Figure 12. Fisher EZ Valve with Optional Drain Plug

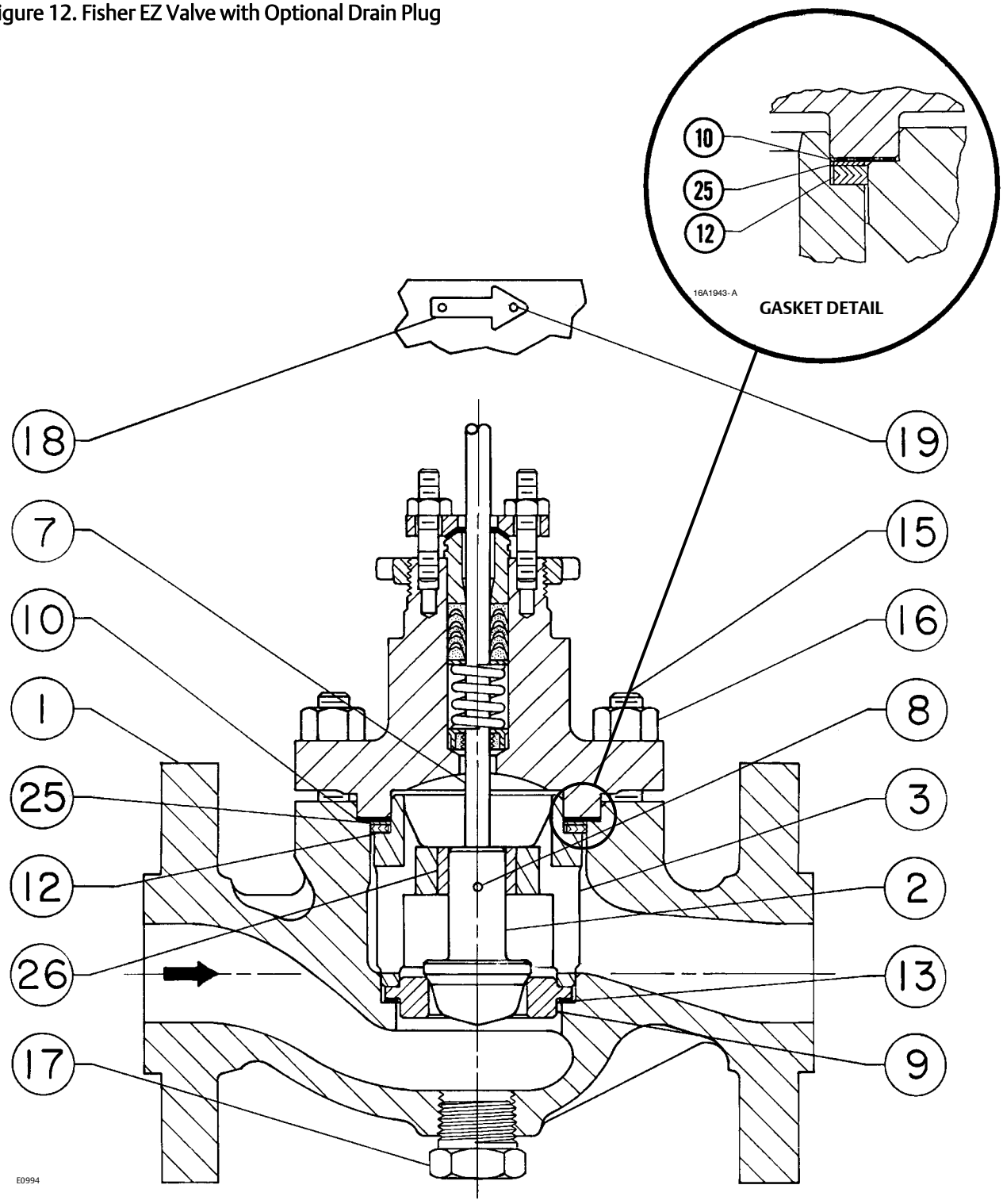
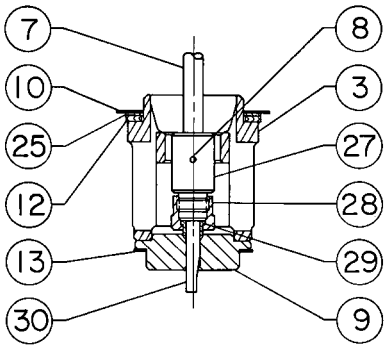
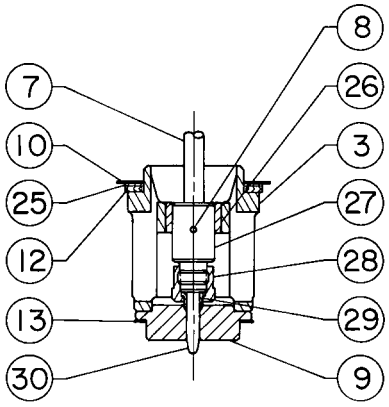


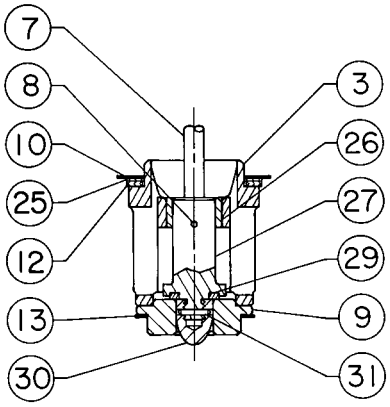
Figure 13. Composition Seats for Fisher EZ Valve



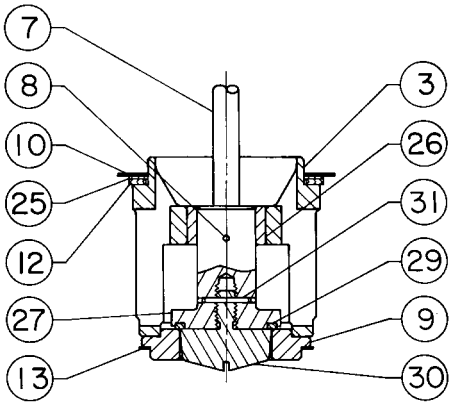
MICRO-FLUTE VALVE PLUG
6.4 mm (0.25 INCH) PORT DIAMETER



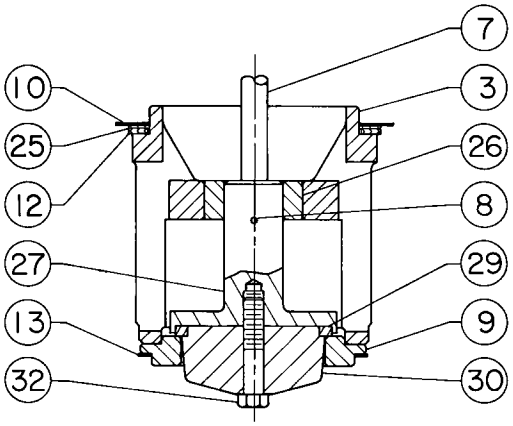
MICRO-FORM VALVE PLUG
6.4 AND 9.5 mm (0.25 AND 0.375 INCH) PORT DIAMETERS



MICRO-FORM VALVE PLUG
12.7 mm THROUGH 25.4 mm (0.5 INCH THROUGH 1 INCH) PORT DIAMETER

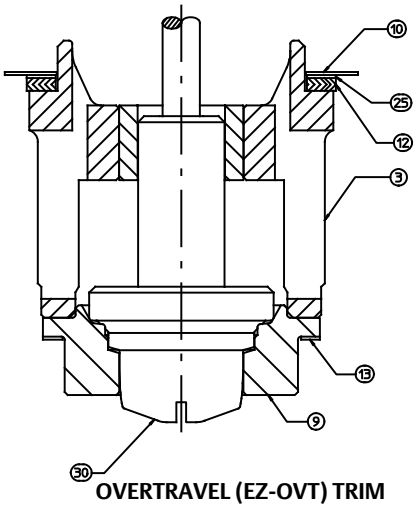


EQUAL PERCENTAGE VALVE PLUG
38.1 mm AND 50.8 mm (1.5 INCH AND 2 INCH) PORT DIAMETER



EQUAL PERCENTAGE VALVE PLUG
76.2 mm AND 101.6 mm (3 INCH AND 4 INCH) PORT DIAMETER

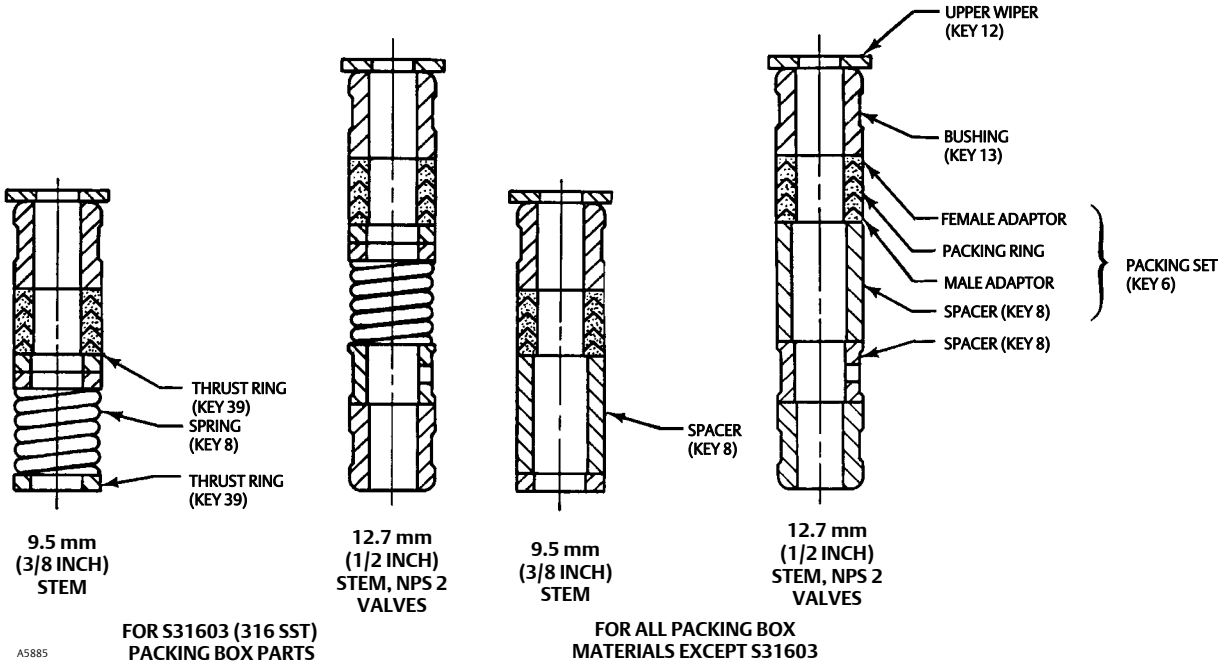
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OVERTRAVEL (EZ-OVT) TRIM VALVE PLUG
ALL SIZES

Figure 14. PTFE Packing Arrangements for ENVIRO-SEAL Bellows Seal Bonnets



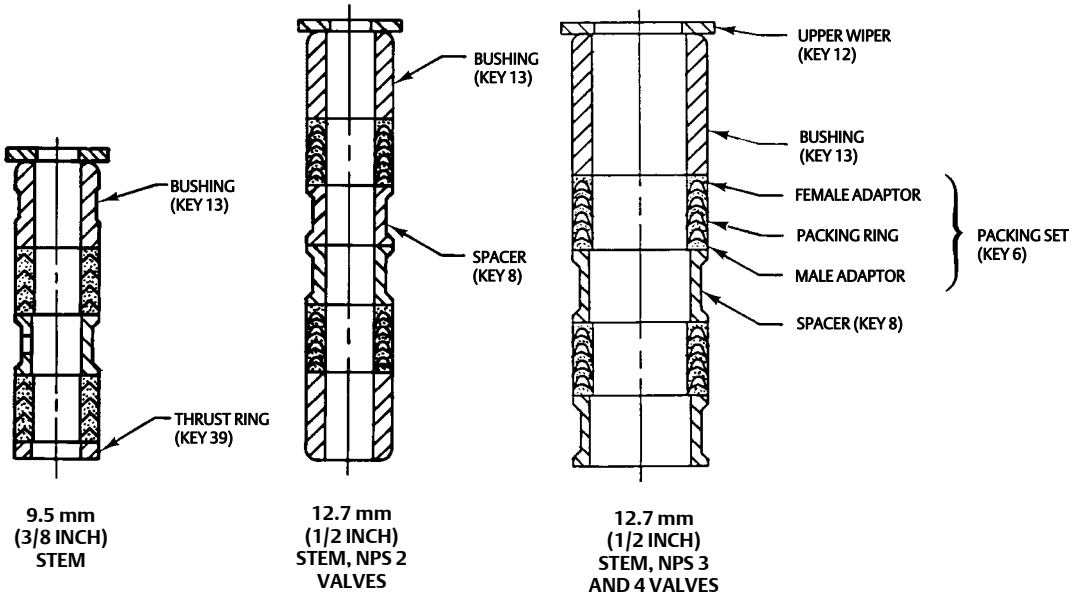
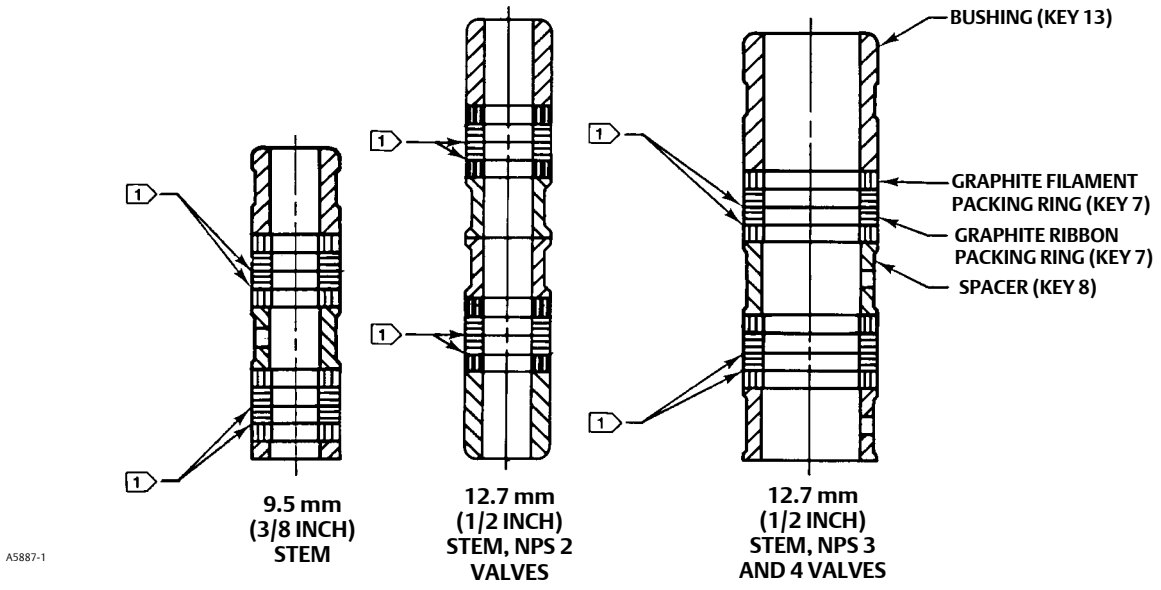


Figure 15. Double Graphite Ribbon/Filament Arrangements for ENVIRO-SEAL Bellows Seal Bonnets



Note:
1 0.102 mm (0.004 inch) thick sacrificial zinc washers: Use only one below each graphite ribbon ring.

Group 1 Actuators

54, 71, & 90 mm (2-1/8, 2-13/16, & 3-9/16 Inch) Yoke Boss
472 & 473
585C & 585CR
1B
644 & 645
655
657 & 667--76 mm (3-inch) max travel
1008--except 90 mm (3-9/16 inch) yoke boss with 51 mm (2-inch) travel

Key 2* Micro-Flow and Micro-Flute Valve Plug

VALVE SIZE, NPS	VALVE PLUG	PORT DIAMETER		VALVE STEM CONNECTION		VALVE PLUG MATERIAL		
		mm	Inch	mm	Inch	S31600 (316 SST) w/R30006 (Alloy 6) Seat & Tip	N05500	S41600 (416 SST)
1/2, 3/4, 1, 1-1/2, 2	Micro-Flow	4.8	0.1875	9.5	3/8	2V926950332	1V108146222	1V108146172
	Micro-Flute (1 flute)	6.4	0.25			2U868246422	1U844546222	1U844546172
	Micro-Flute (3 flutes)	6.4	0.25			2U868446422	1U844746222	1U844746172

*Recommended spare parts

Key 2* Equal Percentage (Including Micro-Form), Linear, and Quick-Opening Valve Plugs

VALVE SIZE, NPS	VALVE PLUG	PORT DIAMETER		VSC(1)		PLUG MATERIAL				
		mm	Inch	mm	Inch	S31600 (316 SST)	S31600 w/ CoCr-A (Alloy 6) Seat	S31600 w/ CoCr-A Seat & Guide	N05500(2)	S41600 (416 SST)
1/2, 3/4, 1, 1-1/2 & 2	Micro-Form	6.4 9.5 12.7 19.1	0.25 0.375 0.5 0.75	9.5	3/8	15A6500X012 16A5708X012 15A6502X012 16A3335X012	15A6663X012 16A5713X012 15A6659X012 16A3337X012	15A6664X012 16A5711X012 15A6660X012 16A3339X012	15A6500X042 16A5708X042 15A6502X042 16A3335X042	15A6500X052 16A5708X052 15A6502X052 16A3335X052
		6.4 9.5 12.7 19.1	0.25 0.375 0.5 0.75	12.7	1/2	15A6501X012 16A5709X012 15A6503X012 16A3336X012	--- 16A5714X012 15A6661X012 16A3338X012	--- 16A5712X012 15A6662X012 16A3340X012	15A6501X042 16A5709X042 15A6503X042 16A3336X042	15A6501X052 16A5709X052 15A6503X052 16A3336X052
	Quick Opening	25.4	1	9.5 12.7	3/8 1/2	15A6490X012 15A6491X012	15A6516X012 15A6518X012	15A6517X012 15A6519X012	15A6490X042 15A6491X042	15A6490X052 15A6491X052
	Linear	25.4	1	9.5 12.7	3/8 1/2	15A6470X012 15A6471X012	15A6614X012 15A6616X012	15A6615X012 15A6617X012	15A6470X042 15A6471X042	15A6470X052 15A6471X052
	Equal Percentage	25.4	1	9.5 12.7	3/8 1/2	15A6480X012 15A6481X012	15A6634X012 15A6636X012	15A6635X012 15A6637X012	15A6480X042 15A6481X042	15A6480X052 15A6481X052
1-1/2	Quick Opening	38.1	1.5	9.5 12.7	3/8 1/2	15A6492X012 15A6493X012	15A6520X012 15A6522X012	15A6521X012 15A6523X012	15A6492X042 15A6493X042	15A6492X052 15A6493X052
	Linear	38.1	1.5	9.5 12.7	3/8 1/2	15A6472X012 15A6473X012	15A6618X012 15A6620X012	15A6619X012 15A6621X012	15A6472X042 15A6473X042	15A6472X052 15A6473X052
	Equal Percentage	38.1	1.5	9.5 12.7	3/8 1/2	15A6482X012 15A6483X012	15A6638X012 15A6640X012	15A6639X012 15A6641X012	15A6482X042 15A6483X042	15A6482X052 15A6483X052
2, 3, 4	Quick Opening	50.8	2	12.7 19.1	1/2 3/4	15A6494X012 15A6495X012	15A6524X012 15A6526X012	15A6525X012 15A6527X012	15A6494X042 15A6495X042	15A6494X052 15A6495X052
	Linear	50.8	2	12.7 19.1	1/2 3/4	15A6474X012 15A6475X012	15A6622X012 15A6624X012	15A6623X012 15A6625X012	15A6474X042 15A6475X042	15A6474X052 15A6475X052
	Equal Percentage	50.8	2	12.7 19.1	1/2 3/4	15A6484X012 15A6485X012	15A6642X012 15A6644X012	15A6643X012 15A6645X012	15A6484X042 15A6485X042	15A6484X052 15A6485X052
3	Quick Opening	76.2	3	12.7 19.1	1/2 3/4	15A6496X012 15A6497X012	15A6528X012 15A6530X012	15A6529X012 15A6531X012	15A6496X042 15A6497X042	15A6496X052 15A6497X052
	Linear	76.2	3	12.7 19.1	1/2 3/4	15A6476X012 15A6477X012	15A6626X012 15A6628X012	15A6627X012 15A6629X012	15A6476X042 15A6477X042	15A6476X052 15A6477X052
	Equal Percentage	76.2	3	12.7 19.1	1/2 3/4	15A6486X012 15A6487X012	15A6646X012 15A6648X012	15A6647X012 15A6649X012	15A6486X042 15A6487X042	15A6486X052 15A6487X052
4	Quick Opening	101.6	4	12.7 19.1	1/2 3/4	15A6498X012 15A6499X012	15A6532X012 15A6534X012	15A6533X012 15A6535X012	15A6498X042 15A6499X042	15A6498X052 15A6499X052
	Linear	101.6	4	12.7 19.1	1/2 3/4	15A6478X012 15A6479X012	15A6630X012 15A6632X012	15A6631X012 15A6633X012	15A6478X042 15A6479X042	15A6478X052 15A6479X052
	Equal Percentage	101.6	4	12.7 19.1	1/2 3/4	15A6488X012 15A6489X012	15A6650X012 15A6652X012	15A6651X012 15A6653X012	15A6488X042 15A6489X042	15A6488X052 15A6489X052

1. Valve stem connection.
2. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

*Recommended spare parts

Key 2*, 7*, and 8* Valve Plug/Stem Assembly for Plain Bonnet

VALVE SIZE, NPS	VALVE PLUG	PORT DIA		VSC(1)		PLUG MATERIAL				
		mm	Inch	mm	Inch	S31600 (316 SST)	S31600 w/ CoCr-A (Alloy 6) Seat	S31600 w/ CoCr-A Seat & Guide	N05500(2)	S41600 (416 SST)
1/2, 3/4, 1, 1-1/2, & 2	Micro-Flow Micro-Flute (1 flute) Micro-Flute (3 flutes)	4.8 6.4 6.4	0.1875 0.25 0.25	9.5	3/8	---	---	2V9269X00A2 2U8682X0032 2U8684X0032	---	1V1081X0142 1U8445X0032 1U8447X00E2
	Micro-Form	6.4 9.5 12.7 19.1	0.25 0.375 0.5 0.75	9.5	3/8	15A6500X082 16A5708X092 15A6502X072 16A3335X112	15A6663X022 16A5713X032 15A6659X022 16A3337X042	15A6664X042 16A5711X022 15A6660X042 16A3339X022	15A6500X152 16A5708X182 15A6502X102 16A3335X212	15A6500X092 16A5708X112 15A6502X112 16A3335X132
		6.4 9.5 12.7 19.1	0.25 0.375 0.5 0.75	12.7	1/2 x 3/8	--- --- 15A6502X162 16A3335X142	--- --- 15A6659X082 16A3337X032	15A6664X022 16A5711X042 15A6660X082 16A3339X092	---	15A6500X252 16A5708X132 15A6502X152 16A3335X182
	Quick Opening	25.4	1	9.5 12.7	3/8 1/2 x 3/8	--- ---	15A6516X022 ---	15A6517X022 ---	--- ---	15A6490X092 15A6490X072
	Linear	25.4	1	9.5 12.7	3/8 1/2 x 3/8	15A6470X092 15A6470X072	--- ---	15A6615X022 15A6615X032	--- ---	15A6470X102 15A6470X122
	Equal Percentage	25.4	1	9.5 12.7	3/8 1/2 x 3/8	15A6480X102 15A6480X202	15A6634X042 15A6634X072	15A6635X022 15A6635X042	15A6480X152 ---	15A6480X112 15A6480X172
1-1/2	Quick Opening	38.1	1.5	9.5	3/8	15A6492X102	15A6520X032	15A6521X022	---	15A6492X082
	Linear	38.1	1.5	9.5	3/8	15A6472X132	---	15A6619X022	---	15A6472X072
	Equal Percentage	38.1	1.5	9.5	3/8	15A6482X102	15A6638X032	15A6639X022	---	15A6482X112
2	Quick Opening	50.8	2	12.7	1/2	15A6494X082	---	15A6525X022	---	15A6494X072
	Linear	50.8	2	12.7	1/2	15A6474X132	---	15A6623X022	---	15A6474X072
	Equal Percentage	50.8	2	12.7	1/2	15A6484X072	15A6642X042	15A6643X032	15A6484X102	15A6484X112
3	Quick Opening	50.8	2	12.7	1/2	---	---	---	---	15A6494X092
	Linear	50.8	2	12.7	1/2	15A6474X172	---	---	---	15A6474X152
	Equal Percentage	50.8	2	12.7	1/2	15A6484X152	---	15A6643X062	---	15A6484X172
	Quick Opening	76.2	3	12.7	1/2	15A6496X082	---	15A6529X022	---	15A6496X072
	Linear	76.2	3	12.7	1/2	15A6476X092	---	15A6627X022	---	15A6476X082
	Equal Percentage	76.2	3	12.7	1/2	15A6486X082	15A6646X022	15A6647X032	---	15A6486X062
4	Equal Percentage	50.8	2	12.7	1/2	---	15A6642X082	---	---	15A6484X182
	Quick Opening	101.6	4	12.7	1/2	---	---	---	---	15A6498X072
	Linear	101.6	4	12.7	1/2	15A6478X072	---	---	---	15A6478X062
	Equal Percentage	101.6	4	12.7	1/2	15A6488X112	15A6650X022	15A6651X022	---	15A6488X072

1. Valve stem connection.
2. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

Key 3*, 26* Seat Ring Retainer and Bushing Assembly[1] [2]

VALVE SIZE, NPS		SEAT RING RETAINER/BUSHING MATERIAL		
		CB7Cu-1/S17400 (17-4PH SST)	CF8M/R30006 (316 SST/Alloy 6)	M35-1/N05500[3]
1/2, 3/4, & 1		25A6683X062	25A6683X072	25A6683X172
1-1/2		25A6685X072	25A6685X082	25A6685X142
2	Full	25A6687X062	25A6687X112	25A6687X192
	Restricted	25A6687X092	25A6687X132	25A6687X182
3		25A6689X152	25A6689X132	25A6689X142
4	Full	35A6691X062	35A6691X082	35A6691X092
	Restricted	35A6691X102	17A4161X082	35A6691X112

1. Seat ring retainer (only) part numbers are listed in the parts list on page 28.
2. Micro-Flow and Micro-Flute constructions do not use bushings.
3. M35-1/N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

Key 7* Stem (for use with Group 1 Actuators)

VALVE SIZE, NPS	STEM DIAMETER		STEM MATERIAL		
	mm	Inch	S31600	N05500	S20910 (NACE)
1/2, 3/4, 1, 1-1/2	9.5	3/8	1U388835162	10A8823XA22	1U3888X0222
	12.7	1/2	1U388935162	1U3889X0012	1U3889X0042
	12.7 x 9.5	1/2 x 3/8	1U530935162	1U530946222	1U5309X0082
2	12.7	1/2	1U388935162	1U3889X0012	1U3889X0042
	12.7 X 9.5	1/2 X 3/8	1U530935162	1U530946222	1U5309X0082
	19.1	3/4	1U226535162	1U226550192	1U2265X0042
3	12.7	1/2	1K586935162	10A8840XH32	1K5869X0102
	19.1	3/4	10A9265XJ62	1U226550192	1U2265X0042
4 (restricted capacity trim)	12.7	1/2	1J320535162	1J3205X0062	1J3205X0072
	19.1	3/4	1U230835162	1U230847492	1U2308X0072
4 (full capacity trim)	12.7	1/2	1K586935162	10A8840XH32	1K5869X0102
	19.1	3/4	1U226535162	1U226550192	1U2265X0042

*Recommended spare parts

Key 8* Pin

VALVE SIZE, NPS	VALVE PLUG STYLE	VSC[1]		PIN MATERIAL	
		mm	Inch	S31600 (316 SST)	N04400[2]
1/2 thru 2	Micro-Flow & Micro-Flute w/ metal seats	9.5	3/8	1B599235072	1B599240032
	Micro-Flute w/comp seats & Micro-Form	9.5 12.7	3/8 1/2	1B599335072 1D5423X00B2	1B5993X00B2 1D5423X0012
1/2 thru 1-1/2	Linear, Equal Percentage & Quick Opening	9.5 12.7	3/8 1/2	1B599335072 1D5423X00B2	1B5993X00B2 1D5423X0012
2	Linear, Equal Percentage & Quick Opening (full cap)	12.7 19.1	1/2 3/4	1B599835072 1B813635072	1B599840032 1B8136X0102
	Linear, Equal Percentage & Quick Opening (restricted port)	9.5 12.7	3/8 1/2	1B599335072 1D5423X00B2	1B5993X00B2 1D5423X0012
3	All	12.7 19.1	1/2 3/4	1B599835072 1B813635072	1B599840032 1B8136X0102
4	Full Capacity	12.7 19.1	1/2 3/4	1B599835072 1B813635072	1B5998X00C2 1B8136X0102
	Restricted	12.7 19.1	1/2 3/4	1B599335072 1F723635072	1B5993X00B2 1B813640032

1. Valve stem connection.
2. N04400 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

Key 9* Seat Ring (non-vaned) for Metal Seats

VALVE SIZE, NPS	PORT DIA		S31600 (316 SST)	S31600 w/ CoCr-A (ALLOY 6) SEAT	S31600 w/ CoCr-A SEAT & BORE	N05500[1]	S41600 (416 SST)
	mm	Inch					
1/2, 3/4, and 1	4.8 6.4 9.5 12.7	0.1875 0.25 0.375 0.5	1V108335072 1U285235072 1U285335072 1U285435072	2V626250332 2U855946052 2U856046052 2U856146052	25A5710X012 25A5711X012 1U2853X0012 26A0651X012	1V108346222 1U285246222 1U285346222 1U825446222	1V108346172 1U285246172 1U285346172 1U285446172
	19.1	0.75	1U285535072	2U856246052	- - -	1U2855X0092	1U285546172
	25.4	1	1U285635072	2U856346052	- - -	1U285646222	1U285646172
1-1/2	4.8 6.4 9.5 12.7 19.1	0.1875 0.25 0.375 0.5 0.75	15A6512X012 15A6513X012 17A6075X012 15A6514X012 16A3350X012	25A8564X012 15A6537X012 27A6076X012 15A6538X012 26A3351X012	25A6536X012 25A6539X012 27A6079X012 26A0653X012 26A3352X012	15A6512X042 15A6513X042 17A6075X042 15A6514X042 16A3350X042	15A6512X052 15A6513X052 17A6075X052 15A6514X052 16A3350X052
	25.4	1	15A6515X012	15A6654X012	- - -	15A6515X042	15A6515X052
	38.1	1.5	15A6504X012	15A6655X012	- - -	15A6504X042	15A6504X052
2	4.8 6.4 9.5 12.7 19.1	0.1875 0.25 0.375 0.5 0.75	15A6692X012 15A6693X012 17A4091X022 15A6694X012 16A3353X012	25A8565X012 25A6698X012 27A6080X012 25A6699X012 26A3354X012	25A6696X012 25A6697X012 27A6081X012 26A0656X012 26A3355X012	15A6692X042 15A6693X042 17A4091X052 15A6694X042 16A3353X042	15A6692X052 15A6693X052 17A4091X012 15A6694X052 16A3353X052
	25.4	1	15A6695X012	25A1085X012	- - -	15A6695X042	15A6695X052
	50.8	2	15A6505X012	15A6656X012	- - -	15A6505X042	15A6505X052
3	50.8	2	25A5713X012	25A5714X012	- - -	25A5713X042	25A5713X052
	76.2	3	15A6506X012	15A6657X012	- - -	15A6506X042	15A6506X052
4	50.8	2	25A5715X012	25A5716X012	- - -	25A5715X042	25A5715X052
	101.6	4	15A6507X012	15A6658X012	- - -	15A6507X042	15A6507X052

1. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

*Recommended spare parts

Key 9* Seat Ring (vaned) for Metal Seats(1)

VALVE SIZE, NPS	PORT DIA		CF8M (316 SST)	CF8M w/ CoCr-A (ALLOY 6) SEAT	CA15 (410 SST)(2)
	mm	Inch			
1/2, 3/4, and 1	19.1	0.75	37B8773X012	38B0600X012	37B8773X022
	25.4	1	37B8771X012	38B0601X012	37B8771X022
1-1/2	25.4	1	37B9001X012	38B0602X012	37B9001X022
	38.1	1.5	37B8999X012	38B0603X012	37B8999X022
2	25.4	1	37B8765X012	38B0604X012	37B8765X022
	50.8	2	37B8763X012	38B0605X012	37B8763X022
3	50.8	2	37B9009X012	38B0606X012	37B9009X022
	76.2	3	37B9007X012	38B0607X012	37B9007X022
4	50.8	2	37B8781X012	38B0608X012	37B8781X022
	101.6	4	37B8779X012	38B0609X012	37B8779X022

1. Emerson Process Management recommends that the Performance+ vaned seat ring be used for non-viscous, flow-up, liquid applications.
2. Vaned seat ring material is CA15 (410 SST) which is cast equivalent of S41600 (416 SST).

Key 9* Seat Ring (non-vaned) for Composition Seats

VALVE SIZE, NPS	PORT DIAMETER		S31600 (316 SST)	N05500(1)	S41600 (416 SST)
	mm	Inch			
1/2, 3/4, & 1	6.4 9.5	0.25 0.375	13A5872X012 13A5873X012	13A5872X062 13A5873X062	13A5872X022 13A5873X032
1-1/2	6.4 9.5	0.25 0.375	16A3467X012 17A6078X012	16A3467X042 17A6078X042	16A3467X052 17A6078X052
2	6.4 9.5	0.25 0.375	16A3468X012 17A6077X012	16A3468X042 17A6077X042	16A3468X052 17A6077X052

1. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

Key 10* Bonnet Gasket
Key 12* Spiral Wound Gasket
Key 13* Seat Ring Gasket
Key 25* Shim

Valve Size, NPS	Key Number	Gasket Set 2[1]	Gasket Set 3[1]
1/2 - 3/4 & 1	Set	RGASKETX162	10A8170X042
	10	1R2859X0042	10A8163X012
	12	1R286099442	10A8184X012
	13	1R2862X0062	10A8177X012
	25	16A1936X012	16A1936X022
1-1/2	Set	RGASKETX172	10A8171X032
	10	1R3101X0032	10A8164X012
	12	1R309999442	10A8185X012
	13	1R3098X0052	10A8178X012
	25	16A1937X012	16A1937X022
2	Set	RGASKETX182	10A8172X032
	10	1R3299X0042	10A8165X012
	12	1R329799442	10A8186X012
	13	1R3296X0042	10A8179X042
	25	16A1938X012	16A1938X022
3	Set	RGASKETX202	10A8174X032
	10	1R3484X0042	10A8167X012
	12	1R348299442	10A8188X012
	13	1R3481X0052	10A8181X032
	25	16A1940X012	16A1940X022
4	Set	RGASKETX212	- - -[2]
	10	1R3724X0042	10A8168X012
	12	1R372299442	10A8189X012
	13	1J5047X0062	10A8182X032
	25	16A1941X012	16A1941X022

1. See table below for description of gasket sets.
2. Consult your Emerson Process Management sales office for gasket set part number.

Gasket Selection Criteria

Gasket Set	Seat Ring Gasket	Bonnet Gasket	Spiral Wound Gasket	Shim	Temperature Capabilities
2[1]	316 SST/graphite flat sheet	316 SST/graphite flat sheet	N06600 / graphite	S31600	-198 to 593°C (-325 to 1100°F)
3	PTFE-coated N04400	PTFE-coated N04400	N04400/PTFE	N04400	-73 to 149°C (-100 to 300°F)

1. FGM gasket set.

Key 26* Bushing

Valve Size, NPS	S17400 (17-4PH SST)	R30006 (Alloy 6)	N05500[1]
1/2, 3/4, & 1	15A6508X012	15A6508X022	15A6508X052
1-1/2	15A7511X012	15A7511X022	15A7511X052
2 (rest. port)	15A6509X012	15A6509X022	15A6509X052
2 (full port)	15A6510X012	15A6510X022	15A6510X052
3	15A7491X012	15A7491X022	15A7491X052
4 (rest. port)	15A5712X012	15A5712X022	15A5712X052
4 (full port)	15A6511X012	15A6511X022	15A6511X052

1. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

Key 27* Valve Plug Guide (composition seat only)

VALVE PLUG	VALVE STEM CONNECTION		PORT DIA		MATERIAL			
	mm	Inch	mm	Inch	S31600 (316 SST)	N05500(1)	S41600 (416 SST)	S31600 w/CoCr-A (Alloy 6)
Micro-Flute	9.5	3/8	6.4	0.25	16A3440X012	16A3440X042	---	19A5814X012
Micro-Form	9.5	3/8	6.4 9.5 12.7 19.1	0.25 0.37 5 0.5 0.75	16A3440X012 16A5703X012 16A3445X012 26A3449X012	16A3440X042 16A5703X042 16A3445X042 26A3449X042	16A3440X052 16A5703X052 16A3445X052 26A3449X052	19A5814X012 19A5815X012 17A7250X012 28A8115X012
	12.7	1/2	9.5 12.7 19.1	0.375 0.5 0.75	16A5707X012 16A3446X012 26A3450X012	16A5707X042 16A3446X042 26A3450X042	16A5707X052 16A3446X052 26A3450X052	19A5815X012 19A5817X012 29A5812X012
Equal Percentage	9.5 12.7 9.5 12.7 12.7 19.1 12.7 19.1	3/8 1/2 3/8 1/2 1/2 3/4 1/2 3/4	25.4 25.4 38.1 50.8 76.2 76.2 102 102	1 1 1.5 2 3 3 4 4	26A3453X012 26A3454X012 26A3457X012 26A3460X012 26A3470X012 26A3471X012 26A3463X012 26A3464X012	26A3453X042 26A3454X042 26A3457X042 26A3460X042 26A3470X042 26A3471X042 26A3463X042 26A3464X042	26A3453X052 26A3454X052 26A3457X052 26A3460X052 26A3470X052 26A3471X052 26A3463X052 26A3464X052	29A5806X012 29A5807X012 28A1253X012 29A5813X012 29A5811X012 29A5810X012 29A5808X012 29A5809X012

1. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

Key 30* Tip

VALVE SIZE, NPS	VALVE PLUG	PORT DIA		VALVE STEM CONNECTION		MATERIAL			
		mm	Inch	mm	Inch	S31600 (316 SST)	Alloy 6	N05500(1)	S41600 (416 SST)
1/2,3/4 1, 1-1/2, & 2	Micro-Flute (1 flute) Micro-Flute (3 flutes)	6.4	0.25	9.5	3/8	--- ---	13A5863X032 13A5865X032	13A5863X042 13A5865X022	--- ---
	Micro-Form	6.4 9.5 12.7 19.1	0.25 0.375 0.5 0.75	9.5	3/8	13A6160X022 16A5704X012 1R9537X0022 1R9540X0012	--- --- --- ---	13A6160X062 16A5704X042 1R9537X0062 1R9540X0072	13A6160X012 16A5704X052 1R9537X0012 1R9540X0042
		9.5 12.7 19.1	0.375 0.5 0.75	12.7	1/2	16A5704X012 1R9537X0022 1R9540X0012	--- --- ---	16A5704X042 1R9537X0062 1R9540X0072	16A5704X052 1R9537X0012 1R9540X0042
	Equal Percentage	25.4 38.1 50.8	1 1.5 2	9.5 & 12.7 9.5 12.7	3/8 & 1/2 3/8 1/2	1R953835072 16A3458X012 12A3889X012	--- --- ---	1R9538X0032 16A3458X042 12A3889X042	1R9538X0012 16A3458X052 12A3889X052
3	Equal Percentage	76.2	3	12.7 & 19.1	1/2 & 3/4	16A3469X012	---	16A3469X042	16A3469X052
4	Equal Percentage	101.6	4	12.7 & 19.1	1/2 & 3/4	12A3760X022	---	12A3760X012	12A3760X052

1. N05500 materials in hydrofluoric acid service require special options. Contact your Emerson Process Management sales office for assistance.

*Recommended spare parts

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Fisher™ EZ-C, ET-C, and EWT-C Cryogenic Sliding-Stem Control Valves

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Figure 1. Typical Fisher Cryogenic Valve with Extension Bonnet and 585C Series Actuator



W6370

Introduction

Scope of Manual

This instruction manual includes installation, maintenance, and parts information for Fisher EZ-C, ET-C and EWT-C valves (see figure 1). Refer to separate manuals for instructions covering the actuator and accessories.

Do not install, operate, or maintain EZ-C, ET-C or EWT-C valves without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson sales office or Local Business Partner before proceeding.

Description

EZ-C: globe-style, single-port, unbalanced valves with integral end connections, post guiding, metal-to-metal seating, and quick-change trim. They feature stainless steel construction materials and fabricated extension bonnets.

ET-C and EWT-C: metal-to-metal seated globe-style, single-port, cage-guided, pressure-balanced valves featuring stainless steel construction materials and fabricated extension bonnets.

Table 1. Specifications

Valve Sizes

EZ-C: NPS ■ 1, ■ 1-1/2, ■ 2, ■ 3, and ■ 4
ET-C: NPS ■ 3, ■ 4, ■ 6, and ■ 8
EWT-C: NPS ■ 6X4(1), ■ 8X4, ■ 8X6, ■ 12X6, and ■ 10X8

End Connection Styles(2)

CL150, 300, and 600 raised-face flanges per ASME B16.5

Maximum Inlet Pressure(2)

CL150 and 300—Valves are consistent with pressure-temperature ratings per ASME B16.34

CL600—Valves with B8M Class 2 bolting are consistent with CL600 pressure-temperature ratings per ASME B16.34 except as shown below:

EZ-C VALVES		
Valve Size, NPS	Maximum Inlet Pressure	
	Bar	Psig
1	77	1110
2	83	1200
3	94	1370

ET-C AND EWT-C VALVES		
Valve Size, NPS	Maximum Inlet Pressure	
	Bar	Psig
3	94	1370
6, 8 x 6, 12 x 6	75	1085
8, 10 x 8	96	1390

CL600—Valves with optional S20910 (XM-19) bolting are consistent with CL600 pressure-temperature ratings per ASME B16.34

Shutoff Classifications per ANSI/FCI 70-2 and IEC 60534-4

VALVE	SHUTOFF CLASS
EZ-C	Class IV—Standard
	Class VI—Optional
ET-C and EWT-C	Class IV—Standard
	Class V Air Test(3) —Optional

Material Temperature Capability(2)

EZ-C: -198 to 149°C (-325 to 300°F)

ET-C and EWT-C:
-198 to 66°C (-325 to 150°F)

Maximum Allowable Actuator Thrust

See table 2

Flow Characteristics

EZ-C: Equal percentage, linear, and quick opening
ET-C and EWT-C: Equal percentage and linear

Flow Directions

EZ-C:Up through the seat ring only

ET-C and EWT-C: Normally down(4)

Approximate Weights

EZ-C:

NPS 1: 11 kg (33 lb)

NPS 1-1/2: 23 kg (48 lb)

NPS 2: 41 kg (90 lb)

NPS 3: 60 kg (130 lb)

NPS 4: 95 kg (210 lb)

ET-C:

NPS 3: 51 kg (135 lb)

NPS 4: 95 kg (210 lb)

NPS 6: 211 kg (465 lb)

NPS 8: 372 kg (820 lb)

EWT-C

NPS 6X4: 200 kg (440 lb)

NPS 8X4: 277 kg (610 lb)

NPS 8X6: 318 kg (700 lb)

NPS 12X6: 730 kg (1610 lb)

NPS 10X8: 753 kg (1660 lb)

1. Valve size number is end connection size by normal trim size. For example, an NPS 6X4 valve has NPS 6 end connections with NPS 4 trim.
2. Do not exceed the pressure/temperature limits in this manual and any applicable code limitation.
3. Class V Air Test is optional. Test will be 50 psid air. Class V shutoff cannot be performed with water. The residual trapped moisture from testing with water can cause valve and trim damage from ice crystals formed at below freezing service temperatures.
4. Down is in through the cage and out the seal ring. (see figure 9).

Table 2. Maximum Allowable Actuator Thrust for Standard Style 3 Bonnet Extension Length

VALVE SIZE, NPS	STEM DIAMETER		MAXIMUM ALLOWABLE STEM LOAD FOR S20910 (XM-19) STEM MATERIAL	
	mm	Inches	N	Lb
1	9.5	3/8	5382	1210
	12.7	1/2	13166	2960
1-1/2	9.5	3/8	5338	1200
	12.7	1/2	13166	2960
2	12.7	1/2	14367	3230
	19.1	3/4	44169	9930
3	12.7	1/2	15301	3440
	19.1	3/4	45459	10220
4, 6X4, 8X4	12.7	1/2	16458	3700
	19.1	3/4	46971	10560
6, 8X6, 12X6	19.1	3/4	36385	8180
	25.4	1	81487	18320
8, 10X8	19.1	3/4	41366	9300
	25.4	1	87003	19560

Educational Services

For information on available courses for Fisher EZ-C, ET-C, and EWT-C valves, as well as a variety of other products, contact:

Emerson Automation Solutions
Educational Services - Registration
Phone: 1-641-754-3771 or 1-800-338-8158
E-mail: education@emerson.com
emerson.com/fishervalvetraining

Installation

Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. Remove actuator supply pressure, and use lockout procedures to be sure that the above measures stay in effect while you work on the equipment. Refer to the **Warnings** at the beginning of the Maintenance section for additional information.

⚠ WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

Personal injury or equipment damage caused by sudden release of pressure may result if the valve assembly is installed where service conditions could exceed the limits given in table 1 or on the appropriate nameplates. To avoid such injury or damage, provide a relief valve for over-pressure protection as required by government or accepted industry codes and good engineering practices.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

CAUTION

When ordered, the valve configuration and construction materials were selected to meet particular pressure, temperature, pressure drop, and controlled fluid conditions. Since some valve body/trim material combinations are limited in their pressure drop and temperature ranges, do not apply any other conditions to the valve without first contacting your Emerson sales office or Local Business Partner.

Before installing the valve, inspect the valve and pipelines for any damage and any foreign material which may cause product damage.

1. Before installing the valve, inspect the valve and associated equipment for any damage and any foreign material.
2. Make certain the valve body interior is clean, that pipelines are free of foreign material, and that the valve is oriented so that pipeline flow is in the same direction as the arrow on the side of the valve.
3. Gas Service: The normal method of mounting for gas service is with the actuator vertical above the valve body. However, the control valve assembly may be installed in any orientation unless limited by seismic criteria. Other positions may result in uneven valve plug and cage wear that could result in improper operation. For mounting assistance, consult your Emerson sales office or Local Business Partner.

CAUTION

To avoid possible damage to the packing, do not allow the installed actuator angle to be so flat as to allow liquid inside the bonnet to come in contact with the packing.

Also, if insulation is applied, do not let the insulation run up the extension bonnet. This could cause the packing to freeze and be damaged.

Liquid Service: The preferred method of mounting for liquid service is with the actuator vertical above the valve body. This will allow a vapor layer to form between the liquid and the packing. If there are piping constraints, the actuator can be angled slightly from vertical. However, in no case should the angle be so flat as to allow liquid inside the bonnet to come in contact with the packing. For mounting assistance, consult your Emerson sales office or Local Business Partner.

4. If insulation is applied, make sure it is applied only to the body/bonnet joint. Do not let the insulation run up the extension bonnet.
5. Use accepted piping and welding practices when installing the valve in the line. For flanged valve bodies, use a suitable gasket between the valve body and pipeline flanges.
6. If the actuator and valve are shipped separately, refer to the actuator mounting procedure in the appropriate actuator instruction manual.

⚠ WARNING

Personal injury could result from packing leakage. Valve packing was tightened before shipment; however, the packing might require some readjustment to meet specific service conditions.

Valves with ENVIRO-SEAL™ live-loaded packing will not require this initial readjustment. See the Fisher instruction manual titled ENVIRO-SEAL Packing System for Sliding-Stem Valves for packing instructions. If you wish to convert your present packing arrangement to ENVIRO-SEAL packing, refer to the retrofit kits listed in the parts kit sub-section near the end of this manual.

Maintenance

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. This section includes instructions for packing maintenance and trim maintenance. All maintenance operations may be performed with the valve in the line.

⚠ WARNING

Avoid personal injury or property damage from sudden release of process pressure. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the pneumatic actuator loading pressure and relieve any actuator spring precompression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline*. Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

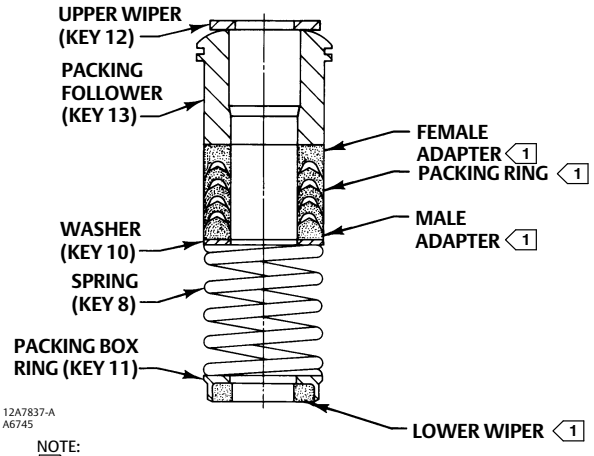
CAUTION

Follow instructions carefully to avoid damaging the product surfaces, which could result in damage to the product.

Note

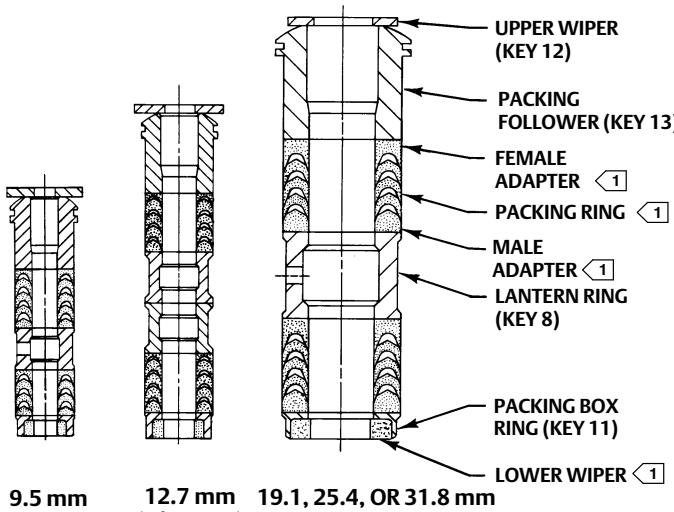
Whenever a gasket seal is disturbed by removing or shifting parts, a new gasket should be installed upon reassembly. This is necessary to ensure a good gasket seal since the used gasket may not seal properly.

Figure 2. Single PTFE V-Ring Packing Arrangement



NOTE:
1 PACKING SET (KEY 6) CONTAINS A FEMALE ADAPTER, V-RING PACKING RINGS, MALE ADAPTER, AND LOWER WIPER RINGS.

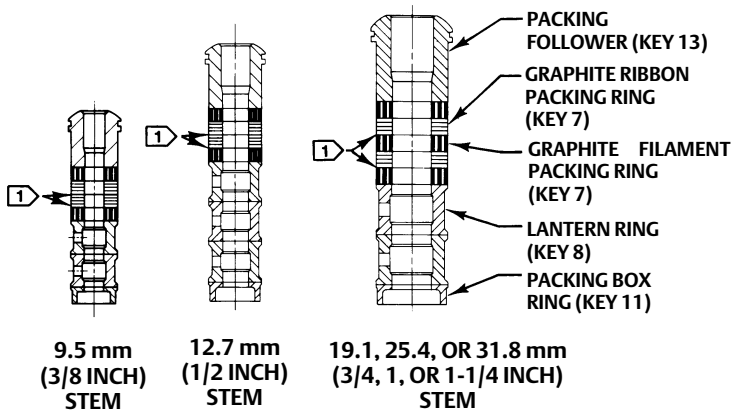
Figure 3. Double PTFE V-Ring Packing Arrangements



NOTE:
1 PACKING SET (KEY 6) CONTAINS A FEMALE ADAPTER, V-RING PACKING RINGS, MALE ADAPTER, AND LOWER WIPER RINGS.

A6746

Figure 4. Graphite Ribbon/Filament Packing Arrangements



NOTE:
1 0.102 mm (0.004 INCH) THICK SACRIFICIAL ZINC WASHERS: USE ONLY ONE BELOW EACH GRAPHITE RIBBON RING.

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Packing Maintenance

This section covers PTFE V-ring, double PTFE, and graphite packing used in extension bonnets (figures 2, 3, and 4).

Note

If the valve has ENVIRO-SEAL live-loaded packing installed, refer to the instruction manual ENVIRO-SEAL Packing System for Sliding Stem Valves for packing instructions. Figure 6 shows typical ENVIRO-SEAL arrangements.

Standard packing key numbers are shown in figures 2, 3, and 4. ENVIRO-SEAL packing key numbers are shown in figure 6. Bonnet key number locations are shown in figure 7, and valve key numbers are shown in figures 8 and 9.

For spring-loaded single PTFE V-ring packing, the spring (key 8) maintains a sealing force on the packing. If leakage is noted around the packing follower (key 13), check to be sure the shoulder on the packing follower is touching the bonnet. If the shoulder is not touching the bonnet, tighten the packing flange nuts (key 5), until the shoulder is against the bonnet. If leakage cannot be stopped in this manner, proceed with replacing packing procedures.

If there is undesirable packing leakage with other than spring-loaded packing, first try to limit the leakage and establish a stem seal by tightening the packing flange nuts.

If the packing is relatively new and tight on the stem, and if tightening the packing flange nuts does not stop the leakage, it is possible that the valve stem is worn or nicked so that a seal cannot be made. The surface finish of a new valve stem is critical for making a good packing seal. If the leakage comes from the outside diameter of the packing, it is possible that the leakage is caused by nicks or scratches around the packing box wall. If performing any of the following procedures, inspect the valve stem and packing box wall for nicks and scratches.

Replacing Packing

⚠ WARNING

Refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

Key numbers and sequence of assembly of packing parts are shown in figures 2, 3, and 4. Bonnet key number locations are shown in figure 7, and valve key number locations are shown in figures 8 and 9, unless otherwise noted.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. If using a power actuator, also shut off all pressure lines to the power actuator, and release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment. Observe the Warnings at the start of the Maintenance section.
2. Disconnect the operating lines from the actuator and any leak-off piping from the bonnet. Disconnect the stem connector and remove the actuator from the valve by unscrewing the yoke locknut (key 15) or hex nuts (key 26, not shown).
3. Loosen the packing flange nuts (key 5) so that the packing is not tight on the valve stem. Remove any travel indicator parts and stem locknuts from the valve stem threads.

⚠ WARNING

- **To avoid personal injury or property damage caused by uncontrolled movement of the bonnet, loosen the bonnet by following the instructions in the next steps.**

Do not remove a stuck bonnet by pulling on it with equipment that can stretch or store energy in any other manner. The sudden release of stored energy can cause uncontrolled movement of the bonnet.

- **To avoid personal injury or damage to the seating surface caused by the valve plug and stem assembly dropping from the bonnet after being lifted out of the valve body, observe the following instructions.**

4. When lifting an EZ-C bonnet, temporarily install a valve stem locknut on the valve stem. This locknut will prevent the valve plug and stem assembly from dropping out of the bonnet.
5. When lifting an ET-C or EWT-C bonnet, be sure the plug and stem assembly and cage remain in the valve body.

⚠ WARNING

To avoid possible personal injury, review your process shutdown procedures to be sure process pressure is not applied to the valve for the following procedure.

6. Hex nuts (key 16) attach the bonnet to the valve body (key 1). Loosen these nuts or cap screws approximately 3 mm (1/8 inch). Then, loosen the body-to-bonnet joint by either rocking the bonnet or prying between the bonnet and valve body. Work with a prying tool around the bonnet until the bonnet loosens.

Table 3. Recommended Torque for Packing Flange Nuts

VALVE STEM DIAMETER		PRESSURE RATING	GRAPHITE PACKING				PTFE PACKING			
			Minimum Torque		Maximum Torque		Minimum Torque		Maximum Torque	
mm	Inch		N•m	Lbf-in	N•m	Lbf-in	N•m	Lbf-in	N•m	Lbf-in
9.5	3/8	150	3	27	5	40	1	13	2	19
		300	4	36	6	53	2	17	3	26
		600	6	49	8	73	3	23	4	35
12.7	1/2	150	5	44	8	66	2	21	4	31
		300	7	59	10	88	3	28	5	42
		600	9	81	14	122	4	39	7	58
19.1	3/4	150	11	99	17	149	5	47	8	70
		300	15	133	23	199	7	64	11	95
		600	21	182	31	274	10	87	15	131
25.4	1	150	19	169	29	254	9	80	14	120
		300	26	226	38	339	12	108	18	162
		600	35	310	53	466	17	149	25	223
31.8	1-1/4	150	27	238	40	357	13	113	19	169
		300	36	318	54	477	17	152	26	228
		600	49	437	74	655	24	209	36	314

Table 4. Body-to-Bonnet Torque Guidelines

VALVE SIZE, NPS	BOLT TORQUES(1)	
	Bolt Material(2)	
	B8M(3) or S20910 (XM-19)(4)	
	N•m	Lbf-ft
1	122	90
1-1/2 or 2	91	67
3	163	120
4, 6X4, or 8X4	258	190
6, 8X6, or 12X6	522	385
8 or 10X8	712	525

1. Determined from laboratory testing.
2. For bolting materials not listed in table 4, contact your Emerson sales office or Local Business Partner for torque information.
3. SA193-B8M strain hardened.
4. Hot rolled.

- If fluid leaks from the joint, it may indicate that process pressure is applied to the valve. Review your process shutdown procedures, and be sure process pressure is not applied to the valve.
- If no fluid leaks from the joint, remove the nuts completely and carefully lift the bonnet off the valve body.

7. For EZ-C valves, remove the stem locknut. Separate the valve plug and stem from the bonnet, and set the parts on a protective surface to prevent damage to gasket or seating surfaces.
8. For ET-C and EWT-C: If it is necessary to remove and inspect the valve trim, refer to the following Trim Maintenance section.
9. Remove the bonnet gasket (key 10) and cover the opening in the valve to protect the gasket surface and prevent foreign material from getting into the valve body cavity.
10. Remove the packing flange nuts, packing flange, upper wiper, and packing follower (keys 5, 3, 12, and 13). Carefully push out all the remaining packing parts from the valve side of the bonnet using a rounded rod or other tool that will not scratch the packing box wall. Clean the packing box and metal packing parts.
11. Inspect the valve stem threads and packing box surfaces for any sharp edges which might cut the packing. Scratches or burrs in the packing box surfaces could cause leakage or damage to the new packing. If the surface condition cannot be improved by light sanding, replace the damaged parts.
12. If necessary, go to the Trim Maintenance procedures to remove, inspect or replace trim parts. Return to this section when installing the bonnet on the valve body.

Installing the Bonnet

13. Remove the covering protecting the valve body cavity and install a new bonnet gasket (key 10), making sure the gasket seating surfaces are clean and smooth. Then slide the bonnet over the stem and onto the stud bolts (key 15).

Note

Proper performance of the bolting procedures in step 10 compresses the spiral wound gasket (key 12) or load ring (key 26) to both load and seal the seat ring gasket (key 13). It also compresses the outer edge of the bonnet gasket (key 10) to seal the body-to-bonnet joint.

The proper bolting procedures in step 14 include, but are not limited to, ensuring that bolting threads are clean and evenly tightening the cap screws or nuts onto the studs in a crisscross pattern. Tightening one cap screw or nut may loosen an adjacent cap screw or nut. Repeat the crisscross tightening pattern several times until each cap screw or nut is tight and the body-to-bonnet seal is made.

Note

Stud(s) and nut(s) should be installed such that the manufacturer's trademark and material grade marking is visible, allowing easy comparison to the materials selected and documented in the Emerson/Fisher serial card provided with this product.

⚠ WARNING

Personal injury or damage to equipment could occur if improper stud and nut materials or parts are used. Do not operate or assemble this product with stud(s) and nut(s) that are not approved by Emerson/Fisher engineering and/or listed on the serial card provided with this product. Use of unapproved materials and parts could lead to stresses exceeding the design or code limits intended for this particular service. Install studs with the material grade and manufacturer's identification mark visible. Contact your Emerson representative immediately if a discrepancy between actual parts and approved parts is suspected.

14. Lubricate the bolting with anti-seize lubricant and install it, using accepted bolting procedures during tightening, so that the body-to-bonnet joint will withstand test pressures and application service conditions. Use the bolt torques in table 4 as guidelines.
15. Install new packing and the metal packing box parts according to the appropriate arrangement in figures 2, 3, or 4. Place a smooth-edged pipe over the valve stem and gently tap each soft packing part into the packing box.
16. Slide the packing follower, upper wiper, and packing flange (keys 12, 13, and 3) into position. Lubricate the packing flange studs (key 4) and faces of the packing flange nuts (key 5). Install the packing flange nuts.
17. Tightening packing flange nuts (key 5):
    a. For spring-loaded PTFE V-ring packing, tighten the packing flange nuts until the shoulder on the packing follower (key 13) contacts the bonnet.
    b. For graphite packing, tighten the packing flange nuts to the maximum recommended torque shown in table 3. Then, loosen the packing flange nuts, and retighten them to the recommended minimum torque shown in table 3.
    c. For double PTFE V-ring packing, tighten the packing flange nuts alternately in small equal increments until one of the nuts reaches the minimum recommended torque shown in table 3. Then, tighten the remaining nut until the packing flange is level and at a 90 degree angle to the valve stem.
    d. For ENVIRO-SEAL live-loaded packing, refer to the Fisher instruction manual titled: ENVIRO-SEAL Packing System for Sliding-Stem Valves.
18. Mount the actuator on the valve assembly and reconnect the actuator and valve stem according to the procedure in the appropriate actuator instruction manual.

Trim Maintenance

⚠ WARNING

Refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

This procedure describes how the valve trim can be completely disassembled. When inspection or repairs are required, perform only those steps necessary to accomplish the task. Observe the Warning at the start of the Maintenance section.

Key number locations are shown in figures 8 and 9, unless otherwise noted.

EZ-C Trim Disassembly

Key number locations are shown in figure 8, unless otherwise noted.

1. Remove the actuator and the bonnet according to steps 1 through 9 of the Replacing Packing procedures in the Maintenance section.

⚠ WARNING

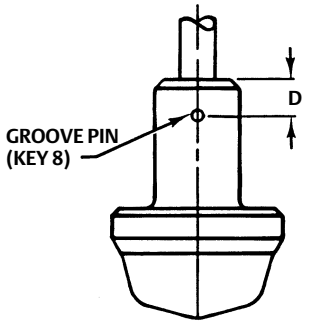
To avoid personal injury due to leaking fluids, avoid damaging gasket sealing surfaces.

The surface finish of the valve stem (key 7) is critical for making a good packing seal.

The seating surfaces of the valve plug (key 2) and seat ring (key 9) are critical for proper shutoff.

Protect these surfaces accordingly.

Figure 5. Fisher EZ-C Valve Stem Torque and Pin Replacement



VALVE STEM		STEM TORQUE		DRILL SIZE, INCHES	D DIMENSION	
mm	Inch	N•m	Lbf-ft		mm	Inch
9.5	3/8	40-47	25-35	3/32	16	0.625
12.7	1/2	81-115	60-85	1/8	19	0.75
19.1	3/4	237-339	175-250	3/16	25	1

Perform the following steps to remove the valve trim.

Note

With some valve plug sizes and configurations, the seat ring retainer and bushing assembly (keys 3 and 26, figure 7, 8, and 9) will come out of the valve body with the valve plug and stem assembly, and in other valve plug sizes and configurations, the valve plug will slide through the seat ring retainer and bushing assembly, leaving the retainer and bushing assembly in the valve body.

2. With the valve plug and stem assembly out of the valve body, either slide the seat ring retainer, bushing assembly (keys 3 and 26), gaskets, and shim (keys 10, 12, and 25) up over the valve plug and stem or, lift the seat ring retainer and bushing assembly, associated gaskets, and shim out of the valve body. If the valve plug is to be reused, protect the valve plug seating surface to prevent damage.
3. To disassemble the stem, plug, and pin, drive or drill out the pin (key 8) and unscrew the valve stem (key 7) from the valve plug (key 2).
4. Remove the seat ring and seat ring gasket (keys 9 and 13).
5. Inspect parts for wear or damage that could prevent proper operation of the valve. Clean, inspect and obtain replacement parts as necessary for reassembly.

EZ-C Trim Assembly

This procedure assumes that all the trim and associated gaskets were removed from the valve body. If these parts were not all removed, start the assembly procedure at the appropriate step.

CAUTION

To avoid weakening the stem that may cause failure in service, never reuse an old stem with a new valve plug. Using an old stem with a new plug requires drilling a new pin hole in the stem, which will weaken the stem. However, a used valve plug may be reused with a new stem.

Key number locations are shown in figure 8, unless otherwise noted.

1. Screw the valve stem (key 7) into the valve plug (key 2). Tighten to the torque valve given in figure 5. Refer to figure 5 to select the proper drill size. Drill through the stem using the hole in the valve plug as a guide. Remove any chips or burrs and drive in a new pin (key 8) to lock the assembly.
2. Install the seat ring gasket (key 13) and seat ring (key 9).

Note

With some valve plug sizes and configurations, the valve plug will slide through the seat ring retainer and bushing assembly (keys 3 and 26), and in other configurations, it will not.

3. If the valve plug (key 2) will not slide through the seat ring retainer and bushing assembly (keys 3 and 26), proceed as follows:
   a. Place the seat ring retainer and bushing assembly (keys 3 and 26) over the stem of the valve plug and stem assembly.
   b. Install the seat ring retainer and bushing assembly, which also includes the valve plug and stem assembly, on top of the seat ring, ensuring that the seat ring retainer slips onto the seat ring properly. Any rotational orientation of the seat ring retainer with respect to the valve body is acceptable.

Table 5. Fisher ET-C and EWT-C Valve Stem Torque and Pin Replacement

VALVE STEM DIAMETER		TORQUE, MINIMUM TO MAXIMUM		DRILL SIZE, INCHES
mm	Inches	N•m	Lbf-ft	
9.5	3/8	40-47	25-35	3/32
12.7	1/2	81-115	60-85	1/8
19.1	3/4	238-339	175-250	3/16
25.4	1	421-482	310-355	1/4
31.8	1-1/4	827-908	610-670	1/4

   c. Place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10) on the shoulder of the seat ring retainer.
4. If the valve plug (key 2) will slide through the seat ring retainer and bushing assembly (keys 3 and 26), proceed as follows:
   a. Install the seat ring retainer and bushing assembly on top of the seat ring, ensuring that the seat ring retainer slips onto the seat ring properly. Any rotational orientation of the seat ring retainer with respect to the valve body is acceptable.
   b. Place the spiral wound gasket, shim, and bonnet gasket (keys 12, 25, and 10) on the shoulder of the seat ring retainer.
   c. Slide the valve plug and stem assembly or the valve plug guide and stem assembly into the seat ring retainer and bushing assembly (keys 3 and 26).
5. Mount the bonnet on the valve body and complete assembly using the Replacing Packing procedures in the Maintenance section.
6. If the valve has soft metal-to-metal seats, refer to the Coining Soft Metal-to-Metal Seats section.

ET-C and EWT-C Trim Disassembly

Key number locations are shown in figure 9, unless otherwise noted.

1. Remove the actuator and the bonnet according to steps 1 through 9 of the Replacing Packing procedure in the Maintenance section.

⚠ WARNING

To avoid personal injury due to leaking fluids, avoid damaging gasket sealing surfaces.

The surface finish of the valve stem (key 7) is critical for making a good packing seal.

The inside surface of the cage (key 3) is critical for tight shutoff and smooth operation of the valve plug.

The seating surfaces of the valve plug (key 2) and seat ring (key 9) are critical for proper shutoff.

Protect these surfaces accordingly.

Perform the following steps to remove the valve trim.

2. Remove the load ring (key 26) from an NPS 8 ET-C or NPS 10X8 EWT-C valve, and wrap it for protection.
3. Remove the plug and stem assembly from the valve body. The cage (key 3) might come out of the valve body with the plug, due to seal ring friction.
   a. If so, carefully separate the cage from the plug and stem assembly.
   b. If the cage was not removed from the valve body with the plug and stem assembly, remove it, the associated gaskets (keys 10 and 12), and shim (key 51).
4. Remove the seat ring (key 9) and seat ring gasket (key 13). Composition seat constructions use a disk (key 23) sandwiched between a disk seat (key 22) and disk retainer (key 21).
5. Clean, inspect, and if necessary obtain replacement parts.

ET-C and EWT-C Valve Plug Maintenance

CAUTION

To avoid the valve plug seal ring (key 28) not sealing properly and affecting valve performance, be careful not to scratch the surfaces of the ring groove on the valve plug or any of the surfaces of the replacement ring.

1. With the valve plug (key 2) removed, according to the disassembly portion of the Trim Maintenance procedure, proceed as follows:
2. The spring-loaded seal ring may be removed by first working the retaining ring (key 27) off with a screwdriver. Then carefully slide the metal backup ring (key 29) and seal ring (key 28) off the valve plug (key 2).
3. A spring-loaded seal ring must be installed so that its open side faces toward the valve stem, or toward the seat of the plug depending on flow direction, as shown in view A of figure 9. To install a spring-loaded seal ring, slide the seal ring (key 28) onto the valve plug followed by the metal backup ring (key 29).
4. Then install the retaining ring (key 27) by inserting one end in the groove and, while turning the plug, press the ring into the groove. Again, be careful not to scratch any surfaces of the ring or plug.

CAUTION

To avoid weakening the stem that may cause failure in service, never reuse an old stem with a new valve plug. Using an old stem with a new plug requires drilling a new pin hole in the stem, which will weaken the stem. However, a used valve plug may be reused with a new stem.

5. To replace the valve stem (key 7), drive or drill out the pin (key 8). Unscrew the valve plug from the stem.
6. Screw the new stem into the valve plug. Tighten to the torque value given in table 5. Refer to table 5 to select the proper drill size. Drill through the stem using the hole in the valve plug as a guide. Remove any chips or burrs and drive in a new pin to lock the assembly.

ET-C and EWT-C Trim Assembly

Key number locations are shown in figure 9, unless otherwise noted.

1. Install the seat ring gasket (key 13), and seat ring (key 9) or disk seat (key 22). With composition seat constructions, install the disk (key 23) and disk retainer (key 21).
2. Install the cage (key 3). Any rotational orientation of the cage with respect to the valve body is acceptable.
3. Lower the valve plug (key 2) and stem assembly into the cage. Make sure the seal ring (key 28) is evenly engaged in the entrance chamfer at the top of the cage (key 3) to avoid damaging the ring.
4. Place the gaskets (keys 12 and 10) and the shim (key 51) on top of the cage.
5. With an NPS 8 ET-C or NPS 10X8 EWT-C valve, install the load ring (key 26).
6. Mount the bonnet on the valve body and complete assembly using the Replacing Packing procedures in the Maintenance section. Torque guidelines for body-to-bonnet bolting are shown in table 4.
7. If the valve has soft metal-to-metal seats, refer to the Coining Soft Metal-to-Metal Seats section, below.

Coining Soft Metal-to-Metal Seats

Soft metal-to-metal seat constructions consist of a valve plug with hardfaced CoCr-A seat and a non-hardfaced S31600 seat ring. For optimum shutoff performance of these constructions, coin seats by stroking the valve plug into the seat ring at least three times with maximum actuator force.

CAUTION

To avoid possible product damage which may affect performance, do not lap soft metal-to-metal seats.

Parts Ordering

Each body-bonnet assembly is assigned a serial number which can be found on the valve. This same number also appears on the actuator nameplate when the valve is shipped from the factory as part of a control valve assembly.

Refer to the serial number when contacting your Emerson sales office or Local Business Partner for technical assistance. When ordering replacement parts, refer to the serial number and to the eleven-character part number for each part required from the following parts kit or parts list information.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Automation Solutions should not, under any circumstances, be used in any Fisher valve, because they may void your warranty, might adversely affect the performance of the valve, and could cause personal injury and property damage.

Parts Kits

Gasket Kits

Includes keys 10, 12, 13, and 25 for EZ-C valves. Includes keys 10, 12, 13, and 51 for ET-C and EWT-C valves.

VALVE SIZE, NPS	KIT PART NUMBER
1	RGASKETX162
1-1/2	RGASKETX172
2	RGASKETX182
3	RGASKETX202
4, 6X4, 8X4	RGASKETX212
6	RGASKETX222
8X6, 12X6	RGASKETX392
8, 10X8	RGASKETX232

Packing Kits

Packing kits for standard packing includes keys 6, 8, 10, 11, and 12. Packing kits do not apply to N10276, N08020, or N04400 trims.

Standard Packing Repair Kits (Non Live-Loaded)

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)	25.4 (1) 127 (5)
PTFE (Contains keys 6, 8, 10, 11, and 12)	RPACKX00012	RPACKX00022	RPACKX00032	RPACKX00342
Double PTFE (Contains keys 6, 8, 11, and 12)	RPACKX00042	RPACKX00052	RPACKX00062	RPACKX00362
Single Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring], 8, and 11)	RPACKX00102	RPACKX00112	RPACKX00122	---
Single Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring], and 11)	---	---	---	RPACKX00532
Single Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring])	RPACKX00132	RPACKX00142	RPACKX00152	---
Double Graphite Ribbon/Filament (Contains keys 7 [ribbon ring], 7 [filament ring], 8, and 11)	RPACKX00162	RPACKX00172	RPACKX00182	---

ENVIRO-SEAL Packing Retrofit Kits

Retrofit kits include parts to convert valves with existing standard bonnets to the ENVIRO-SEAL packing box construction. Refer to figure 6 for key numbers for PTFE and Graphite ULF packing.

Stems and packing box constructions that do not meet Fisher stem finish specifications, dimensional tolerances, and design specifications, may adversely alter the performance of this packing kit.

ENVIRO-SEAL Packing Retrofit Kits

PACKING MATERIAL	STEM DIAMETER AND YOKE BOSS DIAMETER, mm (INCH)			
	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)	25.4 (1) 127 (5)
Double PTFE	RPACKXRT012	RPACKXRT022	RPACKXRT032	RPACKXRT042
Graphite ULF	RPACKXRT262	RPACKXRT272	RPACKXRT282	RPACKXRT292
Duplex	RPACKXRT212	RPACKXRT222	RPACKXRT232	RPACKXRT242

ENVIRO-SEAL Packing Repair Kits

Repair kits include parts to replace the “soft” packing materials in valves that already have ENVIRO-SEAL packing arrangements installed or in valves that have been upgraded with ENVIRO-SEAL retrofit kits. Refer to figure 6 for key numbers for PTFE and Graphite ULF packing.

Stems and packing box constructions that do not meet Fisher stem finish specifications, dimensional tolerances, and design specifications, may adversely alter the performance of this packing kit.

ENVIRO-SEAL Packing Repair Kits

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	9.5 (3/8) 54 (2-1/8)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)	25.4 (1) 127 (5)
Double PTFE (Contains keys 214, 215, & 218)	RPACKX00192	RPACKX00202	RPACKX00212	RPACKX00222
Graphite ULF (Contains keys 207, 208, 209, 210, and 214)	RPACKX00592	RPACKX00602	RPACKX00612	RPACKX00622
Duplex (Contains keys 207, 209, 214, and 215)	RPACKX00292	RPACKX00302	RPACKX00312	RPACKX00322

Figure 6. ENVIRO-SEAL Packing System

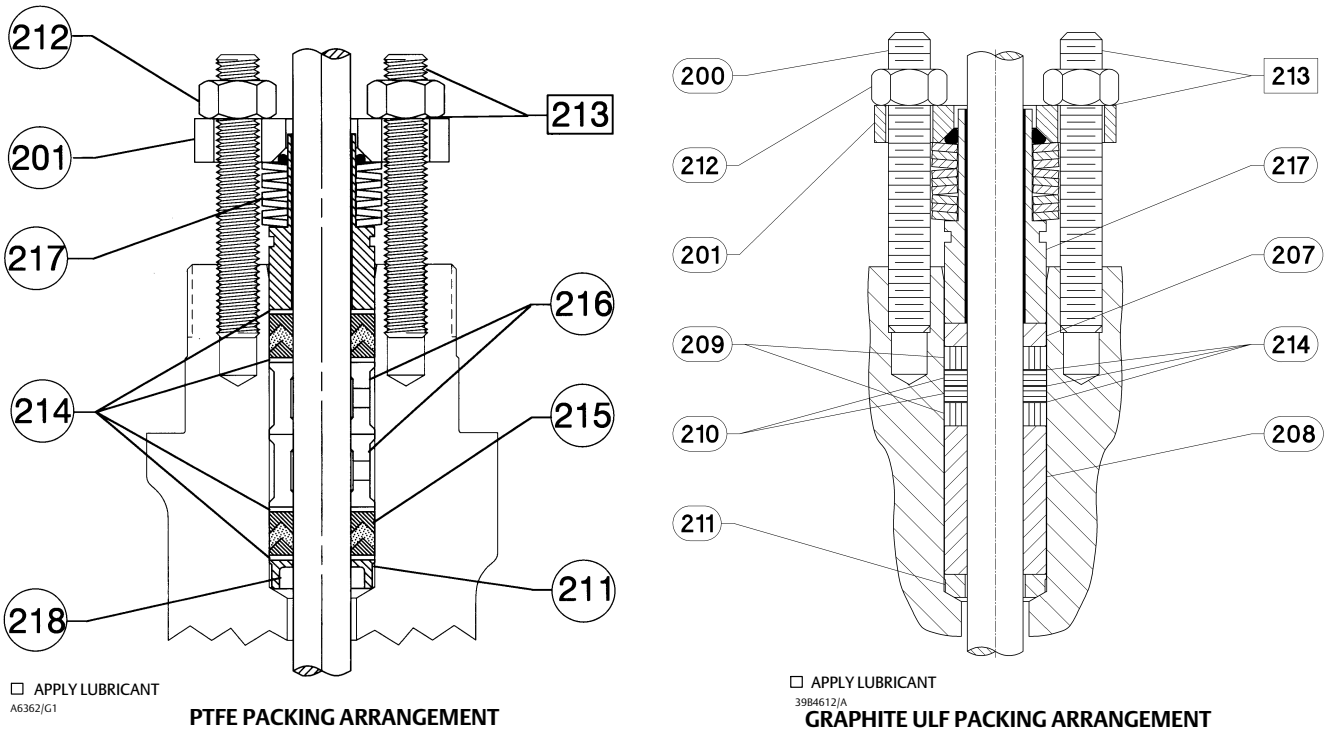
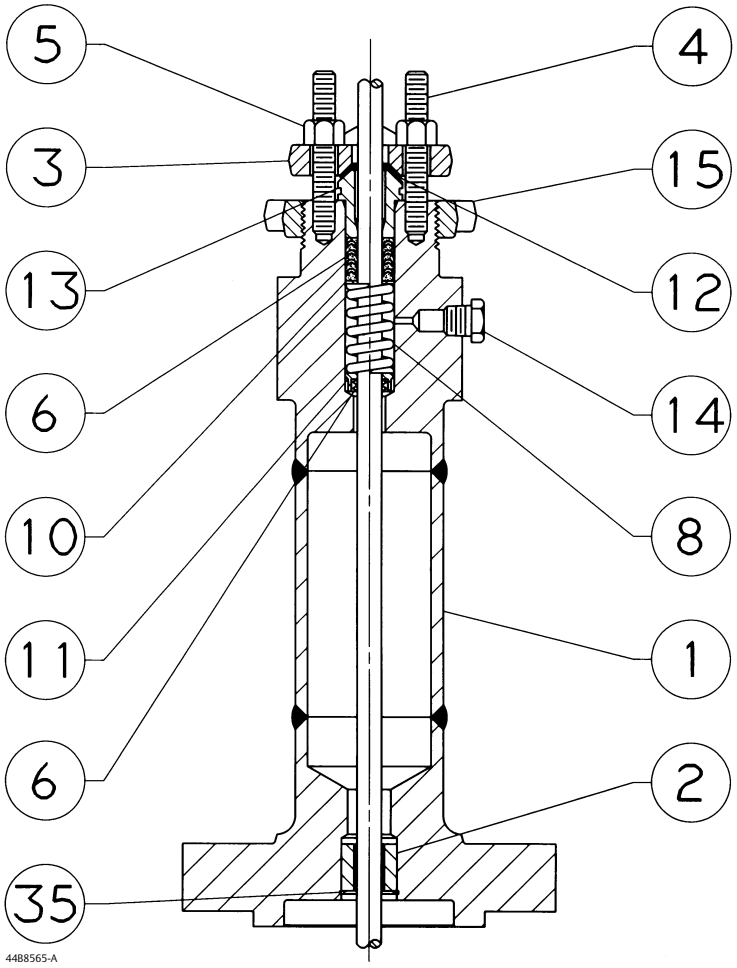


Figure 7. Extension Bonnet Assembly



NOTE:
1 KEY 6 CONTAINS SEVERAL PARTS; REFER TO FIGURES 2, 3, AND 4 FOR PACKING ARRANGEMENTS.

Keys 6* and 7* Packing Box Parts

DESCRIPTION		KEY NO.	STEM DIAMETER, mm (INCHES)			
			9.5 (3/8)	12.7 (1/2)	19.1 (3/4)	25.4 (1)
PTFE V-Ring Packing	Packing Set, PTFE (1 req'd for single, 2 req'd for double)(1)	6	1R290001012	1R290201012	1R290401012	1R290601012
Graphite Ribbon/Filament Packing	Graphite Ribbon Ring (2 req'd)	7	1V3160X0022	1V3802X0022	1V2396X0022	1U6768X0022
	Graphite Filament Ring	7	1F3370X0322	1E3190X0222	1E3191X0282	1D7518X0132
	Quantity Required	---	2	2	3	3

1. Key 6 for double construction contains one extra packing ring for the 9.5 mm (3/8 inch) stem, and one extra lower wiper for all sizes. Discard upon assembly.

*Recommended spare parts

Parts List

Note
Part numbers are shown for recommended spares only. For part numbers not shown, contact your Emerson sales office or Local Business Partner.

Bonnet Parts (figure 7)

Key	Description	Part Number
1	Bonnet If you need a bonnet as a replacement part, order by valve size and stem diameter, serial number, and desired material.	
2	Bushing	
3	Packing Flange	
4	Packing Flange Stud	
5	Packing Flange Nut	
6*	Single V-Ring Packing Set	See following table
7*	Individual Packing Ring	See following table
8	Packing Box Ring or Lantern Ring	
10	Special Washer	
11	Packing Box Ring	
12*	Upper Wiper, felt	
	9.5 mm (3/8 inch) stem	1J872606332
	12.7 mm (1/2 inch) stem	1J872706332
	19.1 mm (3/4 inch) stem	1J872806332
	25.4 mm (1-inch) stem	1J872906332
13	Packing Follower	
14	Pipe Plug	
15	Yoke Locknut	
25	Cap Screw	
26	Hex Nut	
35	Retaining Ring	

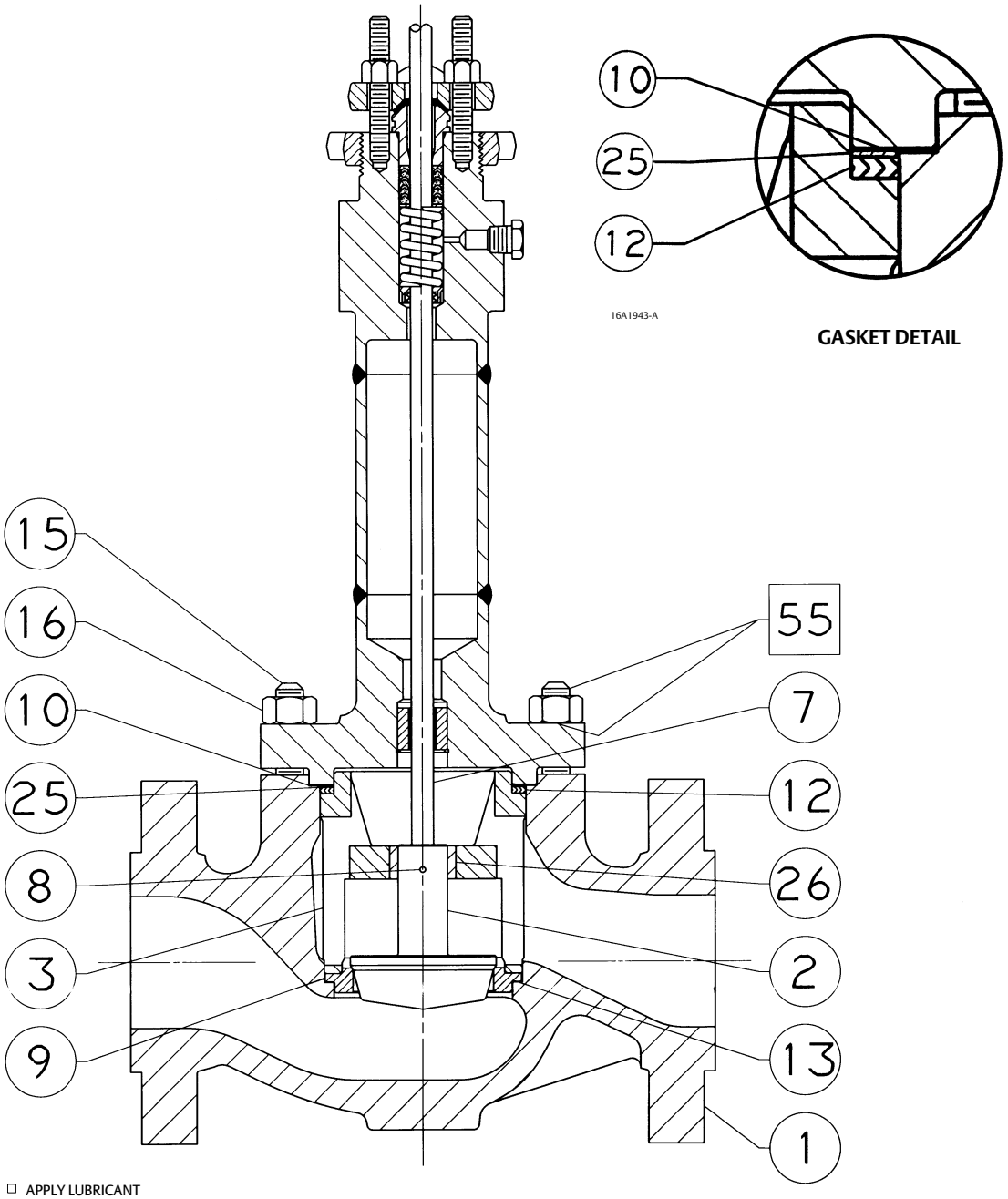
EZ-C Valve Body Parts (figure 8)

Note
Part numbers are shown for recommended spares only. For part numbers not shown, contact your Emerson sales office or Local Business Partner.

Key	Description	Part Number
1	Valve Body If you need a valve body as a replacement part, order by valve size, serial number, and desired material.	
2*	Valve Plug	See following table
3*	Seat Ring Retainer, CF8M (316 SST) (Part numbers for Seat Ring Retainer/Bushing Assemblies are provided in a following table)	
	NPS 1	25A6683X022
	NPS 1-1/2	25A6685X022
	NPS 2	25A6687X022
	NPS 3	25A6689X022
	NPS 4	35A6691X022
7*	Stem	See following table
8*	Pin	See following table
9*	Seat Ring	See following table
10*	Bonnet Gasket, S31600/graphite	
	NPS 1	1R2859X0042
	NPS 1-1/2	1R3101X0032
	NPS 2	1R3299X0042
	NPS 3	1R3484X0042
	NPS 4	1R3724X0042
12*	Gasket, N06600/graphite	
	NPS 1	1R286099442
	NPS 1-1/2	1R309999442
	NPS 2	1R329799442
	NPS 3	1R348299442
	NPS 4	1R372299442
13*	Seat Ring Gasket, S31600/graphite	
	NPS 1	1R2862X0062
	NPS 1-1/2	1R3098X0052
	NPS 2	1R3296X0042
	NPS 3	1R3481X0052
	NPS 4	1J5047X0062
15	Stud Bolt	
16	Hex Nut	
18	Flow Arrow	
19	Drive Screw	
25*	Shim, S31600	
	NPS 1	16A1936X012
	NPS 1-1/2	16A1937X012
	NPS 2	16A1938X012
	NPS 3	16A1940X012
	NPS 4	16A1941X012
26*	Bushing, R30006 (alloy 6) (Part number for Seat Ring Retainer/Bushing Assemblies are provided in a following table)	
	NPS 1	15A6508X022
	NPS 1-1/2	15A7511X022
	NPS 2, restricted port	15A6509X022
	NPS 2, full port	15A6510X022
	NPS 3	15A7491X022
	NPS 4, restricted port	15A5712X022
	NPS 4, full port	15A6511X022
33	Nameplate	
---	Warning Plate	
34	Wire	
55	Lubricant, anti-seize (not included with valve)	---

*Recommended spare parts

Figure 8. Fisher EZ-C Valve Assembly



Key 2* Fisher EZ-C Equal Percentage (Including Micro-Form), Linear, and Quick-Opening Valve Plugs

VALVE SIZE, NPS	VALVE PLUG STYLE	PORT DIAMETER		VALVE STEM CONNECTION		VALVE PLUG MATERIAL	
		mm	Inch	mm	Inch	S31600 w/CoCr-A (alloy 6) Seat	S31600 w/CoCr-A Seat and Guide
1, 1-1/2 and 2	Micro-Form	6.4	0.25	9.5	3/8	15A6663X012	15A6664X012
		9.5	0.375			16A5713X012	16A5711X012
		12.7	0.5			15A6659X012	15A6660X012
		19.1	0.75			16A3337X012	16A3339X012
		9.5	0.375	12.7	1/2	16A5714X012	16A5712X012
		12.7	0.5			15A6661X012	15A6662X012
		19.1	0.75			16A3338X012	16A3340X012
	Quick Opening	25.4	1	9.5	3/8	15A6516X012	15A6517X012
				12.7	1/2	15A6518X012	15A6519X012
	Linear			9.5	3/8	15A6614X012	15A6615X012
				12.7	1/2	15A6616X012	15A6617X012
	Equal Percentage			9.5	3/8	15A6634X012	15A6635X012
				12.7	1/2	15A6636X012	15A6637X012
1-1/2	Quick Opening	38.1	1.5	9.5	3/8	15A6520X012	15A6521X012
				12.7	1/2	15A6522X012	15A6523X012
	Linear			9.5	3/8	15A6618X012	15A6619X012
				12.7	1/2	15A6620X012	15A6621X012
	Equal Percentage			9.5	3/8	15A6638X012	15A6639X012
				12.7	1/2	15A6640X012	15A6641X012
2, 3, 4	Quick Opening	50.8	2	12.7	1/2	15A6524X012	15A6525X012
				19.1	3/4	15A6526X012	15A6527X012
	Linear			12.7	1/2	15A6622X012	15A6623X012
				19.1	3/4	15A6624X012	15A6625X012
	Equal Percentage			12.7	1/2	15A6642X012	15A6643X012
				19.1	3/4	15A6644X012	15A6645X012
3	Quick Opening	76.2	3	12.7	1/2	15A6528X012	15A6529X012
				19.1	3/4	15A6530X012	15A6531X012
	Linear			12.7	1/2	15A6626X012	15A6627X012
				19.1	3/4	15A6628X012	15A6629X012
	Equal Percentage			12.7	1/2	15A6646X012	15A6647X012
				19.1	3/4	15A6648X012	15A6649X012
4	Quick Opening	101.6	4	12.7	1/2	15A6532X012	15A6533X012
				19.1	3/4	15A6534X012	15A6535X012
	Linear			12.7	1/2	15A6630X012	15A6631X012
				19.1	3/4	15A6632X012	15A6633X012
	Equal Percentage			12.7	1/2	15A6650X012	15A6651X012
				19.1	3/4	15A6652X012	15A6653X012

Key 3*, 26* Fisher EZ-C Seat Ring Retainer and Bushing Assembly

VALVE SIZE, NPS		PART NUMBER
1		25A6683X072
1-1/2		25A6685X082
2	Full Port	25A6687X112
	Restricted Port	25A6687X132
3		25A6689X132
4	Full Port	35A6691X082
	Restricted Port	---

*Recommended spare parts

Key 7* Fisher EZ-C Valve Stem, S20910 (Use W/Group 1 Actuators)

VALVE SIZE, NPS	STEM DIAMETER			
	9.5 mm (3/8 Inch)	12.7 mm (1/2 Inch)	12.7 x 9.5 mm (1/2 x 3/8 Inch)	19.1 mm (3/4 Inch)
1 and 1-1/2	10A8823XM72	10A8840XBC2	11A2318X622	---
2	---	10A8840XBD2	11A2318X632	10B9265XBC2
3	---	10A8840XBE2	---	10A9265XBD2
4	---	1U2307X0012	---	10A9265XBE2

Key 8* Fisher EZ-C Pin, S31600

VALVE SIZE, NPS	VALVE PLUG STYLE	VALVE STEM CONNECTION		PART NUMBER
		mm	Inch	
1 and 1-1/2	Micro-Form, Linear, Equal Percentage and Quick Opening	9.5 12.7	3/8 1/2	1B599335072 1D5423X00B2
2	Linear, Equal Percentage and Quick Opening (full capacity)	12.7 19.1	1/2 3/4	1B599835072 1B813635072
	Micro-Form, Linear, Equal Percentage and Quick Opening (restricted capacity)	9.5 12.7	3/8 1/2	1B599335072 1D5423X00B2
3	All	12.7 19.1	1/2 3/4	1B599835072 1B813635072
4	Full Capacity	12.7 19.1	1/2 3/4	1B599835072 1B813635072
	Restricted Capacity	12.7 19.1	1/2 3/4	1B599335072 1F723635072

Key 9* Fisher EZ-C Valve Seat Ring, S31600

VALVE SIZE, NPS	PORT DIAMETER								
	6.4 mm (0.25 Inch)	9.5 mm (0.375 Inch)	12.7 mm (0.5 Inch)	19.1 mm (0.75 Inch)	25.1 mm (1 Inch)	38.1 mm (1.5 Inch)	50.8 mm (2 Inch)	76.2 mm (3 Inch)	101.6 mm (4 Inch)
1	24B7585X012	24B8298X012	24B8299X012	24B8300X012	24B8301X012	---	---	---	---
1-1/2	24B6344X012	24B7586X012	24B7213X012	24B7214X012	24B7215X012	24B7216X012	---	---	---
2	24B8555X012	24B8556X012	24B8557X012	24B8558X012	24B8559X012	---	24B8560X012	---	---
3	---	---	---	---	---	---	24B8561X012	24B8562X012	---
4	---	---	---	---	---	---	24B8510X012	---	24B8563X012

*Recommended spare parts

ET-C and EWT-C Valve Body Parts (figure 9)

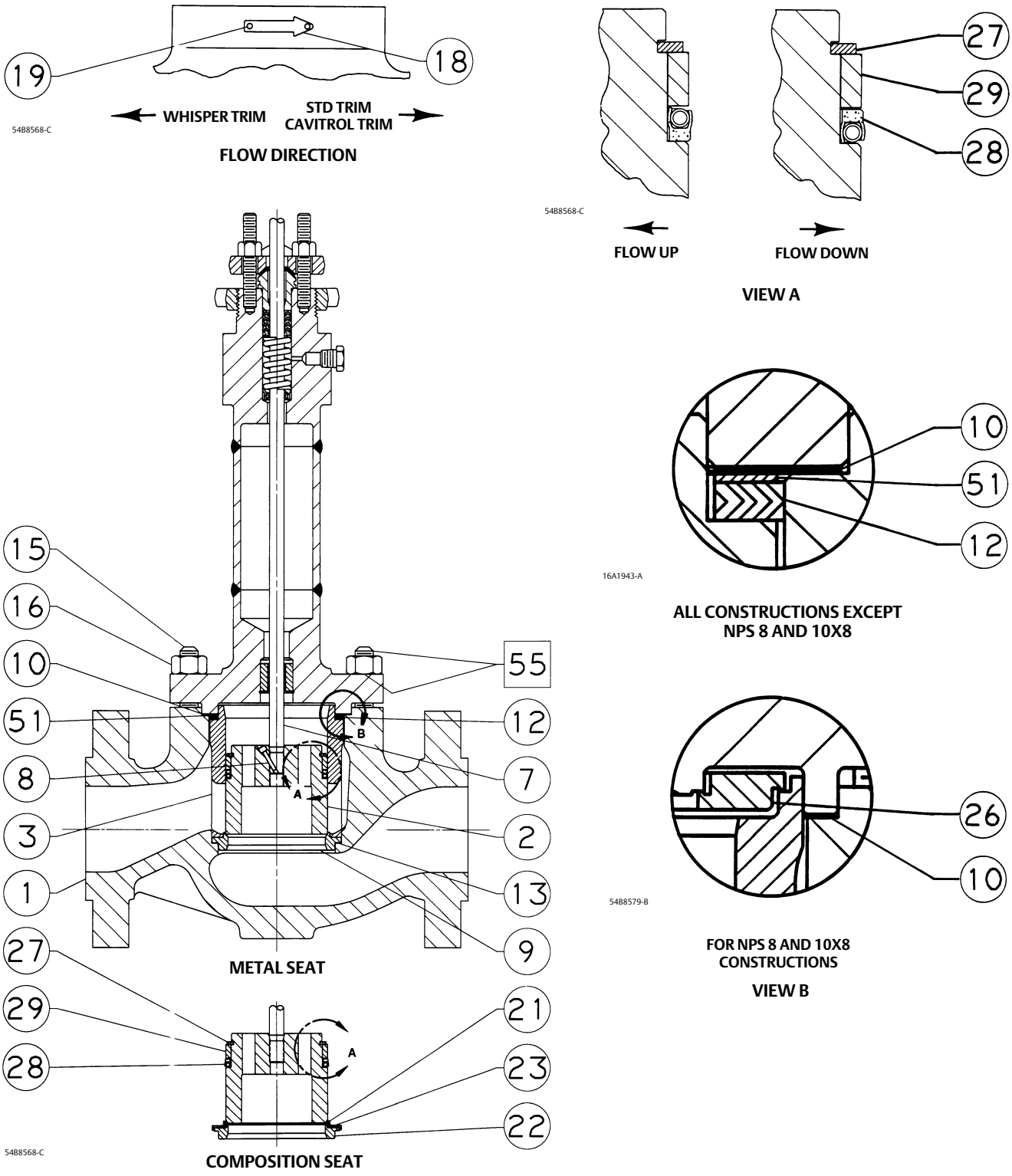
Note

Part numbers are shown for recommended spares only. For part numbers not shown, contact your Emerson sales office or Local Business Partner.

Key	Description	Part Number
1	Valve Body	
	If you need a valve body as a replacement part, order by valve size, serial number, and desired material.	
2*	Valve Plug	See following table
3*	Cage, CF8M (316 SST)/Chrome coat	
	Equal Percentage	
	NPS 3	39B0341X012
	NPS 4, 6X4, 8X4	39B0343X012
	NPS 6, 8X6, 12X6	39B0345X012
	NPS 8, 10X8	39B0347X012
	Linear	
	NPS 3	39B0342X012
	NPS 4, 6X4, 8X4	39B0344X012
	NPS 6, 8X6, 12X6	39B0346X012
	NPS 8, 10X8	39B0348X012
7*	Stem	See following table
8*	Pin, S31600	
	9.5 mm (3/8 inch) stem	1V322635072
	12.7 mm (1/2 inch) stem	1V322735072
	19.1 mm (3/4 inch) stem	1V326035072
	25.4 mm (1-inch), & 38.1 mm (1-1/4 inch) stem	1V334035072
9*	Seat Ring, w/metal seat, 316 SST	
	ET-C	
	NPS 3	23B6127X032
	NPS 4	23B6128X052
	NPS 6	29A9703X072
	NPS 8	29A9704X042
	EWT-C	
	NPS 6X4	23B6129X042
	NPS 8X4	23B6130X022
	NPS 8X6	20B0811X042
	NPS 12X6	33B6131X022
	NPS 10X8	29A9704X042
10*	Bonnet Gasket, S31600/graphite	
	NPS 3	1R3484X0042
	NPS 4, 6X4, 8X4	1R3724X0042
	NPS 6, 8X6, 12X6	1U5081X0052
	NPS 8, 10X8	10A3265X112
12*	Spiral Gasket, N06600/graphite	
	NPS 3	1R348299442
	NPS 4, 6X4, 8X4	1R372299442
	NPS 6, 8X6, 12X6	1U508599442
13*	Seat Ring Gasket	
	NPS 3, S31600/graphite	1R3481X0052
	NPS 4, 6X4, 8X4, S31600/graphite	1J5047X0062
	NPS 6, S31600/graphite	1U5086X0032
	NPS 8X6, 12X6, N06600/graphite	1V644199442
	NPS 8, 10X8, S31600/graphite	10A3266X082
15	Stud Bolt	
16	Hex Nut	
18	Flow Arrow	
19	Drive Screw	
21*	Disk Retainer, w/Composition Seat, 316 SST	
	NPS 3	1V711235072
	NPS 4, 6X4, 8X4	1V711533092
	NPS 6	1V711833092
	NPS 8, 10X8	10A4466X012
22*	Disk Seat, w/Composition Seat, 316 SST	
	ET-C	
	NPS 3	1V711435072
	NPS 4	1V711733092
	NPS 6	1V712033092
	NPS 8	20A4467X012
	EWT-C	
	NPS 6X4	1V712533092
	NPS 8X4	1V712633092
	NPS 8X6	2V721733092
	NPS 12X6	2V712733092
	NPS 10X8	20A4467X012
23*	Disk, PCTFE	
	NPS 3	18A8539X012
	NPS 4, 6X4, 8X4	18A0732X012
	NPS 6, 8X6, 12X6	18A0733X012
	NPS 8, 10X8	20A4468X042
26	Load Ring	
27	Retaining Ring	
28*	Seal Ring, R30003/UHMWPE	
	NPS 3	14B8251X012
	NPS 4, 6X4, 8X4	14B8252X012
	NPS 6, 8X6, 12X6	14B8254X012
	NPS 8, 10X8	14B8255X012
29	Back-Up Ring	
51*	Shim, S31600	
	NPS 3	16A1940X012
	NPS 4, 6x4, 8x4	16A1941X012
	NPS 6, 8X6, 12X6	16A1942X012
53	Nameplate	
55	Lubricant, anti-seize (not included with valve)	---

*Recommended spare parts

Figure 9. Fisher ET-C and EWT-C Valve Assembly



Key 2* Fisher ET-C and EWT-C Valve Plug

VALVE SIZE, NPS	PORT DIAMETER		SEAT STYLE			
			Metal		Composition	
			S31600 w/CoCr-A Seat		S31600 Seat	
	Inches	mm	12.7 mm (1/2 Inch) Stem	19.1 mm (3/4 Inch) Stem	12.7 mm (1/2 Inch) Stem	19.1 mm (3/4 Inch) Stem
3	3.4375	87.3	34B8275X012	34B8190X012	34B8288X012	34B8289X012
4, 6X4, 8X4	4.375	111	34B8276X012	34B7639X012	34B8290X012	34B8291X012
6, 8X6, 12X6	7	178	19.1 mm (3/4 Inch) Stem	25.4 mm (1-Inch) Stem	19.1 mm (3/4 Inch) Stem	25.4 mm (1-Inch) Stem
			34B8278X012	34B8279X012	34B8292X012	34B8293X012
8, 10X8	8	203	34B8280X012	34B8281X012	34B8294X012	34B8296X012

Key 7* Fisher ET-C and EWT-C Valve Stem, S20910

VALVE SIZE, NPS	STEM DIAMETER		ACTUATOR GROUP	S20910 (XM-19)
	mm	Inches		
3	12.7 19.1	1/2 3/4	1 1	10A8840XBD2 10A9265XBF2
4, 6X4, 8X4	12.7 19.1	1/2 3/4	1 1	10A8840XAD2 10A9265XBG2
6, 8X6, 12X6	19.1 25.4 25.4	3/4 1 1	1 100 101	10A9265XBH2 11A3429XR72 11A3429XR62
8, 10X8	19.1 25.4	3/4 1	1 100, 101	10A9265XBJ2 11A3429XR82

*Recommended spare parts

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Fisher™ HP and HPA Control Valves

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Figure 1. HP Valve with 667 Actuator and FIELDVUE™ DVC6200 Digital Valve Controller



X0183-1

Introduction

Scope of Manual

This instruction manual includes installation, maintenance, and parts information for NPS 1 through 6 HP valves with CL900 and CL1500 ratings; NPS 1 through 2 HP with CL2500 ratings; NPS 1 through 8 HPA valves with CL900 and CL1500 ratings; and NPS 1 through 2 HPA valves with CL2500 ratings. Refer to separate manuals for instructions covering the actuator, positioner, and accessories.

Do not install, operate, or maintain HP series valves without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Unless otherwise noted, all NACE references are to NACE MR0175-2002 and MR0103.

Table 1. Specifications

End Connection Styles and Ratings[1,2,3,4]

Flanged: Consistent with CL900, CL1500, and CL2500 per ASME B16.34

Socket Welding: Consistent with CL900, CL1500, and CL2500 per ASME B16.34

Buttwelding: Consistent with CL900, CL1500, and CL2500 per ASME B16.34

Also see table 2

Shutoff Classifications

See table 3

C-seal trim: High-temperature, Class V.
See table 4

TSO (Tight Shutoff) trim: See tables 5 and 6

Flow Characteristic

Standard Cage: ■ Equal percentage, ■ Modified equal percentage, or ■ Linear

Standard Cage with Micro-Form Valve Plug: (HPS and HPAS only): ■ Equal percentage or ■ Modified equal percentage

Standard Cage with Micro-Flute Valve Plug: (HPS and HPAS only): ■ Equal percentage or ■ Modified equal percentage

Standard Cage with Micro-Flat Valve Plug: (HPAS only): ■ Linear

Cavitrol™ III, Whisper Trim™ III, or WhisperFlo™ Cage: ■ Linear

Special cages: Special characterized flow cages are available. Consult your local Emerson Process Management sales office

Flow Direction

Standard Cage

■ *HPD and HPAD:* Normally flow down
■ *HPS and HPAS:* Normally flow up[5]
■ *HPAS Micro-Flat:* Flow down
■ *HPT and HPAT:* Normally flow down
■ *HPS and HPAS Micro-Form:* Flow up only

Cavitrol III Cage: Flow down

Whisper Trim III or WhisperFlo Cage: Flow up

Approximate Weights (valve body and bonnet assemblies)

See table 2

Additional Specifications

For specifications such as materials, valve plug travels, and port, yoke boss, and stem diameters, see the Parts List section

1. EN (or other) ratings and end connections can usually be supplied; consult your Emerson Process Management sales office.
2. CL900 and CL1500 globe valves are identical for NPS 1 and 2 valves. CL900 and CL1500 globe valves for NPS 3, 4, and 6 valves, however, are not identical.
3. The centerline-to-face dimension for CL2500 NPS 1 and 2 HPA valves does not conform to ANSI/ISA S75.12.
4. The pressure or temperature limits in this manual and any applicable standard limitations should not be exceeded.
5. HPS and HPAS valves may be used flow down for on-off service only or where further limited by trim design. HPAS valves may be used flow down for erosive service.

Description

HP Series high-pressure globe and angle valves (figure 1) have metal seats, cage guiding, quick change trim, and push-down-to-close valve plug action. HPD, HPAD, HPT, and HPAT valves use balanced valve plugs. HPS and HPAS valves use an unbalanced valve plug. To provide a seal between the cage and a balanced valve plug, the HPD and HPAD valve plugs use piston rings; the HPT and HPAT valve plugs use a pressure-assisted seal ring. A Whisper Trim or WhisperFlo cage can be used with an HPD, HPAD, HPS, HPAS, HPT, or HPAT valve plug. A Cavitrol III cage can be used with an HPS, HPAS, HPT, or HPAT valve plug.

C-seal trim is available for HPD valves, CL900 and CL1500, in sizes NPS 3, 4, and 6; and for HPAD valves, CL900 and CL1500 in sizes NPS 4, 6, and 8.

With C-seal trim, a balanced valve can achieve high-temperature, Class V shutoff. Because the C-seal plug seal is formed from metal (N07718 nickel alloy) rather than an elastomer, a valve equipped with the C-seal trim can be applied in processes with a fluid temperature of up to 593°C (1100°F), provided other material limits are not exceeded.

Specifications

Specifications for the HP Series valves are shown in table 1.

Table 2. Approximate Weights (Valve and Bonnet Assemblies)

VALVE SIZE, NPS	PRESSURE RATING	KILOGRAMS		POUNDS	
		Flg	SWE & BWE	Flg	SWE & BWE
Globe Valves					
1	CL900 & CL1500	42	38	93	85
	CL2500	45	34	100	76
1-1/2 x 1	CL2500	- - -	34	- - -	76
2	CL900 & CL1500	72	52	158	115
	CL2500	104	74	229	164
3	CL900	125	- - -	276	- - -
	CL1500	129	97	284	213
4	CL900	230	- - -	507	- - -
	CL1500	249	201	548	444
6	CL900	511	- - -	1127	- - -
	CL1500	557	455	1228	1003
Angle Valves					
1	CL900 & CL1500	40	36	88	80
	CL2500	- - -	72(1)	- - -	160(1)
2	CL900 & CL1500	69	50	153	110
	CL2500	- - -	109(1)	- - -	240(1)
3	CL1500	123	78	278	173
4	CL1500	181	117	399	258
6	CL1500	357	202	788	445
8	CL1500	648	405	1428	893

1. Only SWE is available for CL2500.

Educational Services

For information on available courses for Fisher HP and HPA valves, as well as a variety of other products, contact:

Emerson Process Management
Educational Services - Registration
Phone: 1-641-754-3771 or 1-800-338-8158
E-mail: education@emerson.com
http://www.emersonprocess.com/education

Installation

⚠ WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

Personal injury or equipment damage caused by sudden release of pressure may result if the valve assembly is installed where service conditions could exceed the limits given in table 1 or on the appropriate nameplates. To avoid such injury or

damage, provide a relief valve for over-pressure protection as required by government or accepted industry codes and good engineering practices.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

⚠ WARNING

Some bonnet flanges have a tapped hole that was used to handle the bonnet during manufacture. Do not use this tapped hole to lift the valve assembly or personal injury may result.

⚠ WARNING

When ordered, the valve configuration and construction materials were selected to meet particular pressure, temperature, pressure drop, and controlled fluid conditions indicated when the valve was ordered. Since some body/trim material combinations are limited in their pressure drop and temperature ranges, do not apply any other conditions to the valve without first contacting your Emerson Process Management sales office.

1. Before installing the valve, inspect it to ensure that the valve body cavity is free of foreign material.
2. Clean out all pipelines to remove scale, welding slag, and other foreign materials before installing the valve.

Note

If the valve body being installed has small internal flow passages, such as with Whisper Trim III, WhisperFlo, or Cavitrol III cages, consideration should be given to installing an upstream strainer to prevent the lodging of particles in these passages. This is especially important if the pipeline cannot be thoroughly cleaned or if the flowing medium is not clean.

3. Flow through the valve must be in the direction indicated by the flow arrow, which is stamped on or attached to the valve body.

Table 3. Shutoff Classifications per ANSI/FCI 70-2 and IEC 60534-4

VALVE DESIGN	PORT DIAMETER, mm (INCHES)	LEAKAGE CLASS
HPD, HPAD	47.6 (1.875) and smaller	II
	58.7 (2.3125) to 92.1 (3.625)	II - Standard
		III - Optional
	111.1 (4.375) and larger	III - Standard
		IV - Optional
HPS, HPAS w/ Cavitrol III, or HPT, HPAT w/ Cavitrol III, or HPAS w/Micro-Flat	All	V
HPS, HPAS, HPT, HPAT, HPS, HPAS w/ Micro-Form, or HPS, HPAS w/ Micro-Flute	All	IV-Standard
		V-Optional
HPT w/ PEEK anti-extrusion rings	47.6 (1.875) to 136.5 (5.375)	V - Standard

Table 4. Additional Shutoff Classification per ANSI/FCI 70-2 and IEC 60534-4

Valve Design	Valve Size, NPS		Port Diameter		Cage Style	Leakage Class
	HPD	HPAD	mm	Inches		
HPD, HPAD with optional C-seal trim	3	4	73.0	2.875	Equal Percentage, Modified Equal Percentage, Linear (std. cage), Linear (Whisper III, A1, B1)	V
	4	6	73.0	2.875	Linear (Whisper III, D3)	V
	4	6	92.1	3.625	Equal Percentage, Modified Equal Percentage, Linear (std. cage), Linear (Whisper III, A1, B3, C3)	V
	6	8	111.1	4.375	Linear (Whisper III, D3)	V
	6	8	136.5	5.375	Equal Percentage, Modified Equal Percentage, Linear (std. cage), Linear (Whisper III, A1, B3, C3)	V

Table 5. TSO (Tight Shutoff) Leakage Class per ANSI/FCI 70-2 and IEC 60534-4

Leakage Class	Maximum Leakage	Test Medium	Test Pressure	Leakage Class
TSO (Tight Shutoff)	Valves with TSO trim are factory tested to a more stringent Emerson Process Management test requirement of no leakage at time of shipment.	Water	Service $\Delta P^{(1)}$	V

1. Specify service ΔP when ordering.

Table 6. TSO Shutoff Availability

VALVE DESIGN	CONSTRUCTION	LEAKAGE CLASS
HPS, HPT	Std or Cavitrol III trim. Replaceable, protected soft seat	TSO - Standard

Table 7. Recommended Torque for Packing Flange Nuts (Non Live-loaded Graphite Packing)

STEM DIAMETER		VALVE BODY RATING(1)	TORQUE			
			N•m		lbf•ft	
mm	Inches		Min	Max	Min	Max
12.7	1/2	CL900	12	18	9	13
12.7	1/2	CL1500	15	22	11	16
12.7	1/2	CL2500	18	24	13	18
19.1	3/4	CL900	27	41	20	30
19.1	3/4	CL1500	34	50	25	37
19.1	3/4	CL2500	41	61	30	45
25.4	1	CL900	42	62	31	46
25.4	1	CL1500	52	77	38	57
25.4	1	CL2500	61	91	45	67
31.8	1-1/4	CL900	56	83	41	61
31.8	1-1/4	CL1500	68	102	50	75

1. For intermediate class ratings, use the same torque as the next lower standard class.

CAUTION

Depending on valve body materials used, post-weld heat treating might be needed. Post-weld heat treatment can damage internal elastomeric, plastic, and metal parts. Shrink-fit pieces and threaded connections might also loosen. In general, if post-weld heat treating is needed, remove all trim parts. Contact your Emerson Process Management sales office for additional information.

4. Use accepted piping and welding practices when installing the valve in the pipeline. For flanged valve bodies, use a suitable gasket between the body and pipeline flanges.
5. Install a three-valve bypass around the valve if continuous operation is required during maintenance.
6. If the actuator and valve body are shipped separately, refer to the actuator mounting procedure in the appropriate actuator instruction manual.
7. If the valve body was shipped without packing installed in the packing box, install the packing before putting the valve body into service. Refer to instructions given in the Packing Maintenance procedure.

⚠ WARNING

Personal injury could result from packing leakage. Valve packing was tightened before shipment; however, the packing might require some readjustment to meet specific service conditions.

Valves with ENVIRO-SEAL™ live-loaded packing or HIGH-SEAL ULF live-loaded packing will not require this initial re-adjustment. See the instruction manuals titled ENVIRO-SEAL Packing System for Sliding-Stem Valves (D101642X012) or HIGH-SEAL ULF Live-Loaded Packing System (D101453X012) (as appropriate) for packing instructions. If you wish to convert your present packing arrangement to ENVIRO-SEAL packing, refer to the retrofit kits listed in the parts kit sub-section near the end of this manual.

Maintenance

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of service conditions. This section includes instructions for packing lubrication, packing maintenance, and trim maintenance. All maintenance operations may be performed with the valve in the line.

⚠ WARNING

Avoid personal injury or damage to property from sudden release of pressure or uncontrolled process fluid. Before starting disassembly:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure on both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the power actuator loading pressure and relieve any actuator spring precompression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **The valve packing box may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline.* Process fluids may spray out under pressure when removing the packing hardware or packing rings, or when loosening the packing box pipe plug.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

Note

The HP series valve uses spiral-wound gaskets which are crushed to provide their seal. A spiral-wound gasket should never be reused. Whenever a gasket seal is disturbed by removing or shifting gasketed parts, a new gasket must be installed upon reassembly. This is necessary to ensure a good gasket seal, since the used gasket will not seal properly.

Table 8. Torque for Body-to-Bonnet Bolting Using Anti-Seize Lubricant(1)

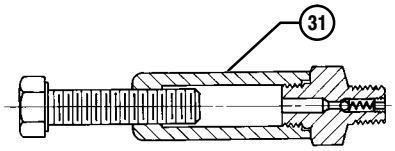
VALVE RATING	VALVE SIZE, NPS		TORQUE	
			N•m	lbf•ft
	HP	HPA	B7, B16, B8M CL2, BD, S20910, and 660 Studs	B7, B16, B8M CL2, BD, S20910, and 660 Studs
CL900 & CL1500	1	1	260	190
	2	2, 3	370	275
	3	4	710	525
	4	6	940	695
	6	8	1650	1220
CL2500	1	1	370	275
	2	2	710	525

1. For other materials, contact your Emerson Process Management sales office for torques.

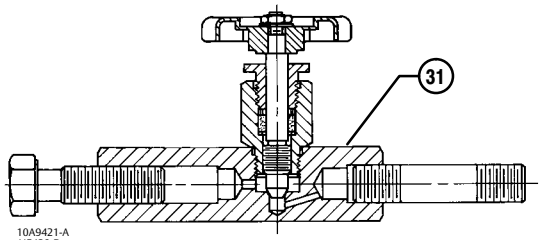
CAUTION

The spiral-wound gaskets are of special design. Failure to use Fisher replacement parts may result in valve damage.

Figure 2. Lubricator and Lubricator/Isolating Valve



LUBRICATOR



LUBRICATOR/ISOLATING VALVE

Note

If the valve has ENVIRO-SEAL live-loaded packing installed (figure 4), see the instruction manual entitled ENVIRO-SEAL Packing System for Sliding-Stem Valves (D101642X012) for packing instructions.

If the valve has HIGH-SEAL ULF live-loaded packing installed (figure 4), see the instruction manual entitled HIGH-SEAL ULF Live-Loaded Packing System (D101453X012) for packing instructions.

Packing Lubrication

CAUTION

Do not lubricate graphite packing. Graphite packing is self-lubricated. Additional lubrication may result in slip-stick movement of the valve.

Note

To avoid lubricants breaking down at elevated temperatures, do not lubricate packing used in processes with temperatures over 260°C (500°F).

⚠ WARNING

Do not lubricate parts when used in oxygen service, or where the lubrication is incompatible with the process media. Any use of lubricant can lead to the sudden explosion of media due to the oil/oxygen mixture, causing personal injury or property damage.

If a lubricator or lubricator/isolating valve (figure 2) is provided for PTFE/composition or other packings that require lubrication, it will be installed in place of the pipe plug (key 31, figure 17, 18, or 19). Use a good quality silicon-base lubricant. Packing used in oxygen service or in processes with temperatures over 260°C (500°F) should not be lubricated. To operate the lubricator, turn the cap screw clockwise to force the lubricant into the packing box. The lubricator/isolating valve operates the same way except the isolating valve must first be opened and then closed after lubrication is completed.

Packing Maintenance

If there is undesirable packing leakage in the spring-loaded PTFE V-ring packing shown in figure 3, tighten the packing flange nuts (key 21, figure 17, 18, or 19) until the shoulder on the packing follower (key 28, figure 17, 18, or 19) contacts the bonnet (key 18, figure 17, 18, or 19). If leakage continues, replace the packing by following the numbered steps presented in the replacing packing procedure.

If there is undesirable packing leakage with other than spring-loaded PTFE V-ring packing, first try to limit the leakage and establish a stem seal by tightening the packing flange nuts (key 21, figure 17, 18, or 19) to at least the minimum recommended torque in table 7. However, do not exceed the maximum recommended torque in table 7 or excessive friction may result. If leakage continues, replace the packing by following the numbered steps presented in the Replacing Packing procedure.

If the packing is relatively new and tight on the valve plug stem, and if tightening the packing flange nuts does not stop the leakage, it is possible that the stem is worn or nicked so that a seal cannot be made. The surface finish of a new stem is critical for making a good packing seal. If the leakage comes from the outside diameter of the packing, it is possible that the leakage is caused by nicks or scratches around the packing box wall. While replacing the packing according to the Replacing Packing procedure, inspect the valve plug stem and packing box wall for nicks or scratches.

Adding Packing Rings

Key numbers referred to in this procedure are shown in figure 17, 18, or 19, unless otherwise indicated.

When using packing with a lantern ring (key 24) it may be possible to add packing rings above the lantern ring as a temporary measure without removing the actuator from the valve body.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. If using a power actuator, also shut-off all pressure lines to the power actuator, release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
2. Remove the packing flange nuts (key 21) and lift the packing flange, upper wiper, and packing follower (keys 19, 27, and 28) away from the valve body.
3. It may be possible to dig out the old packing rings on top of the lantern ring, but use care to avoid scratching the valve plug stem or packing box wall. Clean all metal parts to remove particles that would prevent the packing from sealing.
4. Remove the stem connector and slip the packing rings over the end of the valve plug stem.
5. Reassemble the packing follower, upper wiper, packing flange, and packing flange nuts (keys 28, 27, 19, and 21).
6. Reconnect the body-actuator stem connection according to the appropriate actuator instruction manual.
7. Tighten the packing flange nuts only far enough to stop leakage under operating conditions. Check for leakage around the packing follower when the valve is being put into service. Retighten the packing flange nuts as required (see table 7).

Replacing Packing

⚠ WARNING

Refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

Key numbers referred to in this procedure are shown in figure 17, 18, or 19, unless otherwise indicated.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. If using a power actuator, also shut-off all pressure lines to the power actuator, release all pressure from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.
2. Remove the cap screws in the stem connector, and separate the two halves of the stem connector. Then exhaust all actuator pressure, if any was applied, and disconnect the actuator supply and any leakoff piping.
3. Remove either the yoke locknut (key 32) or the hex nuts (key 30), and remove the actuator from the bonnet (key 18).
4. Loosen the packing flange nuts (key 21) so that the packing (keys 22, 23, 209, or 210, figure 3) is not tight on the valve plug stem (key 6). Remove any travel indicator disk and stem locknuts from the valve plug stem threads.

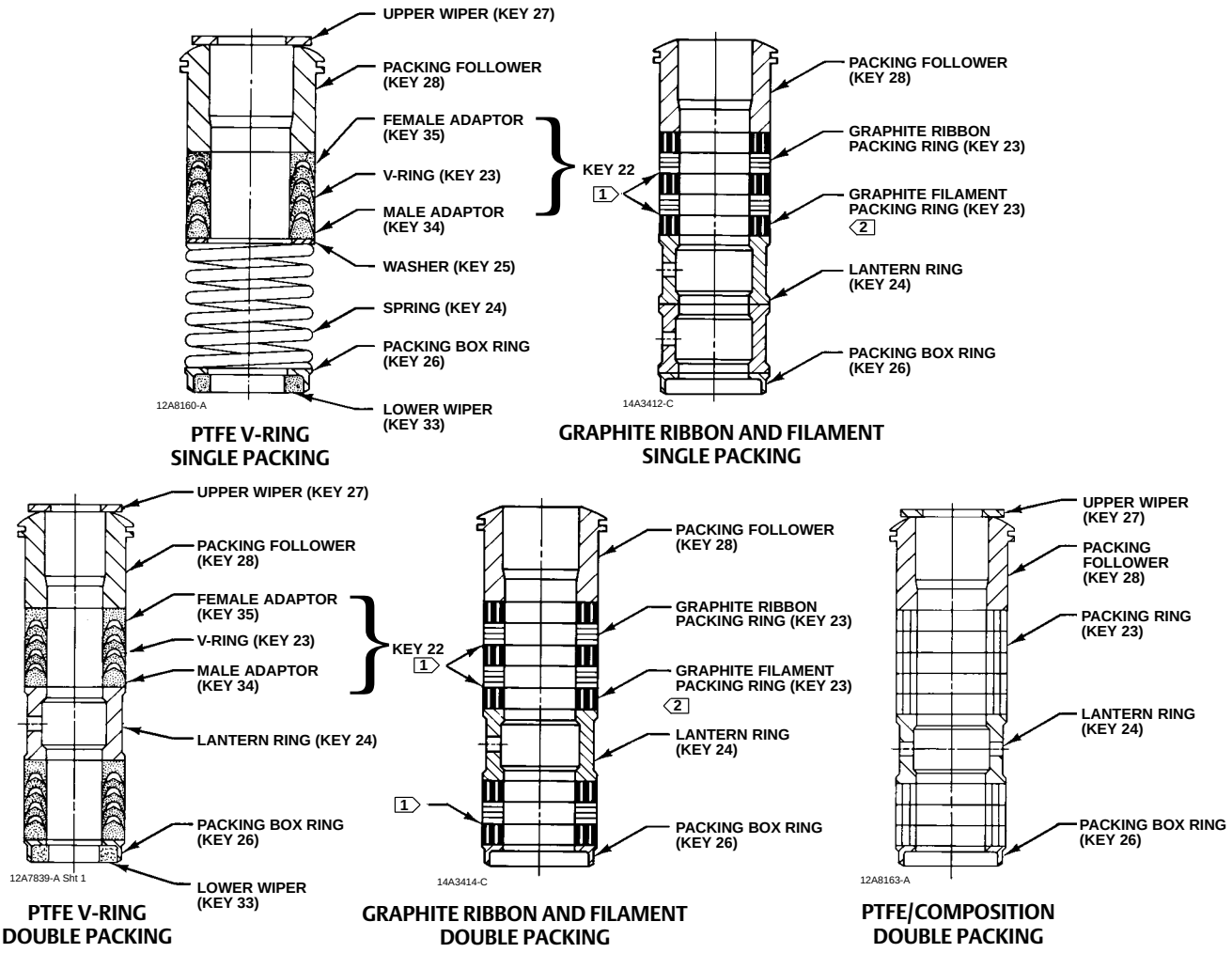
CAUTION

When lifting the bonnet (key 18), be sure that the valve plug and stem assembly (keys 5 and 6) remains on the seat ring (key 4). This avoids damage to the seating surfaces as a result of the assembly dropping from the bonnet after being lifted part way out. The parts are also easier to handle separately.

Use care to avoid damaging gasket sealing surfaces.

The HPD and HPAD piston rings (key 8) are brittle and in two pieces. Avoid damaging the piston rings by dropping or rough handling.

Figure 3. Packing Arrangements



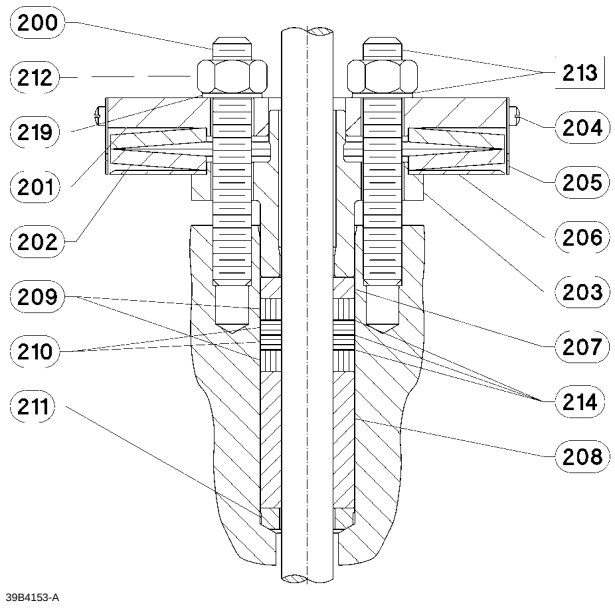
NOTES:
1 0.102 mm (0.004 INCH) THICK SACRIFICIAL ZINC WASHERS. USE ONLY ONE BELOW EACH GRAPHITE RIBBON RING.
2 HAS THE APPEARANCE OF A WOVEN OR BRAIDED RING.

C0747-1

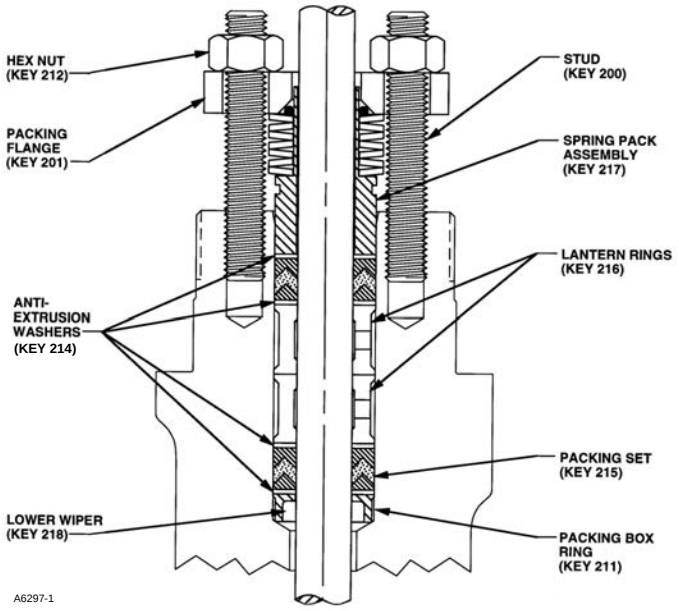
⚠ WARNING

To avoid personal injury or property damage caused by uncontrolled movement of the bonnet, loosen the bonnet by following the instructions in the next step. Do not remove a stuck bonnet by pulling on it with equipment that can stretch or store energy in any other manner. The sudden release of stored energy can cause uncontrolled movement of the bonnet. If the cage sticks to the bonnet, proceed carefully with bonnet removal and support the cage so that it will not fall unexpectedly from the bonnet.

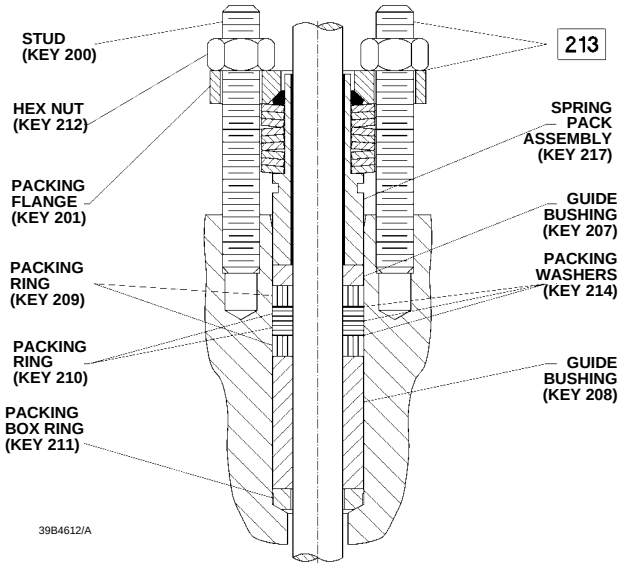
Figure 4. Live-Loaded Packing



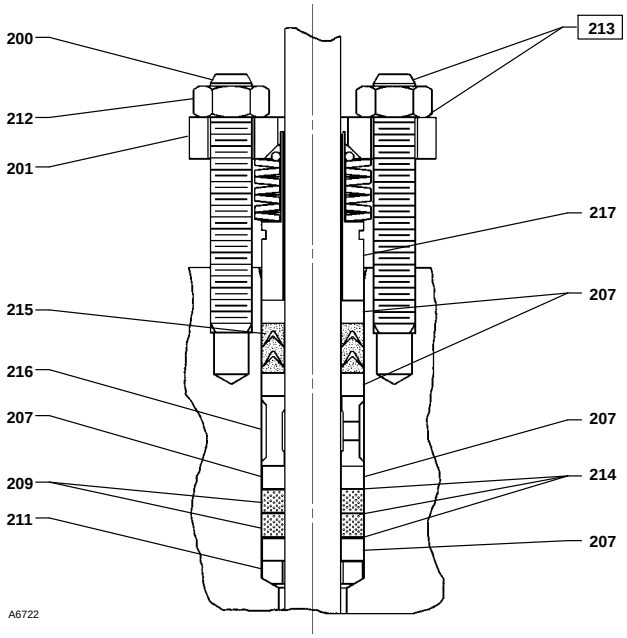
Typical HIGH-SEAL Graphite ULF Packing System



Typical ENVIRO-SEAL Packing System with PTFE Packing



Typical ENVIRO-SEAL Packing System with Graphite ULF Packing



Typical ENVIRO-SEAL Packing System with Duplex Packing

Note

The following step also provides additional assurance that the valve body fluid pressure has been relieved.

5. Hex nuts (key 14) attach the bonnet to the valve body. Loosen these nuts or cap screws approximately 3 mm (1/8 inch). Then loosen the body-to-bonnet gasketed joint by either rocking the bonnet or prying between the bonnet and valve body. Work the prying tool around the bonnet until the bonnet loosens. If no fluid leaks from the joint, proceed to the next step.
6. Unscrew the hex nuts (key 14) and carefully lift the bonnet off the valve stem. If the valve plug and stem assembly starts to lift with the bonnet, use a brass or lead hammer on the end of the stem and tap it back down. Set the bonnet on a cardboard or wooden surface to prevent damage to the bonnet gasket surface.
7. Remove the valve plug (key 5), bonnet gasket (key 11), cage (key 2), seat ring (key 4), and the seat ring gasket (key 12).

CAUTION

Inspect the seat ring, cage, bonnet, and body gasket surfaces. These surfaces must be in good condition, with all foreign material removed. Small burrs less than approximately 0.076 mm (0.003 inches) in height (the thickness of a human hair) can be ignored. Scratches or burrs that run across the serrations are not permitted under any conditions, since they will prevent the gaskets from sealing properly.

8. Clean all gasket surfaces with a good wire brush. Clean in the same direction as the surface serrations, not across them.
9. Cover the opening in the valve body to protect the gasket surface and to prevent foreign material from getting into the valve body cavity.
10. Remove the packing flange nuts (key 21), packing flange (key 19), upper wiper (key 27), and packing follower (key 28). Carefully push out all the remaining packing parts from the valve side of the bonnet using a rounded rod or other tool that will not scratch the packing box wall. For extension bonnets, also remove the baffle (key 36) and retaining ring (key 37).
11. Clean the packing box and the following metal packing parts: packing follower, packing box ring (key 26), spring or lantern ring (key 24), and, for single arrangements of PTFE V-ring packing only, special washer (key 25).
12. Inspect the valve stem threads for any sharp edges that might cut the packing. A whetstone or emery cloth may be used to smooth the threads if necessary.
13. Remove the protective covering from the valve body cavity, and install the seat ring and cage using a new seat ring gasket (key 12) and bonnet gasket (key 11). Install the plug, then slide the bonnet over the stem and onto the studs (key 13). For a valve body with extension bonnet, also install the baffle and retaining rings (keys 36 and 37).

Note

The prelubricated hex nuts (key 14) referred to in step 14 can be identified by a black film coating on the nut threads.

The proper bolting procedures in step 14 include--but are not limited to--ensuring that the bonnet stud threads are clean, and that the hex nuts are evenly tightened to the specified torque values.

Table 9. Valve Stem Connection Torque and Drill Size for Pin Hole

VALVE SIZE, NPS		VALVE STEM DIAMETER		DESIGN	VALVE STEM CONNECTION TORQUE (MINIMUM-MAXIMUM)		DRILL SIZE FOR PIN
HP	HPA	mm	Inches		N•m	Lbf•ft	Inches
1	1	12.7	1/2	HPS, HPAS	81 - 115	60 - 85	1/8
		19.1	3/4	HPS, HPAS	237 - 339	175 - 250	3/16
2	2, 3	12.7	1/2	HPD, HPAD, HPS, HPAS(1), HPT, HPAT	81 - 115	60 - 85	1/8
		19.1	3/4	HPS, HPAS(1)	237 - 339	175 - 250	3/16
				HPD, HPAD, HPT, HPAT	237 - 339	175 - 250	1/8
		25.4	1	HPS, HPAS(1)	420 - 481	310 - 355	1/4
3	4	12.7	1/2	HPD, HPS, HPT, HPAD, HPAT	81 - 115	60 - 85	1/8
		19.1	3/4	HPD, HPS, HPT, HPAD, HPAT	237 - 339	175 - 250	3/16
		25.4	1	HPD, HPS, HPT, HPAD, HPAT	420 - 481	310 - 355	1/4
4	6	19.1	3/4	HPD, HPT, HPAD, HPAT	237 - 339	175 - 250	3/16
		25.4	1	HPD, HPT, HPAD, HPAT	420 - 481	310 - 355	1/4
6	8	19.1	3/4	HPD, HPT, HPAD, HPAT	237 - 339	175 - 250	3/16
		25.4	1	HPD, HPT, HPAD, HPAT	420 - 481	310 - 355	1/4
		31.8	1-1/4	HPD, HPT, HPAD, HPAT	827 - 908	610 - 670	1/4

1. HPAS available in NPS2 only.

CAUTION

Failure to comply with good bonnet-to-body bolting practices and the torque values shown in table 8 may result in damage to the valve. Cheater bars or slug wrenches should not be used for this procedure.

Hot torquing is not recommended.

Note

Stud(s) and nut(s) should be installed such that the manufacturer's trademark and material grade marking is visible, allowing easy comparison to the materials selected and documented in the Emerson/Fisher serial card provided with this product.

⚠ WARNING

Personal injury or damage to equipment could occur if improper stud and nut materials or parts are used. Do not operate or assemble this product with stud(s) and nut(s) that are not approved by Emerson/Fisher engineering and/or listed on the serial card provided with this product. Use of unapproved materials and parts could lead to stresses exceeding the design or code limits intended for this particular service. Install studs with the material grade and manufacturer's identification mark visible. Contact your Emerson Process Management sales office immediately if a discrepancy between actual parts and approved parts is suspected.

14. Lubricate the stud threads and the faces of the hex nuts (key 14) with anti-seize lubricant (not necessary if new factory prelubricated hex nuts are used). Replace the hex nuts and tighten them finger-tight. Stroke the valve several times to center the trim. Torque the nuts in a crisscross pattern to no more than 1/4 of the nominal torque value specified in table 8.

When all nuts are tightened to that torque value, increase the torque by 1/4 of the specified nominal torque and repeat the crisscross pattern. Repeat this procedure until all nuts are tightened to the specified nominal value. Apply the final torque value again and, if any nut still turns, tighten every nut again.

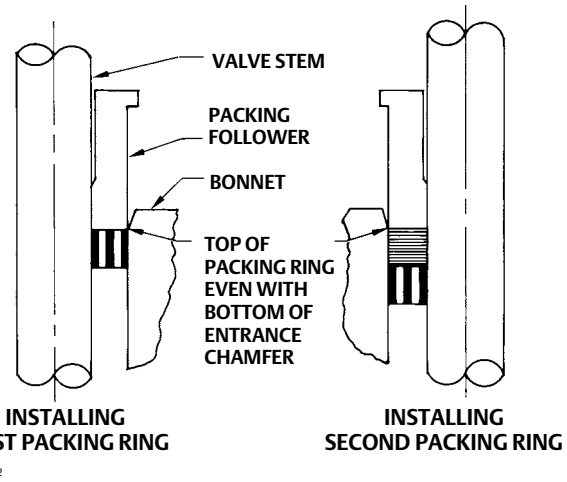
Note

When installing packing rings, prevent entrapping air between the rings. Add the rings one at a time without forcing them below the chamfer of the packing box entrance chamber. As each successive ring is added, the stack should not be pushed down more than the thickness of the added ring (figure 5).

15. Install new packing and the metal packing box parts according to the appropriate arrangement in figure 3. If desired, packing parts may be pre-lubricated with a silicon base grease for easier installation. Slip a smooth-edged pipe over the valve stem, and gently tamp each soft packing part into the packing box, being sure that air is not trapped between adjacent soft parts.
16. Slide the packing follower, wiper, and packing flange into position. Lubricate the packing flange studs (key 20) and the faces of the packing flange nuts (key 21). Replace the packing flange nuts.

For the spring-loaded PTFE V-ring packing shown in figure 3, tighten the packing flange nuts until the shoulder on the packing follower (key 28) contacts the bonnet.

Figure 5. Installing Graphite Ribbon/Filament Packing Rings One at a Time



For graphite packing, tighten the packing flange nuts to the maximum recommended torque shown in table 7. Then, loosen the packing flange nuts, and retighten them to the recommended minimum torque shown in table 7.

For other packing types, tighten the packing flange nuts alternately in small equal increments until one of the nuts reaches the minimum recommended torque shown in table 7. Then, tighten the remaining flange nuts until the packing flange is level and at a 90-degree angle to the valve stem.

For ENVIRO-SEAL or HIGH-SEAL live-loaded packing, refer to the note at the beginning of the Maintenance section.

17. Mount the actuator on the valve body assembly, and reconnect the actuator and valve plug stems according to the procedures in the appropriate actuator instruction manual.

Trim Removal

For C-seal construction, see the appropriate C-seal sections in this manual.

Key numbers referenced in this procedure are shown in figure 17, 18, or 19, except where indicated.

1. Remove the actuator and bonnet by following steps 1 through 6 of the replacing packing procedure. Observe all warnings and cautions.
2. Lift the valve stem and attached valve plug out of the valve body. If the valve plug is to be reused, tape or otherwise protect the valve plug stem and the valve plug seating surface to prevent scratches.
3. Lift out the cage (key 2) and the bonnet gasket (key 11). For an NPS 2 valve body with a Cavitrol III two stage cage, also remove the bonnet spacer and two gaskets.

Constructions other than TSO trim

1. Remove the seat ring (key 4) and the seat ring gasket (key 12).
2. Refer to the Valve Plug Maintenance procedure or to the Lapping Seats procedure.

TSO Trim

TSO trim: 0.8125 Inch Port Diameter (figure 7)

1. Remove the pin that locks the inner plug to the stem.
2. Using a strap wrench or similar tool, unscrew the outer plug from the inner plug. Do not damage the outer plug guide surfaces.
3. Remove the protected soft seat seal.
4. Inspect the parts for damage and replace if needed.
5. Refer to the Valve Plug Maintenance procedure or to the Lapping Seats procedure.

TSO trim: 1.6875 Inch Port Diameter (figure 8)

1. Remove the retainer, backup ring, anti-extrusion rings, and piston ring.
2. Remove the set screws that lock the outer plug to the stem.
3. Using a strap wrench or similar tool, unscrew the outer plug from the inner plug. Do not damage the outer plug guide surfaces.
4. Remove the protected soft seat seal.
5. Inspect the parts for damage and replace if needed.
6. Refer to the Valve Plug Maintenance procedure or to the Lapping Seats procedure.

TSO trim: 2.6875 Inch and Larger Port Diameters (figure 9)

1. Remove the retainer, backup ring, anti-extrusion rings, and piston ring.
2. Remove the set screws that lock the outer plug to the inner plug.
3. Using a strap wrench or similar tool, unscrew the outer plug from the inner plug. Do not damage the outer plug guide surfaces.
4. Remove the protected soft seat seal.
5. Inspect the parts for damage and replace if needed.
6. Refer to the Valve Plug Maintenance procedure or to the Lapping Seats procedure.

Valve Plug Maintenance

Key numbers used in this procedure are shown in figure 17, 18, or 19, except where indicated.

1. With the valve plug (key 5) removed according to the trim removal procedure, proceed as appropriate:

For HPD and HPAD valves, the piston rings (key 8) are each in at least two sections; remove the sections from the grooves in the valve plug.

For HPS and HPAS valves, proceed to step 2.

For HPT and HPAT valves, work the retaining ring (key 10) off the valve plug with a screwdriver. Carefully slide the backup ring and seal ring (keys 9 and 8) off the valve plug.

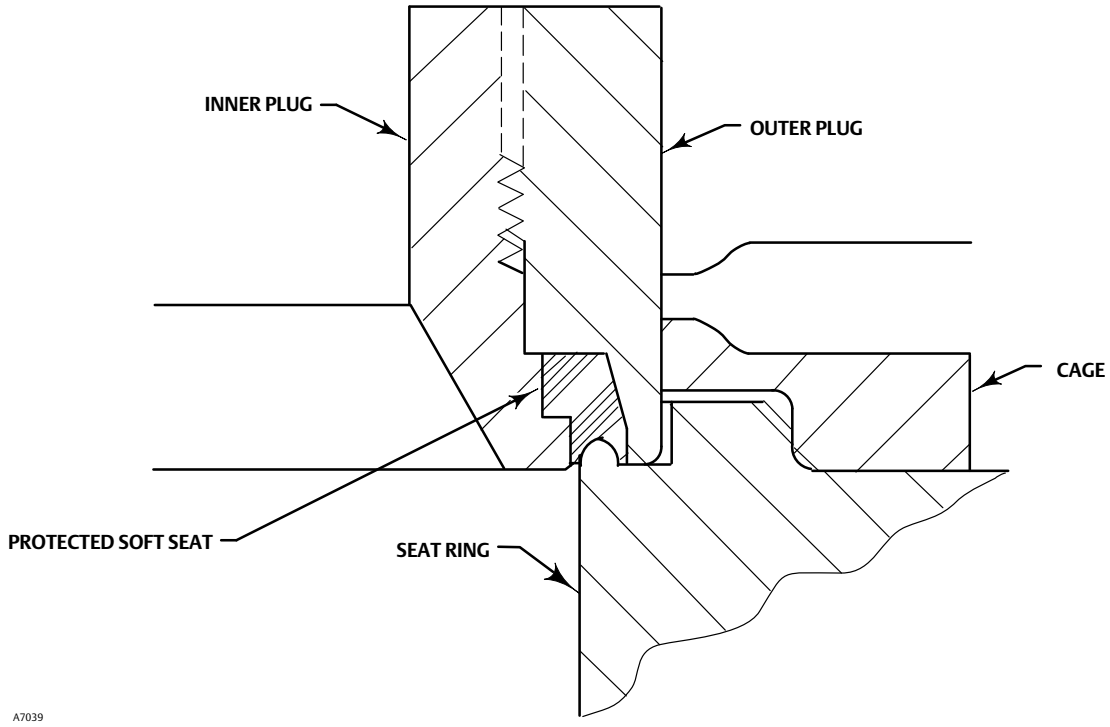
2. To replace the valve plug stem (key 6), drive out the pin (key 7), and unscrew the stem from the valve plug.

CAUTION

Never reuse an old stem with a new valve plug. Using an old stem with a new plug requires drilling a new pin hole in the stem. This weakens the stem and may cause the stem to fail in service. If a new valve plug is required, always order a valve plug, stem, and pin as an assembly. Specify the correct part number of each of the three parts, but state that the parts are being ordered as an assembly.

A used valve plug may be reused with a new stem.

Figure 6. Detail of Protected Soft Seat



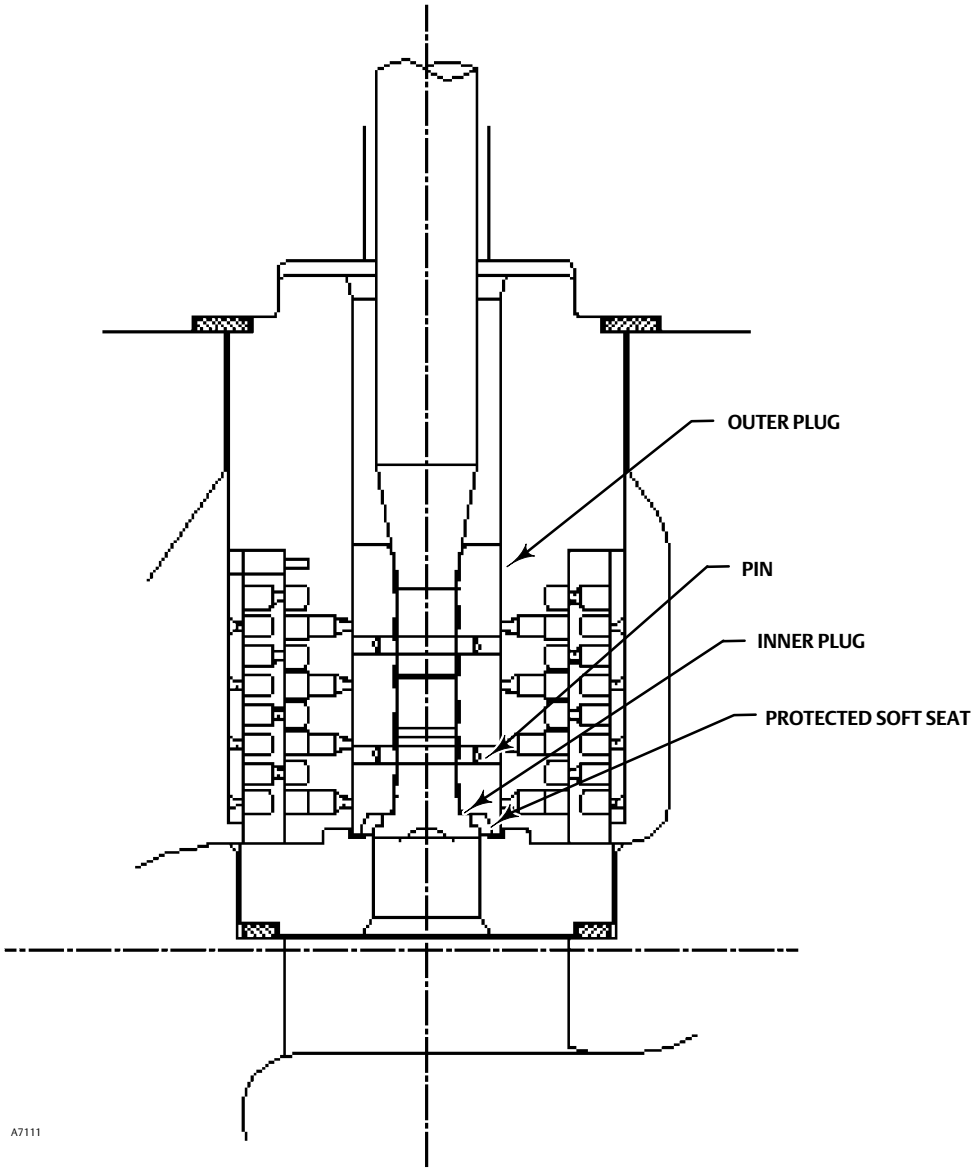
3. Thread the new stem into the valve plug and tighten it to the appropriate torque value given in table 9. Using the valve plug pin hole as a guide, drill the pin hole through the stem. Refer to table 9 for drill sizes.
4. Drive in the pin to lock the assembly.
5. If it is necessary to lap the seating surfaces, complete the lapping seats procedure before installing the HPD/HPAD piston rings or the HPT/HPAT seal ring. The Trim Replacement procedure provides piston ring and seal ring installation instructions and valve reassembly instructions.

Lapping Seats

Key numbers referenced in this procedure are shown in figure 17, 18, or 19, except where indicated.

A certain amount of leakage should be expected with metal-to-metal seating in any valve body. If the leakage becomes excessive, however, the condition of the seating surfaces of the valve plug and seat ring can be improved by lapping. (Deep nicks should be machined out rather than ground out.) Use a good quality lapping compound of a mixture of 280 to 600-grit. Apply the compound to the bottom of the valve plug.

Figure 7. Typical Unbalanced TSO Trim Assembly, Small Port Designs (0.8125 Inch Port Diameter)



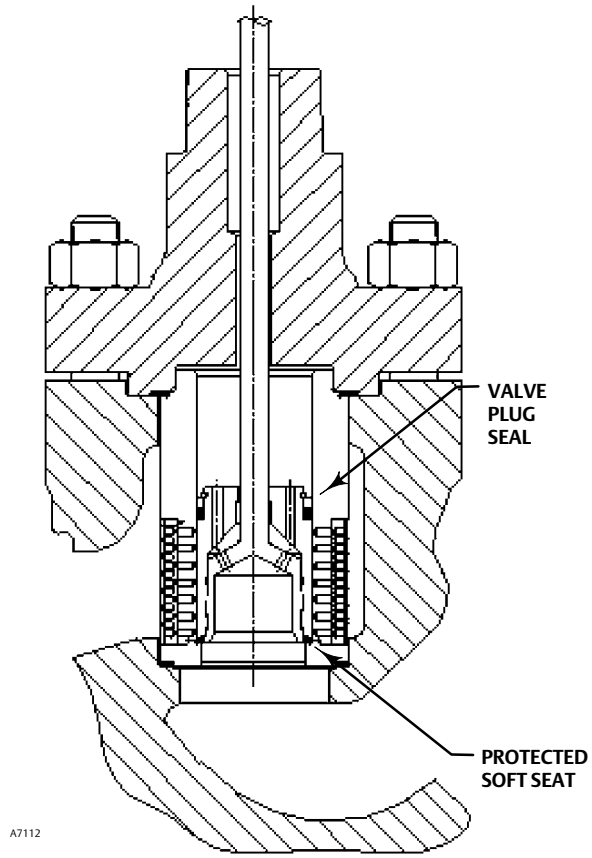
Note

HP Series valves use spiral-wound gaskets. These gaskets provide their seal by being crushed and therefore should never be reused. This includes reusing a gasket after the lapping procedure has been performed.

And "old" gasket can be used to lap the seat, however the gasket must be replaced with a new gasket.

To preserve the effects of lapping, do not change either the position of the seat ring in the valve body cavity or the position of the cage on the seat ring after lapping the seating surfaces. When the parts are removed for cleaning and replacement of the "old" gaskets, return them to the original positions.

Figure 8. Typical Balanced TSO Trim (1.6875 Inch Port Diameter)



Use the following procedure to lap the seating surfaces.

1. Install the following parts according to the instructions presented in the trim replacement procedure: "old" seat ring gasket (key 12), seat ring (key 4), cage (key 2), and "old" bonnet gasket(key 11).
2. Proceed as appropriate:

For an HPD, HPAD, HPT, or HPAT valve, install the valve plug and stem assembly (keys 5 and 6)--without piston rings or seal ring (key 8) --into the cage.

For an HPS or HPAS valve, install the valve plug and stem assembly (keys 5 and 6) into the cage.

3. Install the bonnet (key 18) over the valve stem, and secure the bonnet with four of the hex nuts (key 14).

Figure 9. Typical Balanced TSO Trim, Large Port Designs (2.6875 Inch and Larger Port Diameters)

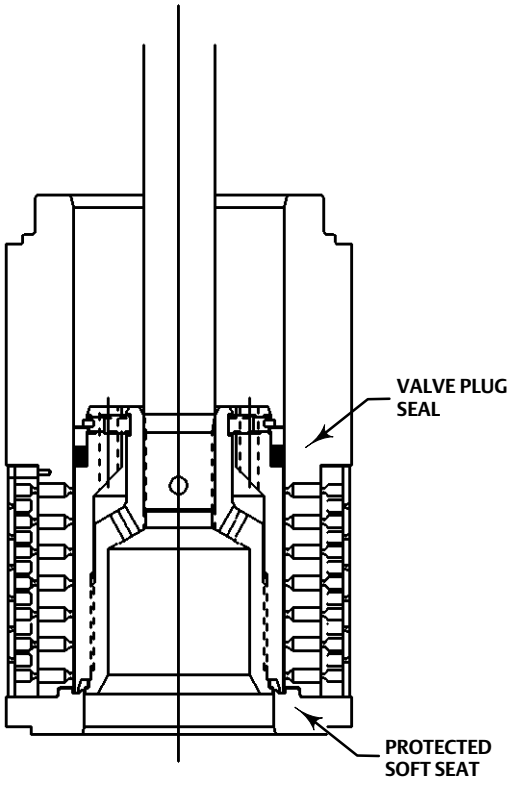


Table 10. Actuator Groups by Type Number

Group 1 71 & 90 mm (2-13/16 & 3-9/16 Inch) Yoke Boss	Group 100 127 mm (5-Inch) Yoke Boss
472 & 473 585C 1B 644 & 645 655 657 & 667 685SE & 685SR 1008	472 473 474 476 585C 657
	Group 101 127 mm (5-Inch) Yoke Boss
	667

4. Attach a handle, such as a piece of strap iron secured by stem locknuts, to the valve stem. Rotate the handle alternately in each direction to lap the seats.
5. After lapping, disassemble as necessary (you may mark the position of the seat ring and cage with a soft tip marker). Clean the seating surfaces, replace the gaskets, reassemble (taking care to return the seat ring and cage to their original positions), and test for shutoff. Repeat the lapping procedure if necessary.

Trim Replacement

⚠ WARNING

Observe the warning at the start of the Maintenance section.

After all trim maintenance has been completed, reassemble the valve body by following the numbered steps below. Be certain that all gasketed surfaces have been well cleaned. Key numbers referenced in this procedure are shown in figure 17, 18, or 19, except where indicated.

CAUTION

Inspect the seat ring, cage, bonnet, and body gasket surfaces. These surfaces must be in good condition, with all foreign material removed. Small burrs less than approximately 0.076 mm (0.003 inches) in height (the thickness of a human hair) can be ignored. Scratches or burrs that run across the serrations are not permitted under any conditions, since they will prevent the gaskets from sealing properly.

CAUTION

The pressure balancing holes in the valve plug are necessary for the proper and safe operation of the valve. Inspect the balancing holes every time the valve is disassembled for service. Any build-up, blockage, or clogging of the balance holes should be removed.

1. Install the seat ring gasket (key 12) into the valve body. Install the seat ring (key 4).
2. Install the cage.

Note

When installing the standard cage, align two of the holes in the cage with the centerline of the valve body. Refer to figure 18.

Constructions other than TSO trim

1. To install the piston rings and seal rings (key 8), proceed as appropriate:

For an HPD or HPAD valve, if it is necessary to install new piston rings, the replacement piston rings will arrive in one piece. Use a vise with smooth or taped jaws to break a replacement piston ring into halves. Place the new ring in the vise so that the jaws compress the ring into an oval. Compress the ring slowly until the ring snaps on both sides. If one side snaps first, do not try to tear or cut the other side. Instead, keep compressing until the other side snaps. The piston ring can also be fractured by scoring and snapping over a hard surface such as a table edge. Sawing or cutting is not recommended.

Remove any protective tape or covering from the valve plug and stem assembly, and set it on a protective surface. Then, place the piston rings in the piston ring grooves with the fractured ends matched.

For an HPT or HPAT valve, install the seal ring (key 8) onto the valve plug (key 5). Install the ring with the open side facing the seat ring end of the valve plug for flow-down applications (view A of figure 20) or with the open side facing

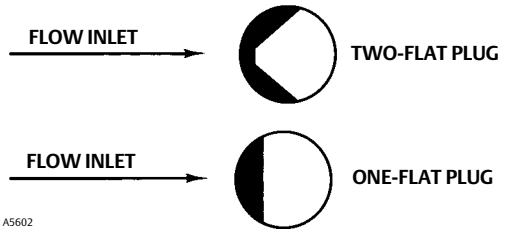
the valve plug stem end of the valve plug for flow-up applications (view B of figure 20). Slide the backup ring (key 9) onto the valve plug. Secure with the retaining ring (key 10).

For an HPAS Micro-Flat valve, ensure the Micro-Flat valve plug and stem assembly is oriented as shown in figure 10 when replacing the bonnet on the valve body. Then slide the bonnet over the stem and onto the stud bolts.

CAUTION

Micro-flat plugs must be installed as shown in figures 10 and18. This proper plug orientation increases the guide support area for the plug and stem.

Figure 10. Micro-Flat Valve Plug Orientation



2. Install the valve plug into the cage.

TSO Trim

TSO trim: 0.8125 Inch Port Diameter (figure 7)

1. Thread the outer plug onto the inner plug until the parts seat metal to metal, using a strap wrench or similar tool that will not damage the outer plug guide surfaces.
2. Mark the inner plug and outer plug with alignment marks in the assembled position.
3. Disassemble the outer plug from the inner plug and install the seal over the inner plug, so that the seal rests below the threaded area.
4. Thread the outer plug onto the inner plug and tighten with a strap wrench or similar tool until the alignment marks line up. This will ensure that the plug parts are metal to metal and the seal is compressed properly. Do not damage the outer plug guide surfaces.
5. Drill through the inner plug with the proper size drill bit (same size as stem pinning) and install the pin.

TSO trim: 1.6875 Inch Port Diameter (figure 8)

1. Thread the outer plug onto the inner plug until the parts seat metal to metal, using a strap wrench or similar tool that will not damage the outer plug guide surfaces.
2. Mark the top of the outer plug and stem with alignment marks in the assembled position.
3. Disassemble the outer plug from the inner plug and install the seal over the inner plug, so that the seal rests below the threaded area.
4. Thread the outer plug onto the inner plug and tighten with a strap wrench or similar tool until the alignment marks line up. This will ensure that the plug parts are metal to metal and the seal is compressed properly. Do not damage the outer plug guide surfaces.
5. Install set screws centering the stem in the outer plug and torque to 11 N•m (8 lbf•ft).
6. Assemble the piston ring, anti-extrusion rings, backup ring, and retainer.

TSO trim: 2.6875 Inch and Larger Port Diameters (figure 9)

1. Thread the outer plug onto the inner plug until the parts seat metal to metal, using a strap wrench or similar tool that will not damage the outer plug guide surfaces.

2. Mark the top of the inner plug and outer plug with alignment marks in the assembled position.
3. Disassemble the outer plug from the inner plug and install the seal over the inner plug, so that the seal rests below the threaded area.
4. Thread the outer plug onto the inner plug and tighten with a strap wrench or similar tool until the alignment marks line up. This will ensure that the plug parts are metal to metal and the seal is compressed properly. Do not damage the outer plug guide surfaces.
5. Install set screws centering the inner plug in the outer plug and torque to 11 N•m (8 lbf•ft).
6. Assemble the piston ring, anti-extrusion rings, backup ring, and retainer.

All Constructions

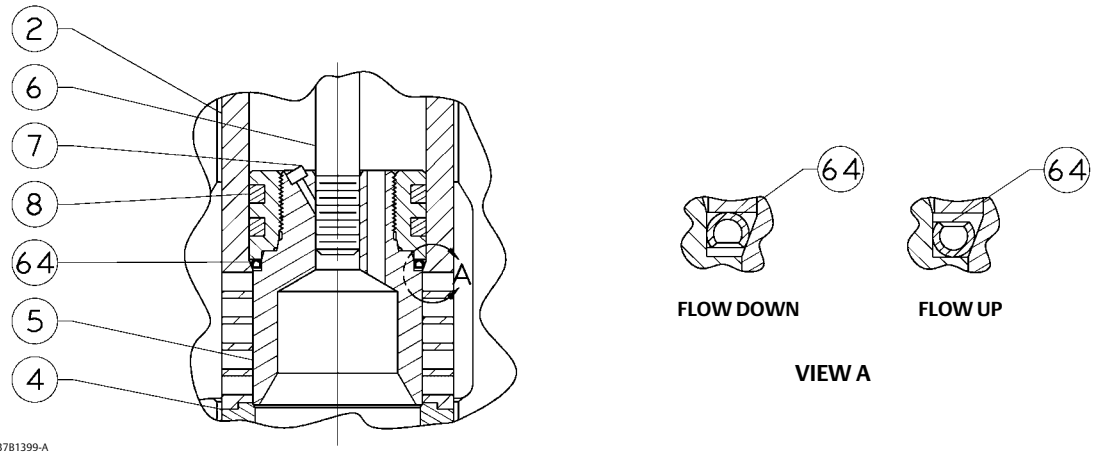
1. Install the bonnet gasket (key 11) on the cage.
2. Install the bonnet over the valve stem and onto the valve body.

Note

The prelubricated hex nuts (key 14) referred to in step 3 can be identified by a black film coating on the nut threads.

The proper bolting procedures in step 3 include--but are not limited to--ensuring that the bonnet stud threads are clean, and that the hex nuts are evenly tightened to the specified torque values.

Figure 11. HPD with C-seal Trim



CAUTION

Failure to comply with good bonnet-to-body bolting practices and the torque values shown in table 8 may result in damage to the valve. Cheater bars or slug wrenches should not be used for this procedure.

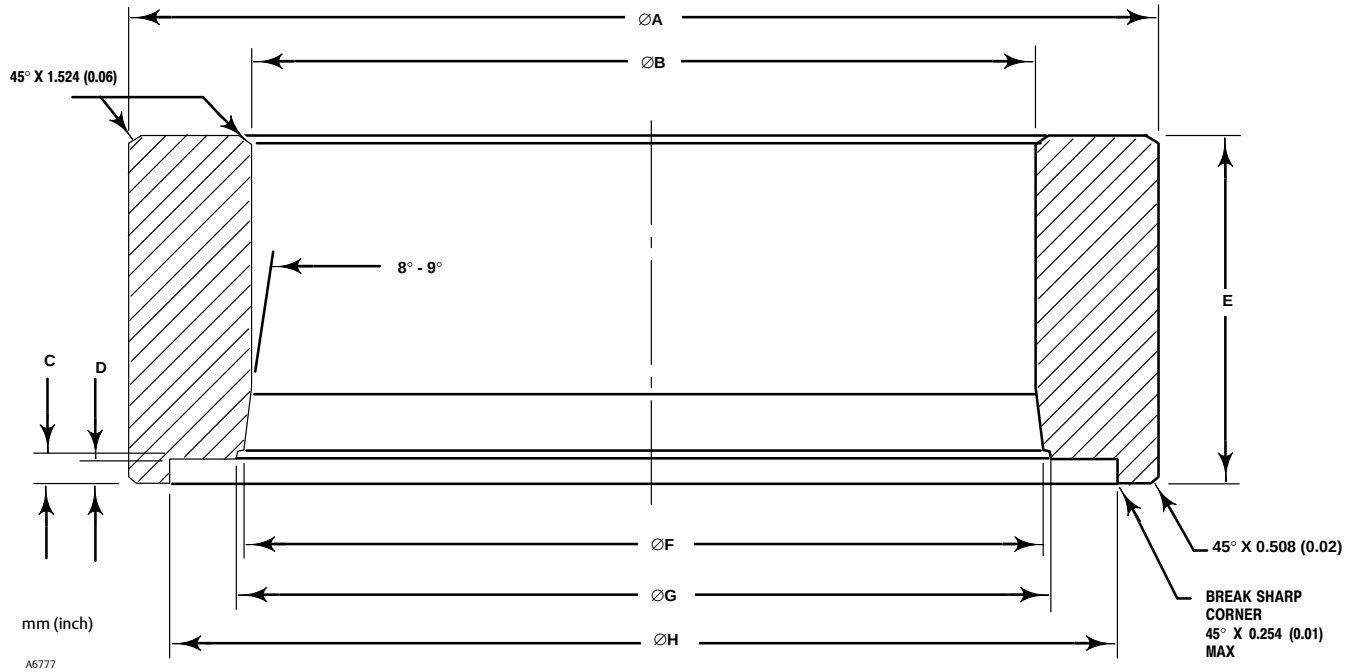
Hot torquing is not recommended.

Note

Stud(s) and nut(s) should be installed such that the manufacturer's trademark and material grade marking is visible, allowing easy comparison to the materials selected and documented in the Emerson/Fisher serial card provided with this product.

FOR VALVE PLUGS FITTING PORT SIZE (Inches)	DIMENSIONS, mm (See Drawing Below)								Part Number (To Order A Tool)
	A	B	C	D	E	F	G	H	
2.875	82.55	52.324 - 52.578	4.978 - 5.029	3.708 - 3.759	41.148	52.680 - 52.781	55.118 - 55.626	70.891 - 71.044	24B9816X012
3.4375	101.6	58.674 - 58.928	4.978 - 5.029	3.708 - 3.759	50.8	61.011 - 61.112	63.449 - 63.957	85.166 - 85.319	24B5612X012
3.625	104.394	65.024 - 65.278	4.978 - 5.029	3.708 - 3.759	50.8	68.936 - 69.037	71.374 - 71.882	89.941 - 90.094	24B3630X012
4.375	125.984	83.439 - 83.693	4.978 - 5.029	3.708 - 3.759	50.8	87.351 - 87.452	89.789 - 90.297	108.991 - 109.144	24B3635X012
5.375	142.748	100.076 - 100.33	4.978 - 5.029	3.708 - 3.759	45.974	103.835 - 103.937	106.274 - 106.782	128.219 - 128.372	23B9193X012
FOR VALVE PLUGS FITTING PORT SIZE (Inches)	**Dimensions, Inches (See Drawing Below)**								**Part Number (To Order A Tool)**
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	
2.875	3.25	2.060 - 2.070	0.196 - 0.198	0.146 - 0.148	1.62	2.074 - 2.078	2.170 - 2.190	2.791 - 2.797	24B9816X012
3.4375	4.00	2.310 - 2.320	0.196 - 0.198	0.146 - 0.148	2.00	2.402 - 2.406	2.498 - 2.518	3.353 - 3.359	24B5612X012
3.625	4.11	2.560 - 2.570	0.196 - 0.198	0.146 - 0.148	2.00	2.714 - 2.718	2.810 - 2.830	3.541 - 3.547	24B3630X012
4.375	4.96	3.285 - 3.295	0.196 - 0.198	0.146 - 0.148	2.00	3.439 - 3.443	3.535 - 3.555	4.291 - 4.297	24B3635X012
5.375	5.62	3.940 - 3.950	0.196 - 0.198	0.146 - 0.148	1.81	4.088 - 4.092	4.184 - 4.204	5.048 - 5.054	23B9193X012

Figure 12. C-seal Plug Seal Installation Tool



⚠ WARNING

Personal injury or damage to equipment could occur if improper stud and nut materials or parts are used. Do not operate or assemble this product with stud(s) and nut(s) that are not approved by Emerson/Fisher engineering and/or listed on the serial card provided with this product. Use of unapproved materials and parts could lead to stresses exceeding the design or code limits intended for this particular service. Install studs with the material grade and manufacturer's identification mark visible. Contact your Emerson Process Management sales office immediately if a discrepancy between actual parts and approved parts is suspected.

3. Lubricate the stud threads and the faces of the hex nuts (key 14) with anti-seize lubricant (not necessary if new factory prelubricated hex nuts are used). Replace the hex nuts, but do not tighten them. Torque the nuts in a crisscross pattern to no more than 1/4 of the nominal torque value specified in table 8. When all nuts are tightened to that torque value, increase the torque by 1/4 of the specified nominal torque and repeat the crisscross pattern. Repeat this procedure until all nuts are tightened to the specified nominal value. Apply the final torque value again and, if any nut still turns, tighten every nut again.
4. Install new packing and packing box parts per steps 15 and 16 of the Replacing Packing procedure. Be certain to observe the note given prior to step 15 of that procedure.
5. Mount the actuator by following the procedures in the actuator instruction manual. Check for packing leakage as the valve is being put into service. Retorque the packing flange nuts as required (see table 7).

Retrofit: Installing C-seal Trim

Note

Additional actuator thrust is required for a valve with C-seal trim. When installing C-seal trim in an existing valve, contact your Emerson Process Management sales office for assistance in determining new actuator thrust requirements.

Assemble the new valve plug/retainer assembly (with C-seal plug seal) using the following instructions:

CAUTION

To avoid leakage when the valve is returned to service, use appropriate methods and materials to protect all sealing surfaces of the new trim parts while assembling the individual parts and during installation in the valve body.

1. Apply a suitable high-temperature lubricant to the inside diameter of the C-seal plug seal. Also, lubricate the outside diameter of the valve plug where the C-seal plug seal must be pressed into the proper sealing position (figure 11).
2. Orient the C-seal plug seal for correct sealing action based on the process fluid flow direction through the valve.

- The open interior of the C-seal plug seal must face up in a valve with flow-up construction (figure 11).
- The open interior of the C-seal plug seal must face down in a valve with flow-down construction (figure 11).

Note

An installation tool must be used to properly position the C-seal plug seal on the valve plug. A tool is available as a Fisher spare part or a tool could be manufactured following the dimensions given in figure 12.

3. Place the C-seal plug seal over the top of the valve plug and press the C-seal plug seal onto the plug using the C-seal installation tool. Carefully press the C-seal plug seal onto the plug until the installation tool contacts the horizontal reference surface of the valve plug (figure 13).
4. Apply a suitable high-temperature lubricant to the threads on the plug. Then, place the C-seal retainer onto the plug and tighten the retainer using an appropriate tool such as a strap wrench.
5. Using an appropriate tool such as a center punch, stake the threads on top of the plug in one place (figure 14) to secure the C-seal retainer.
6. Install the new plug/retainer assembly with C-seal plug seal on the new stem following the appropriate instructions in the Trim Replacement section in this manual.
7. Install piston rings by following instructions in the Trim Replacement section in this manual.
8. Remove the existing valve actuator and bonnet following the appropriate instructions in the Replacing Packing section in this manual.

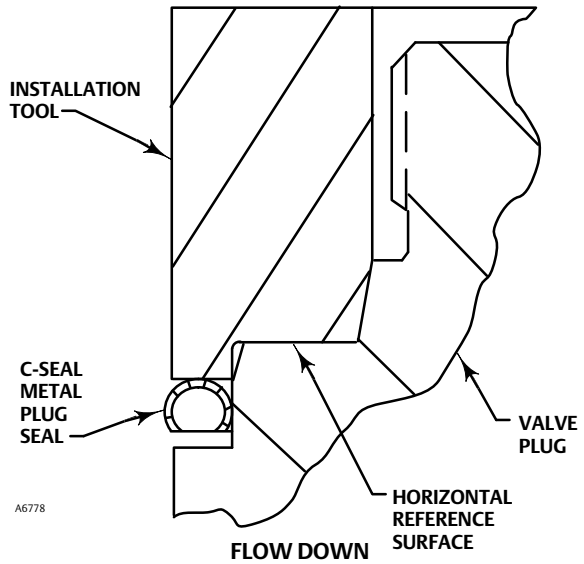
CAUTION

Do not remove the existing valve stem from the valve plug unless you are planning to replace the valve stem.

Never reuse an old valve stem with a new plug or reinstall a valve stem after it has been removed. Replacing a valve stem requires drilling a new pin hole in the stem. This drilling weakens the stem and may cause failure in service. However, a used valve plug may be reused with a new valve stem.

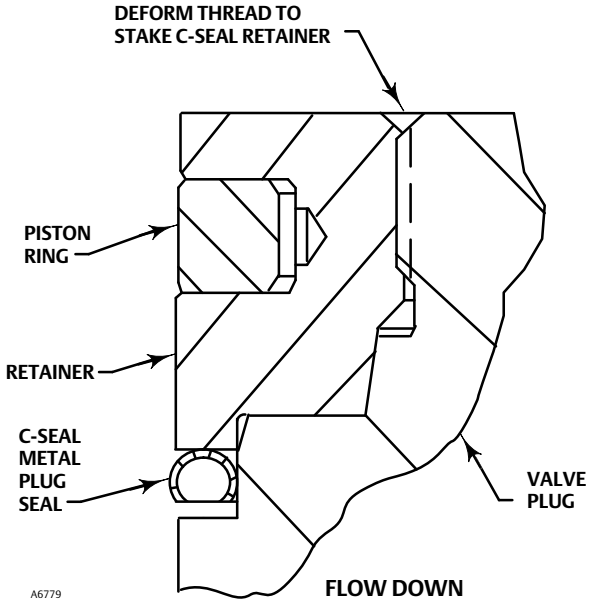
9. Remove the existing valve stem and plug, cage, and seat ring from the valve body following the appropriate instructions in the Trim Removal section in this manual.
10. Replace all gaskets according to appropriate instructions in the Trim Replacement section in this manual.
11. Install the new seat ring, cage, valve plug/retainer assembly, and stem into the valve body and completely reassemble the valve package following the appropriate instructions in the Trim Replacement section in this manual.

Figure 13. Installing the C-seal Plug Seal Using the Installation Tool



NOTE: PRESS THE INSTALLATION TOOL OVER THE VALVE PLUG UNTIL THE TOOL CONTACTS THE HORIZONTAL REFERENCE SURFACE OF THE VALVE PLUG.

Figure 14. Stake the Threads of the C-seal Retainer



CAUTION

To avoid excessive leakage and seat erosion, the valve plug must be initially seated with sufficient force to overcome the resistance of the C-seal plug seal and contact the seat ring. You can correctly seat the valve plug by using the same force calculated for full load when sizing your actuator. With no pressure drop through the valve, this force will adequately drive the valve plug to the seat ring, thus giving the C-seal plug seal a predetermined permanent set. Once this is done, the plug/retainer assembly, the cage, and the seat ring become a matched set.

With full actuator force applied and the valve plug fully seated, align the actuator travel indicator scale with the lower end of valve travel. Refer to the appropriate actuator instruction manual for information on this procedure.

Replacement of Installed C-seal Trim

Trim Removal (C-seal Constructions)

1. Remove the valve actuator and bonnet following the appropriate instructions in the Replacing Packing section in this manual.

CAUTION

To avoid leakage when the valve is returned to service, use appropriate methods and materials to protect all sealing surfaces of the trim parts during maintenance.

Use caution when removing piston ring(s) and C-seal plug seal to avoid scratching any sealing surface.

CAUTION

Do not remove the valve stem from the plug/retainer assembly unless you are planning to replace the valve stem.

Never reuse an old valve stem with a new plug or reinstall a valve stem after it has been removed. Replacing a valve stem requires drilling a new pin hole in the stem. This drilling weakens the stem and may cause failure in service. However, a used valve plug may be reused with a new valve stem.

2. Remove the plug/retainer assembly (with C-seal plug seal), cage, and seat ring from the valve body following the appropriate instructions in the Trim Removal section in this manual.
3. Locate the staked thread on top of the valve plug (figure 14). The staked thread secures the retainer. Use a drill with a 1/8 inch bit to drill out the staked area of the thread. Drill approximately 1/8-inch into the metal to remove the staking.
4. Locate the break between sections of the piston ring(s). Using an appropriate tool such as a flat-blade screwdriver, carefully pry out the piston ring(s) from the groove(s) in the C-seal retainer.
5. After removing the piston ring(s), locate the 1/4-inch diameter hole in the groove. In a retainer with two piston ring grooves, the hole will be found in the upper groove.
6. Select an appropriate tool such as a punch and place the tip of the tool into the hole with the body of the tool held tangent to the outside diameter of the retainer. Strike the tool with a hammer to rotate the retainer and free it from the valve plug. Remove the retainer from the plug.
7. Use an appropriate tool such as a flat-blade screwdriver to pry the C-seal plug seal off the plug. Use caution to avoid scratches or other damage to the sealing surfaces where the C-seal plug seal makes contact with the valve plug (figure 15).
8. Inspect the lower seating surface where the valve plug contacts the seat ring for wear or damage which would prevent proper operation of the valve. Also, inspect the upper seating surface inside the cage where the C-seal plug seal contacts the cage, and inspect the sealing surface where the C-seal plug seal makes contact with the plug (figure 15).
9. Replace or repair trim parts according to the following procedure for Lapping Metal Seats, Remachining Metal Seats, or other valve plug maintenance procedures as appropriate.

Lapping Metal Seats (C-seal Constructions)

Before installing a new C-seal plug seal, lap the lower seating surface (valve plug to seat ring, figure 15) following appropriate procedures in the Lapping Seats section in this manual.

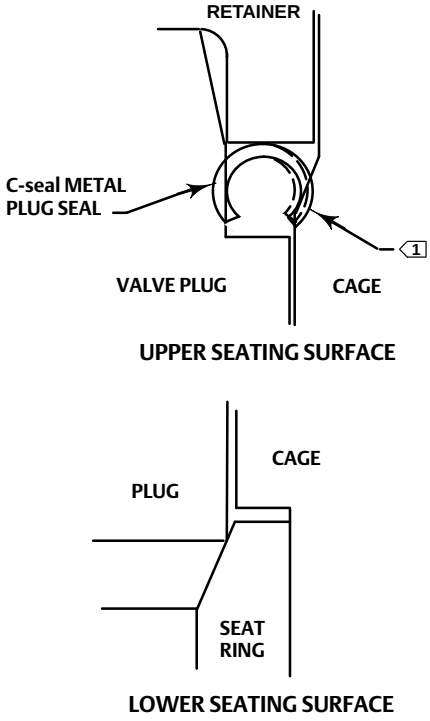
Remachining Metal Seats (C-seal Constructions)

See figure 16. A valve plug with a C-seal metal plug seal features two seating surfaces. One seating surface is found where the valve plug contacts the seat ring. The second seating surface is found where the C-seal plug seal contacts the upper seating surface in the cage. If you machine the seats on the seat ring and/or plug, you must machine an equal dimension from the seating area in the cage.

CAUTION

If metal is removed from the seat ring and plug and a corresponding amount is not removed from the cage seating area, the C-seal plug seal will be crushed as the valve closes and the C-seal retainer will strike the seating area of the cage, preventing the valve from closing.

Figure 15. Lower (Valve Plug to Seat Ring) and Upper (C-seal Plug Seal to Cage) Seating Surfaces



NOTE:
1 UPPER SEATING SURFACE IS THE AREA OF CONTACT BETWEEN THE C-seal METAL PLUG SEAL AND THE CAGE.

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Trim Replacement (C-seal Constructions)

1. Apply a suitable high-temperature lubricant to the inside diameter of the C-seal plug seal. Also, lubricate the outside diameter of the valve plug where the C-seal plug seal must be pressed into the proper sealing position (figure 11).
2. Orient the C-seal plug seal for correct sealing action based on the process fluid flow direction through the valve.

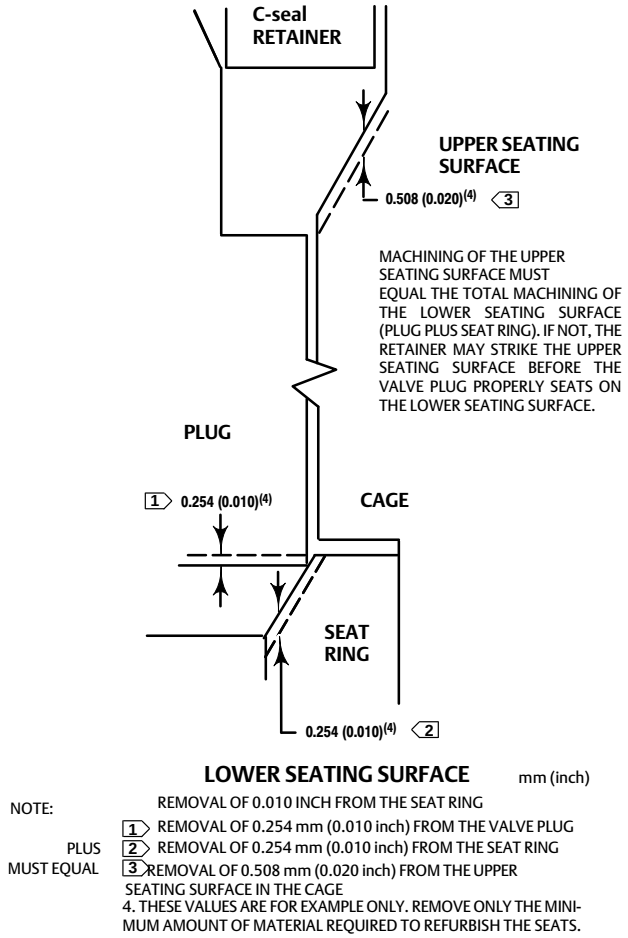
- The open interior of the C-seal plug seal must face up in a valve with flow-up construction (figure 11).
- The open interior of the C-seal plug seal must face down in a valve with flow-down construction (figure 11).

Note

An installation tool must be used to properly position the C-seal plug seal on the valve plug. A tool is available as a Fisher spare part or a tool could be manufactured following the dimensions given in figure 12.

3. Place the C-seal plug seal over the top of the valve plug and press it onto the plug using the installation tool. Carefully press the C-seal plug seal onto the plug until the installation tool contacts the horizontal reference surface of the valve plug (figure 13).
4. Apply a suitable high-temperature lubricant to the threads on the plug. Then, place the C-seal retainer onto the plug and tighten the retainer using an appropriate tool such as a strap wrench.

Figure 16. Example of Machining the Lower (Valve Plug to Seat Ring) and Upper (C-seal Plug Seal to Cage) Seating Surfaces



5. Using an appropriate tool such as a center punch, stake the threads on top of the plug in one place (figure 14) to secure the C-seal retainer.
6. Replace the piston rings following instructions in the Trim Replacement section in this manual.
7. Return the seat ring, cage, plug/retainer assembly, and stem to the valve body and completely reassemble the valve package following the appropriate instructions in the Trim Replacement section in this manual.

CAUTION

To avoid excessive leakage and seat erosion, the valve plug must be initially seated with sufficient force to overcome the resistance of the C-seal plug seal and contact the seat ring. You can correctly seat the valve plug by using the same force calculated for full load when sizing your actuator. With no pressure drop through the valve, this force will adequately drive the valve plug to the seat ring, thus giving the C-seal plug seal a predetermined permanent set. Once this is done, the plug/retainer assembly, the cage, and the seat ring become a matched set.

With full actuator force applied and the valve plug fully seated, align the actuator travel indicator scale with the lower end of valve travel. Refer to the appropriate actuator instruction manual for information on this procedure.

Parts Ordering

Each body-bonnet assembly is assigned a serial number, which can be found on the valve body. This same number also appears on the actuator nameplate when the valve body is shipped from the factory as part of a control valve assembly. Refer to the number when contacting your Emerson Process Management sales office for technical assistance or when ordering replacement parts.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management should not, under any circumstances, be used in any Fisher valve, because they may void your warranty, might adversely affect the performance of the valve, and could cause personal injury and property damage.

Parts Kits

Standard Packing Kits (Non Live-Loaded)

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)	25.4 (1) 127 (5)	31.8 (1-1/4) 127 (5, 5H)
PTFE (Contains keys 22, 24, 25, 26, 27)	RPACKX00022	RPACKX00032	RPACKX00342	RPACKX00352
Double PTFE (Contains keys 22, 24, 26, 27)	RPACKX00052	RPACKX00062	RPACKX00362	RPACKX00372
Single Graphite Ribbon/Filament (Contains keys 23 [ribbon ring], 23 [filament ring], 24, and 26)	RPACKX00112	RPACKX00122	---	---
Single Graphite Ribbon/Filament (Contains keys 23 [ribbon ring], 23 [filament ring], and 26)	---	---	RPACKX00532	RPACKX00542
Single Graphite Ribbon/Filament (Contains keys 23 [ribbon ring], 23 [filament ring])	RPACKX00142	RPACKX00152	---	---

Repair Kits (ENVIRO-SEAL)

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)	25.4 (1) 127 (5)	31.8 (1-1/4) 127 (5, 5H)
Double PTFE (Contains keys 214, 215, 218)	RPACKX00202	RPACKX00212	RPACKX00222	RPACKX00232
Graphite ULF (Contains keys 207, 208, 209, 210, 214)	RPACKX00602	RPACKX00612	RPACKX00622	RPACKX00632
Duplex (Contains keys 207, 209, 214, 215)	RPACKX00302	RPACKX00312	RPACKX00322	RPACKX00332

Retrofit Kits (ENVIRO-SEAL)

Stem Diameter, mm (Inches) Yoke Boss Diameter, mm (Inches)	12.7 (1/2) 71 (2-13/16)	19.1 (3/4) 90 (3-9/16)	25.4 (1) 127 (5)	31.8 (1-1/4) 127 (5, 5H)
Double PTFE (Contains keys 200, 201, 211, 212, 214, 215, 216, 217, 218, tag, cable tie)	RPACKXRT022	RPACKXRT032	RPACKXRT042	RPACKXRT052
Graphite ULF (Contains keys 200, 201, 207, 208, 209, 210, 211, 212, 214, 217, tag, cable tie)	RPACKXRT272	RPACKXRT282	RPACKXRT292	RPACKXRT302
Duplex (Contains keys 200, 201, 207, 209, 211, 212, 214, 215, 216, 217, tag, cable tie)	RPACKXRT222	RPACKXRT232	RPACKXRT242	RPACKXRT252

Gasket Set* (Includes Key 11 Bonnet Gasket and Key 12 Seat Ring Gasket)(1)

VALVE RATING	VALVE STYLE AND SIZE, NPS		MATERIAL	
	HP Globe	HPA Angle	N06600/Graphite	N07750/Graphite
CL1500 Globe and Angle Valves	1 (std)	1 (std)	12B7100X012	12B7100X022
	2 (std)	2 (std) and 3 (std)	12B7100X032	12B7100X042
	2 (Cavitrol III, 2-Stage)	2 (Cavitrol III, 2-Stage)	12B7100X072	---
	3 (std)	4 (std)	12B7100X052	12B7100X062
	4 (std)	6 (std)	12B7100X082	---
	6 (std)	8 (std)	12B7100X112	---
CL2500 Globe and Angle Valves	1 (std)	1 (std)	12B7100X152	12B7100X122
	2 (std)	2 (std)	12B7100X162	12B7100X132
	2 (Cavitrol III, 2-Stage)	2 (Cavitrol III, 2-Stage)	12B7100X172	12B7100X142

1. Gaskets should always be replaced as sets, not separately.

Figure 17. NPS 1 HPS Valve

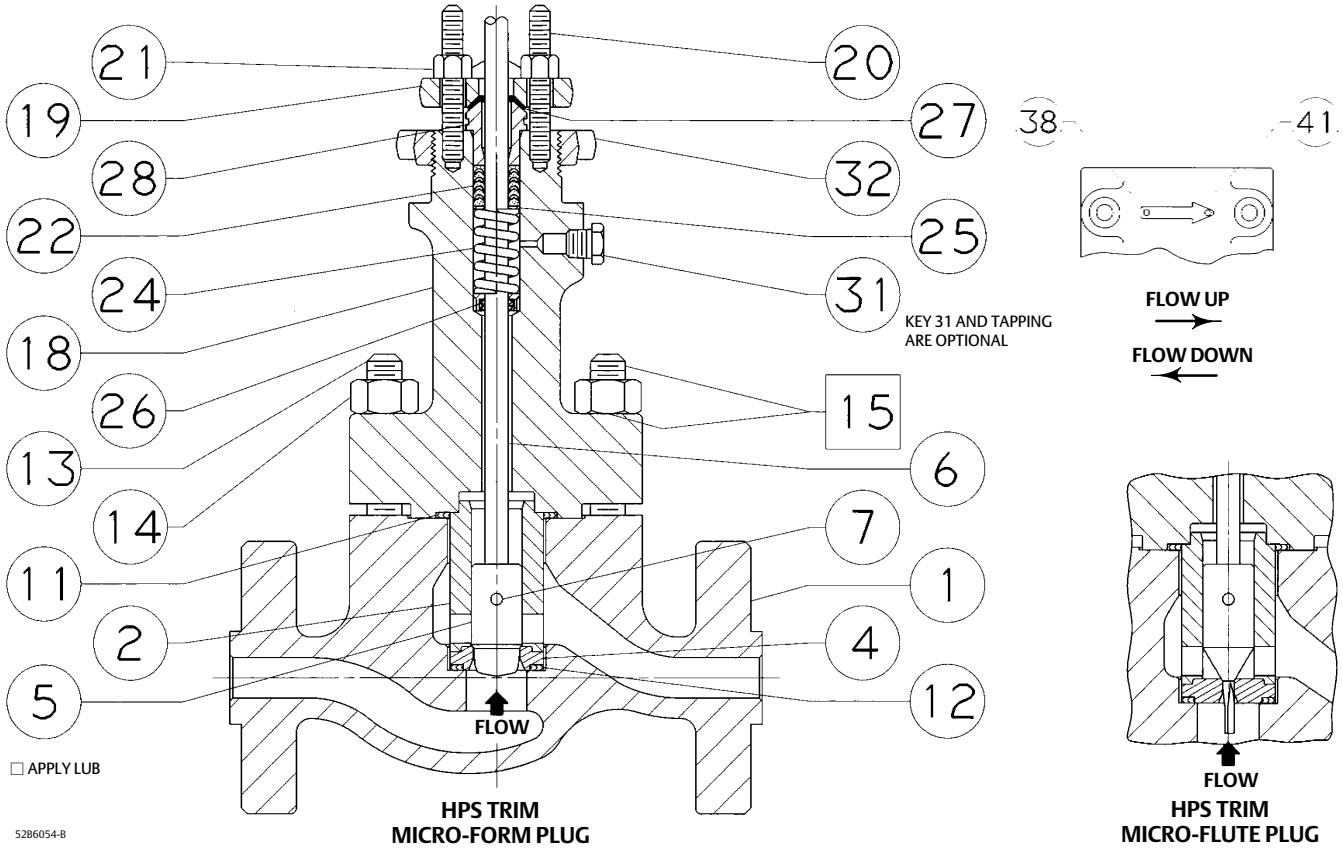


Figure 18. NPS 2 HPAD Valve

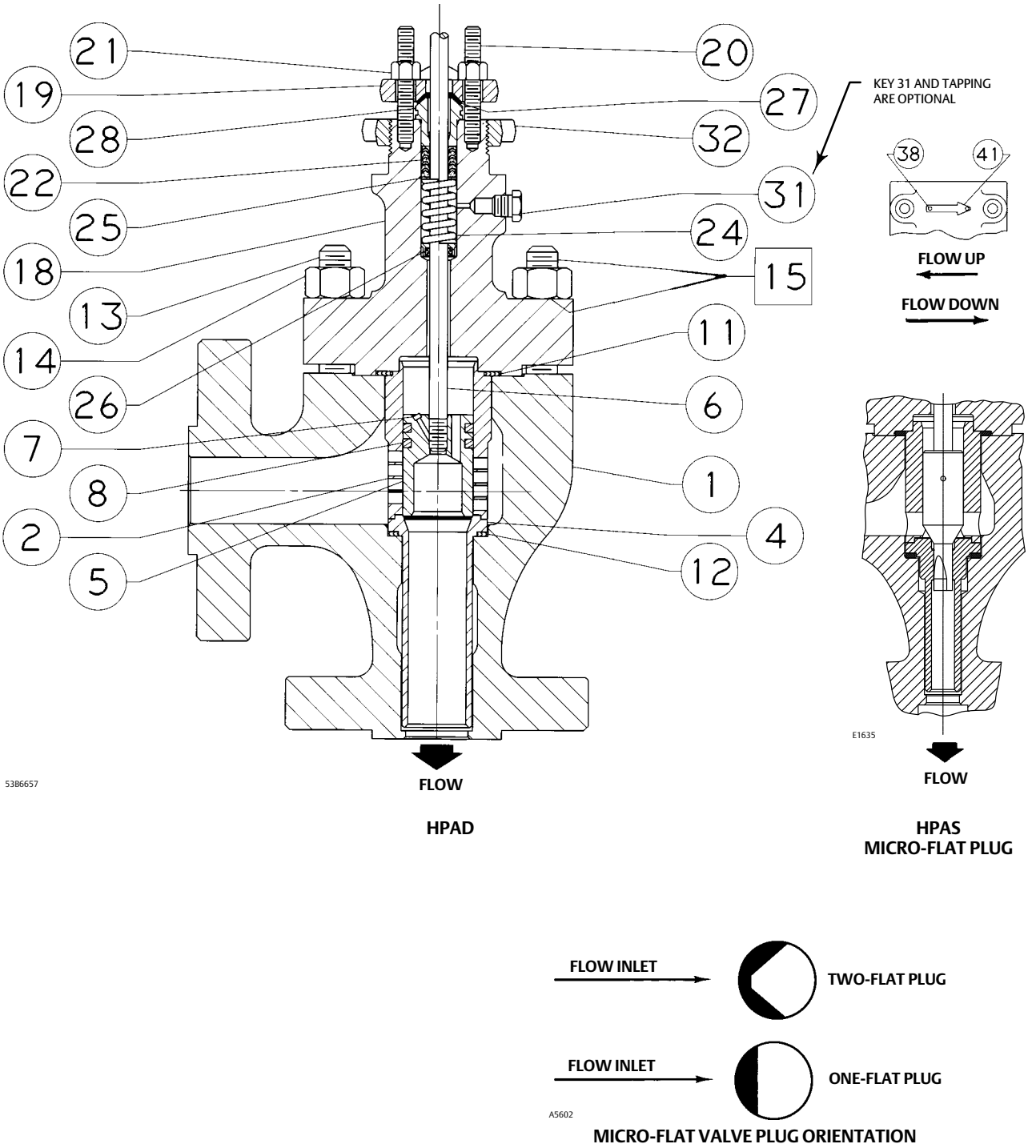


Figure 19. NPS 2-6 HPD Valve

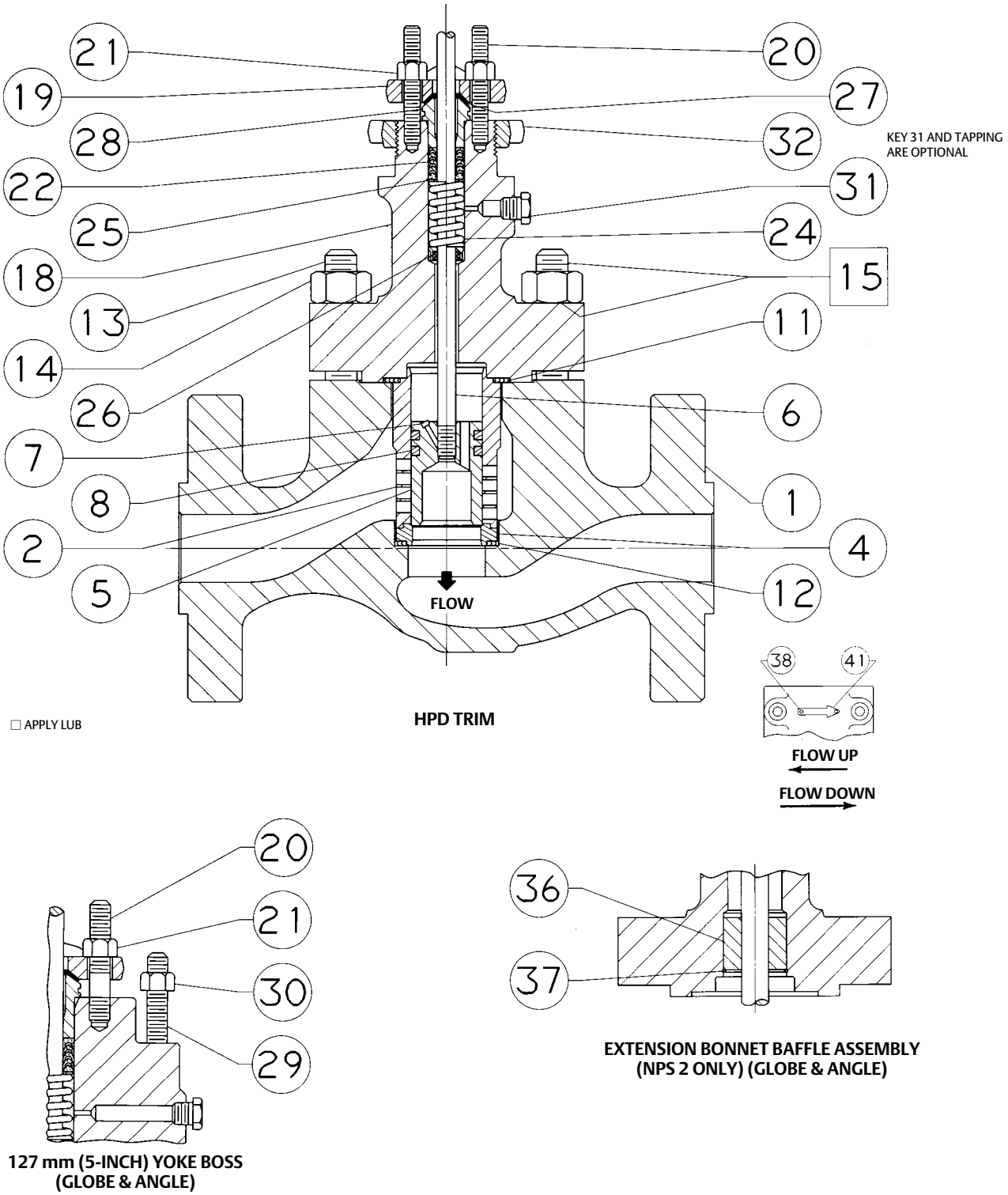


Figure 20. NPS 2-6 HP Valve - Alternate Configurations

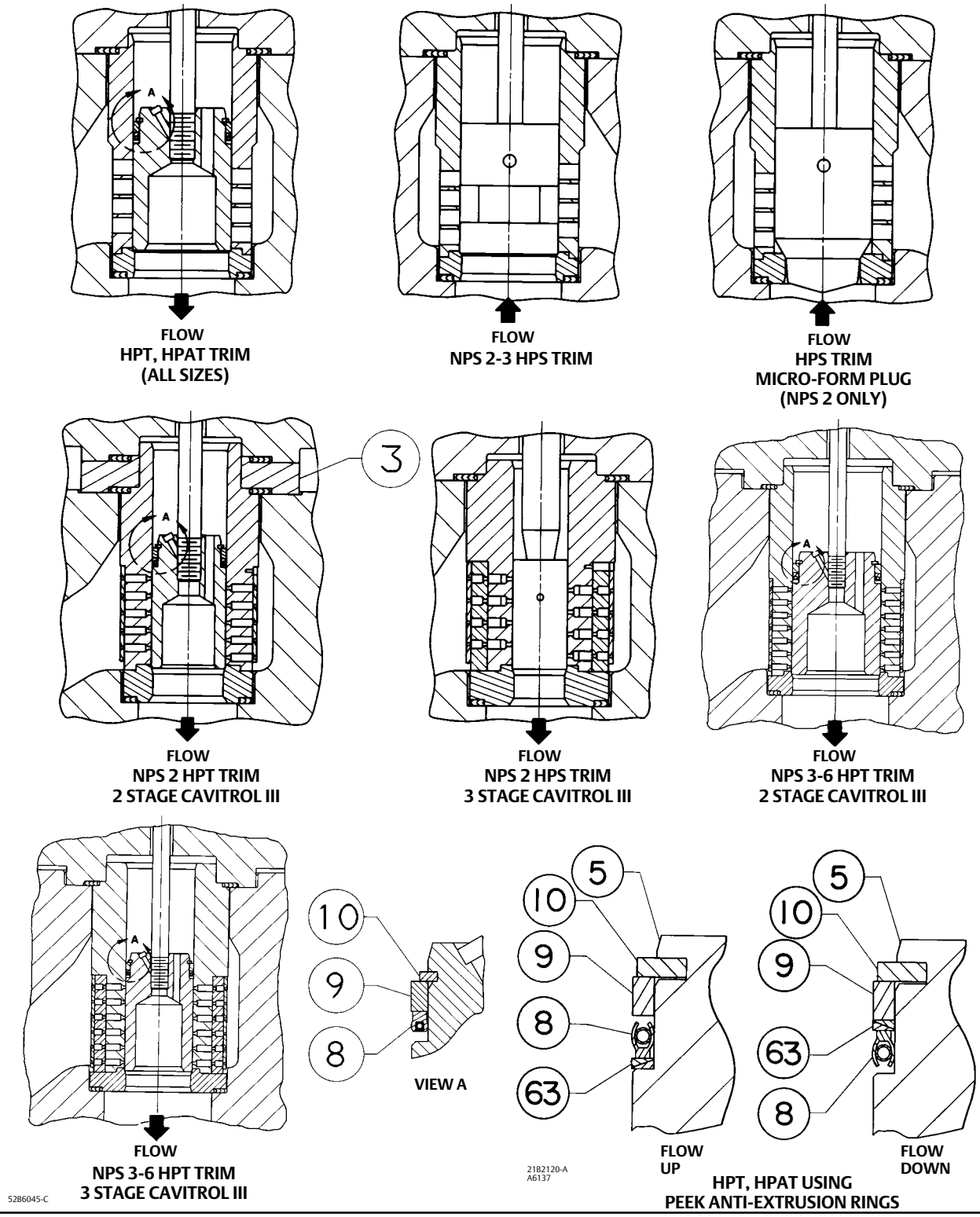
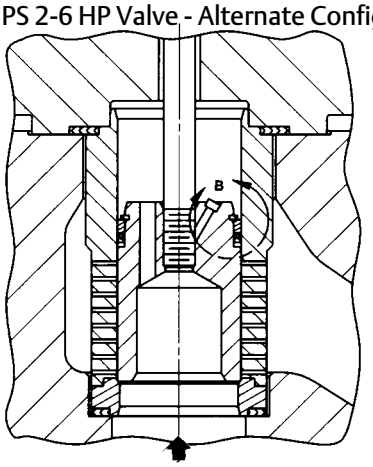
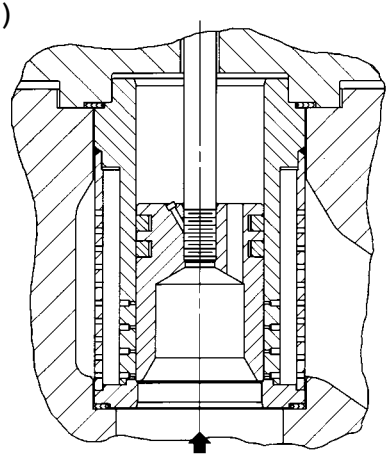


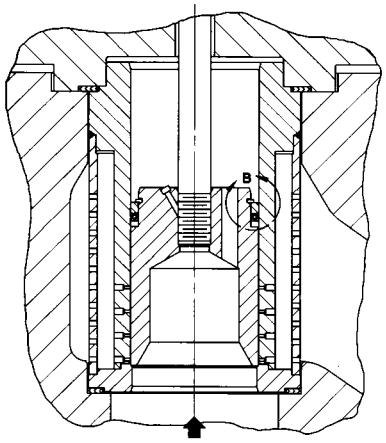
Figure 20. NPS 2-6 HP Valve - Alternate Configurations (Continued)



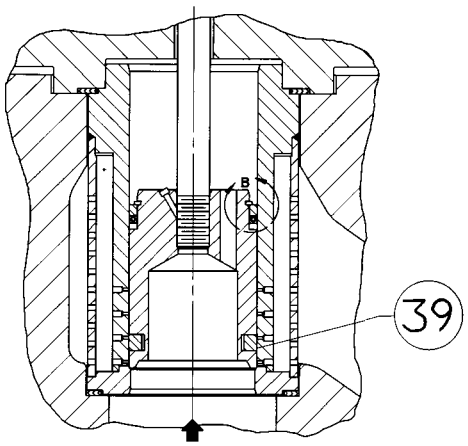
FLOW
HPT, HPAT TRIM WHISPER III, AVAILABLE IN HPD, HPAD, HPS, AND HPAS (NPS 2)



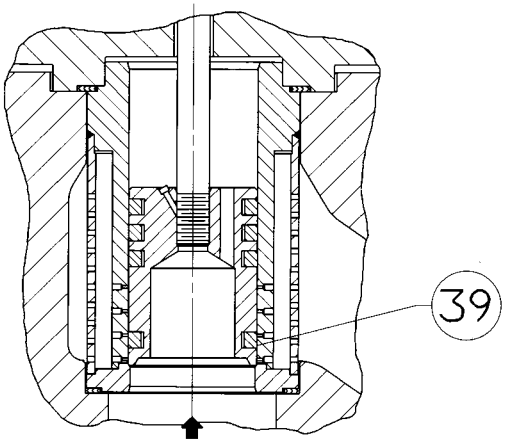
FLOW
NPS 4 HPD TRIM WHISPER III LEVEL D



FLOW
NPS 4 HPT TRIM WHISPER III LEVEL D

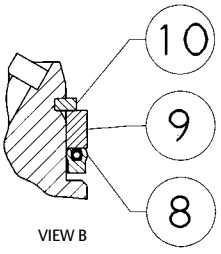


FLOW
NPS 6 HPT TRIM WHISPER III LEVEL D



52B6045-C

FLOW
NPS 6 HPD TRIM WHISPER III LEVEL D



VIEW B

Parts List

Numerous available combinations of valve parts make selection of some parts difficult; when ordering valve parts, provide the valve serial number with the order, permitting proper selection of replacement parts to be made at the factory.

Note

Contact your Emerson Process Management sales office for Part Ordering information.

Key	Description
1	Valve Body --- If you need a valve body as a replacement part, order by valve size, serial number, and desired material.
2*	Cage/Baffle Assy
3	Bonnet Spacer
4*	Seat Ring
5*	Valve Plug
6*	Valve Stem
7*	Pin
8*	Seal Ring/Piston Ring
9*	Back Up Ring
10*	Retaining Ring (for HPT/HPAT only)
11*	Bonnet Gasket
12*	Seat Ring Gasket
13	Stud, Cont Thd
14	Hex Nut
15	Anti-Seize Lubricant (8 lb [3.6 Kg] can)
16	Nameplate
17	Wire
18	Bonnet --- If you need a bonnet as a replacement part, order by valve size and stem diameter, serial number, and desired material.
19	Packing Flange
20	Stud Bolt
21	Hex Nut
22*	Packing Set
23*	Packing Ring
24	Spring or Lantern Ring
25	Washer, Special
26*	Packing Box Ring
27*	Upper Wiper
28	Follower
29	Stud Bolt
30	Hex Nut
31	Pipe Plug (optional)
31	Lubricator (optional)
31	Lubricator/Isolating Valve (optional)
32	Yoke Locknut (optional)
36	Baffle
37	Retaining Ring
38	Drive Screw
39*	Piston Ring
40	Washer
41	Flow Arrow
63*	Anti-Extrusion Ring

C-seal Trim (figure 11)

2*	Cage
4*	Seat Ring
5*	Valve Plug/Retainer
6*	Valve Plug Stem, S20910
8*	Piston Ring, graphite (2 req'd)
64*	C-seal, N07718

TSO Trim (figures 7, 8, and 9)

2*	Cage
4*	Seat Ring
5*	Plug/Stem Assembly
8*	Seal Ring
63*	Anti-Extrusion Ring
9*	Back Up Ring
10*	Retaining Ring

*Recommended spare parts

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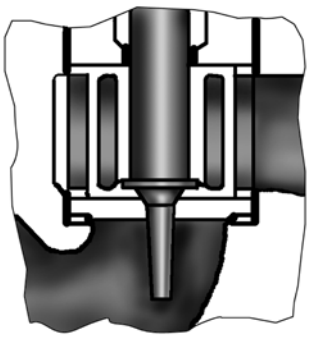
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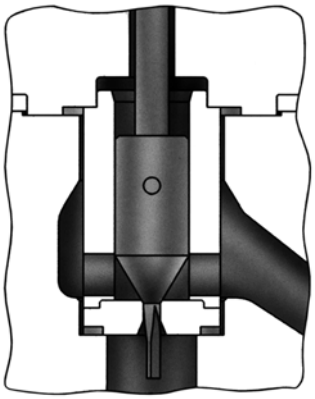
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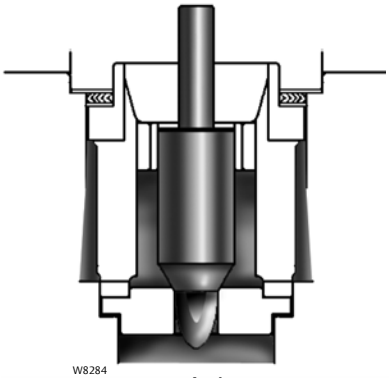
Fisher® Micro Trims for Globe and Angle Valve Applications


W8282

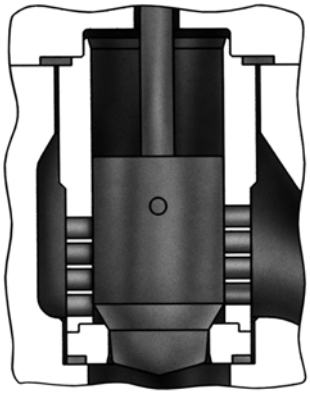
Micro-Flow


W5816-1

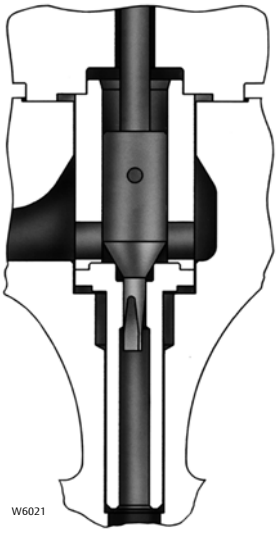
Micro-Flute


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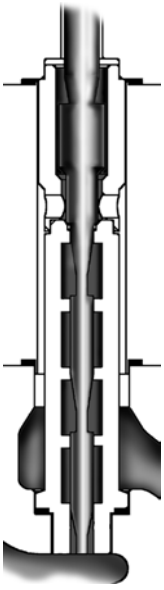
Micro-Flat/Form


W5817-1

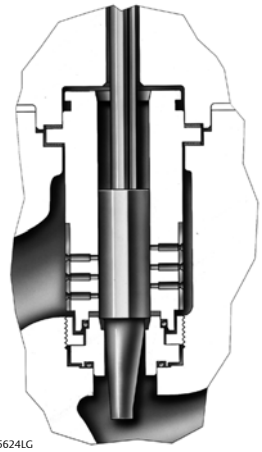
Micro-Form


W6021

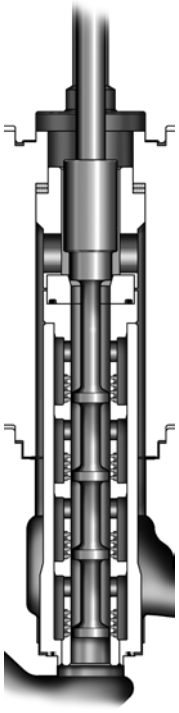
Micro-Flat CAVITATION


W8285

MULTI-STAGE Micro-Flat


W5624LG

CAV III Micro-Flat


X0469-1

CAV4 Mini

Micro Trims

Fisher micro trims are used in those applications where the control of low flow rates is a requirement. A variety of micro trims are offered that provide application solutions for standard and severe service conditions. This bulletin lists the various micro trims available and their service capability.

Trim Descriptions: An Overview

Fisher micro trims fall into two basic application categories: “Standard Service” and “Severe Service”.

Standard Service Micro Trims

These are Plug-Characterized trims. Flow characterization is controlled by the plug.

(A)— Micro-Flow— Ultra low flow control. Linear flow characteristic. Plug-characterized, port-guided. Gas and liquid applications. See figure 1.

(B)— Micro-Flute— Low flow control. Bridges the gap between Micro-Flow and Micro-Form trims. Equal percent flow characteristic. Plug-characterized, port-guided. Gas and liquid applications. See figure 2.

(C)— Micro-Form— Equal percent, contoured plug used in a variety of valve designs. See figure 3.

(D)— Micro-Flat/Form— General service gas or liquid applications where high rangeability (>200:1) is required. See figure 4.

Severe Service Micro Trims

Cavitation Isolation Trim— Controls where cavitation occurs in the valve to minimize trim damage. Does not prevent formation of cavitation.

Cavitation Elimination Trim— Trim design eliminates the effects of cavitation.

(E)— Micro-Flat Cavitation Trim— Cavitation isolation trim. Very low flow control. Isolates cavitation to minimize trim degradation. Plug-characterized, port-guided, unbalanced trim. See figure 5.

(F)— Multi-Stage Micro-Flat— Plug/Cage design with a series of flats on a common stem. High ΔP's and C_v's down to approximately 0.01. This is a cavitation elimination trim for use on liquids. Not intended for gas service. See figure 6.

(G)— CAV III Micro-Flat— Cage-guided cavitation elimination trim. This trim is a CAV III multi-stage trim with the addition of a Micro-Flat style plug to provide staged performance at low flows. Allows CAV III staged cavitation control as low as $C_v = 0.05$. See figure 7.

(H)— CAV4 Mini— Plug/Cage design with a series of staged pressure drops. This multi-stage cavitation elimination valve trim is used in high pressure drops and low flows. See figure 8.

Table 1. Micro Trim Application(1)

Trim	Trim Name	Valve Type	Valve Size Range, NPS	C_V Availability(2, 3)
(A)	Micro-Flow	EZ HP D	1/2, 3/4, 1, 1-1/2, and 2 1 1	0.015 - 0.181 0.00365 - 0.294 0.00365 - 0.294
(B)	Micro-Flute	EZ HPS D	1/2, 3/4, 1, 1-1/2, and 2 1 1	0.0385 - 1.07 0.039 - 4.21 0.0385 - 1.07
(C)	Micro-Form	easy-e ™ HPS EH D	1, 1-1/2, and 2 1 and 2 2 1 and 2	0.075 - 10.2 0.072 - 52.2 0.062 - 50.1 0.070 - 34.5
(D)	Micro-Flat/Form	easy-e HPS EH D	1, 1-1/2, and 2 1 and 2 2 1 and 2	0.02 - 28.9 0.02 - 28.9 0.02 - 28.9 0.02 - 8.8
(E)	Micro-Flat Cavitation	ES EAS HPAS DA	1, 1-1/2, and 2 1 and 2 1 and 2 1	0.001 - 3.4 0.001 - 10.49 0.01 - 7.8 0.01 - 3.4
(F)	Multi-Stage Micro-Flat	ES HPS EHS	1, 1-1/2, and 2 1 and 2 2	0.01 - 1.4 0.01 - 1.4 0.01 - 1.4
(G)	CAV III Micro-Flat	ES HPS EHS	1, 1-1/2, and 2 1 and 2 2	0.05 - 4.9 0.05 - 5.5 0.05 - 5.5
(H)	CAV4 4-Stage Mini	EH	2	0.1 - 2.9

1. Configurations shown are standard. Other configurations are available. Consult your Emerson Process Management sales office.
2. The trim selected may have the minimum or the maximum Cv, as shown below, but usually not both. Refer to Catalog 12 for further detail on flow coefficients for the various valve types.
3. Consult your Emerson Process Management sales office for C_V requirements and availability, dependent on valve size, design, etc.

Detailed Trim Description

Standard Service Trims

Figure 1. Micro-Flow Trim

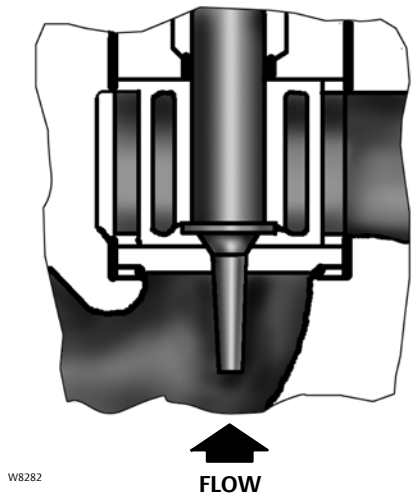
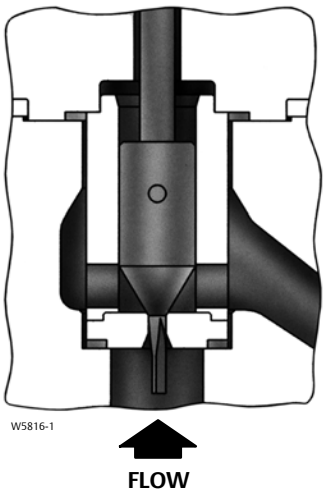


Figure 2. Micro-Flute Trim



(A)—Micro-Flow Trim

Micro-Flow trim (figure 1) provides linear ultra low flow control in gas and liquid applications. Typical application for this trim is flow up, 0.1875 inch port diameter, and 0.75 inch travel.

This is a very rugged, tough trim and therefore available in limited materials, such as R30006/CoCr-A. Micro-Flow trim construction consists of a very tightly controlled angle milled on a flat. This low angle flat provides the required flow control.

This unbalanced trim, with a linear plug characteristic, is available in most valve styles, including easy-e, D, and HP.

(B)—Micro-Flute Trim

Micro-Flute trim (figure 2) is for low flow equal percent control applications and fills the niche between Micro-Flow applications and Micro-Form applications. Standard trim material is R30006/CoCr-A and S44004.

Micro-Flute trim is port guided. The plug tip rides in the seat ring, which is the area where energy is dissipated. Typical applications are port diameters as small as 0.25 inch and flow up (with some flow down applications).

Figure 3. Micro-Form Valve Plug

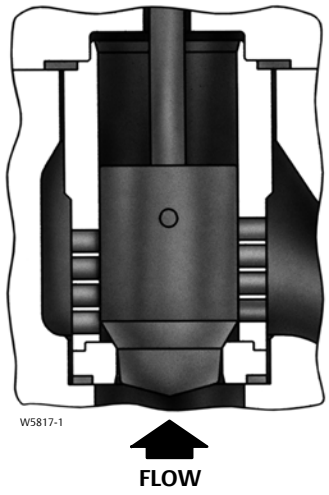
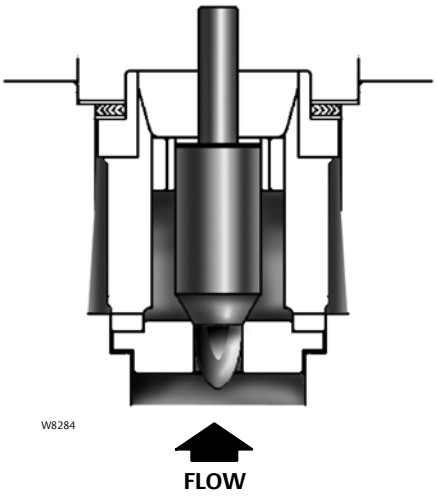


Figure 4. Micro-Flat/Form Trim



(C)—Micro-Form Trim

Micro-Form trim (figure 3) is a contoured plug, equal percent trim for low flow applications. This plug characterized trim is available in 0.25 inch and larger ports. Micro-Form trim is used in flow up applications and not recommended for flow down use.

Depending on valve type, this trim is either cage-guided, stem-guided, or post-guided. Micro-Form trim is widely used in EZ, as well as small size EH and HP control valves.

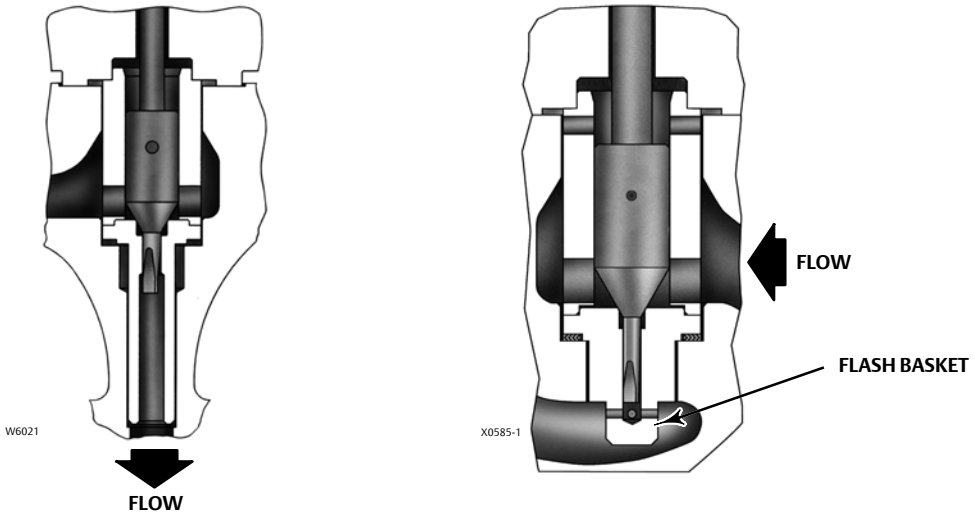
(D)—Micro-Flat/Form Trim

Micro-Flat/Form trim (figure 4) is a special plug design for flow up service only. Using features from both Micro-Flat and Micro-Flow trims, this trim is designed for high rangeability flow service.

Micro-Flat/Form trim initially operates as Micro-Flat, where it is tightly tolerenced to optimize low flow control. Further up in the stroke, the trim transitions to a Micro-Form style plug contour. This provides improved C_v coefficient control. Rangeability is possible in excess of 200 to 1. This trim is available in Micro-Form materials. When choosing materials, be aware of the sliding contact at low lifts.

Severe Service Trims

Figure 5. Micro-Flat Cavitation Trim



(E)—Micro-Flat Cavitation Trim

Micro-Flat Cavitation trim (figure 5) is available in both NPS 1 and 2 Fisher EAS valve bodies and NPS 1, 1-1/2, and 2 Fisher ES valve bodies and is designed for very low flow applications where cavitation is a concern. This trim design does not eliminate cavitation, but isolates the cavitation to minimize trim degradation. Micro-flat Cavitation trim is only available for flow down applications.

Micro-Flat Cavitation trim features a protected seat design to maximize seat life in cavitating environments. This trim is available in 0.25 inch and larger port diameters with a minimum C_v of 0.001.

Recommended maximum pressure drop is 1000 psi. Above this, shortened trim life will result.

This plug-characterized, port-guided trim is available in hardened materials only, such as R30006/CoCr-A and S44004. These materials are needed to provide wear resistance between the plug and seat ring, where cavitation and vibration problems exist.

Micro-Flat Cavitation trim is recommended for angle valve applications. In special cases, use with a globe valve and flash basket is possible. Consult your Emerson Process Management sales office for additional information.

Table 2. Trim Materials(1)

TRIM DESIGNATION	VALVE BODY MATERIAL	VALVE BODY SIZE, NPS	VALVE PLUG	CAGE	SEAT RING / LINER	TEMPERATURE LIMITS	
						°C	°F
26	WCC	all	S44004 SST	S17400 H900	S44004 SST	-29 to 427	-20 to 800
39 (NACE)(2)	WCC	all	CoCr-A	CoCr-A	CoCr-A	-29 to 427	-20 to 800
38	WCC	all	CoCr-A	S17400 H900	CoCr-A	-29 to 427	-20 to 800
39 (NACE)(2)	CF8M	all	CoCr-A	CoCr-A	CoCr-A	-198 to 482	-325 to 900
38	CF8M	1 and 1-1/2	CoCr-A	S17400 H900	CoCr-A	-18 to 343	0 to 650
		2				-18 to 288	0 to 550

1. For additional trim materials, contact your Emerson Process Management sales office.
2. Meets the metallurgical requirements of NACE MR0175, ISO 15156, and MR0103.

Figure 6. Multi-Stage Micro-Flat Trim

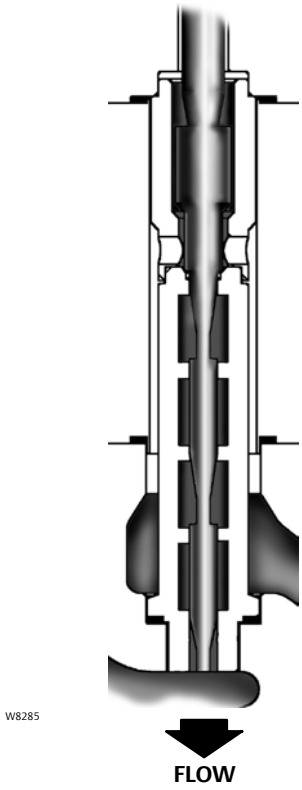
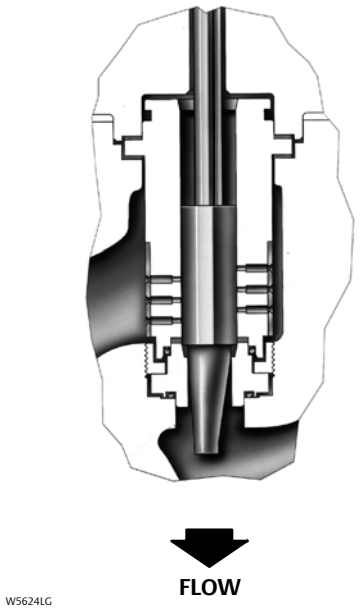


Figure 7. CAV III Micro-Flat Trim



(F)—Multi-Stage Micro-Flat Trim

Multi-Stage Micro-Flat trim (figure 6) is a plug-characterized design with a series of flats on a common stem to provide staged cavitation control. Flow direction is typically flow down, but flow up use is possible in special cases. Consult your Emerson Process Management sales office for additional information.

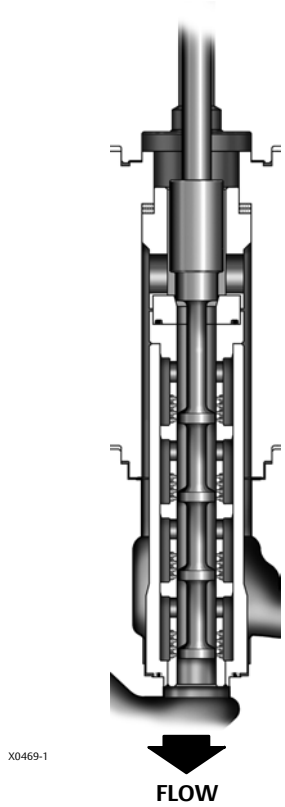
This trim is used to eliminate cavitation. Features include a protected seat design and pressure drops in excess of 4000 psi. To maximize seat life in cavitating environments, staged flow control as low as C_V = 0.01 is possible. This trim must be used with hardened materials, such as R30006/CoCr-A and S44004.

(G)—CAV III Micro-Flat Trim

CAV III Micro-Flat trim (figure 7) is a cavitation elimination trim. Designed as an enhancement to extend the low flow capability of Cavitrol™ III, this is a cage-guided trim with the addition of a Micro-Flat plug.

This trim incorporates a protected seat design and the trim is able to provide a staged cavitation control down to approximately 0.05 C_V. Use of this trim below 0.05 C_V is not recommended. Standard trim materials include an S17400 cage with an S44004 plug and seat ring. Contact your Emerson Process Management sales office for additional materials.

Figure 8. CAV4 Mini



(H)—CAV4 Mini

CAV4 Mini (figure 8) is a multi-stage cavitation elimination trim. Designed as an enhancement to extend the low flow capability of CAV4, this cage-guided trim can be used in services with 6000 psi pressure drops and capacities as low as 0.1 - 2.9 C_V.

Standard trim materials include an S17400 cage with an S44004 plug and seat ring. Contact your Emerson Process Management sales office for additional materials.

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Fisher® Vee-Ball™ V150, V200 and V300 Rotary Control Valves NPS 1 through 12

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Figure 1. Fisher Vee-Ball with 2052 Actuator and FIELDVUE™ DVC6200 Digital Valve Controller



X0187

Introduction

Scope of Manual

This instruction manual provides installation, operation, maintenance, and parts information for the Fisher Vee-Ball V150 (NPS 1 through 12), V200 (NPS 1 through 10), and V300 (NPS 1 through 12) rotary control valves (see figure 1). NPS 3 through 12 valves without an attenuator currently in production are referred to as Series B (for more information on this distinction see Appendix A).

For larger valves (NPS 14, 16, and 20), refer to a separate instruction manual. For information on ENVIRO-SEAL™ packing, see the ENVIRO-SEAL Packing System for Rotary Valves instruction manual (D101643X012). Refer to separate manuals for information concerning the actuator, positioner and accessories.

Do not install, operate, or maintain Vee-Ball valves without being fully trained and qualified in valve, actuator, and accessory installation, operation, and maintenance. **To avoid personal injury or property damage, it is important to carefully read, understand, and follow all the contents of this manual, including all safety cautions and warnings.** If you have any questions about these instructions, contact your Emerson Process Management sales office before proceeding.

Table 1. Specifications

Valve Sizes

See table 2

Valve End Connection Styles

V150: Flanged valves that mate with CL150 raised-face flanges and EN 1092-1 Type B raised-face and Type F Recess

V200: Flangeless (all sizes) and flanged valves that mate with CL600 raised-face flanges (NPS 2-8)

V300: Flanged valves that mate with CL300 raised-face flanges and EN 1092-1 Type B raised-face and Type F Recess

Maximum Inlet Pressure(1)

Consistent with applicable ASME B16.34 or EN 12516-1 ratings

Standard Flow Direction

Forward (into the convex face of the Vee-ball)

Actuator Mounting

■ Right-hand, standard or ■ left-hand, optional, as viewed from upstream end of valve (see figure 23 and the Actuator Mounting section)

Maximum Ball Rotation

Standard: Ball rotates counterclockwise to close when viewed from actuator side of valve

Optional: Ball rotates clockwise to close

Ball rotation is 90 degrees

Valve/Actuator Action

With diaphragm or piston rotary actuator, field-reversible between: ■ push-down-to-close (extending actuator rod closes valve) and ■ push-down-to-open (extending actuator rod opens valve.) See actuator manual for details

1. The pressure/temperature limits in this manual, and any applicable code or standard limitation, should not be exceeded.

Description

The V150, V200, and V300 Vee-Ball valves (figure 1) with a V-notch ball are used in throttling or on-off service. The V200 is a flangeless construction. The V150 and V300 valves are raised-face flanged constructions. The splined valve shaft of all these valves connect to a variety of rotary-shaft actuators.

Specifications

Specifications for these valves are shown in table 1 and in bulletin 51.3:Vee-Ball.

Educational Services

For information on available courses for Fisher Vee-Ball valves, as well as a variety of other products, contact:

Emerson Process Management
Educational Services - Registration
Phone: 1-641-754-3771 or 1-800-338-8158
E-mail: education@emerson.com
http://www.emersonprocess.com/education

Table 2. Valve Body Materials, End Connections, and Ratings

VALVE DESIGN	VALVE BODY MATERIAL	SIZE	RATINGS
		NPS / DN	ASME / PN
V150	WCC	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12, 14, 16, 20, 24x20[5]	CL150
	WCC / 1.0619[1]	DN 80, 100, 150	PN 10-16
		DN 200, 250, 300	PN 10 or PN 16
	LCC	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	CL150
		DN 80, 100, 150	PN 10-16
		DN 200, 250, 300	PN 10 or PN 16
	CF3M[2]	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	CL150
	CF3M/1.4409[1]	DN 80, 100, 150	PN 10-16
		DN 200, 250, 300	PN 10 or PN 16
	CG8M	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12, 14, 16, 20, 24x20[5]	CL150
	CW2M	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	
	M35-2	NPS 1, 1-1/2, 2, 3, 4, 6, 8	
	CD3MN[3]	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	
	CD3MWCuN[3]	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	
	CK3MCuN	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	
V200[4]	WCC, LCC, CG8M, or CF3M[2]	NPS 1, 1-1/2, 2	CL150/300/600 flangeless
		NPS 3, 4	CL150 and CL300/600 flangeless
		NPS 6, 8	CL150/300 and CL600 flangeless
		NPS 10	CL150 flangeless
	WCC, LCC, or CG8M	NPS 2, 3, 4, 6, or 8	CL600
	CW2M, M35-2, or CK3MCuN	NPS 1, 1-1/2, 2, 3, 4, 6, 8	CL150/300/600 flangeless
	CK3MCuN	NPS 10	CL150 flangeless
V300	WCC	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12, 14, 16, 20	CL300
	WCC / 1.0619[1]	DN 25, 40, 50	PN 10-40
		DN 80, 100, 150	PN 25-40
		DN 200, 250, 300	PN 25 or PN 40
	LCC	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	CL300
		DN 25, 40, 50	PN 10-40
		DN 80, 100, 150	PN 25-40
		DN 200, 250, 300	PN 25 or PN 40
	CF3M[2]	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	CL300
	CF3M/1.4409[1]	DN 25, 40, 50	PN 10-40
		DN 80, 100, 150	PN 25-40
		DN 200, 250, 300	PN 25 or PN 40
	CG8M	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12, 14, 16, 20	CL300
	CW2M	NPS 1, 1-1/2, 2, 3, 4, 6, 8	
	M35-2	NPS 1, 1-1/2, 2, 3, 4, 6, 8	
	CD3MN[3]	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	
	CD3MWCuN[3]	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	
	CK3MCuN	NPS 1, 1-1/2, 2, 3, 4, 6, 8, 10, 12	

1. WCC and EN Stl 1.0619 are dual certified. CF3M and EN SST 1.4409 are dual certified.
2. CF3M is a standard offering in Europe and Asia Pacific.
3. NORSOK compliant materials available upon request.
4. Flangeless V200 assemblies mate with raised-face flanges.
5. Valve body mates with NPS 24 ASME CL150 flanges. Internal based on NPS 20 valve design.

Installation

Separate installation steps are provided in this section for V150 and V300 flanged valves, and for V200 flangeless valves. Key numbers in installation procedures are shown in figures 24, 25 and 26 unless otherwise indicated.

Some types of ceramic trim, including VTC, can create a spark under certain conditions. If an edge of a ceramic part is struck against a second ceramic part with enough force, it can produce a spark.

⚠ WARNING

Avoid personal injury and property damage from ignition of process fluid caused by sparks from ceramic trim. Do not use ceramic trim where the process fluid is unstable or if it is an explosive mixture (such as ether and air).

⚠ WARNING

Always wear protective gloves, clothing, and eyewear when performing any installation operations to avoid personal injury.

Personal injury or equipment damage caused by sudden release of pressure may result if the valve assembly is installed where service conditions could exceed either the valve body rating or the mating pipe flange joint rating. To avoid such injury or damage, provide a relief valve for overpressure protection as required by government or accepted industry codes and good engineering practices.

Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If installing into an existing application, also refer to the WARNING at the beginning of the Maintenance section in this instruction manual.

Figure 2. Flange Stud Length for Seal Protector End

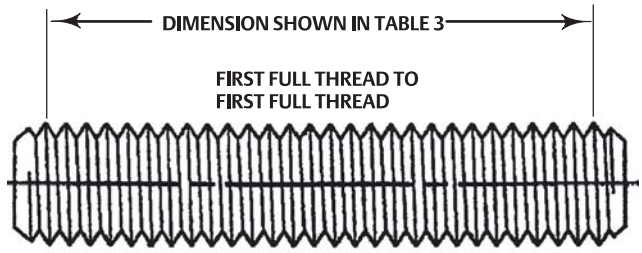


Table 3. Flange Stud Lengths Required for Seal Protector Ring End of Fisher V150 and V300 Valves

VALVE SIZE		V150				V200[1]		V300	
		ANSI/ISA S75.08.02 Face-to-Face		ASME B16.10 Short Face-to-Face		ANSI/ISA S75.08.02 Face-to-Face		ANSI/ISA S75.08.02 Face-to-Face	
DN	NPS	mm	Inches	mm	Inches	mm	Inches	mm	Inches
25	1	70	2.75	95	3.75	---	---	89	3.50
40	1-1/2	83	3.25	127	5.00	---	---	102	4.00
50	2	95	3.75	146	5.75	121	4.75	95	3.75
80	3	95	3.75	133	5.25	140	5.50	121	4.75
100	4	108	4.25	146	5.75	165	6.50	127	5.00
150	6	114	4.50	152	6.00	197	7.75	140	5.50
200	8	121	4.75	171	6.75	216	8.50	152	6.00
250	10	133	5.25	165	6.50	---	---	171	6.75
300	12	140	5.50	159	6.25	---	---	184	7.25

1. For the flanged V200, the same bolt lengths are used for both the inlet and outlet flange ends.

⚠ WARNING

When ordered, the valve configuration and construction materials were selected to meet particular pressure, temperature, pressure drop, and controlled fluid conditions. Responsibility for the safety of process media and compatibility of valve materials with process media rests solely with the purchaser and end-user. To avoid possible personal injury and because

some valve/trim material combinations are limited in their pressure drop and temperature ranges, do not apply any other conditions to the valve without first contacting your Emerson Process Management sales office.

⚠ WARNING

The valve drive shaft is not necessarily grounded to the pipeline when installed. Personal injury or property damage could result from an explosion caused by a discharge of static electricity from valve components if the process fluid or the atmosphere around the valve is flammable. If the atmosphere around the valve or the process fluid is flammable, electrically bond the drive shaft to the valve.

Note

Standard PTFE packing is composed of a partially conductive carbon-filled PTFE female adaptor with PTFE V-ring packing. Standard graphite packing is composed of all conductive graphite ribbon packing. Alternate shaft-to-valve body bonding is available for hazardous service areas where the standard packing is not sufficient to bond the shaft to the valve (see the following step).

Attach the optional bonding strap assembly (key 131, figure 3) to the valve drive shaft (key 6) with the clamp (key 130, figure 3) and connect the other end of the bonding strap assembly to the valve body with the cap screw (key 23).

1. If the valve is to be stored before installation, protect the flange mating surfaces and keep the valve body cavity dry and free of foreign material.
2. Install a three-valve bypass around the control valve assembly if continuous operation will be necessary during inspection and maintenance of the valve.
3. The valve is normally shipped as part of a control valve assembly, with an actuator mounted on the valve. If the valve and actuator have been purchased separately or if the actuator has been removed, mount the actuator according to the Actuator Mounting section and the appropriate actuator instruction manual.
4. Standard flow direction is with the seal protector ring (key 3) facing upstream.
5. Install the valve in a horizontal or vertical pipeline with the drive shaft in a horizontal position.

CAUTION

Do not allow the valve to be installed in the pipeline with the drive shaft in the vertical position because of excessive wear to valve component parts.

6. The actuator can be right- or left-hand mounted with the shaft in a horizontal orientation as shown in figure 1. If necessary, refer to the appropriate actuator instruction manual for actuator installation and adjustment procedures.

CAUTION

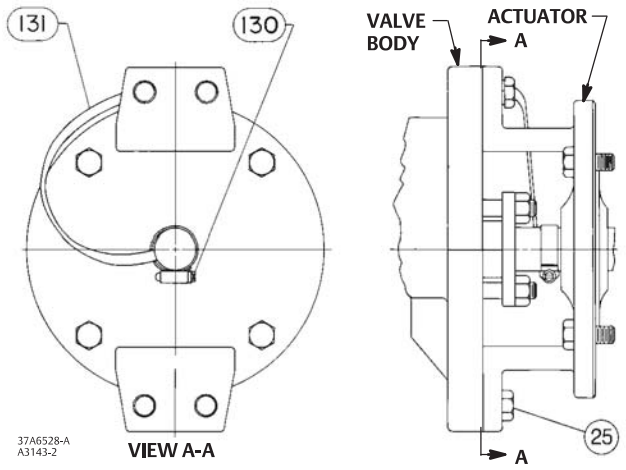
Ensure the valve and adjacent pipelines are free of foreign material that could damage the valve seating surfaces.

7. Be certain the valve and adjacent pipelines are free of any foreign material that could damage the valve sealing surfaces.
8. Be sure the pipeline flanges are in line with each other.

Installing V150, V300, and Flanged V200 Valves

1. Install the V150 and V300 valve using studs (keys 32 and 33, not shown) and nuts to connect the valve flanges to the pipeline flanges. The seal protector ring (key 3) end of the valve requires longer line flange studs (key 32) than standard. Do not use standard-length line flange studs for the seal protector ring end of the valve.

Figure 3. Optional Shaft-to-Body Bonding Strap Assembly



2. See table 3 and figure 2 for length of studs for the seal protector ring end of V150 and V300 valves. Lubricate the studs with anti-seize lubricant.
3. Insert flat-sheet line flange gaskets (or spiral-wound gaskets with compression-controlling center rings) that are compatible with the flowing media.
4. Connect pressure lines to the actuator as indicated in the actuator instruction manual. When an auxiliary manual actuator is used with a power actuator, install a bypass valve on the power actuator (if one is not supplied) for use during manual operation.

⚠ WARNING

Personal injury could result from packing leakage. Valve packing was tightened before shipment; however the packing might require some readjustment to meet specific service conditions. Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

If the valve has ENVIRO-SEAL live-loaded packing installed, this initial re-adjustment will probably not be required. See ENVIRO-SEAL Packing System for Rotary Valves instruction manual (D101643X012) for packing instructions.

Installing V200 Valves

Stud length dimensions are shown in figure 4 for the seal protector ring end of the valve. For V200, CL600, the dimension from the center line of the valve bore to the mounting flange face is larger than a CL150 or 300 valve.

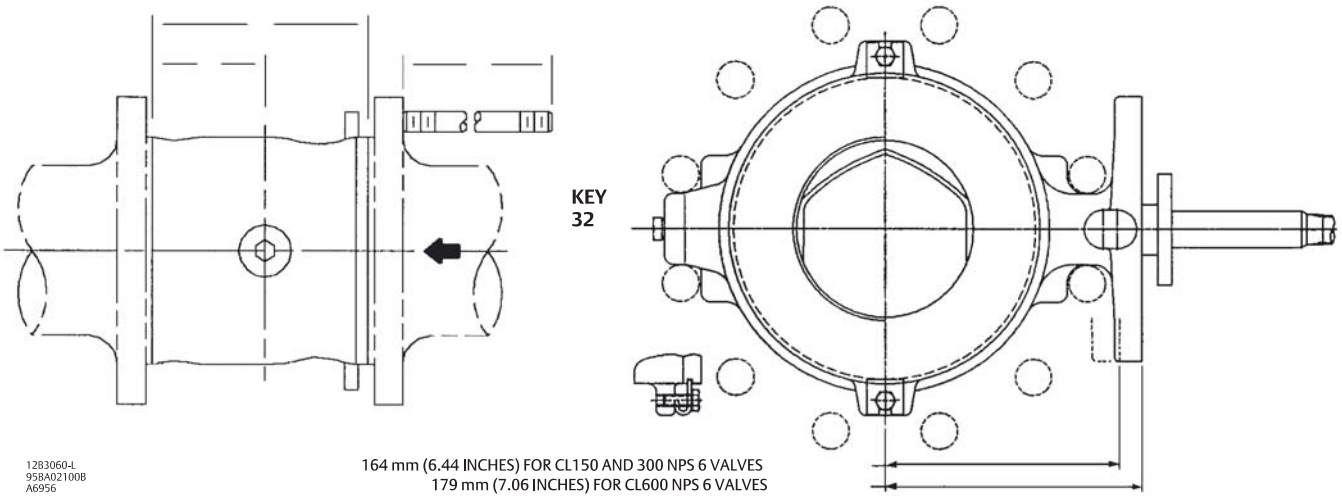
1. Install the V200 valve using long studs (key 32, figure 4) to connect the two pipeline flanges. Refer to figure 4 for the size of studs required. Lubricate the studs with anti-seize lubricant.
2. Install two studs in the flanges before you place the valve in the line. Place the two studs so they will contact the line-centering notches at the bottom of the valve body.

3. Insert flat-sheet line flange gaskets (or spiral-wound gaskets with compression-controlling center rings) that are compatible with the process fluid.
4. Place the valve on the two studs. Install all remaining studs. Measure carefully to be sure the valve is centered on the pipeline flanges, and tighten the flange stud nuts. Tighten the nuts in a criss-cross sequence to be sure the flange gaskets are properly torqued.
5. Connect pressure lines to the actuator as indicated in the actuator instruction manual. When an auxiliary manual actuator is used with a power actuator, install a bypass valve on the power actuator (if one is not supplied) for use during manual operation.

⚠ WARNING

Personal injury could result from packing leakage. Valve packing was tightened before shipment; however the packing might require some readjustment to meet specific service conditions. Check with your process or safety engineer for any additional measures that must be taken to protect against process media.

Figure 4. Fisher V200 Dimensions and Required Clearances for Installation



V200 VALVE SIZE, NPS	DIMENSION						
	A		B	M			
	Standard ANSI/ISA S75.08.02[1]	CL150 ASME B16.10[2] Short (Optional)		Standard CL150 ANSI/ISA S75.08.02[1]	CL150 ASME B16.10[2] Short (Optional)	CL300	CL600
mm							
1	102	127	58	176	202	202	202
1-1/2	114	165	64	189	240	224	224
2	124	178	57	211	268	237	237
3	165	203	87	254	286	279	286
4	194	229	92	286	321	305	343
6	229	267	119	343	381	362	423
8	243	292	119	343	394	387	426
10	297	330	151	419	451	---	---
Inches							
1	4.00	5.00	2.29	6.94	7.94	7.94	7.94
1-1/2	4.50	6.50	2.50	7.44	9.44	8.81	8.81
2	4.88	7.00	2.25	8.31	10.56	9.31	9.31
3	6.50	8.00	3.44	10.00	11.25	11.00	11.25
4	7.62	9.00	3.62	11.25	12.62	12.00	13.50
6	9.00	10.50	4.69	13.50	15.00	14.25	16.25
8	9.56	11.50	4.69	13.50	15.50	15.25	16.75
10	11.69	13.00	5.94	16.50	17.75	---	---

1. IEC 534-3-2 face-to-face dimensions are equivalent to ANSI/ISA S75.08.02 face-to-face dimensions.
2. 150 lb class only.

Maintenance

Valve parts are subject to normal wear and must be inspected and replaced as necessary. The frequency of inspection and replacement depends upon the severity of service conditions.

Key numbers in this procedure are shown in figures 24, 25, and 26, unless otherwise noted.

⚠ WARNING

The Vee-ball closes with a shearing, cutting motion, which could result in personal injury. To avoid injury, keep hands, tools, and other objects away from the Vee-ball while stroking the valve.

Avoid personal injury from sudden release of process pressure. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the power actuator loading pressure and relieve any actuator spring precompression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations.**
- **The valve packing area may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline*. Process fluids may spray out under pressure when removing the packing hardware or packing rings.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

Packing Maintenance

Key numbers in this procedure are shown in figures 24, 25, and 26, unless otherwise noted. A detailed view of the packing is also shown in figure 5.

If the valve is equipped with the ENVIRO-SEAL Packing System, refer to:

- the separate ENVIRO-SEAL Packing System for Rotary Valves instruction manual (D101643X012) for maintenance instructions, and
- the Parts List section of this manual for retrofit kits, parts kits, and individual parts.

If the packing is relatively new and tight on the drive shaft (key 6), and if tightening the packing follower nuts does not stop leakage, it is possible that the drive shaft is worn or nicked so that a seal cannot be made. If the leakage comes from the outside diameter of the packing, it is possible that the leakage is caused by nicks or scratches on the packing box wall. Inspect the drive shaft and packing box wall for nicks or scratches while performing the following procedure.

Replacing Packing

When using this procedure, it is recommended that the actuator **not** be removed from the valve while the valve is still in the pipeline or between flanges. Valve/actuator adjustments must be made with the valve out of the pipeline. Refer to the Determining Closed Position portion of the Actuator Mounting section.

Disassembly

⚠ WARNING

Observe the steps in the WARNING at the beginning of the Maintenance section.

1. Isolate the control valve from the line pressure, release pressure from both sides of the valve body, and drain the process media from both sides of the valve. If using a power actuator, shut off all pressure lines to the power actuator, release pressure from the actuator, and disconnect the pressure lines from the actuator. Use lock-out procedures to be sure that the above measures stay in effect while you are working on the equipment.
2. Remove line bolting, remove the control valve from the pipeline, and place the valve/actuator assembly on a flat surface with the seal protector ring facing up.
3. Remove the actuator cover. Take note of the orientation of the actuator with respect to the valve body and the lever orientation with respect to the valve drive shaft (see figure 6).

⚠ WARNING

When the actuator is removed from the valve, the ball/shaft assembly may suddenly rotate, with a shearing, cutting motion, which could result in personal injury. To avoid injury, carefully rotate the ball to a stable position after the actuator is removed.

CAUTION

When removing the actuator from the valve, do not use a hammer or similar tool to drive the lever or actuator off the valve shaft. Driving the lever or actuator off the valve shaft could damage the ball, seal, and valve.

If necessary, use a puller to remove the lever or actuator from the valve shaft. It is okay to tap the puller screw lightly to loosen lever or actuator, but hitting the screw with excessive force could damage the ball, seal, and valve.

4. Remove the clamped lever (do not loosen the actuator turnbuckle adjustment), remove the actuator mounting screws and nuts (keys 23 and 24), and remove the actuator. (If necessary, refer to the actuator instruction manual for assistance.)
5. If applicable, remove the bonding strap assembly before attempting to remove the packing (see figure 3).
6. Remove the packing follower nuts and packing follower (keys 17 and 20). For alloy packing constructions, the packing follower (key 17) and a separate packing flange (key 40) must be removed if present.

If the valve is equipped with the ENVIRO-SEAL packing system, refer to the ENVIRO-SEAL Packing System for Rotary Valves instruction manual (D101643X012) for disassembly.

⚠ WARNING

Personal injury could result from packing leakage. Do not scratch the drive shaft or packing box wall while removing packing parts in the following procedure.

7. Remove the packing parts (see figure 5, keys 16, 17, 35, and 39 depending on construction) using a formed wire hook with a sharp end. Pierce the rings with the sharp end of the hook in order to remove them. Do not scratch the

drive shaft or packing box wall; scratching these surfaces could cause leakage. Clean all accessible metal parts and surfaces to remove particles that would prevent the packing from sealing.

Assembly

If the valve is equipped with the ENVIRO-SEAL packing system, refer to the ENVIRO-SEAL Packing System for Rotary Valves instruction manual (D101643X012) for assembly.

Series B only

1. For NPS 8, 10, and 12 valves, install the packing spacer (key 34) if it has been removed.
2. To help ensure correct centering of the Vee-ball (key 2) on the seal (key 11), make sure the ball is closed while you install or tighten new packing. Insert a screwdriver, pry bar, or similar tool between the lower ear of the ball and the valve body. Use the pry to move the ball tightly against the bearing on the actuator side of the valve (see figure 6). Keep the ball in that position until you have completed packing installation and adjustment.
3. Install the new packing parts using the parts sequence shown in figure 5. Install the packing follower (key 17). Alloy constructions have a packing follower (key 17) and a separate packing flange (key 40) that must be replaced.
4. Secure the packing follower with the packing follower nuts (key 20). Tighten the nuts far enough to stop leakage under operating conditions.

Handle the seal protector ring, seal, and other parts carefully to prevent damage. A new gasket (key 15) is required whenever the seal protector ring (key 3) (figure 11) is removed.

Flow ring construction does not use a seal, shims, or spring seal. Use this procedure to remove the seal protector ring from flow ring constructions, but disregard any instructions calling for the seal, shims, or spring seal.

Note

If the valve is equipped with a bonding strap assembly (figure 3), re-install the assembly.

---

5. Reconnect the actuator and lever in accordance with the orientations that were noted in step 3 of the disassembly procedures. If necessary, use figure 23 to identify the correct index marks.
6. Refer to the appropriate actuator instruction manual to complete actuator assembly and adjustment.
7. When the control valve is in operation, check the packing follower for leakage and retighten the packing follower nuts (key 20) as necessary.

Replacing the Ball Seal

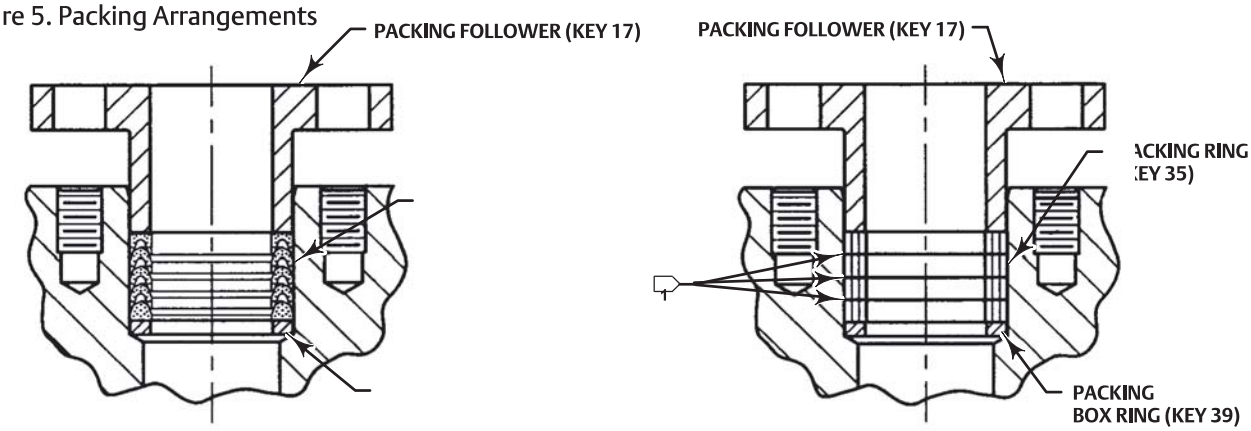
Disassembly

Perform this procedure if the control valve is not shutting off properly or if seal inspection is necessary. If you find upon inspection that the ball, shaft, or bearings need to be replaced, use this procedure to remove the ball seal. Then, proceed to the Bearing and Ball Maintenance procedures. Then, return to this procedure and begin with the assembly of the ball seal steps.

While the actuator/valve assembly must be removed from the pipeline, the actuator may remain mounted on the valve as you replace the ball seal.

Key numbers are shown in figures 24, 25, and 26, unless otherwise indicated. Ball Seal assembly details (with key numbers) are also shown in figures 8, 9 and 10.

Figure 5. Packing Arrangements



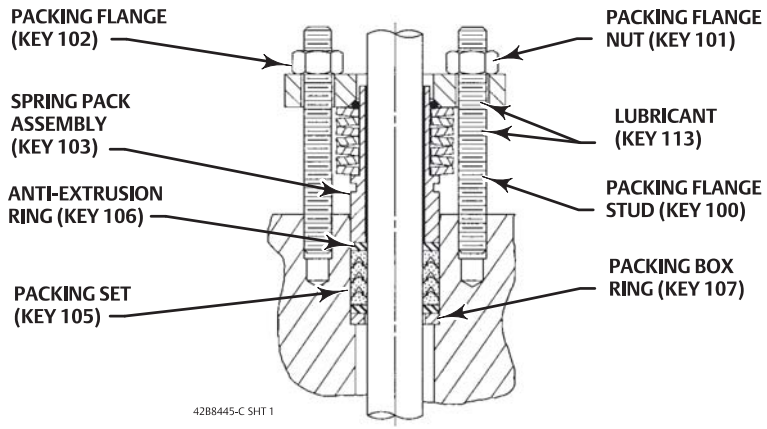
PTFE V-RING PACKING FOR V150, V200, AND V300

FOR V150, V200, AND V300

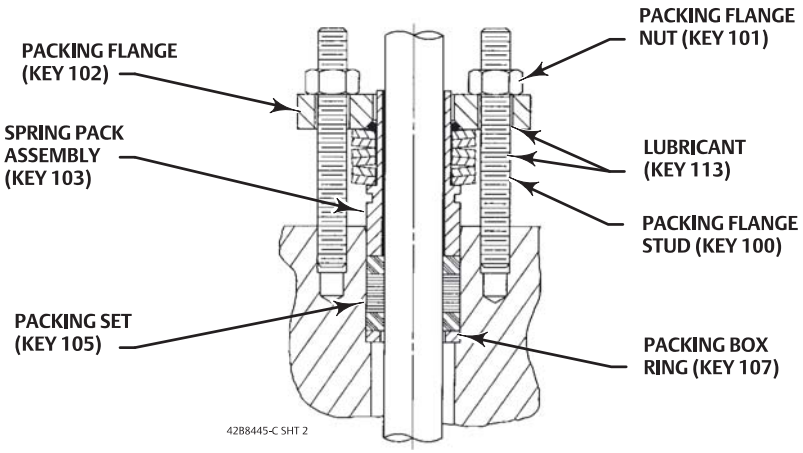
NOTE:
1 INCLUDES ZINC WASHERS (KEY 36) FOR GRAPHITE RIBBON PACKING ONLY.

28B5170

STANDARD PACKING

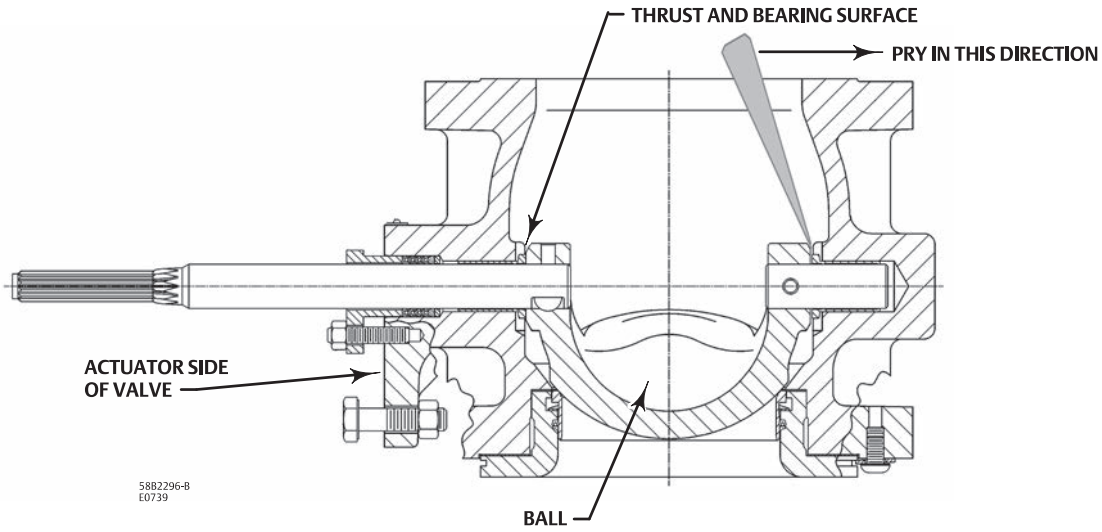


ENVIRO-SEAL PTFE PACKING SYSTEM



ENVIRO-SEAL GRAPHITE PACKING SYSTEM

Figure 6. Typical Vee-Ball Valve Showing Pry Bar



⚠ WARNING

Perform the steps in the WARNING at the beginning of the Maintenance section of this manual.

1. Remove line bolting, remove the control valve from the pipeline, and place the valve on a flat surface with the seal protector ring facing up. Carefully rotate the ball to the open position.
2. Remove protector ring screws and washers (keys 21 and 22). Carefully remove the seal protector ring and gasket (keys 3 and 15). (For flow ring constructions, go to step 4.)
   a. For a Fisher TCM seal, remove the seal (key 11) from the valve body. For NPS 1, 1-1/2, and 2 valves, also remove the backup ring (key 14, figure 8) from the valve body.
   b. For a flat metal seal, remove the spring seal, seal, and shims (keys 13, 11, and 12). (Note: It may be necessary to re-use some of the original shims when reassembling the flat metal seal.)
   c. For an HD ball seal or a high temperature HD ball seal, once the protector ring has been removed from the valve, push the metal seal (key 11) out of the seal protector ring (key 3). Remove the wave spring (key 13), and on the HD metal seal, the radial seal (key 37).

Note

The high temperature HD ball seal also has a piston ring (key 133) that will need to be removed. It will be in two pieces for the NPS 1, 1-1/2 and 2 valves, and one piece with a break in it for the NPS 3 through 12 valves.

CAUTION

Exercise care to avoid damaging components in the following procedure.

- It might be necessary to remove the HD seal by carefully tapping it with a soft punch and hammer. Take care not to damage the seal protector ring.

- NPS 3 through 12 valves, if the seal is difficult to push out, it is recommended that a seal removal plate be used to press the HD seal out of the seal protector ring. Refer to figure 12 for dimensions of the seal removal plate.

- NPS 10 and 12 valves with an attenuator only: Remove the retaining ring (key 41) in the seal protector ring. This retaining ring is an octagonal-shaped support wire. To remove the retaining ring, find one of the free ends of the ring. Use a screwdriver or similar tool to pry inward and upward until the ring is removed.

3. Inspect the gasket and sealing surfaces on the valve body (key 1 or 1A), the seal protector ring (key 3), Vee-ball (key 2), and the retaining ring (key 41 for NPS 10 and 12 valves with an attenuator only). Be sure the sealing surfaces are not damaged.
4. If replacement of the ball, shafts (keys 6 or 9), or bearings (key 10) is needed, proceed to the Bearing and Ball Maintenance procedure. If only the seal is to be replaced, proceed to the Assembly steps below.

Assembly

Refer to figures 8, 9, and 10 for key number locations during seal installation. Valve key number locations are shown in figures 24, 25, and 26.

1. Thoroughly clean all parts that are to be re-used and obtain replacement parts. Be sure that all sealing surfaces are in good condition without scratches or wear. If the valve has been installed between line flanges and the flange studs and nuts have been tightened, always replace the gasket (key 15) with a new gasket.
2. To help ensure correct side-to-side centering of the ball (key 2) on the seal (key 11), make sure the ball is closed while you install the seal or flow ring and seal protector ring. Insert a screwdriver, pry bar, or similar tool between the lower ear of the ball and the valve body (see figure 6).
3. Use the pry to move the ball tightly against the bearing on the actuator side of the valve. Be careful, excessive force may damage the ball. Keep the ball in that position until you have completed seal or flow ring installation. Check the ball's position periodically, and re-center if necessary, during lever assembly and packing adjustments.

⚠ WARNING

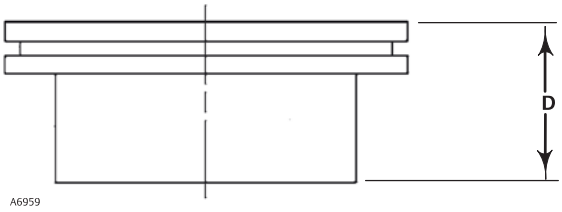
The Vee-Ball closes with a shearing, cutting motion, which could result in personal injury. To avoid injury or property damage, keep hands, tools, and other objects away from the Vee-Ball while stroking the valve.

4. Install the seal.

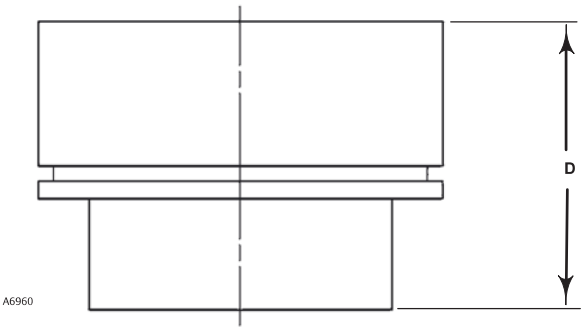
CAUTION

Due to the Vee-ball shape, take care to never completely rotate either the front skirted edge or the circular back edge of the ball out of the ball seal as the seal could be damaged.

Figure 7. NPS 1 and 1-1/2 Seal Protector Ring Measurements



ANSI/ISA S75.08.02 FACE-TO-FACE VALVE



CL150 ASME B16.10 (SHORT) FACE-TO-FACE VALVE

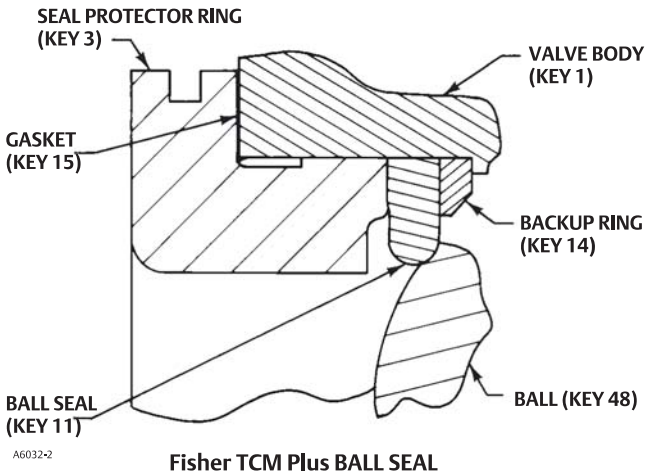
Valve Size, DN	Valve Size, NPS	Construction[1]	TCM Seal "D"	HD Seal "D"	Flow Ring "D"
mm					
25	1	New	37.6	44.7	39.6
		Old	25.1	33.0	26.9
40	1-1/2	New	39.1	44.5	40.9
		Old	27.4	32.8	29.2
Inches					
25	1	New	1.48	1.76	1.56
		Old	0.99	1.30	1.06
40	1-1/2	New	1.54	1.75	1.61
		Old	1.08	1.29	1.15

1. See the Note on page 14 of this Instruction Manual.

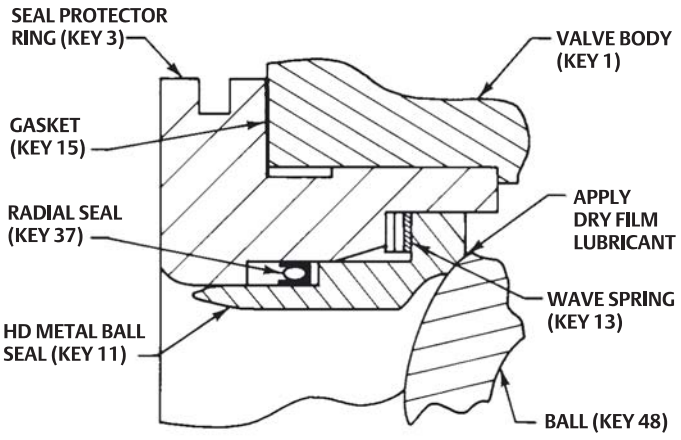
Valve Size, NPS	Construction[1]	TCM Seal "D"	HD Seal "D"	Flow Ring "D"
mm				
1	New	63.0	70.1	65.0
	Old	50.5	58.4	52.3
1-1/2	New	89.9	95.3	91.7
	Old	78.2	83.6	80.0
Inches				
1	New	2.48	2.76	2.56
	Old	1.99	2.30	2.06
1-1/2	New	3.54	3.75	3.61
	Old	3.08	3.29	3.15

1. See the Note on page 14 of this Instruction Manual.

Figure 8. Ball Seal Assembly for NPS 1, 1-1/2, and 2 Valves



Fisher TCM Plus BALL SEAL



HD BALL SEAL

Figure 9. Ball Seal Assembly for NPS 3 through 12 Valves

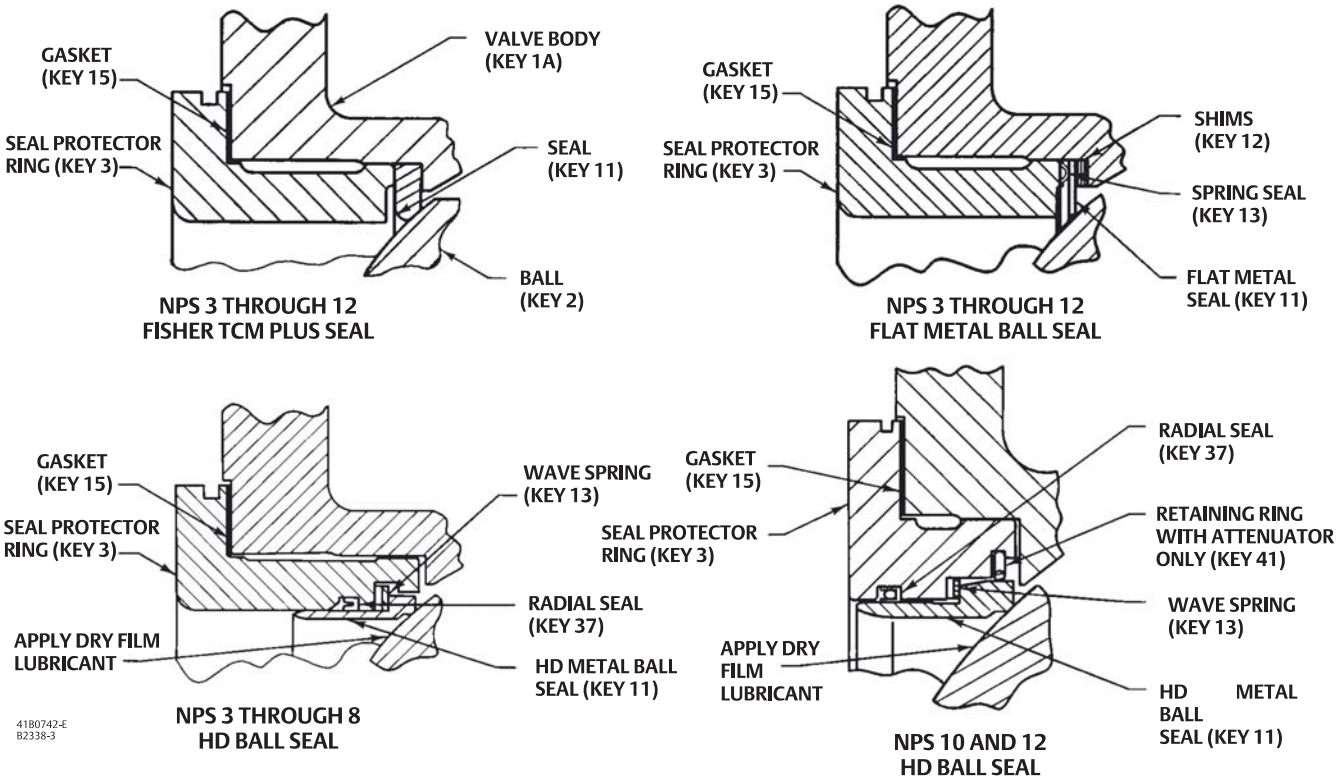


Figure 10. High Temperature HD Ball Seal Details

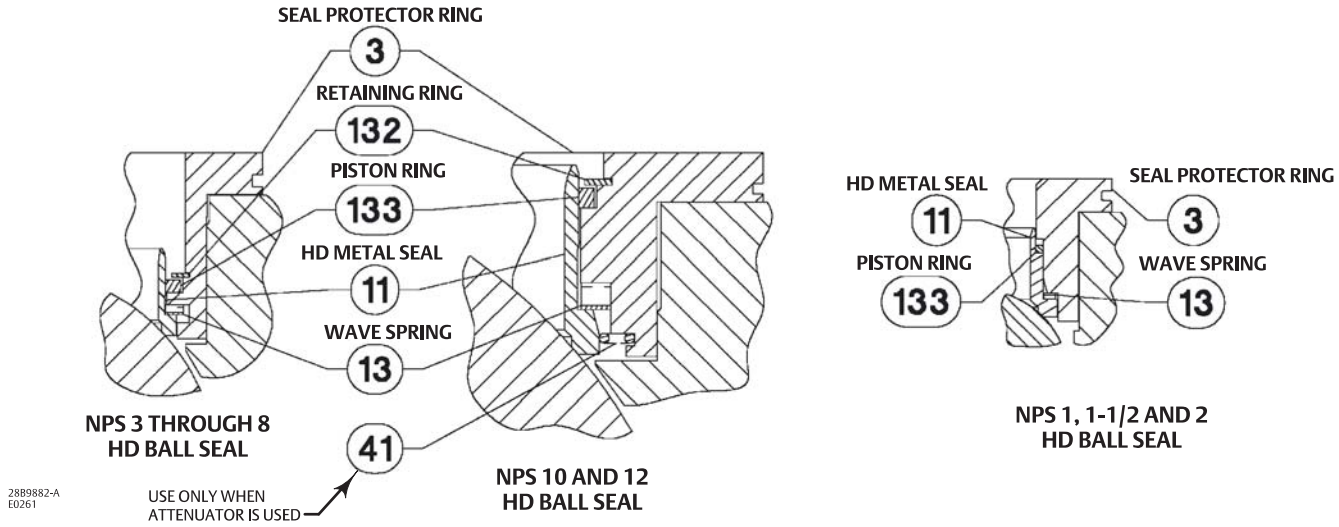


Figure 11. Seal Protector Ring

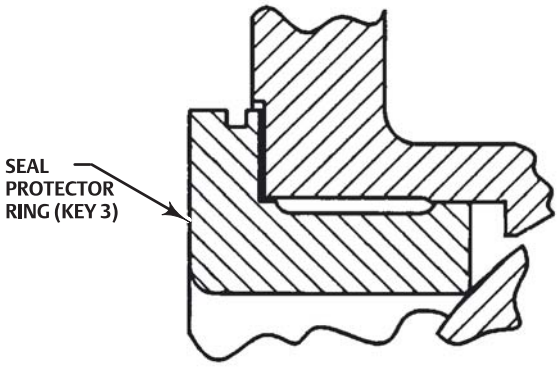
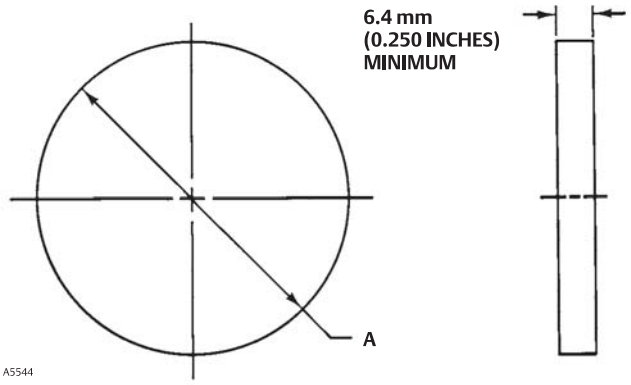


Figure 12. HD Seal Removal Plate Dimensions



VALVE SIZE		DIMENSION A	
DN	NPS	Minimum-Maximum, mm	Minimum-Maximum, Inches
80	3	75.9-76.2	2.990-3.000
100	4	95.0-95.3	3.740-3.750
150	6	126.7-127.0	4.990-5.000
200	8	158.5-158.8	6.240-6.250
250	10	212.5-212.7	8.365-8.375
300	12	263.3-263.5	10.365-10.375

Installing Fisher TCM Plus or Extra ball seals:

a. NPS 1, 1-1/2, and 2 valves: Install the backup ring (key 14). Install the Fisher TCM seal (key 11) into the valve body. Refer to figure 7.

- Install the gasket (key 15) on the valve body.
- Install the seal protector ring (key 3) into the valve body. Now go to step 5 in this procedure.

b. NPS 3 through 12 valves: Install the Fisher TCM seal (key 11) into the valve body.

- Install the gasket (key 15) on the valve body.

- Install the seal protector ring (key 3) into the valve body. Now go to step 5 in this procedure.

Installing flat metal seals:

a. Install 12 shims in the valve and install the flat metal seal on top of the shims.

b. Install the spring seal (key 13) on the flat metal seal (key 11) with the convex side of the spring seal facing the ball.

c. Install the seal protector ring, and install the protector ring screws and washers (keys 21 and 22). Tighten the screws.

d. Add or remove shims under the ball seal as necessary to obtain zero ball seal deflection as accurately as possible.

Note

Zero ball seal deflection for a flat metal seal is the point at which the addition of one 0.13 mm (0.005 inch) thick shim causes contact between the ball and ball seal to be broken. Hold the parts tightly together when determining zero deflection, or improper zero deflection might result.

e. After zero deflection is reached, remove the seal protector ring, spring seal, seal and 4 shims. Final assembly of the control valve should not exceed a maximum of 9 shims for zero deflection. If more than 9 shims are required, contact your Emerson Process Management sales office.

f. Install the gasket (key 15) on the valve body.

g. Install the seal protector ring (key 3) into the valve body. Now go to step 5 in this procedure.

Installing HD ball seals:

Note

The older and newer designs of the NPS 1 and 1-1/2 seal protector ring are functionally the same, but are different lengths and not interchangeable. All NPS 1 and 1-1/2 sizes of V150 and V300 valves are the newer design. The change in seal protector ring length occurred in the 1992/1993 timeframe and affects NPS 1 and 1-1/2 V200 valves only. To determine whether you have the older or newer design, measure the length of the seal protector ring (key 3, figure 26) from its pipeline flange mating surface to its opposite end. Compare your measurement to those listed in figure 7.

a. For NPS 1 and 1-1/2 valves: The older and newer designs of the NPS 1 and 1-1/2 seal protector rings are functionally the same, but are different lengths and not interchangeable. Refer to figure 7 for protector ring dimensions.

- Install the wave spring (key 13) onto the ball seal.
- Lubricate and install the radial seal (key 37) onto the ball seal (key 11). Make sure the open side of the radial seal faces away from the ball.
- Push the ball seal assembly into the seal protector ring (key 3).
- Go to step 5 in this procedure.

b. For all NPS 3 through 8 valves and NPS 10 and 12 valves without attenuator:

- Lubricate and install the radial seal (key 37) into the appropriate groove in the seal protector ring making sure the open side of the radial seal faces away from the ball.
- Install the wave spring (key 13) into the seal protector ring (key 3).
- Install the HD seal (key 11) into the seal protector ring (key 3), past the radial seal. While pushing it past the radial seal, make sure the HD seal is level. Go to step 5 in this procedure.

c. For NPS 10 and 12 valves with attenuator:

- Lubricate the radial seal with lithium grease and install the radial seal (key 37) into the appropriate groove in the seal protector ring making sure the open side of the radial seal faces away from the ball.
- Install the wave spring (key 13) into the seal protector ring (key 3).
- To install the retaining ring (key 41), find one of the free ends of the ring. Insert the free end into the groove in the seal protector ring. Work around the ring, pressing it into the groove until the ring is completely in its groove.
- Install the HD seal (key 11) into the seal protector ring (key 3), past the radial seal. While pushing it past the radial seal, make sure the HD seal is level.
- The HD seal uses a retaining ring (key 41) for NPS 10 and 12 valves only. This retaining ring is an octagonal-shaped support wire. Go to step 5 in this procedure.

Installing high temperature HD ball seals:

a. For NPS 1, 1-1/2 and 2 valves: The older and newer designs of the NPS 1 and 1-1/2 seal protector rings are functionally the same, but are different lengths and not interchangeable. All part numbers in this manual are for the newer design. Refer to figure 7 for ring dimensions.

- Place the wave spring (key 13) on top of the HD seal (key 11).
- Break the piston ring (key 133) into two approximately equal pieces either by placing the ring over a pencil or similar object and applying pressure down-wards on the ring until the ring snaps. Be sure to match the broken ends together as you install it on the HD seal (key 11).
- Lay the HD seal (key 11) down on a flat surface and push the seal protector ring (key 3) into place. Make sure the seal is level. Go to step 5 in this procedure.

b. For NPS 3 through 8 valves:

- Place the piston ring (key 133) and retaining ring (key 132) into the appropriate groove in the seal protector ring (key 3). The piston ring has one break in it; do **not** break it further.
- Install the wave spring (key 13) into the seal protector ring (key 3).
- Lay the HD seal (key 11) down on a flat surface and push the seal protector ring (key 3) past the piston ring (key 133) and into place. Make sure the seal is level. Go to step 5 in this procedure.

c. For NPS 10 and 12 valves:

- Place the piston ring (key 133) and retaining ring (key 132) into the appropriate groove in the seal protector ring (key 3). The piston ring has one break in it; do **not** break it further.

- Install the wave spring (key 13) into the seal protector ring (key 3).
- If the valve has an attenuator, install the retaining ring (key 41). The octagonal shaped support wire ring has two free ends. Place one of the free ends into the groove in the seal protector ring. Then starting at the inserted end, press the rest of the ring into the groove completely.
- Lay the HD seal (key 11) down on a flat surface and push the seal protector ring (key 3) past the piston ring (key 133) and into place. Make sure the seal is level. Go to step 5 in this procedure.

5. Install a replacement gasket (key 15) on the valve body (key 1 or 1A). Install the HD ball seal/seal protector ring assembly into the valve body (key 1 or 1A).
6. Install washers (or clips), and screws that clamp the seal protector ring to the valve body [keys 3, 21, and 22; the V200 valve uses clips (key 22) in place of washers].
7. If necessary, refer to the Packing Maintenance procedures to install the packing. Install the actuator using the Actuator Mounting procedures or to the appropriate actuator instruction manual.

HD Ball Seal Lubrication

To assist with break-in of the HD seals, it is recommended that the ball and seal be lubricated with dry film lubricant or equivalent moly disulfide.

Bearing and Ball Maintenance

⚠ WARNING

Before performing the steps in this section, observe the WARNING at the beginning of the Maintenance section on page 8.

DN 80 - 300 (NPS 3 - 12) Valves

Procedures for disassembly and assembly of the bearings and ball cannot be accomplished until the ball seal and valve packing are removed from the valve.

Refer to the Replacing Packing procedures to remove the actuator, and to remove the packing flange and packing follower from the valve. When the packing disassembly steps are complete, return to this section.

Refer to the Replacing the Ball Seal procedures to remove the ball seal from the valve.

Table 4. Continuous Threaded Rod

Valve Size, DN	Valve Size, NPS	Threaded Rod Thread Size	Thread Depth in Follower Shaft
80	3	0.25-20	0.5
100	4	0.25-20	0.5
150	6	0.25-20	0.5
200	8	0.3125-18	0.62
250	10	0.3125-18	0.62
300	12	0.3125-18	0.94

Disassembly

⚠ WARNING

When the actuator is removed from the valve, the ball/shaft assembly may suddenly rotate, with a shearing, cutting motion, which could result in personal injury. To avoid injury, carefully rotate the ball to a stable position at the bottom of the valve body cavity. Make sure the ball will not rotate.

Key numbers in this procedure are shown in figures 24, 25, and 26, unless otherwise indicated.

1. A taper key (key 4, figures 14, 24, 25 and 30) is used to connect the ball and drive shaft in NPS 3 through 12 valves.
2. Carefully rotate the ball to the open position after the actuator is disconnected. Make sure the ball will not rotate (see warning above). Provide support for the ball during the following disassembly.
3. Working from the small end of the groove pin (key 7), use a pin punch to drive the groove pin out of the ball ear and follower shaft.

For tack welded taper keys, driving the taper key out of the ball ear will shear the tack welding.

4. Locate the small end of the taper key (key 4, see figures 14, 24, 25 and 30). Using a pin punch on the smaller end of the taper key, drive it out of the ball (key 2) and drive shaft (key 6). Note: driving the taper key in the wrong direction will tighten it.
5. Pull the drive shaft (key 6) out of the actuator side of the valve body.

CAUTION

Exercise care to avoid damaging components in the following procedure.

6. The ball will be free to move when both shafts are removed. Make sure the sealing surface of the ball is not damaged while removing the follower shaft.
   a. Unscrew the pipe plug (key 25) if one is installed. Use a punch to drive the follower shaft (key 9) into the center of the ball.
   b. If a pipe plug is not installed, use a piece of continuous threaded rod as a removal rod when moving the follower shaft (key 9) into the center of the ball. Refer to the table 4 for a description of the size threaded rod needed. The length of the rod should allow easy working room from the valve body.
7. Carefully remove the follower shaft and ball (key 2) from the valve body.

For NPS 4 valves with attenuator, remove the ball/attenuator through the inlet of the valve. Taking hold of the follower shaft ear on the ball/attenuator, you must position the scalloped edge of the attenuator against the valve bore opening and then pivot, or roll, the ball/attenuator out of the valve body (see figure 18).

For NPS 6, 8, 10, and 12 valves with attenuator, remove the ball/attenuator through the outlet of the valve by carefully turning and manipulating the ball. The NPS 6, 8, 10, or 12 ball/attenuator will not come straight out of the valve body.

8. Remove the bearings (key 10) by hand. If the bearings are tight in the valve body, then pull or drive them out with a slight pressure.

- To remove the follower shaft bearings, use a blind-hole bearing puller. If you do not have such a tool, you can machine the bearing out.

9. Thoroughly clean surfaces of all parts that are to be re-used or obtain replacement parts.

Assembly

1. Inspect all sealing surfaces to ensure they are in good condition and without scratches or wear.
2. Install the replacement bearings (key 10) by hand. The bearing flanged end should touch the valve body.
3. **Installing the Vee-Ball:** Ensure the ball part number matches up with the appropriate seal type as shown in the key 2 ball table in the parts list section of this instruction manual.

⚠ WARNING

The ball might be damaged if it is allowed to fall into the valve body. To avoid personal injury or damage to the sealing surfaces, support the ball to prevent it from falling into or out of the valve body cavity.

Note

For ease of assembly, the follower shaft (key 9) should be inserted into the ball before installing the ball in the following applications:

- NPS 3 valve without ball/attenuator
- NPS 4 through 12 valves with ball/attenuator.

Carefully install the ball into the valve body cavity.

- For Vee-Ball with attenuator (NPS 4 through 12 valves), carefully install the ball into the valve body cavity. For NPS 4 valves, install the ball/attenuator through the inlet of the valve. For NPS 6, 8, 10, and 12 valves, install the ball/attenuator through the outlet of the valve. Taking hold of the follower shaft ear on the ball/attenuator, you must position the scalloped edge of the attenuator against the valve bore opening and then carefully pivot, or roll, the ball/attenuator into the valve body (see figure 18).

After you have installed the ball (key 2) into the valve body assembly, firmly support the ball while installing the shafts.

4. Installing the follower shaft (key 9):

- For NPS 3 valves: The follower shaft (key 9) should already have been inserted into the ball before the ball was put into the valve body. Insert the follower shaft (key 9) into the valve body bearing (key 10).
- For NPS 4 and larger valves: Insert the follower shaft (key 9) through the ball, and into the valve body bearing (key 10).
- For NPS 4 through 12 valves with ball/attenuator: The follower shaft (key 9) should already have been inserted into the ball/attenuator before the ball was put into the valve body. Insert the follower shaft (key 9) into the valve body bearing (key 10).

Then for all sizes, align the hole in the follower shaft with the holes in the ball. Insert the small end of the groove pin (key 7) into the hole in the ball and into the follower shaft. The pin will hold the parts in place while the drive shaft (key 6) is being installed.

Table 5. Taper Key Minimum Depth

Valve Size, DN	Valve Size, NPS	Minimum Depth To Drive Taper Key After Initial Solid Contact, mm (Inches)
80, 100, 150 200, 250, 300	3, 4, 6 8, 10, 12	4.8 (0.188) 5.6 (0.219)

Table 6. Taper Key Maximum Depth

Valve Size, DN	Valve Size, NPS	Maximum Depth To Drive Taper Key After Initial Solid Contact, mm (Inches)
80, 100 150 200, 250 300	3, 4 6 8, 10 12	7.1 (0.281) 7.9 (0.312) 9.5 (0.375) 10.3 (0.406)

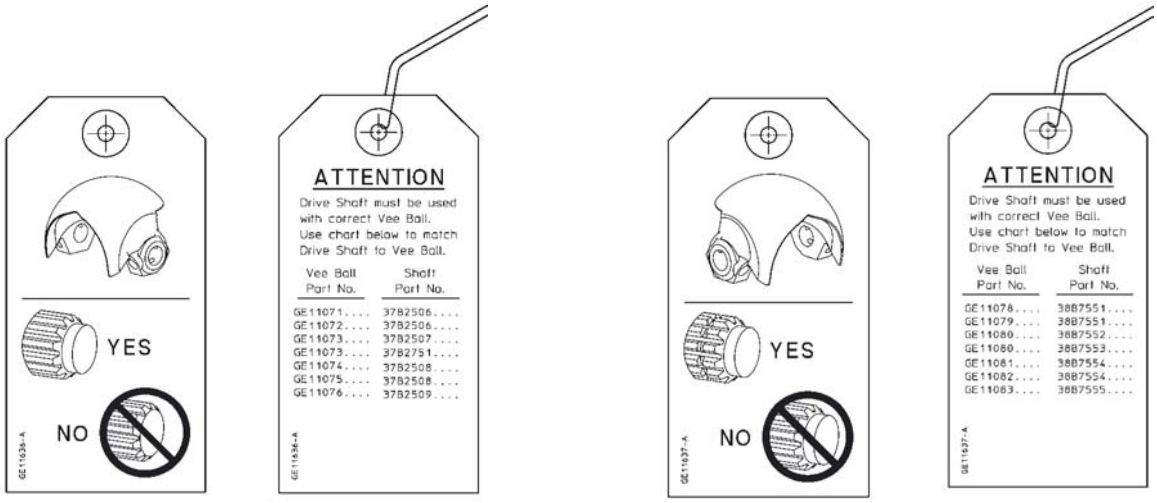
5. Installing the Drive Shaft:

CAUTION

The drive shaft must be used with the correct Vee-Ball. Refer to the tag (see figure 13) attached to the Vee-Ball and to the drive shaft.

Failure to use the correct Vee-Ball/ shaft combination may result in the ball not being in the position indicated by the slash mark on the end of the shaft. If the ball is not properly aligned with the slash mark, the valve will not function correctly and seal damage may result.

Figure 13. Informational Tag



GE11636-A **FOR STANDARD RIGHT/LEFT HAND BALL**

GE11637-A **FOR OPTIONAL LEFT HAND BALL**

CAUTION

Make sure the drive shaft is free of oil or grease, otherwise the taper pin or taper key will not seat properly. Failure to properly set the taper pin or taper key could result in it coming loose while in service. Loosening of the taper key in service could result in improper valve function and equipment damage.

a. Insert the drive shaft into the valve body bearing (key 10), and into the ball ear. Align the hole in the drive shaft with the holes in the ball.

b. Insert the taper key into the ball and drive shaft as shown in figure 14.

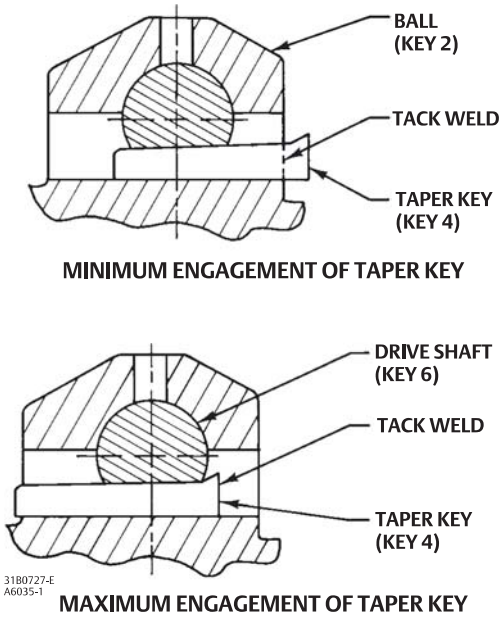
- Installing the Taper Key

Current standard construction materials for all NPS 3 through 12 valves require the taper key (key 4, figure 14) to be tack welded in place after properly seating, using the following procedure. Use standard welding preparations when preparing parts for reassembly.

CAUTION

Make sure the drive shaft (key 6) is free of oil or grease, otherwise the taper key will not seat properly. Failure to properly set the taper pin or taper key could result in it coming loose while in service. Loosening of the taper key in service could result in improper valve function and equipment damage.

Figure 14. Taper Key Installation



6. Install the drive shaft (key 6) into the valve body through the ball and into the lower bearing.
7. Insert the taper key (key 4) into ball and drive shaft (keys 2 and 6) as shown in figure 14. The taper key inserts, with the flat side of the key, facing the drive shaft (key 6).
8. Using a flat end punch, drive the groove pin (key 7) into the ball ear and follower shaft until it is flat with the ball ear surface. Stake both ends of the pin hole with a center punch to ensure the groove pin does not come out.
9. Using a flat end punch, drive the taper key (key 4) into the ball ear and drive shaft (key 6) until solid, heavy contact is obtained between the key and shaft.
10. Measure the position of the taper key head.
11. Drive the taper key in further using the minimum distance shown in table 5.
12. Inspect the ball/shaft taper key connection to verify that the taper key spans the entire shaft flat width. If not, the taper key must be driven in further until this condition is satisfied. However, do not exceed the maximum depths shown in table 6.

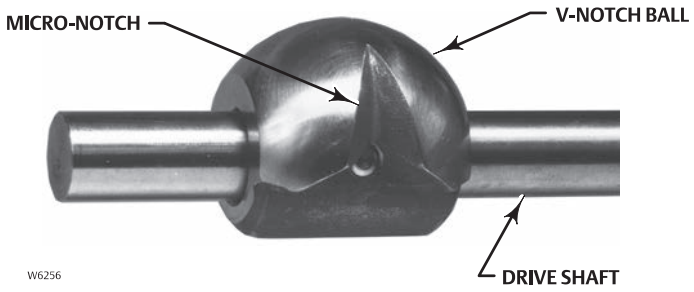
Note

All valve taper keys are tack welded, except titanium.

13. When the above conditions are met, tack weld the taper key (key 4) to the ball ear on the head end of the key (see figures 24 and 25). Use a:

- 1/8 inch diameter weld on NPS 3 through 6 valves,
- 3/16 inch diameter weld on NPS 8 through 10 valves, and
- 1/4 inch diameter weld on NPS 12 valves.

Figure 15. Typical Metal Micro-Notch Ball and Drive Shaft



For all constructions: Refer to Replacing the Ball Seal, Packing Maintenance, and other procedures as necessary to complete the assembly of the valve.

DN 25 - 50 (NPS 1 - 2) Valves

Procedures for disassembly and assembly of the bearings and ball cannot be accomplished until the ball seal and valve packing are removed from the valve.

Refer to the Replacing Packing procedures to remove the actuator, and to remove the packing flange and packing follower from the valve. When the packing disassembly steps are complete, return to this section.

Refer to the Replacing the Ball Seal procedures to remove the ball seal from the valve.

Disassembly

⚠ WARNING

When the actuator is removed from the valve, the ball/shaft assembly may suddenly rotate, with a shearing, cutting motion, which could result in personal injury. To avoid injury, carefully rotate the ball to a stable position at the bottom of the valve body cavity. Make sure the ball will not rotate.

Key numbers in this procedure are shown in figures 24, 25, and 26, unless otherwise indicated.

1. A taper pin (key 4, figure 20) is used in the NPS 1, 1-1/2, and 2 valves, and in the NPS 1 Metal Micro-Notch valve (figure 21).
2. **Ceramic Micro Notch ball constructions:** A screw (key 4, figure 22) is used to attach the ball to the drive shaft.

CAUTION

Exercise care to avoid damaging components in the following procedure.

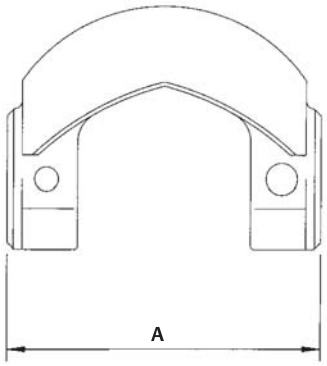
a. The parts are held together with a screw and an adhesive. Remove the screw (key 4) and separate the drive shaft from the ball. In some cases, a small amount of heat can be applied to help loosen the adhesive. However, excessive heat may damage other valve component parts.

b. Once the shafts have been removed from the valve body, the ball may fall. To avoid personal injury or damage to the sealing surfaces, provide support for the ball to prevent it from falling as the shaft(s) are being removed.

Table 7. Continuous Threaded Rod

Valve Size, DN	Valve Size, NPS	Threaded Rod Thread Size	Thread Depth in Follower Shaft
25	1	1/4-20	0.5
40	1.5	1/4-20	0.5
50	2	1/4-20	0.5

Figure 16. Dimensions of Ball in Ball / Shaft Assembly



VALVE SIZE		A			
		NEW - WITHOUT THRUST WASHER		OLD - WITH THRUST WASHER	
DN	NPS	mm	Inches	mm	Inches
25	1	32.9	1.29	31.8	1.25
40	1.5	48.6	1.91	47.7	1.88
50	2	64.5	2.54	63.4	2.50

3. Carefully rotate the ball to the open position after the actuator is disconnected. Make sure the ball will not rotate (see warning above). Provide support for the ball during the following disassembly.
4. Unscrew the pipe plug (key 25). (The pipe plug is optional and may not be available.)
5. Working from the small end of the groove pin (key 7), use a pin punch to drive the groove pin out of the ball ear and follower shaft.

Note

All NPS 1 Micro-Notch constructions use a one piece shaft. They do not have a follower shaft.

6. Locate the small end of the taper key (key 4, figure 14). Using a pin punch on the smaller end of the taper key, drive it out of the ball (key 2) and drive shaft (key 6). Note: driving the taper key in the wrong direction will tighten it.
7. Pull the drive shaft (key 6) out of the actuator side of the valve body.

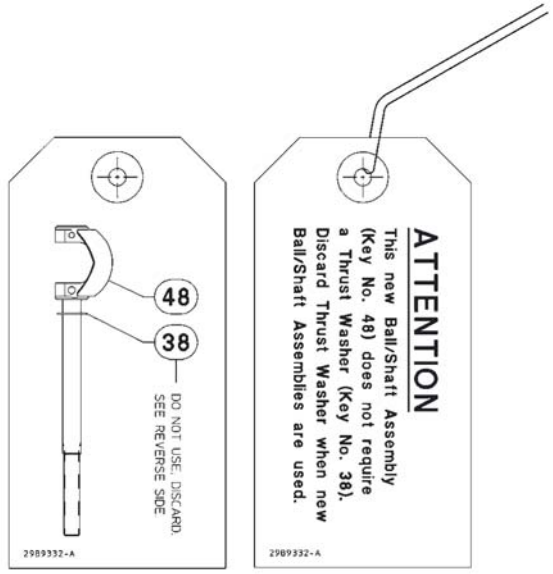
Note

The new ball/shaft assembly (key 48) does not require a thrust washer (key 38) in valves ordered after November 01, 2001.

Discard the thrust washer in valves ordered prior to this date when new ball/shaft assemblies are used as spare parts.

Figure 17 shows the informational tag that is attached with the new ball/shaft assembly when shipped as a spare part. Refer to figure 16 for dimensions of the ball in the ball/shaft assembly.

Figure 17. Informational Tag



29B9332

CAUTION

Exercise care to avoid damaging components in the following procedure.

8. Make sure the sealing surface of the ball is not damaged while removing the follower shaft.
   a. If a pipe plug (key 25) is installed, use a punch to drive the follower shaft (key 9) into the center of the ball.
   b. If a pipe plug is not installed, use a piece of continuous threaded rod as a removal rod when moving the follower shaft (key 9) into the center of the ball. Refer to the table 7 shown below for a description of the size threaded rod needed. The length of the rod should allow easy working room from the valve body.
9. Remove the ball (key 2) by carefully removing the follower shaft and ball from the valve body.
10. Remove the bearings (key 10) by hand. If the bearings are tight in the valve body, then pull or drive them out with a slight pressure.
11. Thoroughly clean surfaces of all parts that are to be re-used or obtain replacement parts.

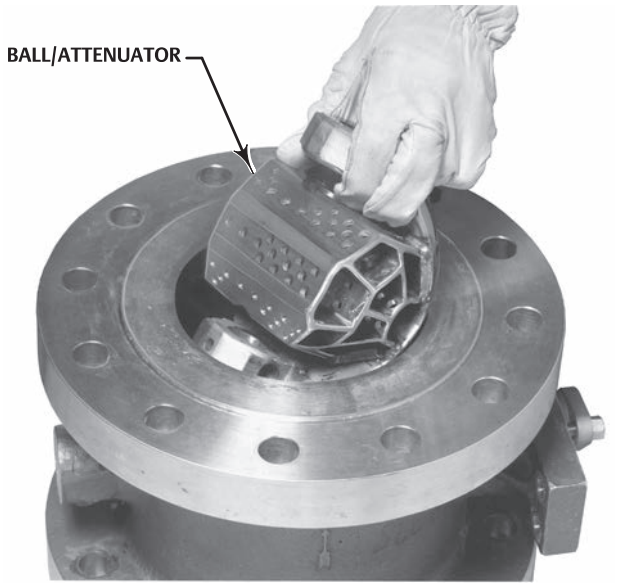
Assembly

1. Inspect all sealing surfaces to ensure they are in good condition and without scratches or wear.
2. Install bearings (key 10) by hand. The bearing flanged end should touch the body.
3. Installing the ball (key 2):

⚠ WARNING

The Vee-Ball might be damaged if it is allowed to fall into the valve body. To avoid personal injury or damage to the sealing surfaces, support the ball to prevent it from falling into or out of the valve body cavity.

Figure 18. Ball/Attenuator Installation and Removal Method



Note

For ease of assembly, the follower shaft (key 9) should be inserted into the ball before installing the ball in an NPS 3 valve without ball/attenuator

Carefully install the ball into the valve body cavity.

After you have installed the ball (key 2) into the valve body assembly, firmly support the ball while installing the shafts.

4. Installing the follower shaft (key 9):

- For NPS 1 through 2 valves: The follower shaft (key 9) should already have been inserted into the ball before the ball was put into the valve body. Insert the follower shaft (key 9) into the valve body bearing (key 10).

Note

All NPS 1 Micro-Notch constructions use a one piece shaft. They do not have a follower shaft.

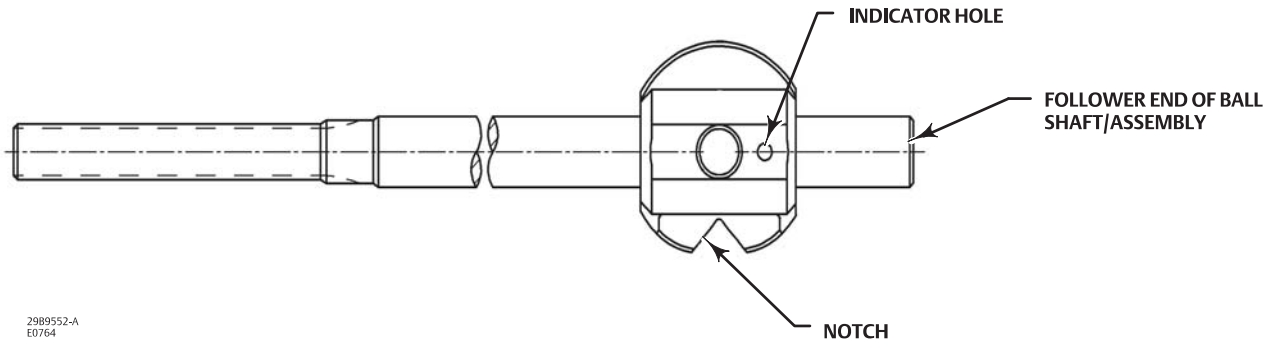
5. Installing the Drive Shaft for Valves with Taper Pins

CAUTION

The drive shaft must be used with the correct Vee-Ball. Refer to the tag (see figure 13) attached to the Vee-Ball and to the drive shaft.

Failure to use the correct Vee-Ball/ shaft combination may result in the ball not being in the position indicated by the slash mark on the end of the shaft. If the ball is not properly aligned with the slash mark, the valve will not function correctly and seal damage may result.

Figure 19. Location of Indicator Hole in Micro-Notch Vee-Balls



CAUTION

Make sure the drive shaft is free of oil or grease, otherwise the taper pin will not seat properly. Failure to properly set the taper pin or taper key could result in it coming loose while in service. Loosening of the taper key in service could result in improper valve function and equipment damage.

6. Insert the drive shaft into the valve body bearing (key 10), and into the ball ear (or ball, for Micro-Notch constructions). Align the hole in the drive shaft with the holes in the ball.

Note

There is an indicator hole drilled in all Micro-Notch balls. This indicator hole must be oriented closest to the follower end of the ball/shaft assembly. See figure 19.

7. Insert the taper pin into the ball and drive shaft as shown in figures 20 and 21. The small end of the taper pin must be inserted into the larger hole side of the ball ear (or ball, for Micro-Notch constructions), and into the large hole side of the drive shaft.

Note

The taper pin will not fit correctly if inserted in the wrong direction through the ball ear (or ball, for Micro-Notch constructions) or through the drive shaft. Make sure the drive shaft and ball ear (or ball, for Micro-Notch constructions) are in the correct orientation for installing the pin.

- Installing Taper Pins in NPS 1, 1-1/2, and 2 Valves

Note

For NPS 1, 1-1/2, and 2 valves, the taper pins (figure 20) do not require welding.

Using a flat-end punch, drive the taper pin into the ball ear (or ball, for Micro-Notch constructions) and drive shaft until solid heavy contact is felt. Make sure the taper pin spans the width of the ball.

Using a flat end punch, drive the groove pin (key 7) into the ball and follower shaft until it is flat with the ball surface.

Installing the Drive Shaft in VTC Ceramic Vee-Ball Valves

CAUTION

The drive shaft must be used with the correct Vee-Ball. Refer to the tag (see figure 13) attached to the Vee-Ball and to the drive shaft.

Failure to use the correct Vee-Ball/ shaft combination may result in the ball not being in the position indicated by the slash mark on the end of the shaft. If the ball is not properly aligned with the slash mark, the valve will not function correctly and seal damage may result.

Figure 20. Taper Pin Installation for Fisher V150, V200, and V300 NPS 1, 1-1/2, and 2 Valves

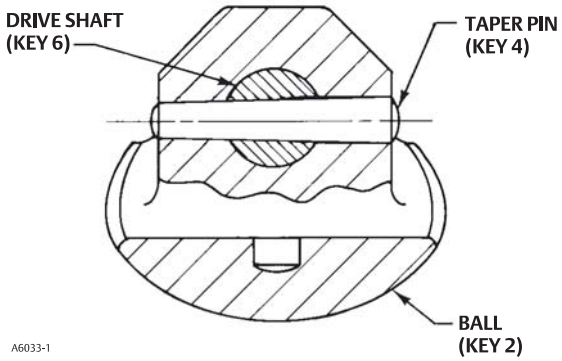
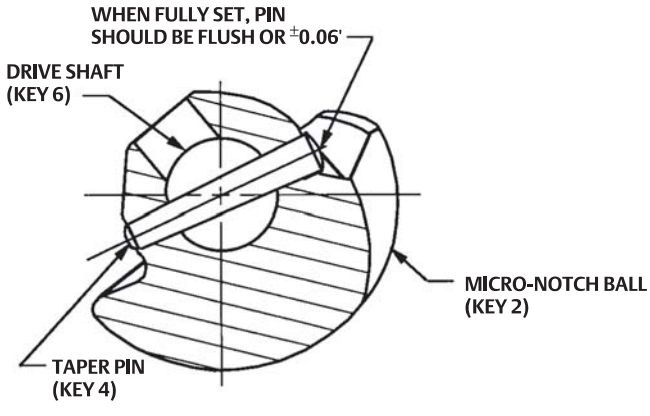
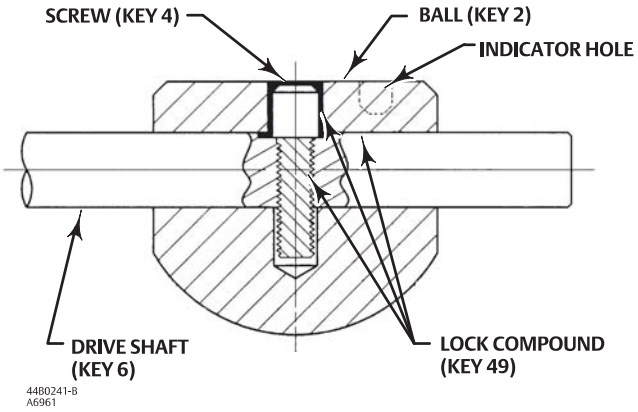


Figure 21. Taper Pin Installation for Fisher V150, V200, and V300 NPS 1 Valves with Micro-Notch Ball Construction



Valves with NPS 1 ceramic micro-notch balls use a screw with a threaded valve shaft to connect the ball to the shaft. An adhesive is used to lock the screw in the valve shaft (keys 4 and 6, figure 22).

Figure 22. Screw Installation for Fisher V150, V200, and V300 NPS 1 Valves with VTC Ceramic Micro-Notch Ball Construction



Note

There is an indicator hole drilled in all Micro-Notch balls. The orientation of this hole in the ceramic Vee-Ball is to the right of the screw in the ball, and must be located closest to the follower end of the ball/shaft assembly. See figures 19 and 22.

⚠ WARNING

Avoid personal injury and property damage from ignition of process fluid caused by sparks from ceramic trim.

Do not use ceramic trim where the process fluid is unstable or if it is an explosive mixture (such as ether and air).

Within the valve body:

8. The threaded hole in the shaft, the screw and screw clearance hole in the ball must be free of oil and grease before applying an activator.
9. Apply Loctite® Depend® Activator 7387 to threaded hole, screw and ball clearance hole. Assemble the ball onto the shaft while aligning threaded shaft hole within the ball clearance hole.
10. The flat on the shaft must be oriented so that the head of the cap screw seats on the flat.
11. Apply 5 drops of Loctite Depend 330 into the hole in the ball.
12. Thread the screw into the shaft tightening it to 9.2 N•m (81 in•lbs) torque. Remove excess adhesive, Allow four hours to cure fully before continuing with assembly.

For all constructions: Refer to Replacing the Ball Seal, Packing Maintenance, and other procedures as necessary to complete the assembly of the valve.

Actuator Mounting

Use the appropriate actuator instruction manual, this section of this manual, and figure 23 of this manual when mounting the actuator or changing actuator styles and positions.

1. To help ensure correct centering of the Vee-Ball (key 2) on the seal (key 11), be sure the ball is closed when mounting the actuator (for applications other than Spring Return Fail-Open).

2. Clean the valve shaft and actuator lever splines to be sure the actuator lever will slide on easily. Only drive the lever in if absolutely necessary.
3. Carefully wedge the ball solidly against the actuator-side bearing, using a screwdriver or similar tool inserted between the lower ear of the ball and the valve body. This will center the ball. See figure 6.
4. Keep the wedge in place while installing the lever, if necessary. Remove the wedge after you have clamped the actuator lever on the valve shaft and have connected the lever to the actuator piston rod or diaphragm rod.

Determining Mounting Position

The actuator can be either right or left-hand mounted, with the actuator on the right or left side when viewed from upstream (see figure 23).

The Series B Vee-Ball, NPS 4 through 12 with attenuator, and the NPS 1 micro-notch Vee-Ball have one V-notch. For **right-hand mounting (standard)**, the ball will be in the top of the valve body when the valve is open and the shaft is horizontal. In this position the ball rotates CCW to Close. For **left-hand mounting (standard)**, the ball will be in the bottom of the valve body when the valve is open and the shaft is horizontal. In this position the ball rotates CCW to Close. An optional ball for **left-hand mounting,** which rotates into the top of the valve body when the shaft is horizontal, is also available. In this position the ball rotates CW to Close.

The NPS 1 through 2 has two notches, and can be rotated in either direction.

Determining Closed Position

1. The valve must be removed from the line to check the position of the ball.

⚠ WARNING

The Vee-Ball closes with a shearing, cutting motion. To avoid personal injury, keep hands, tools, and other objects away from the ball while stroking the valve.

2. Rotate the ball to the closed position.
3. Position the ball in the proper location

For Series B:

- When viewed from the valve body inlet, the ball is in the proper position when the flat spot on the top of the ball is exactly in the center of the seal package.

Make a copy of the centering template in figure 27 out of a suitable stiff material. Place the centering template in the opening at the seal (See figure 27). Find the center of the template and make sure the spot on the ball is centered directly below it.

For NPS 1, 1-1/2, and 2 valves: Follow one of the procedures below:

- When viewed from the valve body inlet, the ball is in the proper position when both V-notches of the ball are centered between the machined diameter of the ledge that supports the seal.
- If the ball has a spot machined on the top, align that spot to the exact center of the seal cavity.

4. Adjust the actuator linkage as described in the appropriate actuator instruction manual until the ball is centered in the closed position. A line is stamped on the actuator end of the drive shaft (see figure 23) to indicate the ball position.

Use the appropriate actuator instruction manual and figure 23 of this manual when mounting the actuator or changing actuator styles and positions.

The Micro-Notch ball closed position is approximately 5 degrees closed from the first point of flow. This establishes the zero degree position for the ball.

Figure 23. Index Marks for Actuator Lever Orientation for NPS 1 through 12 Valves with or without Attenuator

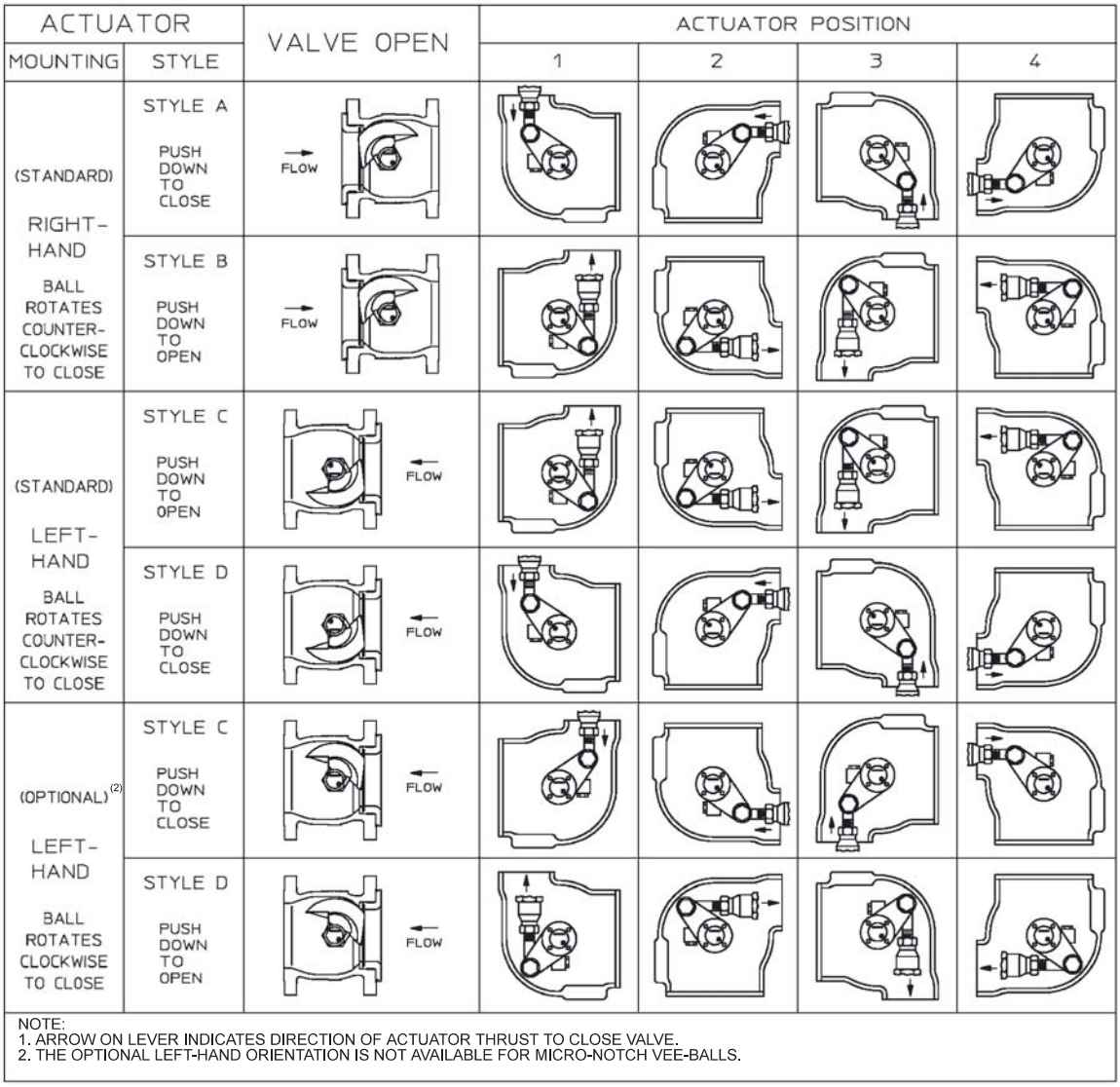
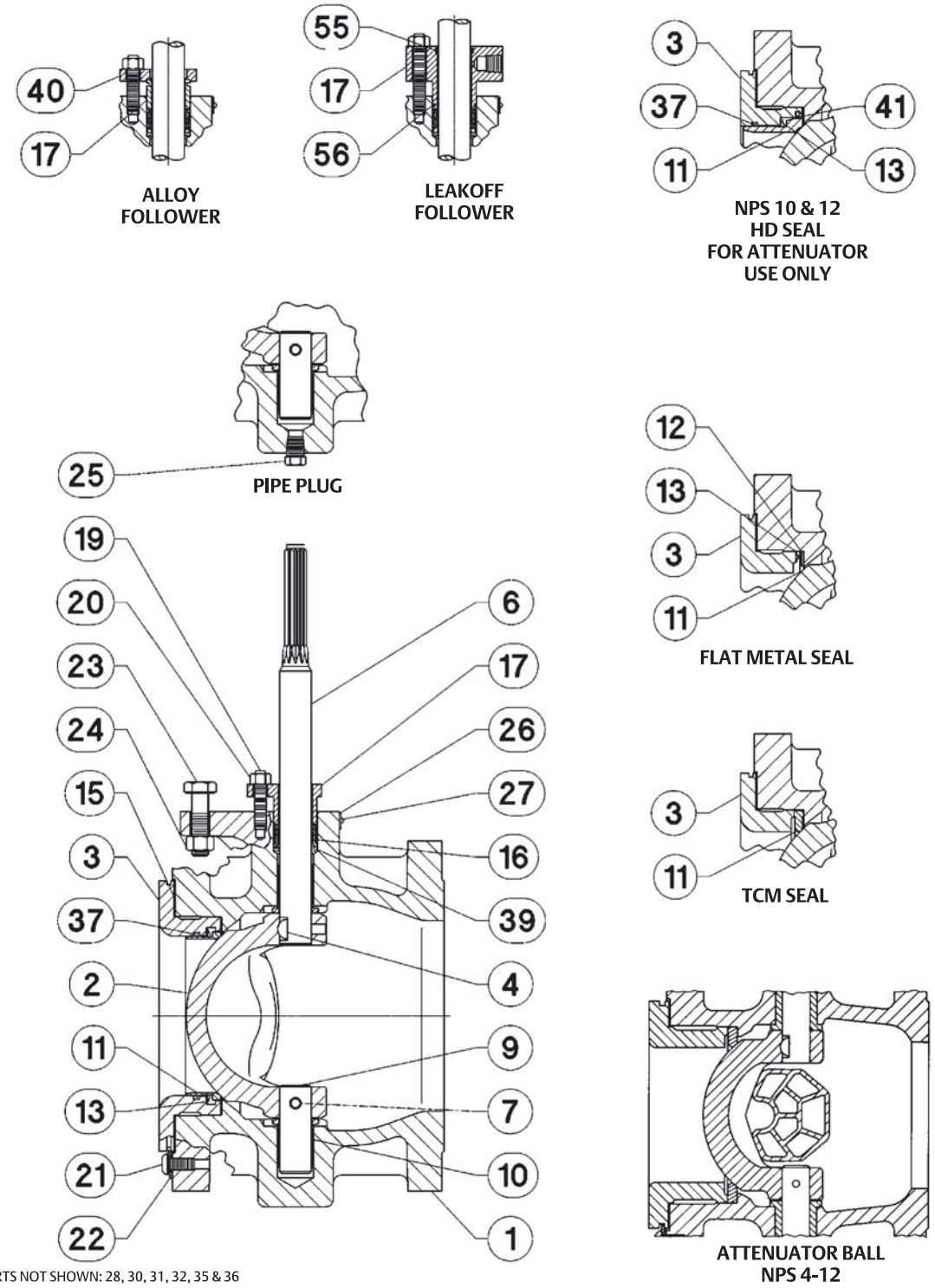


Figure 24. Fisher V150 or V300 (NPS 3 - 12) or Flanged V200 (NPS 3 - 8) Valve Assembly
(Details are typical for V200 Flangeless valve body)



PARTS NOT SHOWN: 28, 30, 31, 32, 35 & 36

Figure 25. Exploded View, Fisher V150 and V300 (NPS 3 - 12) and Flanged V200 (NPS 3-8) without Attenuator Assembly.

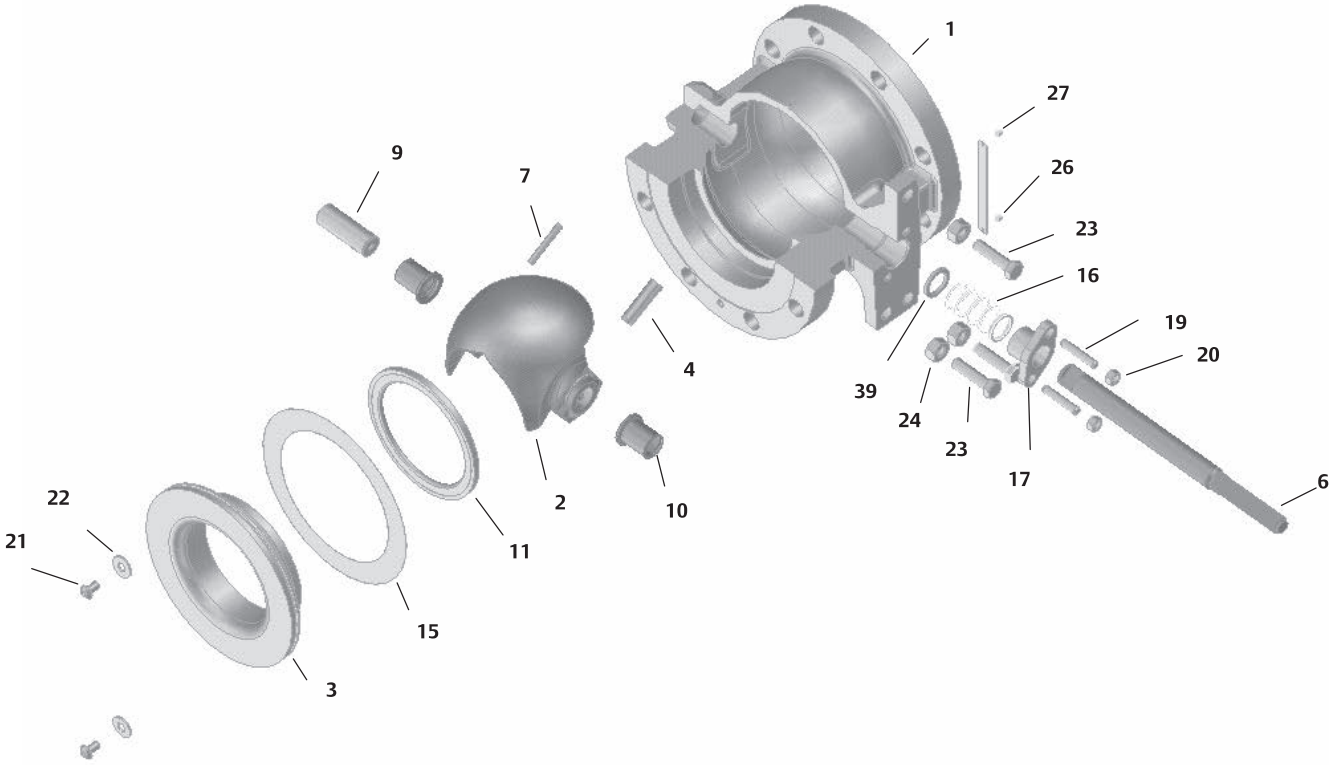
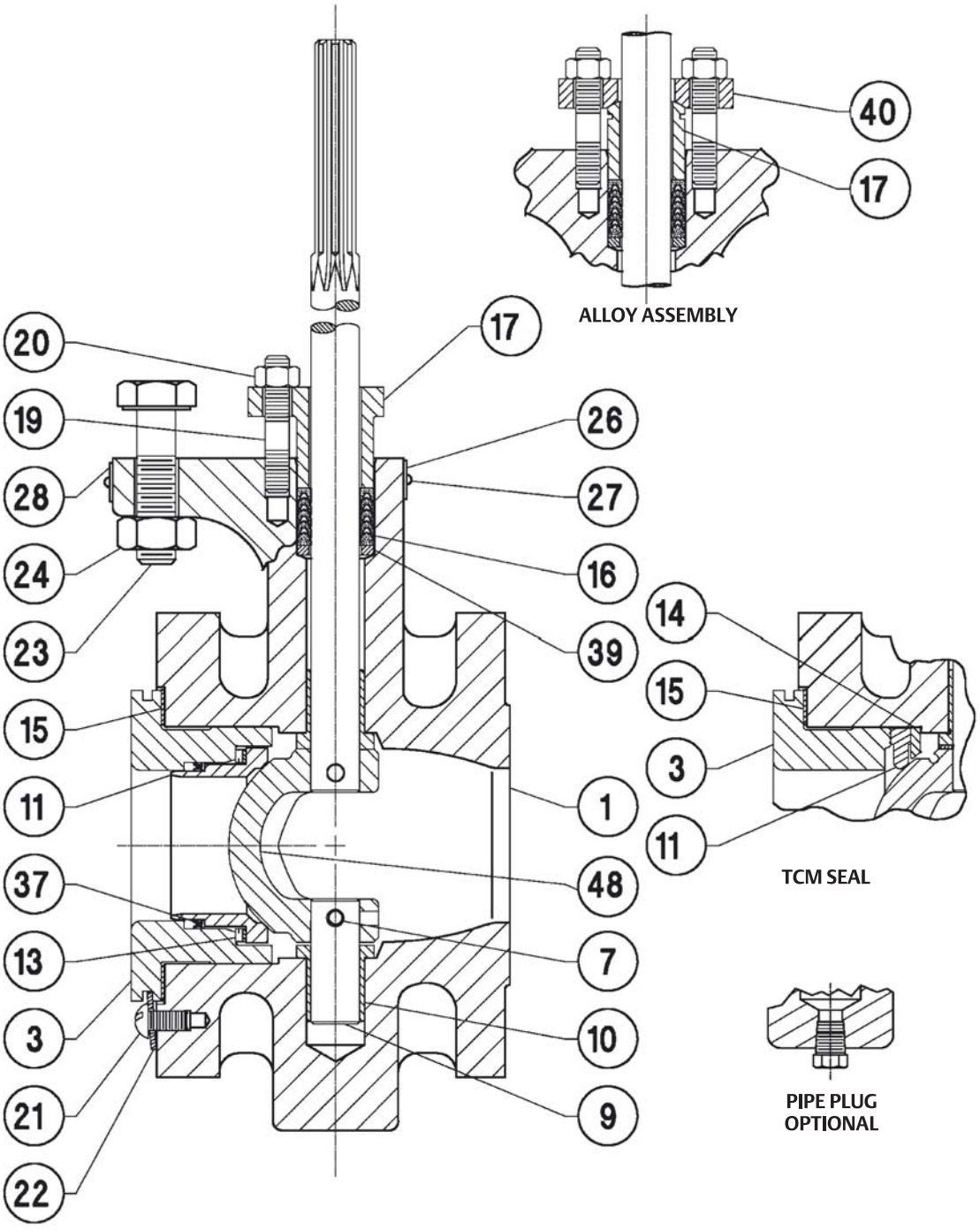
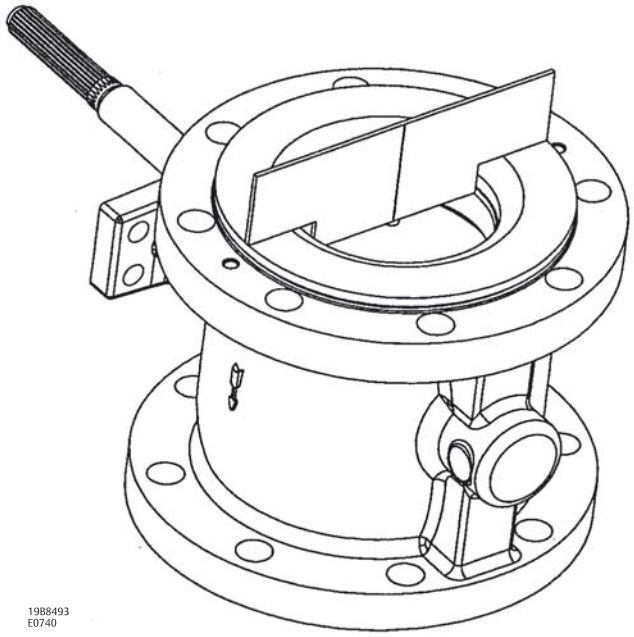


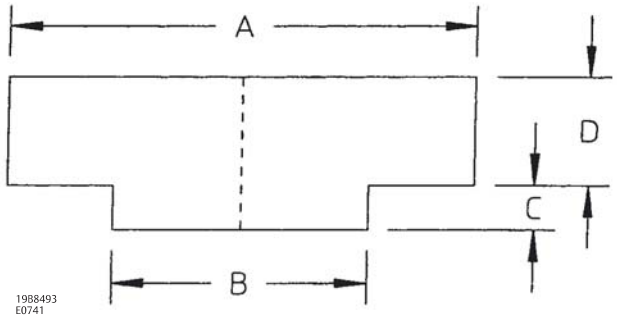
Figure 26. Fisher V150 or V300 (NPS 1, 1-1/2, and 2) and Flanged V200 (NPS 2) Valve Assembly
(Details are typical for Flangeless V200)



NOTE:
PARTS NOT SHOWN: 30, 31, 32, 33, 35 & 36
44B2228-B

Figure 27. Centering Template in Use and Template Dimensions





VALVE SIZE, DN	VALVE SIZE, NPS	A (FOR ASME VALVES)	A (FOR DIN VALVES)	B(1)	C(1) (ANSI/ISA S75.08.02)	C (ASME B16.10 Short(2))	D(1)
mm							
25	1	63	68	19	35	61	25
40	1-1/2	82	88	28	34	85	25
50	2	102	102	38	31	85	25
80	3	127	138	63	24	62	38
100	4	157	157	82	36	71	44
150	6	216	212	117	21	59	51
200	8	270	268	139	12	61	57
250	10	324	320	203	2	35	60
300	12	381	378	254	2	20	63
Inches							
25	1	2.50	2.68	0.75	1.40	2.40	1.00
40	1-1/2	3.25	3.46	1.12	1.34	3.34	1.00
50	2	4.02	4.02	1.50	1.22	3.34	1.00
80	3	5.00	4.55	2.50	0.94	2.44	1.50
100	4	6.19	6.19	3.25	1.42	2.80	1.75
150	6	8.50	8.35	4.62	0.82	2.32	2.00
200	8	10.62	10.55	5.50	0.48	2.42	2.25
250	10	12.75	12.60	8.00	0.09	1.40	2.38
300	12	15.00	14.88	10.00	0.09	0.78	2.50

1. These dimensions are the same for ASME and DIN valves.
2. Note that ASME B16.10 Short dimensions are actually longer than ANSI/ISA S75.08.02 dimensions.

Parts Ordering

A serial number is assigned to each valve and stamped on the nameplate. Always refer to the valve serial number when corresponding with your Emerson Process Management sales office regarding spare parts or technical information. When ordering replacement parts, also specify the key number, part name, and desired material using the parts list.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management should not, under any circumstances, be used in any Fisher valve, because they will void your warranty, might adversely affect the performance of the valve, and could give rise to personal injury and property damage.

Note

For the NPS 2 V150 valve, this manual covers valves with serial numbers 12551183 and higher. Always reference the serial number of your valve when corresponding with your Emerson Process Management sales office.

Retrofit Kits for ENVIRO-SEAL Packing

Retrofit kits include parts to convert existing V150, V200 and V300 valves with shallow (single packing depth) packing box to the ENVIRO-SEAL packing box construction. Retrofit kits include single PTFE packing. See following table.

ENVIRO-SEAL Packing Retrofit Kits

SHAFT DIAMETER(1)		PART NUMBER	
mm	Inches	Single PTFE	Graphite
12.7	1/2	RRTYXRT0012	RRTYXRT0312
15.9	5/8	RRTYXRT0022	RRTYXRT0322
19.1	3/4	RRTYXRT0032	RRTYXRT0332
25.4	1	RRTYXRT0052	RRTYXRT0352
31.8	1-1/4	RRTYXRT0062	RRTYXRT0362
38.1	1-1/2	RRTYXRT0072	RRTYXRT0372
Parts Included in Kit			
Key	**Description**	**Quantity**	
100	Packing stud	2	2
101	Packing nut	2	2
102	Packing flange	1	1
103	Spring pack assembly	1	1
105	Packing set	1	1
106	Anti-extrusion washer	2	---
107	Packing box ring(2)	1	1
---	Tag	1	1
---	Tie Cable	1	1

1. Diameter through the packing box.
2. Not required for all sizes of V150 and V200 or for V300 with 1-1/4 or 1-1/2 inch diameter shafts.

Repair Kits for ENVIRO-SEAL Packing

Repair kits include valves parts for shallow (single packing depth) for ENVIRO-SEAL packing box construction. Repair kits include single PTFE or graphite packing. See following table.

ENVIRO-SEAL Packing Repair Kits

SHAFT DIAMETER(1)		PART NUMBER	
mm	Inches	PTFE	Graphite
12.7	1/2	RRTYX000012	13B8816X012
15.9	5/8	RRTYX000022	13B8816X032
19.1	3/4	RRTYX000032	13B8816X052
25.4	1	RRTYX000052	13B8816X092
31.8	1-1/4	RRTYX000062	13B8816X112
38.1	1-1/2	RRTYX000072	13B8816X142
Parts Included in Kit			
Key	**Description**	**Quantity**	
105	Packing set	1	1
106	Anti-extrusion washer	2	---(2)

1. Diameter through the packing box.
2. Included in key 105.

Repair Kits for Ball Seals

Seal repair kits include recommended spare parts for Fisher TCM Plus, S31600 stainless steel, CF10SMnN, or CD7MCuN ball seal constructions. The following table indicates the repair kit part number and the quantity of parts included in the kit.

Fisher V150, V200, and V300 Repair Kits

VALVE SIZE		KIT PART NUMBER			
		Ball Seal Material			
DN	NPS	TCM Plus	---	Alloy 6	CD7MCuN (Alloy 255 Duplex SST)
25	1	RV150X00CA2	---	RV150XHDAA2	RV150XHDCA2
40	1-1/2	RV150X00CB2	---	RV150XHDAB2	RV150XHDCB2
VALVE SIZE		**Ball Seal Material**			
DN	**NPS**	**TCM Plus**	**S31600 (316 SST)**	**CF10SMnN**	**CD7MCuN (Alloy 255 Duplex SST)**
50	2(1)	RV150X00C12	RV150X00M12	RV150X0HD12	RV150XHDC12
50	2(2)	RV150X00C82	---	RV150X0H082	RV150XHDC82
80	3	RV150X00C22	RV150X00M22	RV150X0HD22	RV150XHDC22
100	4	RV150X00C32	RV150X00M32	RV150X0HD32	RV150XHDC32
150	6	RV150X00C42	RV150X00M42	RV150X0HD42	RV150XHDC42
200	8	RV150X00C52	RV150X00M52	RV150X0HD52	RV150XHDC52
250	10	RV150X00C62	RV150X00M62	RV150X0HD62	RV150XHDC62
300	12	RV150X00C72	RV150X00M72	RV150X0HD72	RV150XHDC72
Parts Included in Kit		**Quantity in Kit**			
Key No.	**Description**				
11	Ball seal	1	1	1	1
12	Shim seal(3)	---	4	---	---
13	Spring seal	---	1	---	---
13	Wave spring	---	---	1	1
15	Gasket	1	1	1	1
37	Radial seal	---	---	1	1
21	Retainer screw	2 or 4(4)	2 or 4(4)	2 or 4(4)	2 or 4(4)
22	Retainer washer	2 or 4(4)	2 or 4(4)	2 or 4(4)	2 or 4(4)

1. **V150's only for serial numbers below 12551183.**
2. **V150's for serial numbers 12551183 and above. All V200's and V300's.**
3. Fewer shim seals are furnished in the parts kits than are used in the original construction of the valve. Most original shim seals can be reused.
4. A quantity of 2 is supplied for NPS 2 through 8 valves, and a quantity of 4 is supplied for NPS 10 and 12 valves.

Parts List

Note

Contact your Emerson Process Management sales office for part numbers.

Common Parts (figures 24, 25 & 26)

Key	Description
1	If you need a valve body as a replacement part, order by valve size, serial number, and desired valve body material. Contact your Emerson Process Management sales office for assistance.
2*	Ball
2*	Ball w/ attenuator
3	Seal Protector Ring
4*	Taper Key R30006 (cobalt alloy 6 casting) N10276
6*	Drive Shaft
6*	Drive Shaft w/ attenuator
7*	Groove Pin S31600 (316 stainless steel) N10276
9*	Follower Shaft
9*	Follower Shaft w/ attenuator
10*	Bearing (2 req'd) PEEK/PTFE R30016 (alloy 6B) Silver-plated R30016 (alloy 6B) 316L SST Nitride Carbon-filled PTFE with N10276 sleeve Glass-filled PTFE with N10276 sleeve
11*	Ball Seal Fisher TCM Plus Fisher TCM Ultra Flat Metal S31600 S30200 HD (Heavy-Duty) Metal CF10SMnN CD7MCuN SST R30006 cobalt alloy 6 casting S31700 (317 SST) w/ CoCr-A seat
12*	Shim Seal, S31600 (12 req'd) Use w/flat metal seal only
13*	Spring Seal, S31600 Use w/ flat metal seal only
13*	Wave Spring, N07750 (NACE) use w/ HD Metal Seal only
14	Backup Ring (Composition seal only)
15*	Gasket Graphite laminate (Standard) Graphite for Oxygen Service
16*	Packing Set, PTFE and carbon-filled PTFE V-ring
17	Packing Follower w/integral flange
17	Packing Follower w/o integral flange
19	Packing Follower Stud
20	Packing Follower Nut
21	Seal Protector Screw
22	Seal Protector Clip
23	Actuator Mounting Screw
24	Actuator Mounting Nut
25	Pipe Plug (Optional) (not shown)
26	Identification Nameplate
27	Drive Screw
28	Flow Arrow
30	Nameplate
31	Nameplate Wire (not shown)
32	Line Flange Stud
33	Line Flange Stud
34	Spacer
35*	Packing Ring, graphite ribbon (4 req'd)
36*	Packing Washer, zinc
37*	Radial Seal, PTFE/CG Use w/HD Metal Seal
39*	Packing Box Ring 316 SST N10276
40	Packing Flange
41	Retaining Ring
48*	Ball-Shaft Assembly
130	Clamp
131	Bonding Strap Assembly

ENVIRO-SEAL Packing System (Parts in all Type Vee-Ball Valves) (figure 5)

Key	Description
100	Packing Flange Stud
101	Packing Flange Nut
102	Packing Flange
103	Spring Pack Assembly
105*	Packing Set W/single PTFE packing
106*	Anti-Extrusion Ring (2 req'd) W/single and double PTFE packing
107*	Packing Box Ring W/single and double PTFE packing
108*	Packing Ring (2 req'd) W/double PTFE packing
109*	Anti-Extrusion Ring (2 req'd) W/double PTFE packing
110	Lantern Ring
111	Tag
112	Tie Cable
113	Lubricant, anti-seize (not furnished with packing system)

*Recommended spare parts

Appendix A Instructions for Non-Series B

The Series B changes affected only the NPS 3 through 12 valves without attenuators. To determine if a Vee-Ball valve is Series B, you will need to examine several of the internal parts. Compare the distinctive skirted V-notch outline of the forward side and the circular edge on the reverse side of the Series B design ball to the V-notch on both sides of the non-series B design ball. Then look for bushings. The lack of bushings indicates the valve body is Series B.

All Vee-Ball valves NPS 3 through 12 produced before the Series B design changes use the Specifications table, the Installation, Maintenance, Packing Maintenance, Replacing Packing, and Replacing the Ball Seal instructions found elsewhere in this manual. Bearing and Vee-Ball Maintenance and Actuator Mounting instructions for these valves may be found below.

Maintenance

⚠ WARNING

The Vee-ball closes with a shearing, cutting motion, which could result in personal injury. To avoid injury, keep hands, tools, and other objects away from the Vee-ball while stroking the valve.

Avoid personal injury from sudden release of process pressure. Before performing any maintenance operations:

- **Do not remove the actuator from the valve while the valve is still pressurized.**
- **Disconnect any operating lines providing air pressure, electric power, or a control signal to the actuator. Be sure the actuator cannot suddenly open or close the valve.**
- **Use bypass valves or completely shut off the process to isolate the valve from process pressure. Relieve process pressure from both sides of the valve. Drain the process media from both sides of the valve.**
- **Vent the power actuator loading pressure and relieve any actuator spring precompression.**
- **Use lock-out procedures to be sure that the above measures stay in effect while you work on the equipment.**
- **Always wear protective gloves, clothing, and eyewear when performing any maintenance operations to avoid personal injury.**
- **The valve packing area may contain process fluids that are pressurized, *even when the valve has been removed from the pipeline*. Process fluids may spray out under pressure when removing the packing hardware or packing rings.**
- **Check with your process or safety engineer for any additional measures that must be taken to protect against process media.**

Procedures for disassembly and assembly of the bearings and ball cannot be accomplished until the ball seal and valve packing are removed from the valve.

1. Refer to the Replacing Packing procedures to remove the actuator, and to remove the packing flange and packing follower from the valve. When the packing disassembly steps are complete, return to this section.
2. Refer to the Replacing the Ball Seal procedures to remove the ball seal from the valve.

Disassembly

⚠ WARNING

When the actuator is removed from the valve, the ball/shaft assembly may suddenly rotate, with a shearing, cutting motion, which could result in personal injury. To avoid injury, carefully rotate the ball to a stable position. Make sure the ball will not rotate.

Key numbers in this procedure are shown in figures 24, 26, and 30, unless otherwise indicated. A taper key (key 4, figure 14) is used in NPS 3 through 12 Non-Series B valves.

3. Carefully rotate the ball to the open position after the actuator is disconnected. Make sure the ball will not rotate (see warning above). Provide support for the ball during the following disassembly.
4. Unscrew the pipe plug (key 25). (With newer valve constructions, the pipe plug is optional and may not be available.)
5. Working from the small end of the groove pin (key 7), use a pin punch to drive the groove pin out of the ball ear and follower shaft.

For tack welded taper keys, driving the taper key out of the ball ear will shear the tack welding.

6. Locate the small end of the taper key (key 4, see figure 14). Using a pin punch on the smaller end of the taper key, drive it out of the ball (key 2) and drive shaft (key 6). Note: driving the taper key in the wrong direction will tighten it.
7. Pull the drive shaft (key 6) out of the actuator side of the valve body.
8. Make sure the sealing surface of the ball is not damaged while removing the follower shaft.

   a. If a pipe plug (key 25) is installed, use a punch to drive the follower shaft (key 9) into the center of the ball.

   b. If a pipe plug is <u>not</u> installed, use a piece of continuous threaded rod as a removal rod when moving the follower shaft (key 9) into the center of the V-notch ball. Refer to the table 8 for a description of the size threaded rod needed. The length of the rod should allow easy working room from the valve body.

9. **Remove the ball** (key 2) by carefully removing the follower shaft and ball from the valve body.
10. Remove the packing box spacer (key 34) for NPS 8, 10, and 12 valves.
11. **Removing the bearings (key 10):**

    a. **For composition bearings,** remove the bearings by hand. If the bearings are tight in the valve body, then pull or drive them out with a slight pressure. Allow the bushings (key 5 or 8) to remain in the valve body.

Table 8. Continuous Threaded Rod

Valve Size, NPS	Threaded Rod Thread Size	Thread Depth in Follower Shaft
3	1/4-20	0.5
4	1/4-20	0.5
6	1/4-20	0.5
8	5/16-18	0.62
10	5/16-18	0.62
12	5/16-18	0.94

    b. **For metal bearings,** use a press and ram to remove the drive shaft bearings out of the valve body. Refer to figures 28 and 29 ram dimensions. The bushings (key 5 or 8) will normally remain in the valve body.

To remove the follower shaft bearings, use a blind-hole bearing puller. If you do not have such a tool, you can machine the bearing out.

Note

For proper shutoff performance, the ball and seal require the bearing (key 10) to be positioned correctly. If you removed the bearings (key 10), be sure to locate the new bearings as shown in figures 28 and 29.

12. Thoroughly clean surfaces of all parts that are to be re-used or obtain replacement parts.

Assembly

1. Inspect all sealing surfaces to ensure they are in good condition and without scratches or wear.
2. Installing bearings (key 10):

   a. For composition bearings, install the bearings by hand. The bearing flanged end should touch the bushing (key 5 or 8).

   b. For metal bearings:

- Use a press and ram to install the bearings (key 10). Refer to figures 28 and 29.
- Press the bearings in until each bearing is flush with the bushing (key 5 or 8). The acceptable tolerance for bearing location is: flush with the bushing to 1.52 mm (0.060 inches) inside the bushing. That is, the bearings should not protrude into the flow cavity of the valve, and they should not be more than 1.52 mm (0.060 inches) inside the bushing.
- Take care not to change the position of the bushings (key 5 or 8) when pressing in new bearings (key 10), otherwise the ball will not center in the valve body and seal.

3. Installing the Vee-Ball (key 2):

⚠ WARNING

The Vee-Ball might be damaged if it is allowed to fall into the valve body. To avoid personal injury or damage to the sealing surfaces, support the ball to prevent it from falling into or out of the valve body cavity.

Note

For ease of assembly, the follower shaft (key 9) should be inserted into the ball before installing the ball in an NPS 3 valve without ball/attenuator.

Carefully install the ball into the valve body cavity.

After you have installed the ball (key 2) into the valve body assembly, firmly support the ball while installing the shafts.

4. Installing the follower shaft (key 9):

- For NPS 3 valves: The follower shaft (key 9) should already have been inserted into the ball before the ball was put into the valve body. Insert the follower shaft (key 9) into the valve body bearing (key 10).
- For NPS 4 and larger valves without attenuator: Insert the follower shaft (key 9) through the ball, and into the valve body bearing (key 10).

Then for all sizes, align the hole in the follower shaft with the holes in the ball. Insert the small end of the groove pin (key 7) into the hole in the ball and into the follower shaft. The pin will hold the parts in place while the drive shaft (key 6) is being installed.

5. Insert the drive shaft (key 6) into the valve body bearing (key 10), and into the ball ear. Align the hole in the drive shaft with the holes in the ball.

CAUTION

The drive shaft must be used with the correct Vee-Ball. Refer to the tag (see figure 13) attached to the Vee-Ball and to the drive shaft.

Failure to use the correct Vee-Ball/ shaft combination may result in the ball not being in the position indicated by the slash mark on the end of the shaft. If the ball is not properly aligned with the slash mark, the valve will not function correctly and seal damage may result.

6. Installing the Taper Key (key 4):

Current standard construction materials for all NPS 3 through 12 valves require the taper key (key 4, figure 14) to be tack welded in place using the following procedure. Use standard welding preparations when preparing parts for reassembly.

CAUTION

Make sure the drive shaft (key 6) is free of oil or grease, otherwise the taper key will not seat properly. Failure to properly set the taper pin or taper key could result in it coming loose while in service. Loosening of the taper key in service could result in improper valve function and equipment damage.

1. Install the drive shaft (key 6) into the valve body through the ball and into the lower bearing.
2. Insert the taper key (key 4) into ball and drive shaft (keys 2 and 6) as shown in figure 14. The taper key inserts, with the flat side of the key, facing the drive shaft (key 6).
3. Using a flat end punch, drive the groove pin (key 7) into the ball ear and follower shaft until it is flat with the ball ear surface.
4. Using a flat end punch, drive the taper key (key 4) into the ball ear and drive shaft (key 6) until solid, heavy contact is obtained between the key and shaft.
5. Measure the position of the taper key head.
6. Drive the taper key in further using the minimum distance shown in table 8.

Table 9. Taper Key Minimum Depth

VALVE SIZE, NPS	MINIMUM DEPTH TO DRIVE TAPER KEY AFTER INITIAL SOLID CONTACT, mm (INCHES)
3, 4, 6	4.8 (0.188)
8, 10, 12	5.6 (0.219)

Table 10. Taper Key Maximum Depth

VALVE SIZE, NPS	MAXIMUM DEPTH TO DRIVE TAPER KEY AFTER INITIAL SOLID CONTACT, mm (INCHES)
3, 4	7.1 (0.281)
6	7.9 (0.312)
8, 10	9.5 (0.375)
12	10.3 (0.406)

7. Inspect the ball/shaft taper key connection to verify that the taper key spans the entire shaft flat width. If not, the taper key must be driven in further until this condition is satisfied. However, do not exceed the maximum depths shown in table 9.

Note

When welding standard valves that have a CG8M (317 SST) or CF3M (316L SST) ball, use 309 or 309L filler rod material.

Alloy valve taper keys are normally not welded.

8. When the above conditions are met, tack weld the taper key (key 4) to the ball ear on the head end of the key (see figure 26). Use a:

- 1/8 inch diameter weld on NPS 3 through 6 valves,

- 3/16 inch diameter weld on NPS 8 through 10 valves, and
- 1/4 inch diameter weld on NPS 12 valves.

For all constructions: Refer to Replacing the Ball Seal, Packing Maintenance, and other procedures as necessary to complete the assembly of the valve.

Actuator Mounting

Use the appropriate actuator instruction manual and figure 23 of this manual when mounting the actuator or changing actuator styles and positions.

To help ensure correct centering of the ball (key 2) on the seal (key 11), be sure the ball is closed when mounting the actuator. Do not use a hammer or other tool to drive the actuator lever onto the valve shaft.

Clean the valve shaft and actuator lever splines to be sure the actuator lever will slide on easily. If the lever does not slide on easily, carefully wedge the ball solidly against the actuator-side bearing using a screwdriver or similar tool inserted between the lower ear of the ball and the valve body.

Keep the wedge in place while installing the lever, but again, do not drive on the lever. Remove the wedge after you have clamped the actuator lever on the valve shaft and connected the lever to the actuator piston rod or diaphragm rod.

Determining Mounting Position

The actuator can be either right or left-hand mounted.

Note

Right-hand mounting—Actuator is on the right side of the valve when viewed from valve inlet.

Left-hand mounting—Actuator is on the left side of the valve when viewed from valve inlet.

The preferred location of the ball is in the top of the valve body when the valve is open. To convert from right to left hand-mounting, turn the valve to position the actuator mounting pad on the left and rotate the ball to the top of the valve.

The number one V-notch controls flow on right-hand mounting. Turn the valve 180 degrees, and rotate the ball to the top of the valve to obtain left-hand mounting. The number two V-notch controls flow for this construction. See figure 31.

Determining Closed Position

1. The valve must be removed from the line to check the position of the ball.

⚠ WARNING

The ball closes with a shearing, cutting motion. To avoid personal injury, keep hands, tools, and other objects away from the ball while stroking the valve.

2. Rotate the ball to the closed position.
3. Follow one of the procedures below:

- When viewed from the valve body inlet, the ball is in the proper position when both V-notches of the ball are centered between the machined diameter of the ledge that supports the seal.
- If the ball has a spot machined on the top, align that spot to the exact center of the seal cavity.

4. Adjust the actuator linkage as described in the appropriate actuator instruction manual until the condition described in step 3 exists. A line is stamped on the actuator end of the drive shaft (see figure 23) to indicate the ball position.

⚠ WARNING

Use only genuine Fisher replacement parts. Components that are not supplied by Emerson Process Management should not, under any circumstances, be used in any Fisher valve, because they will void your warranty, might adversely affect the performance of the valve, and could give rise to personal injury and property damage.

Non-Series B Design Parts (figure 30)

Note
Contact your Emerson Process Management sales office for part numbers.

Key	Description
2	Ball
2	Ball with attenuator (RH mtg in Common parts section)
6	Drive Shaft
9	Follower Shaft
10*	Bearing (2 req'd) PEEK S44004 (440C SST) R30016 (alloy 6B) Silver-plated R30016 (alloy 6B) Carbon-filled PTFE with N10276 sleeve Glass-filled PTFE with N10276 sleeve

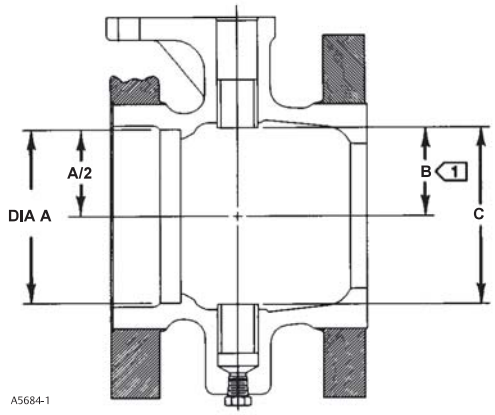
*Recommended spare parts

VALVE SIZE, NPS	BEARING RAM DIMENSIONS								BUSHING RAM DIMENSIONS					
	Ram Lengths				Ram Diameters				Ram Diameters					
	L		M		D		d		D		Long Ram d		Short Ram d	
	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches
3 & 4	201.42 MIN	7.930 MIN(1)	95.25 MIN	3.750 MIN	22.86 22.61	0.900 0.890	19.05 18.80	0.750 0.740	28.19 27.94	1.110 1.100	19.05 18.80	0.750 0.740	22.86 22.61	0.900 0.890
6	247.65 MIN	9.750 MIN	95.25 MIN	3.750 MIN	29.21 28.96	1.150 1.140	25.40 25.15	1.000 0.990	34.54 34.29	1.360 1.350	25.40 25.15	1.000 0.990	29.21 28.96	1.150 1.140
8	338.75 MIN	13.310 MIN	139.70 MIN	5.500 MIN	35.56 35.31	1.400 1.390	31.75 31.50	1.250 1.240	40.89 40.64	1.610 1.600	31.75 31.50	1.250 1.240	35.56 35.31	1.400 1.390
10	396.75 MIN	15.620 MIN	139.70 MIN	5.500 MIN	35.56 35.31	1.400 1.390	31.75 31.50	1.250 1.240	40.89 40.64	1.610 1.600	31.75 31.50	1.250 1.240	35.56 35.31	1.400 1.390
12	476.25 MIN	18.750 MIN	152.40 MIN	6.000 MIN	41.91 41.66	1.650 1.640	38.10 37.85	1.500 1.490	50.42 50.17	1.985 1.975	38.10 37.85	1.500 1.490	41.91 41.66	1.650 1.640

1. MIN = Minimum.

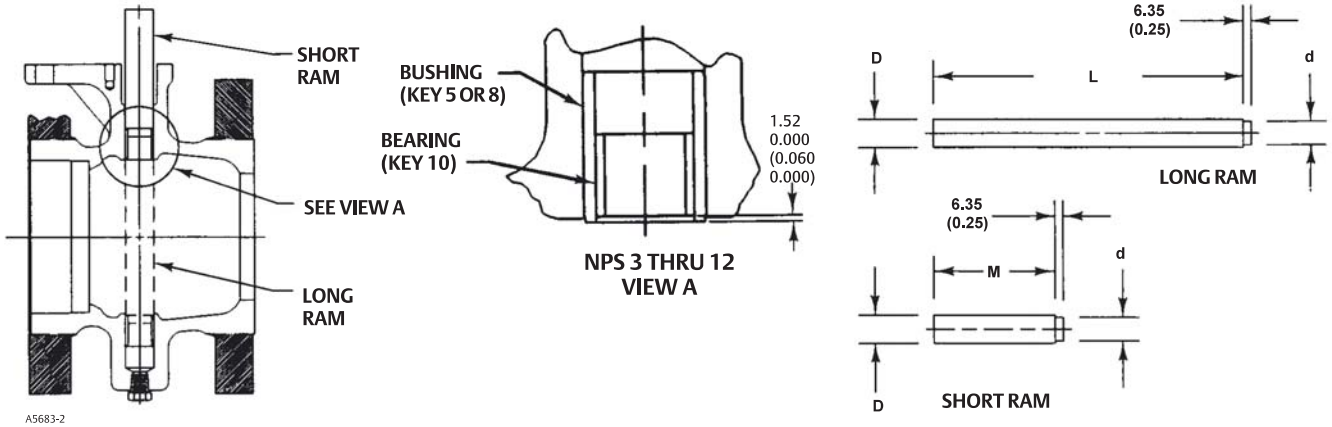
VALVE SIZE, NPS	DIMENSION			
	B	C	B	C
	Millimeters		Inches	
3	48.26 50.04	100.38 100.63	1.960 1.970	3.952 3.962
4	60.10 60.35	121.01 121.26	2.366 2.376	4.764 4.774
6	83.59 83.85	168.00 168.25	3.291 3.301	6.614 6.624
8	106.20 106.45	213.21 213.46	4.181 4.191	8.394 8.404
10	135.33 135.59	271.48 271.73	5.328 5.338	10.688 10.698
12	169.67 169.93	340.16 340.41	6.680 6.690	13.392 13.402

Figure 28. Bushing Location



BUSHING (KEY 5) LOCATION

Figure 29. Metal Bearing Ram Location

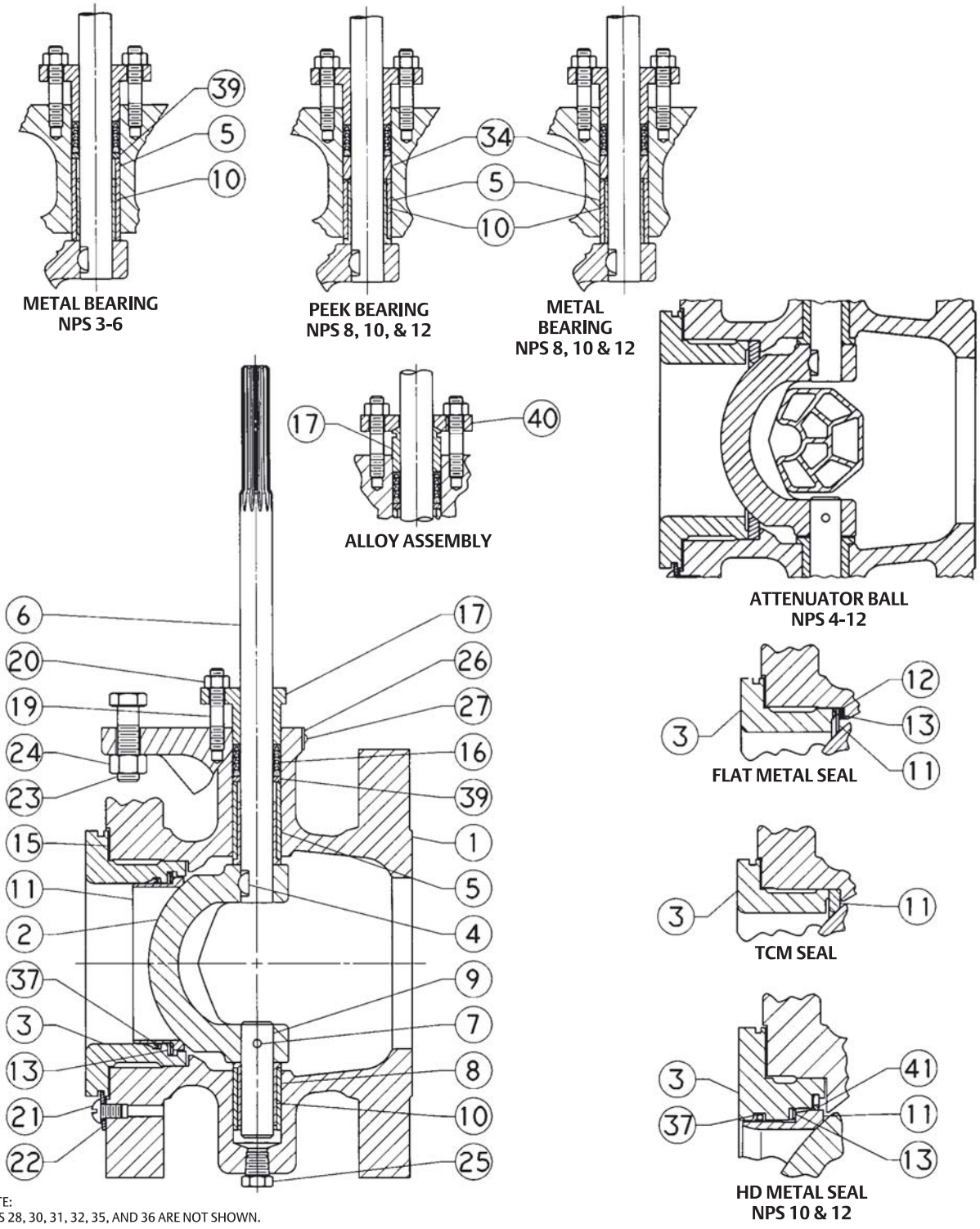


NOTES:
1 DIMENSION B IS THE DISTANCE BETWEEN THE GUIDE BUSHING AND THE CENTER OF DIAMETER A.

BEARING RAM

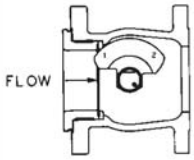
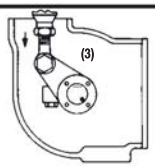
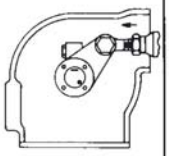
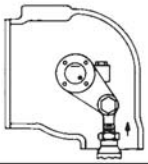
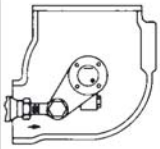
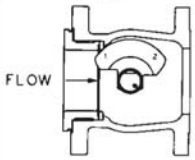
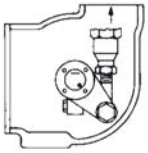
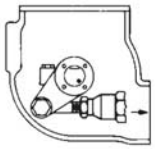
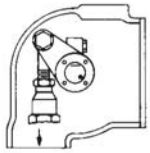
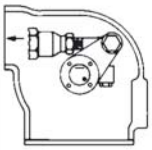
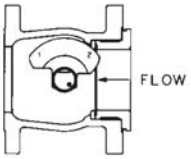
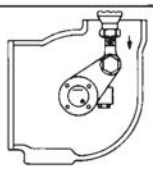
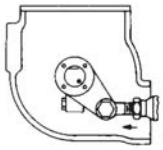
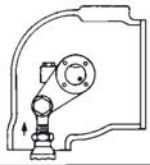
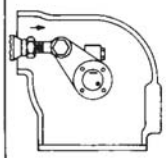
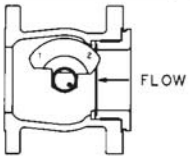
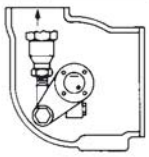
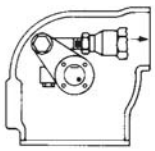
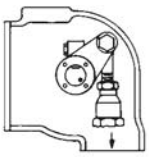
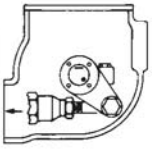
mm
(INCHES)

Figure 30. Fisher V150 and V300 Non-Series B Valve Assembly (NPS 3- 12)
(Details are typical for V200 Valves except V200 does not have flanges)



NOTE:
KEYS 28, 30, 31, 32, 35, AND 36 ARE NOT SHOWN.

Figure 31. Index Marks for Actuator Lever Orientation for Non-Series B Valves

ACTUATOR		VALVE OPEN	ACTUATOR POSITION			
MOUNTING	STYLE		1	2	3	4
RIGHT-HAND(1)	STYLE A (PDTC)(2)					
	STYLE B (PDTO)(2)					
LEFT-HAND(1)	STYLE C (PDTC)(2)					
	STYLE D (PDTO)(2)					

1. Right-hand mounting controls with v notch no. 1; Left-hand mounting controls with v notch no. 2
2. PDTC-push down to close; PDTO-push down to open
3. Arrow on lever indicates direction of actuator thrust to close valve

B2703

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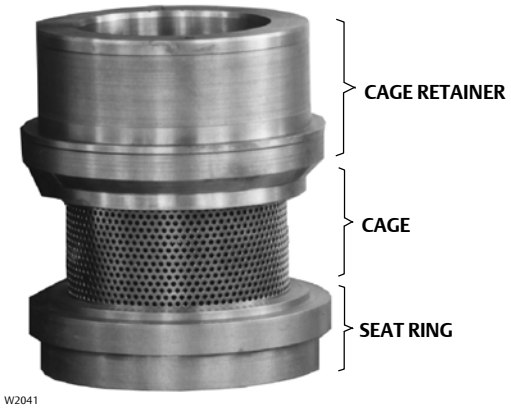
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Fisher® Whisper Trim™ III Cages

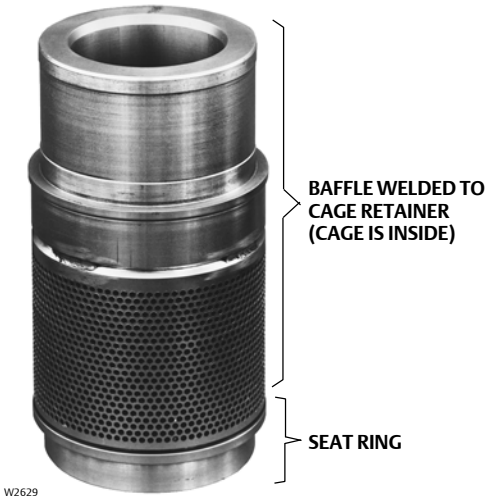
Whisper Trim III cages provide effective attenuation of aerodynamic noise in vapor, gas, or steam applications involving high pressure drops or high pressure drop ratios. Using a Whisper Trim III cage in conjunction with a properly-sized valve body can substantially reduce the noise level of the control application.

Aerodynamic noise is generated by the turbulence created in the flow of vapor, gas, or steam as the fluid passes through a control valve. To achieve effective noise attenuation, a Whisper Trim III cage utilizes multiple orifices of a special shape, size, and spacing. These orifices break up turbulent fluid streams, reducing noise-producing interactions.

Whisper Trim III cages are available for a variety of valve body types (see table 1). Please refer to the appropriate valve body bulletin for additional construction details.



LEVELS A1 THROUGH C3



LEVEL D1 OR D3

Features

- **Outstanding Noise Control—**Use of a Whisper Trim III cage in a properly sized valve can result in a noise reduction up to 30 dBA compared to the same valve with standard trim. Such a reduction would be similar to the reduction in noise level noticed when moving away from the noise source 94m (308 feet).
- **Optimum Performance—**Use of a Whisper Trim III cage provides excellent noise reduction and high flow capacity with the proven control and durability offered by standard Fisher valve trims. The result: optimum overall performance at a minimum investment.
- **Easy Maintenance—**Quick change trim allows fast and easy inspection of the cage without taking the valve body out of the pipeline. Whisper Trim III is interchangeable with standard control valve trim.
- **Long Trim Life—**Hardened materials of construction are standard to provide exceptional wear resistance. For more information about trim materials, see the appropriate valve body bulletin.

Specifications

Availability

See table 1

Trim Material and Selection

See appropriate valve body bulletin

Pressure/Temperature Capability

See appropriate valve body bulletin

Maximum Pressure Drops

As shown in appropriate valve body bulletin, except where further limited by the maximum $\Delta P/P_1$ ratio given in table 1.

(Application limitations are based on calculations of the maximum $\Delta P/P_1$ ratio. Excessive noise levels could occur if application conditions exceed the maximum $\Delta P/P_1$ ratio for a given cage level.)

Flow Characteristic(1)

Linear (restricted linear cages, modified parabolic cages, and special, characterized cages are available--consult your Emerson Process Management sales office)

Flow Direction

Up--through the seat ring and out through the cage orifices

Noise Attenuation

See Catalog 12, section 3 for calculation procedure

Sizing Coefficients(1)

See Catalog 12, section 1 for actual values

Shutoff Classification

See appropriate valve body bulletin

1. For additional sizing information, contact your Emerson Process Management sales office.

Installation

In any installation, the valve must be oriented so the flow complies with the arrow on the side of the valve body. Flow is always up through the seat ring.

Because the Whisper Trim III cage design utilizes a multiple-orifice design, a strainer should be installed upstream of any Whisper Trim III application.

The level A1 through D1 cages have 3.2 mm (0.125 inch) diameter orifices. The level A3 through D3 have 1.6 mm (0.0625 inch) diameter orifices.

Figure 1. Whisper Trim III Cage in NPS 6 Fisher ED Valve

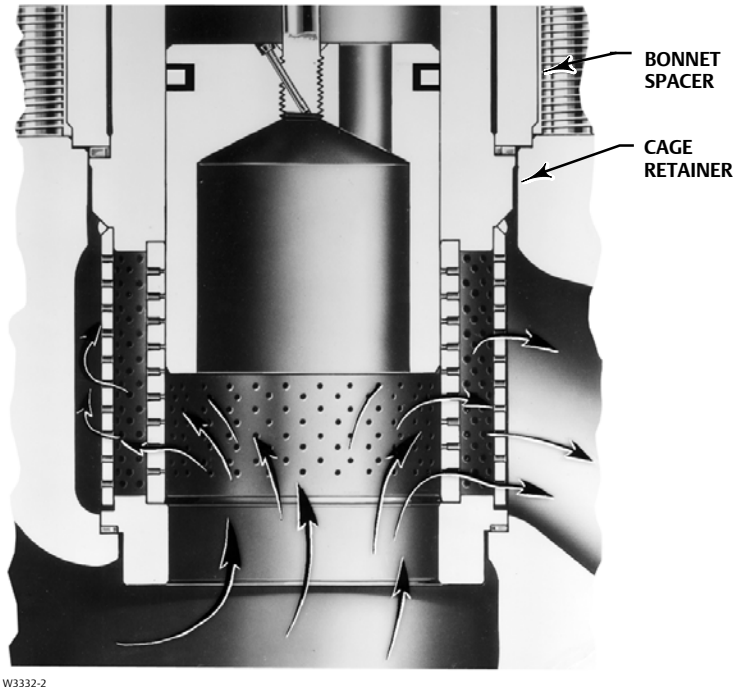


Figure 2. Whisper Trim III Cage in NPS 12 x 8 Fisher EWNT-2 Valve with Seat Ring Threaded Into the Cage

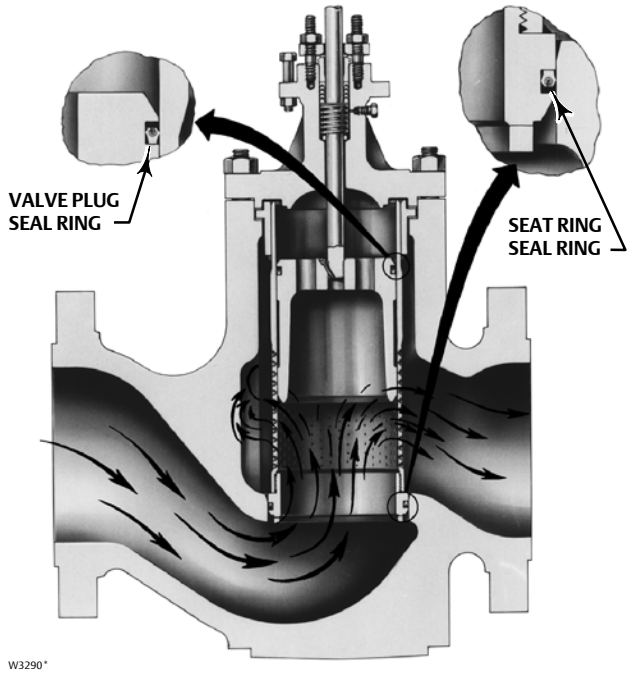


Table 1. Valve Body Constructions with Whisper Trim III Cages

VALVE DESIGN	VALVE SIZE, NPS[3]	PRESSURE RATING	PORT DIAMETER		VALVE PLUG, TRAVEL		PERFORMANCE LEVEL, MAX △ P/P$_1$[4]							
							0.60		0.75		0.85		0.99	
			mm	Inch	mm	Inch	A1	A3	B1	B3	C1	C3	D1	D3
GX	DN 80 (NPS 3)	PN 10 - PN 40 (CL150, 300)	70	---	40	---	X							
	DN 100 (NPS 4)		90		40		X							
			70[5]		40		X							
	DN 150 (NPS 6)		136		60		X							
			90[5]		40		X							
ED, ES, ET	1	CL150, 300, 600	33	1.3125	19	0.75	X							
	1-1/2	CL150, 300, 600	19 27	0.75 1.875	29 19	1.125 0.75	X X					X		X
	2	CL150, 300, 600	33 59	1.3125 2.3125	32 29	1.25 1.125	X X			X		X		X
	3[2]	CL150, 300, 600	59 87	2.3125 3.4375	38 38	1.5 1.5	X X	X		X		X		X
	4[2]	CL150, 300, 600	87 111	3.4375 4.375	51 51	2 2	 X	X		X		X		X
	6[1, 2]	CL150, 300, 600	136 178	5.375 7	76 51	3 2	X X	X		X		X		X
	8	CL150, 300, 600	203 203 203	8 8 8	51 76 102	2 3 4	X X X							
	12 and larger	CL150, 300, 600	Consult Fisher bulletin 51.1:ET/ED Large (D103554X012)											
EHD, EHS, EHT	1	CL2500	19	0.75	38	1.5	X							
	2	CL2500	25 38	1 1.5	29 38	1.125 1.5	X X			X		X		X
	3 x 2	CL2500	38	1.5	38	1.5	X							
	3	CL2500	33 59	1.3125 2.3125	51 38	2 1.5	X X	X	X X	X		X		X
	4 x 3	CL2500	59	2.3125	38	1.5	X		X					
	4	CL2500	59 73	3.3125 2.875	51 51	2 2	X X		X	X				X
	6 x 4	CL2500	73	2.875	51	2	X		X	X				
	6	CL2500	111	4.375	76	3	X	X	X	X				X
	8 x 6	CL2500	111	4.375	76	3	X			X		X		X
	8, 10	CL1500	178	7	178	7	X	X	X	X	X	X	X	X
		CL2500	136	5.375	146	5.75								
	12, 14	CL1500	254	10	184	7.25								
		CL2500	178	7	178	7								

-continued-

Table 1. Valve Body Constructions with Whisper Trim III Cages (continued)

VALVE DESIGN	VALVE SIZE, NPS[3]	PRESSURE RATING	PORT DIAMETER		VALVE PLUG, TRAVEL		PERFORMANCE LEVEL, MAX △ P/P_1[4]							
			mm	Inch	mm	Inch	0.60		0.75		0.85		0.99	
							A1	A3	B1	B3	C1	C3	D1	D3
EWD, EWS, EWT	4 x 2	CL150, 300, 600	33 59	1.3125 2.3125	32 29	1.25 1.125	X X			X		X		X
	6 x 4	CL150, 300, 600	87 111	3.4375 4.375	51 51	2 2	 X	X		X X		X X		X
	8 x 4	CL150, 300, 600	87 111	3.4375 4.375	51 51	2 2	 X	X		X X		X X		X
	8 x 6[1, 2]	CL150, 300, 600, 900	136 178 178	5.375 7 7	127 51 102	5 2 4	X X X	X X		X X		X X		X
	12 x 6[1, 2]	CL150, 300, 600	136 178 178	5.375 7 7	165 51 102	6.5 2 4	X X X	X X		X X		X X		X
	10 x 8	CL150, 300, 600	178 203	7 8	152 152	6 6	 X	 X		 X		 X		X
	12 x 8	CL150, 300, 600, 900	178 178 203 203	7 7 8 8	152 203 152 203	6 8 6 8	 X X	 X X		 X X		 X X		X X
	12 and larger	CL150, 300, 600	Consult Fisher bulletin 51.1:ET/ED Large (D103554X012)											
EWD-1, EWT-1	12 x 8	CL900	197	7.75	146	5.75	X	X	X	X	X	X		
			172	6.75	146	5.75							X	X
EWND-1, EWNT-1	8 x 6	CL900	136	5.375	127	5	X	X		X		X		X
	12 x 8	CL900	197	7.75	203	8	X	X	X	X	X	X		
			172	6.75	203	8							X	X
EWND-1, EWNT-2	12 x 8	CL300, 600	197	7.75	203	8	X	X	X	X	X	X		
			172	6.75	203	8							X	X
EU	16 and 20	Consult Fisher bulletin 51.1:EU (D102004X012)												
EW	20 x 16 thru 24 x 20	Consult Fisher bulletin 51.1:EU (D102004X012)												
FBD, FBT	8 x 12 thru 24 x 24	Consult Fisher bulletin 51.1:FB (D100195X012)					X	X	X	X	X	X	X	X
	16 x 30 thru 36 x 36	Consult Fisher bulletin 51.1:FB (D100195X012)					X		X	X	X	X	X	X
HPD, HPS, HPT	1	CL1500, 2500	19 25	0.75 1	29 19	1.125 0.75	X X							
	2	CL1500, 2500	19 25 48	0.75 1 1.875	29 19 51	1.125 0.75 2	X X X			 X		X X		
	3	CL1500	48 73	1.875 2.875	51 51	2 2	X X		 X			X		X
	4	CL1500	73 92	2.875 3.625	51 51	2 2	 X		 X	 X	 X	 X		X
	6	CL1500	111 136	4.375 5.375	76 76	3 3	 X	 X		 X		 X		

1. Please note that the body/bonnet height may be greater after installing a Whisper Trim III cage. A spacer is required for ED, ET, EWD, and EWT configurations.
2. Other sizes may be available--consult your Emerson Process Management sales office.
3. Two-number valve body size designation for EH, EW, and EWN Series valves indicates end connection size by trim size, but for FB Series valves, it indicates inlet size by outlet size.
4. The X indicates performance level available for given body-trim configuration. Other cage/body configurations available to meet specific applications.
5. GX unbalanced, restricted trim.

Ordering Information

When ordering, please specify:

1. Required C_V
2. Trim material
3. Valve body design
4. Valve body size
5. Valve materials of construction
6. Service conditions and all other information requested in the valve body bulletin

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Reference Manual
00809-0100-4001, Rev JA
November 2012

Rosemount 3051 Pressure Transmitter

with HART® Protocol





HART COMMUNICATION PROTOCOL

ROSEMOUNT

EMERSON. Process Management

Rosemount 3051 Pressure Transmitter

⚠ WARNING

Read this manual before working with the product. For personal and system safety, and for optimum product performance, make sure you thoroughly understand the contents before installing, using, or maintaining this product.

For technical assistance, contacts are listed below:

Customer Central
Technical support, quoting, and order-related questions.

United States - 1-800-999-9307 (7:00 am to 7:00 pm CST)

Asia Pacific- 65 777 8211

Europe/ Middle East/ Africa - 49 (8153) 9390

North American Response Center
Equipment service needs.

1-800-654-7768 (24 hours—includes Canada)

Outside of these areas, contact your local Emerson Process Management representative.

⚠ CAUTION

The products described in this document are NOT designed for nuclear-qualified applications. Using non-nuclear qualified products in applications that require nuclear-qualified hardware or products may cause inaccurate readings.

For information on Rosemount nuclear-qualified products, contact your local Emerson Process Management Sales Representative.

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Section 1 Introduction

1.1 Using this manual

The sections in this manual provide information on installing, operating, and maintaining the Rosemount 3051. The sections are organized as follows:

Section 2: Installation contains mechanical and electrical installation instructions, and field upgrade options.

Section 3: Configuration provides instruction on commissioning and operating Rosemount 3051 transmitters. Information on software functions, configuration parameters, and online variables is also included.

Section 4: Operation and maintenance contains operation and maintenance techniques.

Section 5: Troubleshooting provides troubleshooting techniques for the most common operating problems.

Appendix A: Specifications and reference data supplies reference and specification data, as well as ordering information.

Appendix B: Product certifications contains intrinsic safety approval information, European ATEX directive information, and approval drawings.

1.2 Service support

To expedite the return process outside of the United States, contact the nearest Emerson Process Management representative.

Within the United States, call the Emerson Process Management Instrument and Valve Response Center using the 1-800-654-RSMT (7768) toll-free number. This center, available 24 hours a day, will assist you with any needed information or materials.

The center will ask for product model and serial numbers, and will provide a Return Material Authorization (RMA) number. The center will also ask for the process material to which the product was last exposed.

⚠ CAUTION

Individuals who handle products exposed to a hazardous substance can avoid injury if they are informed of and understand the hazard. The product being returned will require a copy of the required Material Safety Data Sheet (MSDS) for each substance must be included with the returned goods.

Emerson Process Management Instrument and Valve Response Center representatives will explain the additional information and procedures necessary to return goods exposed to hazardous substances.

1.3 Models covered

The following Rosemount 3051 Pressure Transmitters are covered by this manual:

Rosemount 3051C coplanar pressure transmitter

Rosemount 3051CD Differential Pressure Transmitter

Measures differential pressure up to 2000 psi (137,9 bar).

Rosemount 3051CG Gage Pressure Transmitter

Measures gage pressure up to 2000 psi (137,9 bar).

Rosemount 3051CA Absolute Pressure Transmitter

Measures absolute pressure up to 4000 psia (275,8 bar).

Rosemount 3051T in-line pressure transmitter

Rosemount 3051T Gage and Absolute Pressure Transmitter

Measures gage pressure up to 10000 psi (689,5 bar).

Rosemount 3051L liquid level transmitter

Provides precise level and specific gravity measurements up to 300 psi (20,7 bar) for a wide variety of tank configurations.

Rosemount 3051H high process temperature pressure transmitter

Provides high process temperature capability to 375 °F (191 °C) for measuring differential or gage pressure without use of remote diaphragm seals or capillaries.

Note
For Rosemount 3051 with FOUNDATION™ fieldbus, see Rosemount Product Manual 00809-0100-4774. For Rosemount 3051 with Profibus PA, see Rosemount Product Manual 00809-0100-4797.

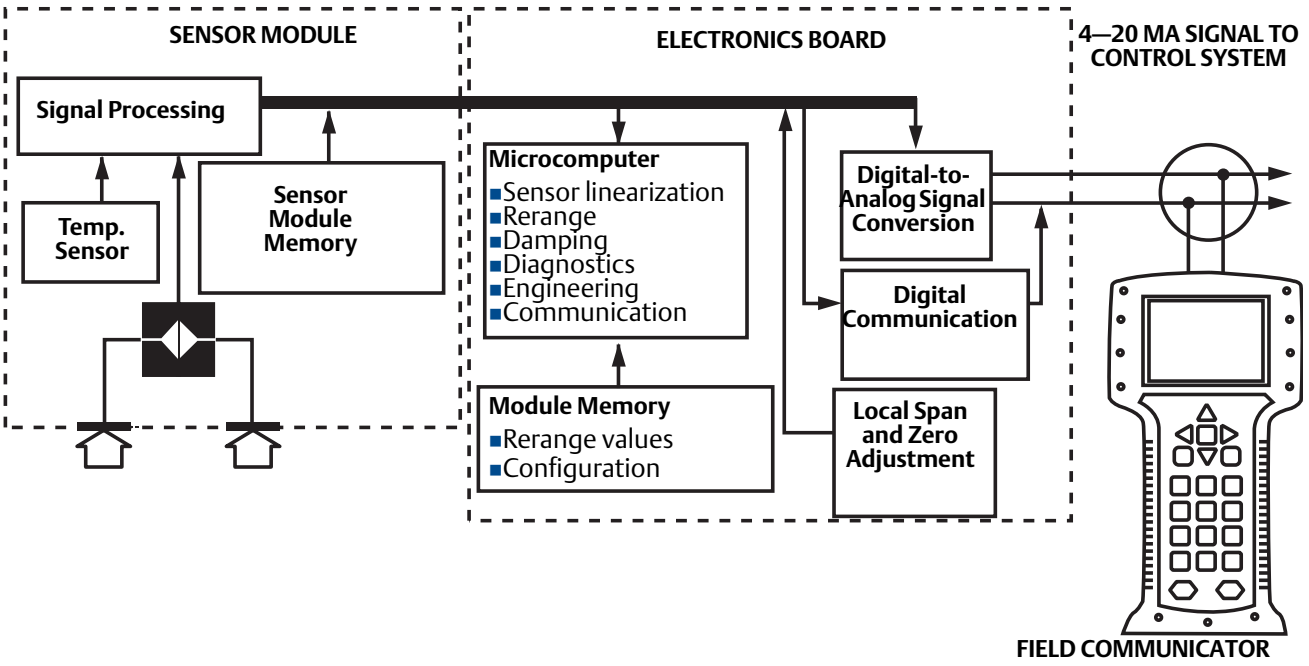
1.4 Transmitter overview

The Rosemount 3051C Coplanar™ design is offered for Differential Pressure (DP), Gage Pressure (GP) and Absolute Pressure (AP) measurements. The Rosemount 3051C utilizes Emerson Process Management capacitance sensor technology for DP and GP measurements. Piezoresistive sensor technology is utilized in the Rosemount 3051T and 3051CA measurements.

The major components of the Rosemount 3051 are the sensor module and the electronics housing. The sensor module contains the oil filled sensor system (isolating diaphragms, oil fill system, and sensor) and the sensor electronics. The sensor electronics are installed within the sensor module and include a temperature sensor (RTD), a memory module, and the capacitance to digital signal converter (C/D converter). The electrical signals from the sensor module are transmitted to the output electronics in the electronics housing. The electronics housing contains the output electronics board, the local zero and span buttons, and the terminal block. The basic block diagram of the Rosemount 3051CD is illustrated in Figure 1-1.

For the Rosemount 3051C design pressure is applied to the isolating diaphragms, the oil deflects the center diaphragm, which then changes the capacitance. This capacitance signal is then changed to a digital signal in the C/D converter. The microprocessor then takes the signals from the RTD and C/D converter calculates the correct output of the transmitter. This signal is then sent to the D/A converter, which converts the signal back to an analog signal and superimposes the HART signal on the 4-20 mA output.

Figure 1-1. Block diagram of operation



1.5 Product recycling/ disposal

Recycling of equipment and packaging should be taken into consideration and disposed of in accordance with local and national legislation/regulations.

Section 2 Installation

Overview . . . . . **page 5**
Safety messages . . . . . **page 5**
General considerations . . . . . **page 6**
Mechanical considerations . . . . . **page 7**
Draft range considerations . . . . . **page 7**
Environmental considerations . . . . . **page 8**
HART installation flowchart . . . . . **page 9**
Installation procedures . . . . . **page 10**
Electrical considerations . . . . . **page 22**
Hazardous locations certifications . . . . . **page 29**
Rosemount 305, 306, and 304 manifolds . . . . . **page 29**
Liquid level measurement . . . . . **page 34**

2.1 Overview

The information in this section covers installation considerations for the Rosemount 3051 with HART protocols. A Quick Installation Guide for HART protocol (document number 00825-0100-4001) is shipped with every transmitter to describe basic pipe-fitting and wiring procedures for initial installation. Dimensional drawings for each 3051 variation and mounting configuration are included on page 13.

2.2 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operation. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

⚠ WARNING

Explosions could result in death or serious injury:

Installation of this transmitter in an explosive environment must be in accordance with the appropriate local, national, and international standards, codes, and practices. Please review the approvals section of the 3051 reference manual for any restrictions associated with a safe installation.

- Before connecting a Field Communicator in an explosive atmosphere, ensure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- In an Explosion-Proof/Flameproof installation, do not remove the transmitter covers when power is applied to the unit.

Process leaks may cause harm or result in death.

- Install and tighten process connectors before applying pressure.

Electrical shock can result in death or serious injury.

- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.

⚠ WARNING

Electrical shock can result in death or serious injury.

- Avoid contact with the leads and terminals.

Process leaks could result in death or serious injury.

- Install and tighten all four flange bolts before applying pressure.
- Do not attempt to loosen or remove flange bolts while the transmitter is in service.

Replacement equipment or spare parts not approved by Emerson Process Management for use as spare parts could reduce the pressure retaining capabilities of the transmitter and may render the instrument dangerous.

- Use only bolts supplied or sold by Emerson Process Management as spare parts.
- Refer to page 164 for a complete list of spare parts.

Improper assembly of manifolds to traditional flange can damage sensor module.

- For safe assembly of manifold to traditional flange, bolts must break back plane of flange web (i.e., bolt hole) but must not contact sensor module housing.

2.3 General considerations

Measurement accuracy depends upon proper installation of the transmitter and impulse piping. Mount the transmitter close to the process and use a minimum of piping to achieve best accuracy. Keep in mind the need for easy access, personnel safety, practical field calibration, and a suitable transmitter environment. Install the transmitter to minimize vibration, shock, and temperature fluctuation.

Important
Install the enclosed pipe plug (found in the box) in unused conduit opening with a minimum of five threads engaged to comply with explosion-proof requirements.

For material compatibility considerations, see document number 00816-0100-3045 on www.emersonprocess.com/rosemount.

2.4 Mechanical considerations

Note
For steam service or for applications with process temperatures greater than the limits of the transmitter, do not blow down impulse piping through the transmitter. Flush lines with the blocking valves closed and refill lines with water before resuming measurement.

Note
When the transmitter is mounted on its side, position the Coplanar flange to ensure proper venting or draining. Mount the flange as shown in Figure 2-8 on page 16, keeping drain/vent connections on the bottom for gas service and on the top for liquid service.

2.5 Draft range considerations

Installation

For the Rosemount 3051CD0 draft range pressure transmitter, it is best to mount the transmitter with the isolators parallel to the ground. Installing the transmitter in this way reduces oil head effect and provides for optimal temperature performance.

Be sure the transmitter is securely mounted. Tilting of the transmitter may cause a zero shift in the transmitter output.

Reducing process noise

There are two recommended methods of reducing process noise: output damping and, in gage applications, reference side filtering.

Output damping

The output damping for the Rosemount 3051CD0 is factory set to 3.2 seconds as a default. If the transmitter output is still noisy, increase the damping time. If faster response is needed, decrease the damping time. Damping adjustment information is available on page 57.

Reference side filtering

In gage applications it is important to minimize fluctuations in atmospheric pressure to which the low side isolator is exposed.

One method of reducing fluctuations in atmospheric pressure is to attach a length of tubing to the reference side of the transmitter to act as a pressure buffer.

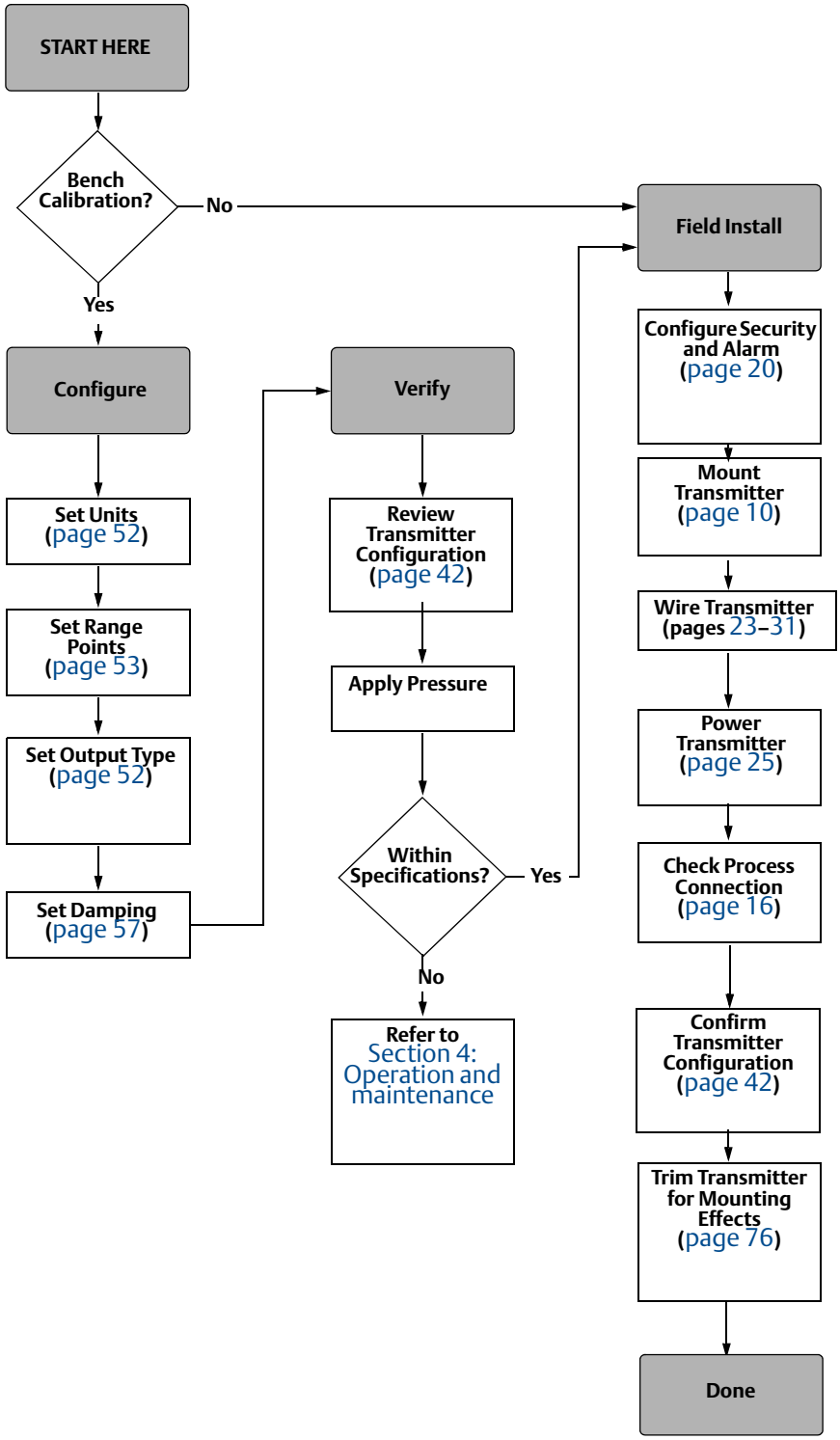
Another method is to plumb the reference side to a chamber that has a small vent to atmosphere. If multiple draft transmitters are being used in an application, the reference side of each device can be plumbed to a chamber to achieve a common gage reference.

2.6 Environmental considerations

Best practice is to mount the transmitter in an environment that has minimal ambient temperature change. The transmitter electronics temperature operating limits are –40 to 185 °F (–40 to 85 °C). Refer to Appendix A: Specifications and reference data that lists the sensing element operating limits. Mount the transmitter so that it is not susceptible to vibration and mechanical shock and does not have external contact with corrosive materials.

2.7 HART installation flowchart

Figure 2-1. HART installation flowchart



2.8 Installation procedures

2.8.1 Mount the transmitter

For dimensional drawing information refer to Appendix A: Specifications and reference data on page 120.

Process flange orientation

Mount the process flanges with sufficient clearance for process connections. For safety reasons, place the drain/vent valves so the process fluid is directed away from possible human contact when the vents are used. In addition, consider the need for a testing or calibration input.

Note
Most transmitters are calibrated in the horizontal position. Mounting the transmitter in any other position will shift the zero point to the equivalent amount of liquid head pressure caused by the varied mounting position. To reset zero point, refer to "Sensor Trim" on page 10.

Housing rotation

See "Housing rotation" on page 18.

Terminal side of electronics housing

Mount the transmitter so the terminal side is accessible. Clearance of 0.75 in. (19 mm) is required for cover removal. Use a conduit plug in the unused conduit opening.

Circuit side of electronics housing

Provide 0.75 in. (19 mm) of clearance for units with out an LCD display. Three inches of clearance is required for cover removal if a meter is installed.

Cover installation

Always ensure a proper seal by installing the electronics housing cover(s) so that metal contacts metal. Use Rosemount O-rings.

Conduit entry threads

For NEMA 4X, IP66, and IP68 requirements, use thread seal (PTFE) tape or paste on male threads to provide a watertight seal.

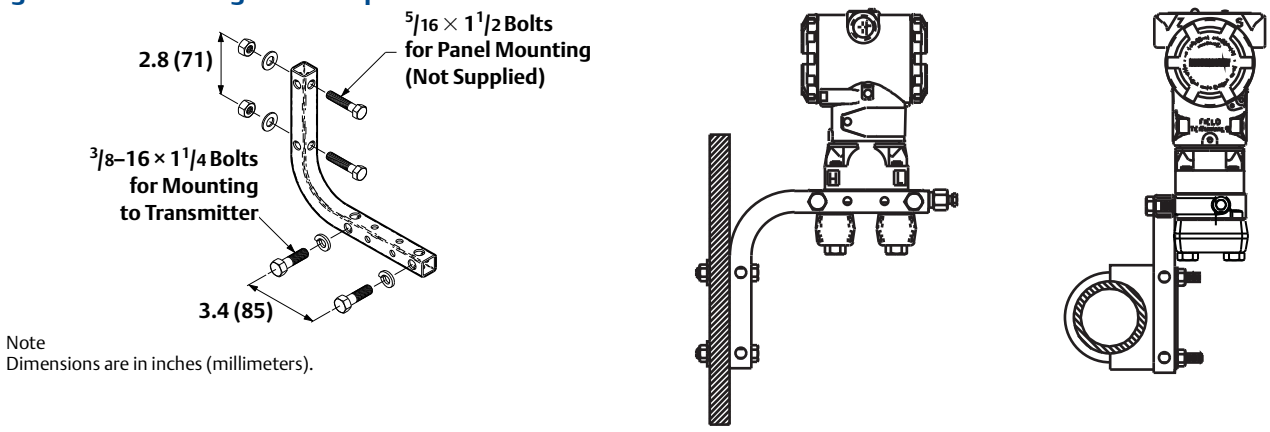
Mounting brackets

Rosemount 3051 Transmitters may be panel-mounted or pipe-mounted through an optional mounting bracket. Refer to Table 2-1 for the complete offering and see Figure 2-2 through Figure 2-5 on pages 11 and 12 for dimensions and mounting configurations.

Table 2-1. Mounting brackets

3051 brackets										
	Process connections			Mounting			Materials			
Option code	Coplanar	In-line	Traditional	Pipe mount	Panel mount	Flat panel mount	CS bracket	SST bracket	CS bolts	SST bolts
B4	X	X		X	X	X		X		X
B1			X	X			X		X	
B2			X		X		X		X	
B3			X			X	X		X	
B7			X	X			X			X
B8			X		X		X			X
B9			X			X	X			X
BA			X	X				X		X
BC			X			X		X		X

Figure 2-2. Mounting bracket option code B4



Note
Dimensions are in inches (millimeters).

Flange bolts

The 3051 can be shipped with a Coplanar flange or a Traditional flange installed with four 1.75-inch flange bolts. Mounting bolts and bolting configurations for the Coplanar and Traditional flanges can be found on page 14. Stainless steel bolts supplied by Emerson Process Management are coated with a lubricant to ease installation. Carbon steel bolts do not require lubrication. No additional lubricant should be applied when installing either type of bolt. Bolts supplied by Emerson Process Management are identified by their head markings:

Figure 2-3. Mounti ng bracket option codes B1, B7, and BA

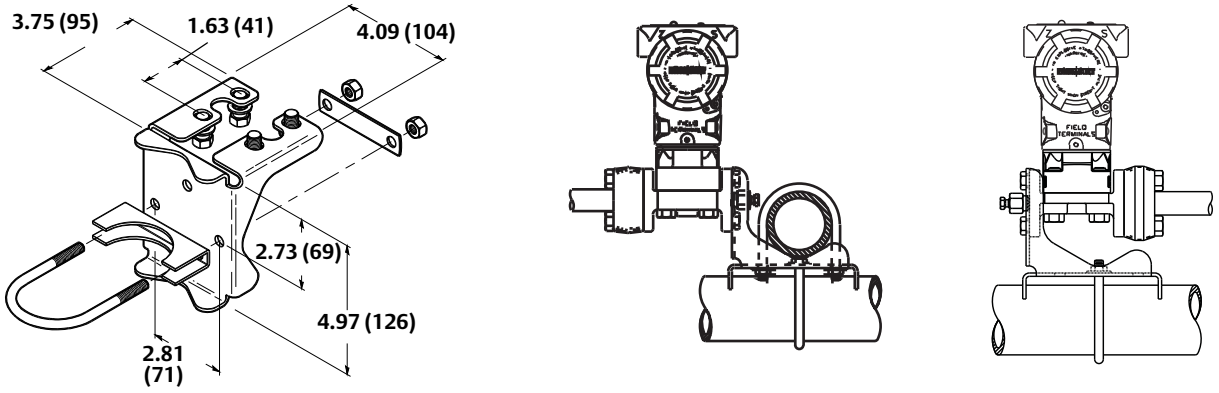


Figure 2-4. Panel mounting bracket option codes B2 and B8

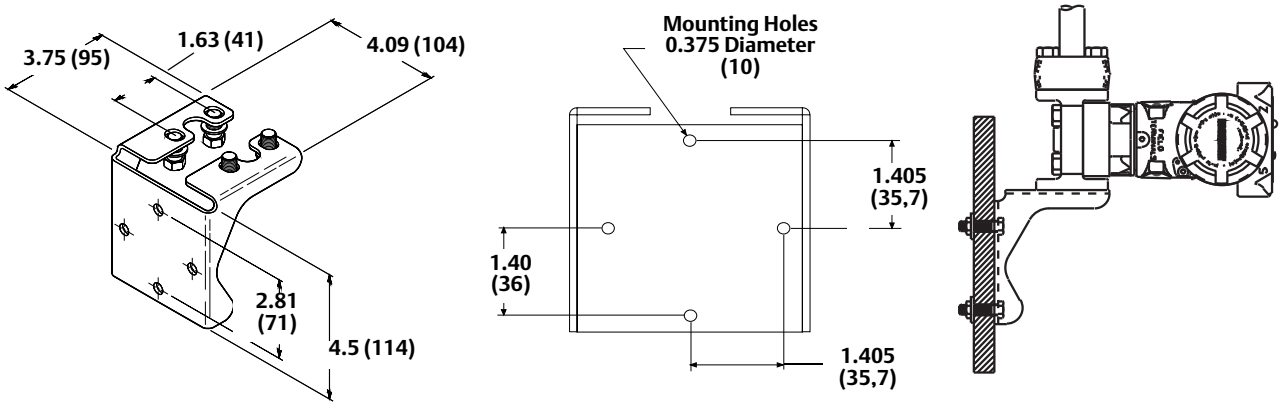
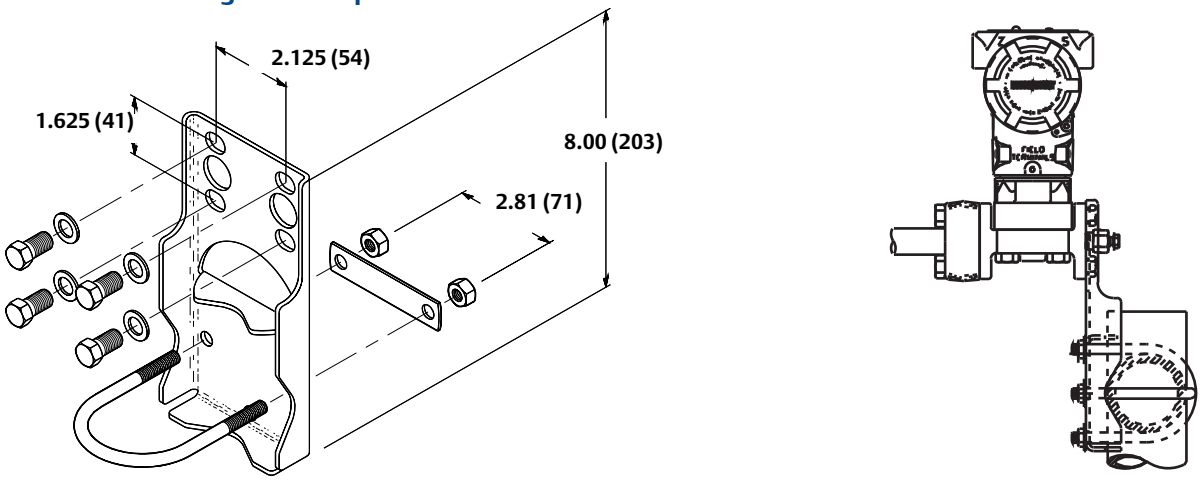
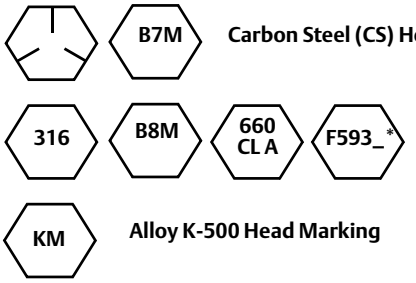


Figure 2-5. Flat mounting bracket option codes B3 and BC



Note
Dimensions are in inches (millimeters).



Carbon Steel (CS) Head Markings

Stainless Steel (SST) Head Markings

* The last digit in the F593_ head marking may be any letter between A and M.

Alloy K-500 Head Marking

Bolt installation

⚠ Only use bolts supplied with the Rosemount 3051 or sold by Emerson Process Management as spare parts for the Rosemount 3051 transmitter. Use the following bolt installation procedure:

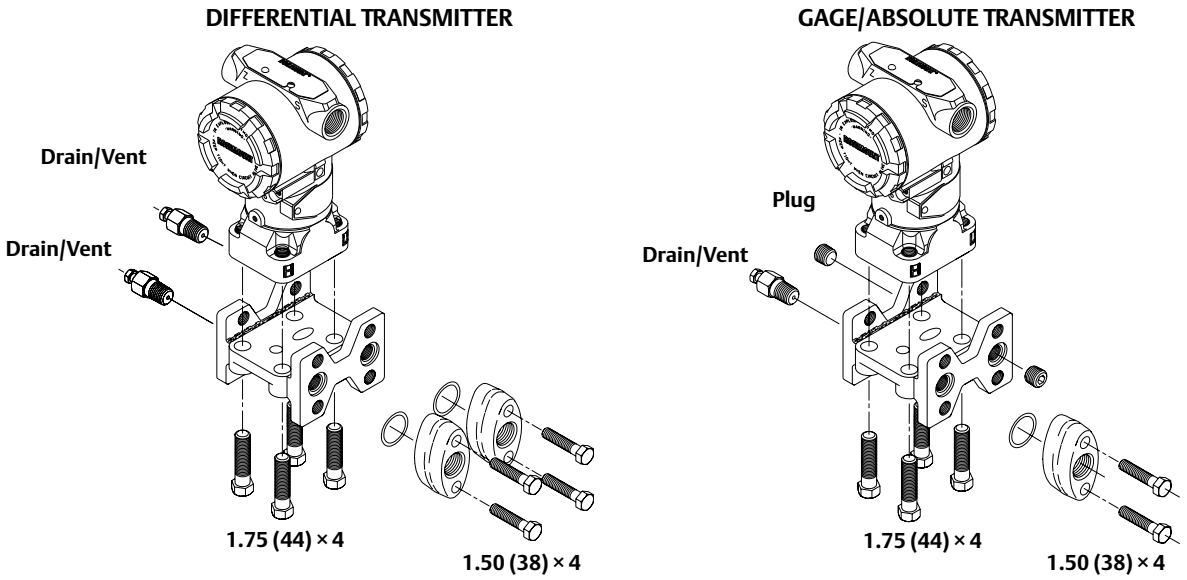
1. Finger-tighten the bolts.
2. Torque the bolts to the initial torque value using a crossing pattern (see Table 2-2 for torque values).
3. Torque the bolts to the final torque value using the same crossing pattern.

Table 2-2. Bolt installation torque values

Bolt material	Initial torque value	Final torque value
CS-ASTM-A445 Standard	300 in.-lb (34 N-m)	650 in.-lb (73 N-m)
316 SST—Option L4	150 in.-lb (17 N-m)	300 in.-lb (34 N-m)
ASTM-A-19 B7M—Option L5	300 in.-lb (34 N-m)	650 in.-lb (73 N-m)
Alloy 400—Option L6	300 in.-lb (34 N-m)	650 in.-lb (73 N-m)

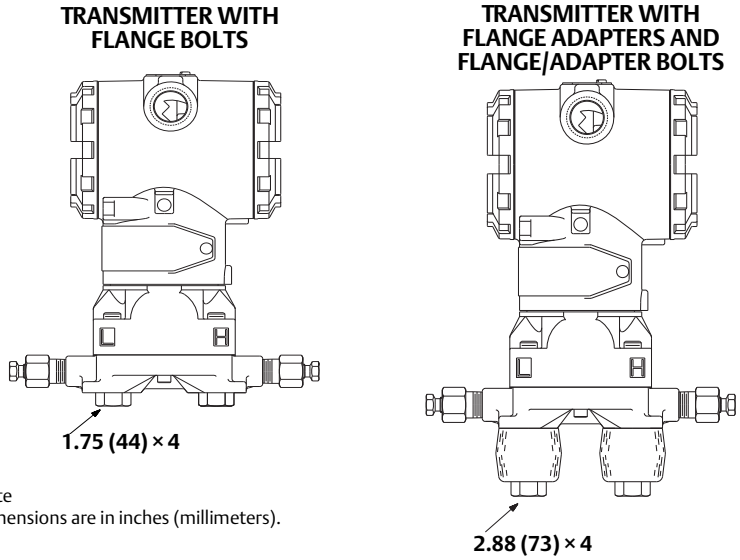
⚠ See "Safety messages" on page 5 for complete warning

Figure 2-4. Traditional flange bolt configurations



Note
Dimensions are in inches (millimeters).

Figure 2-7. Mounting bolts and bolt configurations for coplanar flange



Note
Dimensions are in inches (millimeters).

Description	Qty	Size in. (mm)
Differential Pressure		
Flange Bolts	4	1.75 (44)
Flange/Adapter Bolts	4	2.88 (73)
Gage/Absolute Pressure (1)		
Flange Bolts	4	1.75 (44)
Flange/Adapter Bolts	2	2.88 (73)

(1) Rosemount 3051T transmitters are direct mount and do not require bolts for process connection.

2.8.2 Impulse piping

The piping between the process and the transmitter must accurately transfer the pressure to obtain accurate measurements. There are five possible sources of error: pressure transfer, leaks,

friction loss (particularly if purging is used), trapped gas in a liquid line, liquid in a gas line, and density variations between the legs.

The best location for the transmitter in relation to the process pipe is dependent on the process. Use the following guidelines to determine transmitter location and placement of impulse piping:

- Keep impulse piping as short as possible.
- For liquid service, slope the impulse piping at least 1 in./foot (8 cm/m) upward from the transmitter toward the process connection.
- For gas service, slope the impulse piping at least 1 in./foot (8 cm/m) downward from the transmitter toward the process connection.
- Avoid high points in liquid lines and low points in gas lines.
- Make sure both impulse legs are the same temperature.
- Use impulse piping large enough to avoid friction effects and blockage.
- Vent all gas from liquid piping legs.
- When using a sealing fluid, fill both piping legs to the same level.
- When purging, make the purge connection close to the process taps and purge through equal lengths of the same size pipe. Avoid purging through the transmitter.
- Keep corrosive or hot (above 250 °F [121 °C]) process material out of direct contact with the sensor module and flanges.
- Prevent sediment deposits in the impulse piping.
- Maintain equal leg of head pressure on both legs of the impulse piping.
- Avoid conditions that might allow process fluid to freeze within the process flange.

Mounting requirements

Impulse piping configurations depend on specific measurement conditions. Refer to Figure 2-8 for examples of the following mounting configurations:

Liquid flow measurement

- Place taps to the side of the line to prevent sediment deposits on the transmitter's process isolators.
- Mount the transmitter beside or below the taps so gases can vent into the process line.
- Mount drain/vent valve upward to allow gases to vent.

Gas flow measurement

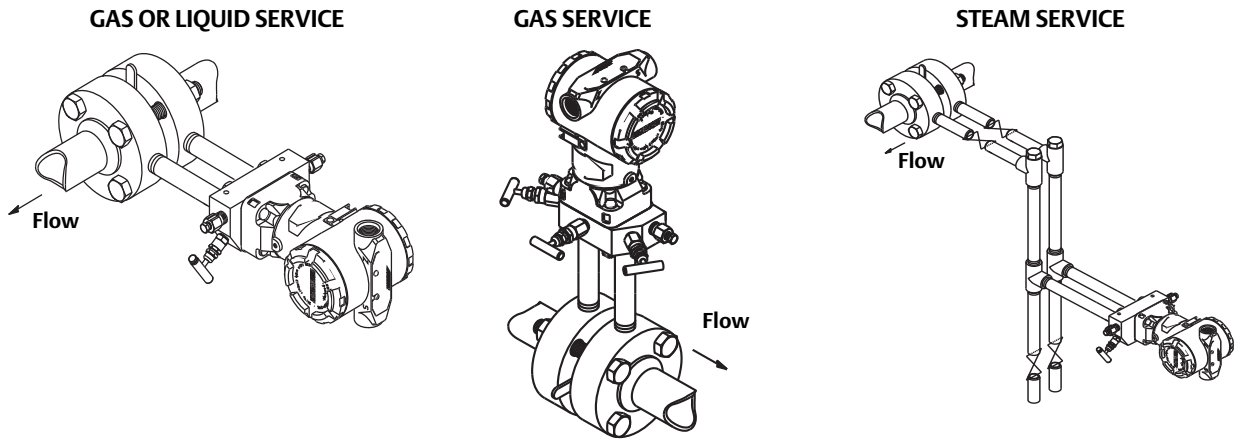
- Place taps in the top or side of the line.
- Mount the transmitter beside or above the taps so liquid will drain into the process line.

Steam flow measurement

- Place taps to the side of the line.
- Mount the transmitter below the taps to ensure that the impulse piping will stay filled with condensate.
- In steam service above 250 °F (121 °C), fill impulse lines with water to prevent steam from contacting the transmitter directly and to ensure accurate measurement start-up.

Note
For steam or other elevated temperature services, it is important that temperatures at the process connection do not exceed the transmitter's process temperature limits.

Figure 2-8. Installation examples



2.8.3 Process connections

Coplanar or traditional process connection

⚠ Install and tighten all four flange bolts before applying pressure, or process leakage will result. When properly installed, the flange bolts will protrude through the top of the sensor module housing. Do not attempt to loosen or remove the flange bolts while the transmitter is in service.

Flange adaptors:

⚠ Rosemount 3051DP and GP process connections on the transmitter flanges are $^1/_4$–18 NPT. Flange adapters are available with standard $^1/_2$–14 NPT Class 2 connections. The flange adapters allow users to disconnect from the process by removing the flange adapter bolts. Use plant-approved lubricant or sealant when making the process connections. Refer to Dimensional Drawings on page 120 for the distance between pressure connections. This distance may be varied $\pm^1/_8$ in. (3.2 mm) by rotating one or both of the flange adapters.

To install adapters to a Coplanar flange, perform the following procedure:

1. Remove the flange bolts.
2. Leaving the flange in place, move the adapters into position with the o-ring installed.
3. Clamp the adapters and the Coplanar flange to the transmitter sensor module using the larger of the bolts supplied.
4. Tighten the bolts. Refer to "Flange bolts" on page 11 for torque specifications.

Whenever you remove flanges or adapters, visually inspect the PTFE o-rings. Replace with o-ring designed for Rosemount transmitter if there are any signs of damage, such as nicks or cuts. Undamaged o-rings may be reused. If you replace the o-rings, retorque the flange bolts after installation to compensate for cold flow. Refer to the process sensor body reassembly procedure in Section 5: Troubleshooting.

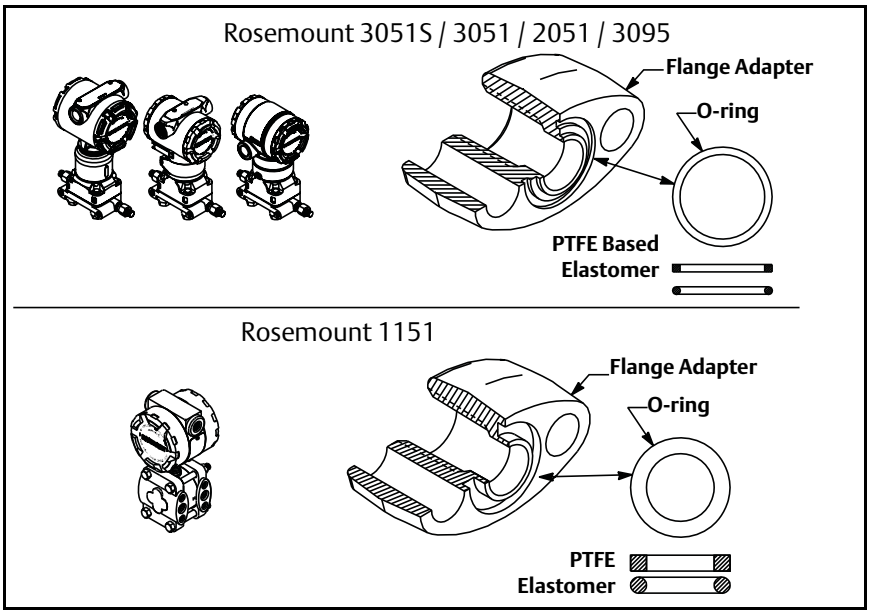
O-rings:

The two styles of Rosemount flange adapters (Rosemount 1151 and Rosemount 3051S/3051/2051/3095) each require a unique O-ring (see Figure 2-9). Use only the O-ring designed for the corresponding flange adaptor.

Figure 2-9. O-Rings.

⚠ WARNING

Failure to install proper flange adapter O-rings may cause process leaks, which can result in death or serious injury. The two flange adapters are distinguished by unique O-ring grooves. Only use the O-ring that is designed for its specific flange adapter, as shown below.



⚠ When compressed, PTFE O-rings tend to “cold flow,” which aids in their sealing capabilities.

Note
PTFE O-rings should be replaced if the flange adapter is removed.

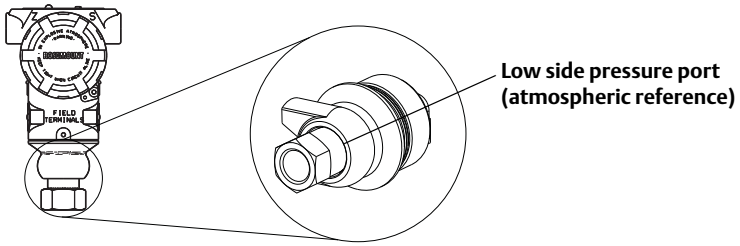
2.8.4 Inline process connection

Inline gage transmitter orientation

The low side pressure port on the inline gage transmitter is located in the neck of the transmitter, behind the housing. The vent path is 360 degrees around the transmitter between the housing and sensor (See Figure 2-10).

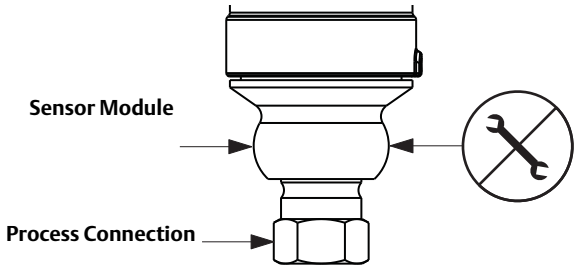
Keep the vent path free of any obstruction, such as paint, dust, and lubrication by mounting the transmitter so that the process can drain away.

Figure 2-10. Inline gage low side pressure port



⚠ WARNING

Do not apply torque directly to the sensor module. Rotation between the sensor module and the process connection can damage the electronics. To avoid damage, apply torque only to the hex-shaped process connection.

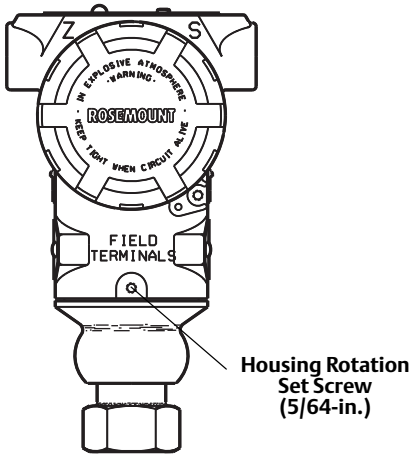


2.8.5 Housing rotation

The electronics housing can be rotated up to 180 degrees in either direction to improve field access, or to better view the optional LCD display. To rotate the housing, perform the following procedure:

1. Loosen the housing rotation set screw using a $\frac{5}{64}$ -in. hex wrench.
2. Turn the housing left or right up to 180° from its original position. Over rotating will damage the transmitter.
3. Retighten the housing rotation set screw.

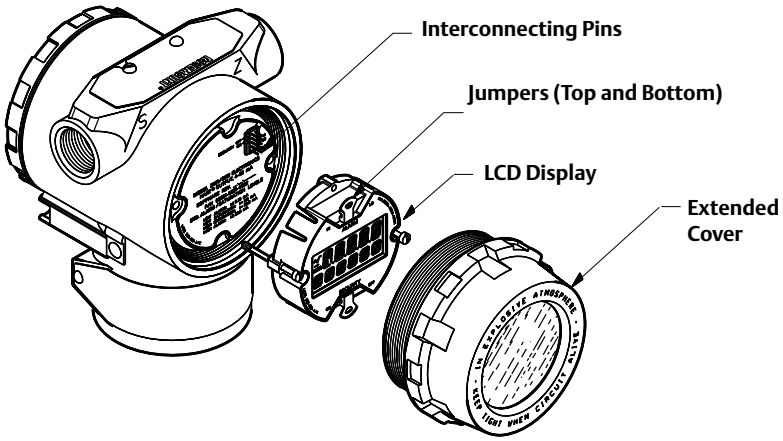
Figure 2-11. Housing rotation



2.8.6 LCD display

Transmitters ordered with the LCD option are shipped with the display installed. Installing the display on an existing 3051 transmitter requires a small instrument screwdriver.

Figure 2-12. LCD display



2.8.7 Configure security and alarm

Security (write protect)

There are three security methods with the Rosemount 3051 transmitter:

1. Security Jumper: prevents all writes to transmitter configuration.
2. Local Keys (Local Zero and Span) Software Lock Out: prevents changes to transmitter range points via local zero and span adjustment keys. With local keys security enabled, changes to configuration are possible via HART.
3. Physical Removal of Local Keys (Local Zero and Span) Magnetic Buttons: removes ability to use local keys to make transmitter range point adjustments. With local keys security enabled, changes to configuration are possible via HART.

You can prevent changes to the transmitter configuration data with the write protection jumper. Security is controlled by the security (write protect) jumper located on the electronics board or LCD display. Position the jumper on the transmitter circuit board in the “ON” position to prevent accidental or deliberate change of configuration data.

If the transmitter write protection jumper is in the “ON” position, the transmitter will not accept any “writes” to its memory. Configuration changes, such as digital trim and reranging, cannot take place when the transmitter security is on.

Note
If the security jumper is not installed, the transmitter will continue to operate in the security OFF configuration.

Configuring transmitter security and alarm jumper procedure

To reposition the jumpers, follow the procedure described below.

1. Do not remove the transmitter covers in explosive atmospheres when the circuit is live. If the transmitter is live, set the loop to manual and remove power.

⚠

2. Remove the housing cover opposite the field terminal side. Do not remove the transmitter covers in explosive atmospheres when the circuit is live.
3. Reposition the jumpers as desired.
   - Figure 2-13 shows the jumper positions for the 4-20 mA HART Transmitter.
   - Figure 2-14 shows the jumper positions for the 1-5 HART Vdc Low Power Transmitter.

⚠

4. Reattach the transmitter cover. Always ensure a proper seal by installing the electronics housing covers so that metal contacts metal to meet explosion-proof requirements.

Figure 2-13. Electronics board

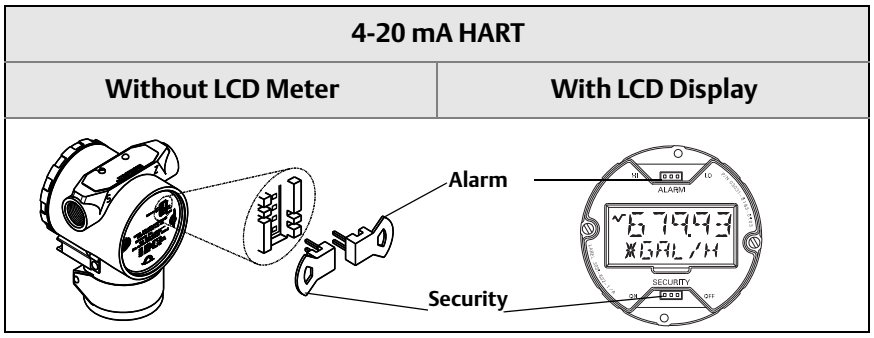
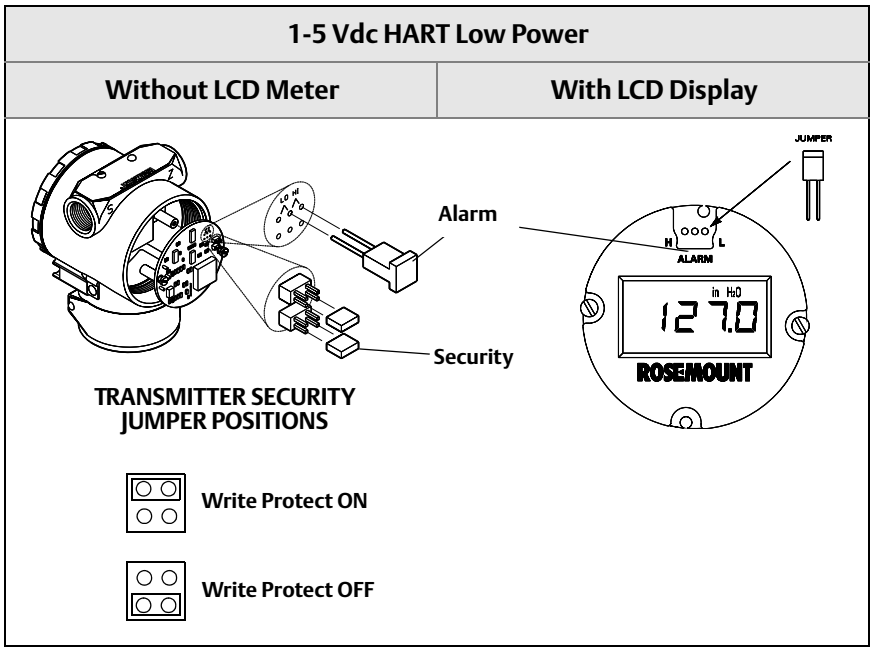


Figure 2-14. Low power transmitter electronics boards



Note
Security jumper not installed = Not Write Protected
Alarm jumper not installed = High Alarm

2.9 Electrical considerations

Note
Make sure all electrical installation is in accordance with national and local code requirements.

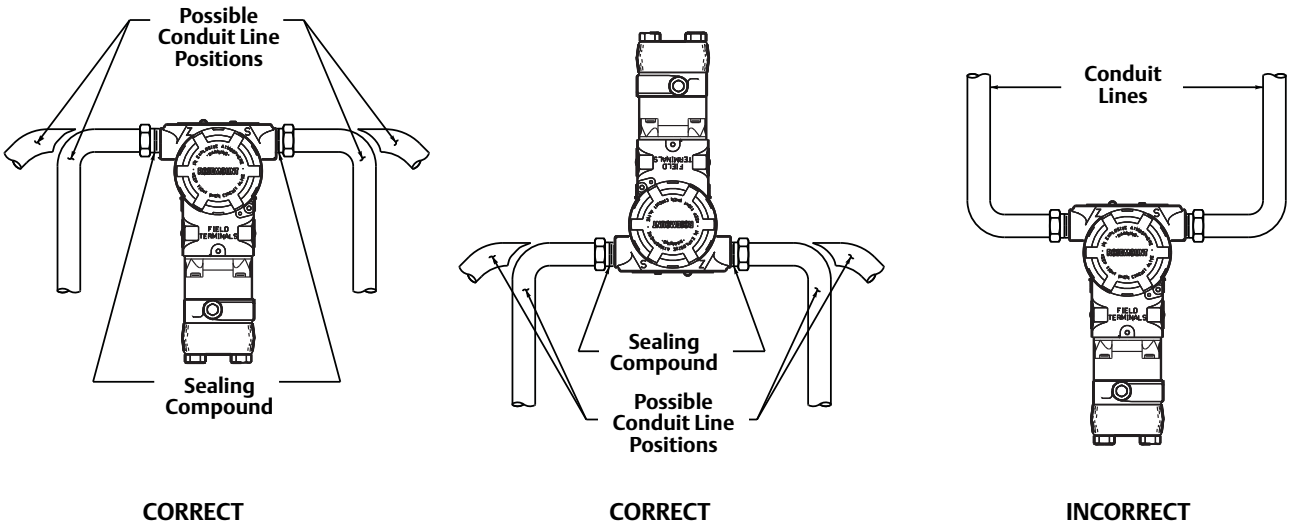
2.9.1 Conduit installation

⚠ CAUTION

If all connections are not sealed, excess moisture accumulation can damage the transmitter. Make sure to mount the transmitter with the electrical housing positioned downward for drainage. To avoid moisture accumulation in the housing, install wiring with a drip loop, and ensure the bottom of the drip loop is mounted lower than the conduit connections or the transmitter housing.

Recommended conduit connections are shown in Figure 2-15.

Figure 2-15. Conduit installation diagrams.



2.9.2 Wiring

⚠ CAUTION

Do not connect the power signal wiring to the test terminals. Voltage may burn out the reverse-polarity protection diode in the test connection.

Note
Use shielded twisted pairs to yield best results. To ensure proper communication, use 24 AWG or larger wire, and do not exceed 5000 feet (1500 meters).

Figure 2-16. 4-20 mA HART wiring

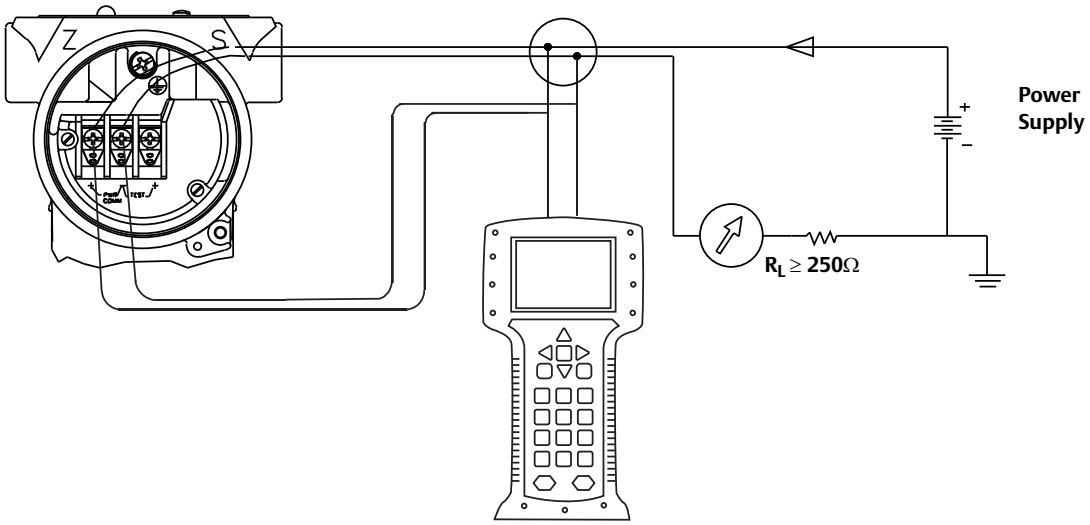
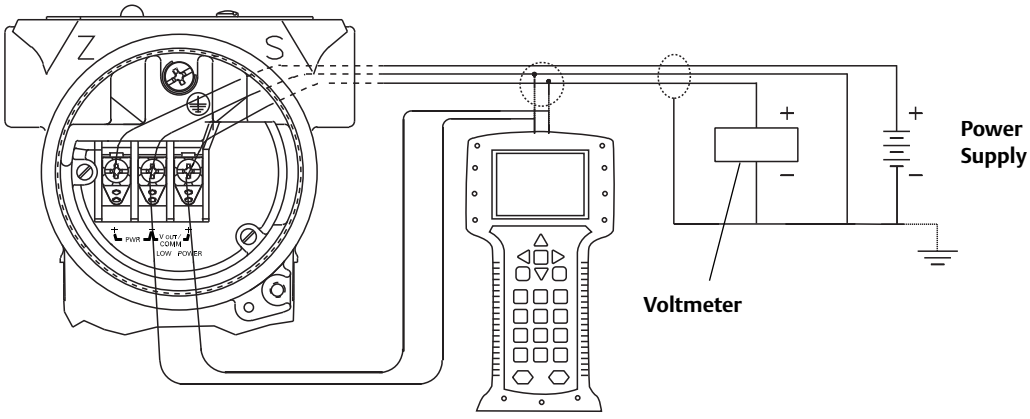


Figure 2-17. 1-5 Vdc low power wiring



Perform the following procedure to make wiring connections:

⚠ 1. Remove the housing cover on terminal compartment side. Do not remove the cover in explosive atmospheres when the circuit is live. Signal wiring supplies all power to the transmitter.

⚠ 2. a. For 4-20 mA HART output, connect the positive lead to the terminal marked (+) and the negative lead to the terminal marked (pwr/comm -). Do not connect powered signal wiring to the test terminals. Power could damage the test diode.

b. For 1-5 Vdc HART Low Power output, connect the positive lead to the terminal marked (+ pwr) and the negative lead to the terminal marked (pwr -). Connect signal lead to V_{out} / comm +.

3. Plug and seal unused conduit connection on the transmitter housing to avoid moisture accumulation in the terminal side. Install wiring with a drip loop. Arrange the drip loop so the bottom is lower than the conduit connections and the transmitter housing.

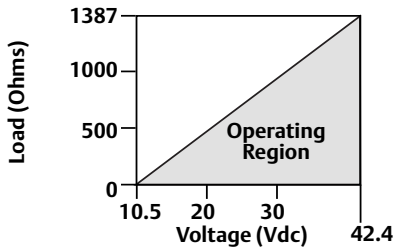
Power supply for 4-20 mA HART

Transmitter operates on 10.5 - 42.4 Vdc. The dc power supply should provide power with less than two percent ripple.

Note
A minimum loop resistance of 250 ohms is required to communicate with a Field Communicator. If a single power supply is used to power more than one 3051 transmitter, the power supply used, and circuitry common to the transmitters, should not have more than 20 ohms of impedance at 1200 Hz.

Figure 2-18. Load limitation

Maximum Loop Resistance = 43.5 * (Power Supply Voltage – 10.5)



The Field Communicator requires a minimum loop resistance of 250Ω for communication.

The total resistance load is the sum of the resistance of the signal leads and the load resistance of the controller, indicator, and related pieces. Note that the resistance of intrinsic safety barriers, if used, must be included.

⚠ See "Safety messages" on page 5 for complete warning

Power supply for 1-5 Vdc HART low power

Low power transmitters operate on 6-14 Vdc. The dc power supply should provide power with less than two percent ripple. The V_{out} load should be 100 kΩ or greater.

2.9.3 Transient protection terminal block

The transmitter will withstand electrical transients of the energy level usually encountered in static discharges or induced switching transients. However, high-energy transients, such as those induced in wiring from nearby lightning strikes, can damage the transmitter.

The transient protection terminal block can be ordered as an installed option (Option Code T1 in the transmitter model number) or as a spare part to retrofit existing 3051 transmitters in the field. See "Spare parts" on page 164 for spare part numbers. The lightning bolt symbol shown in Figure 2-19 and Figure 2-20 identifies the transient protection terminal block.

Figure 2-19. 4-20 mA HART wiring with transient protection

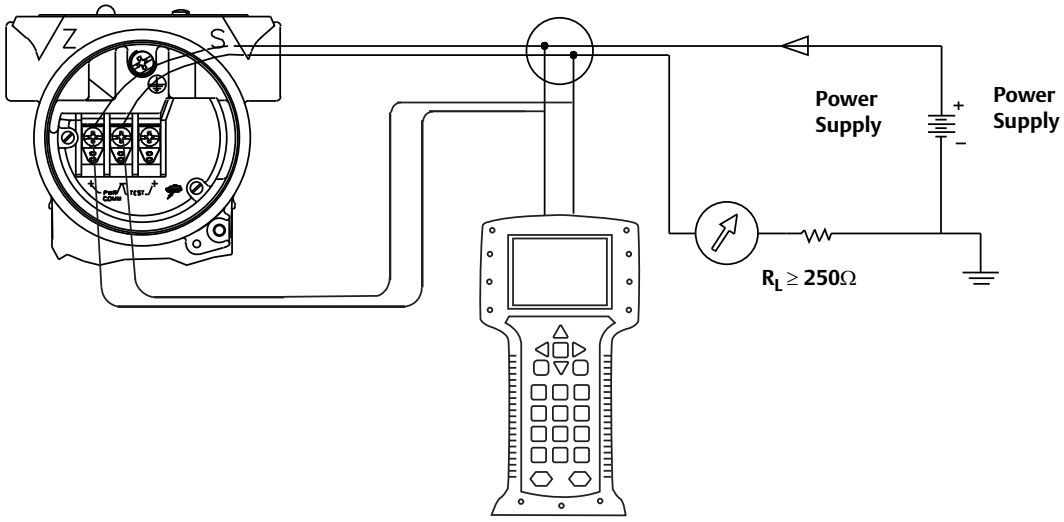


Figure 2-20. 1-5 Vdc low power wiring with transient protection

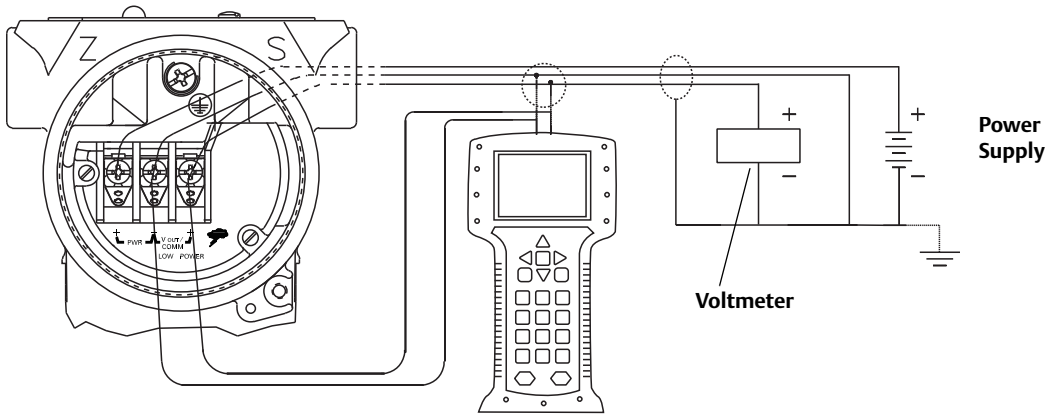
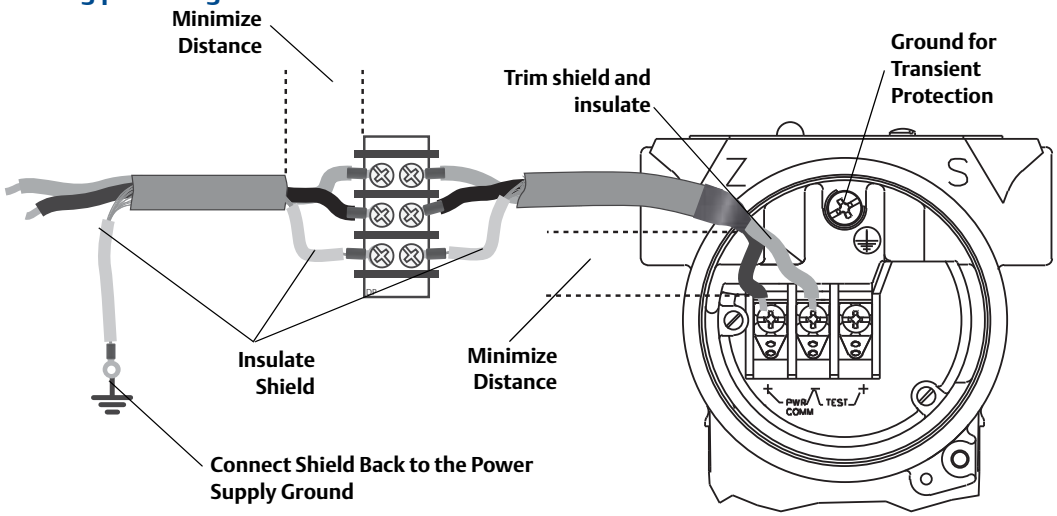


Figure 2-21. Wiring pair and ground



Note
The transient protection terminal block does not provide transient protection unless the transmitter case is properly grounded. Use the guidelines to ground the transmitter case. Refer to page 27.

Do not run the transient protection ground wire with signal wiring as the ground wire may carry excessive current if a lightning strike occurs.

2.9.4 Grounding

⚠ Use the following techniques to properly ground the transmitter signal wiring and case:

Signal wiring

Do not run signal wiring in conduit or open trays with power wiring or near heavy electrical equipment. It is important that the instrument cable shield be:

- Trimmed close and insulated from touching the transmitter housing
- Connected to the next shield if cable is routed through a junction box
- Connected to a good earth ground at the power supply end

For 4-20 mA HART output, the signal wiring may be grounded at any one point on the signal loop or may be left ungrounded. The negative terminal of the power supply is a recommended grounding point.

For 1-5 Vdc HART Low Power output, the power wires may be grounded at only one point or left ungrounded. The negative terminal of the power supply is a recommended grounding point.

Transmitter case

Always ground the transmitter case in accordance with national and local electrical codes. The most effective transmitter case grounding method is a direct connection to earth ground with minimal impedance. Methods for grounding the transmitter case include:

- Internal Ground Connection: The Internal Ground Connection screw is inside the FIELD TERMINALS side of the electronics housing. This screw is identified by a ground symbol (⏚). The ground connection screw is standard on all Rosemount 3051 transmitters. Refer to Figure 2-22.

Figure 2-22. Internal ground screw

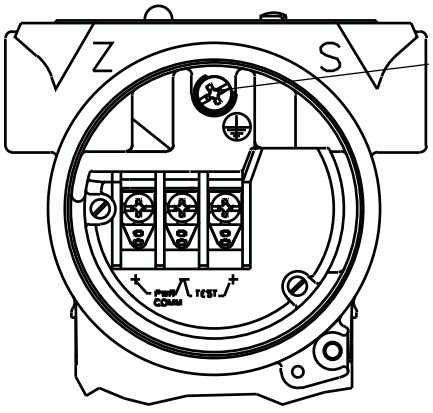
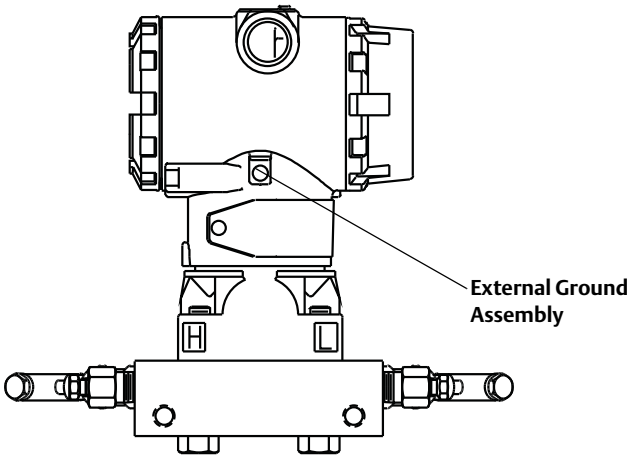


Figure 2-23. External ground assembly



Note
Grounding the transmitter case via threaded conduit connection may not provide sufficient ground continuity.

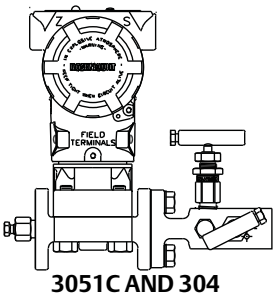
2.10 Hazardous locations certifications

⚠ Individual transmitters are clearly marked with a tag indicating the approvals they carry. Transmitters must be installed in accordance with all applicable codes and standards to maintain these certified ratings. Refer to "Hazardous locations certifications" on page 177 for information on these approvals.

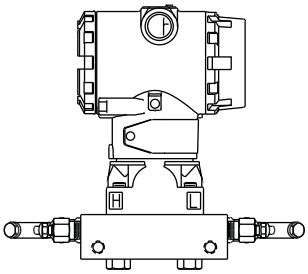
2.11 Rosemount 305, 306, and 304 manifolds

The 305 Integral Manifold is available in two designs: Traditional and Coplanar. The traditional 305 Integral Manifold can be mounted to most primary elements with mounting adapters in the market today. The 306 Integral Manifold is used with the 3051T in-line transmitters to provide block-and-bleed valve capabilities of up to 10000 psi (690 bar).

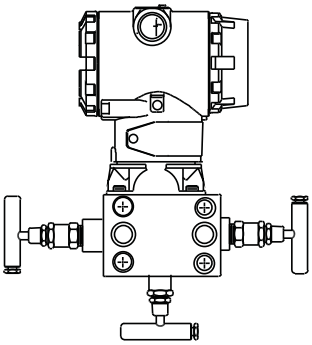
Figure 2-24. Manifolds



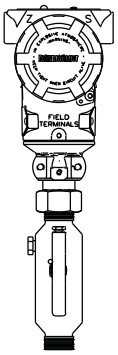
3051C AND 304 CONVENTIONAL



3051C AND 305 INTEGRAL COPLANAR



3051C AND 305 INTEGRAL TRADITIONAL



3051T AND 306 IN-LINE

2.11.1 Rosemount 305 integral manifold installation procedure

To install a 305 Integral Manifold to a 3051 transmitter:

⚠ 1. Inspect the PTFE sensor module o-rings. Undamaged o-rings may be reused. If the o-rings are damaged (if they have nicks or cuts, for example), replace with o-rings designed for Rosemount transmitter.

Important
If replacing the o-rings, take care not to scratch or deface the o-ring grooves or the surface of the isolating diaphragm while you remove the damaged o-rings.

2. Install the Integral Manifold on the sensor module. Use the four 2.25-in. manifold bolts for alignment. Finger tighten the bolts, then tighten the bolts incrementally in a cross pattern to final torque value. See "Flange bolts" on page 11 for complete bolt installation information and torque values. When fully tightened, the bolts should extend through the top of the sensor module housing.

3. If the PTFE sensor module o-rings have been replaced, the flange bolts should be re-tightened after installation to compensate for cold flow of the o-rings.

Note
Always perform a zero trim on the transmitter/manifold assembly after installation to eliminate mounting effects.

2.11.2 Rosemount 306 integral manifold installation procedure

The 306 Manifold is for use only with a 3051T In-line transmitter.

⚠ Assemble the 306 Manifold to the 3051T In-line transmitter with a thread sealant.

2.11.3 Rosemount 304 conventional manifold installation procedure

To install a 304 Conventional Manifold to a 3051 transmitter:

1. Align the Conventional Manifold with the transmitter flange. Use the four manifold bolts for alignment.

2. Finger tighten the bolts, then tighten the bolts incrementally in a cross pattern to final torque value. See "Flange bolts" on page 11 for complete bolt installation information and torque values. When fully tightened, the bolts should extend through the top of the sensor module housing.

3. Leak-check assembly to maximum pressure range of transmitter.

2.11.4 Manifold operation

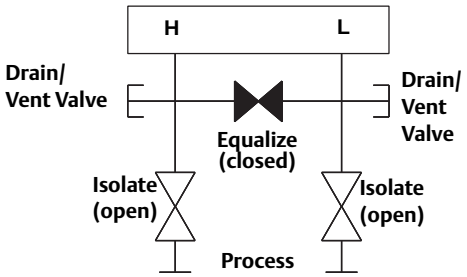
⚠ Improper installation or operation of manifolds may result in process leaks, which may cause death or serious injury.

⚠ See "Safety messages" on page 5 for complete warning information.

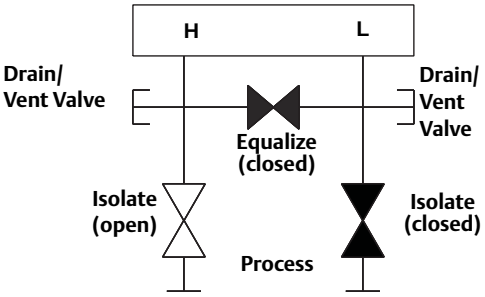
Always perform a zero trim on the transmitter/manifold assembly after installation to eliminate any shift due to mounting effects. See "Sensor Trim Overview" on page 10.

Three and five-valve configurations shown:

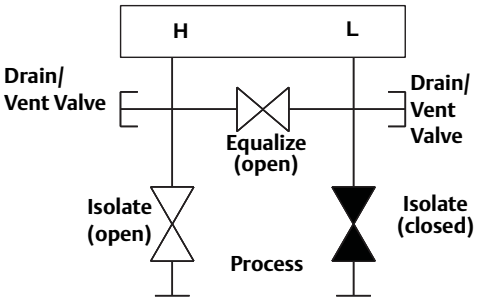
In normal operation the two block valves between the process and instrument ports will be open and the equalizing valve will be closed.



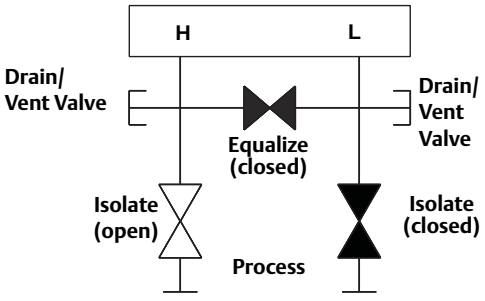
1. To zero the 3051, close the block valve to the low pressure (downstream) side of the transmitter first.



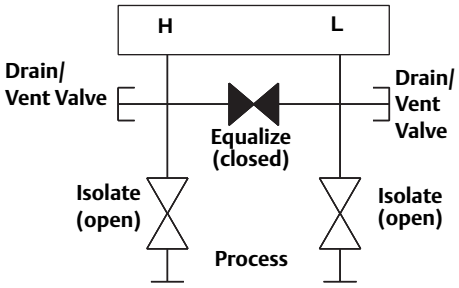
2. Open the center (equalize) valve to equalize the pressure on both sides of the transmitter. The manifold valves are now in the proper configuration for zeroing the transmitter.



3. After zeroing the transmitter, close the equalizing valve.

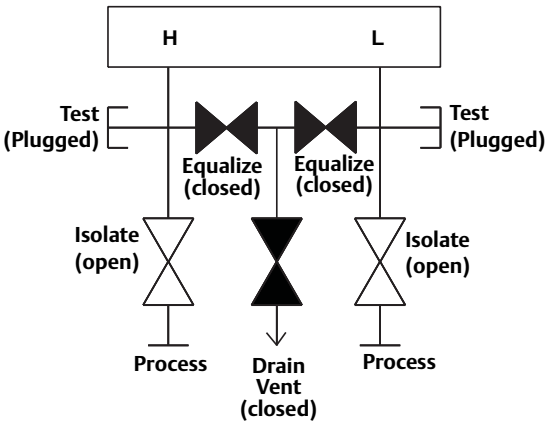


4. Open the block valve on the low pressure side of the transmitter to return the transmitter to service.

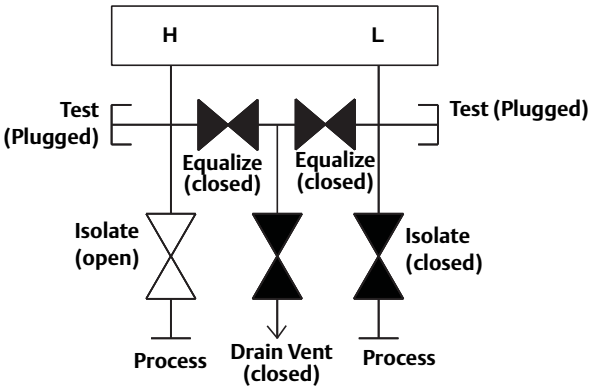


Five-valve Natural Gas configurations shown:

In normal operation, the two block valves between the process and instrument ports will be open, and the equalizing valves will be closed.

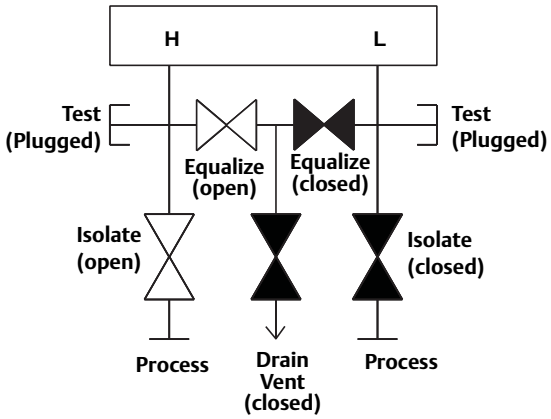


1. To zero the 3051, first close the block valve on the low pressure (downstream) side of the transmitter.

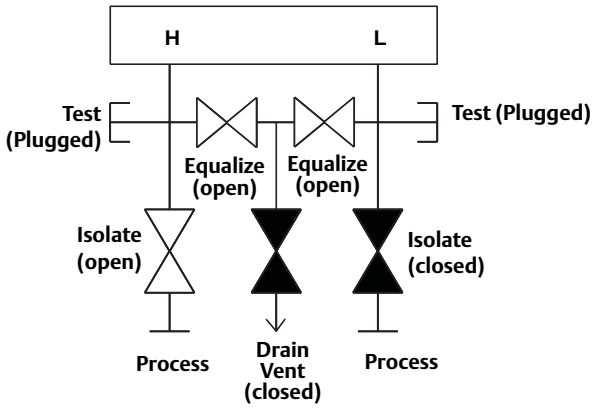


Note
Do not open the low side equalize valve before the high side equalize valve. Doing so will overpressure the transmitter.

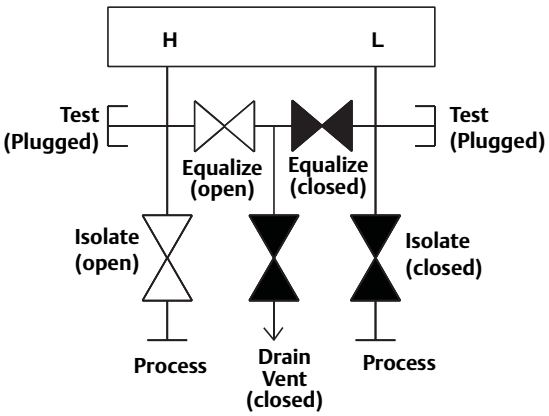
2. Open the equalize valve on the high pressure (upstream) side of the transmitter.



3. Open the equalize valve on the low pressure (downstream) side of the transmitter. The manifold is now in the proper configuration for zeroing the transmitter.



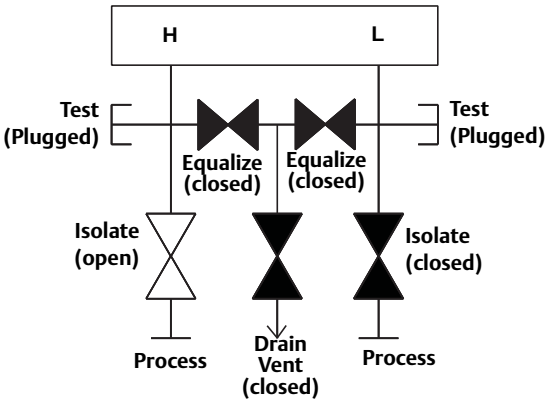
4. After zeroing the transmitter, close the equalize valve on the low pressure (downstream) side of the transmitter.



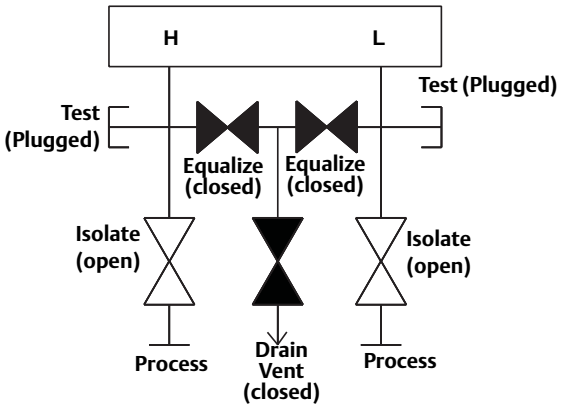
2.12 Liquid level measurement

Differential pressure transmitters used for liquid level applications measure hydrostatic pressure head. Liquid level and specific gravity of a liquid are factors in determining pressure head. This pressure is equal to the liquid height above the tap multiplied by the specific gravity of the liquid. Pressure head is independent of volume or vessel shape.

5. Close the equalize valve on the high pressure (upstream) side.



6. Finally, to return the transmitter to service, open the low side isolation valve.



2.12.1 Open vessels

A pressure transmitter mounted near a tank bottom measures the pressure of the liquid above.

Make a connection to the high pressure side of the transmitter, and vent the low pressure side to the atmosphere. Pressure head equals the liquid's specific gravity multiplied by the liquid height above the tap.

Zero range suppression is required if the transmitter lies below the zero point of the desired level range. Figure 2-25 shows a liquid level measurement example.

2.12.2 Closed vessels

Pressure above a liquid affects the pressure measured at the bottom of a closed vessel. The liquid specific gravity multiplied by the liquid height plus the vessel pressure equals the pressure at the bottom of the vessel.

To measure true level, the vessel pressure must be subtracted from the vessel bottom pressure. To do this, make a pressure tap at the top of the vessel and connect this to the low side of the transmitter. Vessel pressure is then equally applied to both the high and low sides of the transmitter. The resulting differential pressure is proportional to liquid height multiplied by the liquid specific gravity.

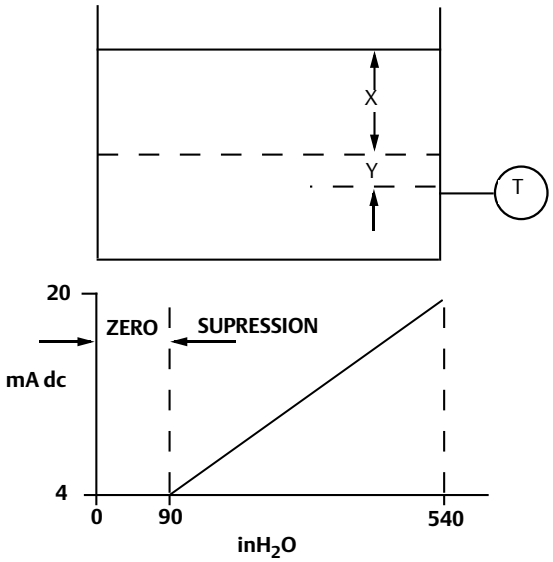
Dry leg condition

Low-side transmitter piping will remain empty if gas above the liquid does not condense. This is a dry leg condition. Range determination calculations are the same as those described for bottom-mounted transmitters in open vessels, as shown in Figure 2-25.

Figure 2-25. Liquid level measurement example.

Let X equal the vertical distance between the minimum and maximum measurable levels (500 in.).
Let Y equal the vertical distance between the transmitter datum line and the minimum measurable level (100 in.).
Let SG equal the specific gravity of the fluid (0.9).
Let h equal the maximum head pressure to be measured in inches of water.
Let e equal head pressure produced by Y expressed in inches of water.
Let Range equal e to e + h.

Then h = (X)(SG)
= 500 x 0.9
= 450 inH_2O
e = (Y)(SG)
= 100 x 0.9
= 90 inH_2O
Range = 90 to 540 inH_2O



Wet leg condition

Condensation of the gas above the liquid slowly causes the low side of the transmitter piping to fill with liquid. The pipe is purposely filled with a convenient reference fluid to eliminate this potential error. This is a wet leg condition.

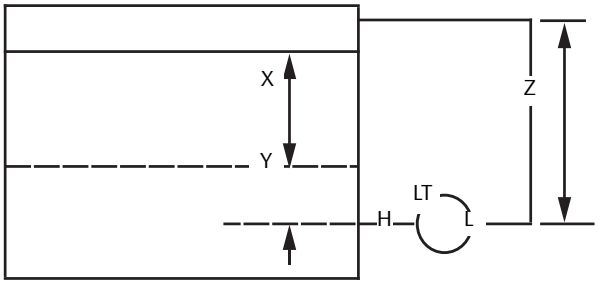
The reference fluid will exert a head pressure on the low side of the transmitter. Zero elevation of the range must then be made. See Figure 2-26.

Bubbler system in open vessel

A bubbler system that has a top-mounted pressure transmitter can be used in open vessels. This system consists of an air supply, pressure regulator, constant flow meter, pressure transmitter, and a tube that extends down into the vessel.

Bubble air through the tube at a constant flow rate. The pressure required to maintain flow equals the liquid's specific gravity multiplied by the vertical height of the liquid above the tube opening. Figure 2-27 shows a bubbler liquid level measurement example.

Figure 2-26. Wet leg example.



Let X equal the vertical distance between the minimum and maximum measurable levels (500 in.).
Let Y equal the vertical distance between the transmitter datum line and the minimum measurable level (50 in.).
Let z equal the vertical distance between the top of the liquid in the wet leg and the transmitter datum line (600 in.).
Let SG_1 equal the specific gravity of the fluid (1.0).
Let SG_2 equal the specific gravity of the fluid in the wet leg (1.1).
Let h equal the maximum head pressure to be measured in inches of water.
Let e equal the head pressure produced by Y expressed in inches of water.
Let s equal head pressure produced by z expressed in inches of water.
Let Range equal e – s to h + e – s.

Then $h = (X)(SG_1)$
$= 500 \times 1.0$
$= 500 \text{ in } H_2O$
$e = (Y)(SG_1)$
$= 50 \times 1.0$
$= 50 \text{ in} H_2O$
$s = (z)(SG_2)$
$= 600 \times 1.1$
$= 660 \text{ in} H_20$
Range = e – s to h + e – s.
= 50 – 660 to 500 + 50 – 660
= –610 to –110 $\text{in} H_20$

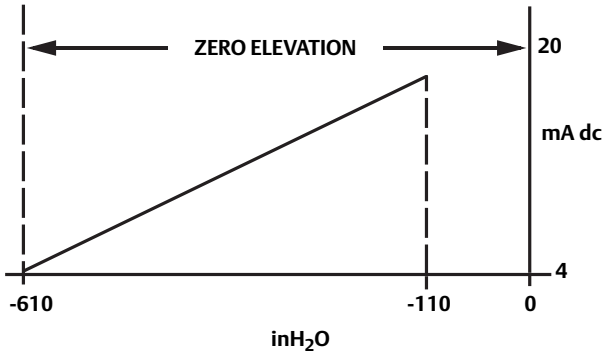
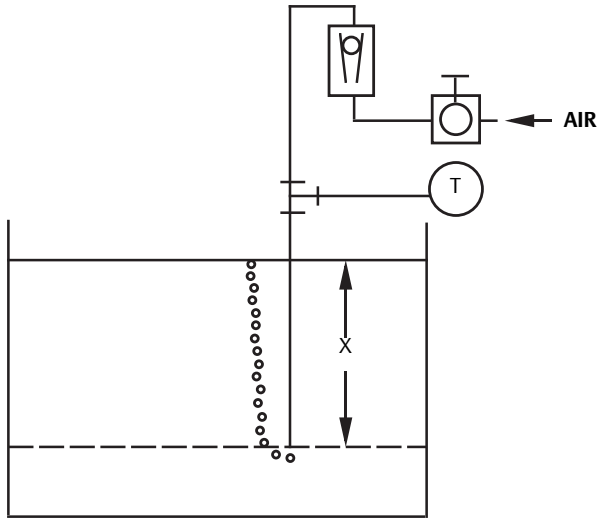
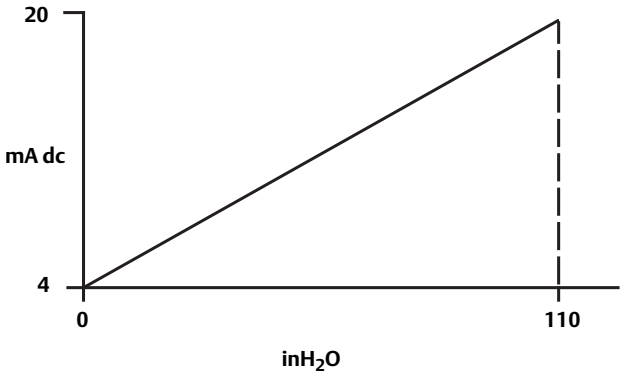


Figure 2-27. Bubbler liquid level measurement example.



Let X equal the vertical distance between the minimum and maximum measurable levels (100 in.).
Let SG equal the specific gravity of the fluid (1.1).
Let h equal the maximum head pressure to be measured in inches of water.
Let Range equal zero to h.
Then h = (X)(SG)
= 100 x 1.1
= 110 inH_2O
Range = 0 to 110 inH_2O



Section 3 Configuration

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Commissioning . . . . . page 40
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Basic setup . . . . . page 52
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Diagnostics and service . . . . . page 62
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3.1 Overview

This section contains information on commissioning and tasks that should be performed on the bench prior to installation.

Field Communicator and AMS Device Manager instructions are given to perform configuration functions. For convenience, Field Communicator fast key sequences are labeled “Fast Keys” for each software function below the appropriate headings.

3.2 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

⚠ WARNING

Explosions could result in death or serious injury:

Installation of this transmitter in an explosive environment must be in accordance with the appropriate local, national, and international standards, codes, and practices. Please review the approvals section of the 3051 reference manual for any restrictions associated with a safe installation.

- Before connecting a Field Communicator in an explosive atmosphere, ensure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- In an explosion-proof/flameproof installation, do not remove the transmitter covers when power is applied to the unit.

Process leaks may cause harm or result in death.

- Install and tighten process connectors before applying pressure.

Electrical shock can result in death or serious injury.

- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.

3.3 Commissioning

Commissioning consists of testing the transmitter and verifying transmitter configuration data. The 3051 transmitters can be commissioned either before or after installation. Commissioning the transmitter on the bench before installation using a Field Communicator or AMS Device Manager ensures that all transmitter components are in working order.

⚠ To commission on the bench, required equipment includes a power supply, a milliamp meter, and a Field Communicator or AMS Device Manager. Wire equipment as shown in Figure 3-1 and Figure 3-2. To ensure successful communication, a resistance of at least 250 ohms must be present between the Field Communicator loop connection and the power supply. Connect the Field Communicator leads to the terminals labeled “COMM” on the terminal block.

Set all transmitter hardware adjustments during commissioning to avoid exposing the transmitter electronics to the plant environment after installation.

When using a Field Communicator, any configuration changes made must be sent to the transmitter by using the Send key. AMS Device Manager configuration changes are implemented when the Apply button is clicked.

3.3.1 Setting the loop to manual

Whenever sending or requesting data that would disrupt the loop or change the output of the transmitter, set the process application loop to manual. The Field Communicator or AMS Device Manager will prompt you to set the loop to manual when necessary. Acknowledging this prompt does not set the loop to manual. The prompt is only a reminder; set the loop to manual as a separate operation.

3.3.2 Wiring diagrams

Connect the equipment as shown in Figure 3-1 for 4-20 mA HART or Figure 3-2 for 1-5 Vdc HART Low Power. To ensure successful communication, a resistance of at least 250 ohms must be present between the Field Communicator loop connection and the power supply. The Field Communicator or AMS Device Manager may be connected at "COMM" on the transmitter terminal block or across the load resistor. Connecting across the "TEST" terminals will prevent successful communication for 4-20 mA HART output.

Turn on the Field Communicator by pressing the ON/OFF key or log into AMS Device Manager. The Field Communicator or AMS Device Manager will search for a HART-compatible device and indicate when the connection is made. If the Field Communicator or AMS Device Manager fail to connect, it indicates that no device was found. If this occurs, refer to Section 5: Troubleshooting.

Figure 3-1. Wiring (4–20 mA)

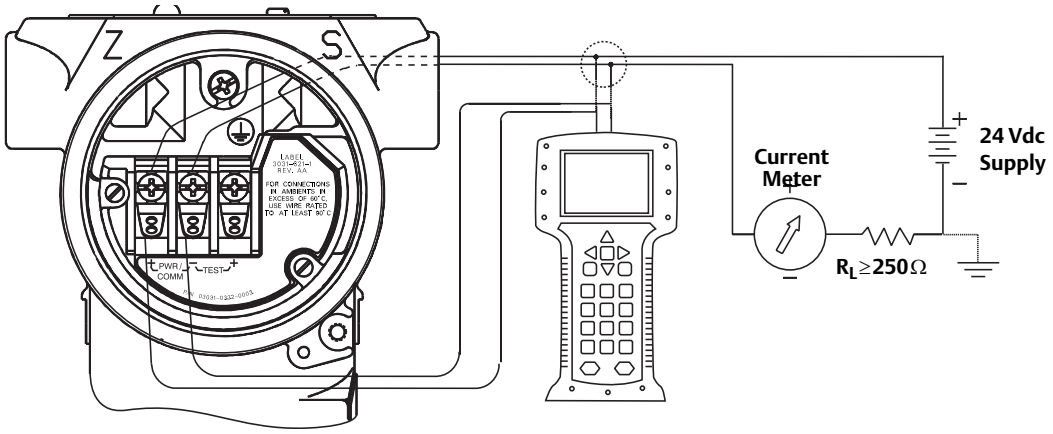
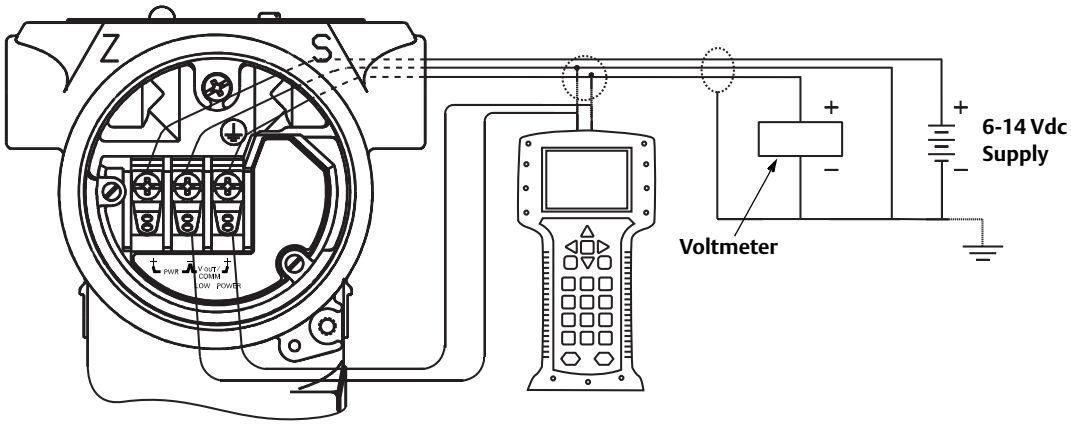


Figure 3-2. Wiring (Low-Power)



3.4 Configuration data review

Note
Information and procedures in this section that make use of Field Communicator fast key sequences and AMS Device Manager assume that the transmitter and communication equipment are connected, powered, and operating correctly.

The following is a list of factory default configurations. These can be reviewed by using the Field Communicator or AMS Device Manager.

Field communicator

Traditional 4-20 mA Fast Keys	1, 5
Traditional 1-5 Vdc Fast Keys	1, 5
Device Dashboard Fast Keys	1, 7

Enter the fast key sequence to view the configuration data.

Transmitter Model	Type
Tag	Range
Date	Descriptor
Message	Minimum and Maximum Sensor Limits
Minimum Span	Units
4 and 20 mA points	Output (linear or sq. root)
Damping	Alarm Setting (high, low)
Security Setting (on, off)	Local Zero/Span Keys (enabled, disabled)
Integral Display	Sensor Fill
Isolator Material	Flange (type, material)
O-Ring Material	Drain/Vent
Remote Seal (type, fill fluid, isolator material, number)	Transmitter S/N
Address	Sensor S/N

AMS device manager

Right click on the device and select Configuration Properties from the menu. Select the tabs to review the transmitter configuration data.

3.5 Field communicator

(Version 1.8)

3.5.1 Field communicator user interface

Figure 3-3. Traditional interface

The corresponding Menu Trees can be viewed on page 44 and page 45.

The fast key sequence can be viewed on page 48.

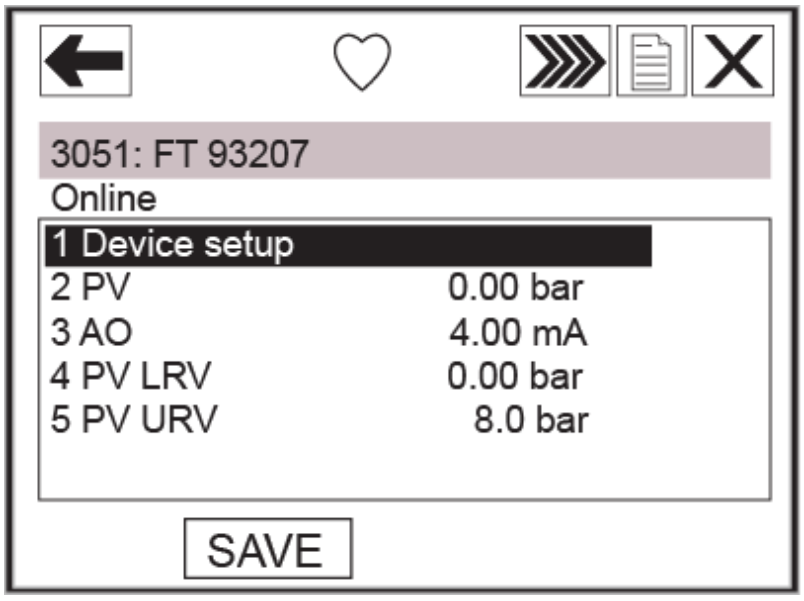
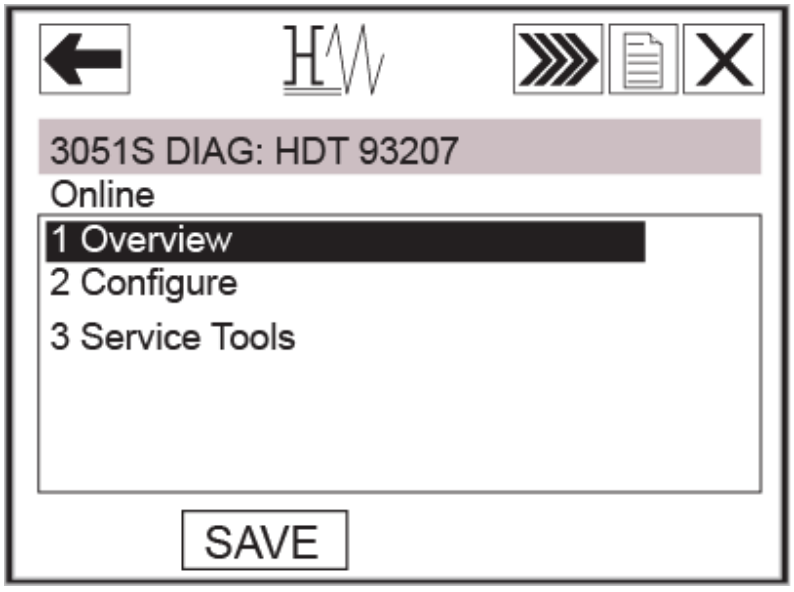


Figure 3-4. Device dashboard

The corresponding Menu Trees can be viewed on page 46 through page 48.

The fast key sequence can be viewed on page 50.



3.6 Field communicator menu trees

Figure 3-5. Rosemount 3051 traditional HART menu tree for 4-20 mA HART output

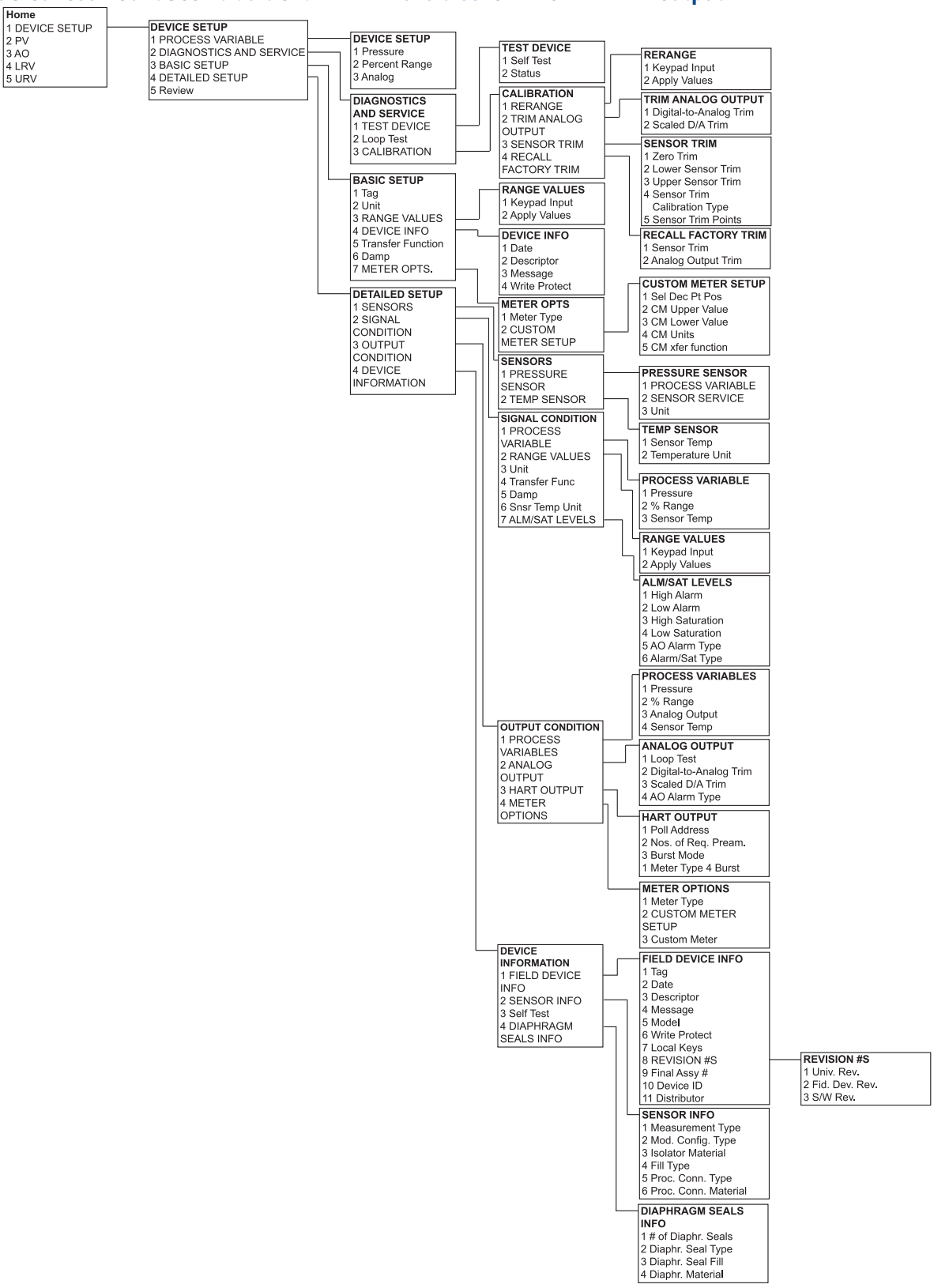


Figure 3-6. Rosemount 3051 traditional HART menu tree for 1-5 Vdc low power

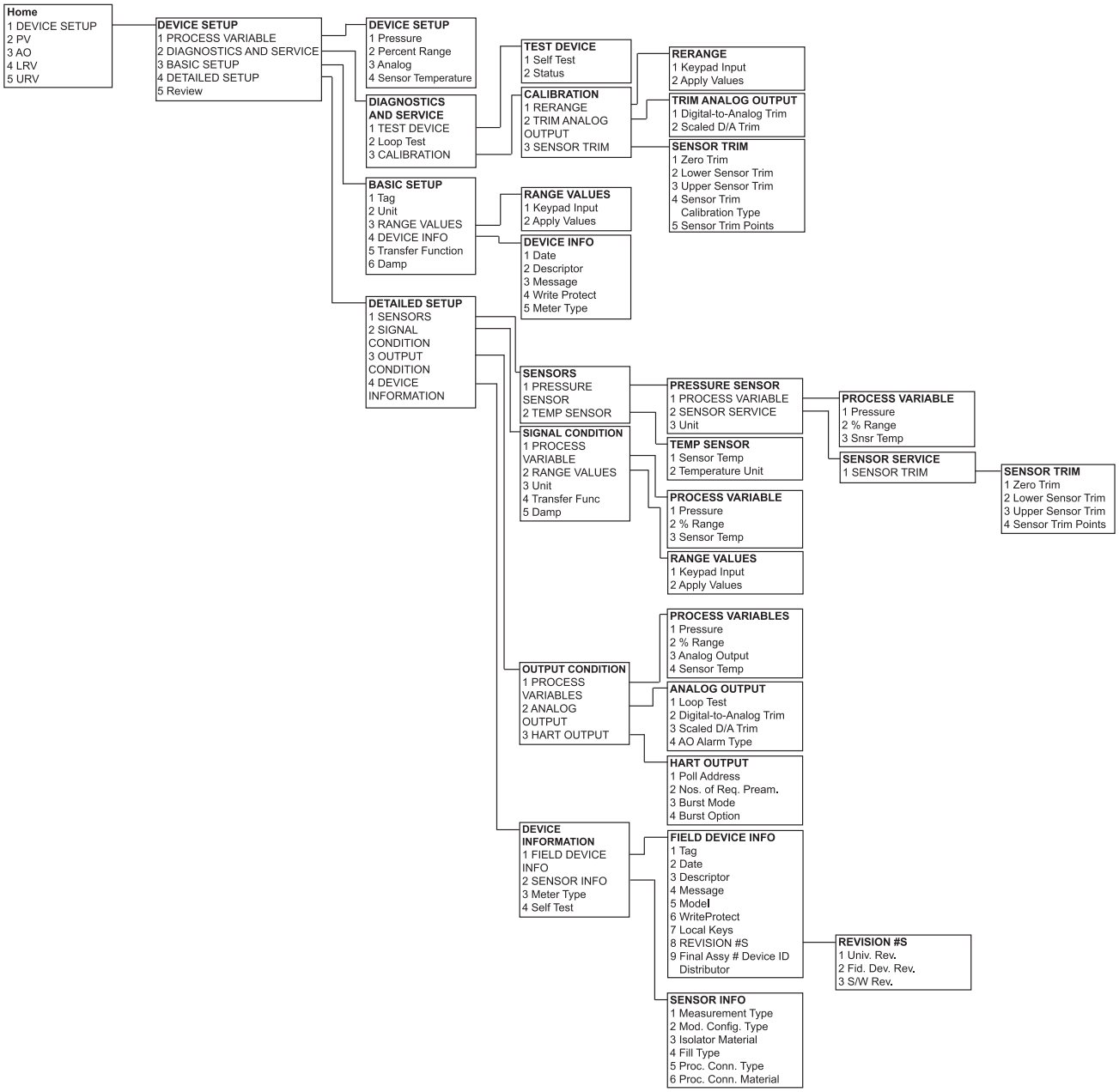


Figure 3-7. Rosemount 3051 device dashboard menu tree - overview

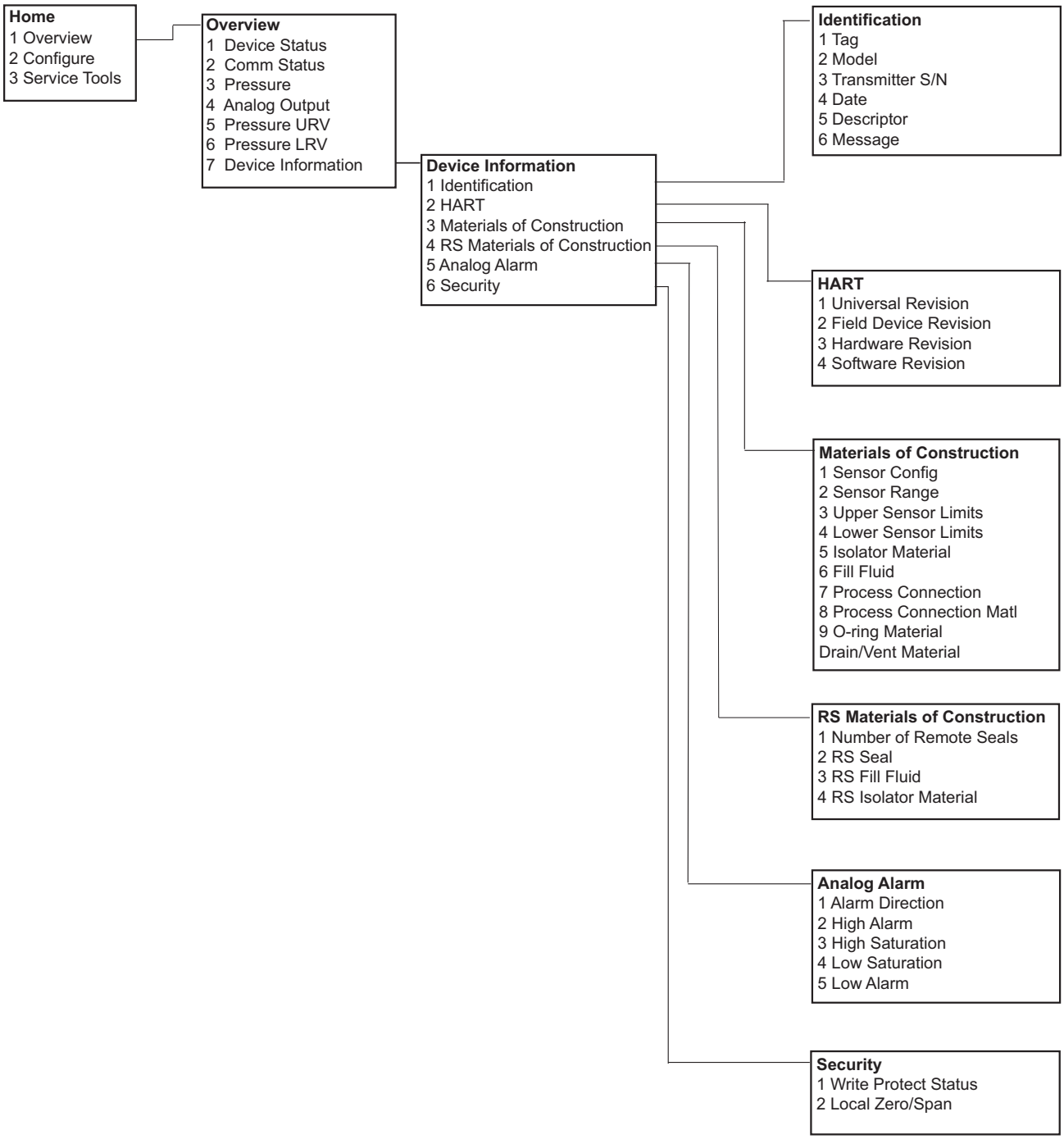


Figure 3-8. Rosemount 3051 device dashboard menu tree - configure

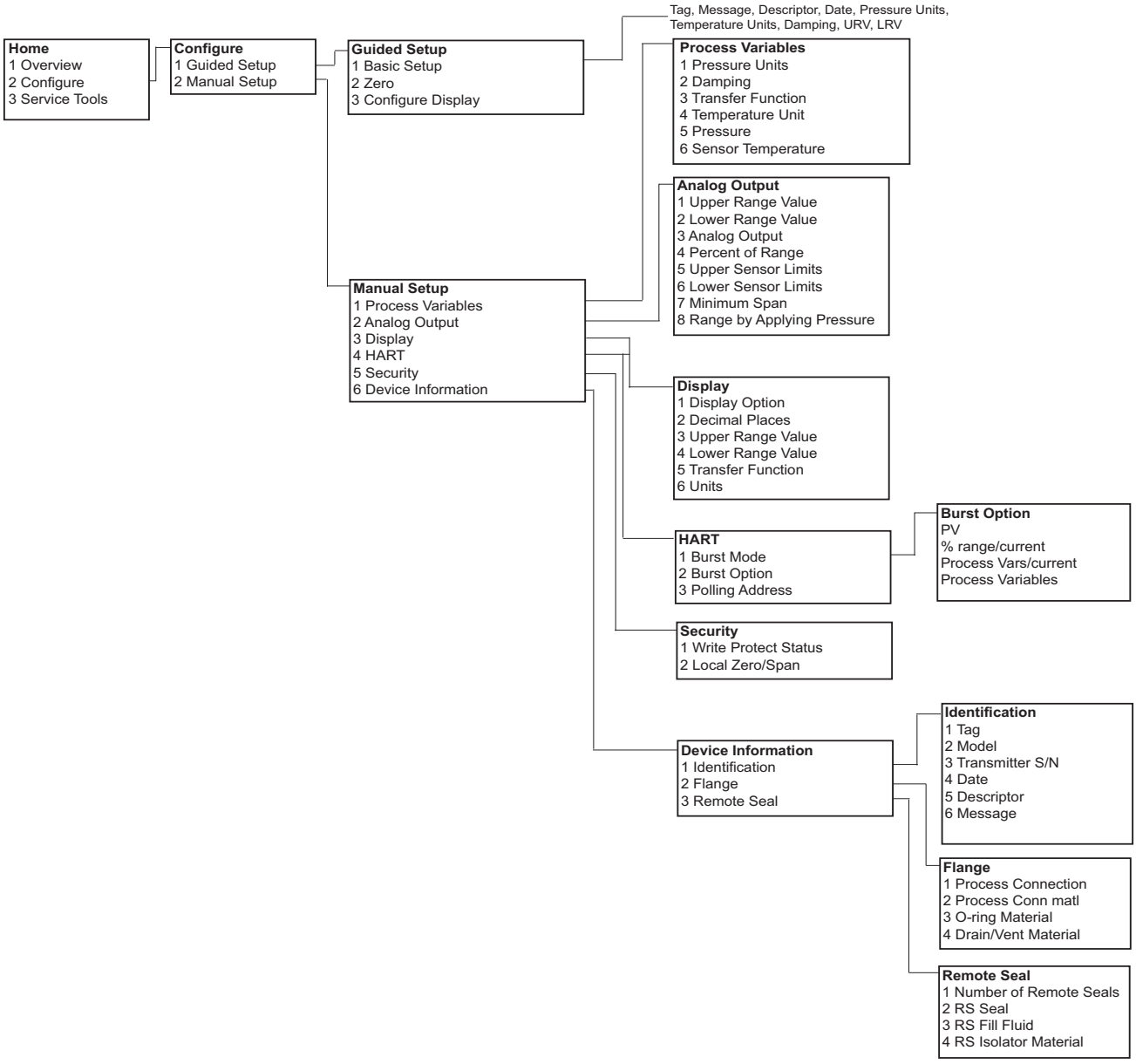
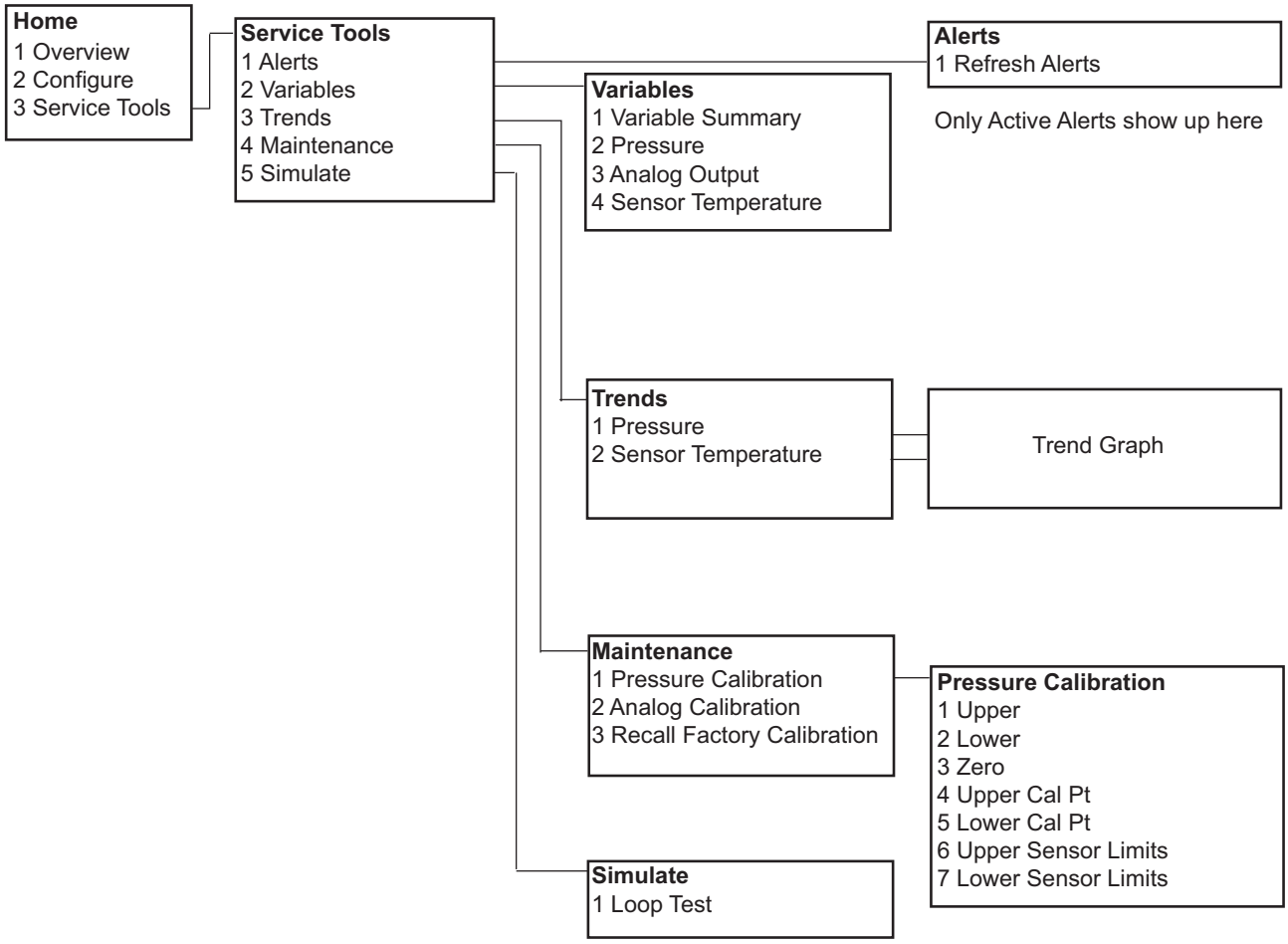


Figure 3-9. Rosemount 3051 device dashboard menu tree - service tools



3.7 Traditional fast key sequence

A check (√) indicates the basic configuration parameters. At minimum, these parameters should be verified as part of the configuration and startup procedure.

Table 3-1. 3051 Traditional fast key sequence

	Function	4-20 mA HART	1-5 Vdc HART low power
√	Alarm and Saturation Levels	1, 4, 2, 7	N/A
	Analog Output Alarm Type	1, 4, 3, 2, 4	1, 4, 3, 2, 4
	Burst Mode Control	1, 4, 3, 3, 3	1, 4, 3, 3, 3
	Burst Operation	1, 4, 3, 3, 4	1, 4, 3, 3, 4
	Custom Meter Configuration	1, 3, 7, 2	N/A

	Function	4-20 mA HART	1-5 Vdc HART low power
	Custom Meter Value	1, 4, 3, 4, 3	N/A
√	Damping	1, 3, 6	1, 3, 6
	Date	1, 3, 4, 1	1, 3, 4, 1
	Descriptor	1, 3, 4, 2	1, 3, 4, 2
	Digital To Analog Trim (4-20 mA Output)	1, 2, 3, 2, 1	1, 2, 3, 2, 1
	Disable Local Span/Zero Adjustment	1, 4, 4, 1, 7	1, 4, 4, 1, 7
	Field Device Information	1, 4, 4, 1	1, 4, 4, 1
	Full Trim	1, 2, 3, 3	1, 2, 3, 3
	Keypad Input – Rerange	1, 2, 3, 1, 1	1, 2, 3, 1, 1
	Local Zero and Span Control	1, 4, 4, 1, 7	1, 4, 4, 1, 7
	Loop Test	1, 2, 2	1, 2, 2
	Lower Sensor Trim	1, 2, 3, 3, 2	1, 2, 3, 3, 2
	Message	1, 3, 4, 3	1, 3, 4, 3
	Meter Options	1, 4, 3, 4	N/A
	Number of Requested Preambles	1, 4, 3, 3, 2	1, 4, 3, 3, 2
	Poll Address	1, 4, 3, 3, 1	1, 4, 3, 3, 1
	Poll a Multidropped Transmitter	Left Arrow, 4, 1, 1	Left Arrow, 4, 1, 1
√	Range Values	1, 3, 3	1, 3, 3
	Rerange	1, 2, 3, 1	1, 2, 3, 1
	Scaled D/A Trim (4–20 mA Output)	1, 2, 3, 2, 2	1, 2, 3, 2, 2
	Self Test (Transmitter)	1, 2, 1, 1	1, 2, 1, 1
	Sensor Info	1, 4, 4, 2	1, 4, 4, 2
	Sensor Temperature	1, 1, 4	1, 1, 4
	Sensor Trim Points	1, 2, 3, 3, 4	1, 2, 3, 3, 4
	Status	1, 2, 1, 2	1, 2, 1, 2
√	Tag	1, 3, 1	1, 3, 1
√	Transfer Function (Setting Output Type)	1, 3, 5	1, 3, 5
	Transmitter Security (Write Protect)	1, 3, 4, 4	1, 3, 4, 4
	Trim Analog Output	1, 2, 3, 2	1, 2, 3, 2
√	Units (Process Variable)	1, 3, 2	1, 3, 2
	Upper Sensor Trim	1, 2, 3, 3, 3	1, 2, 3, 3, 3
	Zero Trim	1, 2, 3, 3, 1	1, 2, 3, 3, 1

Table 3-2. 3051 device dashboard fast key sequence

Function	4-20 mA HART
Alarm and Saturation Levels	1, 7, 5
Analog Output Alarm Type	1, 7, 5
Burst Mode Control	2, 2, 4, 1
Burst Option	2, 2, 4, 2
Custom Display Configuration	2, 2, 3
Damping	2, 2, 1, 2
Date	2, 2, 6, 1, 4
Descriptor	2, 2, 6, 1, 5
Digital to Analog Trim (4 - 20 mA Output)	3, 4, 2
Disable Zero & Span Adjustment	2, 2, 5, 2
Field Device Information	2, 2, 6
Loop Test	3, 5, 1
Lower Sensor Trim	3, 4, 1, 2
Message	2, 2, 6, 1, 6
Poll Address	2, 2, 4, 3
Range Values	1, 5
Rerange with Keypad	1, 5
Scaled D/A Trim (4 - 20 mA Output)	3, 4, 2
Sensor Temperature/Trend	3, 3, 2
Tag	2, 2, 6, 1, 1
Transfer Function	2, 2, 1, 3
Transmitter Security (Write Protect)	2, 2, 5, 1
Units	2, 2, 1, 1
Upper Sensor Trim	3, 4, 1, 1
Zero Trim	3, 4, 1, 3

3.8 Check output

Before performing other transmitter on-line operations, review the digital output parameters to ensure that the transmitter is operating properly and is configured to the appropriate process variables.

3.8.1 Process variables

The process variables for the 3051 provide transmitter output, and are continuously updated. The pressure reading in both engineering units and percent of range will continue to track with pressures outside of the defined range from the lower to the upper range limit of the sensor module.

Field communicator

Traditional 4-20 mA Fast Keys	1, 1
Traditional 1-5 Vdc Fast Keys	1, 1
Device Dashboard Fast Keys	3, 2

The process variable menu displays the following process variables:

- Pressure
- Percent of range
- Analog output

AMS device manager

Right click on the device and select Process Variables... from the menu.The *Process Variable* screen displays the following process variables:

- Pressure
- Percent of range
- Analog output

3.8.2 Sensor temperature

The 3051 contains a temperature sensor near the pressure sensor in the sensor module. When reading this temperature, keep in mind the sensor is not a process temperature reading.

Field communicator

Traditional 4-20 mA Fast Keys	1, 1, 4
Traditional 1-5 Vdc Fast Keys	1, 1, 4
Device Dashboard Fast Keys	3, 2, 4

Enter the fast key sequence “Sensor Temperature” to view the sensor temperature reading.

AMS device manager

Right click on the device and select Process Variables... from the menu. “Snsr Temp” is the sensor temperature reading.

3.9 Basic setup

3.9.1 Set process variable units

The PV Unit command sets the process variable units to allow you to monitor your process using the appropriate units of measure.

Field communicator

Traditional 4-20 mA Fast Keys	1, 3, 2
Traditional 1-5 Vdc Fast Keys	1, 3, 2
Device Dashboard Fast Keys	2, 2, 1, 1

Enter the fast key sequence “Set Process Variable Units.” Select from the following engineering units:

- inH_2O
- inHg
- ftH_2O
- mmH_2O
- mmHg
- psi
- bar
- mbar
- g/cm^2
- kg/cm^2
- Pa
- kPa
- torr
- atm
- inH_2O at 4 °C
- mmH_2O at 4 °C

AMS device manager

Right click on the device and select Configure from the menu. In the *Basic Setup* tab, select Unit from the drop down menu to select units.

3.9.2 Set output (Transfer function)

The 3051 has two output settings: Linear and Square Root. Activate the square root output option to make analog output proportional to flow. As input approaches zero, the 3051 automatically switches to linear output in order to ensure a more smooth, stable output near zero (see Figure 3-10).

For 4-20 mA HART output, the slope of the curve is unity (y = x) from 0 to 0.6 percent of the ranged pressure input. This allows accurate calibration near zero. Greater slopes would cause large changes in output (for small changes at input). From 0.6 percent to 0.8 percent, curve slope equals 42 (y = 42x) to achieve continuous transition from linear to square root at the transition point.

Field communicator

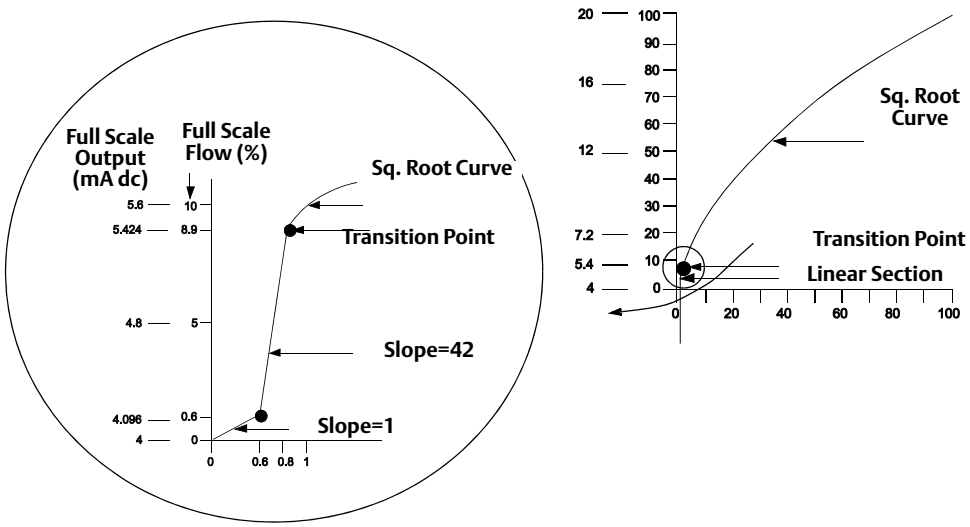
Traditional 4-20 mA Fast Keys	1, 3, 5
Traditional 1-5 Vdc Fast Keys	1, 3, 5
Device Dashboard Fast Keys	2, 2, 1, 3

AMS device manager

Right click on the device and select Configure from the menu.

1. In the *Basic Setup* tab, use Xfer fnctn drop down menu to select output, click Apply.
2. After carefully reading the warning provided, select yes.

Figure 3-10. 4-20 mA HART square root output transition point



Note
For a flow turndown of greater than 10:1 it is not recommended to perform a square root extraction in the transmitter. Instead, perform the square root extraction in the system.

3.9.3 Rerange

The Range Values command sets each of the lower and upper range analog values (4 and 20 mA points and 1 and 5 Vdc points) to a pressure. The lower range point represents 0% of range and the upper range point represents 100% of range. In practice, the transmitter range values may be changed as often as necessary to reflect changing process requirements. For a complete listing of Range & Sensor limits, refer to "Range and sensor limits" on page 108.

Note
Transmitters are shipped from Emerson Process Management fully calibrated per request or by the factory default of full scale (zero to upper range limit).

Note
Regardless of the range points, the 3051 will measure and report all readings within the digital limits of the sensor. For example, if the 4 and 20 mA points are set to 0 and 10 inH_2O, and the transmitter detects a pressure of 25 inH_2O, it digitally outputs the 25 inH_2O reading and a 250% of range reading.

Select from one of the methods below to rerange the transmitter. Each method is unique; examine all options closely before deciding which method works best for your process.

- Rerange with a Field Communicator or AMS Device Manager only.
- Rerange with a pressure input source and a Field Communicator or AMS Device Manager.
- Rerange with a pressure input source and the local zero and span buttons (option D4).

Note
If the transmitter security switch is **ON,** adjustments to the zero and span will not be able to be made. Refer to "Configure security and alarm" on page 20 for security information.

Rerange with a Field Communicator or AMS Device Manager Only.

The easiest and most popular way to rerange is to use the Field Communicator only. This method changes the range values of the analog 4 and 20 mA points (1 and 5 Vdc points) independently without a pressure input. This means that when you change either the 4 or 20 mA setting, you also change the span.

An example for the 4-20 mA HART output:

If the transmitter is ranged so that

4 mA = 0 inH_2O, and
20 mA = 100 inH_2O,

and you change the 4 mA setting to 50 inH_2O using the communicator only, the new settings are:

4 mA = 50 inH_2O, and
20 mA = 100 inH_2O.

Note that the span was also changed from 100 inH_2O to 50 inH_2O, while the 20 mA setpoint remained at 100 inH_2O.

To obtain reverse output, simply set the 4 mA point at a greater numerical value than the 20 mA point. Using the above example, setting the 4 mA point at 100 inH_2O and the 20 mA point at 0 inH_2O will result in reverse output.

Field communicator

Traditional 4-20 mA Fast Keys	1, 2, 3, 1
Traditional 1-5 Vdc Fast Keys	1, 2, 3, 1
Device Dashboard Fast Keys	2, 2, 2, 1

From the *HOME* screen, enter the fast key sequence "Rerange with a Communicator Only."

AMS device manager

Right click on the device and select Configure from the menu. In the *Basic Setup* tab, locate the Analog Output box and perform the following procedure:

1. Enter the lower range value (LRV) and the upper range value (URV) in the fields provided. Click Apply.
2. After carefully reading the warning provided, select yes.

Rerange with a pressure input source and a field communicator or AMS device manager

Reranging using the Field Communicator and applied pressure is a way of reranging the transmitter when specific 4 and 20 mA points (1 and 5 Vdc points) are not calculated.

Note
The span is maintained when the 4 mA point (1 Vdc point) is set. The span changes when the 20 mA point (5 Vdc point) is set. If the lower range point is set to a value that causes the upper range point to exceed the sensor limit, the upper range point is automatically set to the sensor limit, and the span is adjusted accordingly.

Field communicator

Traditional 4-20 mA Fast Keys	1, 2, 3, 1, 2
Traditional 1-5 Vdc Fast Keys	1, 2, 3, 1, 2
Device Dashboard Fast Keys	2, 2, 2, 8

From the *HOME* screen, enter the fast key sequence Rerange with a pressure input source and a field communicator or AMS device manager .

AMS device manager

Right click on the device, select Calibrate, then Apply values from the menu.

1. Select Next after the control loop is set to manual.
2. From the *Apply Values* menu, follow the on-line instructions to configure lower and upper range values.
3. Select Exit to leave the *Apply Values* screen.
4. Select Next to acknowledge the loop can be returned to automatic control.
5. Select Finish to acknowledge the method is complete.

Rerange with a pressure input source and the local zero and span buttons (option D4)

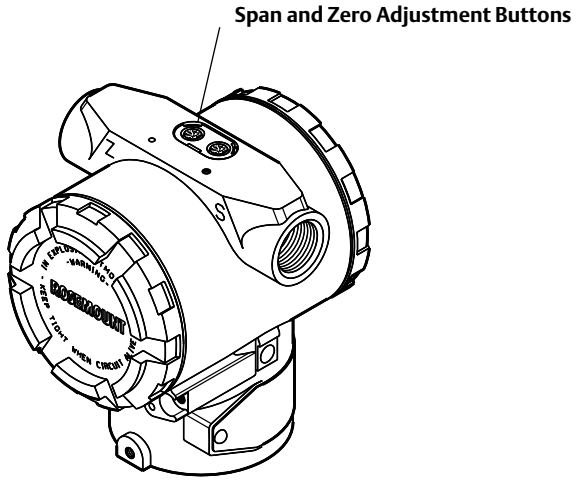
Reranging using the local zero and span adjustments (see Figure 3-11 on page 57) and a pressure source is a way of reranging the transmitter when specific 4 and 20 mA (1 and 5 Vdc) points are not known and a communicator is not available.

Note
When you set the 4 mA (1 Vdc) point the span is maintained; when you set the 20 mA (5 Vdc) point the span changes. If you set the lower range point to a value that causes the upper range point to exceed the sensor limit, the upper range point is automatically set to the sensor limit, and the span is adjusted accordingly.

To rerange the transmitter using the span and zero buttons, perform the following procedure:

1. Loosen the screw holding the certifications label on the top of the transmitter housing. Slide the label to expose the zero and span buttons. See Figure 3-11.
2. Apply the desired 4 mA (1 Vdc) pressure value to the transmitter. Push and hold the zero adjustment button for at least two seconds but no longer than ten seconds.
3. Apply the desired 20 mA (5 Vdc) pressure value to the transmitter. Push and hold the span adjustment button for at least two seconds but no longer than ten seconds.

Figure 3-11. Zero and span buttons



Note
The span is maintained when the 4 mA point (1 Vdc point) is set. The span changes when the 20 mA point (5 Vdc point) is set. If the lower range point is set to a value that causes the upper range point to exceed the sensor limit, the upper range point is automatically set to the sensor limit, and the span is adjusted accordingly.

3.9.4 Damping

The “Damp” command introduces a delay in the micro-processing which increases the response time of the transmitter; smoothing variations in output readings caused by rapid input changes. Determine the appropriate damping setting based on the necessary response time, signal stability, and other requirements of the loop dynamics within your system. The default damping value is 0.4 seconds and it can be set to any of ten pre-configured damping values between 0 and 25.6 seconds. See list below.

■ 0.00 seconds	■ 0.05 seconds	■ 0.10 seconds
■ 0.20 seconds	■ 0.40 seconds	■ 0.80 seconds
■ 1.60 seconds	■ 3.20 seconds	■ 6.40 seconds
■ 12.8 seconds	■ 25.6 seconds	

The current damping value can be determined by executing the Field Communicator fast keys or going to “Configure” in AMS Device Manager.

Field communicator

Traditional 4-20 mA Fast Keys	1, 3, 6
Traditional 1-5 Vdc Fast Keys	1, 3, 6
Device Dashboard Fast Keys	2, 2, 1, 2

AMS device manager

Right click on the device and select Configure from the menu.

1. In the *Basic Setup* tab, enter the damping value in the *Damp* field, click Apply.
2. After carefully reading the warning provided, select yes.

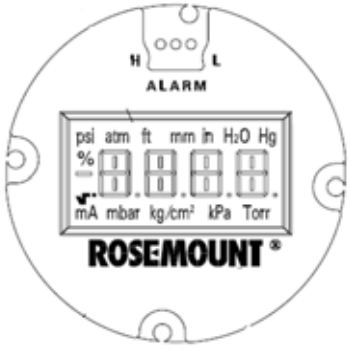
3.10 LCD display

The LCD display connects directly to the interface board which maintains direct access to the signal terminals. The display indicates output and abbreviated diagnostic messages. A display cover is provided to accommodate the display.

For 4-20 mA HART output, the LCD display features a two-line display. The first line of five characters displays the actual measured value, the second line of six characters displays the engineering units. The LCD can also display diagnostic messages. Refer to Figure 3-12.

For 1-5 Vdc HART Low Power output, the LCD display features a single-line display with four characters that display the actual value. The LCD can also display diagnostic messages. Refer to Figure 3-12.

Figure 3-12.

4-20 mA HART	1-5 Vdc HART Low Power
	

3.10.1 LCD display configuration for 4-20 mA HART only

The factory default alternates are between Engineering Units and % of Range. The LCD Display Configuration command allows customization of the LCD display to suit application requirements. The LCD display will alternate between the selected items:

■ Eng. Units only	■ Alternate Eng. Units & % of Range
■ % of Range only	■ Alternate Eng. Units & Custom Display
■ Custom Display only	■ Alternate % of Range & Custom Display

Field communicator

Traditional 4-20 mA Fast Keys	1, 3, 7
Device Dashboard Fast Keys	2, 2, 3

To change the standard default to one of the above options, follow these steps:

1. From the communicators main menu select (1) Device Setup, (3) Basic Setup, (7) Meter Options.
2. Select (1) Meter Type. Using the up or down arrows scroll up or down until the desired display has been highlighted. Press ENTER, SEND, and HOME.

AMS

Right click on the device and select Configuration Properties from the menu.

1. In the *Local Display* tab, locate the *Meter Type* area. Select the desired options to suit your application needs, click Apply.
2. An *Apply Parameter Modification* screen appears, enter desired information and click OK.
3. After carefully reading the warning provided, select OK.

3.10.2 Custom display configuration 4-20 mA HART only

The user-configurable scale is a feature that enables the LCD display to display flow, level, or custom pressure units. With this feature you can define the decimal point position, the upper range value, the lower range value, the engineering units, and the transfer function.The display can be configured using a Field Communicator or AMS.

The user-configurable scale feature can define:

- decimal point position
- upper range values
- lower range values
- engineering units
- transfer function

To configure the display with a Field Communicator, perform the following procedure:

1. Change the Meter Type to "Custom Meter" by using the Fast Key sequence under "LCD display configuration for 4-20 mA HART only" on page 59.
2. Next from the *ONLINE* screen, Select 1 Device Setup, 3 Basic Setup, 7 Meter Options, 2 Meter Options, 2 Custom Meter Setup.
3. To specify decimal point position:
   a. Select 1 Sel dec pt pos. Choose the decimal point representation that will provide the most accurate output for your application. For example, when outputting between 0 and 75 GPM, choose XX.XXX or use the decimal point examples below:

      XXXXX
      XXXX.X
      XXX.XX
      XX.XXX
      X.XXXX

Note
Make sure the selection has been sent and the decimal point has changed before proceeding to the next step.

   b. SEND
4. To specify a custom upper range value:
   a. Select *2 CM Upper Value*. Type the value that you want the transmitter to read at the 20 mA point.
   b. SEND
5. To specify a custom lower range value:
   a. Select *3 CM Lower Value*. Type the value that you want the transmitter to read at the 4 mA point.
   b. SEND
6. To define custom units:
   a. Select *4 CM Units*. Enter the custom units (five characters maximum) that you want the display to display.
   b. SEND
7. To choose the transmitter transfer function for the display:
   a. Select *5 CM xfer fnct*. Enter the transmitter transfer function for the display. Select *sq root* to display flow units. The custom meter transfer function is independent of the analog output transfer function.
8. Select SEND to upload the configuration to the transmitter.

⚠ See "Safety messages" on page 39 for complete warning information.

3.11 Detailed setup

3.11.1 Failure mode alarm and saturation

The 3051 transmitters automatically and continuously perform self-diagnostic routines. If the self-diagnostic routines detect a failure, the transmitter drives its output outside of the normal saturation values. The transmitter will drive its output low or high based on the position of the failure mode alarm jumper. See Table 3-3, Table 3-4, and Table 3-5 for failure mode and saturation output levels. To select alarm position, see "Configure security and alarm" on page 20.

Table 3-3. 4-20 mA HART alarm and saturation values

Level	4–20 mA saturation	4–20 mA alarm
Low	3.9 mA	≤ 3.75 mA
High	20.8 mA	≥ 21.75 mA

Table 3-4. NAMUR-Compliant alarm and saturation values

Level	4–20 mA saturation	4–20 mA alarm
Low	3.8 mA	≤ 3.6 mA
High	20.5 mA	≥ 22.5 mA

Table 3-5. 1-5 Vdc HART low-power alarm and saturation values

Level	1–5 V saturation	1–5 V alarm
Low	0.97 V	≤ 0.95 V
High	5.20 V	≥ 5.4 V

Caution
Alarm level values will be affected by analog trim. Refer to "Analog output trim" on page 77.

Note
When a transmitter is in an alarm condition, the Field Communicator indicates the analog output the transmitter would drive if the alarm condition did not exist. The transmitter will alarm high in the event of failure if the alarm jumper is removed.

3.11.2 Alarm and saturation levels for burst mode

Transmitters set to burst mode handle saturation and alarm conditions differently.

Alarm conditions:

- Analog output switches to alarm value
- Primary variable is burst with a status bit set
- Percent of range follows primary variable
- Temperature is burst with a status bit set

Saturation:

- Analog output switches to saturation value
- Primary variable is burst normally
- Temperature is burst normally

3.11.3 Alarm and saturation values for multidrop mode

Transmitters set to multidrop mode handle saturation and alarm conditions differently.

Alarm conditions:

- Primary variable is sent with a status bit set
- Percent of range follows primary variable
- Temperature is sent with a status bit set

Saturation:

- Primary variable is sent normally
- Temperature is sent normally

3.11.4 Alarm level verification

If the transmitter electronics board, sensor module, or LCD display is repaired or replaced, verify the transmitter alarm level before returning the transmitter to service. This feature is also useful in testing the reaction of the control system to a transmitter in an alarm state. To verify the transmitter alarm values, perform a loop test and set the transmitter output to the alarm value (see Tables 3-3, 3-4, and 3-5 on page 61, and “Loop test” on page 62).

3.12 Diagnostics and service

Diagnostics and service functions listed below are primarily for use after field installation. The Loop Test feature is designed to verify proper loop wiring and transmitter output.

3.12.1 Loop test

The Loop Test command verifies the output of the transmitter, the integrity of the loop, and the operations of any recorders or similar devices installed in the loop.

Field communicator

Traditional 4-20 mA Fast Keys	1, 2, 2
Traditional 1-5 Vdc Fast Keys	1, 2, 2
Device Dashboard Fast Keys	3, 5, 1

To initiate a loop test, perform the following procedure:

1. a. For 4-20 mA HART output, connect a reference meter to the transmitter by either connecting the meter to the test terminals on the terminal block, or shunting transmitter power through the meter at some point in the loop.
   b. For 1-5 Vdc Low Power HART output, connect a reference meter to the V_{out} terminal.
2. From the *HOME* screen, enter the fast key sequence "Loop Test" to verify the output of the transmitter.
3. Select OK after the control loop is set to manual (see "Setting the loop to manual" on page 40).
4. Select a discrete milliamp level for the transmitter to output. At the CHOOSE ANALOG OUTPUT prompt select 1: 4mA (1 Vdc), select 2: 20mA (5 Vdc), or select 3: "Other" to manually input a value.
   a. If you are performing a loop test to verify the output of a transmitter, enter a value between 4 and 20 mA (1 and 5 Vdc).
   b. If you are performing a loop test to verify alarm levels, enter the value representing an alarm state (see Tables 3-3, 3-4, and 3-5 on page 61).
5. Check that the reference meter displays the commanded output value.
   a. If the values match, the transmitter and the loop are configured and functioning properly.
   b. If the values do not match, the meter may be attached to the wrong loop, there may be a fault in the wiring or power supply, the transmitter may require an output trim, or the reference meter may be malfunctioning.

After completing the test procedure, the display returns to the *Loop Test* screen to choose another output value or to end loop testing.

AMS device manager

Right click on the device and select Diagnostics and Test, then Loop Test from the menu.

1. a. For 4-20 mA HART output, connect a reference meter to the transmitter by either connecting the meter to the test terminals on the terminal block, or shunting transmitter power through the meter at some point in the loop.
   b. For 1-5 Vdc Low Power HART output, connect a reference meter to the V_{out} terminal.
2. Click Next after setting the control loop to manual.
3. Select desired analog output level. Click Next.
4. Click Next to acknowledge output being set to desired level.
5. Check that the reference meter displays the commanded output value.
   a. If the values match, the transmitter and the loop are configured and functioning properly.
   b. If the values do not match, the meter may be attached to the wrong loop, there may be a fault in the wiring or power supply, the transmitter may require an output trim, or the reference meter may be malfunctioning.

After completing the test procedure, the display returns to the *Loop Test* screen to choose another output value or to end loop testing.

6. Select End and click Next to end loop testing.
7. Select Next to acknowledge the loop can be returned to automatic control.
8. Select Finish to acknowledge the method is complete.

3.13 Advanced functions

3.13.1 Saving, recalling, and cloning configuration data

Use the cloning feature of the Field Communicator or the AMS Device Manager “User Configuration” feature to configure several 3051 transmitters similarly. Cloning involves configuring a transmitter, saving the configuration data, then sending a copy of the data to a separate transmitter. Several possible procedures exist when saving, recalling, and cloning configuration data. For complete instructions refer to the Field Communicator manual (publication no. 00809-0100-4276) or AMS Device Manager on-line guides. One common method is as follows:

Field communicator

Traditional 4-20 mA Fast Keys	left arrow, 1, 2
Traditional 1-5 Vdc Fast Keys	left arrow, 1, 2
Device Dashboard Fast Keys	3, 4, 3

1. Completely configure the first transmitter.
2. Save the configuration data:
   a. Select SAVE from the Field Communicator *HOME/ONLINE* screen.
   b. Ensure that the location to which the data will be saved is set to MODULE. If it is not, select 1: Location to set the save location to MODULE.
   c. Select 2: Name, to name the configuration data. The default is the transmitter tag number.
   d. Ensure that the data type is set to STANDARD. If the data type is NOT STANDARD, select 3: Data Type to set the data type to STANDARD.
   e. Select SAVE.
3. Connect and power the receiving transmitter and Field Communicator.
4. Select the back arrow from the *HOME/ONLINE* screen. The Field Communicator menu appears.
5. Select 1: Offline, 2: Saved Configuration, 1: Module Contents to reach the *MODULE CONTENTS* menu.
6. Use the DOWN ARROW to scroll through the list of configurations in the memory module, and use the RIGHT ARROW to select and retrieve the required configuration.
7. Select 1: Edit.
8. Select 1: Mark All.
9. Select SAVE.
10. Use the DOWN ARROW to scroll through the list of configurations in the memory module, and use the RIGHT ARROW to select the configuration again.
11. Select 3: Send to download the configuration to the transmitter.
12. Select OK after the control loop is set to manual.
13. After the configuration has been sent, select OK to acknowledge that the loop can be returned to automatic control.

When finished, the Field Communicator informs you of the status. Repeat Steps 3 through 13 to configure another transmitter.

Note
The transmitter receiving cloned data must have the same software version (or later) as the original transmitter.

AMS device manager creating a reusable copy

To create a reusable copy of a configuration perform the following procedure:

1. Completely configure the first transmitter.
2. Select View then User Configuration View from the menu bar (or click the toolbar button).
3. In the User Configuration window, right click and select New from the context menu.
4. In the *New* window, select a device from the list of templates shown, and click OK.
5. The template is copied into the User Configurations window, with the tag name highlighted; rename it as appropriate and press Enter.

Note
A device icon can also be copied by dragging and dropping a device template or any other device icon from AMS Device Manager Explorer or Device Connection View into the User Configurations window.

The “Compare Configurations” window appears, showing the Current values of the copied device on one side and mostly blank fields on the other (User Configuration) side.

6. Transfer values from the current configuration to the user configuration as appropriate or enter values by typing the values into the available fields.
7. Click Apply to apply the values, or click OK to apply the values and close the window.

AMS device manager applying a user configuration

Any amount of user configurations can be created for the application. They can also be saved, and applied to connected devices or to devices in the Device List or Plant Database.

Note
When using AMS Device Manager Revision 6.0 or later, the device to which the user configuration is applied, must be the same model type as the one created in the user configuration. When using AMS Device Manager Revision 5.0 or earlier, the same model type and revision number are required.

To apply a user configuration perform the following procedure:

1. Select the desired user configuration in the User Configurations window.
2. Drag the icon onto a like device in AMS Device Manager Explorer or Device Connection View. The Compare Configurations window opens, showing the parameters of the target device on one side and the parameters of the user configuration on the other.
3. Transfer parameters from the user configuration to the target device as desired. Click OK to apply the configuration and close the window.

3.13.2 Burst mode

When configured for burst mode, the 3051 provides faster digital communication from the transmitter to the control system by eliminating the time required for the control system to request information from the transmitter. Burst mode is compatible with the analog signal. Because the HART protocol features simultaneous digital and analog data transmission, the analog value can drive other equipment in the loop while the control system is receiving the digital information. Burst mode applies only to the transmission of dynamic data (pressure and temperature in engineering units, pressure in percent of range, and/or analog output), and does not affect the way other transmitter data is accessed.

Access to information other than dynamic transmitter data is obtained through the normal poll/response method of HART communication. A Field Communicator, AMS Device Manager or the control system may request any of the information that is normally available while the transmitter is in burst mode. Between each message sent by the transmitter, a short pause allows the Field Communicator, AMS Device Manager or a control system to initiate a request. The transmitter will receive the request, process the response message, and then continue "bursting" the data approximately three times per second.

Field communicator

Traditional 4-20 mA Fast Keys	1, 4, 3, 3, 3
Traditional 1-5 Vdc Fast Keys	1, 4, 3, 3, 3
Device Dashboard Fast Keys	2, 2, 4, 1

AMS device manager

Right click on the device and select Configure from the menu.

1. In the *HART* tab, use the drop down menu to select "Burst Mode ON or OFF." For "Burst option" select the desired properties from the drop down menu. Burst options are as follows:
   - PV
   - % range/current
   - Process vars/crnt
   - Process variables
2. After selecting options click Apply.
3. After carefully reading the warning provided, select yes.

3.14 Multidrop communication

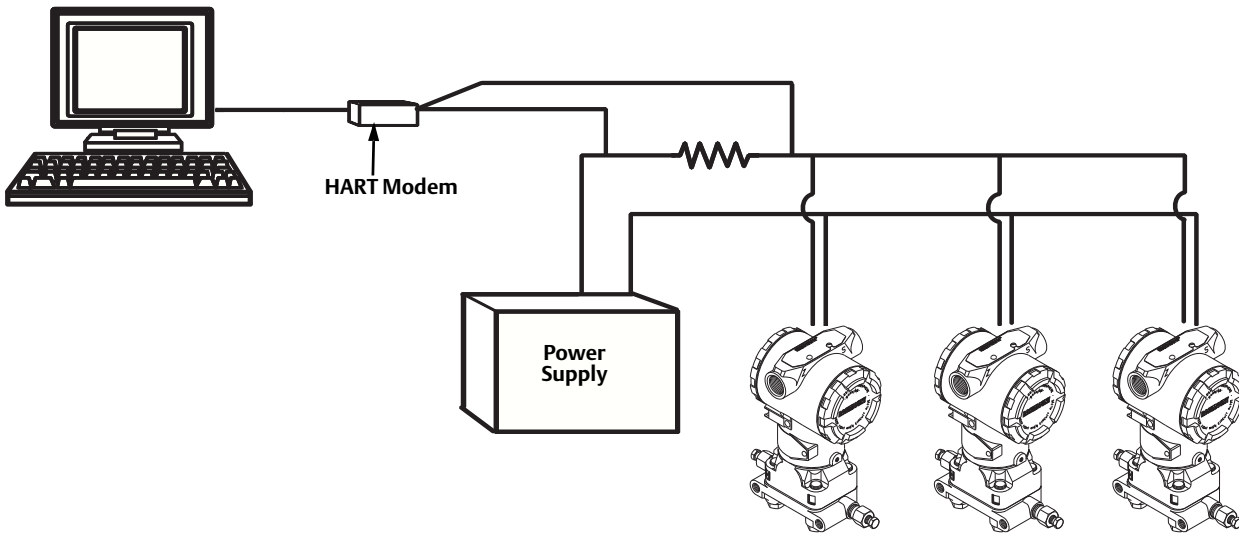
Multidropping transmitters refers to the connection of several transmitters to a single communications transmission line. Communication between the host and the transmitters takes place digitally with the analog output of the transmitters deactivated. With smart communications protocol, up to fifteen transmitters can be connected on a single twisted pair of wires, or over leased phone lines.

Multidrop installation requires consideration of the update rate necessary from each transmitter, the combination of transmitter models, and the length of the transmission line. Communication with transmitters can be accomplished with HART modems and a host implementing HART protocol. Each transmitter is identified by a unique address (1–15) and responds to the commands defined in the HART protocol. Field Communicators and AMS Device Manager can test, configure, and format a multidropped transmitter the same way as a transmitter in a standard point-to-point installation.

Figure 3-13 shows a typical multidrop network. This figure is not intended as an installation diagram.

Note
A transmitter in multidrop mode has the analog output fixed at 4 mA. If an LCD display is installed to a transmitter in multidrop mode, it will alternate the display between “current fixed” and the specified LCD display output(s).

Figure 3-13. Typical multidrop network



The 3051 is set to address zero (0) at the factory, which allows operation in the standard point-to-point manner with a 4–20 mA output signal. To activate multidrop communication, the transmitter address must be changed to a number from 1 to 15. This change deactivates the 4–20 mA analog output, sending it to 4 mA. It also disables the failure mode alarm signal, which is controlled by the upscale/downscale switch position. Failure signals in multidropped transmitters are communicated through HART messages.

3.15 Changing a transmitter address

To activate multidrop communication, the transmitter poll address must be assigned a number from 1 to 15, and each transmitter in a multidropped loop must have a unique poll address.

Field communicator

Traditional 4-20 mA Fast Keys	1, 4, 3, 3, 1
Traditional 1-5 Vdc Fast Keys	1, 4, 3, 3, 1
Device Dashboard Fast Keys	1, 2

AMS device manager

Right click on the device and select Configuration Properties from the menu.

1. In the *HART* tab, in *the ID* box, enter poll address located in the *Poll addr* box, click Apply.
2. After carefully reading the warning provided, select yes.

3.15.1 Communicating with a multidropped transmitter

Field communicator

Traditional 4-20 mA Fast Keys	1, 4, 3, 3, 2
Traditional 1-5 Vdc Fast Keys	1, 4, 3, 3, 2
Device Dashboard Fast Keys	1, 2

To communicate with a multidropped transmitter, configure the Field Communicator to poll for a non-zero address.

1. From the *HOME* screen, enter the fast key sequence “Communicating with a Multidropped Transmitter.”
2. On the polling menu, scroll down and select “Digital Poll.” In this mode, the Field Communicator automatically polls for devices at addresses 0-15 upon start up.

AMS device manager

Click on the HART modem icon and select Scan All Devices.

3.15.2 Polling a multidropped transmitter

Polling a multidropped loop determines the model, address, and number of transmitters on the given loop.

Field communicator

Traditional 4-20 mA Fast Keys	Left arrow, 4, 1
Traditional 1-5 Vdc Fast Keys	Left arrow, 4, 1
Device Dashboard Fast Keys	1, 2

AMS device manager

Click on the HART modem icon and select Scan All Devices.

Section 4 Operation and maintenance

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Safety messages ..... page 71
Calibration overview ..... page 72
Analog output trim ..... page 77
Sensor trim ..... page 81

4.1 Overview

This section contains information on calibrating and diagnostics messages on Rosemount 3051 Pressure Transmitters.

Field Communicator and AMS instructions are given to perform configuration functions. For convenience, Field Communicator fast key sequences are labeled “Fast Keys” for each software function below the appropriate headings.

4.2 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

4.2.1 Warnings

⚠ WARNING

Explosions could result in death or serious injury:

Installation of this transmitter in an explosive environment must be in accordance with the appropriate local, national, and international standards, codes, and practices. Please review the approvals section of the 3051 reference manual for any restrictions associated with a safe installation.

- Before connecting a Field Communicator in an explosive atmosphere, ensure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- In an Explosion-Proof/Flameproof installation, do not remove the transmitter covers when power is applied to the unit.

Process leaks may cause harm or result in death.

- Install and tighten process connectors before applying pressure.

Electrical shock can result in death or serious injury.

- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.

4.3 Calibration overview

Calibration is defined as the process required to optimize transmitter accuracy over a specific range by adjusting the factory sensor characterization curve located in the microprocessor. Possible procedures are:

- Reranging: Setting the lower and upper range points (4 and 20 mA or 1 and 5 Vdc) points at required pressures. Reranging does not change the factory sensor characterization curve. Refer to page 53.
- Analog Output Trim: Adjusts the transmitter's analog characterization curve to match the plant standard of the control loop. There are two types of digital-to-analog output trims. Refer to page 77.
  - Digital-to-Analog Output Trim on 4-20 mA HART output (page 77)
  - Digital-to-Analog Output Trim on 4-20 mA HART output Using Other Scale (page 79)
- Sensor Trim: Adjusts the position of the factory sensor characterization curve due to a change in the sensor characteristics over time or a change in test equipment. Trimming has two steps, zero and sensor trims. Refer to page 82 and page 83.
- Zero Trim (page 82)
- Sensor Trim (page 83)

Figure 4-1 on page 73 illustrates 3051 transmitter data flow. Data flow can be summarized in four major steps:

1. A change in pressure is measured by a change in the sensor output (Sensor Signal).
2. The sensor signal is converted to a digital format that is understood by the microprocessor (Analog-to-Digital Signal Conversion). Sensor trim functions affect this value. Select these options to alter the digital signal on the LCD or Field Communicator.
3. Corrections are performed in the microprocessor to obtain a digital representation of the process input (Digital PV).
4. The Digital PV is converted to an analog value (Digital-to-Analog Signal Conversion). Rerange and Analog trim functions affect this value. Select these options to change the range points (4-20 mA or 1-5 Vdc).

For a summary of recommended calibration procedures, refer to Table 4-1 on page 4-74. Also, Figure 4-1 on page 73 identifies the approximate transmitter location for each calibration task. Data flows from left to right and a parameter change affects all values to the right of the changed parameter.

Figure 4-1. Transmitter data flow with calibration options

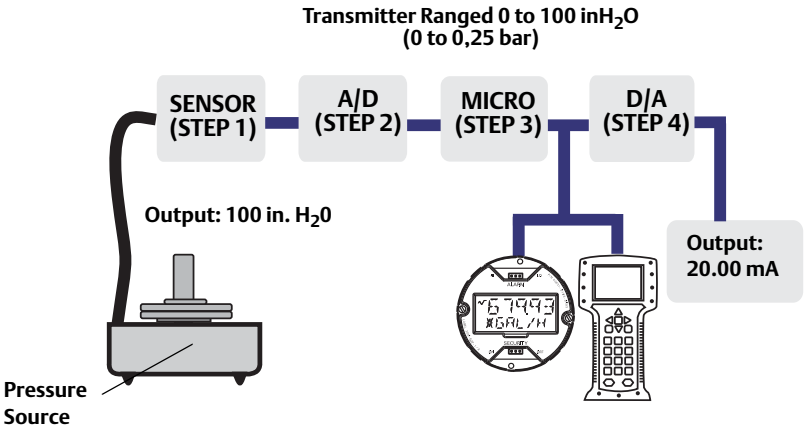


Table 4-1. Recommended calibration tasks

Transmitter	Bench calibration tasks	Field calibration tasks
3051CD 3051CG 3051L 3051TG, Range 1-4	1. Set output configuration parameters: a. Set the range points. b. Set the output units. c. Set the output type. d. Set the damping value. 2. *Optional*: Perform a sensor trim. (Accurate pressure source required.)	1. Reconfigure parameters if necessary. 2. Zero trim the transmitter to compensate for mounting effects or static pressure effects. 3. *Optional*: Perform an analog output trim. (Accurate multimeter required)
3051CA 3051TA 3051TG, Range 5	1. Set output configuration parameters: a. Set the range points. b. Set the output units. c. Set the output type. d. Set the damping value. 2. *Optional*: Perform a sensor trim if equipment available (accurate absolute pressure source required), otherwise perform the low trim value section of the sensor trim procedure.	1. Reconfigure parameters if necessary. 2. Perform low trim value section of the sensor trim procedure to correct for mounting position effects. 3. *Optional*: Perform an analog output trim (Accurate multimeter required)

Note
The 3051 has been carefully calibrated at the factory. Trimming adjusts the position of the factory characterization curve. It is possible to degrade performance of the transmitter if any trim is done improperly or with inaccurate equipment.

Note
A Field Communicator is required for all sensor and output trim procedures. Rosemount 3051C Range 4 and Range 5 transmitters require a special calibration procedure when used in differential pressure applications under high static line pressure (see"Select Finish to acknowledge the method is complete." on page 84).

4.3.1 Determining calibration frequency

Calibration frequency can vary greatly depending on the application, performance requirements, and process conditions. Use the following procedure to determine calibration frequency that meets the needs of your application.

1. Determine the performance required for your application.
2. Determine the operating conditions.
3. Calculate the Total Probable Error (TPE).
4. Calculate the stability per month.
5. Calculate the calibration frequency.

Sample calculation for a standard 3051C

Step 1: Determine the performance required for your application.

Required Performance:	0.30% of span

Step 2: Determine the operating conditions.

Transmitter:	3051CD, Range 2 [URL=250 inH_2O(623 mbar)]
Calibrated Span:	150 inH_2O (374 mbar)
Ambient Temperature Change:	± 50 °F (28 °C)
Line Pressure:	500 psig (34,5 bar)

Step 3: Calculate total probable error (TPE).

$$TPE = \sqrt{(ReferenceAccuracy)^2 + (TemperatureEffect)^2 + (StaticPressureEffect)^2} = 0.117\% \text{ of span}$$

Where:

Reference Accuracy = ± 0.065% of span

Ambient Temperature Effect = $\pm\left(\frac{(0.0125 \quad URL)}{Span} + 0.0625\right)$ % per 50 °F = ±0.0833% of span

Span Static Pressure Effect[1] =

0.1% reading per 1000 psi (69 bar) = ±0.05% of span at maximum span

(1)Zero static pressure effect removed by zero trimming at line pressure.

Step 4: Calculate the stability per month.

$$Stability = \pm\left[\frac{(0.125 \quad URL)}{Span}\right] \% \text{ of span for 5 years} = \pm 0.0035\% \text{ of span per month}$$

Step 5: Calculate calibration frequency.

$$\text{Cal. Freq.} = \frac{(\text{Req. Performance} - TPE)}{\text{Stability per Month}} = \frac{(0.30\% - 0.117\%)}{0.0035\%} = (52) \text{months}$$

Sample calculation for 3051C with P8 option (0.04% accuracy & 5-year stability)

Step 1: Determine the performance required for your application.

Required Performance:	0.30% of span

Step 2: Determine the operating conditions.

Transmitter:	3051CD, Range 2 [URL=250 inH_2O(623 mbar)]
Calibrated Span:	150 inH_2O (374 mbar)
Ambient Temperature Change:	± 50 °F (28 °C)
Line Pressure:	500 psig (34,5 bar)

Step 3: Calculate total probable error (TPE).

$$TPE = \sqrt{(ReferenceAccuracy)^2 + (TemperatureEffect)^2 + (StaticPressureEffect)^2} = 0.105\% \text{ of span}$$

Where:

Reference Accuracy = ± 0.04% of span

Ambient Temperature Effect =

$$\pm\left(\frac{0.0125 \times URL}{Span} + 0.0625\right)\% \text{ per } 50\ °F = \pm 0.0833\% \text{ of span}$$

Span Static Pressure Effect(1) =

0.1% reading per 1000 psi (69 bar) = ±0.05% of span at maximum span

(1)Zero static pressure effect removed by zero trimming at line pressure.

Step 4: Calculate the stability per month.

$$Stability = \pm\left[\frac{(0.125 \times URL)}{Span}\right]\% \text{ of span for 5 years} = \pm 0.0035\% \text{ of span per month}$$

Step 5: Calculate calibration frequency.

$$\text{Cal. Freq.} = \frac{(\text{Req. Performance} - TPE)}{\text{Stability per Month}} = \frac{(0.3\% - 0.105\%)}{0.0035\%} = 27 \text{ months}$$

4.3.2 Choosing a trim procedure

To decide which trim procedure to use, you must first determine whether the analog-to-digital section or the digital-to-analog section of the transmitter electronics need calibration. Refer to Figure 4-1 and perform the following procedure:

1. Connect a pressure source, a Field Communicator or AMS, and a digital readout device to the transmitter.
2. Establish communication between the transmitter and the Field Communicator.
3. Apply pressure equal to the upper range point pressure.
4. Compare the applied pressure to the pressure process variable valve on the Process Variables menu on the Field Communicator or the *Process Variables* screen in AMS. For instructions on how to access process variables, see page 51 of Section 3: Configuration.

a. If the pressure reading does not match the applied pressure (with high-accuracy test equipment), perform a sensor trim. See "Sensor trim overview" on page 81 to determine which trim to perform.

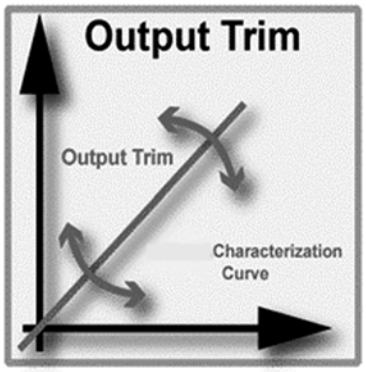
5. Compare the Analog Output (AO) line, on the Field Communicator or AMS, to the digital readout device.

If the AO reading does not match the digital readout device (with high-accuracy test equipment), perform an analog output trim. See "Analog output trim" on page 77.

4.4 Analog output trim

The Analog Output Trim commands allow you to adjust the transmitter's current output at the 4 and 20 mA (1 and 5 Vdc) points to match the plant standards. This command adjusts the digital to analog signal conversion.

Figure 4-2. Output trim



4.4.1 Digital-to-Analog trim

Field communicator

Traditional 4-20 mA Fast Keys	1, 2, 3, 2, 1
Traditional 1-5 Vdc Fast Keys	1, 2, 3, 2, 1
Device Dashboard Fast Keys	3, 4, 2

To perform a digital-to-analog trim with a Field Communicator, perform the following procedure.

1. From the *HOME* screen, enter the fast key sequence “Digital-to-Analog Trim.” Select OK after setting the control loop to manual, see “Setting the loop to manual” on page 40.

2. a. For 4-20 mA HART output, connect a reference meter to the transmitter by either connecting the meter to the test terminals on the terminal block, or shunting transmitter power through the meter at some point in the loop.
   b. For 1-5 Vdc Low Power HART output, connect a reference meter to the V_{out} terminal.

3. Select OK after connecting the reference meter.

4. Select OK at the SETTING FLD DEV OUTPUT TO 4 MA (1 Vdc) prompt. The transmitter outputs 4.0 mA.

5. Record the actual value from the reference meter, and enter it at the ENTER METER VALUE prompt. The Field Communicator prompts you to verify whether or not the output value equals the value on the reference meter.

6. Select 1: Yes, if the reference meter value equals the transmitter output value, or 2: No if it does not.
   a. If 1 is selected: Yes, proceed to Step 7.
   b. If 2 is selected: No, repeat Step 5.

7. Select OK at the SETTING FLD DEV OUTPUT TO 20 MA (5 Vdc) prompt, and repeat Steps 5 and 6 until the reference meter value equals the transmitter output value.

8. Select OK after the control loop is returned to automatic control.

AMS Device Manager

Right click on the device and select Calibrate, then D/A Trim from the menu.

1. Click Next after setting the control loop to manual.
2. Click Next after connecting the reference meter.
3. Click Next at the *Setting fld dev output to 4 mA (1 Vdc)* screen.
4. Record the actual value from the reference meter, and enter it at the *Enter meter value* screen and click Next.
5. Select Yes, if the reference meter value equals the transmitter output value, or No if it does not. Click Next.
   a. If Yes is selected, proceed to Step 6.
   b. If No is selected, repeat Step 4.
6. Click Next at the *Setting fld dev output to 20 mA (5 Vdc)* screen.
7. Repeat Step 4 - Step 5 until the reference meter equals the transmitter output value.
8. Select Next to acknowledge the loop can be returned to automatic control.
9. Select Finish to acknowledge the method is complete.

4.4.2 Digital-to-Analog trim using other scale

The Scaled D/A Trim command matches the 4 and 20 mA (1 and 5 Vdc) points to a user selectable reference scale other than 4 and 20 mA (for example, 2 to 10 volts if measuring across a 500 ohm load, or 0 to 100 percent if measuring from a Distributed Control System (DCS)). To perform a scaled D/A trim, connect an accurate reference meter to the transmitter and trim the output signal to scale, as outlined in the Output Trim procedure.

Note
Use a precision resistor for optimum accuracy. If you add a resistor to the loop, ensure that the power supply is sufficient to power the transmitter to a 20 mA output with additional loop resistance. Refer to "Power supply for 4-20 mA HART" on page 25.

Field communicator

Traditional 4-20 mA Fast Keys	1, 2, 3, 2, 2
Traditional 1-5 Vdc Fast Keys	1, 2, 3, 2, 2
Device Dashboard Fast Keys	3, 4, 2

AMS Device Manager

Right click on the device and select Calibrate, then Scaled D/A trim from the menu.

1. Click Next after setting the control loop to manual.
2. Select Change to change scale, click Next.
3. Enter Set scale-Lo output value, click Next.
4. Enter Set scale-Hi output value, click Next.
5. Click Next to proceed with Trim.
6. Click Next after connecting the reference meter.
7. Click Next at the *Setting fld dev output to 4 mA* screen.
8. Record the actual value from the reference meter, and enter it at the *Enter meter value* screen and click Next.
9. Select Yes, if the reference meter value equals the transmitter output value, or No if it does not. Click Next.
   a. If Yes is selected, proceed to Step 10.
   b. If No is selected, repeat Step 8.
10. Click Next at the *Setting fld dev output to 20 mA* screen.
11. Repeat Step 8 - Step 9 until the reference meter equals the transmitter output value.
12. Select Next to acknowledge the loop can be returned to automatic control.
13. Select Finish to acknowledge the method is complete.

4.4.3 Recall factory trim—analog output

The Recall Factory Trim—Analog Output command allows the restoration of the as-shipped factory settings of the analog output trim. This command can be useful for recovering from an inadvertent trim, incorrect Plant Standard or faulty meter. This command is only available with 4-20 mA output.

Field communicator

Traditional 4-20 mA Fast Keys	1, 2, 3, 4, 2
Device Dashboard Fast Keys	3, 4, 3

AMS Device Manager

Right click on the device and select Calibrate, then Recall Factory Trim from the menu.

1. Click Next after setting the control loop to manual.
2. Select Analog output trim under *Trim to recall* and click Next.
3. Click Next to acknowledge restoration of trim values is complete.
4. Select Next to acknowledge the loop can be returned to automatic control.
5. Select Finish to acknowledge the method is complete.

4.5 Sensor trim

4.5.1 Sensor trim overview

Trim the sensor using either sensor or zero trim functions. Trim functions vary in complexity and are application-dependent. Both trim functions alter the transmitter's interpretation of the input signal.

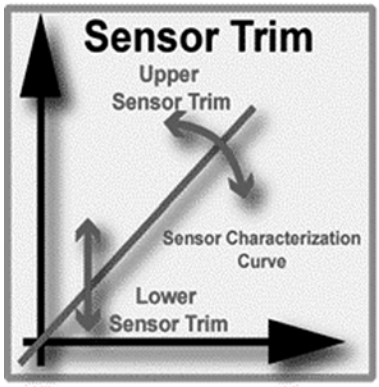
Zero trim is a single-point offset adjustment. It is useful for compensating for mounting position effects and is most effective when performed with the transmitter installed in its final mounting position. Since this correction maintains the slope of the characterization curve, it should not be used in place of a sensor trim over the full sensor range.

When performing a zero trim, ensure that the equalizing valve is open and all wet legs are filled to the correct levels.

Note
Do not perform a zero trim on Rosemount 3051T Absolute pressure transmitters. Zero trim is zero based, and absolute pressure transmitters reference absolute zero. To correct mounting position effects on a 3051T Absolute Pressure Transmitter, perform a low trim within the sensor trim function. The low trim function provides an offset correction similar to the zero trim function, but it does not require zero-based input.

Sensor trim is a two-point sensor calibration where two end-point pressures are applied, and all output is linearized between them. Always adjust the low trim value first to establish the correct offset. Adjustment of the high trim value provides a slope correction to the characterization curve based on the low trim value. The trim values allow you to optimize performance over your specified measuring range at the calibration temperature.

Figure 4-3. Sensor trim



4.5.2 Zero trim

Note
The transmitter PV at zero pressure must be within three percent of URL in order to calibrate using the zero trim function.

Field communicator

Traditional 4-20 mA Fast Keys	1, 2, 3, 3, 1
Traditional 1-5 Vdc Fast Keys	1, 2, 3, 3, 1
Device Dashboard Fast Keys	3, 4, 1, 3

Calibrate the sensor with a Field Communicator using the zero trim function as follows:

1. Vent the transmitter and attach a Field Communicator to the measurement loop.
2. From the *HOME* screen, follow the fast key sequence “Zero Trim.”
3. Follow the commands provided by the Field Communicator to complete the zero trim adjustment.

AMS Device Manager

Right click on the device and select Calibrate, then Zero trim from the menu.

1. Click Next after setting the control loop to manual.
2. Click Next to acknowledge warning.
3. Click Next after applying appropriate pressure to sensor.
4. Select Next to acknowledge the loop can be returned to automatic control.
5. Select Finish to acknowledge the method is complete.

4.5.3 Sensor trim

Note
Use a pressure input source that is at least four times more accurate than the transmitter, and allow the input pressure to stabilize for ten seconds before entering any values.

Field communicator

Traditional 4-20 mA Fast Keys	1, 2, 3, 3
Traditional 1-5 Vdc Fast Keys	1, 2, 3, 3
Device Dashboard Fast Keys	3, 4, 1

To calibrate the sensor with a Field Communicator using the sensor trim function, perform the following procedure:

1. Assemble and power the entire calibration system including a transmitter, Field Communicator, power supply, pressure input source, and readout device.
2. From the *HOME* screen, enter the fast key sequence under "Sensor Trim."
3. Select 2: Lower sensor trim. The lower sensor trim value should be the sensor trim point that is closest to zero.

Examples:

Calibration: 0 to 100" H_2O - lower trim = 0, upper trim = 100

Calibration: -100 to 0" H_2O - lower trim = 0, upper trim = -100

Calibration: -100 to 100" H_2O - lower trim = -100 or 100,
upper trim = -100 or 100

Note
Select pressure input values so that lower and upper values are equal to or outside the 4 and 20 mA (1 and 5 Vdc) points. Do not attempt to obtain reverse output by reversing the high and low points. This can be done by going to "Rerange" on page 53 of Section 3: Configuration. The transmitter allows approximately five percent deviation.

4. Follow the commands provided by the Field Communicator to complete the adjustment of the lower value.
5. Repeat the procedure for the upper value, replacing 2: Lower sensor trim with 3: Upper sensor trim in Step 3.

AMS Device Manager

Right click on the device and select Calibrate, then Sensor trim" from the menu.

1. Select Lower sensor trim. The lower sensor trim value should be the sensor trim point that is closest to zero.
2. Click Next after setting the control loop to manual.
3. Click Next after applying appropriate pressure to sensor.
4. Select Next to acknowledge the loop can be returned to automatic control.
5. Select Finish to acknowledge the method is complete.
6. Right click on the device and select Calibrate, select Sensor trim from the menu.
7. Select Upper sensor trim and repeat steps 5.

4.5.4 Recall factory trim—sensor trim

The Recall Factory Trim—Sensor Trim command allows the restoration of the as-shipped factory settings of the sensor trim. This command can be useful for recovering from an inadvertent zero trim of an absolute pressure unit or inaccurate pressure source. This command is only available with 4-20 mA output.

Field communicator

4-20 mA Fast Keys	1, 2, 3, 4, 1
Device Dashboard Fast Keys	3, 4, 3

AMS Device Manager

Right click on the device and select Calibrate, then Recall Factory Trim from the menu.

1. Click Next after setting the control loop to manual.
2. Select "Sensor trim" under *Trim to recall* and click Next.
3. Click Next to acknowledge restoration of trim values is complete.
4. Select Next to acknowledge the loop can be returned to automatic control.
5. Select Finish to acknowledge the method is complete.

4.5.5 Line pressure effect (range 2 and range 3)

The following specifications show the static pressure effect for the Rosemount 3051 Range 2 and Range 3 pressure transmitters used in differential pressure applications where line pressure exceeds 2000 psi (138 bar).

Zero effect

± 0.1% of the upper range limit plus an additional ± 0.1% of upper range limit error for each 1000 psi (69 bar) of line pressure above 2000 psi (138 bar).

Example: Line pressure is 3000 psi (207 bar) for Ultra performance transmitter. Zero effect error calculation:

± {0.05 + 0.1 x [3 kpsi - 2 kpsi]} = ± 0.15% of the upper range limit

Span effect

Refer to "Line Pressure Effect" on page 105.

4.5.6 Compensating for line pressure

Rosemount 3051 Range 4 and 5 pressure transmitters require a special calibration procedure when used in differential pressure applications. The purpose of this procedure is to optimize transmitter performance by reducing the effect of static line pressure in these applications. The 3051 differential pressure transmitters (Ranges 1, 2, and 3) do not require this procedure because optimization occurs in the sensor.

Applying high static pressure to 3051 Range 4 and Range 5 pressure transmitters causes a systematic shift in the output. This shift is linear with static pressure; correct it by performing the Sensor Trim procedure on page 83.

The following specifications show the static pressure effect for 3051 Range 4 and Range 5 transmitters used in differential pressure applications:

Zero Effect:

± 0.1% of the upper range limit per 1000 psi (69 bar) for line pressures from 0 to 2000 psi (0 to 138 bar)

For line pressures above 2000 psi (138 bar), the zero effect error is ± 0.2% of the upper range limit plus an additional ± 0.2% of upper range limit error for each 1000 psi (69 bar) of line pressure above 2000 psi (138 bar).

Example: Line pressure is 3000 psi (3 kpsi). Zero effect error calculation:

± {0.2 + 0.2 x [3 kpsi - 2 kpsi]} = ± 0.4% of the upper range limit

Span Effect:

Correctable to ±0.2% of reading per 1000 psi (69 bar) for line pressures from 0 to 3626 psi (0 to 250 bar)

The systematic span shift caused by the application of static line pressure is -1.00% of reading per 1000 psi (69 bar) for Range 4 transmitters, and -1.25% of reading per 1000 psi (69 bar) for Range 5 transmitters.

Use the following example to compute corrected input values.

Example

A Range 4 transmitter with model number 3051_CD4 will be used in a differential pressure application where the static line pressure is 1200 psi (83 bar). The transmitter output is ranged with 4 mA at 500 inH_2O (1,2 bar) and 20 mA at 1500 inH_2O (3,7 bar).

To correct for systematic error caused by high static line pressure, first use the following formulas to determine corrected values for the low trim and high trim.

Low Trim Value

LT = LRV - (S/100 x P/1000 x LRV)

Where:	LT =	Corrected Low Trim Value
	LRV =	Lower Range Value
	S =	Span shift per specification (as a percent of reading)
	P =	Static Line Pressure in psi

In this example:

LRV =	500 inH_2O (1.24 bar)
S =	-1.00%
P =	1200 psi
LT =	500 inH_2O - (-1%/100 x 1200 psi/1000 x 500 inH_2O)
LT =	506 inH_2O

High Trim Value

HT = (URV - (S/100 x P/1000 x URV)

Where:	HT =	Corrected High Trim Value
	URV =	Upper Range Value
	S =	Span shift per specification (as a percent of reading)
	P =	Static Line Pressure in psi

In this example:

URV =	1500 inH_2O (3.74 bar)
S =	-1.00%
P =	1200 psi
HT =	1500 - (-1%/100 x 1200 psi/1000 x 1500 inH_2O)
HT =	1518 inH_2O

Complete the Sensor Trim procedure as described on page 83. In the example above, at step 4, apply the nominal pressure value of 500 inH_2O. However, enter the calculated correct lower trim (LT) value of 506 inH_2O with the Field Communicator. Repeat the procedure for the upper value.

Note
The range values for the 4 and 20 mA (1 and 5 Vdc) points should be at the nominal URV and LRV. In the example above, the values are 1500 inH_2O and 500 inH_2O respectively. Confirm the values on the *HOME* screen on the Field Communicator. Modify, if needed, by following the steps in the Rerange section on page 53.

Section 5 Troubleshooting

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Safety messages . . . . . page 89
Diagnostic messages . . . . . page 92
Disassembly procedures . . . . . page 97
Reassembly procedures . . . . . page 100

5.1 Overview

Table 5-1 provides summarized maintenance and troubleshooting suggestions for the most common operating problems.

If you suspect malfunction despite the absence of any diagnostic messages on the Field Communicator display, consider using Table 5-1 on page 5-91 to identify any potential problem.

5.2 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

5.2.1 Warnings (⚠)

⚠ WARNING

Explosions could result in death or serious injury:

Installation of this transmitter in an explosive environment must be in accordance with the appropriate local, national, and international standards, codes, and practices. Please review the approvals section of the 3051 reference manual for any restrictions associated with a safe installation.

- Before connecting a Field Communicator in an explosive atmosphere, ensure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- In an Explosion-Proof/Flameproof installation, do not remove the transmitter covers when power is applied to the unit.

Process leaks may cause harm or result in death.

- Install and tighten process connectors before applying pressure.

Electrical shock can result in death or serious injury.

- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.

Table 5-1. Rosemount 3051 troubleshooting table for 4-20 mA output

Symptom	Corrective actions
Transmitter milliamp reading is zero	Verify power is applied to signal terminals
	Check power wires for reversed polarity
	Verify terminal voltage is 10.5 to 42.4 Vdc
	Check for open diode across test terminal
Transmitter Not Communicating with Field Communicator	Verify the output is between 4 and 20 mA or saturation levels
	Verify terminal voltage is 10.5 to 42.4 Vdc
	Verify clean DC Power to transmitter (Max AC noise 0.2 volts peak to peak)
	Check loop resistance, 250 Ω minimum (PS voltage -transmitter voltage/loop current)
	Have Field Communicator poll for all addresses
Transmitter milliamp reading is low or high	Verify applied pressure
	Verify 4 and 20 mA range points
	Verify output is not in alarm condition
	Verify if 4 – 20 mA output trim is required
Transmitter will not respond to changes in applied pressure	Check test equipment
	Check impulse piping or manifold for blockage
	Verify the transmitter is not in multidrop mode
	Verify applied pressure is between the 4 and 20 mA set points
	Verify output is not in alarm condition
	Verify transmitter is not in Loop Test mode
Digital Pressure Variable reading is low or high	Check test equipment (verify accuracy)
	Check impulse piping for blockage or low fill in wet leg
	Verify transmitter is calibrated properly
	Verify pressure calculations for application
Digital Pressure Variable reading is erratic	Check application for faulty equipment in pressure line
	Verify transmitter is not reacting directly to equipment turning on/off
	Verify damping is set properly for application
Milliamp reading is erratic	Verify power source to transmitter has adequate voltage and current
	Check for external electrical interference
	Verify transmitter is properly grounded
	Verify shield for twisted pair is only grounded at one end

5.3 Diagnostic messages

In addition to the output, the LCD meter displays abbreviated operation, error, and warning messages for troubleshooting the transmitter. Messages appear according to their priority, with normal operating messages appearing last. To determine the cause of a message, use a Field Communicator or AMS to further interrogate the transmitter. A description of each LCD diagnostic message follows.

Error

Error messages appear on the LCD display to inform you of serious problems affecting the operation of the transmitter. The LCD displays an error message until the error condition is corrected, and the analog output is driven to the specified alarm level. No other transmitter information is displayed during an alarm condition.

Fail

The transmitter CPU board and the sensor module are incompatible. See “Disassembly procedures” on page 97.

Fail Module

The sensor module is disconnected or is malfunctioning. Verify that the sensor module ribbon cable is connected to the back of the electronics board. If the ribbon cable is properly connected, there is a problem within the sensor module. Possible sources of problems include:

- Pressure or temperature updates are not being received in the sensor module.
- A non-volatile memory fault that will effect transmitter operation has been detected in the module by the memory verification routine.

Some non-volatile memory faults are user-repairable. Use a Field Communicator to diagnose the error and determine if it is repairable. Any error message that ends in “FACTORY” is not repairable. In cases of non user-repairable errors, you must replace the transmitter.

Fail Elect

The transmitter electronics board is malfunctioning due to an internal fault. Some of the FAIL ELECT errors are user-repairable. Use a 275 Field Communicator to diagnose the error and determine if it is repairable. Any error message that ends in “FACTORY” is not repairable. In cases of non user-repairable errors, you must replace the electronics board. See “Disassembly procedures” on page 97.

Fail Config

A memory fault has been detected in a location that could affect transmitter operation, and is user-accessible. To correct this problem, use a Field Communicator to interrogate and reconfigure the appropriate portion of the transmitter memory.

Warnings

Warnings appear on the LCD display to alert you of user-repairable problems with the transmitter, or current transmitter operations. Warnings appear alternately with other transmitter information until the warning condition is corrected or the transmitter completes the operation that warrants the warning message.

Press Limit

The process variable read by the transmitter is outside of the transmitter's range.

Temp Limit

The secondary temperature variable read by the transmitter is outside of the transmitter's range.

Curr Fixed

The transmitter is in multidrop mode. The analog output is not tracking pressure changes.

Curr Saturd

The pressure read by the module is outside of the specified range, and the analog output has been driven to saturation levels.

Loop Test

A loop test is in progress. During a loop test or 4–20 mA trim, the analog output is set to a fixed value. The meter display alternates between the current selected in milliamps and "LOOP TEST."

Xmtr Info

A non-volatile memory fault has been detected in the transmitter memory by the memory verification routine. The memory fault is in a location containing transmitter information. To correct this problem, use a Field Communicator to interrogate and reconfigure the appropriate portion of the transmitter memory. This warning does not effect the transmitter operation.

Operation

Normal operation messages appear on the LCD meter to confirm actions or inform you of transmitter status. Operation messages are displayed with other transmitter information, and warrant no action to correct or alter the transmitter settings.

Zero Pass

The zero value, set with the local zero adjustment button, has been accepted by the transmitter, and the output should change to 4 mA
(1 Vdc).

Zero Fail

The zero value, set with the local zero adjustment button, exceeds the maximum rangedown allowed for a particular range, or the pressure sensed by the transmitter exceeds the sensor limits.

Span Pass

The span value, set with the local span adjustment button, has been accepted by the transmitter, and the output should change to 20 mA
(5 Vdc).

Span Fail

The span value, set with the local span adjustment button, exceeds the maximum rangedown allowed for a particular range, or the pressure sensed by the transmitter exceeds the sensor limits.

Local Dsbld

This message appears during reranging with the integral zero and span buttons and indicates that the transmitter local zero and span adjustments have been disabled. The adjustments may have been disabled by the transmitter security jumper on the transmitter circuit board or through software commands from the Field Communicator. See "Security (write protect)" on page 20 for information on the position of the security jumper and information on software lockout.

Write Protect

This message appears if you attempt to change the transmitter configuration data while the security jumper is in the ON position. See "Security (write protect)" on page 20 for more information about the security jumper.

Field communicator diagnostics

Table 5-2 is a list of messages used by the Field Communicator (HC) and their corresponding descriptions.

Variable parameters within the text of a message are indicated with <*variable parameter*>.

Reference to the name of another message is identified by *[another message]*.

Table 5-2. Field communicator messages

Message	Description
1k snsr EEPROM error-factory ON	Replace the transmitter
1k snsr EEPROM error-user-no out ON	Use the Field Communicator to reset the following parameters: remote seal isolator, remote seal fill fluid, flange material, o-ring material, transmitter type, remote seal type, flange type, meter type, number of remote seals.
1k snsr EEPROM error-user ON	Perform a full trim to recalibrate the transmitter.
4k micro EEPROM error-factory ON	Replace the electronics board.
4k micro EEPROM error-user-no out ON	Use the Field Communicator to reset the message field.
4k micro EEPROM error-user ON	Use the Field Communicator to reset the following parameters: units, range values, damping, analog output, transfer function, tag, scaled meter values. Perform a D/A trim to ensure that the error is corrected.

Message	Description
4k snsr EEPROM error-factory ON	Replace the transmitter.
4k snsr EEPROM error-user ON	Use the Field Communicator to reset the temperature units and the calibration type.
Add item for ALL device types or only for this ONE device type.	Asks the user whether the hot key item being added should be added for all device types or only for the type of device that is connected.
Command Not Implemented	The connected device does not support this function.
Communication Error	The communicator and the device are not communicating correctly. Check all connections between the Field Communicator and the device and resend the information.
Configuration memory not compatible with connected device	The configuration stored in memory is incompatible with the device to which a transfer has been requested.
CPU board not initialized ON	The electronics board is not initialized. Replace the electronics board.
CPU EEPROM write failure ON	Message sent to electronics board from HART signal failed. Replace the electronics board.
Device Busy	The connected device is busy performing another task.
Device Disconnected	The device failed to respond to a command. Check all connections between the Field Communicator and the device and resend the command.
Device write protected	Device is in write-protect mode. Data can not be written.
Device write protected. Do you still want to shut off?	Device is in write-protect mode. Press YES to turn the Field Communicator off and lose the unsent data.
Display value of variable on hotkey menu?	Asks whether the value of the variable should be displayed adjacent to its label on the hotkey menu if the item being added to the hotkey menu is a variable.
Download data from configuration memory to device	Press the SEND softkey to transfer information from the communicator memory to the device.
Exceed field width	Indicates that the field width for the current arithmetic variable exceeds the device-specified description edit format.
Exceed precision	Indicates that the precision for the current arithmetic variable exceeds the device-specified description edit format.
Ignore next 50 occurrences of status?	Select YES to ignore the next 50 occurrences of device status, or select no to display every occurrence.
Illegal character	An invalid character for the variable type was entered.
Illegal date	The day portion of the date is invalid.
Illegal month	The month portion of the date is invalid.
Illegal year	The year portion of the date is invalid.
Incompatible CPU board and module ON	Upgrade the electronics board or the sensor module to the current revision.
Incomplete exponent	The exponent of a scientific notation floating point variable is incomplete.
Incomplete field	The value entered is not complete for the variable type.

Message	Description
Looking for a device	Polling for multidropped devices at addresses 1–15.
Local buttons operator error ON	Illegal pressure applied during zero or span operation. Repeat the process after verifying the correct pressures.
Mark as read only variable on hotkey menu?	Asks whether the user should be allowed to edit the variable from the hotkey menu if the item being added to the hotkey menu is a variable.
Module EEPROM write failure ON	Message sent to the module from the HART signal failed. Replace the transmitter.
No device configuration in configuration memory	There is no configuration saved in memory available to re-configure off-line or transfer to a device.
No Device Found	Poll of address zero fails to find a device, or poll of all addresses fails to find a device if auto-poll is enabled.
No hotkey menu available for this device.	There is no menu named “hotkey” defined in the device description for this device.
No pressure updates ON	No pressure updates being received from the sensor module. Verify that the sensor module ribbon cable is attached correctly. Or replace the transmitter.
No offline devices available.	There are no device descriptions available to be used to configure a device offline.
No simulation devices available.	There are no device descriptions available to simulate a device.
No temperature updates ON	No temperature updates being received from the sensor module. Verify that the sensor module ribbon cable is attached correctly. Or replace the transmitter.
No UPLOAD_VARIABLES in ddl for this device	There is no menu named “upload_variables” defined in the device description for this device. This menu is required for offline configuration.
No Valid Items	The selected menu or edit display contains no valid items.
OFF KEY DISABLED	Appears when the user attempts to turn the HC off before sending modified data or before completing a method.
Online device disconnected with unsent data. RETRY or OK to lose data.	There is unsent data for a previously connected device. Press RETRY to send data, or press OK to disconnect and lose unsent data.
Out of memory for hotkey configuration. Delete unnecessary items.	There is no more memory available to store additional hotkey items. Unnecessary items should be deleted to make space available.
Overwrite existing configuration memory	Requests permission to overwrite existing configuration either by a device-to-memory transfer or by an offline configuration. User answers using the softkeys.
Press OK...	Press the OK softkey. This message usually appears after an error message from the application or as a result of HART communications.
Restore device value?	The edited value that was sent to a device was not properly implemented. Restoring the device value returns the variable to its original value.
ROM checksum error ON	Checksum of transmitter software has detected a fault. Replace the electronics board.
Save data from device to configuration memory	Prompts user to press SAVE softkey to initiate a device-to-memory transfer.

Message	Description
Saving data to configuration memory.	Data is being transferred from a device to configuration memory.
Sending data to device.	Data is being transferred from configuration memory to a device.
Sensor board not initialized ON	The sensor module electronics board is not initialized. Replace the transmitter.
There are write only variables which have not been edited. Please edit them.	There are write-only variables which have not been set by the user. These variables should be set or invalid values may be sent to the device.
There is unsent data. Send it before shutting off?	Press YES to send unsent data and turn the HC off. Press NO to turn the HC off and lose the unsent data.
Too few data bytes received	Command returns fewer data bytes than expected as determined by the device description.
Transmitter Fault	Device returns a command response indicating a fault with the connected device.
Units for <variable label> has changed. Unit must be sent before editing, or invalid data will be sent.	The engineering units for this variable have been edited. Send engineering units to the device before editing this variable.
Unsent data to online device. SEND or LOSE data	There is unsent data for a previously connected device which must be sent or thrown away before connecting to another device.
Upgrade 275 software to access XMTR function. Continue with old description?	The communicator does not contain the most recent 3051 Device Descriptors (DDs). Select YES to communicate using the existing DDs. Select NO to abort communication.
Use up/down arrows to change contrast. Press DONE when done.	Gives direction to change the contrast of the HC display.
Value out of range	The user-entered value is either not within the range for the given type and size of variable or not within the min/max specified by the device.
<message> occurred reading/writing <variable label>	Either a read/write command indicates too few data bytes received, transmitter fault, invalid response code, invalid response command, invalid reply data field, or failed pre- or post-read method; or a response code of any class other than SUCCESS is returned reading a particular variable.
<variable label> has an unknown value. Unit must be sent before editing, or invalid data will be sent.	A variable related to this variable has been edited. Send related variable to the device before editing this variable.

5.4 Disassembly procedures

⚠ Do not remove the instrument cover in explosive atmospheres when the circuit is live.

5.4.1 Remove from service

Follow these steps:

- Follow all plant safety rules and procedures.
- Isolate and vent the process from the transmitter before removing the transmitter from service.
- Remove all electrical leads and disconnect conduit.
- Remove the transmitter from the process connection.
- The Rosemount 3051C transmitter is attached to the process connection by four bolts and two cap screws. Remove the bolts and separate the transmitter from the process connection. Leave the process connection in place and ready for re-installation.
- The Rosemount 3051T transmitter is attached to the process by a single hex nut process connection. Loosen the hex nut to separate the transmitter from the process. Do not wrench on neck of transmitter.
- Do not scratch, puncture, or depress the isolating diaphragms.
- Clean isolating diaphragms with a soft rag and a mild cleaning solution, and rinse with clear water.
- For the 3051C, whenever you remove the process flange or flange adapters, visually inspect the PTFE o-rings. Replace the o-rings if they show any signs of damage, such as nicks or cuts. Undamaged o-rings may be reused.

5.4.2 Remove terminal block

Electrical connections are located on the terminal block in the compartment labeled "FIELD TERMINALS."

1. Remove the housing cover from the field terminal side.
2. Loosen the two small screws located on the assembly in the 9 o'clock and 5 o'clock positions.
3. Pull the entire terminal block out to remove it.

5.4.3 Remove the electronics board

The transmitter electronics board is located in the compartment opposite the terminal side. To remove the electronics board perform the following procedure:

1. Remove the housing cover opposite the field terminal side.
2. If you are disassembling a transmitter with a LCD display, loosen the two captive screws that are visible on the right and left side of the meter display.
3. ⚠ Loosen the two captive screws that anchor the board to the housing. The electronics board is electrostatically sensitive; observe handling precautions for static-sensitive components. Use caution when removing the LCD as there is an electronic pin connector that interfaces between the LCD and electronics board. The two screws anchor the LCD display to the electronics board and the electronics board to the housing.
4. Using the two captive screws, slowly pull the electronics board out of the housing. The sensor module ribbon cable holds the electronics board to the housing. Disengage the ribbon cable by pushing the connector release.

5.4.4 Remove the sensor module from the electronics housing

1. Remove the electronics board. Refer to "Remove the electronics board" on page 99.

Important
To prevent damage to the sensor module ribbon cable, disconnect it from the electronics board before you remove the sensor module from the electrical housing.

2. Carefully tuck the cable connector completely inside of the internal black cap.

⚠ See "Safety messages" on page 89 for complete warning

Note
Do not remove the housing until after you tuck the cable connector completely inside of the internal black cap. The black cap protects the ribbon cable from damage that can occur when you rotate the housing.

3. Loosen the housing rotation set screw with a $^{5}/_{64}$-inch hex wrench, and loosen one full turn.
4. Unscrew the module from the housing, making sure the black cap and sensor cable do not catch on the housing.

5.5 Reassembly procedures

1. Inspect all cover and housing (non-process wetted) O-rings and replace if necessary. Lightly grease with silicone lubricant to ensure a good seal.
2. Carefully tuck the cable connector completely inside the internal black cap. To do so, turn the black cap and cable counterclockwise one rotation to tighten the cable.
3. Lower the electronics housing onto the module. Guide the internal black cap and cable through the housing and into the external black cap.
4. Turn the module clockwise into the housing.

Important
Make sure the sensor ribbon cable and internal black cap remain completely free of the housing as you rotate it. Damage can occur to the cable if the internal black cap and ribbon cable become hung up and rotate with the housing.

⚠ 5. Thread the housing completely onto the sensor module. The housing must be no more than one full turn from flush with the sensor module to comply with explosion proof requirements.
6. Tighten the housing rotation set screw using a $^{5}/_{64}$-inch hex wrench.

5.5.1 Attach the electronics board

1. Remove the cable connector from its position inside of the internal black cap and attach it to the electronics board.
2. Using the two captive screws as handles, insert the electronics board into the housing. Make sure the posts from the electronics housing properly engage the receptacles on the electronics board. Do not force. The electronics board should slide gently on the connections.
3. Tighten the captive mounting screws.

⚠ 4. Replace the electronics housing cover. The transmitter covers must be engaged metal-to-metal to ensure a proper seal and to meet Explosion-Proof requirements.

⚠ See “Safety messages” on page 89 for complete warning

5.5.2 Install the terminal block

1. Gently slide the terminal block into place, making sure the two posts from the electronics housing properly engage the receptacles on the terminal block.
2. Tighten the captive screws.
3. Replace the electronics housing cover. The transmitter covers must be fully engaged to meet Explosion-Proof requirements.

5.5.3 Reassemble the 3051C process flange

1. Inspect the sensor module PTFE o-rings. Undamaged o-rings may be reused. Replace o-rings that show any signs of damage, such as nicks, cuts, or general wear.

Note
If you are replacing the o-rings, be careful not to scratch the o-ring grooves or the surface of the isolating diaphragm when removing the damaged o-rings.

2. Install the process connection. Possible options include:
   a. Coplanar Process Flange:
      – Hold the process flange in place by installing the two alignment screws to finger tightness (screws are not pressure retaining). Do not overtighten as this will affect module-to-flange alignment.
      – Install the four 1.75-in. flange bolts by finger tightening them to the flange.
   b. Coplanar Process Flange with Flange Adapters:
      – Hold the process flange in place by installing the two alignment screws to finger tightness (screws are not pressure retaining). Do not overtighten as this will affect module-to-flange alignment.
      – Hold the flange adapters and adapter o-rings in place while installing the four configurations, use four 2.88-in. bolts. For gage pressure configurations, use two 2.88-in. bolts and two 1.75-in. bolts.
   c. Manifold:
      – Contact the manifold manufacturer for the appropriate bolts and procedures.
3. Tighten the bolts to the initial torque value using a crossed pattern. See Table 5-3 for appropriate torque values.

Table 5-3. Bolt installation torque values

Bolt material	Initial torque value	Final torque value
CS-ASTM-A445 Standard	300 in-lb. (34 N-m)	650 in-lb. (73 N-m)
316 SST—Option L4	150 in-lb. (17 N-m)	300 in-lb. (34 N-m)
ASTM-A-19 B7M—Option L5	300 in-lb. (34 N-m)	650 in-lb. (73 N-m)
ASTM-A-193 Class 2, Grade B8M—Option L8	150 in.-lb (17 N-m)	300 in.-lb (34 N-m)

Note
If you replaced the PTFE sensor module o-rings, re-torque the flange bolts after installation to compensate for cold flow.

Note
After replacing o-rings on Range 1 transmitters and re-installing the process flange, expose the transmitter to a temperature of 185 °F (85 °C) for two hours. Then re-tighten the flange bolts in a cross pattern, and again expose the transmitter to a temperature of 185 °F (85 °C) for two hours before calibration.

5.5.4 Install the drain/vent valve

1. Apply sealing tape to the threads on the seat. Starting at the base of the valve with the threaded end pointing toward the installer, apply two clockwise turns of sealing tape.
2. Tighten the drain/vent valve to 250 in-lb. (28.25 N-m).
3. Take care to place the opening on the valve so that process fluid will drain toward the ground and away from human contact when the valve is opened.

Appendix A Specifications and reference data

Performance specifications . . . . . **page 103**
Functional specifications . . . . . **page 108**
Physical specifications . . . . . **page 116**
Dimensional Drawings . . . . . **page 120**
Ordering Information . . . . . **page 131**
Options . . . . . **page 156**
Spare parts . . . . . **page 164**

A.1 Performance specifications

This product data sheet covers both HART and fieldbus protocols unless specified.

A.1.1 Conformance to specification (±3σ (Sigma))

Technology leadership, advanced manufacturing techniques and statistical process control ensure specification conformance to at least ±3σ.

A.1.2 Reference accuracy[1]

Models[1]	Standard	High Accuracy Option
3051CD, 3051CG Range 0 (CD)	±0.10% of span For spans less than 2:1, accuracy = ±0.05% of URL	
Range 1	±0.10% of span For spans less than 15:1, accuracy = $\pm\left[0.025 + 0.005\left(\frac{URL}{Span}\right)\right]$% of Span	
Ranges 2-5	±0.065% of span For spans less than 10:1, accuracy = $\pm\left[0.015 + 0.005\left(\frac{URL}{Span}\right)\right]$% of Span	Ranges 2-4 High Accuracy Option, P8 ±0.04% of span For spans less than 5:1, accuracy = $\pm\left[0.015 + 0.005\left(\frac{URL}{Span}\right)\right]$% of Span
3051T Ranges 1-4	±0.065% of span For spans less than 10:1, accuracy = $\pm\left[0.0075\left(\frac{URL}{Span}\right)\right]$% of Span	Ranges 1-4 High Accuracy Option, P8 ±0.04% of span For spans less than 5:1, accuracy = $\pm\left[0.0075\left(\frac{URL}{Span}\right)\right]$% of Span
Range 5	±0.075% of span	
3051CA Ranges 1-4	±0.065% of span For spans less than 10:1, accuracy = $\pm\left[0.0075\left(\frac{URL}{Span}\right)\right]$% of Span	Ranges 2-4 High Accuracy Option, P8 ±0.04% of span For spans less than 5:1, accuracy = $\pm\left[0.0075\left(\frac{URL}{Span}\right)\right]$% of Span
3051H/3051L All Ranges	±0.075% of span For spans less than 10:1, accuracy = $\pm\left[0.025 + 0.005\left(\frac{URL}{Span}\right)\right]$% of Span	

(1) Total performance is determined by performing a root sum square calculation on reference accuracy, ambient temperature effect, and line pressure effect errors. For FOUNDATION fieldbus transmitters, use calibrated range in place of span. For zero based spans, reference conditions, silicone oil fill, SST materials, Coplanar flange (3051C) or 1/2 in. - 18 NPT (3051T) process connections, digital trim values set to equal range points.

A.1.3 Total performance

For ±50 °F (28 °C) temperature changes, up to 1000 psi (6,9 MPa) line pressure (CD only), from 1:1 to 5:1 rangedown.

Models	Total Performance
3051C Ranges 2-5	±0.15% of span
3051T Ranges 1-4	±0.15% of span

A.1.4 Long term stability

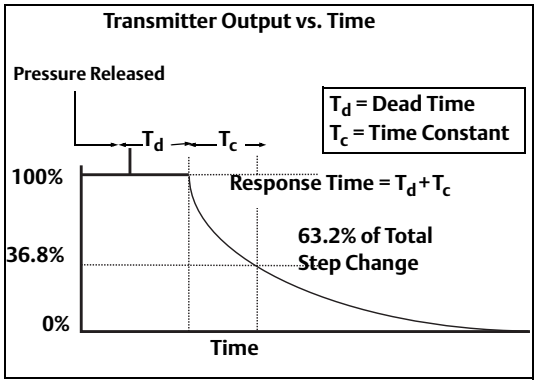
Models	Long Term Stability
3051C Ranges 2-5	±0.125% of URL for 5 years ±50 °F (28 °C) temperature changes, and up to 1000 psi (6,9 MPa) line pressure.
3051CD Low/Draft Range Ranges 0-1	±0.2% of URL for 1 year
3051T Ranges 1-4	±0.125% of URL for 5 years ±50 °F (28 °C) temperature changes, and up to 1000 psi (6,9 MPa) line pressure.
Rosemount 3051H Ranges 2-3 Ranges 4-5	 ±0.1% of URL for 1 year ±0.2% of URL for 1 year

A.1.5 Dynamic performance

	4 - 20 mA (*HART* protocol)[1]	Fieldbus protocol[3]
Total Response Time ($T_d + T_c$)[2]:		
3051C, Ranges 2-5: Range 1: Range 0: 3051T: 3051H/L:	100 ms 255 ms 700 ms 100 ms Consult factory	152 ms 307 ms 752 ms 152 ms Consult factory
Dead Time (Td)	45 ms (nominal)	97 ms
Update Rate	22 times per second	22 times per second

(1) Dead time and update rate apply to all models and ranges; analog output only
(2) Nominal total response time at 75 °F (24 °C) reference conditions.
(3) Transmitter fieldbus output only, segment macro-cycle not included.

Typical HART Transmitter Response Time



A.1.6 Line pressure effect per 1000 psi (6,9 MPa)[1]

Models[1]	Line Pressure Effect
3051CD Range 0	Zero Error[2] ±0.125% of URL/100 psi (6,89 bar)
Range 1	±0.25% of URL/1000 psi (68,9 bar)
Ranges 2-3	±0.05% of URL/1000 psi (68,9 bar) for line pressures from 0 to 2000 psi (0 to 13,7 MPa)
Range 0	Span Error ±0.15% of reading/100 psi (6,89 bar)
Range 1	±0.4% of reading/1000 psi (68,9 bar)
Ranges 2-3	±0.1% of reading/1000 psi (68,9 bar)

Models[1]	Line Pressure Effect
3051HD All Ranges	Zero Error[1] ±0.1% of URL/1000 psi (68,9 bar) for line pressures from 0 to 2000 psi (0 to 13,7 MPa)
All Ranges	Span Error ±0.1% of reading/1000 psi (68,9 bar)

(1) For zero error specifications for line pressures above 2000 psi (137,9 bar) or line pressure effect specifications for DP Ranges 4-5, see "Compensating for Line Pressure" on page 13.
(2) Can be calibrated out at line pressure.

A.1.7 Ambient temperature effect per 50 °F (28 °C)

Models	Ambient Temperature Effect
3051CD/CG Range 0	±(0.25% URL + 0.05% span)
Range 1	±(0.1% URL + 0.25% span)
Ranges 2-5	±(0.0125% URL + 0.0625% span) from 1:1 to 5:1 ±(0.025% URL + 0.125% span) from 5:1 to 100:1
3051T Range 1	±(0.025% URL + 0.125% span) from 1:1 to 10:1 ±(0.05% URL + 0.125% span) from 10:1 to 100:1
Range 2-4	±(0.025% URL + 0.125% span) from 1:1 to 30:1 ±(0.035% URL + 0.125% span) from 30:1 to 100:1
Range 5	±(0.1% URL + 0.15% span)
3051CA All Ranges	±(0.025% URL + 0.125% span) from 1:1 to 30:1
	±(0.035% URL + 0.125% span) from 30:1 to 100:1
3051H All Ranges	±(0.025% URL + 0.125% span + 0.35 inH_2O) from 1:1 to 30:1
	±(0.035% URL + 0.125% span + 0.35 inH_2O) from 1:1 to 30:1
3051L	See Rosemount Inc. Instrument Toolkit® software.

A.1.8 Mounting position effects

Models	Mounting Position Effects
3051C	Zero shifts up to ±1.25 inH_2O (3,11 mbar), which can be calibrated out. No span effect.
3051H	Zero shifts up to ±5 inH_2O (12,43 mbar), which can be calibrated out. No span effect.
3051L	With liquid level diaphragm in vertical plane, zero shift of up to 1 inH_2O (2,49 mbar). With diaphragm in horizontal plane, zero shift of up to 5 inH_2O (12,43 mbar) plus extension length on extended units. All zero shifts can be calibrated out. No span effect.
3051T/CA	Zero shifts up to 2.5 inH_2O (6,22 mbar), which can be calibrated out. No span effect.

A.1.9 Vibration effect

Less than ±0.1% of URL when tested per the requirements of IEC60770-1 field or pipeline with high vibration level (10-60 Hz 0.21mm displacement peak amplitude / 60-2000 Hz 3g).

A.1.10 Power supply effect

Less than ±0.005% of calibrated span per volt.

A.1.11 Electromagnetic compatibility (EMC)

Meets all relevant requirements of EN 61326 and NAMUR NE-21.

A.1.12 Transient protection (option code T1)

Meets IEEE C62.41, Category Location B

6 kV crest (0.5 μs - 100 kHz)
3 kV crest (8 × 20 microseconds)
6 kV crest (1.2 × 50 microseconds)

A.2 Functional specifications

A.2.1 Range and sensor limits

Table A-1. 3051CD, 3051CG, 3051L, and 3051H range and sensor limits

Range	Minimum span	
	3051CD[(1)], CG, L, H	Upper (URL)
0	0.1 inH2O (0,25 mbar)	3.0 inH2O(7,47 mbar)
1	0.5 inH2O (1,2 mbar)	25 inH2O(62,3 mbar)
2	2.5 inH2O (6,2 mbar)	250 inH2O (0,62 bar)
3	10 inH2O (24,9 mbar)	1000 inH2O (2,49 bar)
4	3 psi (0,20 bar)	300 psi (20,6 bar)
5	20 psi (1,38 bar)	2000 psi (137,9 bar)

(1) Range 0 only available with 3051CD. Range 1 only available with 3051CD or 3051CG.

Table A-2. 3051CD, 3051CG, 3051L, and 3051H range and sensor limits (cont.)

Range	Range and sensor limits					
	Lower (LRL)					
	3051C differential	3051C/ gage	3051L differential	3051L gage	3051H differential	3051H gage
0	–3.0 inH2O (-7,47 mbar)	NA	NA	NA	NA	NA
1	–25 inH2O (–62,1 mbar)	–25 inH2O (–62,1 mbar)	NA	NA	NA	NA
2	–250 inH2O (–0,62 bar)	–250 inH2O (–0,62 bar)	–250 inH2O (–0,62 bar)	–250 inH2O (–0,62 bar)	–250 inH2O (–0,62 bar)	–250 inH2O (–0,62 bar)
3	–1000 inH2O (–2,49 bar)	0.5 psia (34,5 mbar abs)	–1000 inH2O (–2,49 bar)	0.5 psia (34,5 mbar abs)	–1000 inH2O (–2,49 bar)	0.5 psia (34,5 mbar abs)
4	–300 psi (–20,6 bar)	0.5 psia (34,5 mbar abs)	–300 psi (–20,6 bar)	0.5 psia (34,5 mbar abs)	–300 psi (–20,6 bar)	0.5 psia (34,5 mbar abs)
5	– 2000 psi (–137,9 bar)	0.5 psia (34,5 mbar abs)	NA	NA	– 2000 psi (–137,9 bar)	0.5 psia (34,5 mbar abs)

Table A-3. Range and sensor limits

3051CA				3051T				
Range	Minimum span	Range and sensor limits		Range	Minimum span	Range and sensor limits		Lower[1] (LRL) (Gage)
		Upper (URL)	Lower (LRL)			Upper (URL)	Lower (LRL)	
1	0.3 psia (20,6 mbar)	30 psia (2,07 bar)	0 psia (0 bar)	1	0.3 psi (20,6 mbar)	30 psi (2,07 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)
2	1.5 psia (0,103 bar)	150 psia (10,3 bar)	0 psia (0 bar)	2	1.5 psi (0,103 bar)	150 psi (10,3 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)
3	8 psia (0,55 bar)	800 psia (55,2 bar)	0 psia (0 bar)	3	8 psi (0,55 bar)	800 psi (55,2 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)
4	40 psia (2,76 bar)	4000 psia (275,8 bar)	0 psia (0 bar)	4	40 psi (2,76 bar)	4000 psi (275,8 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)
				5	2000 psi (137,9 bar)	10000 psi (689,4 bar)	0 psia (0 bar)	–14.7 psig (–1,01 bar)

(1) Assumes atmospheric pressure of 14.7 psig.

A.2.2 Zero and Span Adjustment Requirements (*HART* and Low Power)

Zero and span values can be set anywhere within the range limits stated in Table A-1, Table A-2, and Table A-3.

Span must be greater than or equal to the minimum span stated in Table A-1, Table A-2, and Table A-3.

A.2.3 Service

Liquid, gas, and vapor applications

A.2.4 4–20 mA (Output Code A)

Output

Two-wire 4–20 mA, user-selectable for linear or square root output. Digital process variable superimposed on 4–20 mA signal, available to any host that conforms to the *HART* protocol.

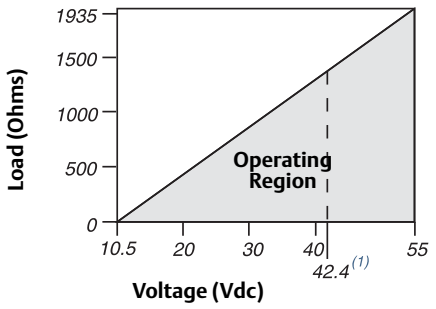
Power Supply

External power supply required. Standard transmitter (4–20 mA) operates on 10.5 to 55 Vdc with no load.

Load Limitations

Maximum loop resistance is determined by the voltage level of the external power supply, as described by:

Max. Loop Resistance = 43.5 (Power Supply Voltage – 10.5)



Communication requires a minimum loop resistance of 250 ohms.

(1) *For CSA approval, power supply must not exceed 42.4 V.*

A.2.5 FOUNDATION fieldbus (output code F) and Profibus (output code W)

Power Supply

External power supply required; transmitters operate on 9.0 to 32.0 Vdc transmitter terminal voltage.

Current Draw

17.5 mA for all configurations (including LCD display option)

A.2.6 FOUNDATION fieldbus function block execution times

Block	Execution Time
Resource	-
Transducer	-
LCD Block	-
Analog Input 1, 2	30 milliseconds
PID	45 milliseconds
Input Selector	30 milliseconds
Arithmetic	35 milliseconds
Signal Characterizer	40 milliseconds
Integrator	35 milliseconds

A.2.7 FOUNDATION fieldbus Parameters

Schedule Entries	7 (max.)
Links	20 (max.)
Virtual Communications Relationships (VCR)	12 (max.)

A.2.8 Standard Function Blocks

Resource Block

Contains hardware, electronics, and diagnostic information.

Transducer Block

Contains actual sensor measurement data including the sensor diagnostics and the ability to trim the pressure sensor or recall factory defaults.

LCD Block

Configures the local display.

2 Analog Input Blocks

Processes the measurements for input into other function blocks. The output value is in engineering units or custom and contains a status indicating measurement quality.

PID Block

Contains all logic to perform PID control in the field including cascade and feedforward.

A.2.9 Backup Link Active Scheduler (LAS)

The transmitter can function as a Link Active Scheduler if the current link master device fails or is removed from the segment.

A.2.10 Advanced control function block suite (Option Code A01)

Input Selector Block

Selects between inputs and generates an output using specific selection strategies such as minimum, maximum, midpoint, average or first "good."

Arithmetic Block

Provides pre-defined application-based equations including flow with partial density compensation, electronic remote seals, hydrostatic tank gauging, ratio control and others.

Signal Characterizer Block

Characterizes or approximates any function that defines an input/output relationship by configuring up to twenty X, Y coordinates. The block interpolates an output value for a given input value using the curve defined by the configured coordinates.

Integrator Block

Compares the integrated or accumulated value from one or two variables to pre-trip and trip limits and generates discrete output signals when the limits are reached. This block is useful for calculating total flow, total mass, or volume over time.

A.2.11 FOUNDATION fieldbus Diagnostics Suite (Option Code D01)

The 3051C FOUNDATION fieldbus Diagnostics provide Abnormal Situation Prevention (ASP) indictation. The integral statistical process monitoring (SPM) technology calculates the mean and standard deviation of the process variable 22 times per second. The 3051C ASP algorithm uses these values and highly flexible configuration options for customization to many user-defined or application specific abnormal situations. The detection of plugged impulse lines is the first available predefined application.

A.2.12 Low Power (output code M)

Output

Three wire 1–5 Vdc or 0.8–3.2 Vdc (Option Code C2) user-selectable output. Also user selectable for linear or square root output configuration. Digital process variable superimposed on voltage signal, available to any host conforming to the *HART* protocol. Low-power transmitter operates on 6–14 Vdc with no load.

Power Consumption

3.0 mA, 18–36 mW

Minimum Load Impedance

100 kΩ (V_{out} wiring)

Indication

Optional 5-digit LCD display

Overpressure Limits

Rosemount 3051CD/CG

- Range 0: 750 psi (51,7 bar)
- Range 1: 2000 psig (137,9 bar)
- Ranges 2–5: 3626 psig (250 bar)
  4500 psig (310,3 bar) for option code P9

Rosemount 3051CA

- Range 1: 750 psia (51,7 bar)
- Range 2: 1500 psia (103,4 bar)
- Range 3: 1600 psia (110,3 bar)
- Range 4: 6000 psia (413,7 bar)

Rosemount 3051H

- All Ranges: 3626 psig (25 MPa)

Rosemount 3051TG/TA

- Range 1: 750 psi (51,7 bar)
- Range 2: 1500 psi (103,4 bar)
- Range 3: 1600 psi (110,3 bar)
- Range 4: 6000 psi (413,7 bar)
- Range 5: 15000 psi (1034,2 bar)

For 3051L or Level Flange Option Codes FA, FB, FC, FD, FP, and FQ, limit is 0 psia to the flange rating or sensor rating, whichever is lower.

Table A-4. 3051L and level flange rating limits

Standard	Type	CS rating	SST rating
ANSI/ASME	Class 150	285 psig	275 psig
ANSI/ASME	Class 300	740 psig	720 psig
ANSI/ASME	Class 600	1480 psig	1440 psig
At 100 °F (38 °C), the rating decreases with increasing temperature.			
DIN	PN 10–40	40 bar	40 bar
DIN	PN 10/16	16 bar	16 bar
DIN	PN 25/40	40 bar	40 bar
At 248 °F (120 °C), the rating decreases with increasing temperature.			

A.2.13 Static Pressure Limit

Rosemount 3051CD Only

Operates within specifications between static line pressures of 0.5 psia and 3626 psig (4500 psig (310, 3 bar) for
Option Code P9).

Range 0: 0.5 psia and 750 psig (3, 4 bar and 51, 7 bar)

Range 1: 0.5 psia and 2000 psig (3, 4 bar and 137, 9 bar)

A.2.14 Burst Pressure Limits

Burst pressure on Coplanar, traditional, or 3051H process flange is 10000 psig (69 MPa).

Burst pressure for the 3051T is:

Ranges 1–4: 11000 psi (75,8 MPa)

Range 5: 26000 psig (179 MPa)

A.2.15 Failure Mode Alarm

Output Code A

If self-diagnostics detect a gross transmitter failure, the analog signal will be driven either below 3.75 mA or to 21.75 mA to alert the user. NAMUR-compliant values are available, option code C4. High or low alarm signal is user-selectable by internal jumper.

Output Code M

If self-diagnostics detect a gross transmitter failure, the analog signal will be driven either below 0.94 V or above 5.4 V to alert the user (below 0.75 V or above 4.4 V for Option C2). High or low alarm signal is user-selectable by internal jumper.

Output Code F and W

If self-diagnostics detect a gross transmitter failure, that information gets passed as a status along with the process variable.

A.2.16 Temperature Limits

Ambient

–40 to 185 °F (–40 to 85 °C)

With LCD display[1]: –40 to 175 °F (–40 to 80 °C)

Storage

–50 to 230 °F (–46 to 110 °C)

With LCD display: –40 to 185 °F (–40 to 85 °C)

Process

At atmospheric pressures and above. See Table A-5

(1) LCD display may not be readable and LCD updates will be slower at temperatures below -4 °F (-20 °C).

Table A-5. 3051 process temperature limits

3051CD, 3051CG, 3051CA	
Silicone Fill Sensor[1]	
with Coplanar Flange	–40 to 250 °F (–40 to 121 °C)[2]
with Traditional Flange	–40 to 300 °F (–40 to 149 °C)[2][3]
with Level Flange	–40 to 300 °F (–40 to 149 °C)[2]
with 305 Integral Manifold	–40 to 300 °F (–40 to 149 °C)[2]
Inert Fill Sensor[1]	-40 to 185 °F (–40 to 85 °C)[4][5]
3051H (process fill fluid)	
D.C.® Silicone 200[1]	–40 to 375 °F (–40 to 191 °C)
Inert[1]	–50 to 350 °F (–45 to 177 °C)
Neobee M-20®[1]	0 to 375 °F (–18 to 191 °C)
3051T (process fill fluid)	
Silicone Fill Sensor[1]	–40 to 250 °F (–40 to 121 °C)[2]
Inert Fill Sensor[1]	–22 to 250 °F (–30 to 121 °C)[2]
3051L low-side temperature limits	
Silicone Fill Sensor[1]	–40 to 250 °F (–40 to 121 °C)[2]
Inert Fill Sensor[1]	0 to 185 °F (–18 to 85 °C)[2]

3051L high-side temperature limits (process fill fluid)	
Sylltherm® XLT	–100 to 300 °F (–73 to 149 °C)
D.C. Silicone 704®	32 to 400 °F (0 to 205 °C)
D.C. Silicone 200	–40 to 400 °F (–40 to 205 °C)
Inert	–50 to 350 °F (–45 to 177 °C)
Glycerin and Water	0 to 200 °F (–18 to 93 °C)
Neobee M-20	0 to 400 °F (–18 to 205 °C)
Propylene Glycol and Water	0 to 200 °F (–18 to 93 °C)

(1) Process temperatures above 185 °F (85 °C) require derating the ambient limits by a 1.5:1 ratio (0.6:1 ratio for the 3051H).
(2) 220 °F (104 °C) limit in vacuum service; 130 °F (54 °C) for pressures below 0.5 psia.
(3) 3051CD0 process temperature limits are –40 to 212 °F (–45 to 100 °C)
(4) 160 °F (71 °C) limit in vacuum service.
(5) Not available for 3051CA.

Humidity Limits

0–100% relative humidity

Turn-On Time

Performance within specifications less than 2.0 seconds (10.0 s for Profibus protocol) after power is applied to the transmitter

Volumetric Displacement

Less than 0.005 in^3 (0,08 cm^3)

Damping

Analog output response to a step input change is user-selectable from 0 to 36 seconds for one time constant. This software damping is in addition to sensor module response time.

A.3 Physical specifications

A.3.1 Electrical Connections

1/2–14 NPT, G1/2, and M20 × 1.5 (CM20) conduit. HART interface connections fixed to terminal block.

A.3.2 Process Connections

All Models except 3051L and 3051T

1/4–18 NPT on 2 1/8-in. centers

1/2–14 NPT on 2-, 2 1/8-, or 2 1/4-in. centers

Rosemount 3051L

High pressure side: 2-, 3-, or 4-in., ASME B 16.5 (ANSI) Class 150, 300 or 600 flange; 50, 80 or 100 mm, PN 40 or 10/16 flange

Low pressure side: 1/4–18 NPT on flange 1/2–14 NPT on adapter

Rosemount 3051T

1/2–14 NPT female. A DIN 16288 Male (available in SST for Range 1–4 transmitters only), or Autoclave type F-250-C (Pressure relieved 9/16–18 gland thread; 1/4 OD high pressure tube 60° cone; available in SST for Range 5 transmitters only).

A.3.3 Process-Wetted Parts

Drain/Vent Valves

316 SST, Alloy C-276, or Alloy 400/K-500(1) material
(Drain vent seat: Alloy 400, Drain vent stem: Alloy K-500)

(1)Alloy 400/K-500 is not available with 3051L or 3051H.

Process Flanges and Adapters

Plated carbon steel
SST: CF-8M (Cast 316 SST) per ASTM A743
Cast C-276: CW-12MW per ASTM A494
Cast Alloy 400: M-30C per ASTM A494

Wetted O-rings

Glass-filled PTFE or Graphite-filled PTFE

Process Isolating Diaphragms

Isolating diaphragm material	3051CD/CG	3051T	3051CA	3051H
316L SST	•	•	•	•
Alloy C-276	•	•	•	•
Alloy 400	•		•	
Tantalum	•			•
Gold-plated Alloy 400	•		•	
Gold-plated SST	•		•	

A.3.4 Rosemount 3051L Process Wetted Parts

Flanged Process Connection (Transmitter High Side)

Process Diaphragms, Including Process Gasket Surface

- 316L SST, Alloy C-276, or Tantalum
- Extension
- CF-3M (Cast version of 316L SST, material per ASTM-A743), or Alloy C-276. Fits schedule 40 and 80 pipe.
- Mounting Flange
- Zinc-cobalt plated CS or SST

Reference Process Connection (Transmitter Low Side)

Isolating Diaphragms

- 316L SST or Alloy C-276

Reference Flange and Adapter

- CF-8M (Cast version of 316 SST, material per ASTM-A743)

A.3.5 Non-Wetted Parts

Electronics Housing

Low copper aluminum or SST: CF-3M or CF-8M (Cast version of 316L or 316 SST, material per ASTM-A743). NEMA 4X, IP 65, IP 66

Coplanar Sensor Module Housing

CF-3M (Cast version of 316L SST, material per ASTM-A743)

Bolts

ASTM A449, Type 1 (zinc-cobalt plated carbon steel)
ASTM F593G, Condition CW1 (Austenitic 316 SST)
ASTM A193, Grade B7M (zinc plated alloy steel)
Alloy 400

Sensor Module Fill Fluid

Silicone oil (D.C. 200) or Fluorocarbon oil (Halocarbon or Fluorinert® FC-43 for 3051T)

Process Fill Fluid (3051L and 3051H only)

3051L: Syltherm XLT, D.C. Silicone 704,
D.C. Silicone 200, inert, glycerin and water, Neobee M-20 or propylene glycol and water

3051H: inert, Neobee M-20, or D.C. Silicone 200

Paint

Polyurethane

Cover O-rings

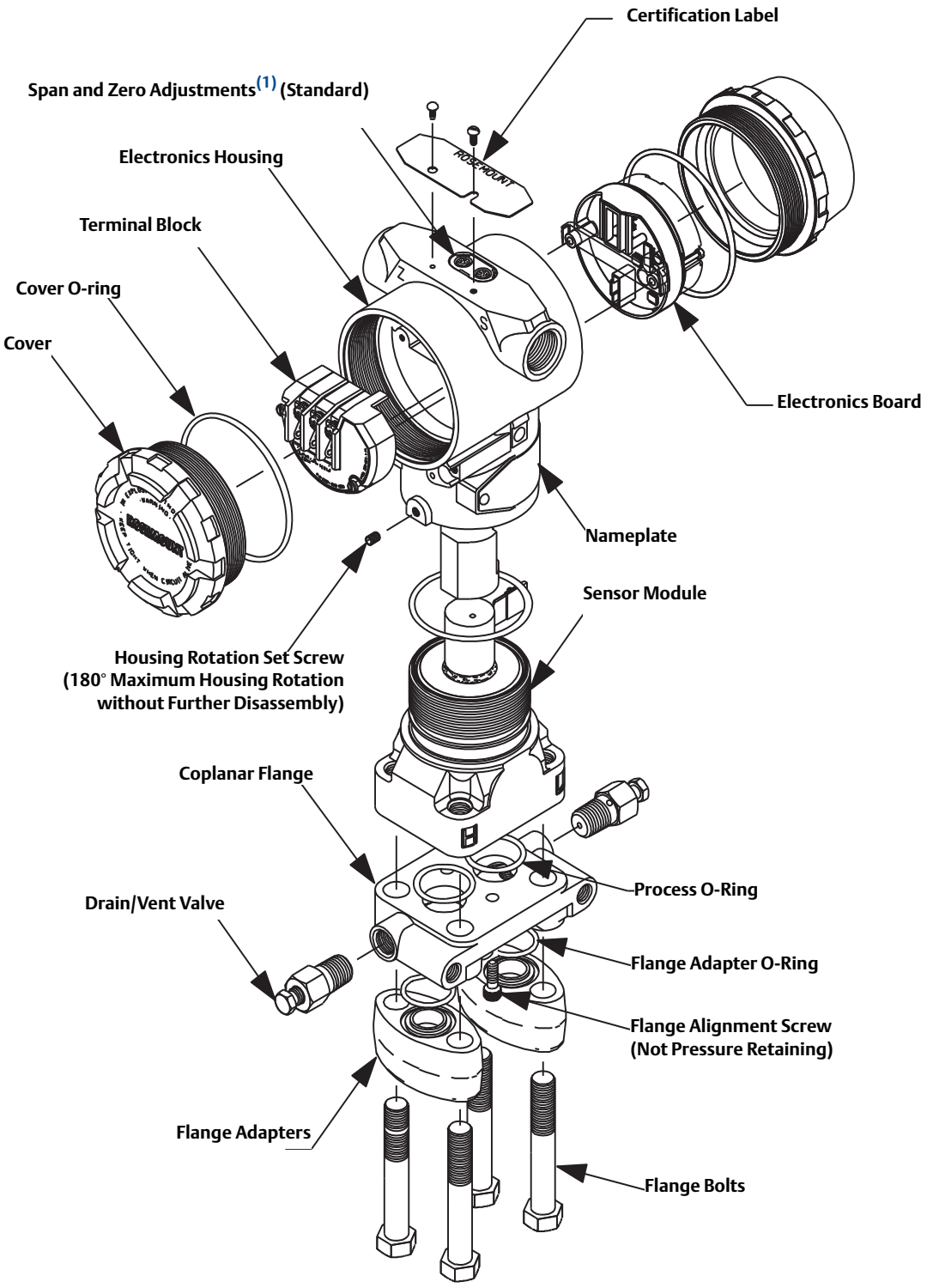
Buna-N

A.3.6 Shipping Weights

Refer to "Shipping weights" on page 159.

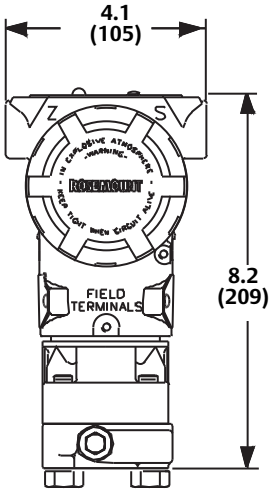
A.4 Dimensional Drawings

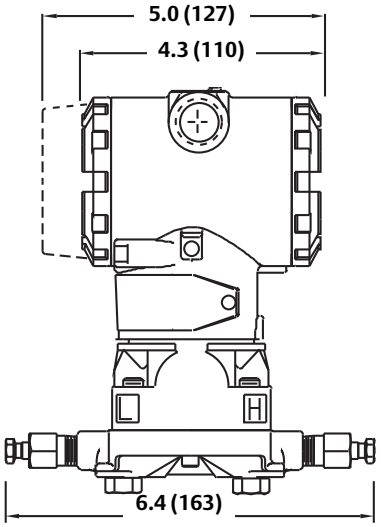
3051 Exploded View



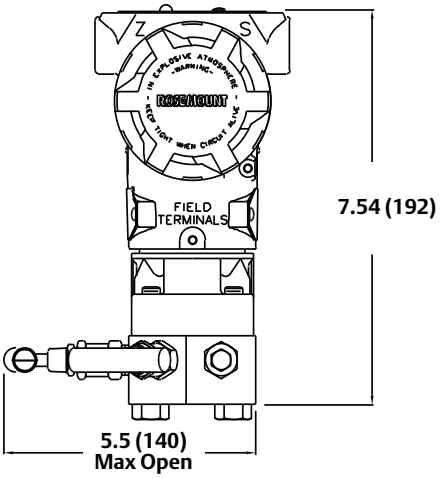
(1) Span and Zero Adjustments are not available with fieldbus or profibus protocols.

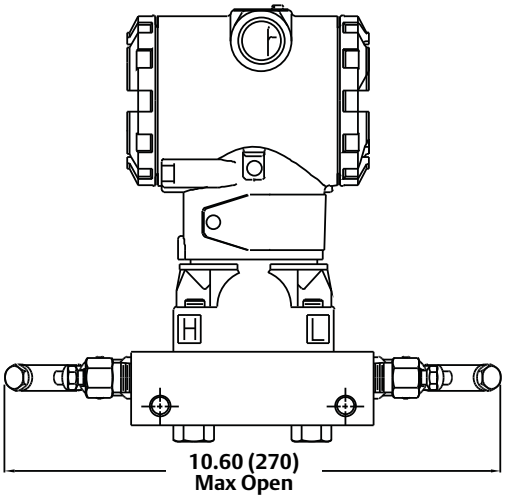
3051C Coplanar Flange





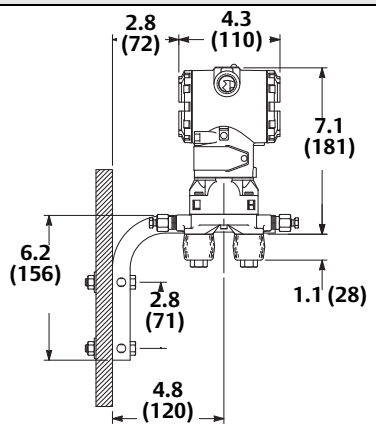
3051C Coplanar Flange with Rosemount 305 Coplanar Integral Manifold

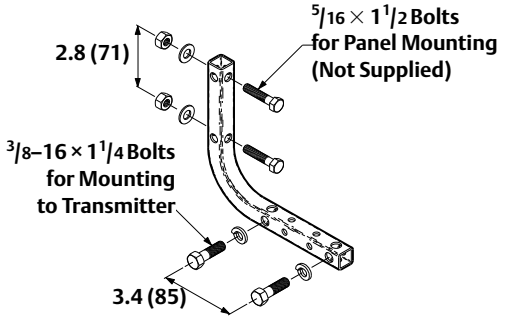




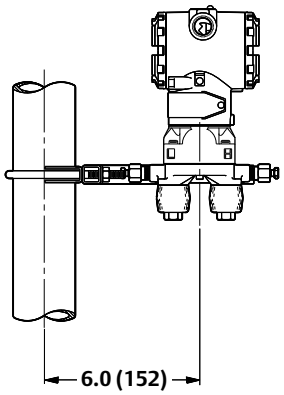
Coplanar Flange Mounting Configurations with Optional Bracket (B4) for 2-in. Pipe or Panel Mounting

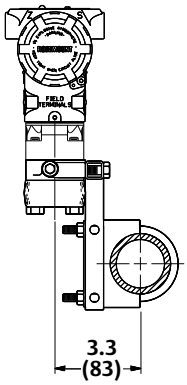
PANEL MOUNTING

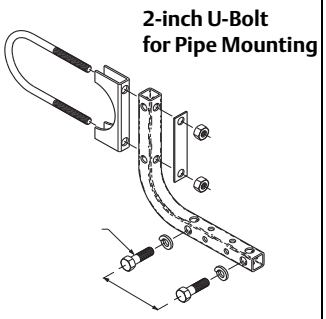




PIPE MOUNTING

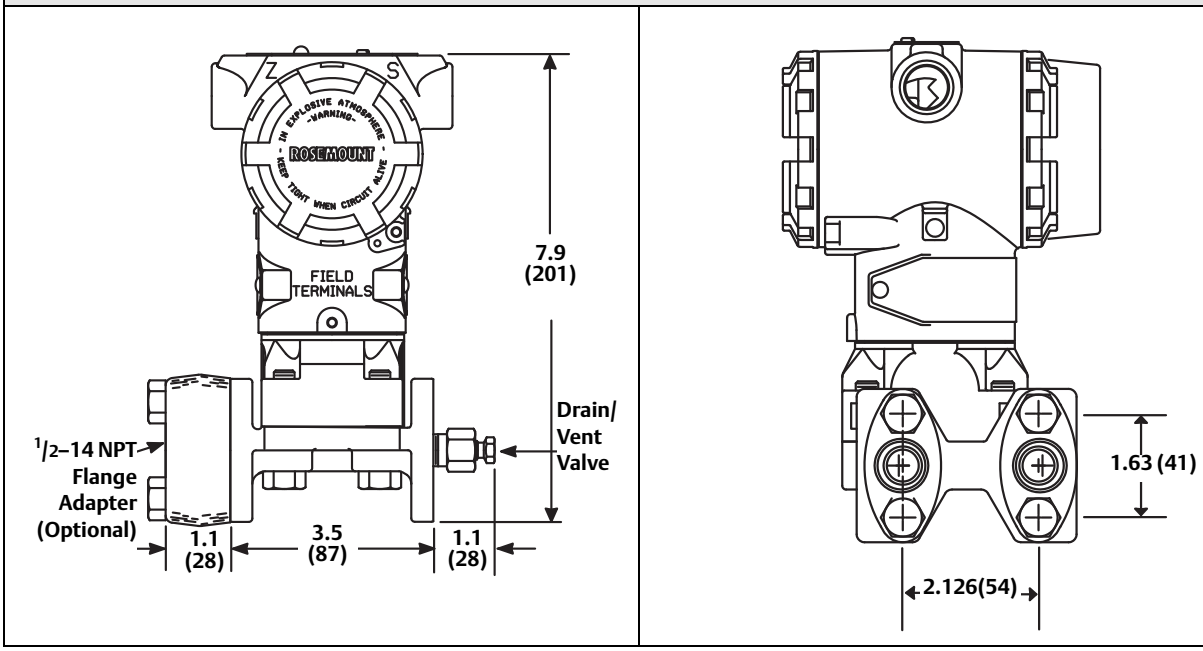






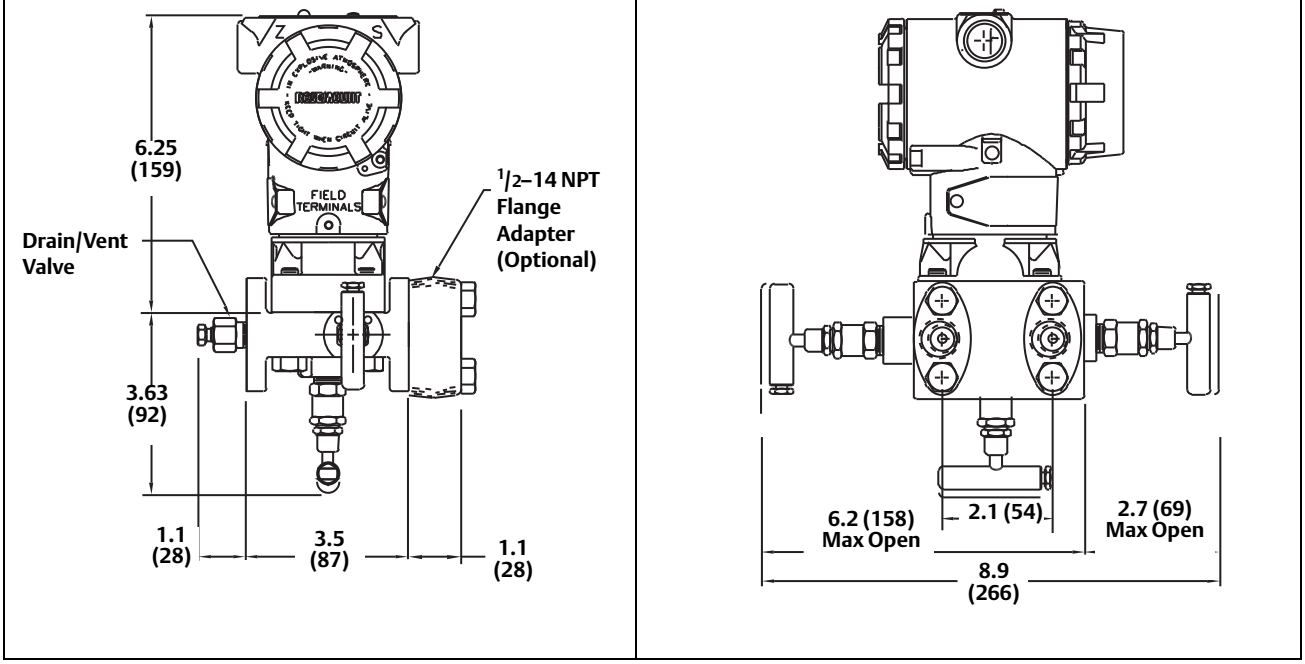
Dimensions are in inches (millimeters)

3051C Coplanar with Traditional Flange



Dimensions are in inches (millimeters)

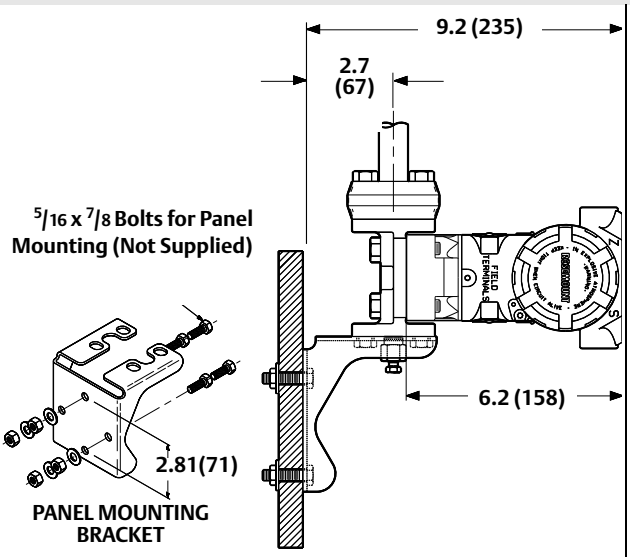
3051C Coplanar with Rosemount 305 Traditional Integral Manifold



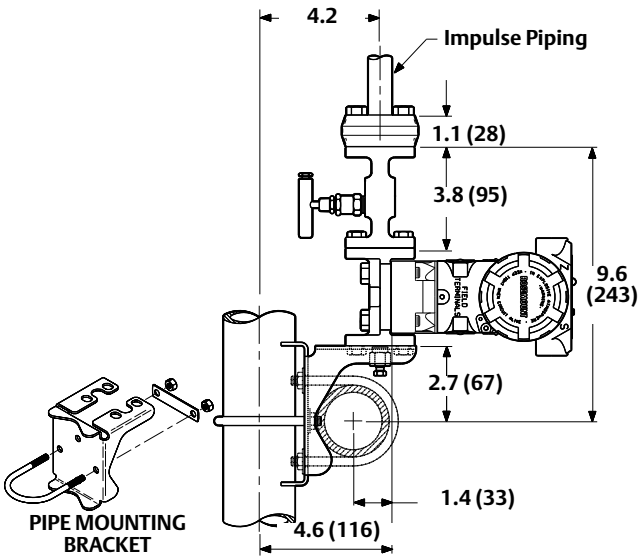
Dimensions are in inches (millimeters)

Traditional Flange Mounting Configurations with Optional Brackets for 2-in. Pipe or Panel Mounting

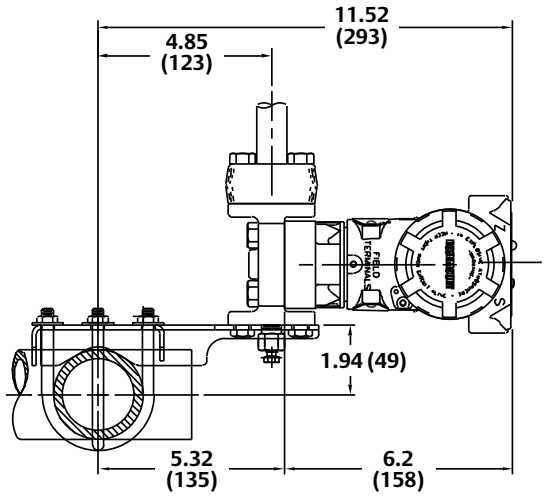
Panel Mounting Bracket (option B2/B8)



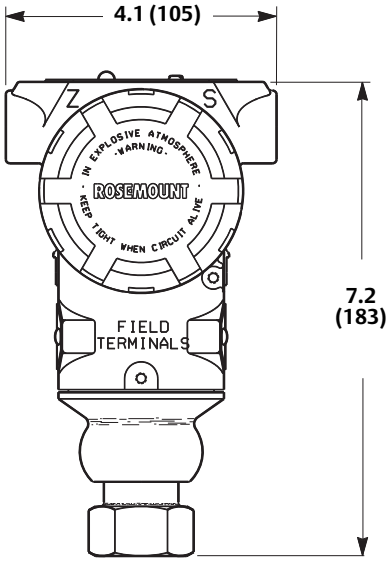
2-in. Pipe Mounting Bracket (option B1/B7/BA)

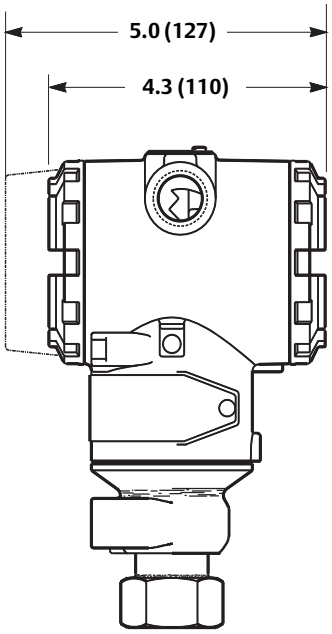


2-in. Pipe Mounting Bracket (option B3/B9/BC)

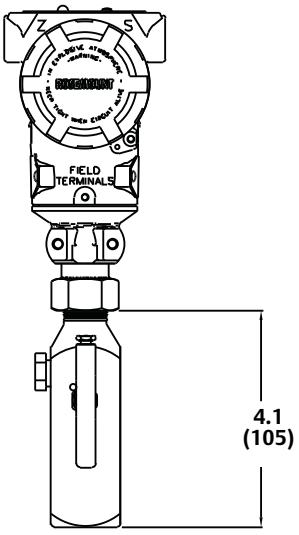


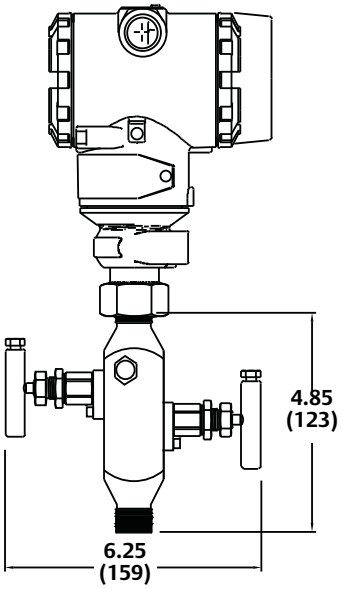
3051T Dimensional Drawings





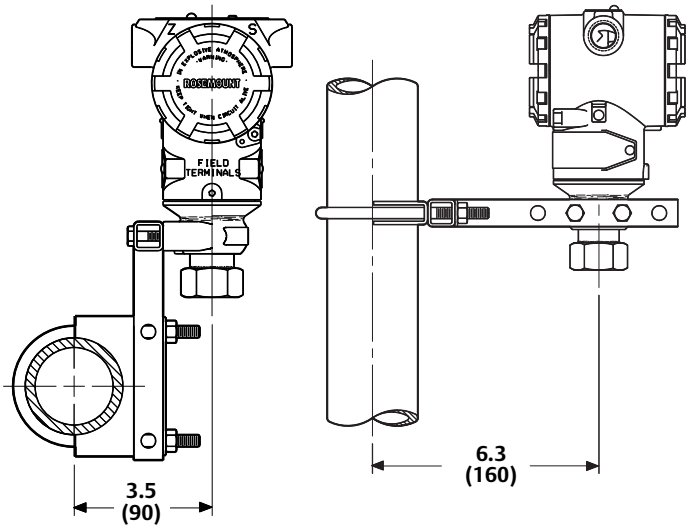
3051T with Rosemount 306 Integral Manifold



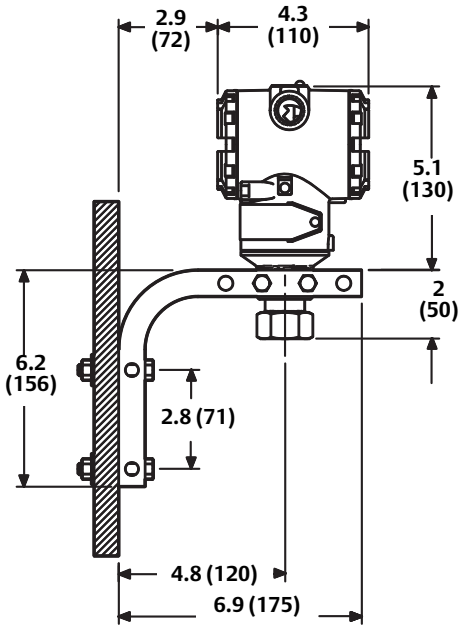


3051T Typical Mounting Configurations with Optional Mounting Bracket

Pipe Mounting



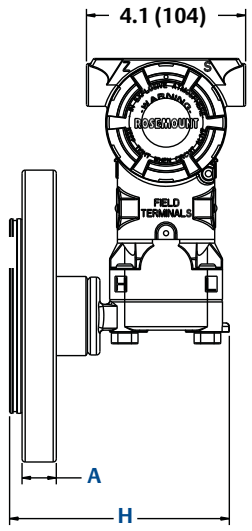
Panel Mounting



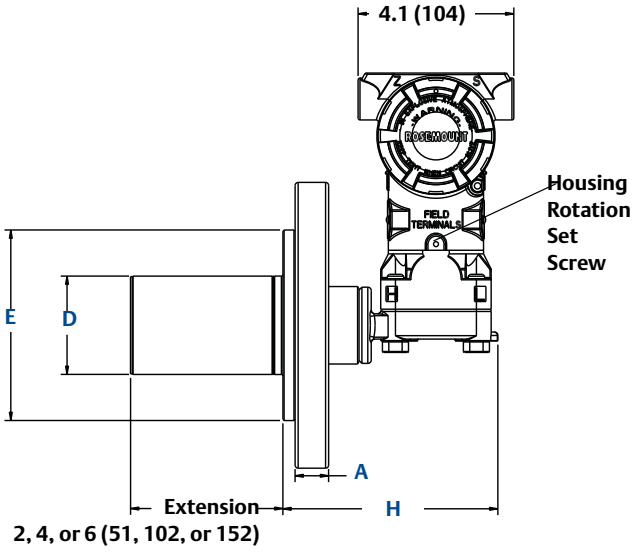
Dimensions are in inches (millimeters)

3051L Dimensional Drawings

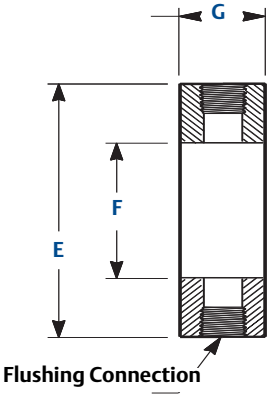
2-in. Flange Configuring (Flush Mount Only)



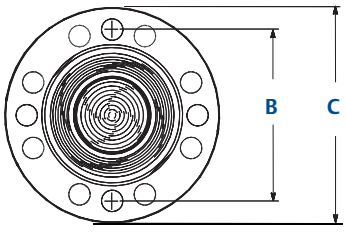
3- and 4-in. Flange Configuration

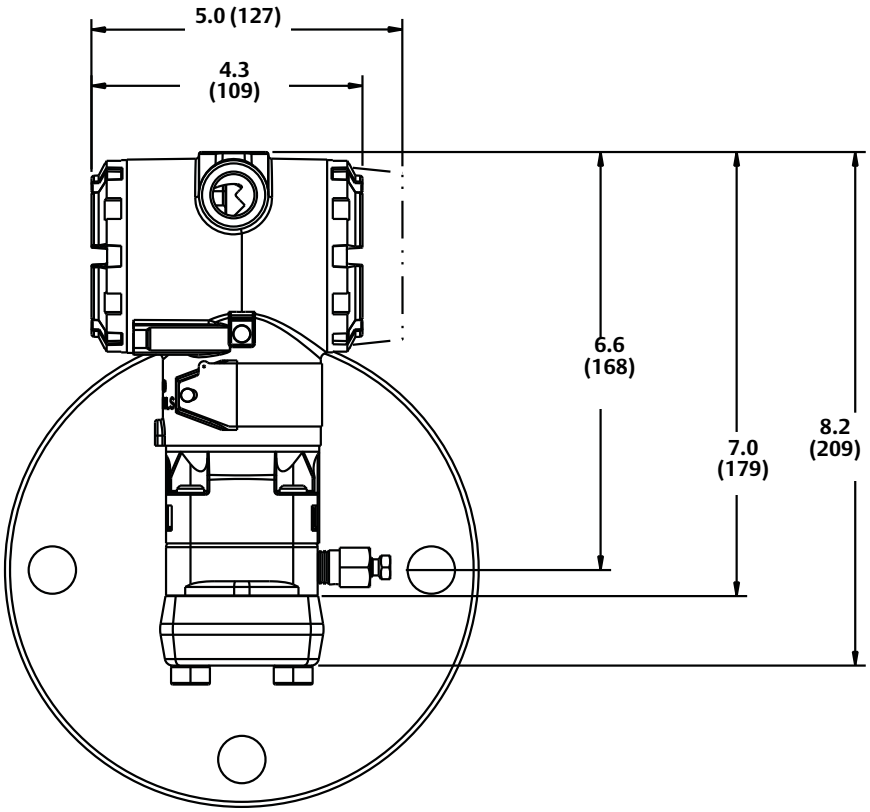


Optional Flushing Connection Ring (Lower Housing)



Diaphragm Assembly and Mounting Flange





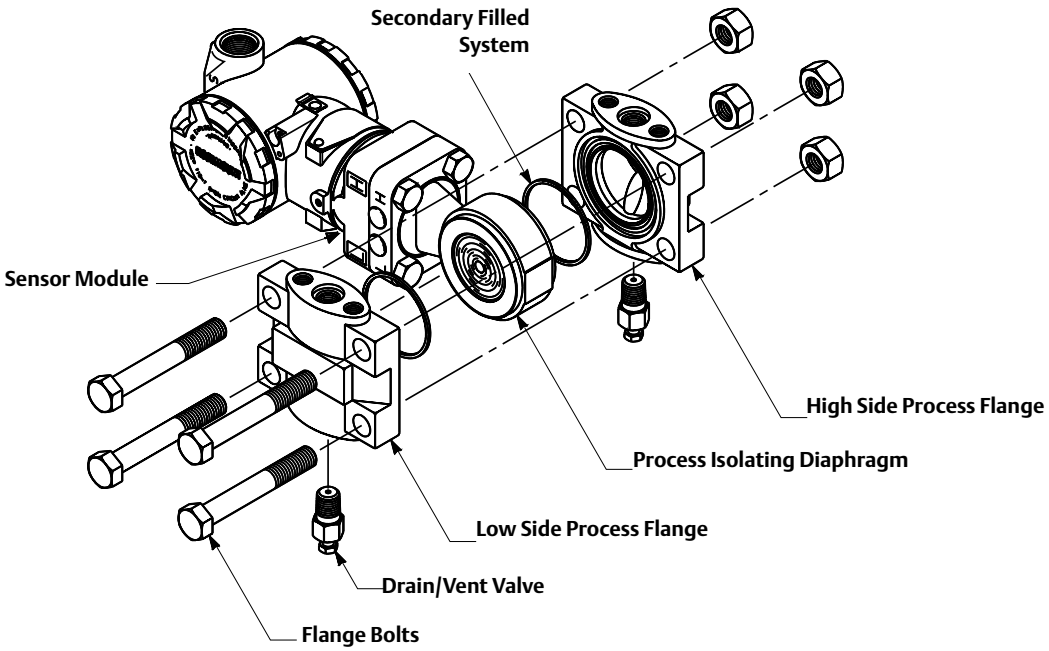
Dimensions are in inches (millimeters)

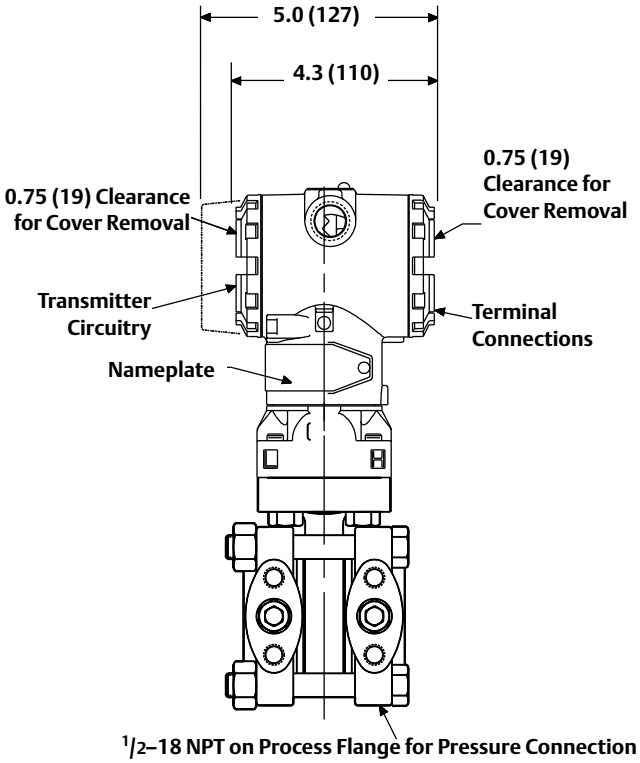
Class	Pipe size	Flange thickness A	Bolt circle diameter B	Outside diameter C	No. of bolts	Bolt hole diameter	Extension diameter[1] D	O.D. gasket surface E
ASME B16.5 (ANSI) 150	2 (51)	0.69 (18)	4.75 (121)	6.0 (152)	4	0.75 (19)	NA	3.6 (92)
	3 (76)	0.88 (22)	6.0 (152)	7.5 (191)	4	0.75 (19)	2.58 (66)	5.0 (127)
	4 (102)	0.88 (22)	7.5 (191)	9.0 (229)	8	0.75 (19)	3.5 (89)	6.2 (158)
ASME B16.5 (ANSI) 300	2 (51)	0.82 (21)	5.0 (127)	6.5 (165)	8	0.75 (19)	NA	3.6 (92)
	3 (76)	1.06 (27)	6.62 (168)	8.25 (210)	8	0.88 (22)	2.58 (66)	5.0 (127)
	4 (102)	1.19 (30)	7.88 (200)	10.0 (254)	8	0.88 (22)	3.5 (89)	6.2 (158)
ASME B16.5 (ANSI) 600	2 (51)	1.00 (25)	5.0 (127)	6.5 (165)	8	0.75 (19)	NA	3.6 (92)
	3 (76)	1.25 (32)	6.62 (168)	8.25 (210)	8	0.88 (22)	2.58 (66)	5.0 (127)
DIN 2501 PN 10–40	DN 50	20 mm	125 mm	165 mm	4	18 mm	NA	4.0 (102)
DIN 2501 PN 25/40	DN 80	24 mm	160 mm	200 mm	8	18 mm	66 mm	5.4 (138)
	DN 100	24 mm	190 mm	235 mm	8	22 mm	89 mm	6.2 (158)
DIN 2501 PN 10/16	DN 100	20 mm	180 mm	220 mm	8	18 mm	89 mm	6.2 (158)

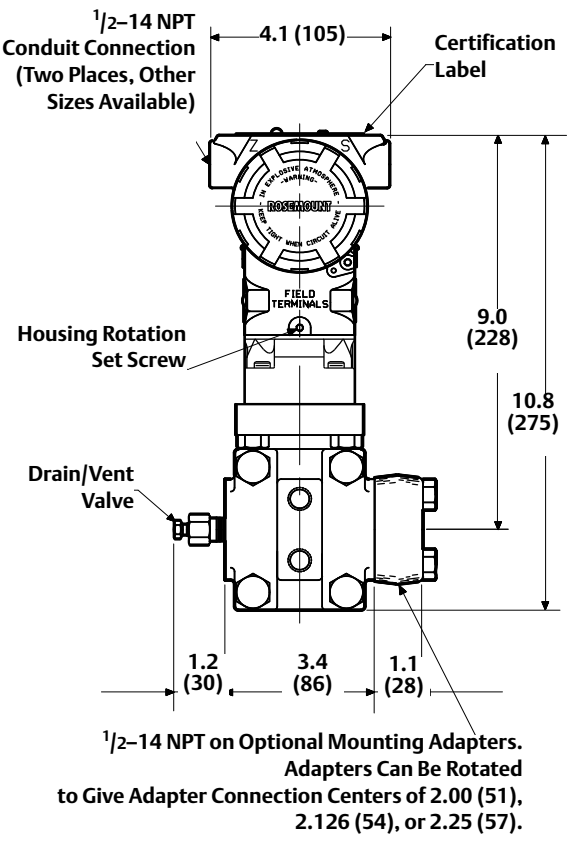
Class	Pipe size	Process side F	Lower housing G		H
			1/4 NPT	1/2 NPT	
ASME B16.5 (ANSI) 150	2 (51)	2.12 (54)	0.97 (25)	1.31 (33)	5.65 (143)
	3 (76)	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
	4 (102)	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
ASME B16.5 (ANSI) 300	2 (51)	2.12 (54)	0.97 (25)	1.31 (33)	5.65 (143)
	3 (76)	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
	4 (102)	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
ASME B16.5 (ANSI) 600	2 (51)	2.12 (54)	0.97 (25)	1.31 (33)	7.65 (194)
	3 (76)	3.6 (91)	0.97 (25)	1.31 (33)	7.65 (194)
DIN 2501 PN 10–40	DN 50	2.4 (61)	0.97 (25)	1.31 (33)	5.65 (143)
DIN 2501 PN 25/40	DN 80	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
	DN 100	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)
DIN 2501 PN 10/16	DN 100	3.6 (91)	0.97 (25)	1.31 (33)	5.65 (143)

(1) Tolerances are 0.040 (1,02), –0.020 (0,51).

3051H Pressure Transmitter Exploded View and Dimensional Drawings



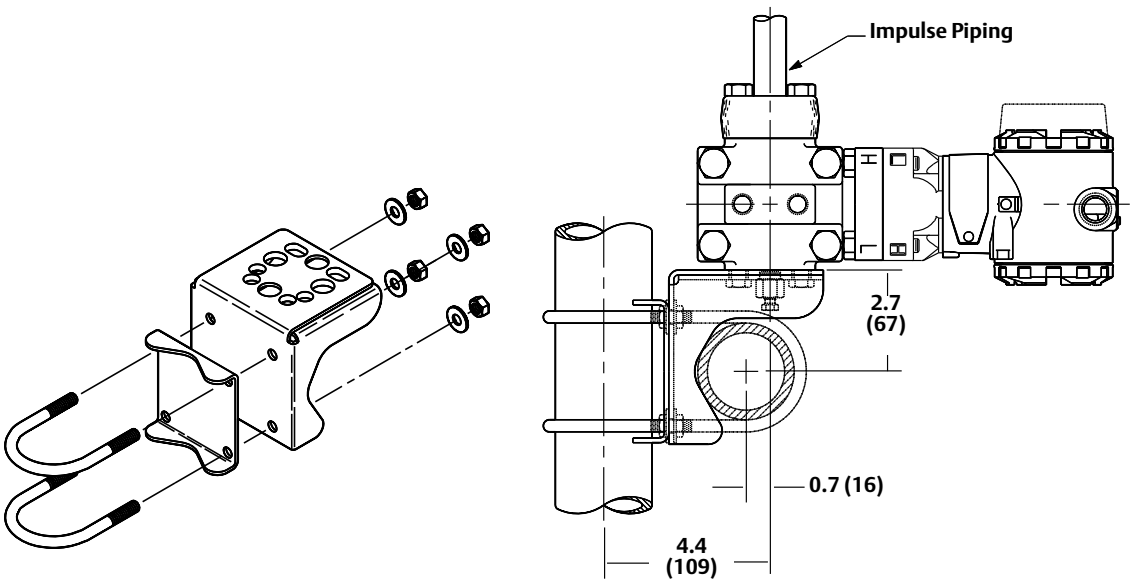




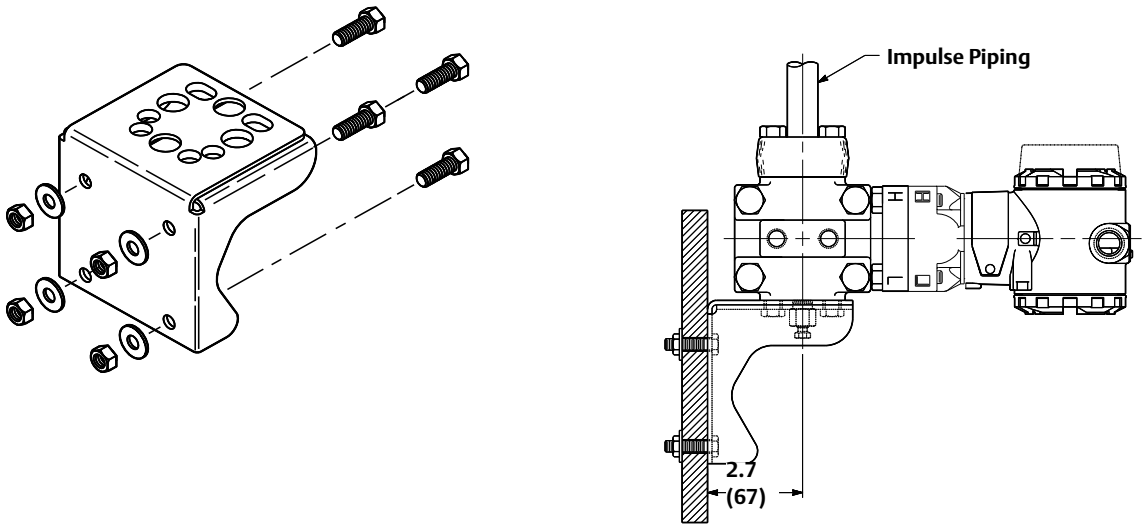
Dimensions are in inches (millimeters)

3051H Mounting Brackets for 2-in. Pipe and Panel Mount (Option Code B5/B6)

PIPE MOUNTING CONFIGURATION



PANEL MOUNTING CONFIGURATION
$^{7}/_{16}$–20 x $^{3}/_{4}$ Bolts Supplied for Attaching Bracket to Transmitter



Dimensions are in inches (millimeters)

A.5 Ordering Information

Model	Transmitter Type			
3051C	Coplanar Pressure Transmitter			
Measurement Type				
Standard				**Standard**
D	Differential			★
G	Gage			★
Expanded				
A	Absolute			
Pressure Ranges (Range/Min. Span)				
	3051CD	3051CG[1]	3051CA	
Standard				**Standard**
1	–25 to 25 inH_2O/0.5 inH_2O (–62,2 to 62,2 mbar/1,2 mbar)	–25 to 25 inH_2O/0.5 inH_2O (–62,1 to 62,2 mbar/1,2 mbar)	0 to 30 psia/0.3 psia (0 to 2,1 bar/20,7 mbar)	★
2	–250 to 250 inH2O/2.5 inH_2O (–623 to 623 mbar/6,2 mbar)	–250 to 250 inH_2O/2.5 inH_2O (–621 to 623 mbar/6,2 mbar)	0 to 150 psia/1.5 psia (0 to 10,3 bar/0,1 bar)	★
3	–1000 to 1000 inH_2O/10 inH_2O (–2,5 to 2,5 bar/25 mbar)	–393 to 1000 inH_2O/10in H_2O (–0,98 to 2,5 bar/25 mbar)	0 to 800 psia/8 psia (0 to 55,2 bar/0,55 bar)	★
4	–300 to 300 psi/3 psi (–20,7 to 20,7 bar/0,2 bar)	–14.2 to 300 psi/3 psi (–0,98 to 20,7 bar/0,2 bar)	0 to 4000 psia/40 psia (0 to 275,8 bar/2,8 bar)	★
5	–2000 to 2000 psi/20 psi (–137,9 to 137,9 bar/1,4 bar)	–14.2 to 2000 psig/20 psi (–0,98 to 137,9 bar/1,4 bar)	Not Applicable	★
Expanded				
0[2]	–3 to 3 inH_2O/0.1 inH_2O (–7,5 to 7,5 mbar/0,25 mbar)	Not Applicable	Not Applicable	
Output				
Standard				**Standard**
A	4–20 mA with Digital Signal Based on HART Protocol			★
F	FOUNDATION fieldbus Protocol			★
W[3]	Profibus PA Protocol			★
Expanded				
M[4]	Low-Power, 1–5 Vdc with Digital Signal Based on HART Protocol *(See Option C2 for 0.8–3.2 V dc)*			

Materials of Construction				
	Process Flange Type	Flange Material	Drain/Vent	
Standard				**Standard**
2	Coplanar	SST	SST	★
3[(5)]	Coplanar	Cast C-276	Alloy C-276	★
4	Coplanar	Cast Alloy 400	Alloy 400/K-500	★
5	Coplanar	Plated CS	SST	★
7[(5)]	Coplanar	SST	Alloy C-276	★
8[(5)]	Coplanar	Plated CS	Alloy C-276	★
0	Alternate Flange—See Options on page 156			★
Isolating Diaphragm				
Standard				**Standard**
2[(5)]	316L SST			★
3[(5)]	Alloy C-276			★
Expanded				
4	Alloy 400			
5	Tantalum (Available on 3051CD and CG, Ranges 2–5 only. Not available on 3051CA)			
6	Gold-plated Alloy 400 (Use in combination with O-ring Option Code B.)			
7	Gold-plated SST			
O-ring				
Standard				**Standard**
A	Glass-filled PTFE			★
B	Graphite-filled PTFE			★
Sensor Fill Fluid				
Standard				**Standard**
1	Silicone			★
2	Inert fill (Differential and Gage only)			★
Housing Material			**Conduit Entry Size**	
Standard				**Standard**
A	Polyurethane-covered Aluminum		½–14 NPT	★
B	Polyurethane-covered Aluminum		M20 × 1.5 (CM20)	★
J	SST		½–14 NPT	★
K	SST		M20 × 1.5 (CM20)	★

Expanded			
D	Polyurethane-covered Aluminum	G½	
M	SST	G½	

A.5.1 Options (Include with selected model number)

Plantweb Control Functionality		
Standard		**Standard**
A01	FOUNDATION fieldbus Advanced Control Function Block Suite	★
Plantweb Diagnostic Functionality		
Standard		**Standard**
D01	FOUNDATION fieldbus Diagnostics Suite	★
Alternate Flange		
Standard		**Standard**
H2	Traditional Flange, 316 SST, SST Drain/Vent	★
H3(5)	Traditional Flange, Alloy C, Alloy C-276 Drain/Vent	★
H4	Traditional Flange, Monel, Monel Drain/Vent	★
H7(5)	Traditional Flange, 316 SST, Alloy C-276 Drain/Vent	★
HJ	DIN Compliant Traditional Flange, SST, 1/16 in. Adapter/Manifold Bolting	★
FA	Level Flange, SST, 2 in., ANSI Class 150, Vertical Mount	★
FB	Level Flange, SST, 2 in., ANSI Class 300, Vertical Mount	★
FC	Level Flange, SST, 3 in., ANSI Class 150, Vertical Mount	★
FD	Level Flange, SST, 3 in., ANSI Class 300, Vertical Mount	★
FP	DIN Level Flange, SST, DN 50, PN 40, Vertical Mount	★
FQ	DIN Level Flange, SST, DN 80, PN 40, Vertical Mount	★
Expanded		
HK	DIN Compliant Traditional Flange, SST, 10 mm Adapter/Manifold Bolting	
HL	DIN Compliant Traditional Flange, SST, 12mm Adapter/Manifold Bolting (Not available on 3051CD0)	
Integral Assembly		
Standard		**Standard**
S3(6)	Assemble to Rosemount 405 Compact Orifice Plate	★
S5(6)	Assemble to Rosemount 305 Integral Manifold (specified separately, see the Rosemount 305 and 306 Integral Manifolds PDS (document number 00813-0100-4733))	★
S6(6)	Assemble to Rosemount 304 Manifold or Connection System	★

Integral Mount Primary Element		
Standard		**Standard**
S4[(6)]	Assemble to Rosemount Annubar or Rosemount 1195 Integral Orifice *(With the primary element installed, the maximum operating pressure will equal the lesser of either the transmitter or the primary element. Option is available for factory assembly to range 1–4 transmitters only)*	★
Seal Assemblies		
Standard		**Standard**
S1[(6)]	Assemble to one Rosemount 1199 seal	★
S2[(6)]	Assemble to two Rosemount 1199 seals	★
All-Welded Seal Assemblies (for high vacuum applications)		
Standard		**Standard**
S0[(6)]	One Seal, All-Welded System (Direct Mount Connection Type)	★
S7[(6)]	One Seal, All-Welded System (Capillary Connection Type)	★
S8[(6)]	Two Seals, All-Welded System (Capillary Connection Type)	★
S9[(6)]	Two Seals, All-Welded System (One Direct Mount and One Capillary Connection Type)	★
Mounting Bracket		
Standard		**Standard**
B1	Traditional Flange Bracket for 2-in. Pipe Mounting, CS Bolts	★
B2	Traditional Flange Bracket for Panel Mounting, CS Bolts	★
B3	Traditional Flange Flat Bracket for 2-in. Pipe Mounting, CS Bolts	★
B4	Coplanar Flange Bracket for 2-in. Pipe or Panel Mounting, all SST	★
B7	B1 Bracket with Series 300 SST Bolts	★
B8	B2 Bracket with Series 300 SST Bolts	★
B9	B3 Bracket with Series 300 SST Bolts	★
BA	SST B1 Bracket with Series 300 SST Bolts	★
BC	SST B3 Bracket with Series 300 SST Bolts	★
Product Certifications		
Standard		**Standard**
C6	CSA Explosion-proof, Dust Ignition-proof, Intrinsically Safe, and Division 2	★
E2	INMETRO Flameproof	★

E3	China Flameproof	★
E4[12]	TIIS Flame-proof	★
E5	FM Explosion-proof, Dust Ignition-Proof	★
E7[7]	IECEx Flameproof, Dust Ignition-proof	★
E8	ATEX Flameproof and Dust	★
I1[7]	ATEX Intrinsic Safety and Dust	★
I2	INMETRO Intrinsic Safety	★
I3	China Intrinsic Safety	★
I4	TIIS Intrinsic Safety	★
I5	FM Intrinsically Safe, Division 2	★
I7[7]	IECEx Intrinsic Safety	★
IA	ATEX FISCO Intrinsic Safety; for FOUNDATION fieldbus protocol only	★
IE	FM FISCO Intrinsically Safe; for FOUNDATION fieldbus protocol only	★
K2	INMETRO Flameproof, Instrinsic Safety	★
K5	FM Explosion-proof, Dust Ignition-Proof, Intrinsically Safe, and Division 2	★
K6[7]	CSA and ATEX Explosion-proof, Intrinsically Safe, and Division 2 (combination of C6 and K8)	★
K7[7]	IECEx Flame-proof, Dust Ignition-proof, Intrinsic Safety, and Type n (combination of I7, N7, and E7)	★
K8[12]	ATEX Flameproof, Intrinsic Safety, Type n, Dust (combination of E8, I1, and N1)	★
KB	FM and CSA Explosion-proof, Dust Ignition Proof, Intrinsically Safe, and Division 2 (combination of K5 and C6)	★
KD[12]	FM, CSA, and ATEX Explosion-proof, Intrinsically Safe (combination of K5, C6, I1, and E8)	★
N1[12]	ATEX Type n and Dust	★
N3	China Type n	★
N7[7]	IECEx Type n	★
Custody Transfer		
Standard		**Standard**
C5[9]	Measurement Canada Accuracy Approval *(Limited availability depending on transmitter type and range. Contact an Emerson Process Management representative)*	★
Bolting Material		
Standard		**Standard**
L4	Austenitic 316 SST Bolts	★
L5	ASTM A 193, Grade B7M Bolts	★
L6	Alloy K-500 Bolts	★
Display Type		
Standard		**Standard**
M4[8]	LCD Display with Local Operator Interface	★
M5	LCD display for Aluminum Housing (Housing Codes A, B, C, and D only)	★
M6	LCD display for SST Housing (Housing Codes J, K, L, and M only)	★

Calibration Certificate		
Standard		**Standard**
Q4	Calibration Certificate	★
QG	Calibration Certificate and GOST Verification Certificate	★
QP	Calibration certification and tamper evident seal	★
Material Traceability Certification		
Standard		**Standard**
Q8	Material Traceability Certification per EN 10204 3.1 *(Only available for the sensor module housing and Coplanar or traditional flanges and adapters (3051C), and for the sensor module housing and low-volume Coplanar flange and adapter (3051C with Option Code S1))*	★
Quality Certification for Safety		
Standard		**Standard**
QS	Certificate of FMEDA Data	★
Zero/Span Adjustment		
Standard		**Standard**
J1[(9)(10)]	Local Zero Adjustment Only	★
J3[(9)(10)]	No Local Zero or Span Adjustment	★
Transient Protection Terminal Block		
Standard		**Standard**
T1	Transient Protection Terminal Block	★
Software Configuration		
Standard		**Standard**
C1[(9)]	Custom Software Configuration (Completed CDS 00806-0100-4001 required with order)	★
Low Power Output		
Expanded		
C2[(9)]	0.8–3.2 Vdc Output with Digital Signal Based on HART Protocol (Output Code M only)	
Gage Pressure Calibration		
Standard		**Standard**
C3	Gage Calibration (Model 3051CA4 only)	★
Alarm Limit		
Standard		**Standard**
C4[(9)(11)]	Analog Output Levels Compliant with NAMUR Recommendation NE 43, Alarm High	★
CN[(9)(11)]	Analog Output Levels Compliant with NAMUR Recommendation NE 43, Alarm Low	★

Pressure Testing		
Expanded		
P1	Hydrostatic Testing with Certificate	
Cleaning Process Area		
Expanded		
P2	Cleaning for Special Service	
P3	Cleaning for <1 PPM Chlorine/Fluorine	
Pressure Calibration		
Expanded		
P4	Calibrate at Line Pressure *(Specify Q48 on order for corresponding certificate)*	
High Accuracy		
Standard		**Standard**
P8	0.04% accuracy to 5:1 turndown (Range 2-4)	★
Flange Adapters		
Standard		**Standard**
DF	1/2 -14 NPT flange adapter(s)	★
D3	¼–18 NPT Process Connections (No flange adapters), Hastelloy	★
D3	¼–18 NPT Process Connections (No flange adapters), *Monel*	★
Vent/Drain Valves		
Expanded		
D7	Coplanar Flange Without Drain/Vent Ports	
Conduit Plug		
Standard		**Standard**
DO	316 SST Conduit Plug	★
RC1/4 RC1/2 Process Connection		
Expanded		
D9	JIS Process Connection—RC ¼ Flange with RC ½ Flange Adapter, CS	
D9	JIS Process Connection—RC ¼ Flange with RC ½ Flange Adapter, 316SST	
Max Static Line Pressure		
Standard		**Standard**
P9	4500 psig Static Pressure Limit (3051CD Ranges 2–5 only)	★

Ground Screw		
Standard		**Standard**
V5[12]	External Ground Screw Assembly	★
Drinking Water Approval		
Standard		**Standard**
DW	NSF drinking water approval	★
Surface Finish		
Standard		**Standard**
Q16	Surface finish certification for sanitary remote seals	★
Toolkit Total System Performance Reports		
Standard		**Standard**
QZ	Remote Seal System Performance Calculation Report	★
Conduit Electrical Connector		
Standard		**Standard**
GE	M12, 4-pin, Male Connector (eurofast®)	★
GM	A size Mini, 4-pin, Male Connector (minifast®)	★
Typical Model Number: 3051CD 2 A 2 2 A 1 A B4$13857 780		

(1) 3051CG lower range limit varies with atmospheric pressure.
(2) 3051CD0 is available only with Output Code A, Process Flange Code 0 (Alternate Flange H2, H7, HJ, or HK), Isolating Diaphragm Code 2, O-ring Code A, and Bolting Option L4.
(3) Option code M4 - LCD Display with Local Operator Interface required for local addressing and configuration.
(4) Not available with hazardous locations certification Options Codes I1, N1, E4, K6 and K8.
(5) Materials of Construction comply with recommendations per NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments.
(6) "Assemble-to" items are specified separately and require a completed model number.
(7) Not available with Low Power code M.
(8) Available only with output code W - Profibus PA.
(9) Not available with Fieldbus (output code F) or Profibus (output code W).
(10) Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.
(11) NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.
(12) The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.

Model	Transmitter Type	
3051T	Pressure Transmitter	
Pressure Type		
Standard		**Standard**
G	Gage	★
A	Absolute	★

Pressure Upper Range Limit - Configurable Description			
	3051TG[1]	**3051TA**	
Standard			**Standard**
1	30 psi (2,1 bar)	30 psia (2,1 bar)	★
2	150 psi (10,3 bar)	150 psia (10,3 bar)	★
3	800 psi (55,2 bar)	800 psia (55,2 bar)	★
4	4000 psi (275,8 bar)	4000 psia (275,8 bar)	★
5	10000 psi (689,5 bar)	10000 psia (689,5 bar)	★
Transmitter Output			
Standard			**Standard**
A	4–20 mA with Digital Signal Based on HART Protocol		★
F	FOUNDATION fieldbus Protocol		★
W[2]	Profibus PA Protocol		★
Expanded			
M	Low-Power 1–5 Vdc with Digital Signal Based on HART Protocol		
Process Connection Style			
Standard			**Standard**
2B	1/2–14 NPT Female		★
2C	G½ A DIN 16288 Male (Available in SST for Range 1–4 only)		★
Expanded			
2F	Coned and Threaded, Compatible with Autoclave Type F-250-C *(Includes Gland and Collar, Available in SST for Range 5 only)*		
61	Non-threaded Instrument flange (Range 1-4 only)		
Isolating Diaphragm		**Process Connection Wetted Parts Material**	
Standard			**Standard**
2[3]	316L SST	316L SST	★
3[3]	Alloy C-276	Alloy C-276	★
Sensor Fill Fluid			
Standard			**Standard**
1	Silicone		★
2	Inert (Fluorinert® FC-43)		★

Housing Material		Conduit Entry Size	
Standard			**Standard**
A	Polyurethane-covered Aluminum	½–14 NPT	★
B	Polyurethane-covered Aluminum	M20 × 1.5 (CM20)	★
J	SST	½–14 NPT	★
K	SST	M20 × 1.5 (CM20)	★
Expanded			
D	Polyurethane-covered Aluminum	G½	
M	SST	G½	

A.5.2 Options (Include with selected model number)

PlantWeb Control Functionality		
Standard		**Standard**
A01	Advanced Control Function Block Suite	★
PlantWeb Diagnostic Functionality		
Standard		**Standard**
D01	FOUNDATION fieldbus Diagnostics Suite	★
Integral Assembly		
Standard		**Standard**
S5[(4)]	Assemble to Rosemount 306 Integral Manifold	★
Seal Assemblies		
Standard		**Standard**
S1[(4)]	Assemble to one Rosemount 1199 seal	★
Mounting Bracket		
Standard		**Standard**
B4	Bracket for 2-in. Pipe or Panel Mounting, All SST	★
Product Certifications		
Standard		**Standard**
C6	CSA Explosion-proof, Dust Ignition-proof, Intrinsically Safe, and Division 2	★
E2	INMETRO Flameproof	★
E3	China Flameproof	★
E4[(5)]	TIIS Flameproof	★

E5	FM Explosion-proof, Dust Ignition-proof	★
E7[5]	IECEx Flameproof, Dust Ignition-proof	★
E8	ATEX Flameproof and Dust	★
I1[5]	ATEX Intrinsic Safety and Dust	★
I2	INMETRO Intrinsic Safety	★
I3	China Intrinsic Safety	★
I5	FM Intrinsically Safe, Division 2	★
I7[5]	IECEx Intrinsic Safety	★
IA	ATEX Intrinsic Safety for FISCO; for *FOUNDATION* fieldbus protocol only	★
IE	FM FISCO Intrinsically Safe; for FOUNDATION fieldbus protocol only	★
K2	INMETRO Flameproof, Intrinsic Safety	★
K5	FM Explosion-proof, Dust Ignition-proof, Intrinsically Safe, and Division 2	★
K6[5]	CSA and ATEX Explosion-proof, Intrinsically Safe, and Division 2 (combination of C6 and K8)	★
K7[5]	IECEx Flameproof, Dust Ignition-proof, Intrinsic Safety, and Type n (combination of I7, N7, and E7)	★
K8[5]	ATEX Flame-proof, Intrinsic Safety, Type n, Dust (combination of E8, I1, and N1)	★
KB	FM and CSA Explosion-proof, Dust Ignition-proof, Intrinsically Safe, and Division 2 (combination of K5 and C6)	★
KD[5]	FM, CSA, and ATEX Explosion-proof, Intrinsically Safe (combination of K5, C6, I1, and E8)	★
N1[5]	ATEX Type n Certification and Dust	★
N3	China Type n	★
N7[5]	IECEx Type n Certification	★
Custody Transfer		
Standard		**Standard**
C5	Measurement Canada Accuracy Approval *(Limited availability depending on transmitter type and range. Contact an Emerson Process Management representative)*	★
Calibration Certification		
Standard		**Standard**
Q4	Calibration Certificate	★
QG	Calibration Certificate and GOST Verification Certificate	★
QP	Calibration Certification and tamper evident seal	★
Material Traceability Certification		
Standard		**Standard**
Q8	Material Traceability Certification per EN 10204 3.1 *NOTE: This option applies to the process connection only.*	★
Quality Certification for Safety		
Standard		**Standard**
QS	Certificate of FMEDA Data	★
QT	Safety certified to IEC 61508 with Certificate of FMEDA data	★

Zero/Span Adjustment		
Standard		**Standard**
J1[6][7]	Local Zero Adjustment Only	★
J3[6][7]	No Local Zero or Span Adjustment	★
Expanded		
D1	Hardware adjustments (zero, span, alarm, security)	
Display Type		
Standard		**Standard**
M4[8]	LCD Display with Local Operator Interface	★
M5	LCD display	★
M6	LCD display for SST Housing (Housing Codes J, K, L and M only)	★
Conduit Plug		
Standard		**Standard**
DO	316 SST Conduit Plug	★
Transient Terminal Block		
Standard		**Standard**
T1	Transient Protection Terminal Block	★
Software Configuration		
Standard		**Standard**
C1[6]	Custom Software Configuration (Completed CDS 00806-0100-4001 required with order)	★
Expanded		
C2[6]	0.8–3.2 Vdc Output with Digital Signal Based on *HART* Protocol (Output Code M only)	
Alarm Limit		
Standard		**Standard**
C4[7][9]	Analog Output Levels Compliant with NAMUR Recommendation NE 43, Alarm High	★
CN[7][9]	Analog Output Levels Compliant with NAMUR Recommendation NE 43, Low Alarm	★
CR	Custom alarm and saturation signal levels, high alarm	★
CS	Custom alarm and saturation signal levels, low alarm	★
CT	Low alarm (standard Rosemount alarm and saturation levels)	★
Pressure Testing		
Expanded		
P1	Hydrostatic Testing with Certificate	

Cleaning Process Area		
Expanded		
P2	Cleaning for Special Service	
P3	Cleaning for <1 PPM Chlorine/Fluorine	
High Accuracy		
Standard		**Standard**
P8	0.04% accuracy to 5:1 turndown (Range 2-4)	★
Ground Screw		
Standard		**Standard**
V5(10)	External Ground Screw Assembly	★
Drinking Water Approval		
Standard		**Standard**
DW	NSF drinking water approval	★
Surface Finish		
Standard		**Standard**
Q16	Surface finish certification for sanitary remote seals	★
Toolkit Total System Performance Reports		
Standard		**Standard**
QZ	Remote Seal System Performance Calculation Report	★
Conduit Electrical Connector		
Standard		**Standard**
GE	M12, 4-pin, Male Connector (eurofast®)	★
GM	A size Mini, 4-pin, Male Connector (minifast®)	★
Typical Model Number: 3051T G 5 F 2A 2 1 A B4		

(1) 3051TG lower range limit varies with atmospheric pressure.
(2) Option code M4 - LCD Display with Local Operator Interface required for local addressing and configuration.
(3) Materials of Construction comply with recommendations per NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments.
(4) "Assemble-to" items are specified separately and require a completed model number.
(5) Not available with low-power Option Code M.
(6) Not available with fieldbus (output code F) or Profibus protocols (output code W).
(7) Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.
(8) Available only with output code W - Profibus PA.
(9) NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.
(10) The V5 option is not needed with T1 option; external ground screw assembly is included with the T1 option.

Model	Transmitter Type			
3051L	Liquid Level Transmitter			
Pressure Range				
Standard				**Standard**
2	–250 to 250 inH_2O (–0,6 to 0,6 bar)			★
3	–1000 to 1000 inH_2O (–2,5 to 2,5 bar)			★
4	–300 to 300 psi (–20,7 to 20,7 bar)			★
Transmitter Output				
Standard				**Standard**
A	4–20 mA with Digital Signal Based on *HART* Protocol			★
F	FOUNDATION fieldbus Protocol			★
W[(1)]	Profibus PA Protocol			★
Expanded				
M[(2)]	Low-Power 1–5 Vdc with Digital Signal Based on *HART* Protocol (See Option Code C2 for 0.8–3.2 Vdc Output)			
Process Connection Size, Material, Extension length (High Side)				
Standard				**Standard**
Code	**Process Connection Size**	**Material**	**Extension Length**	★
G0[(3)]	2-in./DN 50	316L SST	Flush Mount Only	★
H0[(3)]	2-in./DN 50	Alloy C-276	Flush Mount Only	★
J0	2-in./DN 50	Tantalum	Flush Mount Only	★
A0[(3)]	3-in./DN 80	316L SST	Flush Mount	★
A2[(3)]	3-in./DN 80	316L SST	2-in./50 mm	★
A4[(3)]	3-in./DN 80	316L SST	4-in./100 mm	★
A6[(3)]	3-in./DN 80	316L SST	6-in./150 mm	★
B0[(3)]	4-in./DN 100	316L SST	Flush Mount	★
B2[(3)]	4-in./DN 100	316L SST	2-in./50 mm	★
B4[(3)]	4-in./DN 100	316L SST	4-in./100 mm	★
B6[(3)]	4-in./DN 100	316L SST	6-in./150 mm	★
C0[(3)]	3-in./DN 80	Alloy C-276	Flush Mount	★
C2[(3)]	3-in./DN 80	Alloy C-276	2-in./50 mm	★
C4[(3)]	3-in./DN 80	Alloy C-276	4-in./100 mm	★
C6[(3)]	3-in./DN 80	Alloy C-276	6-in./150 mm	★
D0[(3)]	4-in./DN 100	Alloy C-276	Flush Mount	★
D2[(3)]	4-in./DN 100	Alloy C-276	2-in./50 mm	★

D4[3]	4-in./DN 100	Alloy C-276	4-in./100 mm	★
D6[3]	4-in./DN 100	Alloy C-276	6-in./150 mm	★
E0	3-in./DN 80	Tantalum	Flush Mount Only	★
F0	4-in./DN 100	Tantalum	Flush Mount Only	★
Mounting Flange Size, Rating, Material (High Side)				
	Size	**Rating**	**Material**	
Standard				**Standard**
M	2-in.	ANSI/ASME B16.5 Class 150	CS	★
A	3-in.	ANSI/ASME B16.5 Class 150	CS	★
B	4-in.	ANSI/ASME B16.5 Class 150	CS	★
N	2-in.	ANSI/ASME B16.5 Class 300	CS	★
C	3-in.	ANSI/ASME B16.5 Class 300	CS	★
D	4-in.	ANSI/ASME B16.5 Class 300	CS	★
P	2-in.	ANSI/ASME B16.5 Class 600	CS	★
E	3-in.	ANSI/ASME B16.5 Class 600	CS	★
X[3]	2-in.	ANSI/ASME B16.5 Class 150	SST	★
F[3]	3-in.	ANSI/ASME B16.5 Class 150	SST	★
G[3]	4-in.	ANSI/ASME B16.5 Class 150	SST	★
Y[3]	2-in.	ANSI/ASME B16.5 Class 300	SST	★
H[3]	3-in.	ANSI/ASME B16.5 Class 300	SST	★
J[3]	4-in.	ANSI/ASME B16.5 Class 300	SST	★
Z[3]	2-in.	ANSI/ASME B16.5 Class 600	SST	★
L[3]	3-in.	ANSI/ASME B16.5 Class 600	SST	★
Q	DN 50	PN 10-40 per EN 1092-1	CS	★
R	DN 80	PN 40 per EN 1092-1	CS	★
S	DN 100	PN 40 per EN 1092-1	CS	★
V	DN 100	PN 10/16 per EN 1092-1	CS	★
K[3]	DN 50	PN 10-40 per EN 1092-1	SST	★
T[3]	DN 80	PN 40 per EN 1092-1	SST	★
U[3]	DN 100	PN 40 per EN 1092-1	SST	★
W[3]	DN 100	PN 10/16 per EN 1092-1	SST	★
7[3]	4 in.	ANSI/ASME B16.5 Class 600	SST	★
Expanded				
1	—	10K per JIS B2238	CS	
2	—	20K per JIS B2238	CS	
3	—	40K per JIS B2238	CS	
4[3]	—	10K per JIS B2238	316 SST	

5[(3)]	—	20K per JIS B2238		316 SST	
6[(3)]	—	40K per JIS B2238		316 SST	
Process Fill-High Pressure Side		**Specific Gravity**	**Temperature Limits (Ambient Temperature of 70 °F (21 °C))**		
Standard					**Standard**
A	Syltherm XLT	0.85	-102 to 293 °F (-75 to 145 °C)		★
C	Silicone 704	1.07	32 to 401 °F (0 to 205 °C)		★
D	Silicone 200	0.93	-49 to 401 °F (-45 to 205 °C)		★
H	Inert (Halocarbon)	1.85	-49 to 320 °F (-45 to 160 °C)		★
G	Glycerine and Water	1.13	5 to 203 °F (-15 to 95 °C)		★
N	Neobee M-20	0.92	5 to 401 °F (-15 to 205 °C)		★
P	Propylene Glycol and Water	1.02	5 to 203 F (-15 to 95 °C)		★
Low Pressure Side					
	Configuration	**Flange Adapter**	**Diaphragm Material**	**Sensor Fill Fluid**	
Standard					**Standard**
11[(3)]	Gage	SST	316L SST	Silicone	★
21[(3)]	Differential	SST	316L SST	Silicone	★
22[(3)]	Differential	SST	Alloy C-276	Silicone	★
2A[(3)]	Differential	SST	316L SST	Inert (Halocarbon)	★
2B[(3)]	Differential	SST	Alloy C-276	Inert (Halocarbon)	★
31[(3)]	Tuned-System Assembly with Remote Seal	None	316L SST	Silicone *(Requires Option Code S1)*	★
O-ring					
Standard					**Standard**
A	Glass-filled PTFE				★
Housing Material			**Conduit Entry Size**		
Standard					**Standard**
A	Aluminum		½–14 NPT		★
B	Aluminum		M20 × 1.5		★
J	SST		½–14 NPT		★
K	SST		M20 × 1.5		★

Expanded			
D	Aluminum	G½	
M	SST	G½	

A.5.3 Options (Include with selected model number)

PlantWeb Control Functionality		
Standard		**Standard**
A01	FOUNDATION fieldbus Advanced Control Function Block Suite	★
PlantWeb Diagnostic Functionality		
Standard		**Standard**
D01	FOUNDATION fieldbus Diagnostics Suite	★
Seal Assemblies		
Standard		**Standard**
S1[(4)]	Assembled to One Rosemount 1199 Seal (Requires 1199M)	★
Product Certifications		
Standard		**Standard**
E5	FM Explosion-proof, Dust Ignition-proof	★
I5	FM Intrinsically Safe, Division 2	★
K5	FM Explosion-proof, Dust Ignition-proof, Intrinsically Safe, and Division 2	★
I1[(5)]	ATEX Intrinsic Safety and Dust	★
N1[(5)]	ATEX Type n Certification and Dust	★
E8	ATEX Flameproof and Dust	★
E4[(5)]	TIIS Flameproof	★
C6	CSA Explosion-proof, Dust Ignition-proof, Intrinsically Safe, and Division 2	★
K6[(5)]	CSA and ATEX Explosion-proof, Intrinsically Safe, and Division 2 (combination of C6 and K8)	★
KB	FM and CSA Explosion-proof, Dust Ignition-proof, Intrinsically Safe, and Division 2 (combination of K5 and C6)	★
K7[(5)]	IECEx Flameproof, Dust Ignition-proof, Intrinsic Safety, and Type n (combination of I7, N7, and E7)	★
K8[(5)]	ATEX Flame-proof and Intrinsic Safety Approvals (combination of I1 and E8)	★
KD[(5)]	FM, CSA, and ATEX Explosion-proof, Intrinsically Safe (combination of K5, C6, I1, and E8)	★

I7[5]	IECEx Intrinsic Safety	★
E7[5]	IECEx Flameproof, Dust Ignition-proof	★
N7[5]	IECEx Type n Certification	★
IA	ATEX FISCO Intrinsic Safety	★
IE	FM FISCO Intrinsically Safe	★
E2	INMETRO Flameproof	★
I2	INMETRO Intrinsic Safety	★
K2	INMETRO Flameproof, Intrinsic Safety	★
E3	China Flameproof	★
I3	China Intrinsic Safety	★
N3	China Type n	★
Bolting Material		
Standard		**Standard**
L4	Austenitic 316 SST Bolts	★
L5	ASTM A 193, Grade B7M bolts	★
L6	Alloy K-500 Bolts	★
L8	ASTM A 193 Class 2, Grade B8M Bolts	★
Display Type		
Standard		**Standard**
M4[6]	LCD Display with Local Operator Interface	★
M5	LCD Display for Aluminum Housing (Housing Codes A, B, C, and D only)	★
M6	LCD Display for SST Housing (Housing Codes J, K, L, and M only)	★
Calibration Certification		
Standard		**Standard**
Q4	Calibration Certificate	★
QP	Calibration Certificate and tamper evident seal	★
QG	Calibration Certificate and GOST Verification Certificate	★
Material Traceability Certification		
Standard		**Standard**
Q8	Material Traceability Certification per EN 10204 3.1	★
Quality Certification for Safety		
Standard		**Standard**
QS[7]	Prior-use certificate of FMEDA data	★

Toolkit Total System Performance Reports		
Standard		**Standard**
QZ	Remote Seal System Performance Calculation Report	★
Conduit Electrical Connector		
Standard		**Standard**
GE	M12, 4-pin, Male Connector (eurofast®)	★
GM	A size Mini, 4-pin, Male Connector (minifast®)	★
Hardware Adjustments		
Standard		**Standard**
J1[8][9]	Local Zero Adjustment Only	★
J3[8][9]	No Local Zero or Span Adjustment	★
Transient Protection		
Standard		**Standard**
T1[10]	Transient Protection Terminal Block	★
Software Configuration		
Standard		**Standard**
C1[8]	Custom Software Configuration (Completed CDS 00806-0100-4001 required with order)	★
Low Power Output		
Standard		**Standard**
C2[8]	0.8–3.2 Vdc Output with Digital Signal Based on HART Protocol (Available with Output code M only)	★
Alarm Limit		
Standard		**Standard**
C4[8][11]	NAMUR alarm and saturation levels, high alarm	★
CN[8][11]	NAMUR alarm and saturation levels, low alarm	★
CR	Custom alarm and saturation signal levels, high alarm	★
CS	Custom alarm and saturation signal levels, low alarm	★
CT	Low alarm (standard Rosemount alarm and saturation levels)	★
Conduit Plug		
Standard		**Standard**
D0	316 SST Conduit Plug	★
Ground Screw		
Standard		**Standard**
V5[12]	External Ground Screw Assembly	★

Lower Housing Flushing Connection Options				
	Ring Material	**Number**	**Size (NPT)**	
Standard				**Standard**
F1	316 SST	1	1/4-18 NPT	★
F2	316 SST	2	1/4-18 NPT	★
F3	Alloy C-276	1	1/4-18 NPT	★
F4	Alloy C-276	2	1/4-18 NPT	★
F7	316 SST	1	1/2-14 NPT	★
F8	316 SST	2	1/2-14 NPT	★
F9	Alloy C-276	1	1/2-14 NPT	★
F0	Alloy C-276	2	1/2-14 NPT	★
Typical Model Number: 3051L 2 A A0 D 21 A A F1				

(1) Option code M4 - LCD Display with Local Operator Interface required for local addressing and configuration.
(2) Not available with hazardous certification Option Codes I1, N1, E4, K6, and K8.
(3) Materials of Construction comply with metallurgical requirements highlighted within NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments.
(4) "Assemble-to" items are specified separately and require a completed model number.
(5) Not available with low-power Option Code M
(6) Available only with output code W - Profibus PA.
(7) Only available with HART 4-20 mA output (output code A).
(8) Not available with fieldbus (output code F) or profibus protocols (output code W).
(9) Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.
(10) The T1 option is not needed with FISCO Product Certifications; transient protection is included in the FISCO product certification codes IA, IE, IF, and IG.
(11) NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.
(12) The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.

Model	**Transmitter Type (Select One)**		**HD**	**HG**	
3051HD	Differential Pressure Transmitter for High Temperature Processes		•	—	
3051HG	Gage Pressure Transmitter High-Temperature Processes		•—	••	
Code	**Pressure Ranges (Range/ Min. Span)**				
	3051HD	3051HG			
2	–250 to 250 inH_2O/2.5 inH_2O (–0,62 to 0,62 bar/6,2 mbar)	–250 to 250 inH_2O/2.5 inH_2O (–0,62 to 0,62 bar/6,2 mbar)			
3	–1000 to 1000 inH_2O/10 inH_2O (–2,5 to 2,5 bar/25 mbar)	–407 to 1000 inH_2O/10in H_2O (–1,01 to 2,5 bar/25 mbar)			
4	–300 to 300 psi (–20,7 to 20,7 bar/0.2 bar)	–14.7 to 300 psi/3 psi (–1,01 to 20,7 bar/0,2 bar)			
5	–2000 to 2000 psi (–138 to 138 bar/1,4 bar)	–14.7 to 2000 psi/20 psi (–1,01 to 138 bar/1,4 bar)			
NOTE: 3051HG lower range limit varies with atmospheric pressure.					
Code	**Output**		**HD**	**HG**	
Expanded					
A	4–20 mA with Digital Signal Based on HART Protocol		••	••	
F	FOUNDATION fieldbus Protocol		••	••	

M[1]	Low-Power, 1–5 Vdc with Digital Signal Based on HART Protocol		• •	• •	
W	Profibus – PA		••	••	
Code	**Process Connection**		**HD**	**HG**	
	Process Flange Material	Drain/Vent			
2	SST	SST	• •	• •	
7[2]	SST	Alloy C-276	••	••	
Code	**Process Isolating Diaphragm**		**HD**	**HG**	
2	316L SST		• •	• •	
3[2]	Alloy C-276		• •	• •	
5	Tantalum		••	••	
Code	**O-ring Material**		**HD**	**HG**	
Expanded					
A	Glass-Filled PTFE		• •	• •	
Code	**Process Fill Fluid**		**HD**	**HG**	
Expanded					
D	*D.C. 200* Silicone		• •	• •	
H	Inert		• •	• •	
N	*Neobee M-20*		••	••	
P	Propylene glyco/water		• •	• •	
Code	**Sensor Module Isolator Material**		**HD**	**HG**	
Expanded					
2	316L SST		• •	• •	
Code	**Sensor Module Fill Fluid**		**HD**	**HG**	
Expanded					
1	Silicone		• •	• •	
2	Inert fill (Halocarbon)		• •	• •	
Code	**Housing Material**	**Conduit Entry Size**	**HD**	**HG**	
Expanded					
A	Polyurethane-covered Aluminum	½–14 NPT	•	•	
B	Polyurethane-covered Aluminum	M20 × 1.5 (CM20)	•	••	
D	Polyurethane-covered Aluminum	G½	•	••	
J	SST	½–14 NPT	•	•	
K	SST	M20 × 1.5 (CM20)	•	••	
M	SST	G½	••	••	

A.5.4 Options (Include with selected model number)

Code	***PlantWeb* Control Anywhere Software**	HD	HG	
Expanded				
A01	Advanced Control Function Block Suite • •	• •	• •	
Code	***PlantWeb* Advanced Diagnostic Software**	**HD**	**HG**	
Expanded				
D01	FOUNDATION fieldbus Diagnostics Suite	• •	• •	
Code	**Integral Mount Primary Elements (Optional)**	**HD**	**HG**	
Expanded				
S4[3]	Assemble to Rosemount Annubar or Rosemount 1195 Integral Orifice	• • •	— •—	
Code	**Mounting Bracket Options**	**HD**	**HG**	
Expanded				
B5	Universal Mounting Bracket for 2-in. Pipe or Panel Mount, CS Bolts	• •	• •	
B6	Universal Mounting Bracket for 2-in. Pipe or Panel Mount, SST Bolts	••	••	
Code	**Product Certifications (Optional)**	**HD**	**HG**	
Expanded				
C6	CSA Explosion-proof, Dust Ignition-proof, Intrinsically Safe, and Division 2	•	•	
E4[5]	TIIS Flameproof	•	•	
E5	FM Explosion-proof, Dust Ignition-proof	•	•	
E7	IECEx Flameproof, Dust Ignition-proof	•	•	
E8	ATEX Flameproof and Dust Certification	•	•	
I1[4]	ATEX Intrinsic Safety and Dust	•	•	
I5	FM Intrinsically Safe, Division 2	•	•	
I7	IECEx Intrinsic Safety	•	•	
IA	ATEX FISCO Intrinsic Safety	•	•	
IE	FM FISCO Intrinsically Safe	•	•	
K5	FM Explosion-proof, Dust Ignition-proof, Intrinsically Safe, and Division 2	•	•	
K6[5]	CSA and ATEX Explosion-proof, Intrinsically Safe, and Division 2 (combination of C6 and K8)	•	•	
K7	SAA Flameproof, Dust Ignition-proof, Intrinsic Safety, and Type n (combination of I7, N7, and E7)	•	•	
K8[5]	ATEX Flameproof, Intrinsic Safety, Type n, Dust (combination of E8, I1, and N1)	•	•	
KB	FM and CSA Explosion-proof, Dust Ignition-Proof, Intrinsically Safe, and Division 2 (combination of K5 and C6)	•	•	
KD[5]	CSA, FM, and ATEX Explosion-proof and Intrinsically Safe (combination of K5, C6, I1, and E8)	•	•	
N1[5]	ATEX Type n Certification and Dust	•	•	

N7	IECEx Type n Certification	•	•	
E2	INMETRO Flameproof	—	•	
I2	INMETRO Intrinsic Safety	—	•	
K2	INMETRO Flameproof, Intrinsic Safety	—	•	
DW	NSF drinking water approval	•—	•	
Code	**Bolting Material**	**HD**	**HG**	
Expanded				
L4	Austenitic 316 SST Bolts	•	•••	
Code	**Display and Interface Options**	**HD**	**HG**	
Expanded				
M4	LCD Display with Local Operator Display	• •	• •	
M5	LCD Display for Aluminum Housing *(Housing codes A, B, C, and D only)*	• •	• •	
M6	LCD Display for SST Housing *(Housing codes J, K, L, and M only)*	•	•••	
Code	**Calibration Certification**	**HD**	**HG**	
Expanded				
Q4	Calibration Certificate	•	•	
QG	Calibration Certificate and GOST Verification Certificate	• •	• •	
QP	Calibration Certificate and tamper evident seal	• •	• •	
Code	**Material Traceability Certification**	**HD**	**HG**	
Expanded				
Q8	Material traceability certification per EN 10204 3.1	•	•	
Code	**Zero/Span Adjustment**	**HD**	**HG**	
Expanded				
J1[(5)(6)]	Local Zero Adjustment Only	•	•	
J3[(5)(6)]	No Local Zero or Span Adjustment	• •	• •	
Code	**Transient Terminal Block**	**HD**	**HG**	
Expanded				
T1	Transient Protection Terminal Block	•	•	
Code	**Software Configuration**	**HD**	**HG**	
Expanded				
C1[(5)]	Custom Software Configuration (Completed CDS 00806-0100-4001 required with order)	• •	• •	
Code	**Lower Power Output**	**HD**	**HG**	
Expanded				
C2[(5)]	0.8–3.2 Vdc Output with Digital Signal Based on HART Protocol *(Output Code M only)*	•	•	

Code	Alarm Limit	HD	HG	
Expanded				
C4[5][7]	Analog Output Levels Compliant with NAMUR Recommendation NE 43	• •	• •	
CN[5][7]	Analog Output Levels Compliant with NAMUR Recommendation NE 43: Alarm Configuration–Low	•	•	
Code	**Pressure Testing**	**HD**	**HG**	
Expanded				
P1	Hydrostatic Testing with Certificate	• •	• •	
Code	**Cleaning Process Area**	**HD**	**HG**	
Expanded				
P2	Cleaning for Special Service	•	•	
Code	**Flange Adapters**	**HD**	**HG**	
Expanded				
DF	1/2–14 NPT flange adapters—SST	• •	• •	
Code	**Vent/Drain Valves**	**HD**	**HG**	
Expanded				
D8	Ceramic Ball Drain/Vents	•	•	
Code	**Conduit Plug**	**HD**	**HG**	
Expanded				
DO	316 SST Conduit Plug	• •	• •	
Code	**Ground Screw**	**HD**	**HG**	
Expanded				
V5[8]	External Ground Screw Assembly	• •	• •	
Code	**Bar Code Tag**	**HD**	**HG**	
Expanded				
BT	Customer Specified Barcode Tag	• •	• •	
Code	**Quality Certification for Safety**	**HD**	**HG**	
Expanded				
QS	Certificate of FMEDA Data	• •	• •	
Code	**Conduit Electrical Connector**	**HD**	**HG**	
Expanded				
GE	M12, 4-pin, Male Connector (*eurofast*)	• •	• •	
GM	A size Mini, 4-pin, Male Connector (*minifast*)	• •	• •	

Code	A Number Specials	HD	HG	
Expanded				
Axxxx	Specials	• •	• •	
Typical Model Number: 3051HG 2 A 2 2 A H 2 1 A B5				

(1) Not available with hazardous certification Option Codes I1, N1, E4, K6, and K8.
(2) Materials of Construction comply with recommendations per NACE MR0175/ISO 15156 for sour oil field production environments. Environmental limits apply to certain materials. Consult latest standard for details. Selected materials also conform to NACE MR0103 for sour refining environments.
(3) "Assemble-to" items are specified separately and require a completed model number.
(4) Not available with Low Power code M.
(5) Not available with fieldbus (output code F) or profibus protocols (output code W).
(6) Local zero and span adjustments are standard unless Option Code J1 or J3 is specified.
(7) NAMUR-Compliant operation is pre-set at the factory and cannot be changed to standard operation in the field.
(8) The V5 option is not needed with the T1 option; external ground screw assembly is included with the T1 option.

A.6 Options

Standard Configuration

Unless otherwise specified, transmitter is shipped as follows:

Engineering units ***Differential/Gage*:** ***Absolute/3051T*:**	inH_2O (Range 0, 1, 2, and 3) psi (Range 4 and 5) psi (all ranges)
4 mA (1 Vdc)[(1)]:	0 (engineering units above)
20 mA (5 Vdc):	Upper range limit
Output:	Linear
Flange type:	Specified model code option
Flange material:	Specified model code option
O-ring material:	Specified model code option
Drain/vent:	Specified model code option
Integral meter:	Installed or none
Alarm[(1)]:	Upscale
Software tag:	(Blank)

(1) Not applicable to fieldbus.

Custom Configuration HART protocol only[(1)]

If Option Code C1 is ordered, the customer may specify the following data in addition to the standard configuration parameters.

- Output Information
- Transmitter Information
- LCD display Configuration
- Hardware Selectable Information
- Signal Selection

Refer to the “HART Protocol C1 Option Configuration Data Sheet” document number 00806-0100-4001.

(1)Not applicable to fieldbus.

Tagging (3 options available)

- Standard SST hardware tag is wired to the transmitter. Tag character height is 0.125 in. (3,18 mm), 56 characters maximum.
- Tag may be permanently stamped on transmitter nameplate upon request, 56 characters maximum.
- Tag may be stored in transmitter memory (30 characters maximum). Software tag is left blank unless specified.

Commissioning tag (fieldbus only)

A temporary commissioning tag is attached to all transmitters. The tag indicates the device ID and allows an area for writing the location.

Optional Rosemount 304, 305, or 306 Integral Manifolds

Factory assembled to 3051C and 3051T transmitters. Refer to the following Product Data Sheet (document number 00813-0100-4839 for Rosemount 304 and 00813-0100-4733 for Rosemount 305 and 306) for additional information.

Optional Diaphragm and Sanitary Seals

Refer to Product Data Sheet 00813-0100-4016 or 00813-0201-4016 for additional information.

Output Information(1)

Output range points must be the same unit of measure. Available units of measure include:

inH2O	inH2O@4 °C(1)	psi	Pa
inHg	ftH2O	bar	kPa
mmH2O	mmH2O@4 °C(1)	mbar	torr
mmHg	g/cm2	kg/cm2	atm

(1) Not available on low power or previous versions.

LCD display

M5 Digital Display, 5-Digit, 2-Line LCD

- Direct reading of digital data for higher accuracy
- Displays user-defined flow, level, volume, or pressure units
- Displays diagnostic messages for local troubleshooting
- 90-degree rotation capability for easy viewing

M6 Digital Display with 316 Stainless Steel Cover

- For use with stainless steel housing option (housing codes J, K, and L)

Local Span and Zero Adjustment[(1)]

Transmitters ship with local span and zero adjustments standard unless otherwise specified.

- Non-interactive external zero and span adjustments ease calibration
- Magnetic switches replace standard potentiometer adjustments to optimize performance

J1 Local Zero Adjustment Only[(1)]

J3 No Local Zero or Span Adjustment[(1)]

Bolts for Flanges and Adapters

- Options permit bolts for flanges and adapters to be obtained in various materials
- Standard material is plated carbon steel per ASTM A449, Type 1

L4 Austenitic 316 Stainless Steel Bolts

L5 ASTM A 193, Grade B7M Bolts

L6 Alloy K-500 Bolts

Rosemount 3051C Coplanar Flange and 3051T Bracket Option

B4 Bracket for 2-in. Pipe or Panel Mounting

- For use with the standard Coplanar flange configuration
- Bracket for mounting of transmitter on 2-in. pipe or panel
- Stainless steel construction with stainless steel bolts

Rosemount 3051H Bracket Options

B5 Bracket for 2-in. Pipe or Panel Mounting

- For use with the 3051H Pressure Transmitter for high process temperatures
- Carbon steel construction with carbon steel bolts

B6 B5 Bracket with SST Bolts

- Same bracket as the B5 option with Series 300 stainless steel bolts.

Traditional Flange Bracket Options

B1 Bracket for 2-in. Pipe Mounting

- For use with the traditional flange option
- Bracket for mounting on 2-in. pipe
- Carbon steel construction with carbon steel bolts
- Coated with polyurethane paint

(1)Not applicable to fieldbus.

B2 Bracket for Panel Mounting

- For use with the traditional flange option
- Bracket for mounting transmitter on wall or panel
- Carbon steel construction with carbon steel bolts
- Coated with polyurethane paint

B3 Flat Bracket for 2-in. Pipe Mounting

- For use with the traditional flange option
- Bracket for vertical mounting of transmitter on 2-in. pipe
- Carbon steel construction with carbon steel bolts
- Coated with polyurethane paint

B7 B1 Bracket with SST Bolts

- Same bracket as the B1 option with Series 300 stainless steel bolts

B8 B2 Bracket with SST Bolts

- Same bracket as the B2 option with Series 300 stainless steel bolts

B9 B3 Bracket with SST Bolts

- Same bracket as the B3 option with Series 300 stainless steel bolts

BA Stainless Steel B1 Bracket with SST Bolts

- B1 bracket in stainless steel with Series 300 stainless steel bolts

BC Stainless Steel B3 Bracket with SST Bolts

- B3 bracket in stainless steel with Series 300 stainless steel bolts

Shipping weights

Table A-6. Transmitter weights without options

Transmitter	Add weight In lb (kg)
3051C	6.0 (2,7)
3051L	Table A-7
3051H	13.6 (6,2)
3051T	3.0 (1,4)

Table A-7. 3051L weights without options

Flange	Flush lb. (kg)	2-in. Ext. lb (kg)	4-in. Ext. lb (kg)	6-in. Ext. lb (kg)
2-in., 150	12.5 (5,7)	—	—	—
3-in., 150	17.5 (7,9)	19.5 (8,8)	20.5 (9,3)	21.5 (9,7)
4-in., 150	23.5 (10,7)	26.5 (12,0)	28.5 (12,9)	30.5 (13,8)
2-in., 300	17.5 (7,9)	—	—	—
3-in., 300	22.5 (10,2)	24.5 (11,1)	25.5 (11,6)	26.5 (12,0)
4-in., 300	32.5 (14,7)	35.5 (16,1)	37.5 (17,0)	39.5 (17,9)
2-in., 600	15.3 (6,9)	—	—	—
3-in., 600	25.2 (11,4)	27.2 (12,3)	28.2 (12,8)	29.2 (13,2)
DN 50/PN 40	13.8 (6,2)	—	—	—
DN 80/PN 40	19.5 (8,8)	21.5 (9,7)	22.5 (10,2)	23.5 (10,6)
DN 100/ PN 10/16	17.8 (8,1)	19.8 (9,0)	20.8 (9,5)	21.8 (9,9)
DN 100/ PN 40	23.2 (10,5)	25.2 (11,5)	26.2 (11,9)	27.2 (12,3)

Table A-8. Transmitter options weights

Code	Option	Add lb (kg)
J, K, L, M	Stainless Steel Housing(T)	3.9 (1,8)
J, K, L, M	Stainless Steel Housing (C, L, H, P)	3.1 (1,4)
M5	LCD display for Aluminum Housing	0.5 (0,2)
M6	LCD display for SST Housing	1.25 (0,6)
B4	SST Mounting Bracket for Coplanar Flange	1.0 (0,5)
B1 B2 B3	Mounting Bracket for Traditional Flange	2.3 (1,0)
B7 B8 B9	Mounting Bracket for Traditional Flange	2.3 (1,0)
BA, BC	SST Bracket for Traditional Flange	2.3 (1,0)
B5 B6	Mounting Bracket for 3051H	2.9 (1,3)
H2	Traditional Flange	2.4 (1,1)
H3	Traditional Flange	2.7 (1,2)
H4	Traditional Flange	2.6 (1,2)
H7	Traditional Flange	2.5 (1,1)
FC	Level Flange—3 in., 150	10.8 (4,9)
FD	Level Flange—3 in., 300	14.3 (6,5)
FA	Level Flange—2 in., 150	10.7 (4,8)
FB	Level Flange—2 in., 300	14.0 (6,3)

Table A-8. Transmitter options weights

Code	Option	Add lb (kg)
FP	DIN Level Flange, SST, DN 50, PN 40	8.3 (3,8)
FQ	DIN Level Flange, SST, DN 80, PN 40	13.7 (6,2)

Table A-9. 3051C differential/gage pressure transmitter range limits

	Range 1 span		Range 2 span		Range 3 span		Range 4 span		Range 5 span	
Units	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**
inH_2O	0.5	25	2.5	250	10	1000	83.040	8304	553.60	55360
inHg	0.03678	1.8389	0.18389	18.389	0.73559	73.559	6.1081	610.81	40.720	4072.04
ftH_2O	0.04167	2.08333	0.20833	20.8333	0.83333	83.3333	6.9198	691.997	46.13	4613.31
mmH_2O	12.7	635.5	63.553	6355	254	25421	2110.95	211095	14073	1407301
mmHg	0.93416	46.7082	4.67082	467.082	18.6833	1868.33	155.145	15514.5	1034.3	103430
psi	0.01806	0.903	0.0902	9.03183	0.36127	36.127	3	300	20	2000
bar	0.00125	0.06227	0.00623	0.62272	0.02491	2.491	0.20684	20.6843	1.37895	137.895
mbar	1.2454	62.2723	6.22723	622.723	24.9089	2490.89	206.843	20684.3	1378.95	137895
g/cm^2	1.26775	63.3875	6.33875	633.875	25.355	2535.45	210.547	21054.7	1406.14	140614
kg/cm^2	0.00127	0.0635	0.00635	0.635	0.0254	2.54	0.21092	21.0921	1.40614	140.614
Pa	124.545	6227.23	622.723	62160.6	2490.89	249089	20684.3	2068430	137895	13789500
kPa	0.12545	6.2272	0.62272	62.2723	2.49089	249.089	20.6843	2068.43	137.895	13789.5
torr	0.93416	46.7082	4.67082	467.082	18.6833	1868.33	155.145	15514.5	1034.3	103430
atm	0.00123	0.06146	0.00615	0.61460	0.02458	2.458	0.20414	20.4138	1.36092	136.092

When using a Field Communicator, ±5% adjustment is allowed on the sensor limit to allow for unit conversions.

Table A-10. 3051L/3051H pressure transmitter range limits

	Range 2 span		Range 3 span		Range 4 span		Range 5 span	
Units	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**
inH_2O	2.5	250	10	1000	83.040	8304	553.60	55360
inHg	0.18389	18.389	0.73559	73.559	6.1081	610.81	40.720	4072.04
ftH_2O	0.20833	20.8333	0.83333	83.3333	6.9198	691.997	46.13	4613.31
mmH_2O	63.553	6355	254	25421	2110.95	211095	14073	1407301
mmHg	4.67082	467.082	18.6833	1868.33	155.145	15514.5	1034.3	103430
psi	0.0902	9.03183	0.36127	36.127	3	300	20	2000
bar	0.00623	0.62272	0.02491	2.491	0.20684	20.6843	1.37895	137.895
mbar	6.22723	622.723	24.9089	2490.89	206.843	20684.3	1378.95	137895
g/cm^2	6.33875	633.875	25.355	2535.45	210.547	21054.7	1406.14	140614
kg/cm^2	0.00635	0.635	0.0254	2.54	0.21092	21.0921	1.40614	140.614
Pa	622.723	62160.6	2490.89	249089	20684.3	2068430	137895	13789500
kPa	0.62272	62.2723	2.49089	249.089	20.6843	2068.43	137.895	13789.5
torr	4.67082	467.082	18.6833	1868.33	155.145	15514.5	1034.3	103430
atm	0.00615	0.61460	0.02458	2.458	0.20414	20.4138	1.36092	136.092

When using a Field Communicator, ±5% adjustment is allowed on the sensor limit to allow for unit conversions.

Table A-11. 3051T gage and absolute pressure transmitter range limits (cont. below with Ranges 3-5)

	Range 1 span		Range 2 span	
Units	**min**	**max**	**min**	**max**
inH_2O	8.30397	831.889	41.5198	4159.45
inHg	0.61081	61.0807	3.05403	305.403
ftH_2O	0.69199	69.3241	3.45998	345.998
mmH_2O	211.10	21130	1054.60	105460.3
mmHg	15.5145	1551.45	77.5723	7757.23
psi	0.3	30	1.5	150
bar	0.02068	2.06843	0.10342	10.3421
mbar	20.6843	2068.43	103.421	10342.11
g/cm^2	21.0921	2109.21	105.461	10546.1
kg/cm^2	0.02109	2.10921	0.10546	10.5461
Pa	2068.43	206843	10342.1	1034212
kPa	2.06843	206.843	10.3421	1034.21
torr	15.5145	1551.45	77.5726	7757.26
atm	0.02041	2.04138	0.10207	10.2069

When using a Field Communicator, ±5% adjustment is allowed on the sensor limit to allow for unit conversions.

Table A-12. 3051T gage and absolute pressure transmitter range limits (cont.)

	Range 3 span		Range 4 span		Range 5 span	
Units	**min**	**max**	**min**	**max**	**min**	**max**
inH_2O	221.439	22143.9	1107.2	110720	55360	276799
inHg	16.2882	1628.82	81.441	8144.098	4072.04	20360.2
ftH_2O	18.4533	1845.33	92.2663	9226.63	4613.31	23066.6
mmH_2O	5634.66	563466	28146.1	2814613	1407301	7036507
mmHg	413.72	41372	2068.6	206860.0	103430	517151
psi	8	800	40	4000	2000	10000
bar	0.55158	55.1581	2.75791	275.7905	137.895	689.476
mbar	551.581	55158.1	2757.91	275790.5	137895	689476
g/cm^2	561.459	56145.9	2807.31	280730.6	140614	703067
kg/cm^2	0.56246	56.2456	2.81228	281.228	140.614	701.82
Pa	55158.1	5515811	275791	27579054	13789500	68947600
kPa	55.1581	5515.81	275.791	27579.05	13789.5	68947.6
torr	413.721	413721	2068.6	206859.7	103430	517151
atm	0.54437	54.4368	2.72184	272.1841	136.092	680.46

When using a Field Communicator, ±5% adjustment is allowed on the sensor limit to allow for unit conversions.

Table A-13. 3051C absolute pressure transmitter range limits

	Range 1 span		Range 2 span		Range 3 span		Range 4 span	
Units	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**
inH_2O	8.30397	831.889	41.5198	4151.98	221.439	22143.9	1107.2	110720
inHg	0.61081	61.0807	3.05403	305.403	16.2882	1628.82	81.441	8144.098
ftH_2O	0.69199	69.3241	3.45998	345.998	18.4533	1845.33	92.2663	9226.63
mmH_2O	211.10	21130	6.35308	635.308	5634.66	563466	28146.1	2814613
mmHg	15.5145	1551.45	1055.47	105547	413.72	41372	2068.6	206860.0
psi	0.3	30	1.5	150	8	800	40	4000
bar	0.02068	2.06843	0.10342	10.342	0.55158	55.1581	2.75791	275.7905
mbar	20.6843	2068.43	103.421	10342.1	551.581	55158.1	2757.91	275790.5
g/cm^2	21.0921	2109.21	105.27	105.27	561.459	56145.9	2807.31	280730.6
kg/cm^2	0.02109	2.10921	0.10546	10.546	0.56246	56.2456	2.81228	281.228
Pa	2068.43	206843	10342.1	1034210	55158.1	5515811	275791	27579054
kPa	2.06843	206.843	10.3421	1034.21	55.1581	5515.81	275.791	27579.05
torr	15.5145	1551.45	77.5726	7757.26	413.721	413721	2068.6	206859.7
atm	0.02041	2.04138	0.10207	10.207	0.54437	54.4368	2.72184	272.1841

When using a Field Communicator, ±5% adjustment is allowed on the sensor limit to allow for unit conversions.

A.7 Spare parts

Model 3051C Sensor Modules (Min. Span/Range)	Silicone Fill Part Number	Inert Fill Part Number
Note: One spare part is recommended for every 50 transmitters. *Note: Listed by Range and Process Isolator Order Numbers.*		
–3 to 3/0.1 inH2O, Range 0 (includes Traditional SST flange and SST bolts).		
316L SST	03031-1045-0002	03031-1145-0002
–25 to 25 inH_2O/0.5 inH_2O, Range 1		
316L SST	03031-1045-0012	03031-1145-0012
Alloy C-276	03031-1045-0013	03031-1145-0013
Alloy	03031-1045-0014	03031-1145-0014
Gold-plated *Alloy*	03031-1045-0016	03031-1145-0016
Gold-plated 316 SST	03031-1045-0017	03031-1145-0017
–250 to 250 inH_2O/2.5 inH_2O, Range 2		
316L SST	03031-1045-0022	03031-1145-0022
Alloy C-276	03031-1045-0022	03031-1145-0022
Alloy	03031-1045-0024	03031-1145-0024
Tantalum	03031-1045-0025	03031-1145-0025
Gold-plated *Alloy*	03031-1045-0026	03031-1145-0026
Gold-plated 316 SST	03031-1045-0027	03031-1145-0027
–1000 to 1000 inH_2O/10 inH_2O, Range 3		
316L SST	03031-1045-0032	03031-1145-0032
Alloy C-276	03031-1045-0033	03031-1145-0033
Alloy	03031-1045-0034	03031-1145-0034
Tantalum	03031-1045-0035	03031-1145-0035
Gold-plated *Alloy*	03031-1045-0036	03031-1145-0036
Gold-plated 316 SST	03031-1045-0037	03031-1145-0037
–300 to 300 psi/3 psi, Range 4		
316L SST	03031-1045-2042	03031-1145-2042
Alloy C-276	03031-1045-2043	03031-1145-2043
Alloy	03031-1045-2044	03031-1145-2044
Tantalum	03031-1045-2045	03031-1145-2045
Gold-plated *Alloy*	03031-1045-2046	03031-1145-2046
Gold-plated 316 SST	03031-1045-2047	03031-1145-2047

–2000 to 2000/20 psi, Range 5		
316L SST	03031-1045-2052	03031-1145-2052
Alloy C-276	03031-1045-2053	03031-1145-2053
Alloy	03031-1045-2054	03031-1145-2054
Tantalum	03031-1045-2055	03031-1145-2055
Gold-plated *Alloy*	03031-1045-2056	03031-1145-2056
Gold-plated 316 SST	03031-1045-2057	03031-1145-2057

Rosemount 3051C gage and differential sensor modules (Min. Span/Range)			Silicone fill	Inert fill
			Part number	Part number
Note: One spare part is recommended for every 50 transmitters. *Note: Listed by Range and Process Isolator Order Numbers.*				
	Gage pressure range	**Differential pressure range**		
Range 1	**–25 to 25 in H2O/0.5 in H2O**	**–25 to 25 in H2O/0.5 in H2O**		
316L SST			03031-1045-0012	03031-1145-0012
Alloy C-276			03031-1045-0013	03031-1145-0013
Alloy 400			03031-1045-0014	03031-1145-0014
Gold-plated Alloy 400			03031-1045-0016	03031-1145-0016
Gold-plated 316 SST			03031-1045-0017	03031-1145-0017
Range 2	**–250 to 250 inH_2O/2.5 inH_2O**	**–250 to 250 inH_2O/2.5 inH_2O**		
316L SST			03031-1045-0022	03031-1145-0022
Alloy C-276			03031-1045-0023	03031-1145-0023
Alloy 400			03031-1045-0024	03031-1145-0024
Tantalum			03031-1045-0025	03031-1145-0025
Gold-plated Alloy 400			03031-1045-0026	03031-1145-0026
Gold-plated 316 SST			03031-1045-0027	03031-1145-0027
Range 3	**–407 to 1000 inH_2O/10 inH_2O**	**-1000 to 1000 inH_2O/10 inH_2O**		
316L SST			03031-1045-0032	03031-1145-0032
Alloy C-276			03031-1045-0033	03031-1145-0033
Alloy 400			03031-1045-0034	03031-1145-0034
Tantalum			03031-1045-0035	03031-1145-0035
Gold-plated Alloy 400			03031-1045-0036	03031-1145-0036
Gold-plated 316 SST			03031-1045-0037	03031-1145-0037

Range 4	**–14.2 to 300 psi/3 psi**	**-300 to 300 psi/3 psi**		
316L SST			03031-1045-2042	03031-1145-2042
Alloy C-276			03031-1045-2043	03031-1145-2043
Alloy 400			03031-1045-2044	03031-1145-2044
Tantalum			03031-1045-2045	03031-1145-2045
Gold-plated Alloy 400			03031-1045-2046	03031-1145-2046
Gold-plated 316 SST			03031-1045-2047	03031-1145-2047
Range 5	**–14.2 to 2000 psi/20 psi**	**-2000 to 2000psi/20 psi**		
316L SST			03031-1045-2052	03031-1145-2052
Alloy C-276			03031-1045-2053	03031-1145-2053
Alloy 400			03031-1045-2054	03031-1145-2054
Tantalum			03031-1045-2055	03031-1145-2055
Gold-plated Alloy 400			03031-1045-2056	03031-1145-2056
Gold-plated 316 SST			03031-1045-2057	03031-1145-2057

Rosemount 3051C absolute sensor modules (Min. Span/Range)	**Silicone fill** **Part number**	**Inert fill** **Part number**
Note: One spare part is recommended for every 50 transmitters. *Note: Listed by Range and Process Isolator Order Numbers.*		
Range 1, 0 to 30 psia/0.3 psia		
316L SST	03031-2020-0012	—
Alloy C-276	03031-2020-0013	—
Alloy 400	03031-2020-0014	—
Gold-plated Alloy 400	03031-2020-0016	—
Gold-plated 316 SST	03031-2020-0017	—
Range 2, 0 to 150/1.5 psia		
316L SST	03031-2020-0022	—
Alloy C-276	03031-2020-0023	—
Alloy 400	03031-2020-0024	—
Gold-plated Alloy 400	03031-2020-0026	—
Gold-plated 316 SST	03031-2020-0027	—
Range 3, 0 to 800 psia/8 psia		
316L SST	03031-2020-0032	—
Alloy C-276	03031-2020-0033	—
Alloy 400	03031-2020-0034	—
Gold-plated Alloy 400	03031-2020-0036	—
Gold-plated 316 SST	03031-2020-0037	—

Range 4, 0 to 400 psia/40 psia		
316L SST	03031-2020-0042	—
Alloy C-276	03031-2020-0043	—
Alloy 400	03031-2020-0044	—
Gold-plated Alloy 400	03031-2020-0046	—
Gold-plated 316 SST	03031-2020-0047	—

Electronics board assemblies	Part number
4-20 mA HART Standard	03031-0001-0002
4-20 mA HART NAMUR compliant	03031-0001-0003
1-5 Vdc HART Low Power	03031-0001-1001
FOUNDATION fieldbus	03031-0001-2001
PROFIBUS PA fieldbus	03031-0001-2101
LCD display	**Part number**
LCD Display Kits	
4-20 mA HART - Aluminum	03031-0193-0101
4-20 mA HART - 316 SST	03031-0193-0111
1-5 Vdc HART Low Power - Aluminum	03031-0193-0001
1-5 Vdc HART Low Power - 316 SST	03031-0193-0011
Fieldbus (FOUNDATION or PROFIBUS PA) - Aluminum	03031-0193-0104
Fieldbus (FOUNDATION or PROFIBUS PA) - 316 SST	03031-0193-0112
LCD Display Only	
4-20 mA HART	03031-0193-0103
1-5 Vdc HART Low Power	03031-0193-0003
Fieldbus (FOUNDATION or PROFIBUS PA)	03031-0193-0105
Terminal block assemblies	**Part number**
4-20 mA HART Output	
Standard terminal block	03031-0332-0003
Transient terminal block (option T1)	03031-0332-0004
1-5 Vdc HART Low Power Output	
Standard terminal block	03031-0332-1001
Transient terminal block (option T1)	03031-0332-1002
Fieldbus (FOUNDATION or PROFIBUS PA)	
Standard terminal block	03031-0332-2001
Transient terminal block (option T1)	03031-0332-2002
FISCO terminal block	03031-0332-2005

Electrical housings (without terminal block)	Part number
Standard - Aluminum	
1/2 - 14 NPT conduit entry	03031-0635-0001
M20 conduit entry	03031-0635-0002
G1/2 conduit entry	03031-0635-0004
Standard - 316 SST	
1/2 - 14 NPT conduit entry	03031-0635-0041
M20 conduit entry	03031-0635-0042
1-5 Vdc HART Low Power - Aluminum	
1/2 - 14 NPT conduit entry	03031-0635-0101
1-5 Vdc HART Low Power - 316 SST	
1/2 - 14 NPT conduit entry	03031-0635-0141
Housing conduit plugs	**Part number**
1/2 NPT Conduit plug	03031-0544-0003
M20 Conduit plug	03031-0544-0001
G1/2 Conduit plug	03031-0544-0004
Housing covers (include o-ring)	**Part number**
Field terminal cover - Aluminum	03031-0292-0001
Field terminal cover - 316 SST	03031-0292-0002
HART electronics cover - Aluminum	03031-0292-0001
HART electronics cover - 316 SST	03031-0292-0002
HART LCD Display cover - Aluminum	03031-0193-0002
HART LCD Display cover - 316 SST	03031-0193-0012
Fieldbus extended electronics cover - Aluminum	03031-0292-0003
Fieldbus extended electronics cover - 316 SST	03031-0292-0004
Fieldbus extended LCD Display cover - Aluminum	03031-0193-0007
Fieldbus extended LCD Display cover - 316 SST	03031-0193-0013
Miscellaneous hardware	**Part number**
Local Zero and Span Kit	03031-0293-0002
External ground screw assembly (option V5)	03031-0398-0001
Flanges	**Part number**
Differential Coplanar Flange	
316 SST	03031-0388-0022
Cast C-276	03031-0388-0023
Cast Alloy 400	03031-0388-0024
Nickel-plated carbon steel	03031-0388-0025

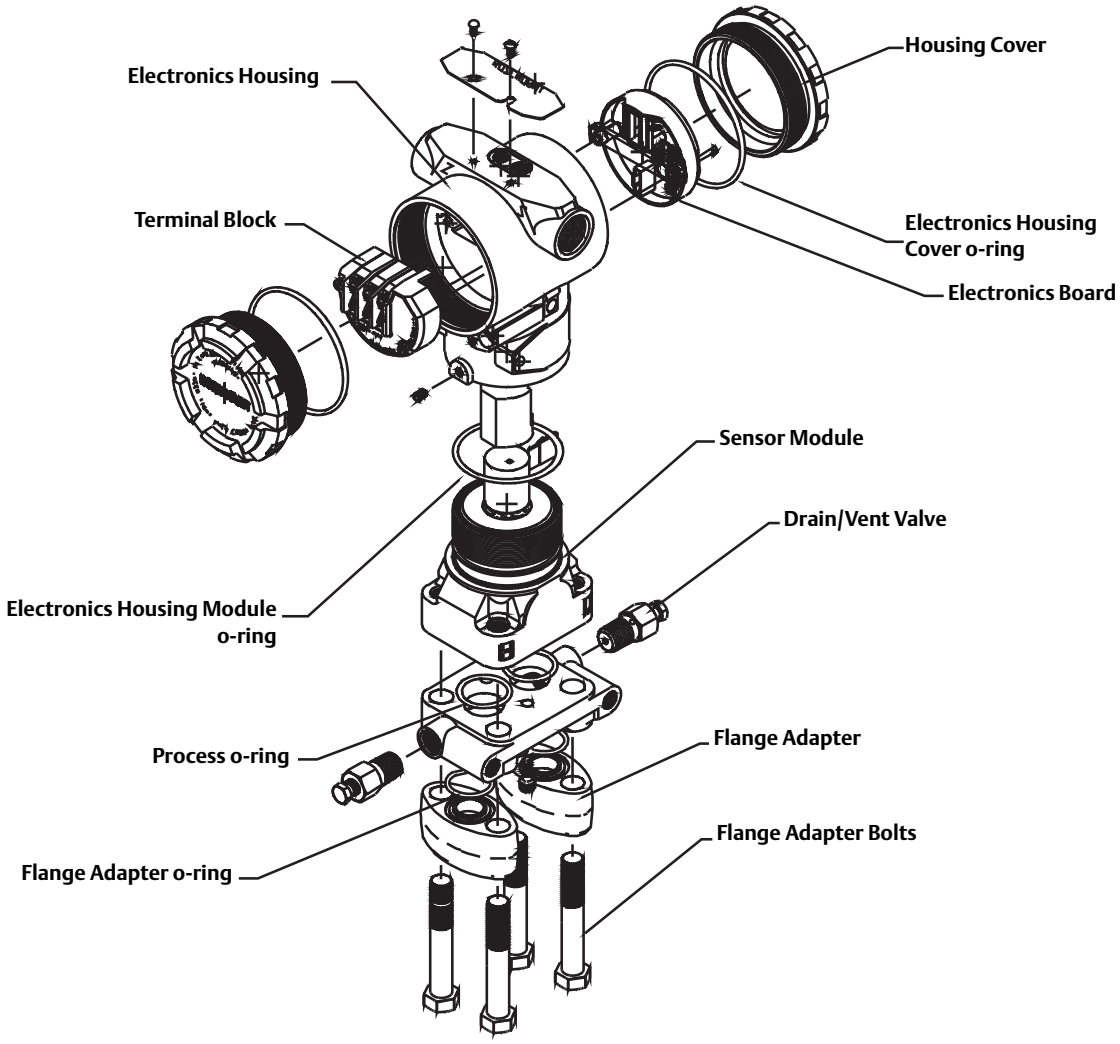
Gage/Absolute Coplanar Flange	
316 SST	03031-0388-1022
Cast C-276	03031-0388-1023
Cast Alloy 40	03031-0388-1024
Nickel-plated carbon steel	03031-0388-1025
Coplanar flange alignment screw (package of 12)	03031-0309-0001
Traditional Flange	
316 SST	03031-0320-0002
Cast C-276	03031-0320-0003
Cast Alloy 400	03031-0320-0004
316 SST - DIN Compliant (Option Code HJ)	03031-1350-0012
Level Flange, Vertical Mount	
2 in., class 150, SST	03031-0393-0221
2 in., class 300, SST	03031-0393-0222
3 in., class 150, SST	03031-0393-0231
3 in., class 300, SST	03031-0393-0232
DIN, DN 50, PN 40	03031-0393-1002
DIN, DN 80, PN 40	03031-0393-1012
Flange adapter kits (each kit contains parts for one DP transmitter or two GP/AP transmitters)	**Part number**
CS bolts, glass-filled PTFE O-Rings	
SST adapters	03031-1300-0002
Cast Alloy C-276 adapters	03031-1300-0003
Alloy 400 adapters	03031-1300-0004
Nickel-plated carbon steel adapters	03031-1300-0005
SST bolts, glass-filled PTFE O-Rings	
SST adapters	03031-1300-0012
Cast Alloy C-276 adapters	03031-1300-0013
Alloy 400 adapters	03031-1300-0014
Nickel-plated carbon steel adapters	03031-1300-0015
CS bolts, graphite-filled PTFE O-Rings	
SST adapters	03031-1300-0102
Cast Alloy C-276 adapters	03031-1300-0103
Alloy 400 adapters	03031-1300-0104
Nickel-plated carbon steel adapters	03031-1300-0105
SST bolts, graphite-filled PTFE O-Rings	
SST adapters	03031-1300-0112
Cast Alloy C-276 adapters	03031-1300-0113

Alloy 400 adapters	03031-1300-0114
Nickel-plated carbon steel adapters	03031-1300-0115
Flange adapters	**Part number**
1/2 - 14 NPT Adapters	
316 SST	02024-0069-0002
Cast C-276	02024-0069-0003
Cast Alloy 400	02024-0069-0004
Nickel-plated carbon steel	02024-0069-0005
Socket Weld Adapters	
316 SST	02024-0069-1002
Cast C-276	02024-0069-1003
Cast Alloy 400	02024-0069-1004
O-Ring packages (package of 12)	**Part number**
Electronics housing, cover	03031-0232-0001
Electronics housing, module	03031-0233-0001
Process flange, glass-filled PTFE (White)	03031-0234-0001
Process flange, graphite-filled PTFE (Black)	03031-0234-0002
Process flange for 3051H, PTFE (White)	02051-0167-0001
Flange adapter, glass-filled PTFE (Light Brown)	03031-0242-0001
Flange adapter, graphite-filled PTFE (Black)	03031-0242-0002
Bolt kits	**Part number**
COPLANAR FLANGE	
Flange Bolt Kit {44mm (1.75 in.)} (set of 4)	
Carbon steel	03031-0312-0001
316 SST	03031-0312-0002
ASTM A 193, Grade B7M	03031-0312-0003
Alloy K-500	03031-0312-0004
Flange/Adapter Bolt Kit {73mm (2.88 in.)} (set of 4)	
Carbon steel	03031-0306-0001
316 SST	03031-0306-0002
ASTM A 193, Grade B7M	03031-0306-0003
Alloy K-500	03031-0306-0004

TRADITIONAL FLANGE	
Differential Flange/Adapter Bolt Kit {44mm (1.75 in.)} (set of 8)	
Carbon steel	03031-0307-0001
316 SST	03031-0307-0002
ASTM A 193, Grade B7M	03031-0307-0003
Alloy K-500	03031-0307-0004
Gage/Absolute Flange/Adapter Bolt Kit {44mm (1.75 in.)} (set of 6)	
Carbon steel	03031-0307-1001
316 SST	03031-0307-1002
ASTM A 193, Grade B7M	03031-0307-1003
Alloy K-500	03031-0307-1004
Conventional Manifold/Traditional Flange Bolts	
Carbon steel	Use bolts supplied with manifold
316 SST	Use bolts supplied with manifold
Level Flange, Vertical Mount Bolt Kit (Set of 4)	
Carbon steel	03031-0395-0001
316 SST	03031-0395-0002
3051H Process Flange Bolt Kit (Set of 4)	
Carbon Steel	02051-0164-0001
316 SST	02051-0164-0002
Drain/Vent valve kits (each kit contains parts for one transmitter)	**Part number**
Differential Drain/Vent Kits	
316 SST stem and seat kit	01151-0028-0022
Alloy C-276 stem and seat kit	01151-0028-0023
Alloy K-500 stem and Alloy 400 seat kit	01151-0028-0024
316 SST ceramic ball drain/vent kit	03031-0378-0022
Alloy C-276 ceramic ball drain/vent kit	03031-0378-0023
Alloy 400/K-500 ceramic ball drain/vent kit	03031-0378-0024
Gage/Absolute Drain/Vent Kits	
316 SST stem and seat kit	01151-0028-0012
Alloy C-276 stem and seat kit	01151-0028-0013
Alloy K-500 stem and Alloy 400 seat kit	01151-0028-0014
316 SST ceramic ball drain/vent kit	03031-0378-0012
Alloy C-276 ceramic ball drain/vent kit	03031-0378-0013
Alloy 400/K-500 ceramic ball drain/vent kit	03031-0378-0014

Mounting brackets	Part number
3051C and 3051L Coplanar Flange Bracket kit	
B4 bracket, SST, 2-in. pipe mount, SST bolts	03031-0189-0003
3051T Inline Bracket Kit	
B4 bracket, SST, 2-in. pipe mount, SST bolts	03031-0189-0004
3051C Traditional Flange Bracket Kits	
B1 bracket, 2-in. pipe mount, CS bolts	03031-0313-0001
B2 bracket, panel mount, CS bolts	03031-0313-0002
B3 flat bracket, 2-in. pipe mount, CS bolts	03031-0313-0003
B7 (B1 bracket, SST bolts)	03031-0313-0007
B8 (B2 bracket, SST bolts)	03031-0313-0008
B9 (B3 bracket, SST bolts)	03031-0313-0009
BA (SST B1 bracket, SST bolts)	03031-0313-0011
BC (SST B3 bracket, SST bolts)	03031-0313-0013
3051H Bracket Kits	
B5 universal bracket, 2-in. pipe and panel mount, CS bolts	03051-1081-0001
B6 universal bracket, 2-in. pipe and panel mount, SST bolts	03051-1081-0002
FOUNDATION fieldbus upgrade kit	**Part number**
Aluminum Housing	03031-0198-0001
316 SST Housing	03031-0198-0002

Figure A-1. Spare parts diagram



Appendix B Product certifications

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European directive information . . . . . page 176
Hazardous locations certifications . . . . . page 177
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B.1 Overview

This Appendix contains information on Approved manufacturing locations, European directive information, Ordinary Location certification, Hazardous Locations Certifications and approval drawings for HART protocol.

B.2 Safety messages

Procedures and instructions in this section may require special precautions to ensure the safety of the personnel performing the operations. Information that raises potential safety issues is indicated by a warning symbol (⚠). Refer to the following safety messages before performing an operation preceded by this symbol.

B.2.1 Warnings

⚠ WARNING

Explosions could result in death or serious injury:

Installation of this transmitter in an explosive environment must be in accordance with the appropriate local, national, and international standards, codes, and practices. Please review this section of the Model 3051 reference manual for any restrictions associated with a safe installation.

- Before connecting a HART-based communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- In an Explosion-Proof/Flameproof installation, do not remove the transmitter covers when power is applied to the unit.

Process leaks may cause harm or result in death.

- Install and tighten process connectors before applying pressure.

Electrical shock can result in death or serious injury.

- Avoid contact with the leads and terminals. High voltage that may be present on leads can cause electrical shock.

⚠ WARNING

Cable gland and plug must comply with the requirements listed on the certificates.

B.3 Approved manufacturing locations

Emerson Process Management - Rosemount Inc. — Chanhassen, Minnesota, USA
Emerson Process Management — Wessling, Germany
Emerson Process Management Asia Pacific Private Limited — Singapore
Emerson Process Management — Beijing, China
Emerson Process Management — Daman, India

B.4 European directive information

The most recent revision of the EC declaration of conformity can be found at www.emersonprocess.com.

B.4.1 Ordinary location certification for factory mutual

As standard, the transmitter has been examined and tested to determine that the design meets basic electrical, mechanical, and fire protection requirements by FM, a nationally recognized testing laboratory (NRTL) as accredited by the Federal Occupational Safety and Health Administration (OSHA).

B.5 Hazardous locations certifications

B.5.1 North american certifications

FM Approvals

E5 Explosion-Proof and Dust Ignition Proof
Certificate No: 0T2H0.AE
Applicable Standards: FM Class 3600 – 1998, FM Class 3615 – 2006, FM Class 3810 – 2005, ANSI/NEMA 250 - 2003

Markings: Explosion-Proof for Class I, Division 1, Groups B, C, and D.

Dust-Ignition-Proof for Class II, Division 1, Groups E, F, G; and Class III, Division 1.
T5 (Ta = -50 °C to +85 °C), Factory Sealed, Enclosure Type 4x

I5 Intrinsically Safe and Non-Incendive
Certificate No: 1Q4A4.AX
Applicable Standards: FM Class 3600 – 1998, FM Class 3610 – 2010, FM Class 3611 – 2004, FM Class 3810 – 2005
Markings: Intrinsically Safe for use in Class I, Division 1, Groups A, B, C, and D; Class II, Division 1, Groups E, F, and G; Class III, Division 1 when connected per Rosemount drawing 03031-1019 and 00375-1130 (When used with a Field Communicator); Non-incendive for Class I, Division 2, Groups A, B, C, and D.
Temperature Code: T4 (Ta = -50 °C to +40 °C), T3 (Ta = -50 °C to +85 °C), Enclosure Type 4x.

Special Conditions for Safe Use:

1.) The Rosemount 3051 transmitter housing contains aluminum and is considered a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact and friction.

2.) The Rosemount 3051 transmitter with the transient terminal block (Option code T1) will not pass the 500Vrms dielectric strength test and this must be taken into account during installation.

CSA international

All CSA hazardous location approved transmitters are certified to ANSI/ISA 12.27.01-2003.

E6 Explosion-Proof, Dust Ignition Proof and Class I Division 2
Certificate No.: 1053834
Applicable Standards: CSA Std. C22.2 No. 142 – M1987, CSA Std. C22.2 No. 30 – M1986, CSA Std. C22.2 No. 213 – M1987, ANSI/ISA 12.27.01-2003.
Markings: Explosion-Proof for Class I, Division 1, Groups B, C, and D.
Dust-Ignition-Proof for Class II and Class III, Division 1, Groups E, F, and G.
Suitable for Class I, Division 2 Groups A, B, C, and D. Enclosure type 4X, factory sealed. Single Seal (See Drawing 03031-1053).

I6 Intrinsically Safe
Certificate No.: 1053834
Applicable Standards: CSA Std. C22.2 No. 142 – M1987, CSA Std. C22.2 No. 157 – 92, ANSI/ISA 12.27.01-2003.
Markings: Intrinsically safe for Class I, Division 1, Groups A, B, C, and D when connected in accordance with Rosemount drawings 03031-1024. Temperature Code T3C. Enclosure Type 4X, Single Seal. Single Seal (See Drawing 03031-1053).

European certifications

E8 ATEX Flame-Proof
Certification No.: KEMA 00ATEX2013X
Applicable Standards: EN60079-0: 2009, EN60079-1: 2007, EN60079-26: 2007, IEC 60079-0:2011
Markings: ⟨Ex⟩ II 1/2 G, Ex d IIC T6 (–50 ≤ Ta ≤ 65 °C) Ga/Gb,
Ex d IIC T5 (–50 ≤ Ta ≤ 80 °C) Ga/Gb,
CE 1180

Process Temp	Ambient Temp	Temp Class
-50 to 65	-50 to 65	T6
-50 to 80	-50 to 80	T5

Special Conditions for Safe Use (X):

1.) In case of repair, contact the manufacturer for information on the dimensions of the flameproof joints.

2.) This device contains a thin wall diaphragm. Installation, maintenance and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.

3.) The capacitance of the wrap around label to the enclosure, 1.6E-9 F, exceeds the limit in Table 9 of IEC 60079-0. The user shall determine suitability for the specific application.

4.) Wait at least 5 minutes after powering down device before opening covers, when a hazardous atmosphere is present.

I1 ATEX Intrinsic Safety and Dust
Certificate No.: BAS 97ATEX1089X
Applicable Standards: IEC60079-0:2011, EN60079-11: 2012, EN60079-31: 2009,
Markings: ⟨Ex⟩ II 1 GD, Ex ia IIC T4 Ga (–60 ≤ Ta ≤ +70 °C),
Ex ia IIC T5 Ga (–60 ≤ Ta ≤ +40 °C)
Ex ta IIIC T50 °C T_{500} 60°C Da, Ui = 30 V Ii = 200 mA Pi = 0.9 W Ci = 0.012 µF, IP66,
CE 1180

Special Conditions for Safe Use (X):

1.) The apparatus is not capable of withstanding the 500 V insulation test required by EN60079-11. This must be taken into account when installing the apparatus.

2.) The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however care should be taken to protect it from impact or abrasion if located in Zone 0.

N1 ATEX Non-incendive/Type n and Dust
Certification No.: BAS 00ATEX3105X
Applicable Standards: IEC60079-0:2011, EN60079-15:2010, EN60079-31:2009
Markings: ⟨Ex⟩II 3 GD, Ex nA IIC Gc T5 (–40 ≤ Ta ≤ 70 °C),
Ex ta IIIC T50 °C T_{500} 60°C Da, IP66
CE 1180

Specific Conditions for Safe Use (X):

1.) The apparatus is not capable of withstanding the 500 V insulation test required by EN60079-15. This must be taken into account when installing the apparatus.

2.) This device contains a thin wall diaphragm. Installation, maintenance, and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime. In case of repair, contact the manufacturer for more information on the dimensions of the flameproof joints.

Japanese certifications

E4 TIIS Flame-Proof

Certificate	Description
TC15850	3051C/D/1 4–20 mA HART — no meter
TC15851	3051C/D/1 4–20 mA HART — with meter
TC15854	3051T/G/1 4–20 mA HART, SST, Silicon — no meter
TC15855	3051T/G/1 4–20 mA HART, Alloy C-276, Silicon — no meter
TC15856	3051T/G/1 4–20 mA HART, SST, Silicon — with meter
TC15857	3051T/G/1 4–20 mA HART, Alloy C-276, Silicon — with meter

Markings: Ex d IIC T6

I4 TIIS Intrinsic Safety
Certification No.: TC16406
Markings: Ex ia IIC T4

IECEx certifications

E7 IECEx Flame-proof
Certification No.: IECEx KEM 09.0034X
Applicable Standards: IEC60079-0:2011, IEC60079-1:2007-04, IEC60079-26:2006,
Markings: Ex d IIC T5...T6 Ga/Gb, T5 (-50 °C ≤ Ta ≤ 80 °C)/T6 (-50 °C ≤ Ta ≤ 65 °C)

Process Temp	Ambient Temp	Temp Class
-50 to 65	-50 to 65	T6
-50 to 80	-50 to 80	T5

Conditions of Certification (X):

1.) This device contains a thin wall diaphragm. Installation, maintenance, and use shall take into account the environmental conditions to which the diaphragm will be subjected. The manufacturer's instructions for installation and maintenance shall be followed in detail to assure safety during its expected lifetime.

2.) For information on the dimensions of the flameproof joints the manufacturer shall be contacted.

3.) The capacitance of the wrap around label to the enclosure, 1.6E-9 F, exceeds the limit in Table 9 of IEC 60079-0. The user shall determine suitability for the specific application.

4.) Wait at least 5 minutes after powering down device before opening covers, when a hazardous atmosphere is present.

I7 IECEx Intrinsic Safety
Certification No.: IECEx BAS 09.0076X
Applicable Standards: IEC60079-0:2011, IEC 60079-11:2006
Markings: Ex ia IIC T5 Ga (-60°C ≤ Ta ≤ 40°C), Ex ia IIC T4 Ga (-60°C ≤ Ta ≤ 70°C)
Ui = 30V, Ii = 200mA, Pi = 0.9W, Ci = 0.012 μF, Li = 0

Conditions of Certification (X):

1.) If the apparatus is fitted with an optional 90V transient suppressor, it is not capable of withstanding the 500V insulation test required by IEC 60079-11. This must be taken into account when installing the apparatus.

2.) The enclosure may be made of aluminum alloy and given a protective polyurethane paint finish; however, care should be taken to protect it from impact or abrasion if located in Zone 0.

N7 IECEx Type 'n'
Certification No.: IECEx BAS 09.0077X
Applicable Standards: IEC60079-0:2011, IEC60079-15:2010
Markings: Ex nA IIC T5 Gc (-40 ≤ Ta ≤ 70 °C)

Conditions of Certification (X):

The apparatus is not capable of withstanding the 500V insulation test required by IEC 60079-15. This must be taken into account when installing the apparatus.

Inmetro certifications

E2 Flameproof
Certificate No: CEPEL 97.0073X (Mfg USA and Singapore)
Certificate No: CEPEL 07.1383X (Mfg Brazil)
Applicable Standards: IEC60079-0:2008, IEC60079-1:2009, IEC60079-26:2008, IEC60529:2009
Markings: Ex d IIC T6 Ga/Gb (-50°C ≤ T_a ≤ +65°C)
Ex d IIC T5 Ga/Gb (-50°C ≤ T_a ≤ +80°C)
IP66W

I2 Intrinsic Safety
Certificate No.: CEPEL 97.0072X (Mfg USA and Singapore)
Certificate No.: CEPEL 07.1412X (Mfg Brazil)
Applicable Standards: IEC60079-0:2008, IEC60079-11:2009, IEC60079-26:2008, IEC60529:2009
Markings: Ex ia IIC Ga T5 (-20°C ≤ T_a ≤ +40°C)
Ex ia IIC Ga T4 (-20°C ≤ T_a ≤ +70°C)
IP66W, Ui=30V, Ii= 200mA, Pi=0.9W, Ci =0.012uF, Li=Desprezivel

Specific Conditions for Safe Use (X):

See Certificate.

China certifications

E3 Flameproof and Dust
NEPSI Certificate No.: GYJ091065X
Applicable Standards: GB3836.1-2000, GB3836.4-2000,GB4208-1993, GB12476-2000
Markings: Ex d II C T5/T6, -50°~+80°C (T5), -50°~+65°C (T6), DIP A21 TA T90°C, IP66

Specific Conditions for Safe Use (X):

The symbol "X" placed after the certificate number indicates special condition for safe use, that is the transmitter contains a thin wall diaphragm. Installation, maintenance, and use shall not only take into account the environmental condition, but also follow the manufacturer's instructions.

2.1 The relation between ambient temperature range and temperature class is as follows:

T_a	Temperature class
-50 °C to 80 °C	T5
-50 °C to 65 °C	T6

When used in combustible dust environment, the maximum ambient temperature is 80 °C.

2.2 The earth connection facility in the enclosure should be connected reliably.

2.3 Cable entry certified by notified body with type of protection Ex d II C in accordance with GB3836.1-2000 and GB3836.2-2000, should be applied when installing in hazardous location. When used in combustible dust environment, cable entry in accordance with IP66 or higher level should be applied.

2.4 Obey the warning "Keep tight when the circuit is alive."

2.5 End users are not permitted to change any component's insides.

2.6 When installing, using, and maintaining the transmitter, observe the following standards
GB3836.13-1997 "Electrical apparatus for explosive gas atmospheres Part 13: Repair and overhaul for apparatus used in explosive gas atmospheres"
GB3836.15-2000 "Electrical apparatus for explosive gas atmospheres Part 15: Electrical installations in hazardous area (other than mines)"
GB3836.16-2006 "Electrical apparatus for explosive gas atmospheres Part 16: Inspection and maintenance of electrical installation (other than mines)"
GB50257-1996 "Code for construction and acceptance of electric device for explosion atmospheres and fire hazard electrical equipment installation engineering"
GB12476.2-2006 "Electrical apparatus for use in the presence of combustible dust Part 1-2: Electrical apparatus protected by enclosures and surface temperature limitation-Selection, installation and maintenance"
GB15577-2007 "Safety regulations for dust explosion prevention and protection"

I3 Intrinsic Safety and Dust
NEPSI Certificate No: GYJ091066X
Applicable Standards: GB3836.1-2000, GB3836.2-2000,GB4208-1993, GB12476-2000
Markings: Ex ia II C T4/T5, -60°~+40°C (T5), -60°~+70°C (T4), DIP A21 TA T80°C

Specific Conditions for Safe Use (X):

1. The relation between ambient temperature range and temperature class is as following:

T_a	Temperature Class
-60 °C +40 °C	T5
-60 °C +70 °C	T4

When used in combustible dust environment, the maximum ambient temperature is -20 °C+40 °C.

2. The earth connection facility in the enclosure should be connected reliably.

3. The maximum internal parameters of the transmitter are as following:
U_i = 30 V, I_i=200 mA, P_i=0.9 W, L_i=0 mH, C_i=0.012 μ F

4. End users is not permitted to change any components insides.

5. When installing, using, and maintaining transmitter, observe following standards:
GB3836.1 1997 “Electrical apparatus for explosive gas atmospheres Part 13: Repair and overhaul for apparatus used in explosive gas atmospheres”
GB3836.15-2000 “Electrical apparatus for explosive gas atmospheres Part 15: Electrical installations in hazardous area (other than mines)”
GB3836.16-2006 “Electrical appartus for explosive gas atmospheres Part 16: Inspection and maintenance of electrical installation (other than mines)”
GB50257-1996 “Code for construction and acceptance of electric device for explosion atmospheres and fire hazard eletrical equipment installation engineering”
GB12476.2-2006 “"Electrical apparatus for use in the presence of combustible dust Part 1-2: Electrical apparatus protected by enclosures and surface temperature limitation-Selection, installation and maintenance"
GB15577-2007 “Safety regulations for dust explosion prevention and protection”

U_i = 30 V
I_i = 200 mA
P_i = 1 W
C_i = 0.012 μF
L_i = 0

N3 China Type n - Non-Sparking
NEPSI Certificate No.: GYJ101111X
Applicable Standards: GB3836.1-2000, GB3836.8-2003
Markings: Ex nA nL IIC T5 (-40 °C < TA < 70 °C)

Specific Conditions for Safe Use (X):

1. Symbol "X" is used to denote specific conditions of use: The apparatus is not capable of withstanding the 500 V test to earth for one minute. This must be taken into consideration during installation.

2. The ambient temperature range is: -40 °C $\leq T_a \leq$ +70 °C

3. Maximum input voltage: 42.4 V.

4. Cable glands, conduit or blanking plugs, certified by NEPSI with Ex e or Ex n protection type and IP66 degree of protection provided by enclosure, should be used on external connections and redundant cable entries.

5. Maintenance should be done in non-hazardous location.

6. End users are not permitted to change any components insides, but to settle the problem in conjunction with manufacturer to avoid damage to the product.

7. When installing, using, and maintaining transmitter, observe following standards:
GB3836.1 1997 “Electrical apparatus for explosive gas atmospheres Part 13: Repair and overhaul for apparatus used in explosive gas atmospheres”
GB3836.15-2000 “Electrical apparatus for explosive gas atmospheres Part 15: Electrical installations in hazardous area (other than mines)”
GB3836.16-2006 “Electrical appartus for explosive gas atmospheres Part 16: Inspection and maintenance of electrical installation (other than mines)”
GB50257-1996 “Code for construction and acceptance of electric device for explosion atmospheres and fire hazard eletrical equipment installation engineering”

Combinations of certifications

Stainless steel certification tag is provided when optional approval is specified. Once a device labeled with multiple approval types is installed, it should not be reinstalled using any other approval types. Permanently mark the approval label to distinguish it from unused approval types.

K1 – E1, N1

K5 – E5, I5

K6 – E5, I5, E6, I6, E1, I1

K7 – E7, I7, N7

K8 – E8, I1

KA – E1, I1, N1, E6, I6

KB – E5, I5, E1, I1

KC – E5, I5, E1, I1

KD – E5, I5, E6, I6, I1

B.6 Approval drawings

B.6.1 Factory mutual 03031-1019

CONFIDENTIAL AND PROPRIETARY INFORMATION IS CONTAINED HEREIN AND MUST BE HANDLED ACCORDINGLY	REVISIONS				
	REV	DESCRIPTION	CHG. NO.	APP'D	DATE
	AE	ADD 3051G	RTC1019922	J.G.	7/11/05
	AF	ADD FISCO DETAILS	RTC1021913	N.J.H.	7/9/06
	AG	ADD FISCO ENTITY PARAMETERS TO SHT 12	RTC1022876	N.J.H.	10/27/06

ENTITY APPROVALS FOR

3051C	3001C
3051L	3001CL
3051P	3001CH
3051H	3001S
3051CA	3001SL
3051T	3001SH
3051G	

OUTPUT CODE A (4-20 mA HART) I.S. SEE SHEETS 2-5
OUTPUT CODE M (LOW POWER) I.S. SEE SHEETS 6-7
OUTPUT CODE F/W (FIELDBUS) I.S. SEE SHEETS 8-12
ALL OUTPUT CODES NONINCENDIVE SEE SHEET 13

THE ROSEMOUNT TRANSMITTERS LISTED ABOVE ARE F.M. APPROVED AS INTRINSICALLY SAFE WHEN USED IN CIRCUIT WITH F.M. APPROVED BARRIERS WHICH MEET THE ENTITY PARAMETERS LISTED IN THE CLASS I, II, AND III, DIVISION 1 GROUPS INDICATED, TEMP CODE T4. ADDITIONALLY, THE ROSEMOUNT 751 FIELD SIGNAL INDICATOR IS F.M. APPROVED AS INTRINSICALLY SAFE WHEN CONNECTED IN CIRCUIT WITH ROSEMOUNT TRANSMITTERS (FROM ABOVE) AND F.M. APPROVED BARRIERS WHICH MEET THE ENTITY PARAMETERS LISTED FOR CLASS I, II, AND III, DIVISION 1, GROUPS INDICATED, TEMP CODE T4.

TO ASSURE AN INTRINSICALLY SAFE SYSTEM, THE TRANSMITTER AND BARRIER MUST BE WIRED IN ACCORDANCE WITH THE BARRIER MANUFACTURER'S FIELD WIRING INSTRUCTIONS AND THE APPLICABLE CIRCUIT DIAGRAM.

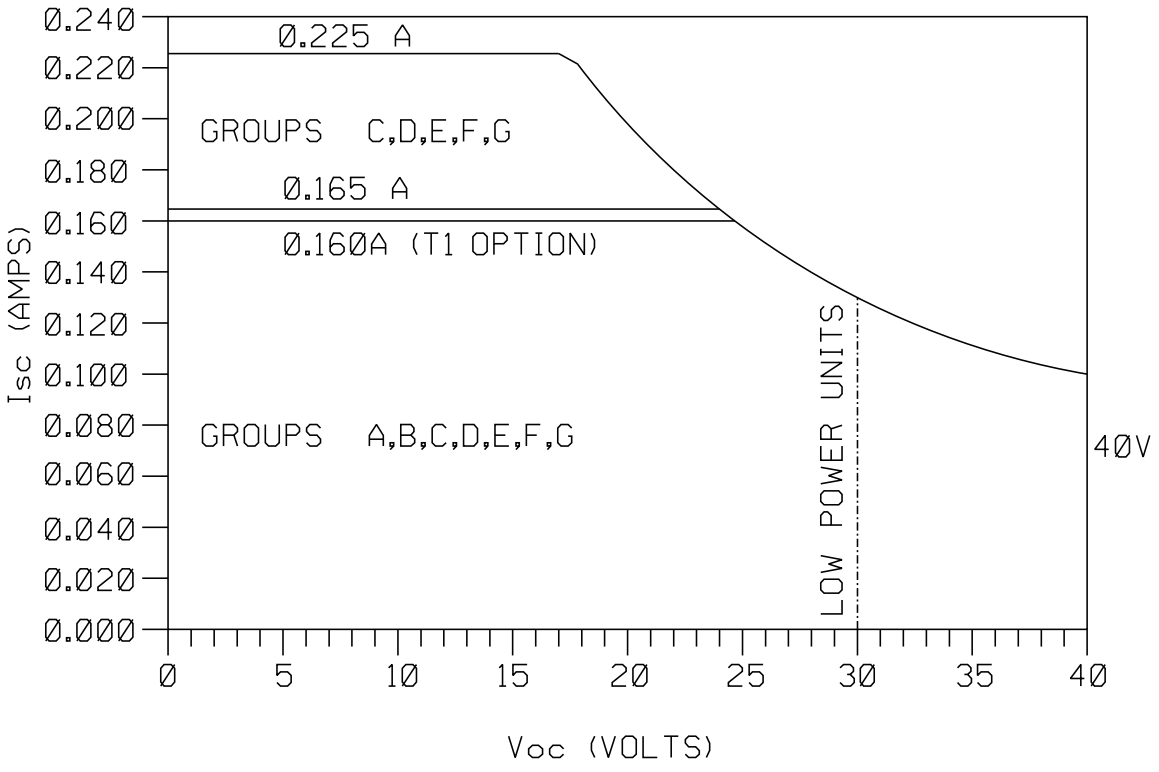
CAD MAINTAINED (MicroStation)

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES [mm]. REMOVE ALL BURRS AND SHARP EDGES. MACHINE SURFACE FINISH 125 -TOLERANCE- .X ± .1 [2,5] .XX ± .02 [0,5] .XXX ± .010 [0,25] FRACTIONS ± 1/32 ANGLES ± 2° DO NOT SCALE PRINT	CONTRACT NO. DR. MIKE DOBE 03/21/89 CHK'D APP'D. KELLY ORTH 03/22/89 APP'D. GOVT.	EMERSON. Process Management ROSEMOUNT® 8200 Market Boulevard • Chanhassen, MN 55317 USA TITLE: INDEX OF I.S. & NONINCENDIVE F.M. FOR 3051C/L/P/H/T AND 3001C/S SIZE A | FSCM NO | DWG NO. 03031-1019 SCALE N/A | WT. | SHEET 1 OF 13	

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AG				

BARRIER PARAMETERS (APPLICABLE TO OUTPUT CODES A & M)

Pmax = 1WATT

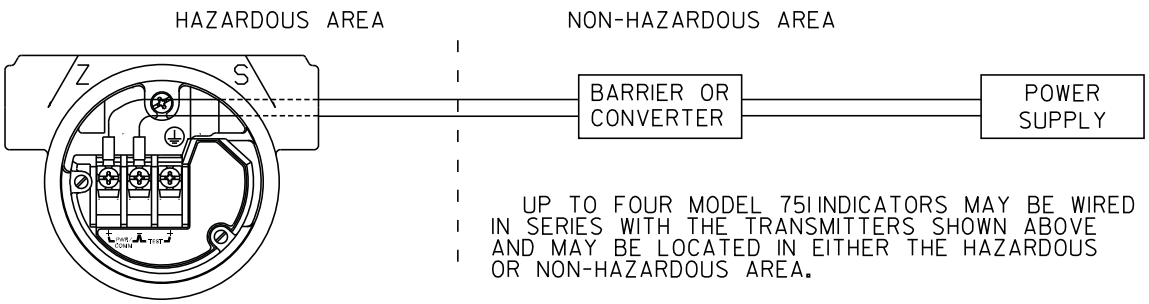


Rosemount Inc. 8200 Market Boulevard Chanhassen, MN 55317 USA			CAD MAINTAINED (MicroStation)
DR. MIKE DOBE	SIZE A	FSCM NO	DWG NO. 03031-1019
ISSUED	SCALE N/A	WT. ———	SHEET 2 OF 13

Form Rev AC

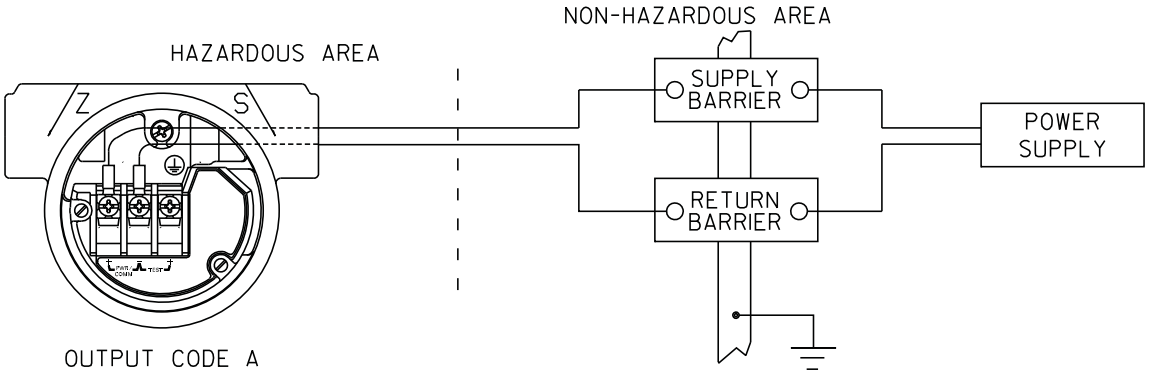
REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AG				

CIRCUIT DIAGRAM 1
ONE BARRIER OR CONVERTER:
SINGLE OR DUAL CHANNEL



OUTPUT CODE A
MODELS INCLUDED
3051C, L, P, H, T, CA, G
3001C, CL, CH, S, SL, SH

CIRCUIT DIAGRAM 2
SUPPLY AND RETURN BARRIERS
(ONLY FOR USE WITH BARRIERS APPROVED IN THIS CONFIGURATION)



OUTPUT CODE A
MODELS INCLUDED
3051C, L, P, H, T, CA, G
3001C, CL, CH, S, SL, SH

Rosemount Inc.
8200 Market Boulevard
Chanhassen, MN 55317 USA

DR. MIKE DOBE
ISSUED

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SIZE	FSCM NO	DWG NO.	
A		03031-1019	
SCALE N/A	WT. ———	SHEET 3 OF 13	

Form Rev AC

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AG				

ENTITY CONCEPT APPROVALS

THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIFICALLY EXAMINED IN COMBINATION AS A SYSTEM. THE APPROVED VALUES OF MAX. OPEN CIRCUIT VOLTAGE (Voc OR Vt) AND MAX. SHORT CIRCUIT CURRENT (Isc OR It) AND MAX.POWER (Voc X Isc/4) OR (Vt X It/4), FOR THE ASSOCIATED APPARATUS MUST BE LESS THAN OR EQUAL TO THE MAXIMUM SAFE INPUT VOLTAGE (Vmax), MAXIMUM SAFE INPUT CURRENT (Imax), AND MAXIMUM SAFE INPUT POWER (Pmax) OF THE INTRINSICALLY SAFE APPARATUS. IN ADDITION, THE APPROVED MAX. ALLOWABLE CONNECTED CAPACITANCE (Ca) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE CAPACITANCE AND THE UNPROTECTED INTERNAL CAPACITANCE (C_i) OF THE INTRINSICALLY SAFE APPARATUS, AND THE APPROVED MAX. ALLOWABLE CONNECTED INDUCTANCE (La) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE INDUCTANCE AND THE UNPROTECTED INTERNAL INDUCTANCE (L_i) OF THE INTRINSICALLY SAFE APPARATUS.

FOR OUTPUT CODE A

NOTE: ENTITY PARAMETERS LISTED APPLY ONLY TO ASSOCIATED APPARATUS WITH LINEAR OUTPUT.

CLASS I, DIV. 1, GROUPS A AND B

V_{MAX} = 40V	V_T OR V_{OC} IS LESS THAN OR EQUAL TO 40V
I_{MAX} = 165mA	I_T OR I_{SC} IS LESS THAN OR EQUAL TO 165mA
P_{MAX} = 1 WATT	$(\frac{V_T \times I_T}{4})$ OR $(\frac{V_{OC} \times I_{SC}}{4})$ IS LESS THAN OR EQUAL TO 1 WATT
C_I = .01μf	C_A IS GREATER THAN .01μf
L_I =10μH	L_A IS GREATER THAN 10μH

✳ FOR T1 OPTION:

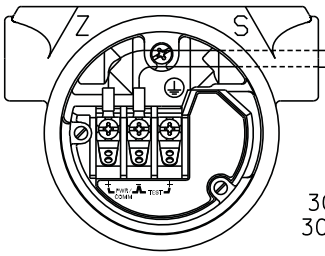
Imax = 160mA	I_T OR I_{SC} IS LESS THAN OR EQUAL TO 160mA
L_I =1.05mH	L_A IS GREATER THAN 1.05mH

CLASS I, DIV. 1, GROUPS C AND D

V_{MAX} = 40V	V_T OR V_{OC} IS LESS THAN OR EQUAL TO 40V
I_{MAX} = 225mA	I_T OR I_{SC} IS LESS THAN OR EQUAL TO 225mA
P_{MAX} = 1 WATT	$(\frac{V_T \times I_T}{4})$ OR $(\frac{V_{OC} \times I_{SC}}{4})$ IS LESS THAN OR EQUAL TO 1 WATT
C_I = .01μf	C_A IS GREATER THAN .01μf
L_I =10μH	L_A IS GREATER THAN 10μH

✳ FOR T1 OPTION:

L_I =1.05mH	L_A IS GREATER THAN 1.05mH



HAZARDOUS AREA | NON-HAZARDOUS AREA

ASSOCIATED APPARATUS

(SEE SHEET 3)

OUTPUT CODE A
MODELS INCLUDED
305IC, L, P, H, T, CA, G
300IC, CL, CH, S, SL, SH

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DR. MIKE DOBE

ISSUED

CAD MAINTAINED (MicroStation)

SIZE	FSCM NO	DWG NO.	
A		03031-1019	
SCALE N/A	WT. ———	SHEET 4 OF 13	

Form Rev AC

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AG				

MODEL 3051G

FOR OUTPUT CODE A

CLASS I, DIV. 1, GROUPS A AND B

V_{MAX} = 30V	Vt or Voc IS LESS THAN OR EQUAL TO 30V
I_{MAX} = 165mA	It or Isc IS LESS THAN OR EQUAL TO 165mA
P_{MAX} = 1 WATT	(Voc X Isc/4) or (Vt X It/4) IS LESS THAN OR EQUAL TO 1 WATT
C_I = 0.01 µF	C_A IS GREATER THAN 0.01 µF + C_{CABLE}
L_I = 10 µH	L_A IS GREATER THAN 10 µH + L_{CABLE}

FOR T1 OPTION:

I_{MAX} = 160mA	It or Isc IS LESS THAN OR EQUAL TO 145mA
L_I = 1.06 mH	L_A IS GREATER THAN 1.06 mH + L_{CABLE}

CLASS I, DIV. 1, GROUPS C AND D

V_{MAX} = 30V	Vt or Voc IS LESS THAN OR EQUAL TO 30V
I_{MAX} = 225mA	It or Isc IS LESS THAN OR EQUAL TO 225mA
P_{MAX} = 1 WATT	(Voc X Isc/4) or (Vt X It/4) IS LESS THAN OR EQUAL TO 1 WATT
C_I = 0.01 µF	C_A IS GREATER THAN 0.01 µF + C_{CABLE}
L_I = 10 µH	L_A IS GREATER THAN 10 µH + L_{CABLE}

FOR T1 OPTION:

L_I = 1.06 mH	L_A IS GREATER THAN 1.06 mH + L_{CABLE}

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SIZE	FSCM NO	DWG NO.	
A		03031-1019	

SCALE N/A WT. ——— SHEET 5 OF 13

Form, Rev AC

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AG				

FOR OUTPUT CODE M

CLASS I, DIV. 1, GROUPS A AND B

V_{MAX} = 30V	V_T OR V_{OC} IS LESS THAN OR EQUAL TO 30V
I_{MAX} = 165mA	I_T OR I_{SC} IS LESS THAN OR EQUAL TO 165mA
P_{MAX} = 1 WATT	$(\frac{V_T \times I_T}{4})$ OR $(\frac{V_{OC} \times I_{SC}}{4})$ IS LESS THAN OR EQUAL TO 1 WATT
C_I = .042µf	C_A IS GREATER THAN .042µf
L_I =10µH	L_A IS GREATER THAN 10µH

* FOR T1 OPTION:

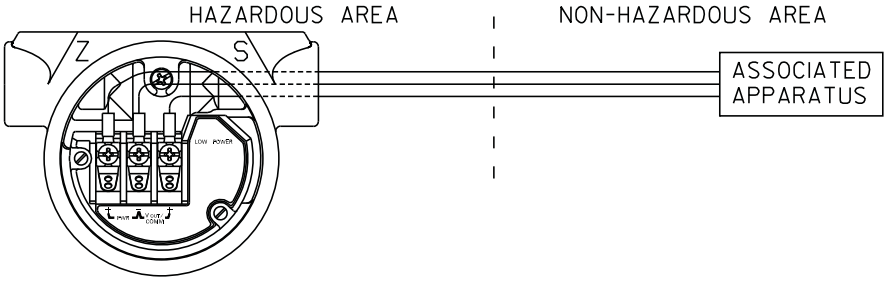
L_I =0.75mH	L_A IS GREATER THAN 0.75mH

CLASS I, DIV. 1, GROUPS C AND D

V_{MAX} = 30V	V_T OR V_{OC} IS LESS THAN OR EQUAL TO 30V
I_{MAX} = 225mA	I_T OR I_{SC} IS LESS THAN OR EQUAL TO 225mA
P_{MAX} = 1 WATT	$(\frac{V_T \times I_T}{4})$ OR $(\frac{V_{OC} \times I_{SC}}{4})$ IS LESS THAN OR EQUAL TO 1 WATT
C_I = .042µf	C_A IS GREATER THAN .042µf
L_I =10µH	L_A IS GREATER THAN 10µH

* FOR T1 OPTION:

L_I =0.75mH	L_A IS GREATER THAN 0.75mH



OUTPUT CODE M
AVAILABLE FOR THE MODELS LISTED

3051C	3051H
3051L	3051CA
3051P	3051T

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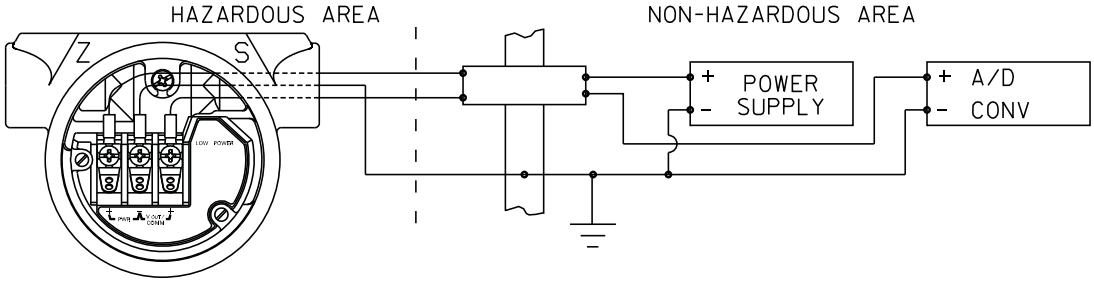
CAD MAINTAINED (MicroStation)

DR. MIKE DOBE	SIZE A	FSCM NO	DWG NO. 03031-1019
ISSUED	SCALE N/A	WT. ———	SHEET 6 OF 13

Form Rev AC

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AG				

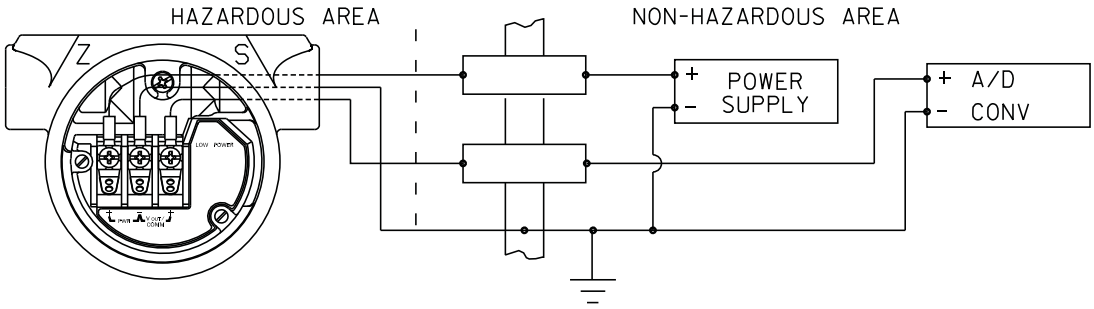
CIRCUIT DIAGRAM 3
ONE DUAL CHANNEL BARRIER



OUTPUT CODE M
AVAILABLE FOR THE MODELS LISTED

305IC	305IH
305IL	305ICA
305IP	305IT

CIRCUIT DIAGRAM 4
TWO SINGLE CHANNEL BARRIERS
(ONLY FOR USE WITH BARRIERS APPROVED
IN THIS CONFIGURATION)



OUTPUT CODE M
AVAILABLE FOR THE MODELS LISTED

305IC	305IH
305IL	305ICA
305IP	305IT

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DR. SANDI MANSON	SIZE A	FSCM NO	DWG NO. 03031-1019
ISSUED	SCALE N/A	WT. ———	SHEET 7 OF 13

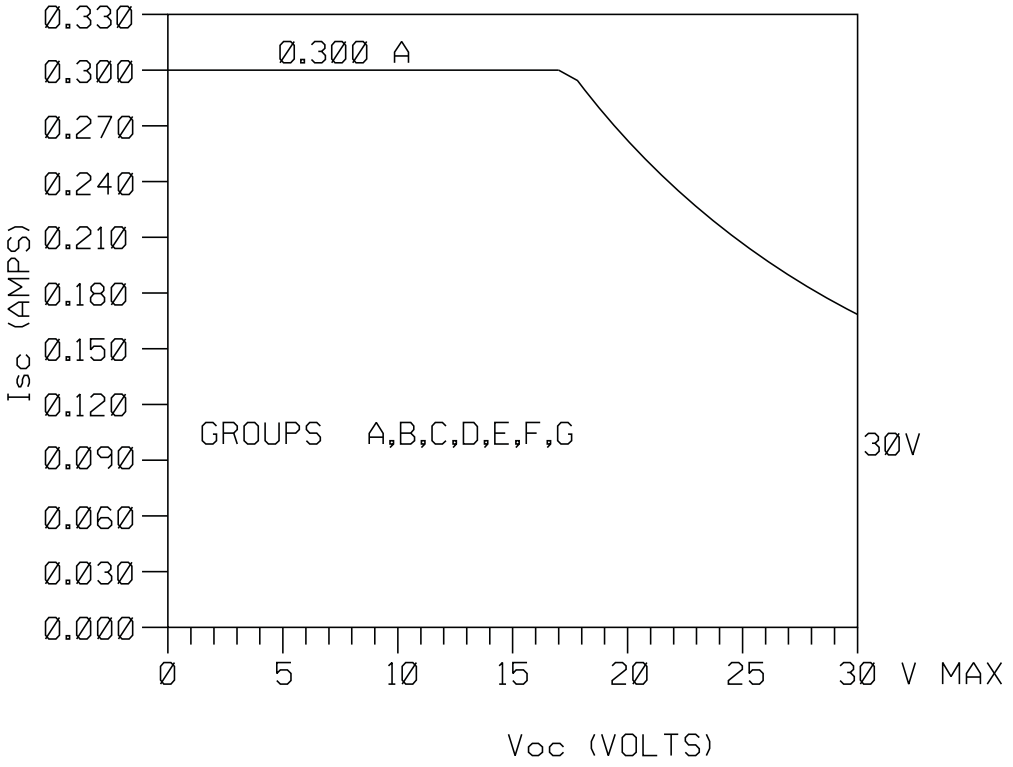
Form Rev AC

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AG				

3051 WITH FOUNDATION FIELDBUS OR PROFIBUS. (OUTPUT CODE F OR W)

BARRIER PARAMETERS (APPLICABLE TO OUTPUT CODE F OR W)

Pmax = 1.3 WATT



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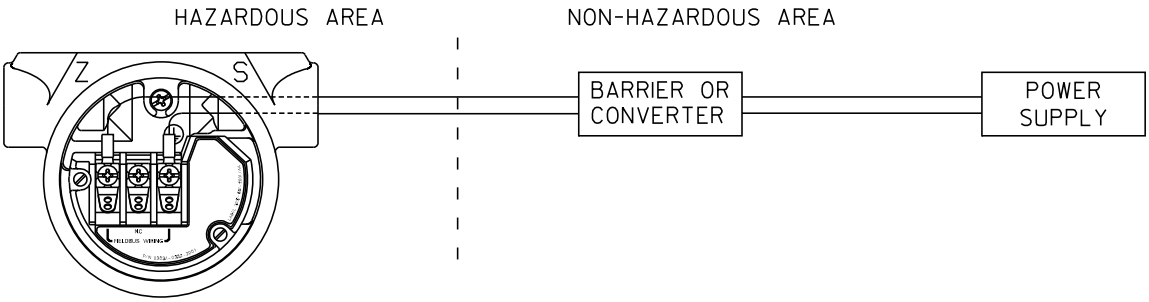
CAD MAINTAINED (MicroStation)

DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03031-1019
ISSUED	SCALE N/A	WT. ———	SHEET 8 OF 13

Form Rev. AC

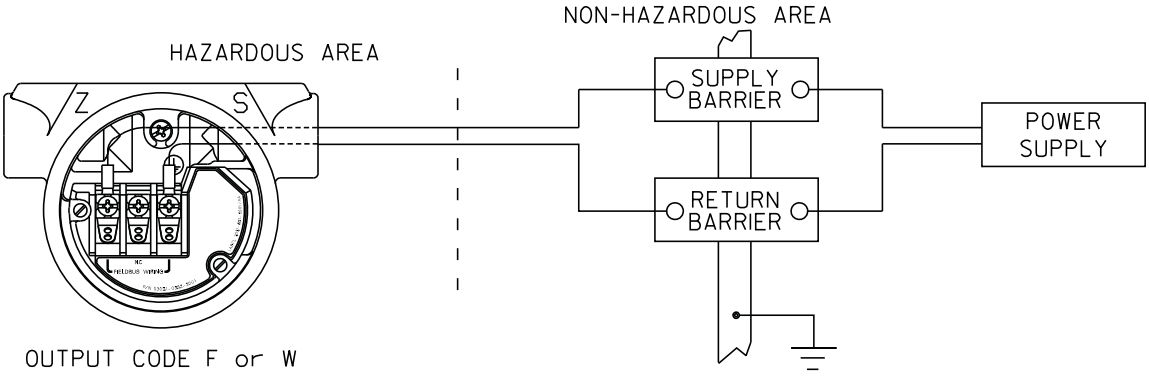
REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AG				

CIRCUIT DIAGRAM 1
ONE BARRIER OR CONVERTER:
SINGLE OR DUAL CHANNEL



OUTPUT CODE F or W
MODELS INCLUDED
305IC, L, P, H, T, CA
300IC, CL, CH

CIRCUIT DIAGRAM 2
SUPPLY AND RETURN BARRIERS
(ONLY FOR USE WITH BARRIERS APPROVED IN THIS CONFIGURATION)



OUTPUT CODE F or W
MODELS INCLUDED
305IC, L, P, H, T, CA
300IC, CL, CH

Rosemount Inc.
8200 Market Boulevard
Chanhassen, MN 55317 USA

DR. Myles Lee Miller
ISSUED

CAD MAINTAINED (MicroStation)

SIZE	FSCM NO	DWG NO.	
A		03031-1019	

SCALE N/A WT. ——— SHEET 9 OF 13

Form Rev AC

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AG				

ENTITY CONCEPT APPROVALS

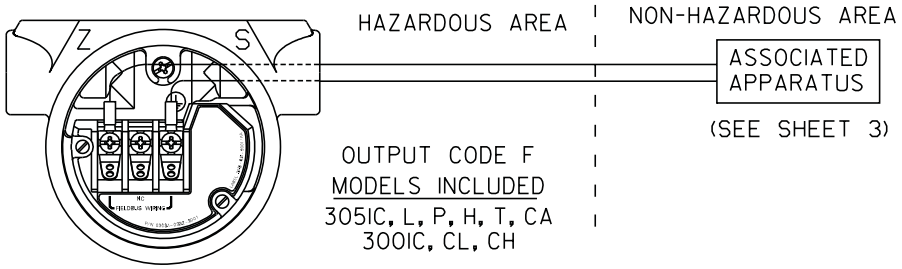
THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIFICALLY EXAMINED IN COMBINATION AS A SYSTEM. THE APPROVED VALUES OF MAX. OPEN CIRCUIT VOLTAGE (Voc OR Vt) AND MAX. SHORT CIRCUIT CURRENT (Isc OR It) AND MAX. POWER (Voc X Isc/4) OR (Vt X It/4), FOR THE ASSOCIATED APPARATUS MUST BE LESS THAN OR EQUAL TO THE MAXIMUM SAFE INPUT VOLTAGE (Vmax), MAXIMUM SAFE INPUT CURRENT (Imax), AND MAXIMUM SAFE INPUT POWER (Pmax) OF THE INTRINSICALLY SAFE APPARATUS. IN ADDITION, THE APPROVED MAX. ALLOWABLE CONNECTED CAPACITANCE (C_a) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE CAPACITANCE AND THE UNPROTECTED INTERNAL CAPACITANCE (C_i) OF THE INTRINSICALLY SAFE APPARATUS, AND THE APPROVED MAX. ALLOWABLE CONNECTED INDUCTANCE (L_a) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE INDUCTANCE AND THE UNPROTECTED INTERNAL INDUCTANCE (L_i) OF THE INTRINSICALLY SAFE APPARATUS.

NOTE: ENTITY PARAMETERS LISTED APPLY ONLY TO ASSOCIATED APPARATUS WITH LINEAR OUTPUT.

FOR OUTPUT CODE F or W

CLASS I, DIV. 1, GROUPS A, B, C AND D

V_{MAX} = 30V	V_T OR V_{OC} IS LESS THAN OR EQUAL TO 30V
I_{MAX} = 300mA	I_T OR I_{SC} IS LESS THAN OR EQUAL TO 300mA
P_{MAX} = 1.3 WATT	$(\frac{V_T \times I_T}{4})$ OR $(\frac{V_{OC} \times I_{SC}}{4})$ IS LESS THAN OR EQUAL TO 1.3 WATT
C_I = 0μf	C_A IS GREATER THAN 0μf
L_I = 0μH	L_A IS GREATER THAN 0μH



Rosemount Inc. 8200 Market Boulevard Chanhassen, MN 55317 USA			CAD MAINTAINED (MicroStation)
DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03031-1019
ISSUED	SCALE N/A	WT. ———	SHEET 10 OF 13

Form Rev AC

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AG				

FISCO CONCEPT APPROVALS

THE FISCO CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIALLY EXAMINED IN SUCH COMBINATION. FOR THIS INTERCONNECTION TO BE VALID THE VOLTAGE (U_i or Vmax), THE CURRENT (I_i or Imax), AND THE POWER (P_i or Pma) THAT INTRINSICALLY SAVE APPARATUS CAN RECEIVE AND REMAIN INTRINSICALY SAFE, INCLUDING FAULTS, MUST BE EQUAL OR GREATER THAN THE VOLTAGE (Uo, Voc, or Vt), THE CURRENT (Io, Isc, or It), AND THE POWER (Po or Pmax) LEVELS WHICH CAN BE DELIVERED BY THE ASSOCIATED APPARATUS, CONSIDERING FAULTS AND APPLICABLE FACTORS. ALSO, THE MAXIMUM UNPROTECTED CAPACITANCE (C_i) AND THE INDUCTANCE (L_i) OF EACH APPARATUS (BESIDES THE TERMINATION) CONNECTED TO THE FIELDBUS MUST BE LESS THAN OR EQUAL TO 5nF AND 10μH RESPECTVELY.
ONLY ONE ACTIVE DEVICE IN EACH SECTION (USUALLY THE ASSOCIATED APPARATUS) IS ALLOWED TO CONTRIBUTE THE DESIRED ENERGY FOR THE FIELDBUS SYSTEM. THE ASSOCIATED APPARATUS' VOLTAGE Uo (or Voc or Vt) IS LIMITED TO A RANGE OF 14V TO 24 V.D.C. ALL OTHER EQUIPENT COMBINED IN THE BUS CABLE MUST BE PASSIVE (THEY CANNOT PROVIDE ENERGY TO THE SYSTEM, EXCEPT A LEAKAGE CURRENT OF 50 μA FOR EACH CONNECTED DEVICE) SEPARATELY POWERED EQUIPMENT REQUIRES A GALVANIC ISOLATION TO AFFIRM THAT THE INTRINSICALLY SAFE FIELDBUS CIRCUIT WILL REMAIN PASSIVE. THE PARAMETER OF THE CABLE USED TO INTERCONNECT THE DEVICES MUST BE IN THE FOLLOWING RANGE:

LOOP RESISTANCE R':	15...150 OHM/km
INDUCTANCE PER UNIT LENGTH L':	0.4...1mH/KM
CAPACITANCE PER UNLIT LENGTH C':	80...200nF

C' = C' LINE/LINE +0.5C' LINE/SCREEN, IF BOTH LINES ARE FLOATING, OR
C' = C' LINE/LINE +C' LINE/SCREEN, IF THE SCREEN IS CONNECTED TO ONE LINE

TRUNK CABLE LENGTH:	$\leq$ 1000 m
SPUR CABLE LENGTH:	$\leq$ 30 m
SPLICE LENGTH:	$\leq$ 1 m

AN APPROVED INFALLIBLE LINE TERMINATION TO EACH END OF THE TRUNK CABLE, WITH THE FOLLOWING PARAMETERS IS APPROPRIATE:

R = 90...100 OHMS C = 2.2μF

AN ALLOWED TERMINATION MIGHT ALREADY BE LINKED IN THE ASSOCIATED APPARATUS. DUE TO I.S. REASONS, THE NUMBER OF PASSIVE APPARATUS CONNECTED TO THE BUS SEGMENT IS NOT LIMITED. IF THE RULES ABOVE ARE FOLLOWED, UP TO A TOTAL LENGTH OF 1000 m (THE SUMMATION OF TRUNK AND ALL SPUR CABLES), THE INDUCTANCE AND THE CAPACITANCE OF THE CABLE WILL NOT DAMAGE THE INTRINSIC SAFETY OF THE SYSTEM.

NOTES:
INTRINSICALLY SAFE CLASS I, DIV. 1, GROUPS A, B, C, D

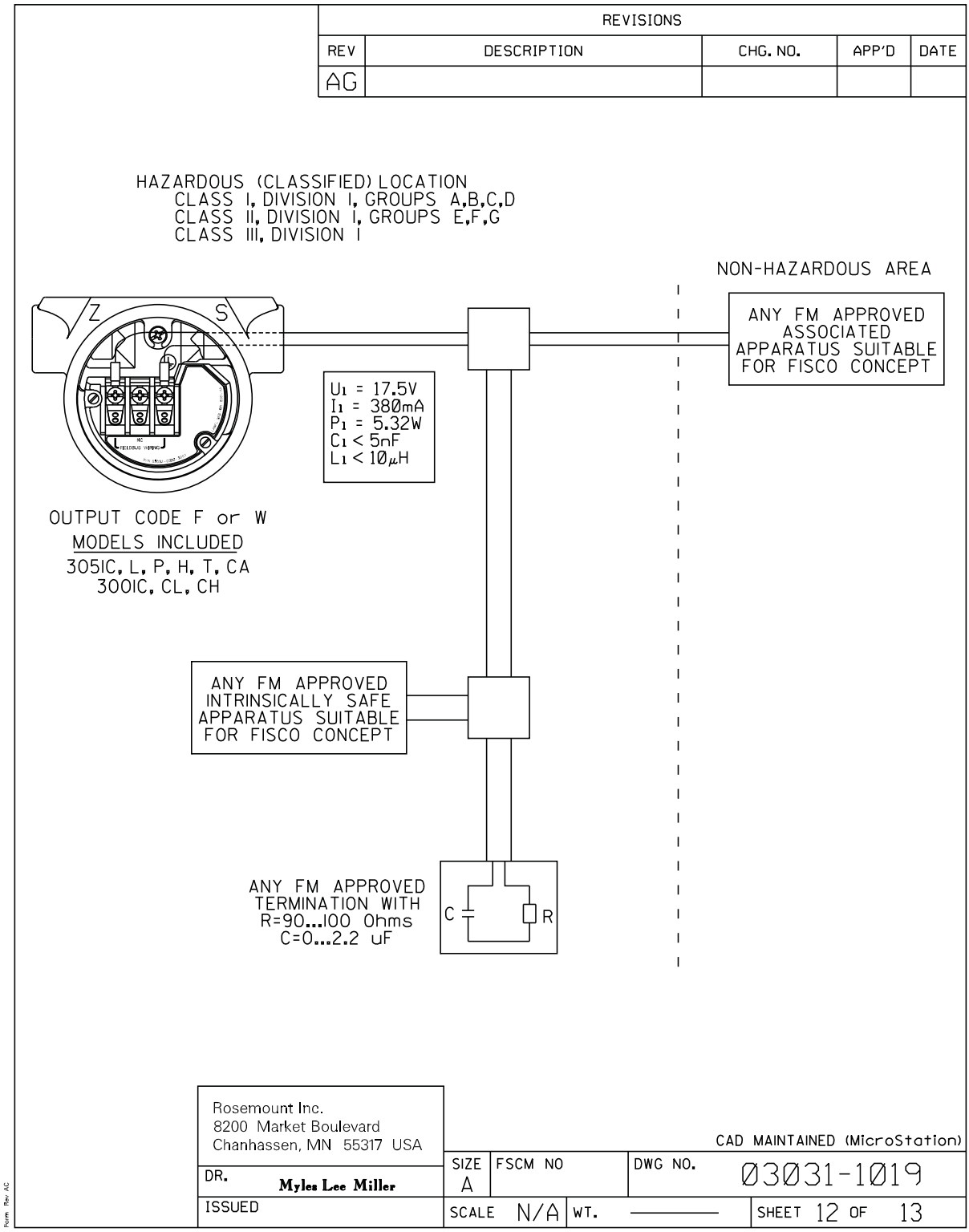
1. THE MAXIMUM NON-HAZARDOUS AREA VOLTAGE MUST NOT EXCEED 250 V.
2. CAUTION: ONLY USE SUPPLY WIRES SUITABLE FOR 5°C ABOVE SURROUNDING TEMPERATURE.
3. WARNING: REPLACEMENT OF COMPONENTS MAY DAMAGE INTRINSIC SAFETY.

Rosemount Inc.
8200 Market Boulevard
Chanhassen, MN 55317 USA

CAD MAINTAINED (MicroStation)

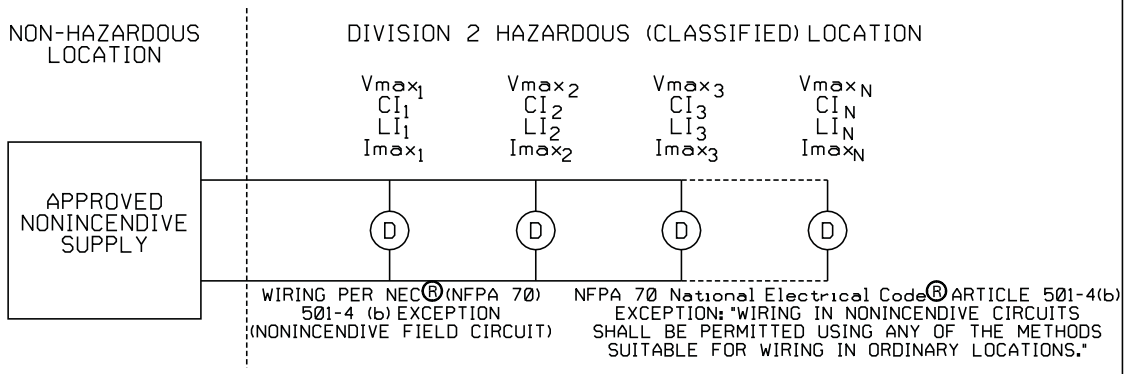
DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03031-1019
ISSUED	SCALE N/A	WT. ———	SHEET 11 OF 13

Form Rev AC


REVISIONS
REV
DESCRIPTION
CHG. NO.
APP'D
DATE
AG
HAZARDOUS (CLASSIFIED) LOCATION
CLASS I, DIVISION I, GROUPS A,B,C,D
CLASS II, DIVISION I, GROUPS E,F,G
CLASS III, DIVISION I
NON-HAZARDOUS AREA
ANY FM APPROVED ASSOCIATED APPARATUS SUITABLE FOR FISCO CONCEPT
U1 = 17.5V
I1 = 380mA
P1 = 5.32W
C1 < 5nF
L1 < 10µH
OUTPUT CODE F or W
MODELS INCLUDED
305IC, L, P, H, T, CA
300IC, CL, CH
ANY FM APPROVED INTRINSICALLY SAFE APPARATUS SUITABLE FOR FISCO CONCEPT
ANY FM APPROVED TERMINATION WITH R=90...100 Ohms C=0...2.2 uF
C
R
Rosemount Inc.
8200 Market Boulevard
Chanhassen, MN 55317 USA
DR.
Myles Lee Miller
ISSUED
CAD MAINTAINED (MicroStation)
SIZE
A
FSCM NO
DWG NO.
03031-1019
SCALE N/A
WT.
SHEET 12 OF 13

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AG				

NONINCENDIVE FIELD CIRCUIT
CLASS I, DIV. 2 LOCATIONS



IN NORMAL OPERATION

DEVICES CONTROL THROUGH-CURRENT

PARAMETERS DEVICE

Voc <= Minimum of ($Vmax_1$, $Vmax_2$, ... $Vmax_N$)

$Imax_1$ >= Iq_1 + $Isignal_1$

$Imax_2$ >= Iq_1 + $Isignal_2$

.

.

.

$Imax_N$ >= Iq_N + $Isignal_N$

Ca <= Ci_1 + Ci_2 +... + Ci_N + Ccable

La <= Li_1 + Li_2 +... + Li_N + Lcable

Imax for an individual device = Iq + Isignal

Iq =Quiescent current through device (Maximum quiescent current for the device)

Isignal =Signaling current through device (Protocol may limit signaling to one device at a time)

Operating Imax = Iq_1 + Iq_2 +...+ Iq_N + I_{signal} max

I_{signal} max = Max. of ($Isignal_1$, $Isignal_2$ ..... $Isignal_N$)

ROSEMOUNT 3051/3001

	4-20mA / HART	FIELDBUS (F or W)
Vmax	40v	30v
Maximum normal operating current	22mA	27mA
Ca	.010uF	0uF
La	10uH	0uH

ROSEMOUNT 3051 TRANSMITTERS ARE CURRENT CONTROLLERS ON INDIVIDUAL PARALLEL BRANCHES WITH RESPECT TO THE POWER SUPPLY. IN NONINCENDIVE INSTALLATIONS THE Imax FOR EACH TRANSMITTER IS NOT RELATED TO THE MAXIMUM CURRENT OF THE POWER SUPPLY (Isc) IN THE SAME MANNER AS FOR TRANSMITTER INSTALLED PER I.S. REQUIREMENTS, BECAUSE NONINCENDIVE REQUIREMENTS INCLUDE ONLY NORMAL OPERATING CONDITIONS.

REFERENCE: APPENDIX A7.3 (FM3611)

Rosemount Inc.
8200 Market Boulevard
Chanhassen, MN 55317 USA

CAD MAINTAINED (MicroStation)

DR. Jon Steffens	SIZE A	FSCM NO	DWG NO. 03031-1019	
ISSUED	SCALE N/A	WT. ———	SHEET 13 OF 13	

Form Rev AC

B.6.2 Canadian standards association (CSA) 03031-1024

CONFIDENTIAL AND PROPRIETARY INFORMATION IS CONTAINED HEREIN AND MUST BE HANDLED ACCORDINGLY

REVISIONS

REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AA	ADD FIELDBUS	RTC1004232	M.L.M.	5/28/98
AB	ADD PROFIBUS, ENTITY PARAMETERS	RTC1008326	P.C.S.	2/4/00
AC	REM It, Vt FROM ENTITY PARAMETERS	RTC1009279	W.C.R.	7/11/00
AD	ADD FISCO FIELDBUS	RTC1012624	J.P.W.	4/4/02

APPROVALS FOR

3051C	3001C
3051L	3001CL
3051P	3001CH
3051H	3001S
3051CA	3001SL
3051T	3001SH

OUTPUT CODE A (4-20 mA HART) I.S. SEE SHEETS 2-3
OUTPUT CODE M (LOW POWER) I.S. SEE SHEETS 3-4
OUTPUT CODE F/W (FIELDBUS) I.S. SEE SHEETS 5-7
OUTPUT CODES A,F,W I.S. ENTITY PARAMETERS SHEET 8-9

TO ASSURE AN INTRINSICALLY SAFE SYSTEM, THE TRANSMITTER AND BARRIER MUST BE WIRED IN ACCORDANCE WITH THE BARRIER MANUFACTURER'S FIELD WIRING INSTRUCTIONS AND THE APPLICABLE CIRCUIT DIAGRAM.

WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.

AVERTISSEMENT - RISQUE D'EXPLOSION - LA SUBSTITUTION DE COMPOSANTS PEUT RENDRE CE MATERIEL INACCEPTABLE POUR LES EMPLACEMENTS DE CLASSE I, DIVISION 2.

CAD MAINTAINED (MicroStation)

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES [mm]. REMOVE ALL BURRS AND SHARP EDGES. MACHINE SURFACE FINISH 125

-TOLERANCE-
.X ± .1 [2,5]
.XX ± .02 [0,5]
.XXX ± .010 [0,25]

FRACTIONS ± 1/32
ANGLES ± 2°

DO NOT SCALE PRINT

CONTRACT NO.

DR. Mike Debe 08/27/90

CHK'D

APP'D. GLEN MONZO 8/31/90

APP'D. GOVT.

EMERSON. Process Management

ROSEMOUNT®
8200 Market Boulevard • Chanhassen, MN 55317 USA

TITLE
INDEX OF I.S. CSA FOR 3051C/L/P/H/T & 3001C/S

SIZE	FSCM NO	DWG NO.
A		03031-1024

SCALE N/A WT. SHEET 1 OF 9

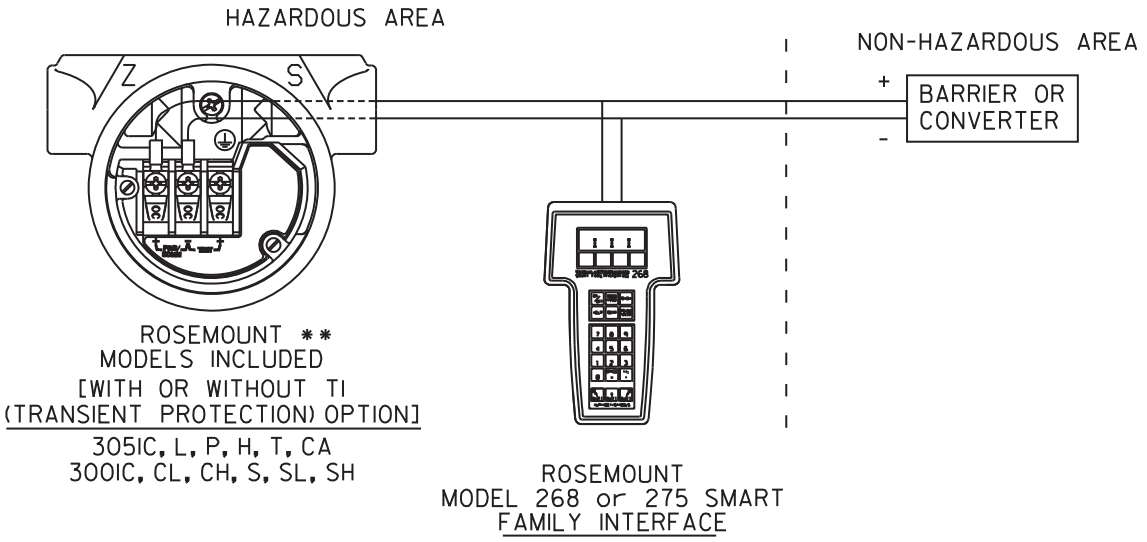
REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AD				

CSA INTRINSIC SAFETY APPROVALS

CIRCUIT CONNECTION WITH BARRIER OR CONVERTER

Ex ia

INTRINSICALLY SAFE/SECURITE INTRINSEQUE
4-20 mA, ("A" OUTPUT CODE)



ROSEMOUNT **
MODELS INCLUDED
[WITH OR WITHOUT TI
(TRANSIENT PROTECTION) OPTION]
305IC, L, P, H, T, CA
300IC, CL, CH, S, SL, SH

ROSEMOUNT
MODEL 268 or 275 SMART
FAMILY INTERFACE

** FOR THE LOW POWER OPTION, SEE PAGE 4 FOR THE CIRCUIT CONNECTION WITH BARRIER OR CONVERTER. FOR FIELDBUS OPTIONS("F" or "W" OUTPUT CODE), SEE PAGE 5 FOR PARAMETERS AND CIRCIUT CONNECTION TO BARRIER.

Rosemount Inc. 8200 Market Boulevard Chanhassen, MN 55317 USA			CAD MAINTAINED (MicroStation)
DR. Mike Debe 08/27/90	SIZE A	FSCM NO	DWG NO. 03031-1024
ISSUED	SCALE N/A	WT. ———	SHEET 2 OF 9

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AD				

4-20 mA, ("A" OUTPUT CODE)

DEVICE	PARAMETERS	APPROVED FOR CLASS I, DIV.I
CSA APPROVED SAFETY BARRIER	30 V OR LESS *330 OHMS OR MORE * 28 V OR LESS 300 OHMS OR MORE 25 V OR LESS 200 OHMS OR MORE * 22 V OR LESS 180 OHMS OR MORE	GROUPS A, B, C, D
FOXBORO CONVERTER 2AI-I2V-CGB, 2AI-I3V-CGB, 2AS-I3I-CGB, 3A2-I2D-CGB, 3A2-I3D-CGB, 3AD-I3I-CGB, 3A4-I2D-CGB, 2AS-I2I-CGB, 3F4-I2DA		GROUPS B, C, D
CSA APPROVED SAFETY BARRIER	30 V OR LESS 150 OHMS OR MORE	GROUPS C, D

LOW POWER, ("M" OUTPUT CODE)

DEVICE	PARAMETERS	APPROVED FOR CLASS I, DIV.I
	Supply ≤ 28V, ≥ 300 Ω Return ≤ 10V, ≥ 47 Ω	GROUPS A, B, C, D
CSA APPROVED SAFETY BARRIER	Supply ≤ 30V, ≥ 150 Ω Return ≤ 10V, ≥ 47 Ω	GROUPS C, D

* MAY BE USED WITH ROSEMOUNT MODEL 268 or 275 SMART FAMILY INTERFACE.

Rosemount Inc. 8200 Market Boulevard Chanhassen, MN 55317 USA			CAD MAINTAINED (MicroStation)	
DR. Mike Debe	SIZE A	FSCM NO	DWG NO. 03031-1024	
ISSUED	SCALE N/A	WT. ———	SHEET 3 OF 9	

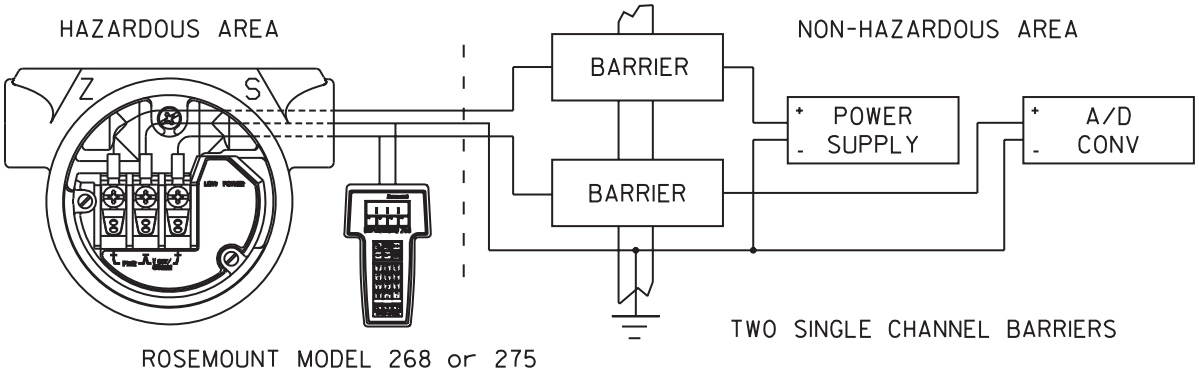
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REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AD				

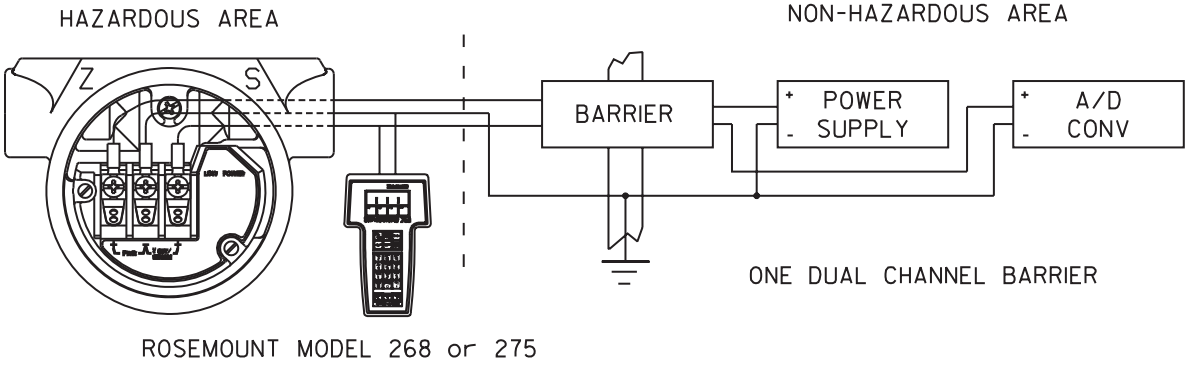
CSA INTRINSIC SAFETY APPROVALS

305IC LOW POWER CIRCUIT CONNECTION WITH INTRINSIC SAFETY BARRIERS

Ex ia

INTRINSICALLY SAFE/SECURITE INTRINSEQUE
LOWPOWER, ("M" OUTPUT CODE)





APPROVED FOR CLASS I, DIVISION I, GROUPS A,B,C,D WHEN USED IN CIRCUIT WITH TWO CSA APPROVED SINGLE CHANNEL SAFETY BARRIERS, ONE WITH APPROVED SAFETY PARAMETERS OF 28 VOLTS OR LESS AND 300 OHMS OR MORE IN +PWR LINE, AND ONE WITH APPROVED SAFETY PARAMETERS OF 10 VOLTS OR LESS AND 47 OHMS OR MORE IN Vout LINE, OR ONE CSA APPROVED DUAL CHANNEL SAFETY BARRIER WITH IDENTICAL APPROVED SAFETY PARAMETERS CONNECTED IN LIKE MANNER, AS ABOVE.

APPROVED FOR CLASS I, DIVISION I, GROUPS C,D WHEN USED IN CIRCUIT WITH TWO CSA APPROVED SINGLE CHANNEL SAFETY BARRIERS, ONE WITH APPROVED SAFETY PARAMETERS OF 30 VOLTS OR LESS AND 150 OHMS OR MORE IN +PWR LINE AND ONE WITH APPROVED SAFETY PARAMETERS OF 10 VOLTS OR LESS AND 47 OHMS OR MORE IN Vout LINE.

Rosemount Inc. **8200 Market Boulevard** **Chanhassen, MN 55317 USA**			CAD MAINTAINED (MicroStation)
DR. **SANDI MANSON**	SIZE A	FSCM NO	DWG NO. 03031-1024
ISSUED	SCALE N/A	WT. ———	SHEET 4 OF 9

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AD				

FIELDBUS, ("F" or "W" OUTPUT CODE)

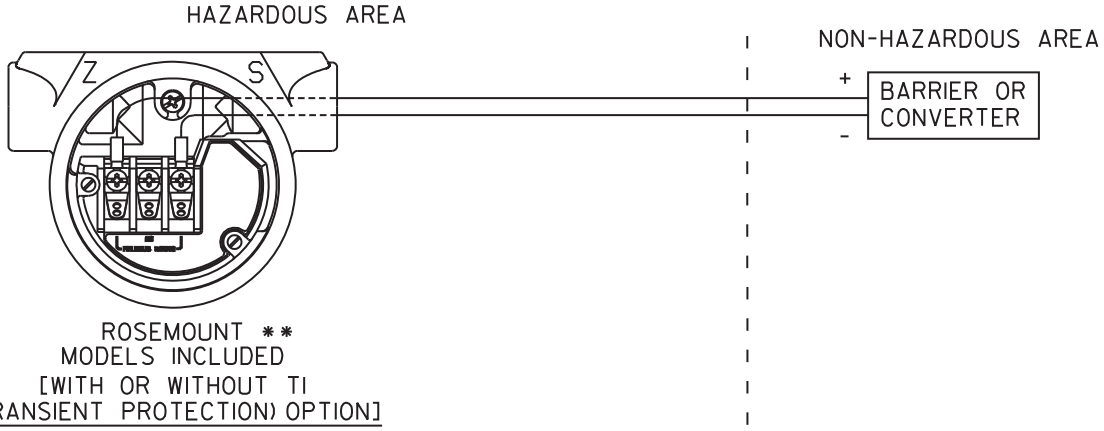
DEVICE	PARAMETERS	APPROVED FOR CLASS I, DIV.I
CSA APPROVED SAFETY BARRIER	30 V OR LESS 300 OHMS OR MORE 28 V OR LESS 235 OHMS OR MORE 25 V OR LESS 160 OHMS OR MORE 22 V OR LESS 100 OHMS OR MORE	GROUPS A, B, C, D

CSA INTRINSIC SAFETY APPROVALS

CIRCUIT CONNECTION WITH BARRIER OR CONVERTER

Ex ia

INTRINSICALLY SAFE/SECURITE INTRINSEQUE
FIELDBUS, ("F" or "W" OUTPUT CODE)



ROSEMOUNT **
MODELS INCLUDED
[WITH OR WITHOUT TI
(TRANSIENT PROTECTION) OPTION]
3051C, L, P, H, T, CA
3001C, CL, CH, S, SL, SH

WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.

AVERTISSEMENT - RISQUE D'EXPLOSION - LA SUBSTITUTION DE COMPOSANTS PEUT RENDRE CE MATERIEL INACCEPTABLE POUR LES EMPLACEMENTS DE CLASSE I, DIVISION 2.

Rosemount Inc. 8200 Market Boulevard Chanhassen, MN 55317 USA			CAD MAINTAINED (MicroStation)
DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03031-1024
ISSUED	SCALE N/A	WT. ———	SHEET 5 OF 9

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AD				

FISCO CONCEPT APPROVALS

THE FISCO CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIALLY EXAMINED IN SUCH COMBINATION. FOR THIS INTERCONNECTION TO BE VALID THE VOLTAGE (U_i or Vmax), THE CURRENT (I_i or Imax), AND THE POWER (P_i or Pma) THAT INTRINSICALLY SAVE APPARATUS CAN RECEIVE AND REMAIN INTRINSICALY SAFE, INCLUDING FAULTS, MUST BE EQUAL OR GREATER THAN THE VOLTAGE (Uo, Voc, or Vt), THE CURRENT (Io, Isc, or It), AND THE POWER (Po or Pmax) LEVELS WHICH CAN BE DELIVERED BY THE ASSOCIATED APPARATUS, CONSIDERING FAULTS AND APPLICABLE FACTORS. ALSO, THE MAXIMUM UNPROTECTED CAPACITANCE (C_i) AND THE INDUCTANCE (L_i) OF EACH APPARATUS (BESIDES THE TERMINATION) CONNECTED TO THE FIELDBUS MUST BE LESS THAN OR EQUAL TO 5nF AND 10µH RESPECTVELY.
ONLY ONE ACTIVE DEVICE IN EACH SECTION (USUALLY THE ASSOCIATED APPARATUS) IS ALLOWED TO CONTRIBUTE THE DESIRED ENERGY FOR THE FIELDBUS SYSTEM. THE ASSOCIATED APPARATUS' VOLTAGE Uo (or Voc or Vt) IS LIMITED TO A RANGE OF 14V TO 24 V.D.C. ALL OTHER EQUIPENT COMBINED IN THE BUS CABLE MUST BE PASSIVE (THEY CANNOT PROVIDE ENERGY TO THE SYSTEM, EXCEPT A LEAKAGE CURRENT OF 50 µA FOR EACH CONNECTED DEVICE) SEPARATELY POWERED EQUIPMENT REQUIRES A GALVANIC ISOLATION TO AFFIRM THAT THE INTRINSICALLY SAFE FIELDBUS CIRCUIT WILL REMAIN PASSIVE. THE PARAMETER OF THE CABLE USED TO INTERCONNECT THE DEVICES MUST BE IN THE FOLLOWING RANGE:

LOOP RESISTANCE R':	15...150 OHM/km
INDUCTANCE PER UNIT LENGTH L':	0.4...1mH/KM
CAPACITANCE PER UNLIT LENGTH C':	80...200nF

C' = C' LINE/LINE +0.5C' LINE/SCREEN, IF BOTH LINES ARE FLOATING, OR
C' = C' LINE/LINE +C' LINE/SCREEN, IF THE SCREEN IS CONNECTED TO ONE LINE

TRUNK CABLE LENGTH:	≤ 1000 m
SPUR CABLE LENGTH:	≤ 30 m
SPLICE LENGTH:	≤ 1 m

AN APPROVED INFALLIBLE LINE TERMINATION TO EACH END OF THE TRUNK CABLE, WITH THE FOLLOWING PARAMETERS IS APPROPRIATE:

R = 90...100 OHMS C = 2.2µF

AN ALLOWED TERMINATION MIGHT ALREADY BE LINKED IN THE ASSOCIATED APPARATUS. DUE TO I.S. REASONS, THE NUMBER OF PASSIVE APPARATUS CONNECTED TO THE BUS SEGMENT IS NOT LIMITED. IF THE RULES ABOVE ARE FOLLOWED, UP TO A TOTAL LENGTH OF 1000 m (THE SUMMATION OF TRUNK AND ALL SPUR CABLES), THE INDUCTANCE AND THE CAPACITANCE OF THE CABLE WILL NOT DAMAGE THE INTRINSIC SAFETY OF THE SYSTEM.

NOTES:
INTRINSICALLY SAFE CLASS I, DIV. 1, GROUPS A, B, C, D

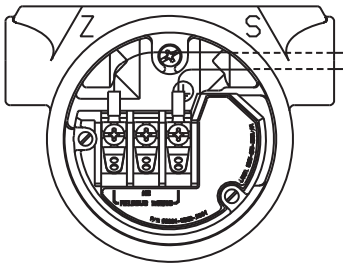
1. THE MAXIMUM NON-HAZARDOUS AREA VOLTAGE MUST NOT EXCEED 250 V.
2. CAUTION: ONLY USE SUPPLY WIRES SUITABLE FOR 5°C ABOVE SURROUNDING TEMPERATURE.
3. WARNING: REPLACEMENT OF COMPONENTS MAY DAMAGE INTRINSIC SAFETY.

Rosemount Inc. 8200 Market Boulevard Chanhassen, MN 55317 USA			CAD MAINTAINED (MicroStation)	
DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03031-1024	
ISSUED	SCALE N/A	WT. ———	SHEET 6 OF 9	

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AD				

HAZARDOUS (CLASSIFIED) LOCATION
CLASS I, DIVISION I, GROUPS A,B,C,D
CLASS II, DIVISION I, GROUPS E,F,G
CLASS III, DIVISION I

NON-HAZARDOUS AREA

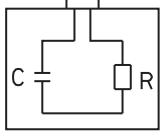


OUTPUT CODE F or W
MODELS INCLUDED
305IC, L, P, H, T, CA
300IC, CL, CH

ANY CSA APPROVED ASSOCIATED APPARATUS SUITABLE FOR FISCO CONCEPT

ANY CSA APPROVED INTRINSICALLY SAFE APPARATUS SUITABLE FOR FISCO CONCEPT

ANY CSA PPROVED TERMINATION WITH
R=90...100 Ohms
C=0...2.2 uF



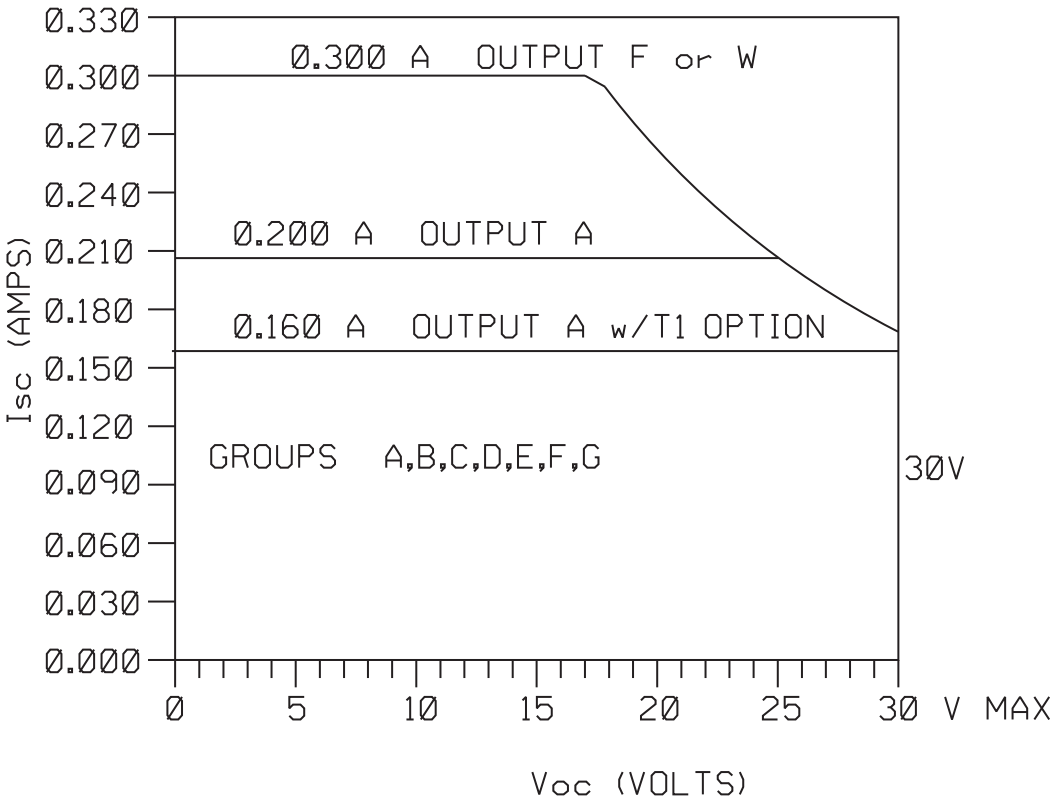
Rosemount Inc. 8200 Market Boulevard Chanhassen, MN 55317 USA			CAD MAINTAINED (MicroStation)	
DR. Myles Lee Miller	SIZE A	FSCM NO	DWG NO. 03031-1024	
ISSUED	SCALE N/A	WT. ———	SHEET 7 OF 9	

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AD				

3051 I.S. ENTITY PARAMETERS. (OUTPUT CODE A,F, or W)

BARRIER PARAMETERS (APPLICABLE TO OUTPUT CODE A,F, or W)

Pmax = 1.3 WATT OUTPUT F or W
Pmax = 1.0 WATT OUTPUT A



Rosemount Inc. 8200 Market Boulevard Chanhassen, MN 55317 USA			CAD MAINTAINED (MicroStation)	
DR. JON STEFFENS	SIZE A	FSCM NO	DWG NO. 03031-1024	
ISSUED	SCALE N/A	WT. ———	SHEET 8 OF 9	

REVISIONS				
REV	DESCRIPTION	CHG. NO.	APP'D	DATE
AD				

ENTITY CONCEPT APPROVALS

THE ENTITY CONCEPT ALLOWS INTERCONNECTION OF INTRINSICALLY SAFE APPARATUS TO ASSOCIATED APPARATUS NOT SPECIFICALLY EXAMINED IN COMBINATION AS A SYSTEM. THE APPROVED VALUES OF MAX. OPEN CIRCUIT VOLTAGE (Voc) AND MAX. SHORT CIRCUIT CURRENT (Isc) AND MAX. POWER (Voc X Isc/4), FOR THE ASSOCIATED APPARATUS MUST BE LESS THAN OR EQUAL TO THE MAXIMUM SAFE INPUT VOLTAGE (Vmax), MAXIMUM SAFE INPUT CURRENT (Imax), AND MAXIMUM SAFE INPUT POWER (Pmax) OF THE INTRINSICALLY SAFE APPARATUS. IN ADDITION, THE APPROVED MAX. ALLOWABLE CONNECTED CAPACITANCE (Ca) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE CAPACITANCE AND THE UNPROTECTED INTERNAL CAPACITANCE (C_i) OF THE INTRINSICALLY SAFE APPARATUS, AND THE APPROVED MAX. ALLOWABLE CONNECTED INDUCTANCE (La) OF THE ASSOCIATED APPARATUS MUST BE GREATER THAN THE SUM OF THE INTERCONNECTING CABLE INDUCTANCE AND THE UNPROTECTED INTERNAL INDUCTANCE (L_i) OF THE INTRINSICALLY SAFE APPARATUS.

FOR OUTPUT CODE A

CLASS I, DIV. 1, GROUPS A, B, C AND D

V_{MAX} = 30V	V_{OC} IS LESS THAN OR EQUAL TO 30V
I_{MAX} = 200mA	I_{SC} IS LESS THAN OR EQUAL TO 200mA
P_{MAX} = 1 WATT	$(\frac{Voc \times Isc}{4})$ IS LESS THAN OR EQUAL TO 1 WATT
C_I = .01μf	C_A IS GREATER THAN .01μf + C CABLE
L_I =10μH	L_A IS GREATER THAN 10μH + L CABLE

* FOR T1 OPTION:

Imax = 160mA	I_{SC} IS LESS THAN OR EQUAL TO 160mA
L_I =1.05mH	L_A IS GREATER THAN 1.05mH + L CABLE

FOR OUTPUT CODE F or W

CLASS I, DIV. 1, GROUPS A, B, C AND D

V_{MAX} = 30V	V_{OC} IS LESS THAN OR EQUAL TO 30V
I_{MAX} = 300mA	I_{SC} IS LESS THAN OR EQUAL TO 300mA
P_{MAX} = 1.3 WATT	$(\frac{Voc \times Isc}{4})$ IS LESS THAN OR EQUAL TO 1.3 WATT
C_I = 0μf	C_A IS GREATER THAN 0μf + C CABLE
L_I = 0μH	L_A IS GREATER THAN 0μH + L CABLE

NOTE: ENTITY PARAMETERS LISTED APPLY ONLY TO ASSOCIATED APPARATUS WITH LINEAR OUTPUT.

Rosemount Inc. 8200 Market Boulevard Chanhassen, MN 55317 USA			CAD MAINTAINED (MicroStation)
DR. JON STEFFENS	SIZE A	FSCM NO	DWG NO. 03031-1024
ISSUED	SCALE N/A	WT. ———	SHEET 9 OF 9

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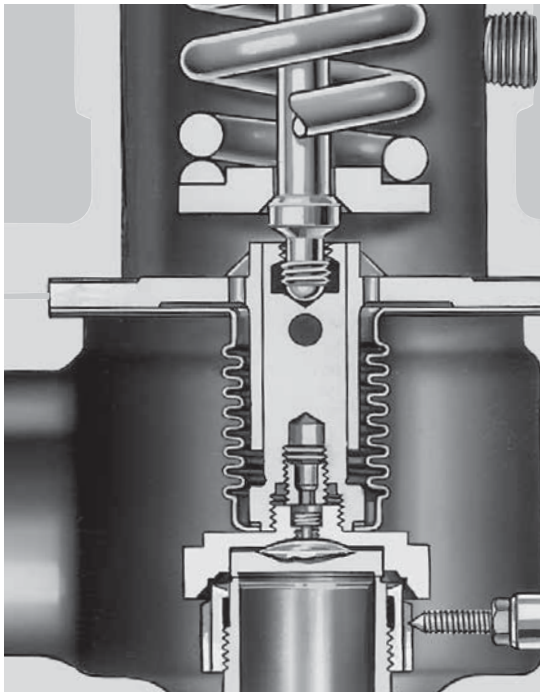
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00809-0100-4001 Rev JA, 11/12

EMERSON.
Process Management

Series 2600

Maintenance Manual







CURTISS WRIGHT
Flow Control Company
Farris Engineering

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1. Introduction

This maintenance manual is provided because you have Farris Engineering 2600 Series pressure relief valves protecting equipment and personnel in your plant. We trust that you will find this manual useful, as it is intended to clearly present all the essential information you will need in order to keep your Farris valves in perfect operating condition.

Any maintenance and repair work or testing performed on Farris pressure relief valves should be done in strict accordance with the requirements of all applicable Codes and Standards. Persons performing the work should maintain proper authorization through applicable governing authorities.

To ensure reliable and safe operation, installation, testing, maintenance, adjustment, and repair of Farris valves, these activities shall only be performed by qualified personnel having the required skills and training. No repair, assembly, adjustment or testing performed by individuals other than Farris-authorized representatives shall be covered by the warranty extended by Farris to its customers. All applicable regulations, directives, codes and standards shall be adhered to when performing these activities. Failure to follow proper test procedures or failure to use proper test equipment will lead to incorrect test results, damage to the valve and will invalidate the warranty.

Farris Engineering provides programs which coordinate classroom and hands-on training. It is recommended that individuals performing pressure relief valve maintenance receive training specific to those valve series they expect to repair and set. Only this type of training will ensure the proper application of these instructions. The National Board of Boiler and Pressure Vessel Inspectors conducts training programs on valve repair in conjunction with their VR program. This is a broad-based program and is recommended to supplement training received from specific manufacturers.

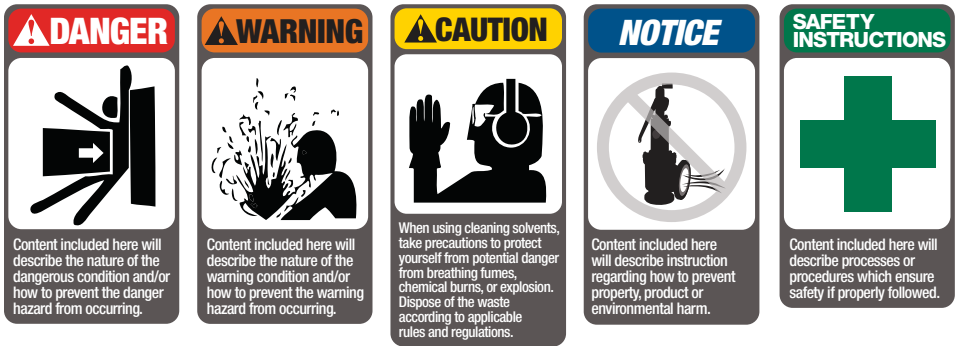
These instructions do not cover all details or variations in equipment, nor do they provide for every possible contingency to be met in regards to installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, please contact Farris Engineering.

2. Safety Warning and Instruction System

You will find safety warnings and instruction labels throughout this manual. These have been included to ensure your safety and must be followed. Safety labels are vertically oriented rectangles as shown in the samples below. These labels consist of three panels inside a border. Each safety label will communicate the following three key pieces of information. This information is communicated using narrative and pictorials.

- The nature and severity of the hazard
- The consequence of the hazard, if not avoided
- The precautions and measures required to avoid the hazard.

The top panel of the safety label illustrates the signal word (DANGER, WARNING, or CAUTION) which communicates the severity of the hazard, per the above explanations. The center panel contains a pictorial which communicates the nature of the hazard, and the possible consequence of hazard, if not avoided. In some cases, the pictorial may depict the precautions or measures required to avoid the hazard. The bottom panel will then contain the remaining narrative information needed to ensure all three key pieces of information have been conveyed.



DANGER:
Indicates hazards which, if not avoided, will result in death or serious injury.

WARNING:
Indicates hazards which, if not avoided, could result in death or serious injury.

CAUTION:
Indicates hazards which, if not avoided, could result in minor or moderate injury.

NOTICE:
"NOTICE" is reserved for instructions given to prevent property, product, or environmental harm.

SAFETY INSTRUCTIONS:
"SAFETY INSTRUCTIONS" indicates processes or procedures recommended to ensure safety.

General Safety Instructions

The maintenance manual is provided by Farris Engineering, a business unit of Curtiss-Wright Flow Control Company, to its customers as general guidance for the repair and maintenance of Farris valves described herein. Pressure relief/safety valves are critical components in pressurized systems to ensure the safety of people, the environment, and property. Always follow all manufacturer and industry standard recommendations relating to proper installation, testing, maintenance, and reconditioning.

This manual should not be considered an exhaustive manual. Certain configurations, applications, and usages may not be covered. If there is specific information needed which is not covered in this manual, the customer is advised to contact Farris using the contact information on the back of this manual. All information presented in this manual is subject to change without notice. The purchaser should contact Farris regarding any possible changes in information or specifications.

To ensure reliable and safe operation, installation, testing, maintenance, adjustment, and repair of Farris valves, these activities shall only be performed by qualified personnel having the required skills and training.

No repair, assembly, adjustment or testing performed by individuals other than Farris-authorized representatives shall be covered by the warranty extended by Farris to its customers. All applicable regulations, directives, codes and standards shall be adhered to when performing these activities. Failure to follow proper test procedures or failure to use proper test equipment will lead to incorrect test results, damage to the valve and will invalidate the warranty.

Likewise, use of parts in any maintenance or repair activity other than factory-supplied OEM parts will invalidate the warranty extended by Farris to its customers. Incorrect selection or application of Farris valves on the part of the customer is not covered by the warranty extended by Farris to its customers.

These general safety instructions have been provided not only to protect the product and warranty but also are provided for an individual's personal safety in handling Farris pressure relief valves. Failure to follow these procedures could result in severe bodily harm or even death.

- All possible hazards may not be identified in this manual. Conduct your own safety risk assessment given your specific system, environment, and configuration, and ensure proper control procedures are in place to prevent personal injury or illness and property, product or environmental harm.

DANGER

- When the valve is under pressure, do not place any part of your body near or in the path of the outlet of the main valve or other discharge areas. Doing so will result in serious injury or death upon release.
- If a test gag is provided with the valve, it must be removed prior to service installation. Failure to do so will result in equipment failure, serious injury or death in the instance of an overpressure event.

WARNING

- In certain applications it may be impossible to remove the valve from service. Never attempt to remove, adjust, maintain, or repair a pressure relief valve either while it is installed in a pressurized system or on a test stand, unless you have been properly trained to do so. Doing so may result in serious injury or death. Ensure the proper isolation of energy sources and residual pressures by complying with all local, state and country-specific regulations/directives applying to energy control procedures and “lockout/tagout.”
- Ensure that the pressure relief valve and system is at an ambient temperature before inspecting, servicing, or repairing. The valve, system, and contents may be extremely hot or cold. Failure do so may result in serious injury.
- The exhaust from the main valve outlet or any other ports that could exhaust, should be vented to a safe location to eliminate the potential for serious injury or damage during relief operation.
- Prior to valve disassembly, ensure that proper controls are implemented to address potential exposures to hazardous substances, including gases, liquids, or process byproducts contained in or contaminating the valve. Consult applicable material safety data sheets (MSDSs) and established exposure limits for the substances expected to be present to ensure proper exposure controls are implemented. Failure to do so could result in serious injury or illness.
- Ensure the valve is operable at all times and free of potential obstructions due to the conditions of use, or process fluid obstructions resulting from solidifications, byproducts, polymerization or other obstructions. Failure to do so could render the valve inoperable, leading to serious injuries or damage in the event of system over-pressurization.
- Use extreme caution when inspecting a pressure relief valve for leakage. Never use body parts to inspect for flow leaks. Doing so could result in serious injection, burn, or chemical injuries.
- Use all appropriate personal protective equipment to protect against process hazards, including but not limited to, pressurization, temperature extremes, noise, and chemical hazards. Failure to do so could result in serious injury or death.

CAUTION

- Always use the appropriate tools, and in the correct manner, for adjustment or servicing of valves. Failure to do so could result in injury.

SAFETY INSTRUCTIONS

- It is the responsibility of the customer and user of Farris valves to properly train their personnel on all required safety standards and procedures to prevent injuries and illnesses.

3. Serial and Type Numbering Systems

Familiarity with Farris valve type and serial numbering systems will greatly benefit anyone using this manual or any other Farris literature. The ability to recognize certain valve types and construction features along with identifying serial numbers will assist correct maintenance procedures and spare part selection/ordering. All Farris valve nameplates contain a specific valve type number and serial number unique to that particular valve. See Figure 1.2 on page 6 for an example of a typical 2600 Series nameplate.

Serial Numbering System

Each Farris pressure relief valve is assigned a unique serial number. This serial number is assigned by the factory and remains part of the factory records. Providing this serial number to the factory will assist in the identification of the construction and metallurgy of the valve in question. The following outline will give general guidelines on the serial numbering system used on 2600 Series valves.

Serial Suffix Summary For 2600 Maintenance Manual

Serial # Suffix	Valve Type	Description	Production Dates
-A15/H	2600L BalanSeal "O" Ring Seat Design (Liquid Service)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A14/H	2600L Conventional "O" Ring Seat Design (Liquid Service)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A15/G	2600L BalanSeal Metal Seat Design (Liquid Service)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A14/G	2600L Conventional Metal Seat Design (Liquid Service)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A15/M	2600L BalanSeal Design - "O" Ring (air, steam, vapor & liquid services)	Modified "D" through "K" orifice "O" ring seat design that replaced original A14 & A15 "O" ring seat design. Starts at Serial #'s above 300000.	July 1993 - present
-A14/M	2600L Conventional Design - "O" Ring (air, steam, vapor & liquid services)		
-A15	2600L BalanSeal Design (air, steam, vapor & liquid services)	Full nozzle valves conforming to API Standard 526 with ASME Section VIII certification for liquid service. Air & steam certification added in 2005.	1985 - present
-A14	2600L Conventional Design (air, steam, vapor & liquid services)		
-A13	2600 & 2600L BalanSeal Piston Design - All design variations and Services	2600 & 2600L Balanced Piston version of standard 2600 BalanSeal Design. Use of serial suffix changed from A12 to A13 for consistency of numbering system.	Nov. 1997 - present
-A12			1978 - Nov. 1997
-A11/R	2600 BalanSeal Design - "O" Ring (air, steam, & vapor services)	Modified "D" through "K" orifice "O" ring seat design that replaced the modified A10/M & A11/M "O" ring seat design. Starts at Serial #'s above 312123.	August 1996 - present
-A10/R	2600 Conventional Design - "O" Ring (air, steam, & vapor services)		
A11/N	2600 & 2600L BalanSeal Design (air, steam, vapor & liquid services)	Special version of 2600 series built to military specifications with MIL Spec. flanges and semi-nozzle construction	2000 - present
A10/N	2600 & 2600L Conventional Design (air, steam, vapor & liquid services)		2000 - present
A11/H	2600 BalanSeal "O" Ring Seat Design (air, steam, & vapor services)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
A10/H	2600 Conventional "O" Ring Seat Design (air, steam, & vapor services)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
A11/G	2600 BalanSeal Metal Seat Design (air, steam, & vapor services)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
A10/G	2600 Conventional Metal Seat Design (air, steam, & vapor services)	Improved "G" orifice (150# & 300# Class only) and "F" orifice designs.	2006 - present (G) 2011 - present (F)
-A11/M	2600 BalanSeal Design - "O" Ring (air, steam, & vapor services)	Modified "D" through "K" orifice "O" ring seat design that replaced original A10 & A11 "O" ring seat design. Starts at Serial #'s above 300000.	July 1993 - July 1996
-A10/M	2600 Conventional Design - "O" Ring (air, steam, & vapor services)		July 1993 - July 1996
-A11	2600 BalanSeal Design (air, steam, & vapor services)	Full nozzle valves conforming to API Standard 526 with nozzles revised to incorporate ASME 0.9 capacity reduction factor.	1976 - present
-A10	2600 Conventional Design (air, steam, & vapor services)		
-A9	BalanSeal Bellows Design	Full nozzle valves conforming to API Standard 526.	1959 - 1976
-A8	Conventional Design		
-A3, A5, & A7	BalanSeal Bellows Design	Includes both 2605 & 2675 Series	1955 - 1967
-A2, A4, & A6	Conventional Design		
-A	Full nozzle valves, conventional and BalanSeal bellows types.	Serial suffix covers all types of construction including Conventional, FarriSeal, BalanSeal, enclosed and exposed spring designs.	1943 - 1955

Note: Valves covered by serial number suffixes in RED are for obsolete designs.

Type Numbering System

Our type numbering system simplifies the selection and specifying of Farris pressure relief valves because the digits that comprise a specific type number have a distinct significance. The digits describe the basic valve series, orifice, seat and internal construction, inlet temperature range, body, bonnet and spring material, inlet flange class and Code liquid design.

Prefix (if applicable)	26	D	A	1
	Series Number	Orifice Areas	Construction	Temperatures & Materials

H* Set Pressure Above API 526

SJ Steam Jacket

HTF Heat Transfer Fluid

*Available Only on Q, R, T and U Orifices

26

Orifice Letter	Area, Sq. In. API	Area, Sq. In. Actual	Area, Sq. mm API	Area, Sq. mm Actual
D	0.110	0.150	71	97
E	0.196	0.225	126	145
F	0.307	0.371	198	239
G	0.503	0.559	325	361
H	0.785	0.873	506	563
J	1.287	1.430	830	923
K	1.838	2.042	1186	1317
L	2.853	3.170	1841	2045
M	3.60	4.000	2323	2581
N	4.34	4.822	2800	3111
P	6.38	7.087	4116	4572
Q	11.05	12.27	7129	7916
R	16.0	17.78	10323	11471
T	26.0	28.94	16774	18671
U	—	31.5	—	203.2*
V	—	49.4	—	318.6*
W	—	63.6	—	410.2*
W2	—	104.0	—	670.8*
X	—	113.1	—	729.5*
Y	—	143.1	—	923.0*
Z	—	176.7	—	1139.7*

*The U – Z orifices are not API standard sizes. U – Z metric areas = cm^2.
This manual only covers maintenance for D – U orifices. For larger orifices, please consult the factory.

A Conventional construction

B BalanSeal construction

C Conventional with O-ring seat pressure seal

D BalanSeal with O-ring seat pressure seal

E BalanSeal with auxiliary balancing piston

F BalanSeal with auxiliary balancing piston and O-ring seat pressure seal

T Teflon seat, conventional

U Teflon seat, BalanSeal

Designation	Inlet Temperature Range °F	Material: Body & Bonnet	Material: Spring
1	-20 to 800	Carbon Steel	Chrome Alloy
2**	451 to 800	Carbon Steel	Chrome Alloy
3	801 to 1000	Chrome Moly Steel	High Temp. Alloy
4*	1001 to 1200	—	—
5*	1201 to 1500	Austenitic St. St.	Inconel Alloy
1	-21 to -75	Use “S3” Trim Options	
1	-76 to -450	Use “S4” Trim Options	
6	-21 to -75	3-1/2% Nickel Steel	Carbon Steel
7	-76 to -150	3-1/2% Nickel Steel	Austenitic St. St.
8	-151 to -451	Austenitic St. St.	Austenitic St. St.

* Temperature ranges 4 and 5 are beyond the scope of this catalog. Consult the Factory.

** Temperature range 2 is no longer used as the standard range valve handles temperatures to 800°F.

Note: Items listed in **RED** are for non-current nomenclature designations or options no longer offered.

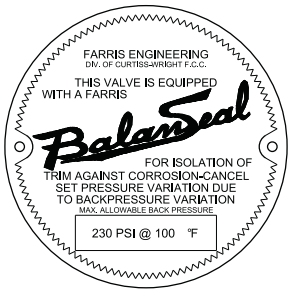


Figure 1.1 – BalanSeal Identification Plate

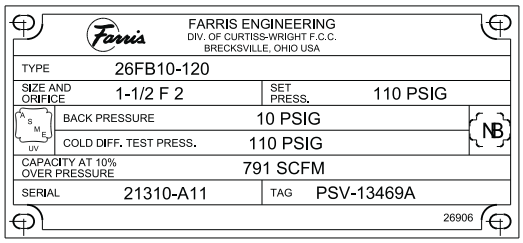
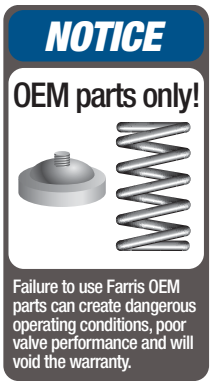


Figure 1.2 – Typical Farris Nameplate

Parts Replacement

Valves – If an exact replacement valve is required, then the valve type, size and serial number must be specified to ensure proper dimensions and material being supplied. If a specific valve is obsolete, a recommendation of the current equivalent will be made if possible.

Spare Parts – When ordering parts, use part names as listed in the bills of materials. Specify valve type, size and serial number. If the serial number is not available, the original Farris factory order number will help us supply the proper part and material.



Springs – Order as an assembly to include spring with upper and lower spring buttons. Specify valve type, size, serial number, set pressure and backpressure, if any.

Note: If valve modification or set pressure changes are required, consideration must be given to correct the nameplate and other data.

2	L -	1	2	0	/S4
Inlet Class	**Special Construction (if applicable)**	**Inlet Facing**	**Cap Construction**	**Test Gag**	**Special Material**

Designation	ANSI Nominal Inlet Flange Class
0	150
1	300 lightweight valve
2	300 heavyweight valve
3	600
4	900
5	1500
6	2500

A Expanded API sizes: air, steam and gas service*

B Expanded API sizes: ASME liquid valve*

C Expanded API sizes: ASME Code Section VIII exposed spring design*

D Valve suitable for heat transfer service-vapor

E Valve suitable for heat transfer service-liquid

F Expanded API size valves suitable for heat transfer service-vapor*

G Expanded API size valves suitable for heat transfer service-liquid*

H Integral steam jacket expanded API Sizes – Vapor Service

J Integral steam jacket Vapor Service

K Integral steam jacket – Liquid Service

L ASME Code certified for liquid, air and steam service

S ASME Code Section VIII exposed spring design

X Integral steam jacket expanded API sizes – Liquid Service

*Letter suffixes for expanded API sizes where 2-1/2" inlet or outlet has been replaced by 3" size.

0 Special[2]

1 Raised Face, ANSI Std. (125 to 160 AARH)

2 Large Female, ANSI Std.

3 Small Male, ANSI Std.

4 Small Female, ANSI Std.

5 Large Tongue, ANSI Std.

6 Large Groove, ANSI Std.

7 Small Tongue, ANSI Std.

8 Small Groove, ANSI Std.

9 Ring Joint (octagonal), ANSI Std.

A 125 AARH Smooth Finish

B 125 AARH (Outlet Only)

C 125 to 160 AARH (Inlet & Outlet) (now indicated by a '1')

H 63-83 AARH Smooth Finish RF

The following designation can apply to inlet and/or outlet:

J 63 to 83 AARH (outlet only)

K 63 to 83 AARH (inlet & outlet)

X High pressure hub style connection

2 Screwed Cap

3 Bolted Cap

4 Packed Lever

5 L Type Packed Lever

6 R Type Packed Lever

7 Open Lever

8 Remoter (with Packed Lever)

0 Without Gag

1 With Gag

See "Materials for Corrosive Service" Table below.

Materials for Corrosive Service

Designation	Special Material Description			
	Body Bonnet, Cap	Internal Parts		
		Nozzle & Disc	Other	Springs & Buttons
/S1	Standard	316	316[1]	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/S2	Standard	316	316	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/S3	316	316	316	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/S4	316	316	316	316
/S5	Standard (NACE)	316	316 & Monel w/Inconel 625 bellows	Standard[2]
/S6	Standard (NACE)	316	316 SAS w/standard bellows	Standard[2]
/S7	Standard (NACE)	316	316 & Monel w/standard bellows	Standard[2]
/H1	Standard	Hastelloy C	Standard	Standard
/H2	Standard	Hastelloy C	Hastelloy C & Monel	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/H3	Hastelloy C®	Hastelloy C	Hastelloy C	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/H4	Hastelloy C	Hateloy C	Hastelloy C	Hastelloy C
/M1	Standard	Monel	Standard	Standard
/M2	Standard	Monel	Monel	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/M3	Monel	Monel	Monel	316 buttons, Chrome Alloy or High Temperature Alloy Nickel Plated spring
/M4	Monel	Monel	Monel	Inconel spring, Monel buttons
/N1	Carbon Steel (NACE)	316 (NACE)	316[1]	Standard[2]
/N4	316 (NACE)	316 (NACE)	316[1]	316[2]

1. Spring adjusting screw in standard material
2. The springs shown assume bellows construction. For conventional construction, use Inconel X750.

4. Valve Cross-Section, Parts and Construction

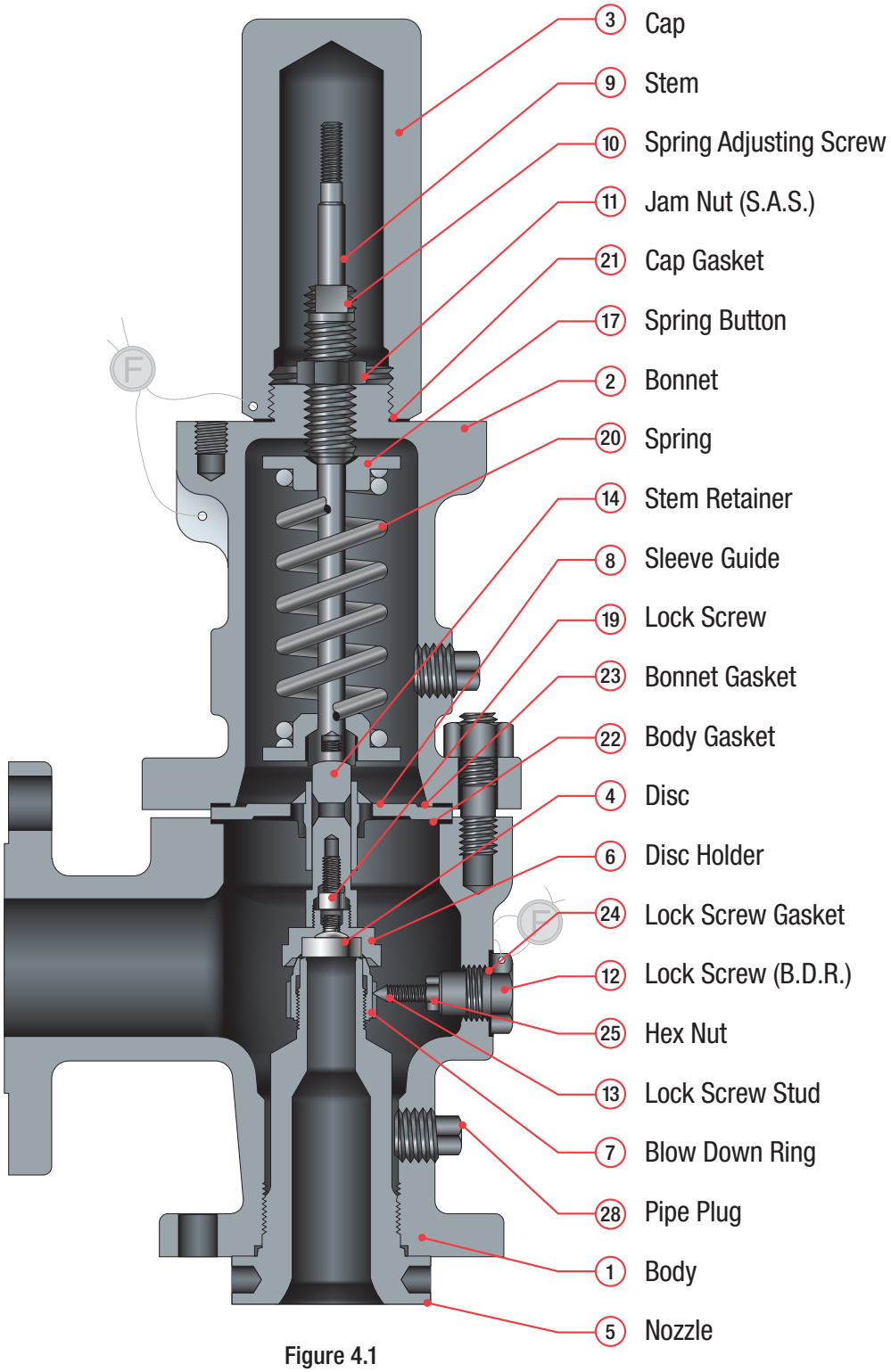


Figure 4.1

General Notes:
The safety valve cross-section illustrated is typical and actual construction details will vary depending on valve size and pressure rating.
Consult the other illustrations contained elsewhere in this manual for greater detail or consult the factory for a cross-section drawing for the actual valve size and pressure rating.

Valve Bill of Materials

Item	Part Name		Conventional (A10) Material	BalanSeal (A11) Material
1	Body	26( )( )10 thru 26( )( )16	SA-216 Gr. WCB, Carbon Steel	SA-216 Gr. WCB, Carbon Steel
		26( )( )32 thru 26( )( )36	SA-217 Gr. WC6, Chrome Moly	SA-217 Gr. WC6, Chrome Moly
2	Bonnet	26( )( )10 thru 26( )( )16	SA-216 Gr. WCB, Carbon Steel	SA-216 Gr. WCB, Carbon Steel
		26( )( )32 thru 26( )( )36	SA-217 Gr. WC6, Chrome Moly	SA-217 Gr. WC6, Chrome Moly
3	Cap		Carbon Steel	Carbon Steel
4	Disc		316 St. St.	316 St. St.
5	Nozzle		316 St. St.	316 St. St.
6	Disc Holder		316 St. St.	316 St. St.
7	Blow Down Ring		316 St. St.	316 St. St.
8	Sleeve Guide		316 St. St.	316 St. St.
9	Stem		316 St. St.	316 St. St.
10	Spring Adjusting Screw		Stainless Steel	Stainless Steel.
11	Jam Nut (S.A.S.)		316 St. St.	316 St. St.
12	Lock Screw (B.D.R.)		316 St. St.	316 St. St.
13	Lock Screw Stud		316 St. St.	316 St. St.
14	Stem Retainer		17-4 Ph. St. St.	17-4 Ph. St. St.
15	Bellows (not shown)		N/A	Inconel Composite
16	Bellows Gasket (not shown)		N/A	Non-Asbestos
17	Spring Button		Carbon Steel, Rust Proofed	Carbon Steel, Rust Proofed
18	Body Stud		ASME SA-193 Gr. B7, Alloy Steel	ASME SA-193 Gr. B7, Alloy Steel
19	Lock Screw (D.H.)		Stainless Steel	Stainless Steel
20	Spring	26( )( )10 thru 26( )( )16	Chrome Alloy Rust Proofed	Chrome Alloy Rust Proofed
		26( )( )32 thru 26( )( )36	High Temp. Alloy Rust Proofed	High Temp. Alloy Rust Proofed
21	Cap Gasket		316 St. St.	316 St. St.
22	Body Gasket		316 St. St.	316 St. St.
23	Bonnet Gasket		316 St. St.	316 St. St.
24	Lock Screw Gasket		316 St. St.	316 St. St.
25	Hex Nut (B.D.R.L.S.)		Stainless Steel	Stainless Steel
26	Hex Nut (Body)		ASME SA-194 Gr. 2H, Alloy Steel	ASME SA-194 Gr. 2H, Alloy Steel
27	Pipe Plug (Bonnet)		Steel	N/A
28	Pipe Plug (Body)		Steel	Steel

Table 4.1

General Notes:
Parenthesis in type number indicates orifice designation and valve construction, example: 26FA10

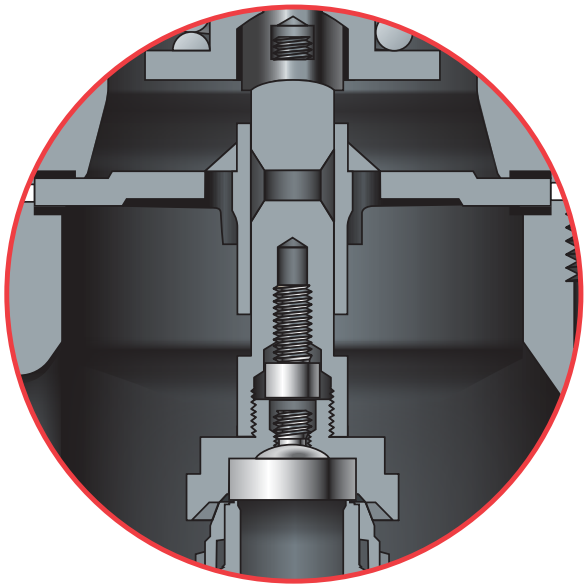


Figure 4.2
Internals for Orifice D-J

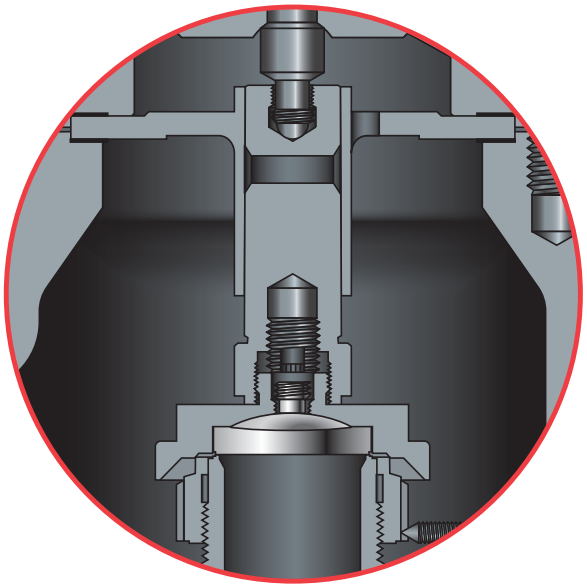


Figure 4.3
Internals for Orifice K-P

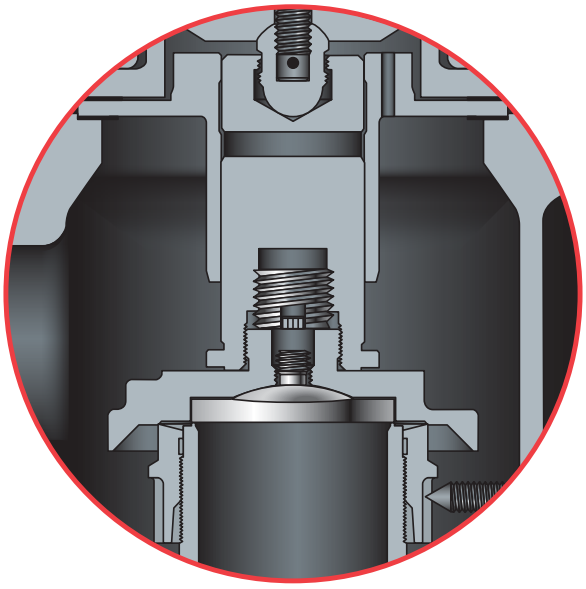


Figure 4.4
Internals for Orifice Q-U

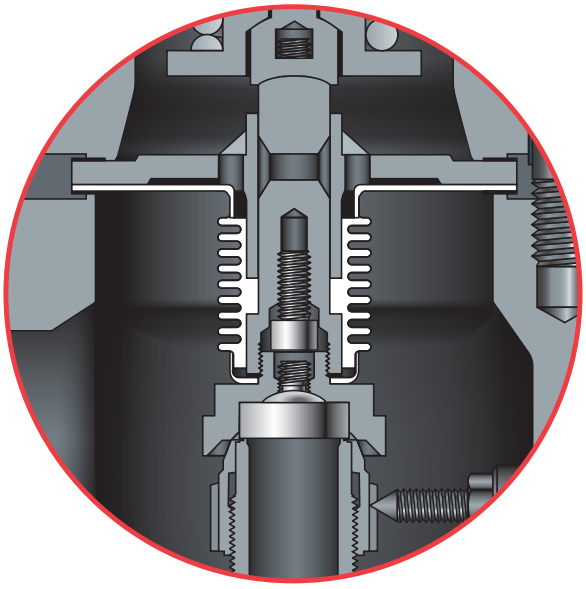
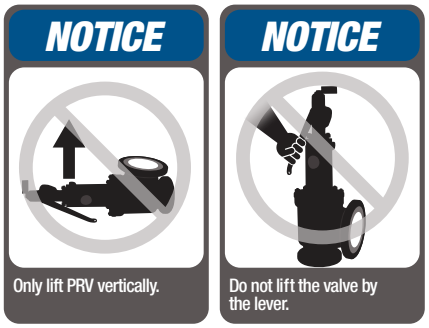


Figure 4.5
BalanSeal® Bellows Safety Valve

5. Valve Removal and Pre-Inspection

General Handling:



After the pressure relief valve is removed from the installation it should be transported to the shop for inspection, testing, maintenance, and resetting. Careful handling in transit is important, as rough handling can change the pressure setting or deform the pressure relief valve parts so they cannot be set or function properly. Flanges on the piping and flange faces on the valve should be protected so that gasket faces are not damaged. Large valves should be handled with suitable rigging equipment to avoid dropping or rough handling. Pressure relief devices should not be stocked in a careless manner and, where practical, they should be segregated and not stored with heavy pipe fittings or other types of valves. Pressure relief valves should be treated as delicate instruments because their accurate functioning is very important to safe plant operation.



Because cleanliness is essential for the satisfactory operation and tightness of a pressure relief valve, all necessary precautions should be taken to keep out foreign materials. Valves which are not installed soon after repair should be closed off properly at both inlet and outlet flanges. Particular care should be taken to keep the valve inlet and internals absolutely clean. Preferably, valves should be stored indoors or in locations where dirt and other forms of contamination are at a minimum. Valves should be handled carefully and not subjected to heavy shocks. If due consideration is not given to this point, some internal damage or misalignment can result and seat tightness may be adversely affected. Store, transport and install valves with the stem in the vertical position.

In practice, a repaired pressure relief valve including one that has been only cleaned or readjusted is called upon to provide the same degree of protection as a new valve. It follows that maintenance personnel must be trained to a level of proficiency that enables them to restore a valve to original condition and function. It is recommended that historical records be established and maintained including test reports. This will provide data to determine the frequency of inspection and repair for various services. One excellent publication for reference on pressure relieving devices is the American Petroleum Institute's (API) **Recommended Practice RP 576, Inspection of Pressure-Relieving Devices**. The use of original manufacturer's replacement parts is necessary to maintain new valve performance, capacity flow and warranty. Farris Engineering expressly voids its warranty and will not be responsible for faulty valve operation if non-factory replacement parts or methods are utilized in product repair.

Field Removal

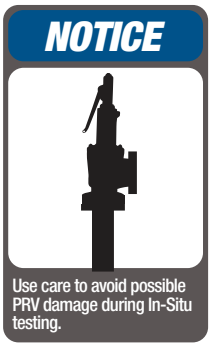
A visual inspection of pressure relief valves should be made when the valves are first removed from the system. Many types of deposits or corrosive debris may be loose and drop out from the pressure relief valve while it is being transported to the shop. When fouling is a frequent problem, it may be desirable to collect samples for further testing and to make notes regarding deposit location and appearance. Any obstructions in the valve should be noted and corrected.

Inspection of Inlet and Outlet Piping

When a pressure relief valve is removed from service, the upstream and downstream piping is often open and available for inspection. However, where it is the practice to remove pressure relief devices from equipment during operation by closing block valves, it is usually not possible to make a complete inspection of piping. Such inspection should be made when the operation equipment is out of service. Inspection of the piping at the pressure relief valve will often indicate the condition of other process piping which is not readily available for inspection. Piping should be checked for corrosion, indications of thinning and deposits which may interfere with valve operation. The characteristics of the deposits may supply clues regarding leakage from the pressure relief valve in a closed system.

In-Situ Testing

In-situ or in place testing is frequently performed as a substitute for valve removal and in-shop testing. This should not be considered as equivalent to shop maintenance; however it may be employed under controlled situations to extend the shop service frequency of particular valves. The most common method of in-situ testing employs an external power source applied to the valve to determine the valve set pressure at some lower system pressure. While this method can accurately determine the valve set pressure, valve reseat pressure cannot be determined using the method. Care must be exercised with this method to avoid possible valve damage that may go undetected during the in-situ test.



In-Shop Inspection

When a valve is first received in the shop it should be given a visual inspection to note its condition when removed from service. The results of this inspection should be noted on appropriate forms. It is generally considered important to determine the set pressure of the valve when removed from service and prior to the valve being disassembled. If the valve opens at the set pressure, the valve need not be tested further to determine the as-received relieving pressure. If the initial pop is higher than the set pressure, it is advisable to test a second time. If the valve then pops at approximately the set pressure, this indicates that the valve was probably stuck because of deposits. If the valve does not pop near the set pressure, this indicates that the valve setting was either in error originally or may have been changed during operation.

Valves which are found acceptable upon shop pre-test cannot be returned to service with a National Board “VR” stamp being applied unless they are completely disassembled and complete repairs are undertaken. Some maintenance programs may however authorize valves found acceptable on shop pretest to be returned to service based on historical records, tear-down cycles and all seals and valve identifications remaining intact.

Preparation For Maintenance

Before valve teardown is performed a review of previous maintenance records will assist in an understanding of past valve performance, settings and maintenance requirements. A complete maintenance records management system will allow proper stocking of common replacement items such as gaskets and seals and adequate stocking of major replacement parts such as nozzles, discs, and springs. Maintenance records, when properly updated, can serve to identify the need for ordering spare parts when valve servicing shows that the useful life of a particular part has been reached. Rework details and installation of new parts should be recorded to aid future service activities.

6. Disassembly Instructions

General Disassembly of Valves

After the valve is received and checked it is ready for shop inspection and repair. The valve should be carefully dismantled. If you are unfamiliar with this line of Farris valves carefully study the cross-sectional drawings in Figures 4.1 through 4.5 to familiarize yourself with part terminology and location. Proper facilities should be available for segregating parts as the valve is dismantled. At each stage in the dismantling process, all parts of the valve should be visually inspected for evidence of wear and corrosion. If parts are worn, replace them. See Appendix G for necessary tools.

The following general points will provide a brief checklist to follow during disassembly. Detailed discussion will follow for specific critical parts.



- Check for the presence of wire seals at all points of adjustment.
- Check for complete and properly identified nameplates and tags.
- Check the condition of flanges; look for evidence of pitting, roughening, deterioration of gasket surface, distortion, etc.
- Visually inspect springs for evidence of corrosion, cracking, and correct selection.
- Visually inspect bellows (if the valve is of bellows type).
- Examine o-ring condition (if applicable).
- Visually inspect inlet and outlet openings; look for evidence of deposits of foreign material and for corrosion. Note the condition of external surfaces and look for any indication of corrosion or evidence of mechanical damage.
- Check and note the body, nozzle and bonnet wall thickness, thread and stud condition.
- Verify valve components and material and check against nameplate information.

Disassembly Instructions:



Farris 2600 Series valves should be disassembled as described below. Parts identification may be found in Figure 4.1 on page 8. The parts from each valve should be properly marked and segregated to keep them separate from parts used in other valves.

1. Cut the wire seals and remove the **Cap** [3] and **Cap Gasket** [21]. For valves equipped with a lifting lever, follow the instructions in Appendix D. **(Figure 6.1)**
2. Before loosening the **Jam Nut** [11], measure the location of the **Spring Adjusting Screw (SAS)** [10] by marking the **SAS** [10] above the **Jam Nut** [11]; or by counting the number of counter clockwise revolutions of the **SAS** [10] until the **Spring** [20] is no longer compressed. This will allow the approximate set pressure to be re-established when reassembling the valve. **(Figure 6.2)**
3. Remove the **Jam Nut** [11] and **SAS** [10].

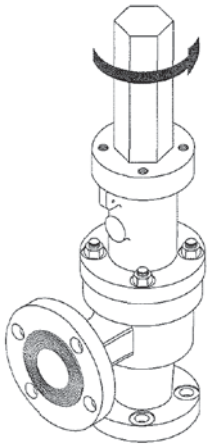


Figure 6.1

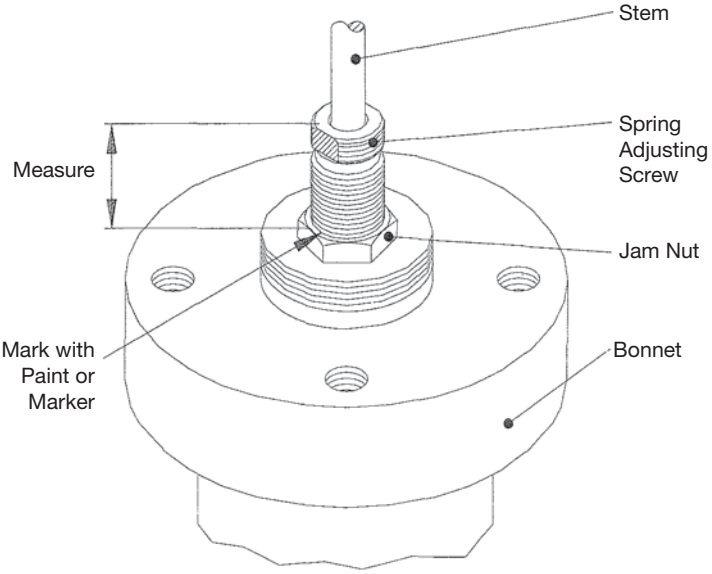


Figure 6.2

4. Remove the **Blow Down Ring Lock Screw** assembly [12,13, 25] and **Lock Screw Gasket** [24]. Record the position of the **Blow Down Ring** [7] with respect to the **Disc Holder** [6] by counting the number of notches required to raise the ring until it just touches the **Disc Holder** [6]. This information will be needed again when reassembling the valve. **(Figure 6.3)**
5. Remove the **Body Hex Nuts** [19]
6. Record the position of the bonnet drain relative to the valve outlet and remove the **Bonnet** [2].
   a. On larger valves, the combination of bonnet weight and the height that it must be lifted to clear the **Stem** [9] requires that a hoist be used to remove the **Bonnet** [2]. During this operation, the valve **Body** [1] should be secured to prevent it from tipping over once the **Bonnet** [2] is removed.
   b. Use care when lifting the **Bonnet** [2] as the **Spring** [20] and **Stem** [9] will be able to tip over.
7. Remove the spring assembly (**Spring** [20] and **Spring Buttons** [17]) from the **Stem** [9]. The spring assembly must be kept together. The **Spring Buttons** [17] should be tagged for later identification as the upper and lower buttons may not be identical.

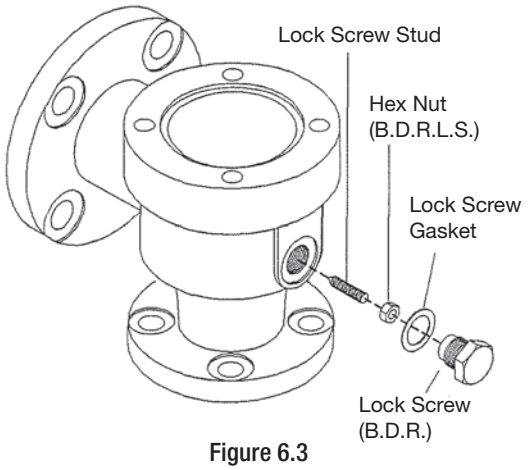


Figure 6.3

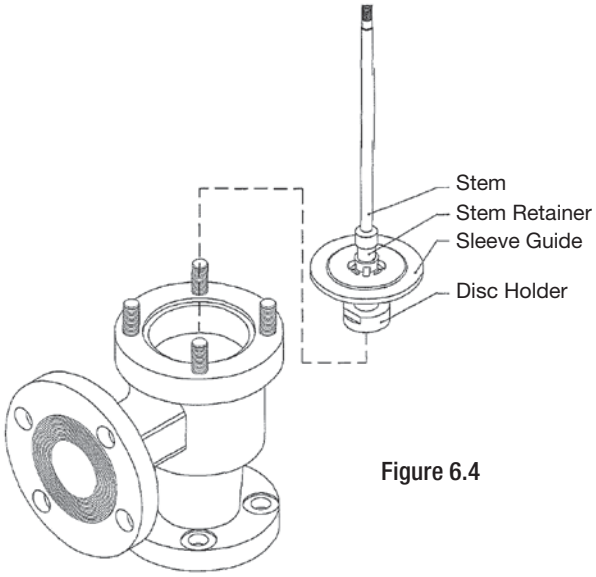


Figure 6.4

8. Using the **Stem** [9] as a handle, lift the complete internal assembly from the valve **Body** [1]. **(Figure 6.4)**
   a. On larger valves a hoist is advisable due to the weight of the internal assembly.
   b. An eye bolt may be attached to the stem test washer thread at the end of the **Stem** [9] to assist in lifting.
   c. For balanced bellows valves, use care not to damage the bellows assembly.
   d. If parts are difficult to remove due to the presence of corrosive or foreign material soaking in a suitable solvent may be required.
9. Remove the **Body Gasket** [22] and **Bonnet Gasket** [23].
10. To remove the **Stem** [9] from the **Stem Retainer** [14], lift up on the **Stem** [9] while holding the **Stem Retainer** [14] down and rotate counter-clockwise at the same time. This will engage the thread. Continue rotating until the **Stem** [9] is removed. **(Figure 6.5)**

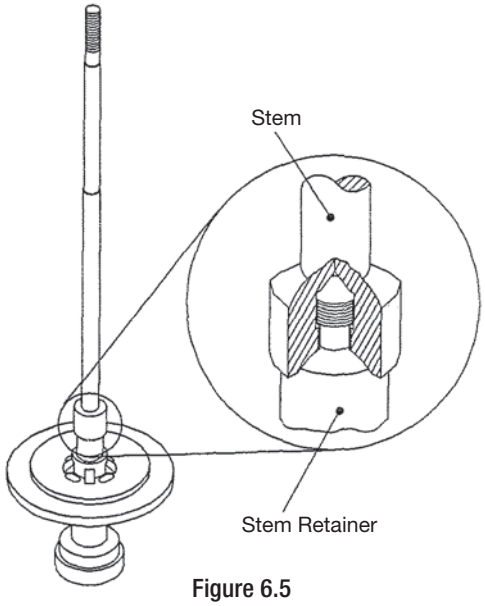


Figure 6.5

11. Remove the **Disc** [4] from the **Disc Holder** [6] **(Figure 6.6)**.
    a. Hold the assembly and rotate the **Disc** [4] with the tip of your finger.
    b. For o-ring seat type valves, refer to Appendix C for instructions.
12. To separate the **Disc Holder** [6] from the **Stem Retainer** [14], first thread the lock screw up into the **Stem Retainer** [14] using the fixture shown in **Figure 6.7** to hold the assembly.
    a. Except for the D & E orifice bellows (A11) designs which have a one piece stem retainer/disc holder, the **Stem Retainer** [14] and **Disc Holder** [6] are held together with a **Disc Holder Lock Screw** [26].
    b. The **Disc Holder Lock Screw** [26] has a hex socket requiring the use of an Allen key **(Figure 6.8)**.
    c. Locking tension is relieved by threading the lock screw UP INTO the **Stem Retainer** [14].

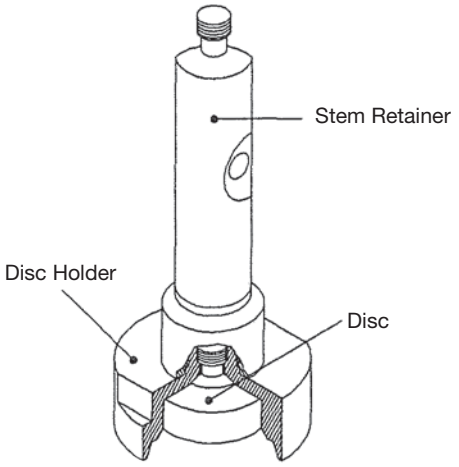


Figure 6.6

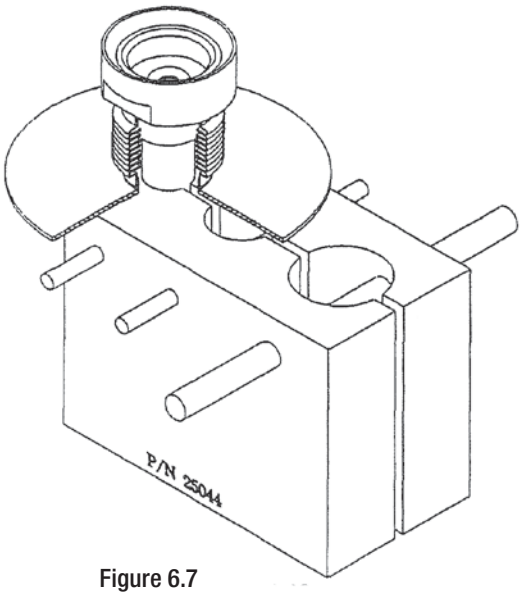


Figure 6.7

    d. Allen key wrench sizes are shown in **Table 6.1**.
    e. Be careful not to damage the guiding surface of the **Stem Retainer** [14] during disassembly.
    f. For bellows valves see Appendix B.
13. Remove the **Blow Down Ring** [7] from the **Nozzle** [5].
14. Turn the valve **Body** [1] over and re-clamp to the work bench. With a spanner wrench and mallet, remove the **Nozzle** [5] from the **Body** [1]
    a. Some valves may use wrenching flats instead of spanner holes.

NOTES:

1. **For BalanSeal Bellows construction,** please see Appendix B for disassembly instructions.
2. **For O-Ring seat construction,** please see Appendix C for disassembly instructions.
3. **For open lever, packed lever and bolted cap construction,** please see Appendix D for disassembly Instructions.

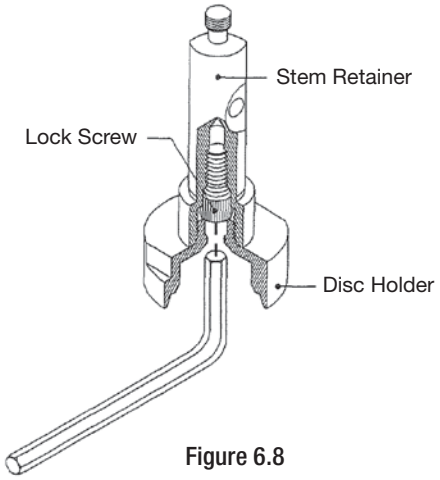


Figure 6.8

Allen Key Sizes	
Disc Holder Lock Screw	
Orifices	**Allen Key Size**
D thru J	3/16"
K thru P	7/32"
Q thru T	3/8"

Table 6.1

7. Cleaning and Inspection

7.1 Cleaning

Blast Cleaning

2600 Series body, bonnet and cap castings can be sand or bead blasted. When blast cleaning, exercise caution to protect internal and machined surfaces to avoid causing damage. Protect the nameplate prior to blast cleaning. It is not recommended to blast internal parts.

Brush Cleaning

Internal parts (except for guiding surfaces) and the inside of the body and bonnet castings can be cleaned with a wire brush and/or grinder until they are clean. Exercise caution when brush cleaning to avoid damaging or eroding the parts. Only clean stainless steel brushes should be used on stainless steel components.

Immersion/Washing

Castings and internal parts should be thoroughly cleaned with an appropriate solvent or cleaning solution. After immersion/washing, ensure that any residue is removed and parts are dried completely.

Polishing

Guiding surfaces on the stem, stem retainer and guide can be polished using a fine emery cloth.

CAUTION



When using cleaning solvents, take precautions to protect yourself from potential danger from breathing fumes, chemical burns, or explosion. Dispose of the waste according to applicable rules and regulations.

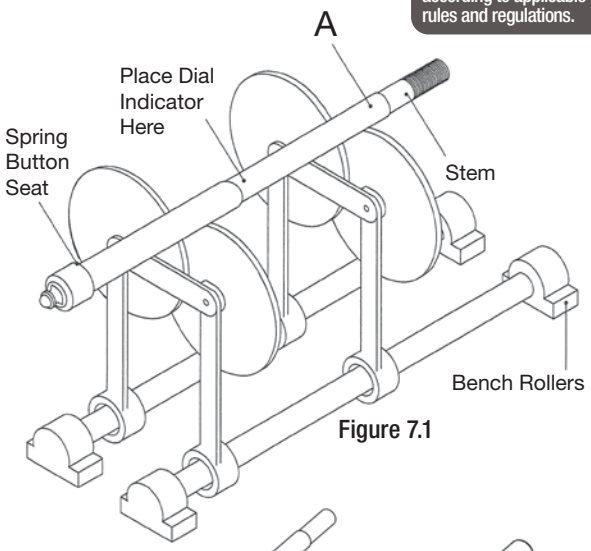


Figure 7.1

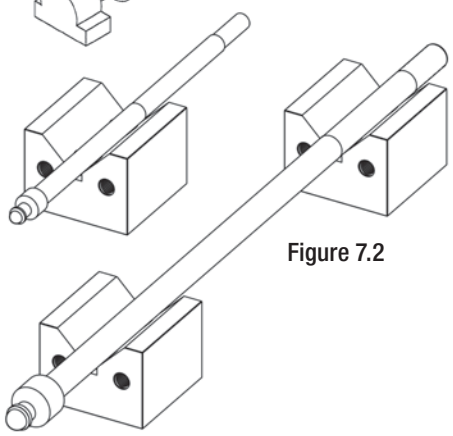
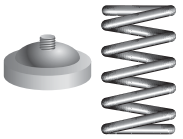


Figure 7.2

7.2 Inspection

NOTICE

OEM parts only!



Failure to use Farris OEM parts can create dangerous operating conditions, poor valve performance and will void the warranty.

Check all valve parts for wear and corrosion. Inspection of valve components is important to ensure proper valve performance. **Damaged valve parts must be repaired or replaced with OEM parts.**

The valve seat (nozzle and disc) must be examined to determine if they have been damaged. Typically, lapping the nozzle and/or disc is all that is needed to restore these parts to their original condition. Prior to lapping, or If machining is necessary, consult section 8 and Appendix E, Critical Dimensions.

The valve spring should be inspected for evidence of cracking, pitting, corrosion or deformation. If any of these are found, the spring should be replaced.

The guiding surfaces on the sleeve guide and stem retainer should be checked for evidence of pitting, corrosion, distortion or galling. If found, these parts should be replaced.

Stems should be inspected as follows:

1. Check the bearing point on the stem tip for a smooth surface. Lap if necessary against the mating part to improve the surface. If the spherical contact is destroyed, the stem should be replaced.
2. Check the critical stem areas for concentricity using the following procedures (Figure 7.1 and 7.2):
   a. Using “V”-Blocks or bench rollers, check the stem at the midpoint and also at the lower spring button radius for any runout.
   b. By applying a machinist’s dial indicator and rotating the stem, the total indicator reading should not exceed 0.007 inches. Straighten if necessary.
3. The top area of the stem just below the threads serves as the valve’s upper guiding surface in conjunction with the spring adjusting screw. This area is supplied from the factory with a 63 AARH finish. This area should be free from any signs of galling, corrosion, distortion or pitting. If seen, the stem should be replaced.

For BalanSeal valves, the bellows should be inspected for evidence of cracking, pitting, corrosion or deformation that might develop into a leak.

Check and inspect all gaskets for evidence of damage or corrosion. Typically, gaskets should be replaced prior to assembly.

8. Maintenance and Repair Procedures

Nozzle Refacing



1. Prior to refacing the nozzle seating area, grip the nozzle flange in a lathe chuck fitted with soft jaws (preferably with removable top jaws), and bored on each set-up to fit the nozzle flange outside diameter.
2. True up the nozzle by means of an indicator, ensuring that the nozzle bore and the machined surface between the nozzle threads and body sealing surface are concentric with each other, within 0.002" full indicator reading.
3. Machine a light cut across the seat until the damaged areas are removed, ensuring compliance with Appendix E. The seat should be machined to the smoothest possible finish. Rigidity of the cutting tool is critical.
4. Relap to the required finish.
5. Discard and replace the nozzle when the length from the seat to the flange becomes less than the minimum specified by the manufacturer. Do not reduce the nozzle flange thickness in an attempt to maintain the “L” dimension. The valve center to face dimension will be altered as a result and nozzle strength may be impaired.
6. See Appendix E for Critical Dimensions.

Disc Refacing

1. Prior to refacing the disc seating area, grip the disc outside diameter in a universal three-jaw lathe chuck fitted with soft jaws (preferably with removable jaws), and bored on each set-up to the disc outside diameter. Avoid excessive chucking force.
2. True up the disc by means of an indicator, ensuring that the disc outside diameter and seat face are true with each other within 0.002" full indicator reading.
3. Machine light cuts across the seat at 90° to the axis until the damaged areas are removed, facing to the smoothest possible finish. Rigidity of the cutting tool is critical.
4. Relap flat across the full width of the raised seating surface.
5. Discard and replace the disc when the thickness is less than the value in Appendix E.
6. See Appendix E for Critical Dimensions.

Lapping Compounds

The three grades of Farris Lapping Compounds are prepared especially for the requirements of pressure relief valves. These are the only compounds recommended for achieving extreme valve tightness, These compounds are available in 2 ounce tubes. Use sparingly.

Farris Lapping Compounds

Part No.	Grade	Finish	Size
18632X1 (055)	3F	Roughing	1/2 oz. tube
18633X1 (075)	38-500	Medium	1/2 oz. tube
18634X1 (105)	38-1200	Final	1/2 oz. tube

Lapping Procedures (Manual)

1. Use a cast iron lapping block or Pyrex lapping glass which is known to have a perfectly flat face.
2. Select the appropriate lapping compound. When lapping the disc, operate with a light figure eight motion over entire block surface. In this way complete contact will be made (Figure 8.1).

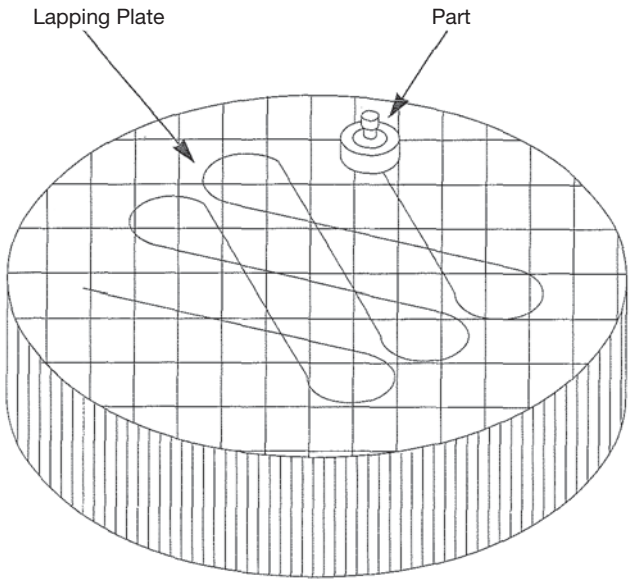


Figure 8.1

3. Lap the disc until all blemishes and score marks have been removed. As the figure eight motion is executed, frequently lift the disc away from the block to get a fresh bite on the compound. Most important, do not contaminate compounds with dirt. Store lapping blocks and lapping glass in a clean, dust-free area.
4. Follow the same procedure for lapping the nozzle. When lapping nozzles, the nozzle can be placed on a table and a lapping block placed on the nozzle. Be sure that the lapping block does not tip over the side of the nozzle (which would cause rounding of the edges). Use a light, rapid figure eight stroke, lifting the block from the nozzle occasionally.
5. When finished, be sure that all parts are carefully cleaned of all lapping compound using a suitable solvent. Residual compound may damage the seating surfaces during valve operation. When reassembling the parts in the valve be careful not to scratch or score the seating surfaces.
6. If the nozzle or disc is badly scored or pitted a fine machine cut should be made to reface the surfaces following instructions in the refacing section of this manual.

Lapping Procedures (Machine)

Lapping machines come in a variety of styles. There are limitations to the parts that can be lapped, which may be due to constraints of the lapping machine or the nature of the part to be lapped.

Limitations:

1. **The size of the lapping machine.**
   Obviously, you will be limited by the size of the lapping plate on the machine. A part that is larger than the lapping plate capacity will have to be hand lapped.
2. **The weight of the part to be lapped.**
   Some parts will be too heavy to lap on the machine, relative to the area to be lapped. These parts will have to be hand lapped.
3. **How well the part can be balanced on the lapping machine.**
   Due to geometry and weight distribution of the part, the part may tend to wobble or fall over in the lapping machine. For these types of parts a holding fixture should be designed or the part should be lapped by hand.

General Operation

This is a general procedure for the use of lapping machines. ALWAYS FOLLOW THE MANUFACTURER'S OPERATING INSTRUCTIONS.

Thoroughly clean all contaminates from the seat area of the nozzle or disc to be lapped. Place the nozzle or disc seating area on the lapping plate. Turn on the machine and adjust the flow of lapping fluid which should be enough to keep the lapping plate covered with a thin film. The lapping plate should be neither dry nor overly lubricated.

The duration of time that the nozzle or disc should be lapped is dependent on the weight of the part, the hardness of the material, and the area to be lapped. A combination of a heavy part with a small area to be lapped made from a soft material will take the shortest time to lap. A combination of a light part with a large area to be lapped made from a hard material will take the longest time to lap.

Once the lapping is complete, remove the nozzle or disc from the lapping plate and remove the lapping fluid with soft tissue and suitable solvent. Protect the seating areas with soft tissue covered by a plastic cap.

Lapping Machine Maintenance and Seat Inspection

Seat flatness is critical to achieving leak tight seats. As the width of most pressure relief valve seats is quite narrow, it is difficult to check seat flatness directly with a monochromatic light. Instead, a standard test block should be kept on the lapping machine that can be periodically checked to determine the condition of the lapping plate. If the test block "reads" flat then all parts lapped on the machine will also be flat. Since the lapped surface needs to be reflective in order to "read" the surface flatness using a monochromatic light source and optical flat, a polishing stand is a needed accessory. Remove the test block from the lapping machine and clean off all lapping fluid. Rub the test block on the polishing stand as if you were hand lapping the test block. Only a few strokes will be necessary to make the surface reflective enough to allow reading the lines produced by the monochromatic light. For full details on how to read these lines and the subsequent adjustments of the machine consult the lapping machine manufacturer.

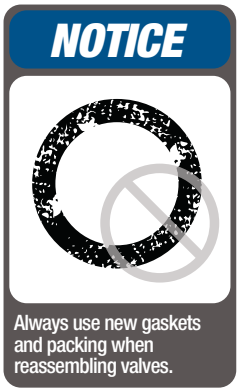
The quality of the lapped surface produced by the lapping machine can only be as good as the level of maintenance of the machine itself.

9. Assembly Instructions

Lubrication and Sealant:

Threaded parts should be lubricated to prevent galling, especially parts made of similar materials. In addition, guides and pivot points should contain lubricant which is compatible with the service conditions. Sealant should also be applied to prevent fluid from escaping valve boundaries, especially if back pressure is present. The adjacent table lists the suggested lubricant and sealant for air, steam, and liquid service. Service conditions may dictate that other lubricant or sealant be used.





Item	Thread Lubrication	Air	Steam	Liquid
1	Pipe Plug/Body	A	A	A
2	Lock Screw (BDR) Body	A	A	A
3	Blowdown Ring/Nozzle	D	D	D
4	Lock Screw Stud/Jam Nut (BDRLS)	A	A	A
5	Disc/Disc Holder	A	A	A
6	Stem Retainer/Disc Holder (if Applicable)	A	A	A
7	Lock Screw (DH)/Stem Retainer	A	A	A
8	Stem Retainer/Stem	A	A	A
9	Pipe Plug/Bonnet (if applicable)	A	A	A
10	Spring Adjusting Screw/Bonnet/Jam Nut	A	A	A
11	Plain Cap/Bonnet (if applicable)	A	A	A
12	Body Stud/Body/Hex Nut	A	A	A
	Guiding and Pivot Lubrication			
13	Disc/Disc Holder	A	A	A
14	Sleeve Guide/Stem Retainer	D	D	D
15	Stem Retainer/Stem	A	A	A
16	Spring Button/Stem	A	A	A
17	Spring Button/Spring Adjusting Screw	A	A	A
	Sealant			
18	Body/Nozzle	A	A	A
19	Body/Bonnet/Sleeve Guide/Gaskets	A	A	A
20	Bonnet/Gasket/Cap (if applicable)	A	A	A
21	Bellows Gasket	B	B	B

Code for Above Recommended Lubrication and Sealant

A = Bostic Never Seez
B = Molykote 3452
D = No Lubrication

* Service conditions may require an alternate lubricant or sealant

Assembly Instructions

Farris 2600 Series valves should be assembled as described below. Parts identification may be found in Figure 4.1 on page 8.

For torque requirements, please refer to Appendix H.

1. Thread the **Nozzle** [5] into the **Body** [1].
2. Thread the **Pipe Plug** [28] into the **Body** [1].
3. Thread the **Blow Down Ring** [7] onto the **Nozzle** [5].
4. Thread the **Hex Nut** [25] onto the **Lock Screw Stud** [13]. Thread the **Lock Screw Stud** [13] into the **Lock Screw** (BDR) [12].
5. Thread the **Lock Screw Assembly** into the **Body** [1] including the **Lock Screw Gasket** [24]. Adjust the position of the **Lock Screw Stud** [13] so that it prevents rotation of the **Blow Down Ring** [7] yet does not bind it. Use the position noted during disassembly. **(Figure 9.1)**
6. Thread the **Body Studs** into the **Body** [1].
7. Place the **Body Gasket** [22] in the **Body** [1] counter-bore.
8. Thread the **Lock Screw** [19] into the **Stem Retainer** [14]. **(Figure 9.2)**

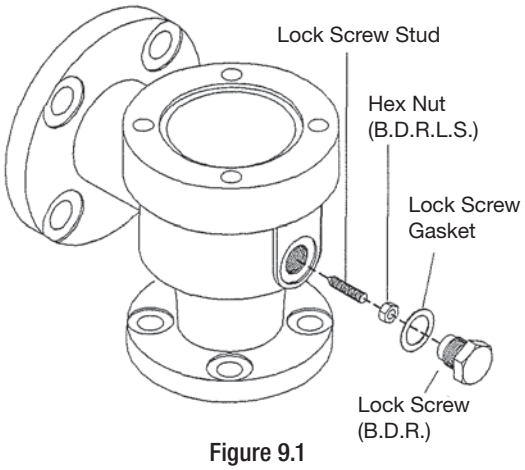


Figure 9.1

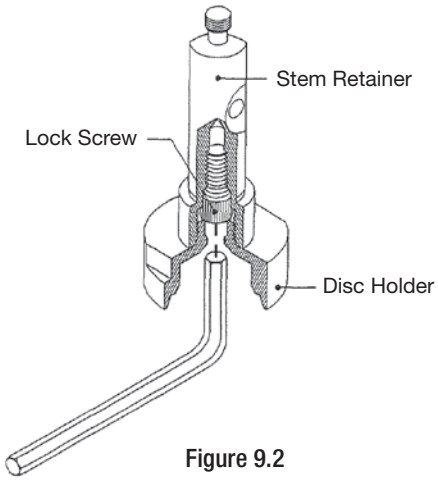


Figure 9.2

9. Thread the **Disc Holder** [6] onto the **Stem Retainer** [14] using a special assembly block **(see Figure 9.3)**. Do not attempt to hold the **Stem Retainer** [14] on the guiding surface. Thread the **Lock Screw** [19] counter clockwise until contact is made with the **Disc Holder** [6]. Tighten to lock the assembly together.
10. Thread the **Disc** [4] into the **Disc Holder** [6]. Be sure the **Disc** [4] is free-floating. **(Figure 9.4)**
11. Place the **Sleeve Guide** [8] over the **Stem Retainer** [14] with the long lift stop facing down. Be sure that the guiding motion is smooth.
12. Thread the **Stem** [9] and **Stem Retainer** [14] together. Be sure this connection is free-floating. **(Figure 9.5)**
13. Lower the **Assembly (Stem** [9], **Sleeve Guide** [8], and **Disc Holder** [6]) into the **Body** [1] counter-bore. **(Figure 9.6)**
14. Place the **Bonnet Gasket** [23] on the **Sleeve Guide** [8], or secure with sealant in the **Bonnet** [2] counter-bore.
15. Place the lower **Spring Button** [17] on the **Stem** [9]. **Caution** – in some valve sizes the upper and lower **Spring Buttons** [17] are different.
16. Place the **Spring** [20] on the lower **Spring Button** [17].

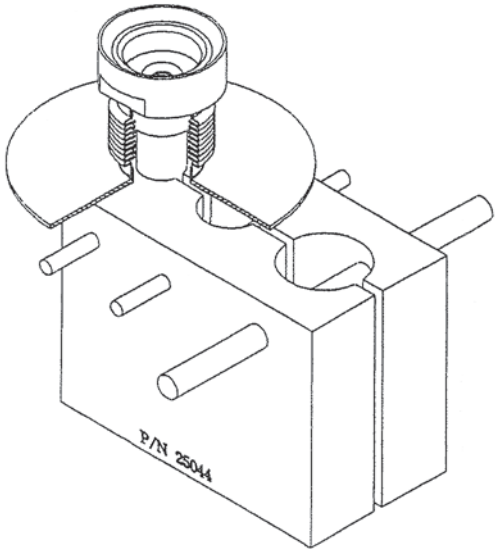


Figure 9.3

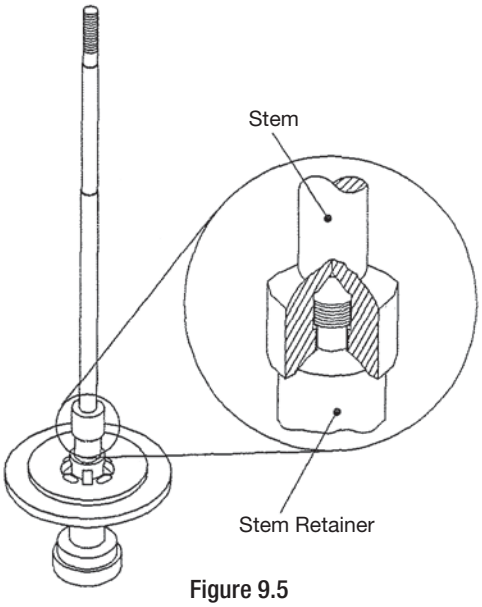


Figure 9.5

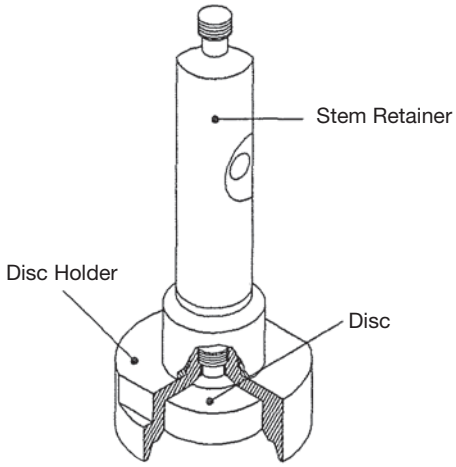


Figure 9.4

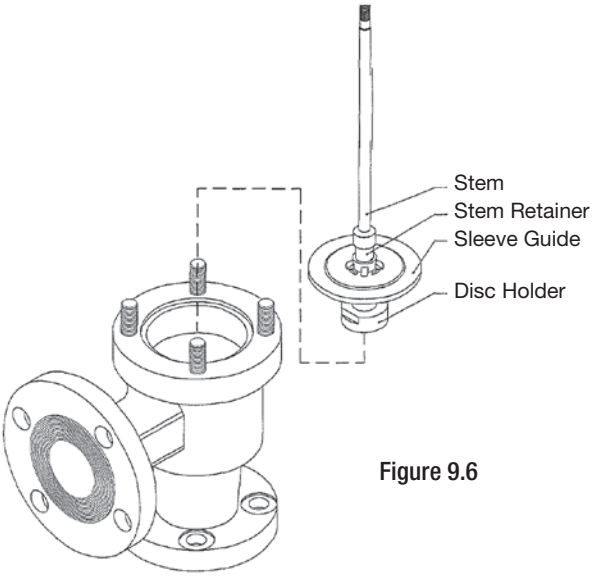


Figure 9.6

17. Place the upper **Spring Button** [17] on the **Spring** [20].
18. Thread the **Pipe Plug** [27] into the **Bonnet** [2]. Skip this step for Bellows Construction.
19. Place the **Bonnet** [2] onto the **Body** [1], making sure to align the **Pipe Plug** [27] to the position indicated in disassembly notes. Normal convention is to position the **Pipe Plug** [27] opposite of the valve outlet.
20. Thread the Hex Nuts (Body) onto Body Studs and tighten. Ensure that the **Body Gasket** [22] and **Bonnet Gasket** [23] are properly positioned in the respective counter-bores.
21. Thread the **Jam Nut (SAS)** [11] onto the **Spring Adjusting Screw (SAS)** [10].
22. Thread the **SAS** [10] into the **Bonnet** [2] to the position indicated in disassembly notes.
23. Valve should now be ready for testing, final assembly and sealing.
24. Following testing, place the **Cap Gasket** [21] on the **Bonnet** [2].
25. Thread the **Cap** [3] onto the **Bonnet** [2] and wire-seal.

NOTES:

1. **For Balanseal Bellows construction** please see Appendix B for assembly instructions.
2. **For O-Ring seat construction** please see Appendix C for assembly instructions.
3. **For open lever, packed lever and bolted cap construction** please see Appendix D for assembly Instructions.

10. Setting, Testing and Adjustments

Equipment

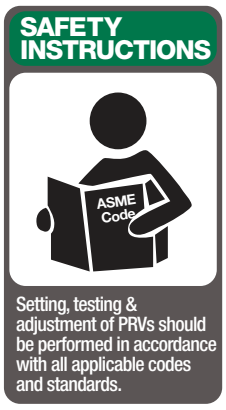
Air testing is the usual method of testing and setting pressure relief valves; however, valves should be set and tested using the approved media according to applicable codes and standards. A pressure source supplies air to a test drum usually 1-1/2 cubic feet internal volume. The air pressure to the test drum is controlled by a quick opening valve (approximately 1 inch). The valve being tested is mounted directly on the test drum without restrictions. If considerable numbers·of valves are tested, it is advisable to provide an air receiver between the compressor and the quick opening valve. This arrangement allows a small-volume high-pressure compressor to store air during off-hours.



Adjustments & Performance

The use of the correct spring is a matter of critical importance. Attempting to employ a spring below its rated pressure range may result in a loss of lift with resulting loss of capacity and a generally sluggish valve action. Using a spring above or below its rated temperature range may cause a change in spring characteristics and possibly failure of the spring itself. Before changing the set pressure of any valve verify that the new pressure is within the range of the spring and valve construction. When raising the set pressure, check the applicable design code and the design pressure of the protected equipment to ensure compliance with equipment design and local requirements. Before reducing the set pressure, make certain that the capacity at the reduced pressure is sufficient for the protection of your equipment. Valves which are properly installed on steam, gas, or vapor services will relieve with a pronounced pop when opening. After the excess pressure has been relieved, the valve will generally reseat at approximately 5% to 7% below the set pressure. Actual blowdown will vary with each valve and installation. There is generally no distinct pop with liquid service relief valves as the opening will generally be proportional to the rise in pressure. It is important for blowdown rings to be adjusted carefully and accurately in accordance with the table values.

Procedure



To properly test a valve, the test drum pressure is brought up to about 90% of the set pressure of the valve. The quick opening valve is now opened sufficiently to cause the test drum pressure to continue to increase 2 psi/sec until the valve pops. A test gauge connected to the test drum in a static pressure zone will indicate the pressure the valve pops. Further spring setting adjustments may be necessary to achieve the desired set pressure of the valve. The tightness of a pressure relief valve on gas or vapor service is closely connected with the operation of the valve i.e. unless a valve opens and closes sharply, it may leak. The action of such a valve depends upon the expansive and reactive forces of the flowing medium (gas or vapor only) which in turn depends upon the location of the blowdown ring. Since the capacity of the test stand is considerably less than the actual valve capacity, it is essential that the blowdown ring be adjusted for good test stand operation. The lowest ring position that can be tolerated for a given size test drum depends upon the valve size and its set pressure relative to the test drum size. Raising the nozzle ring to within two notches from touching the disc holder will obtain the maximum reaction from the smallest amount of the test fluid. However, this position may produce excessive impact and seat damage to small valves set at high pressures. Using a test gag while testing valves can reduce the damage to the seating surfaces.

Adjusting Valve to Required Set Pressure

After the valve has been reconditioned and reassembled minus the cap and/or lever assembly, it is ready for a final spring adjustment to the required set pressure. If a new set pressure is required, the limits for adjustment of the spring must be observed. It may be necessary to provide a different spring. After the jam nut is tightened, the valve should be popped at least once more to prove the accuracy of the setting.

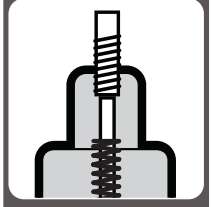
Air Test Stand Settings

For spring adjustment or checking set point on air test stands, raise the ring to a position 2 notches down from contact with the disc holder. Return ring to tabulated field setting or setting established through in-place testing before installation. Be sure to include temperature compensation of set pressure where applicable.

Liquid Service

Liquid service valves must be set on water with set pressure indicated as the first steady stream of water perpendicular to the outlet of the valve. Intermittent opening and closing indicates leakage. The reduction in inlet pressure required to reseat the valve depends on the rate of flow and operator manipulation. Set the blow down ring to the position indicated in Table 10.3. Do not attempt to adjust the blow down ring without gagging the valve first (or reducing inlet pressure to zero). Remove the gag. When the valve is first mounted there will be some air under the disc of the valve. This may cause the valve to pop open suddenly. To remove the air, lift up on the stem to let the air slowly seep out, if possible. Pressure may need to be added under the valve to assist in lifting the stem. Next, raise the pressure to the desired set point. When the pressure is within 90% of the set pressure, raise the pressure at a rate of 1 psig per 2 seconds. Adjust the spring adjusting screw until the desired set pressure is reached. We define set pressure for a liquid valve as the first continuous flow which is flowing 90 degrees from the outlet. Confirm that you have the set pressure correct by raising the pressure to where the first steady stream is evident. Then, lower the pressure until the valve re-seats. Repeat this procedure until the valve shows a consistent opening pressure.

NOTICE



When making the adjustments under pressure, be sure the valve is lightly gagged to avoid accidental popping. The gag screw must be removed immediately after use. Failure to do so will render the valve inoperable.

Securing The Blowdown Ring

The adjusted position of the ring is maintained by a blow down ring lock screw which threads into the valve body from the outside and engages notches (like gear teeth) on the outside diameter of the blowdown ring. To make an adjustment, loosen and remove the blow down ring lock screw assembly. Insert a screw driver and rotate the nearest notch toward the left to lower the ring or toward the right to raise it, counting the notches as they are moved. Reinstall the lock screw assembly, ensuring that it intercepts a notch without exerting side-pressure on the ring.

Seat Tightness Testing (Figure 10.1)

After the valve is satisfactorily checked for set pressure, it is necessary to check the valve for seat leakage. It is important to minimize leakage from pressure relief valves. Excessive leakage could lead to fouled and inoperable valves, serious product loss and could also be hazardous to personnel and equipment. The valve can be tested for tightness on the test stand by increasing the pressure on the valve to 90 percent or more of the set pressure and observing the discharge side of the valve for evidence of leakage. Methods of determining leakage are covered by applicable standards and specific user requirements.

API Standard 527 is a widely accepted standard for the procedure and acceptance criteria for assessing the seat tightness of pressure relief valves. The user should be familiar with this standard, in addition to any information presented therein. The following seat tightness methods and requirements are in general compliance with API Standard 527.

Air Testing

All openings from the secondary pressure zone shall be closed before counting the bubble rate. This includes such items as caps, drain holes, vents and outlets. A soap solution or equivalent test shall be applied to secondary joints to detect escape of air other than that being measured. Seat tightness tests are normally conducted with pressure at the pressure relief valve inlet held at 90 percent of the set pressure immediately after popping. For valves set at 50 psig or below, the pressure shall be held a 5 psig below the set pressure immediately after popping. Before starting the bubble count, the test pressure shall be applied for a minimum of: 1 minute for valves of inlet sizes 2 inches and smaller; 2 minutes for sizes 2-1/2, 3, and 4 inches; 5 minutes for sizes 6 inches and larger.

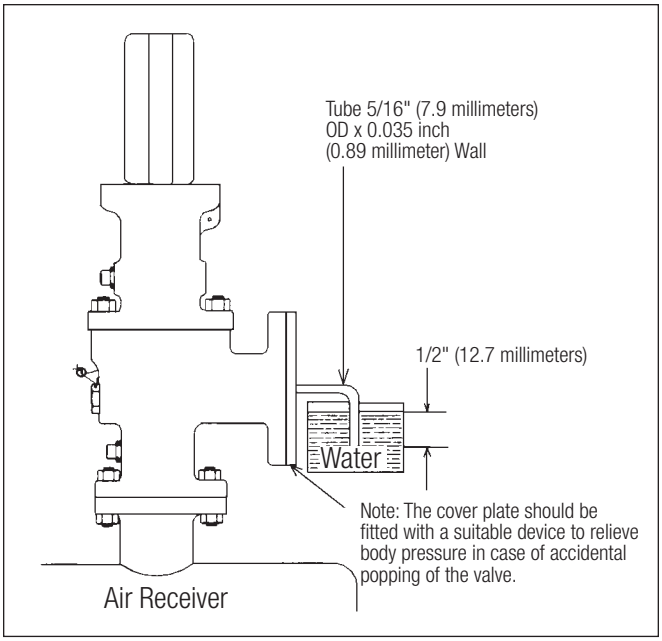


Figure 10.1

Air at ambient temperature shall be used as the pressure medium. The valve shall be observed for leakage for at least 1 minute. The leakage rate in bubbles per minutes shall not exceed the numbers listed in Table 10.1. For an 0-ring seated valve, there shall be no leakage for 1 minute (Zero bubbles per minute @ 95% of set pressure). (Figure 10.1)

Maximum Seat Leakage Rates for Metal-Seated Pressure Relief Valves

Set Pressure psig	Leakage Rate (Bubbles per Minute)	
	F Orifice and Smaller	G Orifice and Larger
15-1000	40	20
1500	60	30
2000	80	40
2500	100	50
3000	100	60
4000	100	80
5000	100	100
6000	100	100

Table 10.1

Steam Testing

Steam service pressure relief valves which are set and adjusted on steam shall be leak-tested on steam visually using a black background. There shall be no visible leakage from the valve outlet when the inlet pressure is held at 90% of the set pressure after popping and reseating. For set pressure below 50 psig this test shall be conducted at 5 psig below set pressure. The valve shall be observed for leakage for at least 1 minute. This criteria applies to both metal and o-ring seated valves.

Liquid Testing

Liquid service pressure relief valves are set and adjusted on water shall be leak-tested on water at near ambient conditions. Before starting the seat tightness test, the set pressure shall be verified, and the outlet body bowl shall be filled with water, which shall be allowed to stabilize with no visible flow from the valve outlet. The inlet pressure shall be increased to the test pressure. The valve shall be observed for 1 minute at the test pressure. For valves set at 50 psig or below, the pressure shall be held at 5 psig below the set pressure. Above 50 psig set pressure hold the pressure at 90% of the set pressure.

Blow Down Ring Settings: Air, Gas, and Vapor Applications

Orifice	Set Pressure Range, psig								
	15 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 - 800	801 - 1000	1001 & Up
D_1	3 2	4 2	6 3	7 4	7 4	9 5	9 5	9 6	10 7
E_1	5 2	9 2	12 3	15 4	15 4	18 5	18 5	19 6	20 7
F	2	3	4	5	5	7	8	9	10
G	3	4	5	6	6	8	9	10	11
H	3	4	5	6	6	8	9	10	11
J	3	5	5	6	6	8	9	10	11
K	4	5	6	7	7	9	10	11	12
L	4	6	9	9	9	10	10	11	12
M	4	6	12	12	12	12	12	12	12
N	5	10	15	15	15	15	15	15	15
P	6	16	20	20	20	20	20	20	20
Q	6	16	20	20	20	20	20	20	–
R	4	16	20	20	–	–	–	–	–
T	4	16	20	–	–	–	–	–	–
U	4	16	20	–	–	–	–	–	–

Blow Down Ring Settings: Steam Applications

Orifice	Set Pressure Range, psig								
	15 - 100	101 - 200	201 - 300	301 - 400	401 - 500	501 - 600	601 - 800	801 - 1000	1001 & Up
D_1	3 2	4 3	6 4	7 5	7 6	9 7	9 8	9 9	10 10
E_1	5 2	3 2	12 4	15 5	15 6	18 7	18 8	19 9	20 10
F	2	4	5	6	7	8	9	10	12
G	3	5	6	7	8	9	10	11	13
H	3	5	6	7	8	9	10	11	13
J	3	6	6	7	8	9	10	11	13
K	4	6	7	8	9	10	11	12	14
L	4	7	7	8	9	10	11	12	14
M	4	7	7	8	9	10	11	12	14
N	4	7	7	8	9	10	11	12	14
P	4	7	7	8	11	10	11	12	14
Q	4	8	9	10	11	12	13	15	–
R	4	8	9	10	–	–	–	–	–
T	4	8	9	–	–	–	–	–	–
U	4	8	9	–	–	–	–	–	–

Table 10.2

Note 1: Use the second row only for “D” & “E” orifice valves purchased before July 1, 1993

For both metal and O-Ring seated valves in liquid service, Farris' standard acceptance criteria is no visible leakage at 90% of set pressure for valves with a set pressure of 50 psig and higher. For valves with a set pressure below 50 psig, the test is performed at a 5 psig differential. API Standard 527, Seat Tightness of Pressure Relief Valves, does allow for a more liberal leakage acceptance criteria of 10 cubic centimeters per hour per inch of inlet size. Ultimately, the acceptance criteria selected and the amount of leakage that can be tolerated is the responsibility of the end user based on his experience with the specific application.

Blowdown Ring Setting

Tables 10.2 and 10.3 give blow down ring settings in the number of notches down from disc holder contact. The higher the ring, the sharper the pop and longer the blowdown. The lower the ring, the poorer the pop, the shorter the blowdown.

The 2600L series is now ASME Code Section VIII Certified for use in air, steam and vapor service. Regardless of the service, 2600L Series valves should be adjusted using the liquid service blowdown ring settings in Table 10.3.

Liquid Service Applications

Orifice	Notches
D/E	2
F	3
G/H/J	4
K/L	8
M/N/P	12
Q/R/T/U	20

Table 10.3

Field Settings

The above settings are final average field settings for good performance under actual operating conditions on the installation. Use recommended number of notches, or maximum adjustment possible if less than table. Finer adjustments may be desirable or necessary because of individual piping and service differences. On applications where the valve will operate at substantially reduced flow, fewer notches may help eliminate chatter and ensure seat tightness.

Compensation for Temperature

Any increase in temperature causes a reduction in set pressure of a safety-relief valve. The primary factors are the linear expansion of the body and top works, which reduces the spring loading, and the direct effect of temperature on the spring itself.

It is customary to compensate for this effect by increasing the setting when a valve is set at ambient conditions on a test stand and the valve is intended for a higher operating temperature in service. Although the adjustment is approximate and may be outweighed by other differences caused by variations in media and blowdown ring adjustments, compensation for temperature as an independent variable improves the accuracy of the setting. It is not recommended to reduce a spring setting for valves intended for sub-zero service. (Table 10.4)

CDTP Temperature Compensation

Normal Operating Temperature		% Increase in Set Pressure at Atmospheric Temp.
°F	°C	
-400 to 300	-240 to 149	none
301 to 600	150 to 316	1%
601 to 900	317 to 482	2%
901 to 1200	483 to 649	3%

Table 10.4

COLD DIFFERENTIAL TEST PRESSURE (CDTP) is the inlet pressure at which the valve is adjusted to open on a test stand at ambient temperature conditions, discharging to atmosphere. Computation includes compensation for constant back pressure (if required) and inlet operation temperature. Cold Differential Test Pressure is the sum of the Spring Selection and the Increase in Setting to compensate for temperature. The abbreviation is Cold Set. (Table 10.4)

Compensation for Backpressure

Back Pressure is the pressure existing at the valve outlet and in the valve outlet and in the downstream portion of the valve body. It may be superimposed, built-up, constant, or variable. The spring setting should be compensated for constant and superimposed back pressure, except for BalanSeal valves. For these type valves, variable back pressure is not compensated for, but the maximum pressure limit of the bellows is stamped on BalanSeal tag (Figure 1.1).

Operating Differentials

The variety of service conditions which a pressure relief valve is subjected to precludes a rigid set of rules. Operating difficulties can be minimized by providing as much differential as possible for known conditions on a particular application. Table 10.5 lists the suggested minimum differentials.

Final Notes

Once your valve has been assembled and tested make sure that you have completed all necessary records before placing it back in service. These records are important for the effective future use of the valve. They will provide some guidance as to when to retire valves and replace components as well as providing the historical record of the conditions and services under which the valve operated. A sample maintenance record appears in Appendix F which can be photocopied and used for this purpose.

The valve should be properly installed in service or prepared for storage. If the valve is to be stored the inlet and outlet of the valve should be covered to protect against any foreign matter entering the valve.

Set Pressure Tolerance And Operating Differentials: Gases, Vapors, and Liquids

	Set Pressure psig	Set Pressure Tolerance (+) or (-)	Minimum Differential Suggested (Gases & Vapors)	Minimum Differential Suggested (Liquids)
Metal Seat Soft Seat	15 to 70	2 psi	5 psi	5 psi
Metal Seat Soft Seat	71 to 1000	3%	10%	10%
Metal Seat Soft Seat	1001 to 6000	3%	10%	10%

Table 10.5

11. Troubleshooting

Chatter

The valve is oversized for installation.
If the inlet capacity is less than 25% of the valve capacity there will be a tendency for the valve to chatter.

The inlet piping is of excessive length or the inlet pipe diameter is less than the inlet size of the valve.
Design inlet piping systems so that the pressure drop to the valve is less than 3%. The inlet pipe diameter should be at least the inlet size of the valve.

The outlet piping is of excessive length or the diameter is less than the valve flange size.
Design outlet piping so that the diameter is at least the outlet size of the valve and that pressure on the outlet does not build up causing the valve to shut.

Incorrect Set Pressure

Misreading the nameplate
Always compensate for backpressure and temperature when bench testing the safety-relief valve by following the Cold Differential Test Pressure.

The blowdown ring position changed
Check that the lock screw stud has engaged between the teeth on the blowdown ring to prevent rotation. This could also cause erratic blowdown characteristics as well as leakage.

Internals are misaligned.
See section on leakage.

Jam nut is loose.
Tighten jam nut.

Rough handling.
A safety-relief valve is a precision instrument and should be handled with care. It is also recommended that the valve be popped once or twice to realign the parts after rough handling.

Pressure surge at inlet.
Sudden impact of a fluid may cause the valve to open prematurely. Pressure build-up should be gradual.

The valve contains a bellows and the bonnet is not vented.
Remove bonnet pipe plug so that the bonnet is exposed to atmospheric pressure.

Leakage

The seats are damaged.
Lap the seats to remove the damage. If the scratches are deep, machining may be required. Remove any foreign particles from the system to prevent scoring the seats.

The system operating pressure is too close to the valve set pressure.
Always have at least 10% (or 5 psig, whichever is greater) differential between operating pressure vs. set pressure for metal seated and soft seated valves. See Table 10.5.

Misaligned lifting gear.
Adjust the stem test washer so that there is 1/8 inch clearance between either the cam or lever and the stem test washer. See Appendix D.

Horizontal mounting.
Safety-relief valves must be mounted with the stem in the vertical plane. If mounted horizontally the valve will experience excessive friction on the guides and will not align properly.

Lock screw stud not adjusted properly.
Adjust the length of the lock screw stud so that it does not press into the blowdown ring causing misalignment.

Misaligned internals.
Disassemble valve and check all universal ball joints, flatness of disc and nozzle seat and repair or replace.

Other.
Check for bent stem, springs with uneven ends or out of alignment. A common cause of bent stems is overgagging. Test gags are designed to be finger tightened only.

Blowdown

Blowdown is excessive/the valve is hanging up
Lower the blowdown ring until the desired blowdown is achieved. Also check for dirt or other foreign material in the seating area or on the guiding surfaces.

Blowdown is too short.
Raise the blowdown ring to lengthen the desired blowdown.

Appendix A: Valve Terminology

Safety Valve - An automatic pressure relieving device actuated by the static pressure upstream of the valve, and characterized by rapid full opening or pop action. It is used for steam, gas, or vapor service.

Relief Valve - An automatic pressure relieving device actuated by the static pressure upstream of the valve which opens in proportion to the increase in pressure over the opening pressure. It is used primarily for liquid service.

Safety Relief Valve - An automatic pressure actuated relieving device Suitable for use as either a safety or relief valve, depending on application.

Pressure Relief Valve - A pressure relief valve is a pressure relief device which is designed to reclose and prevent the further flow of fluid after normal conditions have been restored.

Set Pressure - Set pressure, in pounds per square inch gauge, is the inlet pressure at which the pressure relief valve is adjusted to open under service conditions. In a pressure or safety relief valve in gas, vapor, or steam service, the set pressure is the inlet pressure at which the valve starts to discharge under service conditions.

Differential Set Pressure - The pressure differential in pounds per square inch between the set pressure and the constant superimposed back pressure. It is applicable only when a conventional type safety relief valve is being used in service against constant superimposed back pressure.

Cold Differential Test Pressure - Cold differential test pressure, in pounds per square inch gauge, is the inlet static pressure at which the pressure relief valve is adjusted to open on the test stand. This pressure includes the corrections for service conditions of back pressure or temperature, or both.

Operating Pressure - The operating pressure of a vessel is the pressure, in pounds per square inch gauge, to which the vessel is usually subjected in service. A vessel is usually designed for a maximum allowable working pressure, in pounds per square inch gauge, which will provide a suitable margin above the operating pressure in order to prevent any undesirable operation of the relief device. (It is suggested that this margin be as great as possible consistent with economical vessel and other equipment design, system operation and the performance characteristics of the pressure relieving device.)

Maximum Allowable Working Pressure - Maximum allowable working pressure is the maximum gauge pressure permissible at the top of a completed vessel in its operating position for a designated temperature. This pressure is based on calculations for each element in a vessel using nominal thicknesses, exclusive of allowances for corrosion and thickness required for loadings other than pressure. It is the basis for the pressure setting of the pressure-relieving devices protecting the vessel. The design pressure may be used in place of the maximum allowable working pressure in cases where calculations are not made to determine the value of the latter.

Overpressure - Overpressure is a pressure increase over the set pressure of a pressure relief valve, usually expressed as a percentage of set pressure.

Accumulation - Accumulation is the pressure increase over the maximum allowable working pressure of the vessel during discharge through the pressure relief valve, expressed as a percent of that pressure or in pounds per square inch.

Blowdown - Blowdown is the difference between actual popping pressure of a pressure relief valve and actual reseating pressure expressed as a percentage of set pressure or in pressure units.

Lift - Lift is the actual travel of the disk away from closed position when a valve is relieving.

Back Pressure - Back pressure is the static pressure existing at the outlet of a pressure relief device due to pressure in the discharge system.

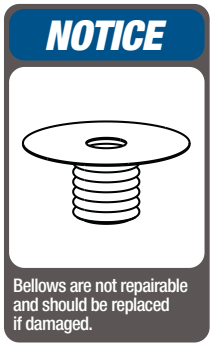
Superimposed Back Pressure - Superimposed back pressure is the static pressure existing at the outlet of a pressure relief device at the time the device is required to operate. It is the result of pressure in the discharge system from other sources when the valve is closed. Superimposed back pressure can be constant, variable or both:

- **Constant Superimposed Back Pressure** - Back pressure which does not change appreciably under any condition of operation whether the pressure relief valve is closed or open.
- **Variable Superimposed Back Pressure** - The pressure existing at the outlet of a pressure relief device, which does not remain constant when the pressure relief valve is closed.

Built-Up Back Pressure - Built-up back pressure is pressure existing at the outlet of a pressure relief device occasioned by the flow through that particular device into a discharging system.

Appendix B: Bellows Construction

Bellows require very thin materials to provide the required flexibility. This results in a delicate assembly which should be carefully handled. Do not attempt to repair a bellows assembly. Any pitting or surface corrosion are sure signs of limited service life even though the bellows may be pressure tight. All bellows assemblies should be pressure tested in accordance with Figure B.1. Any leakage should be cause for bellows replacement. For BalanSeal bellows equipped valves use the assembly fixture shown in Figure B.2. Exercise care in handling the internal assembly when equipped with a bellows as any damage to the bellows in the form of a nick or dent will render the bellows unfit for service. Bellows are not repairable.



1. Place bellows/stem retainer/disc holder assembly into bellows leak test fixture with the bellows flange at the base.
2. Seal the flange of the bellows to the base of the bellows test fixture as illustrated in Figure B.1.
3. Compress the bellows approximately 1/8 inch with a securing bar so that the bellows does not elongate when pressure is applied as in Figure B.1.
4. Fill the disc holder with water. Omit this step for D & E Balanseal designs as these designs have a one piece disc holder/stem retainer.
5. Apply 30 psig pressure to the back side of the bellows.
6. Apply soapy water to bellows exterior to check for bellows integrity.
7. If bubbles appear on bellows exterior there are pin holes or a tear. Replace bellows and repeat the procedure.
8. Check to be sure the bellows/disc holder connection is leak tight. If water in disc holder bubbles or the connection bubbles, tighten the connection or replace gasket.
9. Vent pressure.
10. Release bellows assembly.
11. Air dry bellows assembly to remove soapy water.

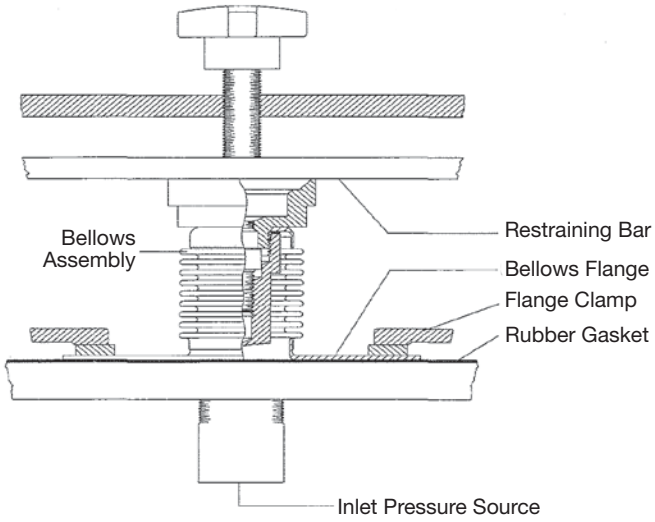


Figure B.1 Bellows Assembly Leak Test

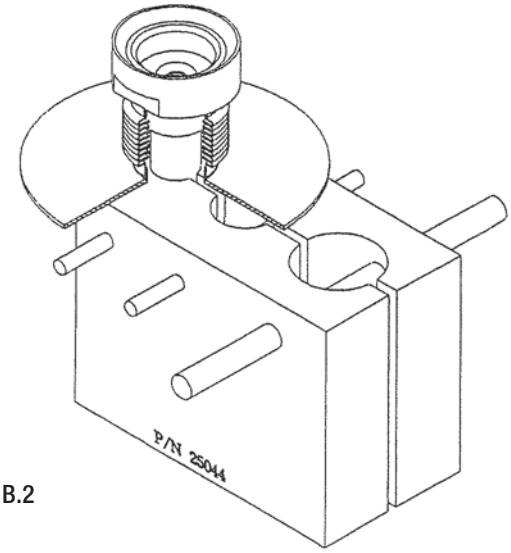


Figure B.2

BalanSeal® Bellows Construction Assembly/Disassembly Instructions

The following instructions are assembly instructions. For disassembly, reverse the order. Parts identification may be found below. Follow the same procedures as for conventional type valves except as follows:

For D and E orifice valves only (Refer to B.3 below):

1. Place the **Bellows Gasket** [16] on **Disc Holder** [6].
2. Thread the **Bellows** [15] onto the **Disc Holder** [6] and securely tighten.
3. Do not thread **Pipe Plug (Bonnet)** into **Bonnet** [2]. **Bonnet** [2] must be vented In accordance with ASME Code.

For all other orifices (Refer to B.4 below):

1. Place the **Bellows Gasket** [16] on the **Stem Retainer** [14].
2. Place the **Bellows** [15] on the **Stem Retainer** [14].
3. Thread the **Disc Holder** [6] to the **Stem Retainer** [14] using the special assembly block.
4. Thread the **Lock Screw** [19] counter clockwise until contact is made with the **Disc Holder** [6]. See **Figure B.1** for bellows leak test.
5. Do not thread **Pipe Plug (Bonnet)** into **Bonnet** [2]. **Bonnet** [2] must be vented In accordance with ASME Code.

Note: For F - K orifices, O-ring seat construction only, an additional **Disc Holder Lock Screw Gasket** must be placed between the **Stem Retainer** [14] and the **Disc Holder** [6].

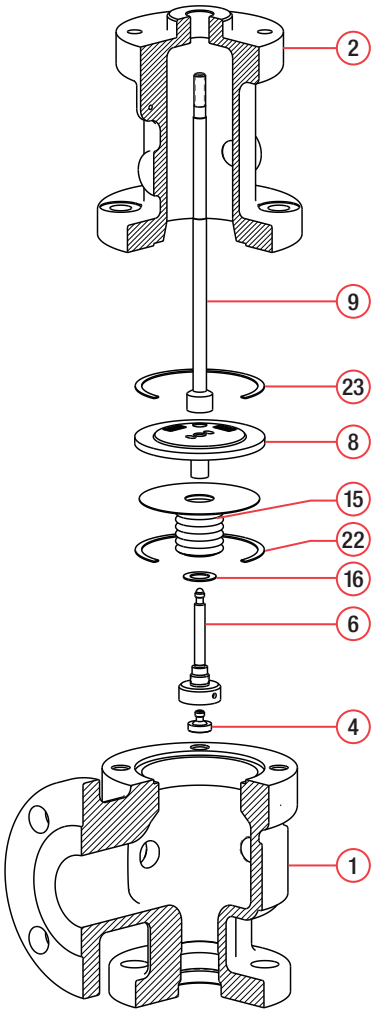


Figure B.3

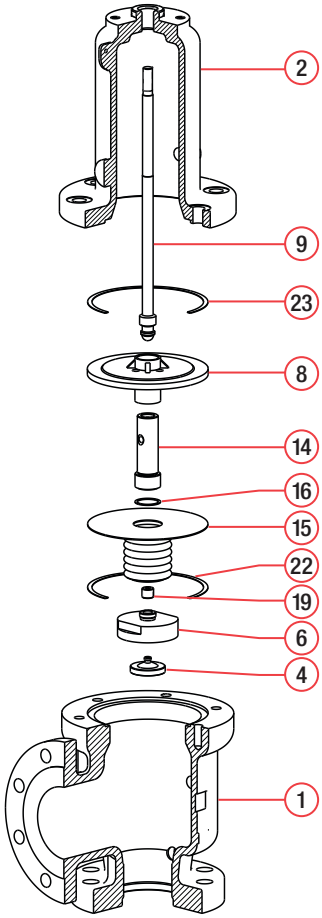


Figure B.4

Appendix C: O-Ring Construction

Due to corrosion, metal-to-metal seats can eventually leak. With the proper selection of the Farris O-ring seat pressure seal, seat tightness can be improved and maintained. Because O-rings are elastomeric, they should be handled carefully. Typically, O-rings should be replaced during your normal maintenance interval. O-rings are not repairable.

Standard seat tightness for O-ring seated valves is no leakage at 90% of set pressure for both conventional and bellows valves following Farris standard seat tightness test procedure. At set pressures of 50 psig and below, leakage test shall be made at 5 psig below set pressure.

The O-ring seat seal option is available for 2600/2600L/2600S Series valves in both conventional and bellows construction. Farris Engineering has two different O-ring designs which depend on the orifice of the pressure relief valve.

NOTICE



O-rings are not repairable and should be replaced if worn or damaged.

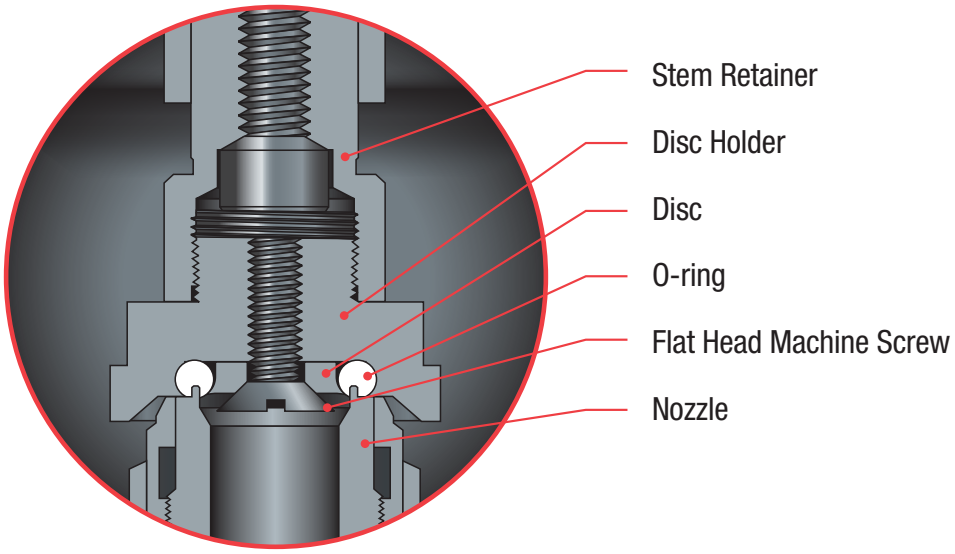


Figure C.1 – O-ring Detail D-K Orifice

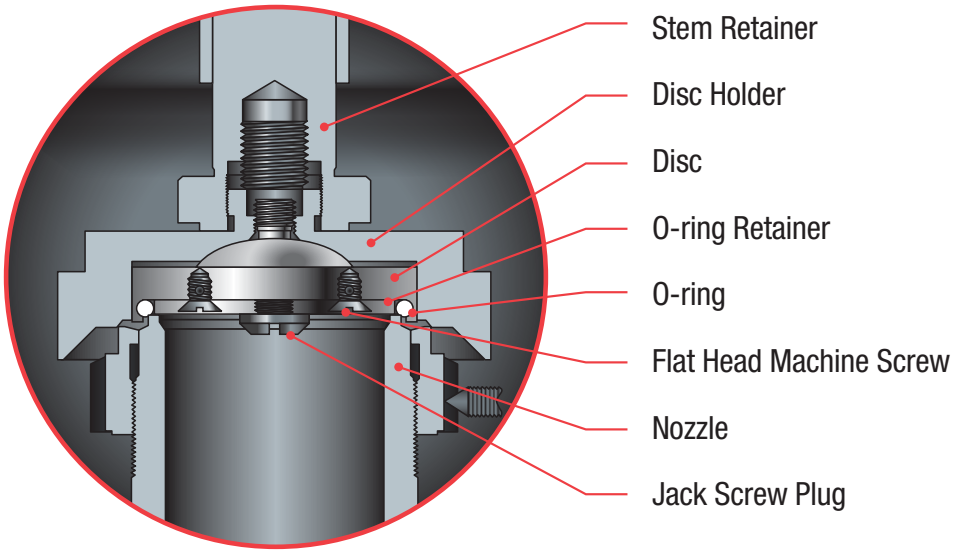


Figure C.2 – O-ring Detail L-U Orifice

O-Ring Material Selection Table

Material	Temperature Range °F	D to K Orifice		L to T Orifice	
		Set Pressure (psig)	Durometer (Shore A)	Set Pressure (psig)	Durometer (Shore A)
Viton[4]	-20 to 450	15 to 100	50	15 to 150	50
	-20 to 450	101 to 650	75	150 to 450	75
	-20 to 125	650 to 950	75	450 to 750	75
	125 to 450		90		90
	-20 to 450	950 to 1500	90	750 to 1500	90
Ethylene Propylene	0 to 350	15 to 100	50	15 to 150	50
	0 to 350	101 to 650	70	150 to 450	70
	0 to 125	650 to 950	70	450 to 750	70
	125 to 350		80		80
	0 to 350	950 to 1500	80	750 to 1500	80
Buna N	0 to 200	15 to 100	50	15 to 100	50
	0 to 200	101 to 650	70	100 to 450	70
	0 to 125	650 to 950	70	150 to 750	70
	125 to 200		90		90
	0 to 200	950 to 1500	90	750 to 1500	90
Silicone	-150 to 450	15 to 100	50	15 to 100	50
	-150 to 0	101 to 600	50	100 to 200	50
	0 to 450		70		70
	-150 to 450	600 to 850	70	200 to 450	70
	-150 to 125	850 to 1100	70	450 to 750	70
	125 to 450		80		80
	-150 to 450	1100 to 1500	80	750 to 1500	80
Kalrez	-20 to 550	15 to 200	65	15 to 150	65
	-20 to 550	201 to 650	80	150 to 450	80
	-20 to 200	650 to 950	80	450 to 750	80
	200 to 550		90		90
	-20 to 550	950 to 1500	90	750 to 1500	90
Neoprene	-45 to 300	50 to 750	70	50 to 750	70
	-45 to 300	751 to 1500	80	751 to 1500	80

General Notes:
1. Viton and Kalrez are registered trademarks of DuPont Performance Elastomers. We reserve the right to substitute comparable fluorocarbon materials.
2. PTFE seat seals available on an application basis. Consult the factory

O-Ring Seat Construction Assembly/Disassembly Instructions

The following instructions are assembly instructions. For disassembly, reverse the order. Parts identification can be found on page 31. Follow the same procedures as for conventional type valves except as follows:

To connect the **Disc Holder** to the **Stem Retainer** for O-ring valves, use the allen key sizes found in Table C.1

Allen Key Sizes

Disc Holder Lock Screw	
Orifices	**Allen Key Size**
D thru K	1/8"
L thru U	See Table 6.1

Table C.1

For D and E orifice (Bellows Construction only)(See Figure C.1):
1. Place the **O-ring** in the **Disc Holder** groove.
2. Thread the **Disc** into the **Disc Holder/Stem Retainer**.

For orifices D and E (Conventional) through K only (See Figure C.1):
1. Place the **O-ring** in the **Disc Holder** groove.
2. Place the **Disc** into the **Disc Holder**.
3. Thread the **Flat Head Machine Screw** through the **Disc** into the **Disc Holder**.

For orifices L through U only (See Figure C.2)
1. Place **Disc** in a vice with soft jaws or in a 3-jaw chuck. Be careful not to hold too tight as the **Disc** can be damaged.
2. Place the **O-ring** into the **Disc** groove.
3. Place the **O-ring Retainer** on the **Disc**.
4. Thread the **Flat Head Machine Screws** through the **O-ring Retainer** into the **Disc**.
5. Thread the **Jack Screw Plug** into the **O-ring Retainer**.
6. Thread the **Disc** into the **Disc Holder** (ensure the **Disc** is free floating).

Appendix D: Cap Construction

Section VIII of the ASME Code requires the use of a lifting device on all steam, air and hot water (over 140°F/60°C) applications. Packed levers should be used on all liquid applications or where cap tightness is a requirement. Levers should be inspected for proper operation and parts replaced as needed.

Packed Levers

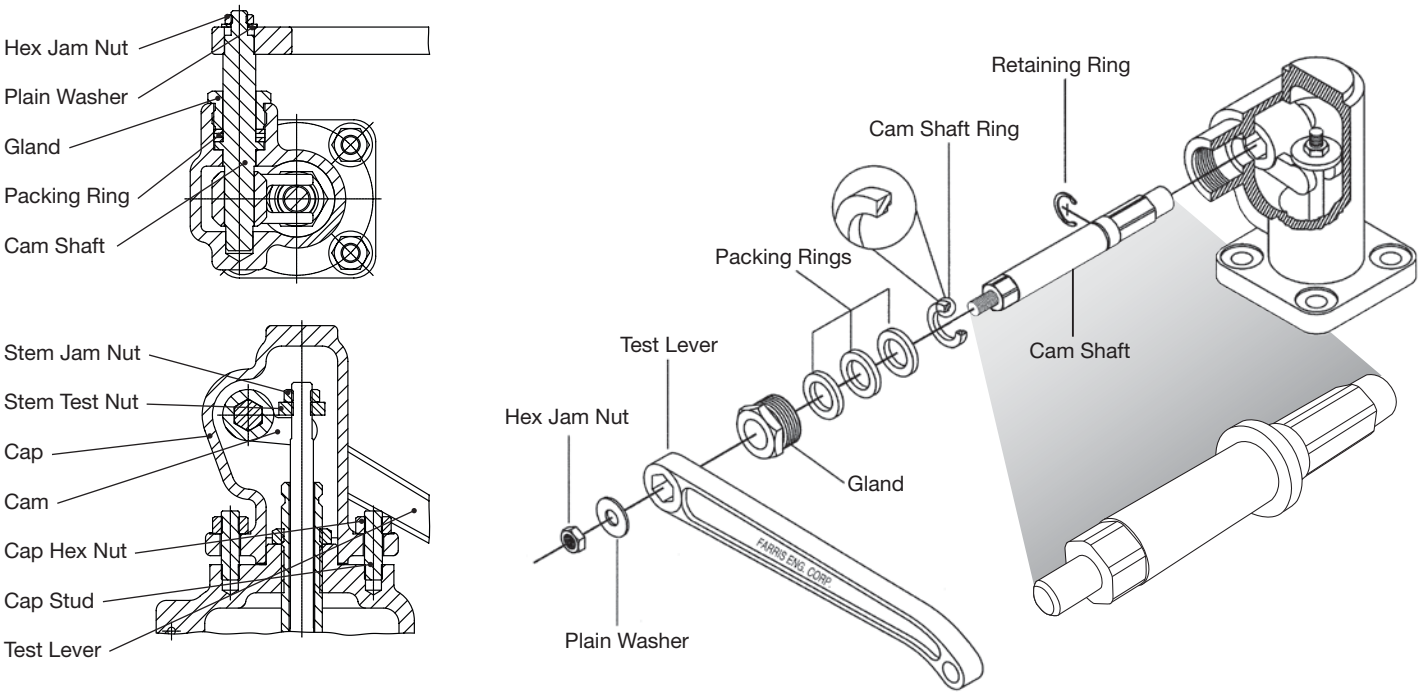


Figure D.1 – Packed Lever Cap Construction
2600 Series, All Sizes

Packed Lever Construction Assembly/Disassembly Instructions

The following instructions are assembly instructions. For disassembly, reverse the order. Parts identification may be found above. Assembly procedures for the balance of valve is identical for all cap design options: plain cap, open lever, bolted cap and packed lever.

1. Thread the **Stem Test Nut** onto the **Stem**.
2. Thread the **Stem Jam Nut** onto the **Stem**.
3. Place the **Cap Gasket** on the **Bonnet**.
4. Place the counter-bored side of the **Retaining Ring** onto the **Cam Shaft**.
5. Place the **Packing Rings** over the **Cam Shaft** and into the **Retaining Ring** cavity.
6. While holding the **Cam** in-place inside the **Cap**, slide the **Cam Shaft** through the hole in the side of the **Cap** and through the **Cam**.
7. Place the **Cap** onto the **Bonnet** ensuring that the cap protrusion is facing the valve outlet.
8. Thread the **Cap Studs** through the **Cap** into the **Bonnet** and tighten.
9. Adjust the **Stem Test Nut** until there is 1/8" clearance between **Stem Test Nut** and the **Cam**.
10. Tighten the **Stem Jam Nut**.
11. Thread the **Gland** into the **Cap**.
12. Place the **Test Lever** on the **Cam Shaft**. **Ensure that the Test Lever Is oriented away from the valve outlet.**
13. Place the **Plain Washer** over the **Cam Shaft**.
14. Thread the **Lever Hex Jam Nut** onto the **Cam Shaft**.

Open Levers

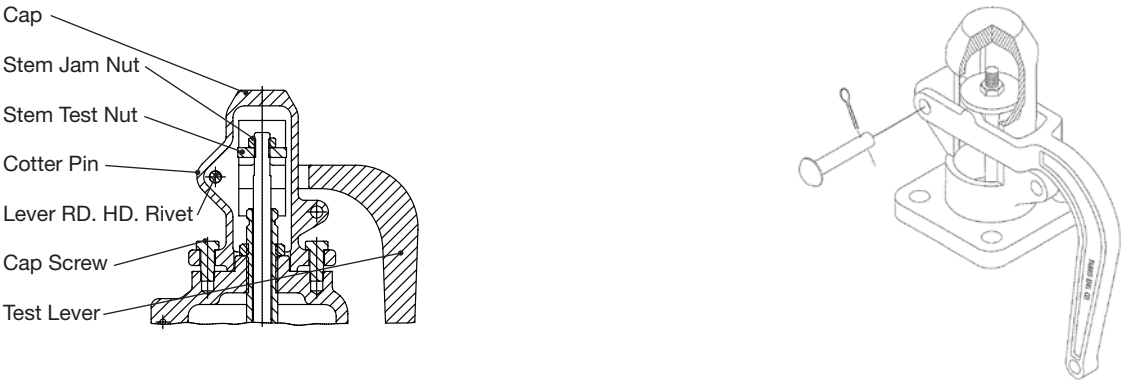


Figure D.2 – Open Lever (Single Acting)
2600 Series, Types 26( )A10, A11, A20, A21, All Sizes Except 8x10

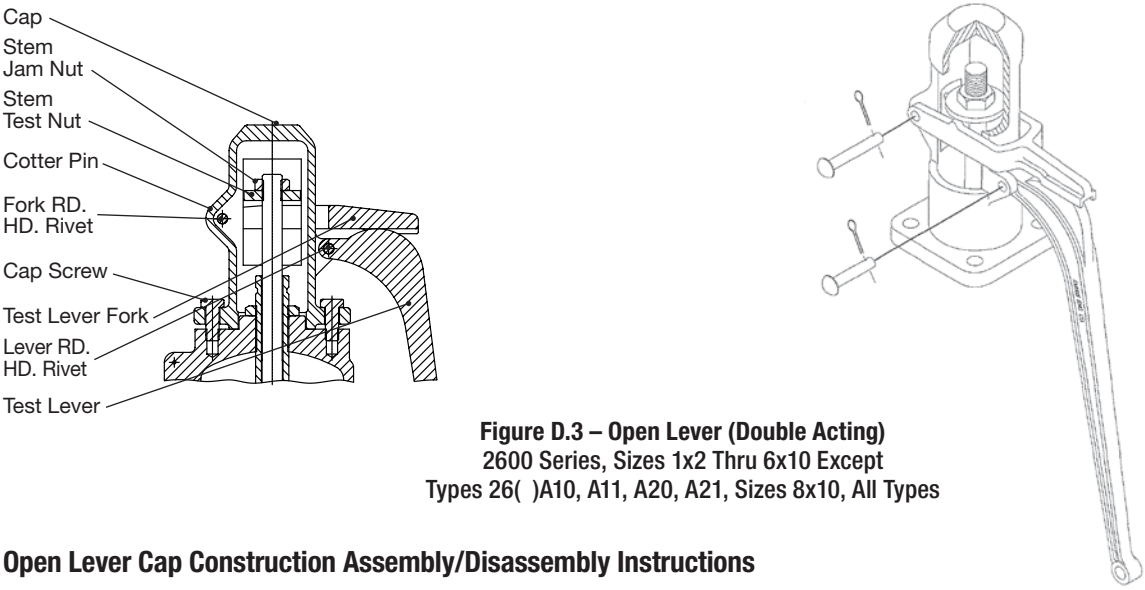


Figure D.3 – Open Lever (Double Acting)
2600 Series, Sizes 1x2 Thru 6x10 Except
Types 26( )A10, A11, A20, A21, Sizes 8x10, All Types

Open Lever Cap Construction Assembly/Disassembly Instructions

The following instructions are assembly instructions. For disassembly, reverse the order. Parts identification may be found above. Assembly procedures for the balance of valve is identical for all cap design options: plain cap, open lever, bolted cap and packed lever.

For single acting lever only:

1. Thread the **Stem Test Nut** onto the **Stem**.
2. Thread the **Stem Jam Nut** onto the **Stem**.
3. Place the **Cap** onto the **Bonnet** ensuring that the cap protrusion is facing the outlet of the valve.
4. Thread the **Cap Studs** through the **Cap** into the **Bonnet** and tighten.
5. Place the **Lever Round Head Rivet** through the **Test Lever** and **Cap** hole and secure with the **Cotter Pin**.
6. Adjust the **Stem Test Nut** so there is 1/8" clearance between the **Test Lever** fulcrum and the **Stem Test Nut**.
7. Tighten the **Stem Jam Nut**.

For double acting lever only:

1. Thread the **Stem Test Nut** onto the **Stem**.
2. Thread the **Stem Jam Nut** onto the **Stem**.
3. Place the **Cap** onto the **Bonnet** ensuring that the cap protrusion is facing the outlet of the valve.
4. Thread the **Cap Studs** through the **Cap** into the **Bonnet** and tighten.
5. Place the **Fork Round Head Rivet** through the **Test Lever Fork** and **Cap** hole and secure with a **Cotter Pin**.
6. Place the **Lever Round Head Rivet** through the **Test Lever** and **Cap** hole and secure with the **Cotter Pin**.
7. Adjust the **Stem Test Nut** so there is 1/8" clearance between the **Test Lever Fork** and the **Stem Test Nut**.
8. Tighten the **Stem Jam Nut**.

Cap Constructions
Standard Material & Material for Corrosive/Low Temperature Service - Stainless Steel

Cap Description	Part Name	Std. Materials S1, N1 -20°F to 800°F	S3 -75°F to 800°F	S4 -450 °F to 450°F
Packed Lever	Cap	Carbon Steel	316 St.	316 St.
	Test Lever	Carbon Steel		
	Cam	316 St. St.		
	Cam Shaft	316 St. St.		
	Gland	316 St. St.		
	Stem Jam Nut	316 St. St.		
	Stem Test Nut	316 St. St.		
	Packing Ring	Graphite		
	Plain Washer	Steel		
	Lever Hex. Jam Nut	Steel		
	Cap Stud	Alloy Steel	Stainless Steel	Stainless Steel
	Cap Hex. Nut	Alloy Steel	Stainless Steel	Stainless Steel
Open Lever (Single or Double Acting)	Cap	Iron		
	Test Lever	Iron		
	Test Lever Fork	Iron		
	Stem Jam Nut	316 St. St.		
	Stem Test Nut	316 St. St.		
	Cap Screw	Steel, Plated		
	Fork Rd. Hd. Rivet	Steel		
	Lever Rd. Hd. Rivet	Steel		
	Cotter Pin	Steel, Plated		

Table D.1

Appendix E: Critical Dimensions

These dimensions apply to 2600 Series valves with “A10” through “A15” serial numbers and supersede any dimensions provided in previous revisions to the manual.

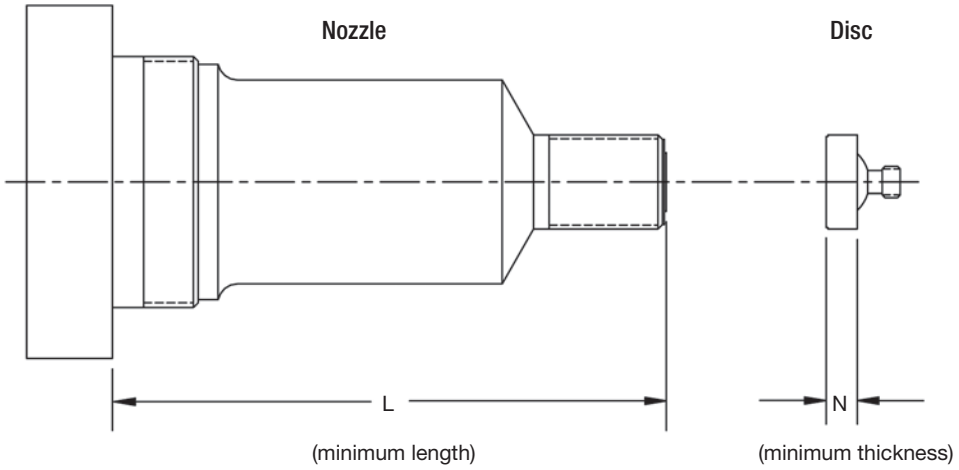
Table E.1: Metal Seats - Serial Number Suffixes: A10 & A11 / A14 & A15

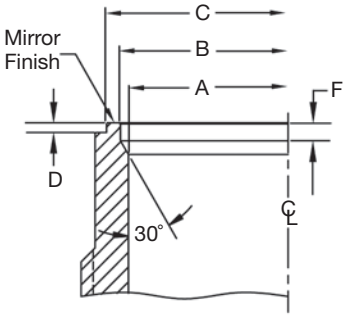
Type	Z[1]	Nozzle Dimensions								Disc Dimensions			
		A +.010 -.000	B +.000 -.005	C +.005 -.000	D min	E min	F min	L min	Nozzle Fig.	H +.000 -.005	J +.005 -.000	N min.	Disc Fig.
26D( )( )z	0 - 3	0.437	0.520	0.580	0.010	0.005	0.010	4.125	2, 3[2]	0.480	–	0.156	1
	4 - 6	0.437	0.520	0.614	0.005	–	0.010	4.375	1				
26E( )( )z	0 - 3	0.535	0.585	0.645	0.010	0.005	0.010	4.062	2	0.545	0.725	0.234	2
	4 - 6	0.535	0.585	0.685	0.005	0.005	0.010	4.375	2				
26F( )( )z[4]	0 - 1	0.687	0.720	0.780	0.005	0.005	0.010	4.250	2				
	2 - 5	0.687	0.720	0.780	0.005	0.005	0.010	4.375	2	0.680	–	0.265	1
	6	0.687	0.720	0.820	0.005	0.005	0.010	4.375	2				
26G( )( )z	0 - 1	0.844	0.885	0.945	0.010	–	0.010	4.093	1				
	2 - 4	0.844	0.885	0.945	0.005	–	0.010	4.234	1	0.845	–	0.296	1
	5	0.844	0.885	0.995	0.005	–	0.010	5.031	1				
	6	0.844	0.885	0.995	0.005	0.010	0.010	5.031	2				
26H( )( )z	0 - 1	1.054	1.110	1.170	0.005	–	0.010	4.937	1				
	2	1.054	1.110	1.170	0.010	–	0.010	4.156	1				
	3[3]	1.054	1.110	1.210	0.005	–	0.010	5.031	1	1.070	–	0.296	1
	4 - 5	1.054	1.110	1.210	0.005	–	0.010	5.031	1				
26H( )( )33		1.054	1.110	1.170	0.010	–	0.010	4.156	1				
26J( )( )z	0 - 1	1.350	1.416	1.476	0.005	–	0.010	4.125	1				
	2 - 3	1.350	1.416	1.496	0.005	–	0.010	5.187	1				
	4[3]	1.350	1.416	1.516	0.010	–	0.010	6.562	1	1.376	–	0.296	1
	5	1.350	1.416	1.516	0.010	–	0.010	6.562	1				
26J( )( )34		1.350	1.416	1.496	0.005	–	0.010	5.187	1				
26K( )( )z	0 - 3	1.612	1.730	1.830	0.010	0.010	0.010	6.546	2				
	4[3]	1.612	1.730	1.830	0.005	0.010	0.010	7.921	2	1.570	–	0.296	1
	5	1.612	1.730	1.830	0.005	0.010	0.010	7.921	2				
26K( )( )34		1.612	1.730	1.830	0.010	0.010	0.010	6.546	2				
26L( )( )z	0 - 1	2.009	2.106	2.166	0.005	0.010	0.010	6.484	2	2.056	–	0.312	1
	2 - 5	2.009	2.106	2.196	0.010	0.020	0.010	7.609	2				
26M( )( )z	0 - 4	2.257	2.366	2.446	0.005	0.030	0.010	7.546	2	2.306	–	0.375	1
26N( )( )z	0 - 4	2.478	2.598	2.678	0.010	0.030	0.010	7.546	2	2.538	–	0.375	1
26P( )( )z	0 - 4	3.004	3.080	3.200	0.010	0.030	0.010	7.500	2	3.020	–	0.421	1
26Q( )( )z	0 - 3	3.952	4.080	4.220	0.010	0.030	0.010	8.750	2	4.020	–	0.453	1
H26Q( )( )3		3.952	4.080	4.220	0.010	0.030	0.010	8.750	2				
26R( )( )z	0 - 3	4.758	4.985	5.145	0.005	0.030	0.010	8.031	2	4.895	–	0.703	1
H26R( )( )3		4.758	4.985	5.145	0.005	0.030	0.020	8.031	2				
26T( )( )z	0 - 2	6.070	6.366	6.546	0.005	0.030	0.010	10.406	2	6.256	–	0.953	1
H26T( )( )3		6.070	6.366	6.546	0.005	0.030	0.010	10.406	2				

General Notes:
1. Z column designates flange class number to be inserted in type number, example: 26D( )( )3 would designate any of the D orifice 2600 designs (conventional or bellows) with a 600# inlet flange.
2. For type 2600 (A10 & A11 Serials) see Figure 2. For type 2600L (A14 & A15 serials) see Figure 3.
3. Does not apply to valve type numbers designated for use at a temperature range of 801 to 1000 F.
4. For serial numbers suffixes; A10/G, A11/G, A14/G, A15/G, please consult factory for critical dimensions.

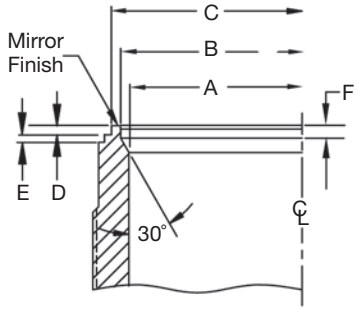
Metal Seats A10, A11, A14, A15 Critical Dimensions

Refer to Table E.1

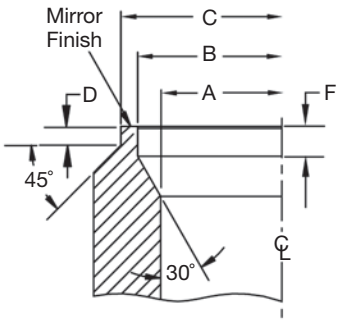




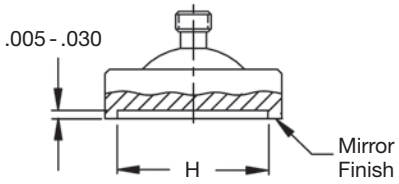
Nozzle Figure 1



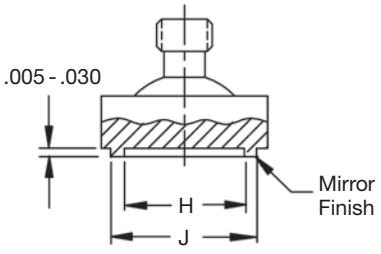
Nozzle Figure 2



Nozzle Figure 3



Disc Figure 1



Disc Figure 2

United States

A10 serial numbers 30000 and above.

A11 serial numbers 4000 and above.

Canada

A10 & A11 serial numbers C12001 and above.

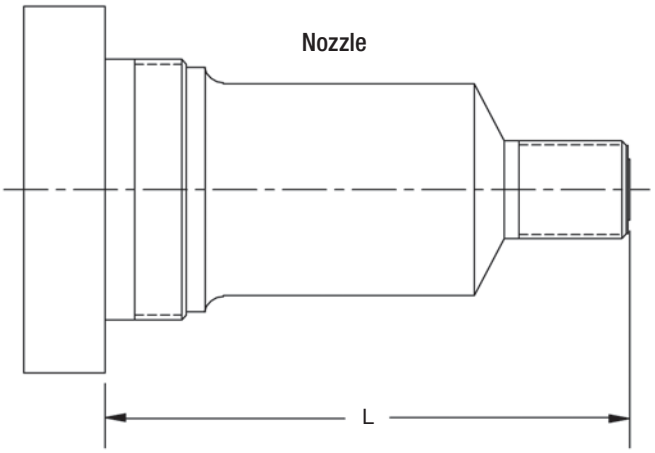
Table E.2: O-ring Seats - Serial Number Suffixes: A10 & A11 / A14 & A15

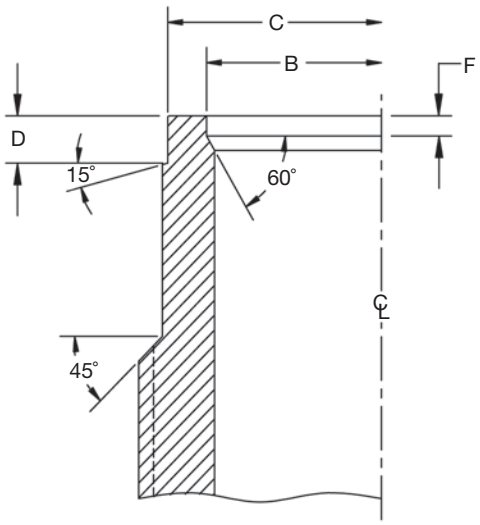
Type	Z[1]	Nozzle Dimensions					
		B +.000 -.005	C +.000 -.002	D min	F min	L min	Figure
26D( )( )z	0 - 3	0.520	0.615	0.078	0.01	4.141	4
	4[2]					4.375	
26E( )( )z	0 - 3	0.585	0.800	–	0.01	4.081	5
	4[2]					4.375	
26F( )( )z[3]	0	0.720	0.880	0.078	0.01	4.219	4
	2 - 3					4.344	
	4[2]					4.344	
26G( )( )z	0	0.885	1.052	–	0.01	4.063	5
	2 - 3					4.203	
	4[2]					4.203	
26H( )( )z	0	1.110	1.255	0.078	0.01	4.906	4
	2					4.125	
	3					5.000	
	4[2]					5.000	
26J( )( )z	0	1.416	1.568	0.094	0.01	4.094	4
	2 - 3					5.156	
	4[2]					6.531	
26K( )( )z	0 - 3	1.730	1.937	0.094	0.01	6.516	4
	4[2]					7.891	
26L( )( )z	0	2.106	2.312	0.094	0.01	6.438	4
	2 - 3					7.563	
	4[2]					7.563	
26M( )( )z	0 - 3	2.366	2.566	0.094	0.01	7.531	4
	4[2]						
26N( )( )z	0 - 3	2.598	2.824	0.094	0.01	7.531	4
	4[2]						
26P( )( )z	0 - 3	3.080	3.317	0.094	0.01	7.516	4
	4[2]						
26Q( )( )z	0 - 3	4.045	4.191	0.094	0.01	8.734	4
26R( )( )z	0 - 3	4.985	5.191	0.094	0.02	8.016	4
26T( )( )z	0 - 2	6.366	6.581	0.094	0.01	10.375	4

General Notes:
1. Z column designates flange class number to be inserted in type number, example: 26D( )( )3 would designate any of the “D” orifice 2600 designs (conventional or bellows) with a 600# inlet flange.
2. Applies to valves with the A10 & A11 serial number suffix only. All others apply to both the A10 & A11 as well as the A14 & A15 Serial numbers.
3. For serial numbers suffixes; A10/H, A11/H, A14/H, A15/H, please consult factory for critical dimensions.

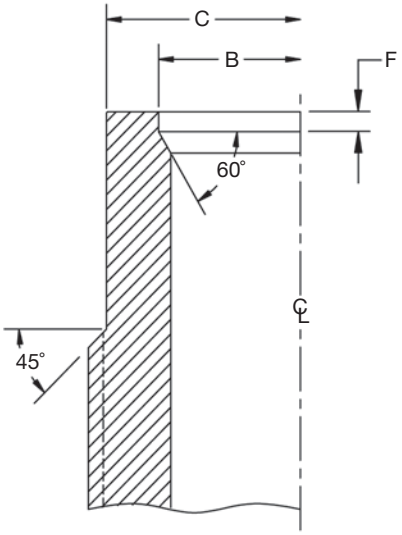
O-ring Seats A10, A11, A14, A15 Critical Dimensions

Refer to table E.2





Nozzle Figure 4



Nozzle Figure 5

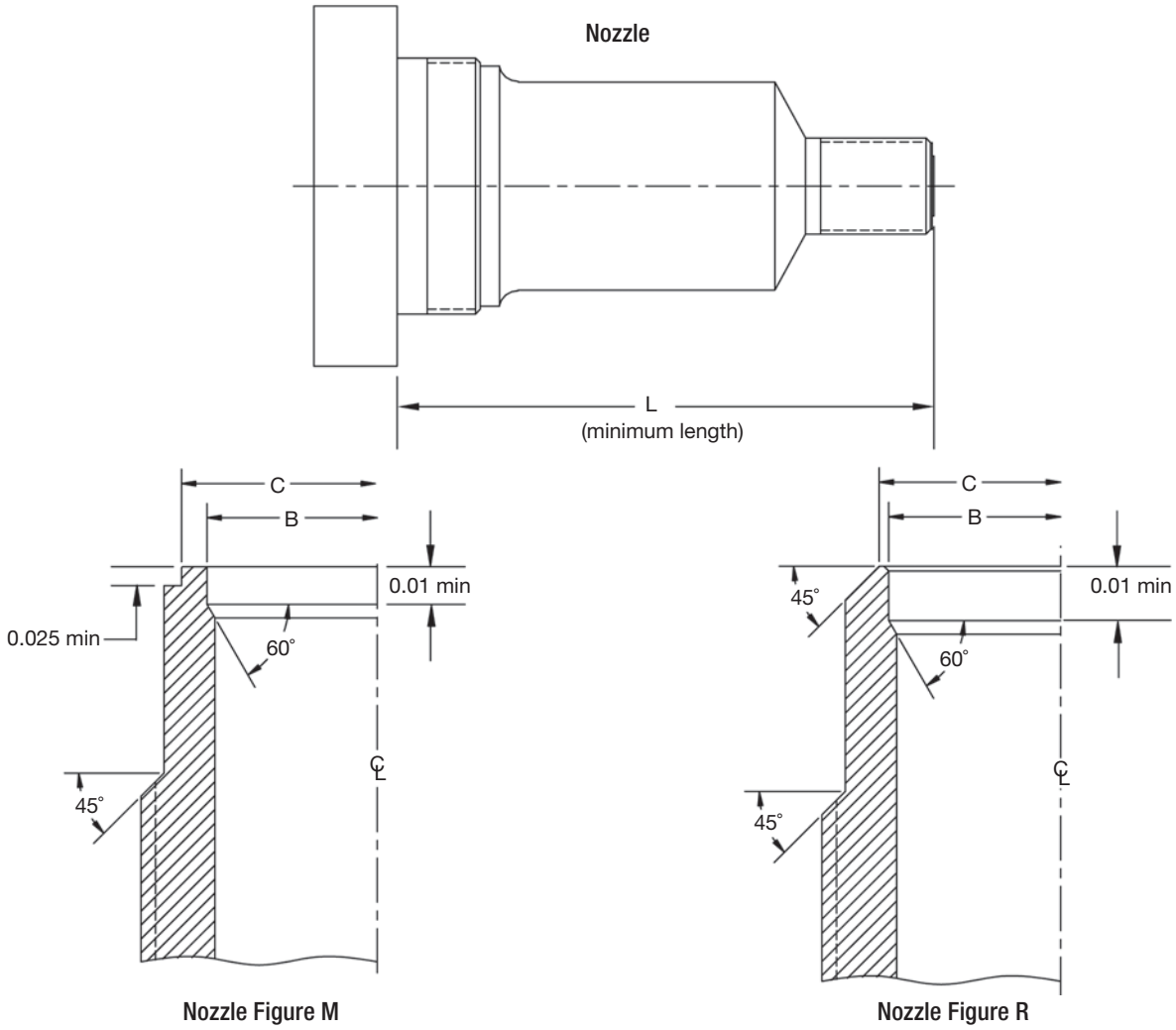
Table E.3: O Ring Seats - Serial Number Suffixes: A10/M, A11/M, A14/M, A15/M, A10/R and A11/R

Type	Z[1]	Nozzle Dimensions					
		/M[3]			/R[3]		
		B +.000 -.003	C +.003 -.000	L min	B +.000 -.003	C +.003 -.000	L min
26D( )( )z	0 - 3 4[2]	0.520	0.564	4.145 4.390	0.520	0.560	4.145 4.390
26E( )( )z	0 - 3 4[2]	0.585	0.635	4.081 4.390	0.585	0.625	4.081 4.390
26F( )( )z[4]	0 2 - 3 4[2]	0.720	0.828	4.260 4.390 4.390	0.720	0.760	4.294 4.294 4.294
26G( )( )z	0 2 - 3 4[2]	0.885	0.985	4.100 4.260 4.260	0.885	0.925	4.100 4.260 4.260
26H( )( )z	0 2 3 4[2]	1.110	1.204	4.950 4.170 5.040 5.040	1.110	1.150	4.950 4.170 5.040 5.040
26J( )( )z	0 2, 3 4[2]	1.416	1.536	4.170 5.230 6.600	1.416	1.456	4.170 5.230 6.600
26K( )( )z	0 - 3 4[2]	1.730	1.877	6.590 7.960	1.730	1.770	6.590 7.960

General Notes:
1. Z column designates flange class number to be inserted in type number, example: 26D( )( )3 would designate any of the D orifice 2600 designs (conventional or bellows) with a 600# inlet flange.
2. Applies to valves with the A10 & A11 serial number suffix only. All others apply to both the A10 & A11 as well as the A14 & A15 Serial numbers.
3. For valves with serial number suffix "/M" use figure "M". Use figure "R" for valves with serial number suffix "/R".
4. For serial numbers suffixes; A10/H, A11/H, A14/H, A15/H, please consult factory for critical dimensions.

O Ring Seats A10/M, A11/M, A14/M, A15/M, A10/R and A11/R Critical Dimensions

Refer to table E.3



Nozzle Figure M

Nozzle Figure R

Table E.4: Metal Seats - Serial Number Suffixes: A10 & A11 Interim

Type	Nozzle Dimensions								Disc Dimensions			
	A +.010 -.000	B +.000 -.005	C +.005 -.000	D min	E +.005 -.005	F min	L min	Nozzle Fig.	H +.000 -.005	J +.005 -.000	N min.	Disc Fig.
26D( )( )0	0.437	0.520	0.580	0.005	–	.010	4.125	1	0.480	0.653*	0.156	1, 2[1]
26D( )( )1	0.437	0.520	0.580	0.005	–	.010	4.125	1	0.480	0.653*	0.156	1, 2[1]
26D( )( )2	0.437	0.520	0.580	0.005	–	.010	4.125	1	0.480	0.653*	0.156	1, 2[1]
26D( )( )3	0.437	0.520	0.580	0.005	–	.010	4.125	1	0.480	0.653*	0.156	1, 2[1]
26D( )( )4	0.437	0.520	0.613	0.005	0.015	.010	4.375	2	0.480	–	0.156	2
26D( )( )5	0.437	0.520	0.613	0.005	0.015	.010	4.375	2	0.480	–	0.156	2
26D( )( )6	0.437	0.520	0.613	0.005	0.015	.010	4.375	2	0.480	–	0.156	2
26E( )( )0	0.535	0.585	0.645	0.005	–	.010	4.062	1	0.545	0.725	0.234	1
26E( )( )1	0.535	0.585	0.645	0.005	–	.010	4.062	1	0.545	0.725	0.234	1
26E( )( )2	0.535	0.585	0.645	0.005	–	.010	4.062	1	0.545	0.725	0.234	1
26E( )( )3	0.535	0.585	0.645	0.005	–	.010	4.062	1	0.545	0.725	0.234	1
26E( )( )4	0.535	0.585	0.685	0.005	0.015	.010	4.375	2	0.545	0.725	0.234	1
26E( )( )5	0.535	0.585	0.685	0.005	0.015	.010	4.375	2	0.545	0.725	0.234	1
26E( )( )6	0.535	0.585	0.685	0.005	0.015	.010	4.375	2	0.545	0.725	0.234	1

General Notes:
1. Only bellows valves use Disc Figure 2 and the 0.653 inch dimension. Conventional valves use Disc Figure 1.

These dimensions only apply to "D" and "E" orifice valves as follows:

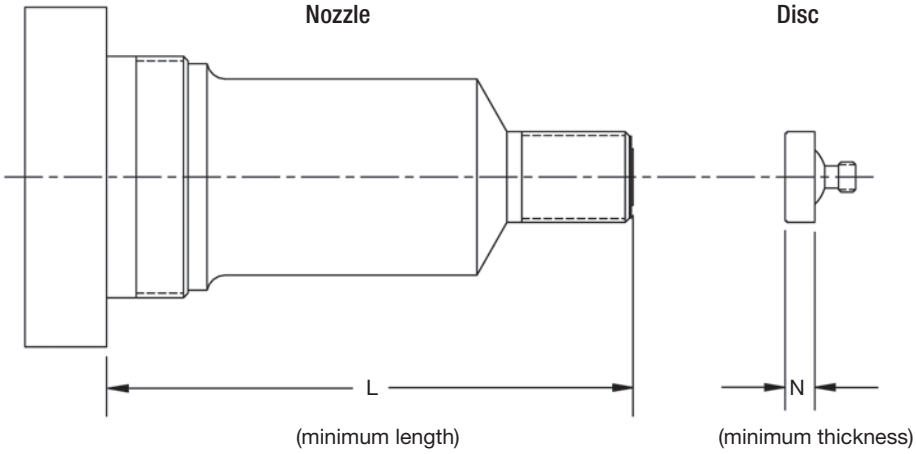
United States
A10 serial numbers below 30000.

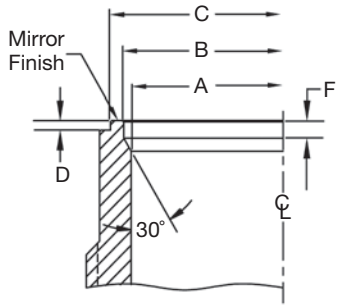
A11 serial numbers below 4000.

Canada
A10 & A11 serial numbers C12001 and above.

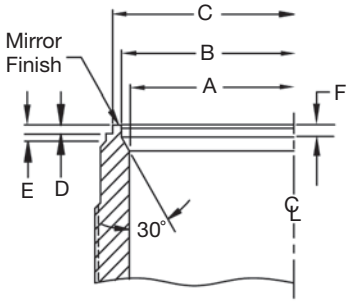
Metal Seats A10, A11 Interim Critical Dimensions

Refer to Table E.4

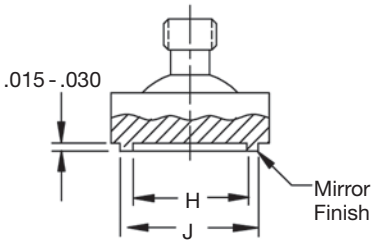




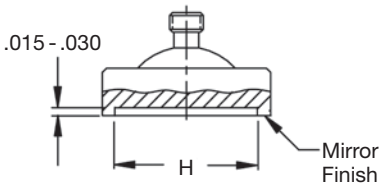
Nozzle Figure 1



Nozzle Figure 2



Disc Figure 1



Disc Figure 2

Appendix F: Maintenance & Inspection Specification Record

The information in the below form is typical of the data that should be recorded for all valves. This information should be compiled for new valves as well as valves removed from service for maintenance. This form should be photocopied and used as part of any repair shops' proper record keeping system on maintenance of valves.

Valve Type	S/N:	Relieving Pressure:	
Manufacturer:		Remarks:	
Body and Bonnet Material:			
Nozzle and Disc Material:			
Trim Material:			
Spring Material	**Spring No.**		
Carbon Steal:			
Alloy:			
Inlet:			
Orifice:			
Back Pressure:		Maintenance Engineers Phone:	
Spring Set Pressure			

No	Unit	Location

Historical Record

Date Tested	Popped	Reseat	Disposition	Condition	Repairs	Remarks

Appendix G: Required Tools

Required Tools	Orifice													
	D	E	F	G	H	J	K	L	M	N	P	Q	R	T
Open End Wrenches														
7/16"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
9/16"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
3/4"	•	•	•	•	•	•	•	•	•	•	•			
13/16"	•	•	•	•	•	•	•	•	•	•	•			
7/8"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
1"	•	•	•	•	•	•	•	•	•	•	•	•	•	•
1-1/16"	•	•	•	•	•	•	•	•	•	•	•	•	•	
1-1/8"								•	•	•	•	•	•	•
1-1/4"			•	•	•	•	•	•	•	•	•	•	•	•
1-3/8"	•	•	•	•	•									
1-1/2"				•										
1-5/8"					•									
1-3/4"						•	•	•	•	•	•			
2"								•	•	•	•	•	•	•
2-1/4"	•	•	•	•	•	•	•	•	•	•	•			
2-3/4"							•							
3-1/4"						•	•	•	•	•	•	•	•	•
3-1/2"								•	•					
3-11/16"				•	•									
3-3/4"										•				
5"							•				•			
5-1/4"						•								
5-3/4"												•		
6"													•	
6-3/16"							•	•	•	•	•	•	•	
Allen Wrenches														
3/16"	•	•	•	•	•	•								
7/32"							•	•	•	•	•			
3/8"												•	•	•
Adjustable Pin Spanners														
1-1/4" to 3"	•	•	•		•									
2" to 4-3/4"				•	•	•								
4-1/2" to 6-1/4"							•	•	•	•	•	•	•	
8-1/2"												•	•	
10-5/8"														•
Adjustable Hook Spanners														
2" to 4-3/4"								•	•	•				
4-1/2" to 6-1/4"											•			
6-1/8" to 8-3/4"												•	•	
9-1/4"														•
Adjustable Wrenches	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Flat Head Screw Drivers	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Wire Cutters	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Super Joint Pliers	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Pipe Wrench	•	•												
O-Ring Pick	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Flashlight	•	•	•	•	•	•	•	•	•	•	•	•	•	•

Appendix H: Torque Requirements

This appendix contains the minimum torquing requirements for body/bonnet and bolted/packed cap for Farris pressure relief valves.

Valve: Body/Bonnet - Bolted/Packed Cap Procedure

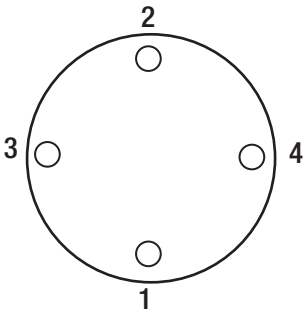
(See figures to the right):

1. Valve studs, nuts and bolts shall be visually inspected to ensure they are free of rust, dirt, or physical damage.
2. Install nuts on the studs finger-tight.
3. Tighten the nuts per the sequence shown in the diagram to the right to approximately one-half the torque value shown in Table H.1. Repeat the same sequence of tightening to the torque value shown in Table H.1. Then starting with the Nut Number 1, tighten each nut in order in a clockwise or counterclockwise direction to the value shown in Table H.1. (16 stud pattern, similar to 12 stud pattern).
4. Bolting torque tolerance: ±10%. **Measure torque with a calibrated torque wrench or torque device.**

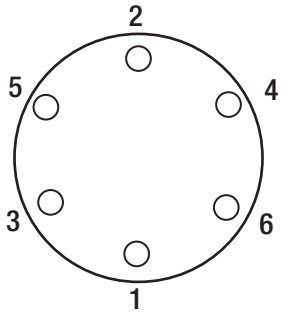
Torque Values

Stud Thread	Torque (Ft. Lbs.) to Produce Stress in Stud Bolts		
	30 Ksi Stress (B8M, B8MA)	45 Ksi Stress (B7M)	60 Ksi Stress (B7)
	Material Codes 069, 269, D53, D59	Material Codes 235, 551	Material Codes 114
7/16 - 20	20	30	40
1/2 - 13	30	45	60
5/8 - 11	60	90	120
3/4 - 10	100	150	200
7/8 - 9	160	240	320
1 - 8	240	370	500
1 1/8 - 8	355	533	710

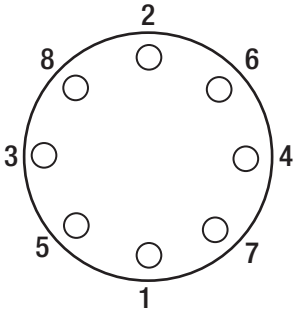
Table H.1



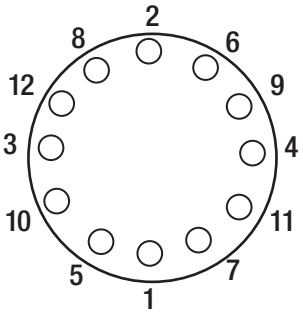
4 Studs



6 Studs



8 Studs



12 Studs

Valve Component Bolting Procedure:

1. **Blow down Ring Lock screw:**
   Lubricate lock screw with Bostik Never-Seez, except in oxygen service where Holocarbon 25-5s or equivalent is used. Torque lock screw to: 80-100 Ft. Lbs.
2. **½"-14 NPT Pipe Plug (P/N: 5098):**
   Lubricate threads with: Bostic Never-Seez. Torque pipe plug to: 18-22 Ft. Lbs.
3. **SAS Jam Nut to Bonnet:**
   Lubricate threads with Bostik Never-Seez, except in oxygen service where Holocarbon 25-5s or equivalent is used. Torque jam nut to: 25-30 Ft. Lbs.

Notes

Farris Aftermarket Services

Real Value Behind Every Valve.

Farris Engineering's aftermarket department and global FAST Center Network adds value to every Farris valve. At Farris, our work is never done. Once we sell you a valve, our FAST Team is there to keep your valves in service and your plant safe. Our FAST Centers are:



Responsive. Farris Engineering and its FAST Centers understand the need to quickly and efficiently respond to customer needs.

- **Global Access** - FAST Centers work with and in our extensive representative network, providing support to all global regions.
- **24/7 Valve Service and Replacement** - FAST Centers offer quick, localized testing and repair of valves, or the prompt installation of new Farris ASME certified valves.
- **Mobile Repair Units** - Available at select FAST Centers.

Experienced. Farris Engineering recognizes the value of having pressure relief valve experts as close to the customer as possible. This is accomplished through comprehensive training offered at the factory or on-site. FAST Center sales personnel and technicians are able to provide valuable experience to their customers.

- **Valve Expertise** - Every FAST Center is technically supported by Farris Engineering, a leader in valve design.
- **Factory Trained Technicians** - FAST technicians go through mandatory training consisting of classroom lecture and hands-on practical instruction on Farris Engineering pressure relief valves, repair procedures and applicable codes and standards. The result is a team of highly skilled technicians capable of handling both routine and complex pressure relief valve requirements around the world.
- **OEM parts** - FAST Centers use only OEM parts, restoring valves to OEM specifications. All valves are assembled and tested to ASME standards.

Dedicated. FAST Centers have committed to large investments in inventory, equipment and certifications to better support the customers in their territory.

- **Local Inventory** - Every FAST Center carries a large inventory of new pressure relief valves and spare parts, backed by a web-based global inventory to draw from.
- **ASME Certification** - FAST Centers carry all the required certifications to assemble, set and test Farris valves.
- **VR Certification** - FAST Centers have VR certification issued by The National Board of Boiler and Pressure Vessel Inspectors to effectively and efficiently repair all pressure relief valves where applicable.



CURTISS WRIGHT Flow Control Company
Farris Engineering

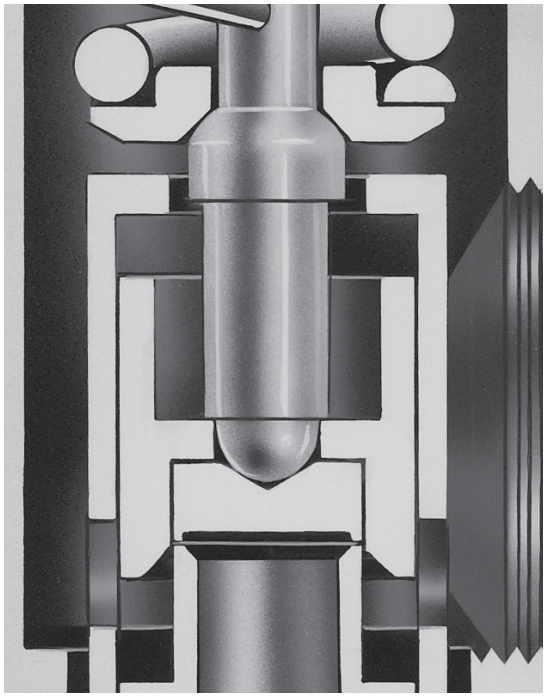
UV NV

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Series 2700
Maintenance Manual







CURTISS WRIGHT
Flow Control Company
Farris Engineering

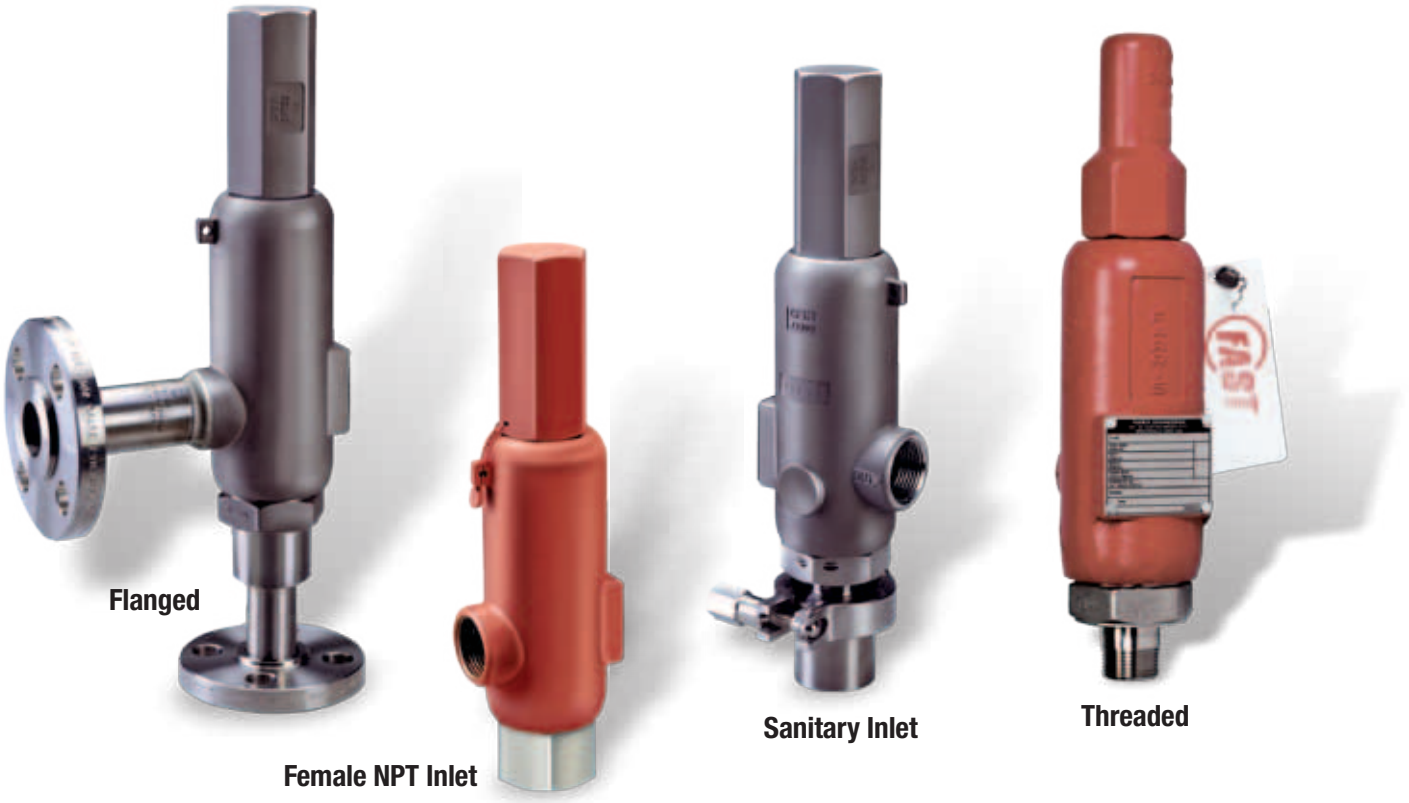


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1. Introduction

Numbering System

The chart below illustrates the Farris Series 2700 valve type numbering system. The type number is imprinted on the nameplate of every Farris Series 2700 valve and describes its construction and metallurgy. Valve types with numbers ending in "SP" are special valves. Example: 27DA23-120/SP. Contact the Farris Factory for assistance when replacement parts or maintenance are required on these valves.

27	D	A	2	3	H –	M	2	0	/S4
Series Number	**Orifice Area**	**Seat Construction**	**Inlet Size[1]**	**Outlet Size[1]**	**Special Variations**	**Inlet Connections**	**Cap Construction**	**Test Gag[2]**	**Special Materials**
27	**US Customary Units Sq. In.** **C** 0.068 **D** 0.125 **E** 0.223 **F** 0.350 **G** 0.573 **Metric mm²** **C** 43.87 **D** 80.65 **E** 143.87 **F** 225.81 **G** 369.68	**A** Metal Seat **C** Soft Seat **T** Teflon Seat	**1** 1/2" **2** 3/4" **3** 1" **4** 1-1/2"	**3** 1" **4** 1-1/2" **5** 2" **6** 2-1/2"	**H** High pressure variations of standard types **B** Balanced design[3] **D** Heat transfer fluid standard pressure **E** Heat transfer fluid high pressure	**M** MNPT **F** FNPT **1** Flanged-150RF **2** Flanged-300RF **3** Flanged-600RF **4** Flanged-900RF **5** Flanged-1500RF **6** Flanged-2500RF **0** Special **S** Socket Weld **T** Sanitary **W** Welding Nipple	**2** Plain **4** Packed Lever **7** Open Lever	**0** No Gag **1** Test Gag	**S4** Complete 316 St. St. **N1** NACE Trim: Standard **N4** NACE Trim: All St. St. **M1** Monel Body & Disc **M2** Monel Internals **M4** Complete Monel **H1** Hastelloy C Body & Disc **H2** Hastelloy C Internals **H4** Complete Hastelloy C

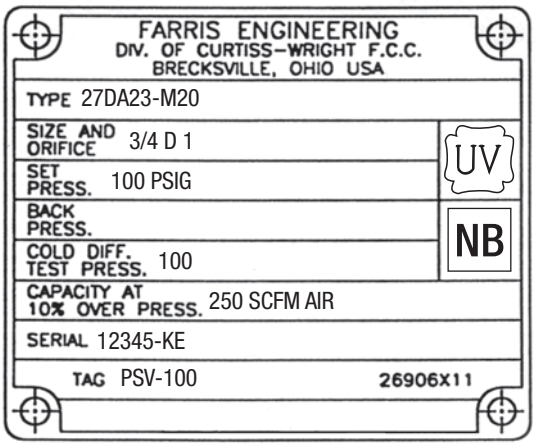


Figure 1.1 Nameplate for 2700 Series

Teflon is a registered trademark of the DuPont Company.
Monel is a registered trademark of Inco Alloys International Inc.
Hastelloy and Hastelloy C are registered trademarks of Haynes International Inc.

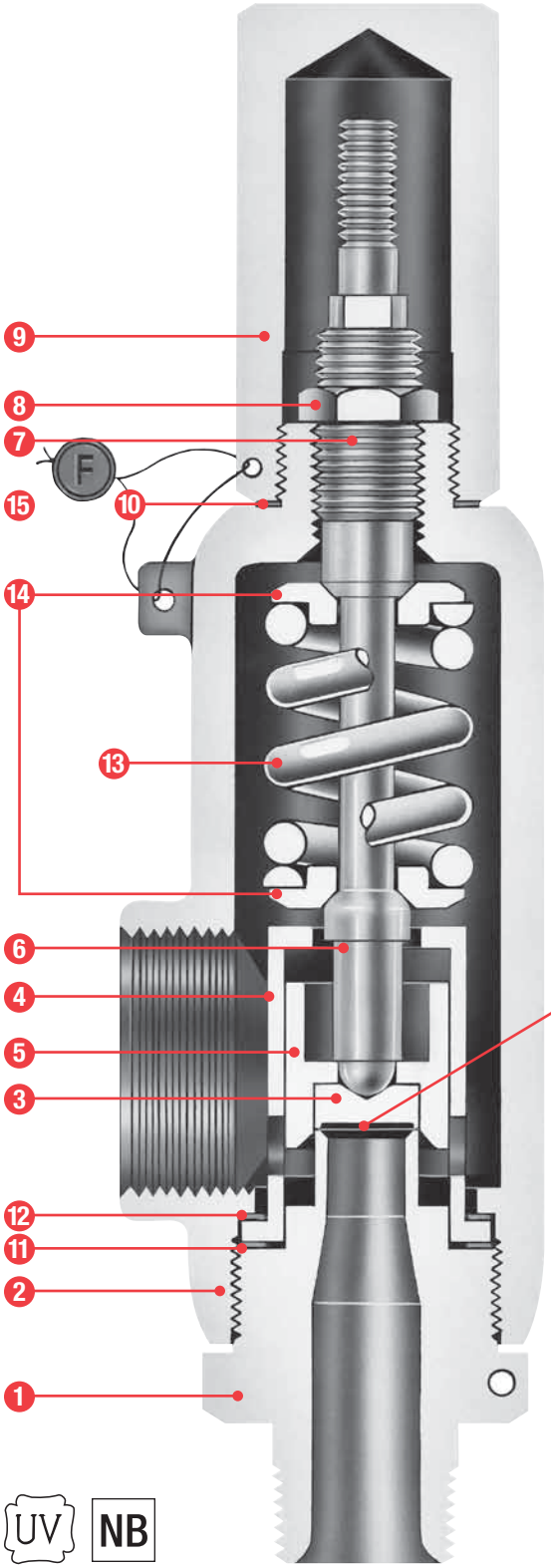
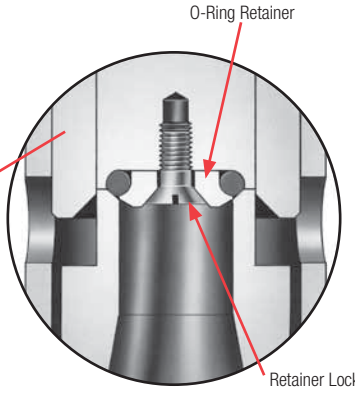


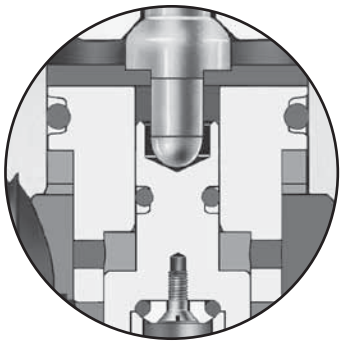
Figure 1.2
Conventional Design

Bill of Materials

Item	Part Name	Standard Material[1]
1	Body	SA-351, Gr. CF8M St. St. or SA-479 Type 316 St. St.
2	Bonnet	SA-216, Gr. WCB, Carb. St.
3	Disc	316 St. St.
4	Guide	316 St. St.
5	Disc Holder	316 St. St.
6	Stem	316 St. St.
7	Spring Adj. Screw	316 St. St.
8	Jam Nut	316 St. St.
9	Cap, Plain Screwed	Carbon Steel
10	Cap Gasket	316 St. St.
11	Body Gasket	316 St. St.
12	Guide Gasket	316 St. St.
13	Spring (-20°F to +750°F)	Chrome Alloy, Rust Proofed
14	Spring Buttons	316 St. St.
15	Wire Seal	St. St. Wire / Lead Seal
16	Nameplate (Not Shown)	Stainless Steel
17	Welding Nipple (Inlet)	316 St. St.
18	Welding Nipple (Outlet)	Carbon Steel
19	Lap Joint Stub End (Inlet)	316 St. St.
20	Lap Joint Stub End (Outlet)	Carbon Steel
21	Lap Joint Flange (Inlet)	Carbon Steel
22	Lap Joint Flange (Outlet)	Carbon Steel



O-Ring Design (Optional)



Balanced Design

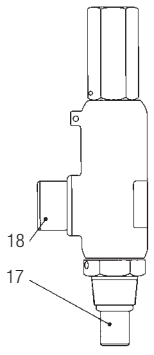


Figure 1.3

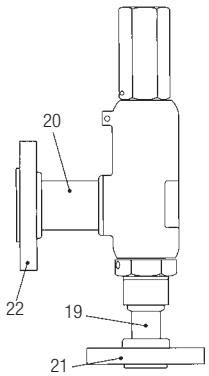


Figure 1.4

UV NB

Built in conformance to ASME Code Section VIII, capacity certified by National Board for air, gas, steam and liquid.

General Notes:
1. See 2700 Series Catalog for alternate materials of construction.

2. Disassembly of Valves

Dismantling

1. Place the valve at a suitable height. The work surface should be clean, and strong enough to handle the weight of the parts and the forces required during disassembly and assembly.
2. Mount valve vertically in a vise using the flats on the valve body.
3. Remove wire seal. Unscrew cap by turning counter-clockwise. (For packed and open lever cap construction, refer to the section on Lifting Lever Assemblies, pg 6.) Remove the cap gasket.
4. Using a smooth jaw wrench, hold the spring adjusting screw and remove the jam nut (spring adjusting screw).
5. Measure the distance from the top of the spring adjusting screw to the top of the bonnet, or count the number of turns of the spring adjusting screw. Use this measurement when reassembling the valve to approximately duplicate the original set pressure.
6. Remove the spring adjusting screw by turning counterclockwise.
7. Thread a pipe into the outlet and turn the bonnet counterclockwise, removing it from the body. Alternatively, the bonnet can be held in a vise and a wrench can be used on the body to loosen it.
8. Lift out the stem with spring and buttons attached. Remove upper button, spring and lower button from stem.
9. Remove the guide gasket.
10. Remove the body and trim assembly from the vise. Place one hand on top of the guide and invert the assembly, allowing the guide which contains the disc holder and disc to drop free of the body. Turn the guide upright and allow the disc holder to slide out of the guide, being careful not to drop either piece. Remove disc from disc holder and body gasket from the body.
11. Clean all parts and threaded surfaces thoroughly. Replace all gaskets.
12. Lap the body seat and disc surfaces. See Section 3 for lapping procedure and Appendix A for critical dimensions.

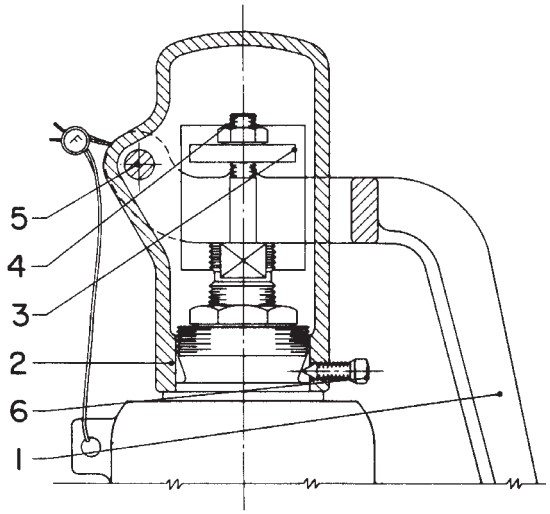
Accessories

Cap Construction: M70 Open Lever, M40 Packed Lever

Bill of Materials

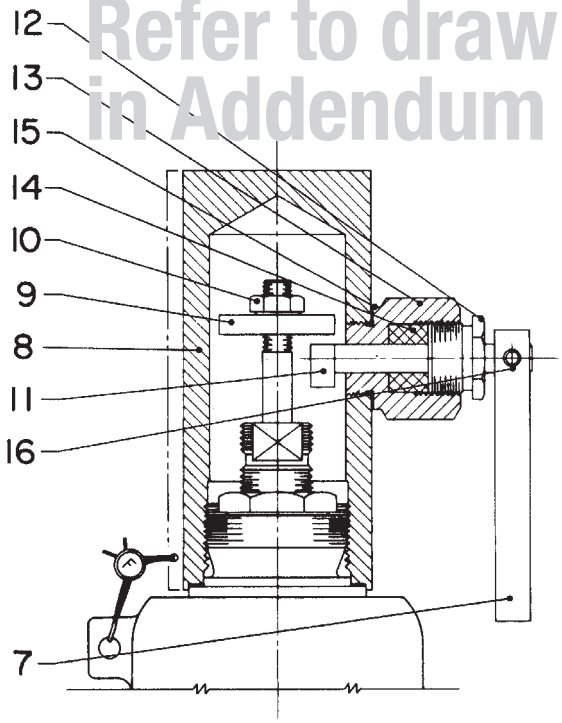
Cap Construction	Item No.	Part Name	Standard Materials[1]
M70 Open Lever	1	Test Lever	Iron
	2	Cap, Open Lever	Iron
	3	Stem Test Washer	St. St.
	4	Stem Jam Nut	St. St.
	5	Button Head Rivet	Steel
	6	Set Screw	Steel
M40 Packed Lever	7	Test Lever	Steel
	8	Cap, Packed Lever	Steel
	9	Stem Test Washer	St. St.
	10	Stem Jam Nut	St. St.
	11	Cam	St. St.
	12	Gland	St. St.
	13	Gland Nut	St. St.
	14	Packing Ring	Graphite
	15	Gland Nut Gasket	Flexible Graphite
	16	Groove Pin	Steel Plt'd

General Notes:
1. See 2700 Series Catalog for alternate materials of construction.



Open Lever Construction
Figure 1.5

Refer to drawing in Addendum



Packed Lever Construction
Figure 1.6

Lifting Lever Assemblies

A. Open Lifting Lever (Figure 1.5)

1. Remove wire seal and slide out button head rivet, releasing lever from cap. Pull lever free of cap.
2. Remove set screw from base of cap and lift cap off bonnet.
3. Holding the stem with pliers (wrap the jaws to avoid marring), remove stem jam nut and stem test washer.
4. Clean all parts and reassemble in reverse order.

B. Packed Lifting Lever (Figure 1.6)

1. Remove groove pin from lever and slide lever off the cam.
2. Remove gland from gland nut. Unscrew gland nut from cap and remove packing ring and cam. If any signs of leakage exist, replace packing ring.
3. Break wire seal and unscrew cap from bonnet. Holding stem with smooth jaw pliers, remove stem jam nut and stem test washer.
4. Reassemble in reverse order, making sure the cam lobe is pointing down. Stem test washer should be adjusted to ensure the cam will make contact with stem test washer and lift stem when lever is actuated.

3. Refacing and Lapping

Body Refacing (when necessary)

1. True up body by means of an indicator, ensuring that body bore and outside diameter are concentric with each other within 0.002" full indicator reading.
2. Machine a light cut across the seat until damaged areas are removed. The seat should be machined to the smoothest possible finish. Rigidity of the cutting tool is critical.
3. Relap to a mirror finish.
4. Discard and replace the body when the minimum requirement on dimension B, listed in Appendix A, is not met.
5. Bodies on O-ring seat valves do not require refacing. Contact surfaces should be cleaned of any dirt or scale and lightly lapped.

Disc Relapping (metal and Teflon discs)

1. The disc should not be refaced, only relapped.
2. Discard and replace the disc when disc thickness becomes less than dimension A, listed in Appendix A[1].

Lapping Compounds

The three grades of Farris Lapping Compounds are prepared especially for the requirements of pressure relief valves. These are the only compounds recommended for achieving extreme valve tightness.

Farris Lapping Compounds

Part No.	Grade	Finish	Size
18632X1(055)	3F	Roughing	1/2-oz. tube
18633X1(075)	38-500	Medium	1/2-oz. tube
18634X1(105)	38-1200	Final	1/2-oz. tube

Table 1

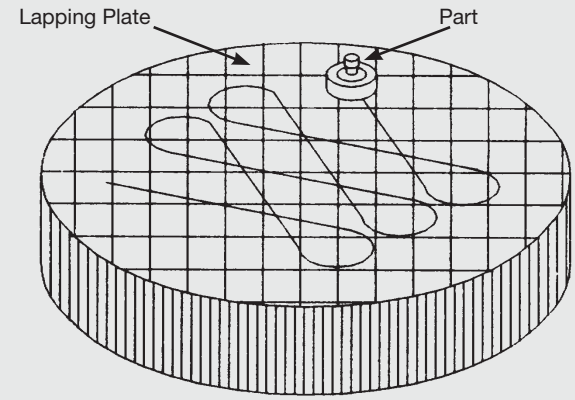


Figure 1.7

Lapping Procedures (manual)

1. Use a cast iron lapping block or Pyrex lapping glass which is known to have a perfectly flat face.

Pyrex Lapping Plates

Part No.	Material Code	Size	Thickness
7688	164	1 1/2"	1/4"
7689	164	2 1/4"	3/8"

2. Select the appropriate lapping compound. When lapping the disc, operate with a light figure eight motion over entire block surface for complete contact. See Figure 1.7. With this motion, the complete surface of the part will be evenly lapped and you will avoid wearing a groove in the block.
3. Lap disc until all blemishes and score marks have been removed. As you execute the figure eight motion, frequently lift disc away from the block to get a fresh bite on the compound. Most important, do not contaminate compounds with dirt. Keep the lid on the lapping compound when not in use. Use only clean applicators to transfer the lapping compound from jar to lapping glass. Store lapping blocks and lapping glass in clean, dust-free area.
4. Follow the same procedure for lapping body seat. Place the body on a table and a lapping block on the body. Be sure that lapping block does not tip over the side of the body (this would cause rounding of the edges). Use a light, rapid figure eight stroke, lifting the block from the body occasionally.
5. Carefully clean compound from all parts. Failure to do this may foul seat and disc surfaces. When reinstalling parts in the valve and assembling disc in the guide, be careful not to scratch either surface.
6. Clean the lapping glass.

General Notes:
1. See Appendix A for critical seat dimensions.

4. Assembly

1. Refer to Figure 1.2 for construction details, and Figures 1.5 and 1.6 for open lever and packed lever cap construction details.
2. Verify that all parts required are grouped for assembly. Visually inspect all parts, paying close attention so that the body and disc seats are clear of imperfections and all parts are clean. Special attention should also be given to the guide, checking for any dirt or scale in exit holes and undercuts, and making sure that guide surface is in good condition.
3. All threaded surfaces should be lubricated with Bostik Never-Seez or equivalent. Sealing surfaces, such as body and cap gasket, should be lightly coated with a pipe thread sealant such as Never Seez® or equivalent.

   Sliding and bearing surfaces such as disc holder/guide and disc-to-disc holder contact surfaces should be left clean and assembled without lubricants.
4. Place disc in disc holder, making sure V-notch is facing the stem radius. Insert assembly into guide. Install body gasket on the body.
5. Hold guide/disc holder assembly horizontally in your left hand and insert body, being careful not to damage disc or body seating surfaces.
6. Mount body/guide assembly vertically in a vise, gripping body securely by the flats. Install guide gasket on top of guide flange.
7. Place spring and spring buttons onto stem assembly and insert into disc holder. Hold in place in vertical position.
8. Place bonnet over assembled parts and screw down handtight onto the body. For C and D orifices, torque the bonnet to the body to 140-160 ft. lbs. For E, F, and G orifices, torque should be 180-200 ft. lbs.
9. Thread the jam nut onto the spring adjusting screw. Place spring adjusting screw over stem and into bonnet. Hand tighten spring adjusting screw until it contacts spring and lightly compresses it. Compress spring to the same point as in disassembly, if same set pressure is required. Install cap gasket.
10. Test the valve according to the procedure described in Section 5. After testing, install the appropriate cap or lever assembly.

5. Setting & Testing

Testing Procedures

Testing consists of adjusting the valve set pressure, performing a seat leakage test and a backpressure test. The set pressure test is always performed first.

Set Pressure Test

1. Set pressure testing must always be performed using the appropriate test fluid shown in Table 2.

Pressure Relief Valve Test Fluids

Service Fluid	Test Fluid
Air, gas & vapor	Air or gas
Steam	Steam*
Liquid	Water

*air may be used for ASME Code Section VIII valves.

Table 2

2. Mount valve on test stand, making a note of set pressure and cold differential test pressure (CDTP). The valve will be set at the CDTP.

All Service Fluids

Operating Temperature	% Increase in Set Pressure at Atmospheric Temperature
-450°F to 300°F (-268 °C to 149 °C)	None
301°F to 600°F (-150 °C to 316 °C)	1%
601°F to 750°F (316 °C to 399 °C)	2%

Table 3

3. Hold the stem tightly and tighten (clockwise) spring adjusting screw to increase the set pressure. Make sure stem does not rotate while tightening the adjusting screw as this can damage seat and disc.
4. Slowly raise test drum pressure and observe the opening (set) pressure. The set pressure on air and steam is the point at which it makes an audible pop. For water, the set pressure is the first continuous flow of liquid that forms a stream approximately 1/16" thick perpendicular to the outlet.
5. If necessary, reduce test drum pressure 25% below the opening pressure and adjust the spring adjusting screw. Repeat until the valve opens at the required pressure, designated as the cold differential test pressure (CDTP). The set pressure tolerance is equal to +/-3% of set pressure.

   ⚠ **Caution:** *Never adjust the spring when the pressure under the valve is near its popping point as the body seat and disc may score and/or gall. Always lower the pressure in the test vessel at least 25% below popping pressure before making adjustments. This will put a loading on the seating surfaces and prevent rotation and damage.*
6. Lock the jam nut in place and pop valve once more to ensure set pressure adjustment was not disturbed.

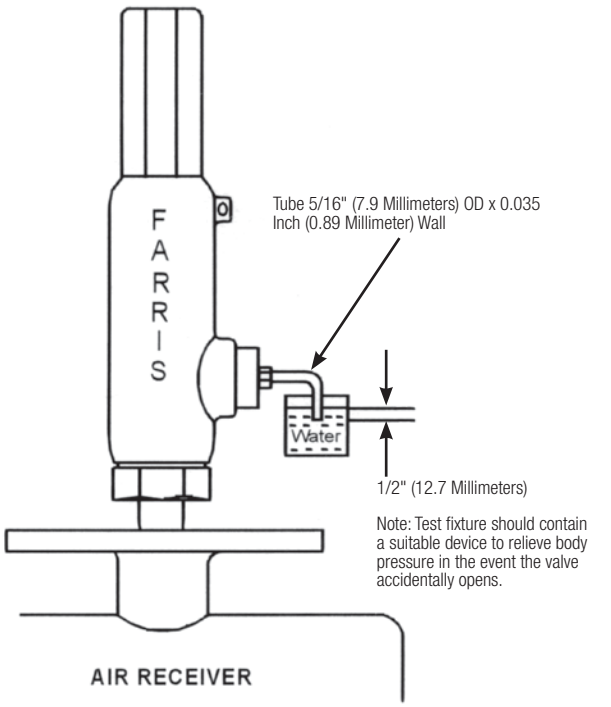


Figure 1.8

Seat Leakage Test

1. After the set pressure test, perform the seat leakage test. With the valve mounted on the test stand, attach a blind test fixture as shown in Figure 1.8 (air, gas & vapor service valves only). For steam and water seat leakage testing, see #4-5.
2. For metal and soft seated valves, the pressure is held at 90% of cold differential test pressure (CDTP) when CDTP is greater than 50 psig. For CDTP of 50 psig and below, the pressure should be held 5 psig below CDTP.
3. Bring the pressure up and hold it for one minute for valves up to 2" inlet size, two minutes for valves from 2 1/2"- 4" inlet size, and five minutes for valves with inlet sizes 6" and larger. Count the number of bubbles for one minute. See Table 3 for acceptance criteria for metal seat valves. For O-ring and soft seat valves, there should be no leakage (zero bubbles per minute).

Seat Leakage Rates for Air, Gas & Vapor Service

Set Pressure		Leakage Rate Bubbles per Minute	Std. Cubic Feet per 24 Hours	Std. Cubic Meters per 24 Hours
(psig)	(barg)			
15-1000	1.03 to 68.9	40	0.60	0.017
1500	103	60	0.90	0.026
2000	138	80	1.20	0.034
6500	448	100	1.50	0.043

Table 4

4. **Steam:** Apply test pressure as per #2 for three minutes before seat tightness test. Observe the valve for leakage for at least one minute. There should be no visible sign of leakage at the valve outlet when viewed against a black background.

   Where the Code allows ASME Section VIII steam valves to be tested on air, seat leakage may be verified using the procedure for air, gas & vapor service as listed in #1-3.
5. **Water:** Liquid valves are tested on water. Apply test pressure as per #2 for two minutes. There should be no visible sign of leakage.

   Note: When performing the seat leakage test on valves with open levers, a plain screwed test cap must be used to prevent venting of the test pressure through the top of the bonnet.

Backpressure Test

1. The backpressure test applies to all valves designed to discharge to a closed system, including valves with plain caps and packed lever assemblies. Open lever valves and valves with exposed springs (open bonnet) do not require this test.
2. Test the secondary pressure zone of all valves exceeding 1" inlet size with air or other suitable gas at a pressure of at least 30 psi. Use a suitable leak detection solution to verify tightness of all gasket joints and vent/drain plugs.
3. If leakage is detected at any location, rework the valve to eliminate the leak path.

Final Notes

Once your valve has been assembled and tested, make sure you have completed all necessary records before placing it back in service. These records are important for the effective future use of the valve. They provide guidance as to when to retire valves and replace components as well as offer a historical record of the conditions and services under which the valve operated.

The valve should be properly installed in service or prepared for storage. If the valve is to be stored, the inlet and outlet should be covered to protect against any foreign matter entering the valve.

Appendix A

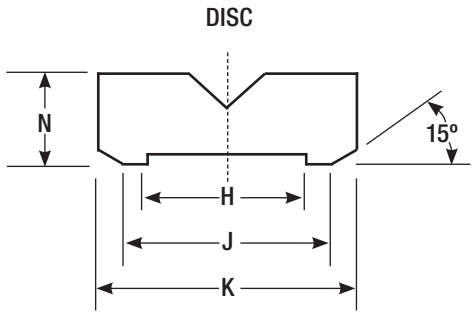
Critical Seat and Disc Dimensions

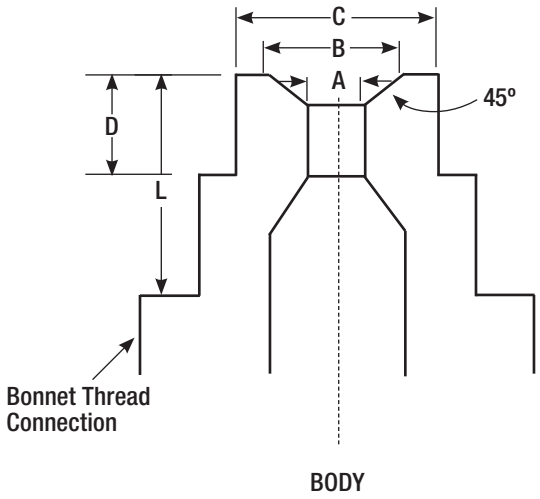
Use these dimensions when lapping and/or refacing is required. Parts must be replaced if the minimum dimension is reached as indicated in the drawings.

Refer to Addendum

Orifice Letter	Size	Body Dimensions					Disc Dimensions			
		A Min.	B +.002 -.002	C +.000 -.002	D Min.	L Min.	H +.002 -.000	J +.005 -.005	K Min.	N Min.
C	1/2 x 1 3/4 x 1 1 x 1	0.295	0.475	0.561	0.246	0.985	0.503	0.530	0.560	0.344
D	1/2 x 1 3/4 x 1 1 x 1	0.399	0.499	0.561	0.246	0.985	0.503	0.530	0.560	0.344
E	1 x 1 1/2	0.533	0.665	0.746	0.516	0.821	0.685	0.715	0.747	0.363
F	1 1/2 x 2	0.668	0.835	0.935	0.553	0.950	0.865	0.905	0.938	0.734
G	1 1/2 x 2 1/2	0.855	1.070	1.201	0.700	0.910	1.114	1.154	1.204	0.738

General Notes:
1. All dimensions are in inches.
2. Dimensions for body apply to both metal seat and O-ring seat designs.
3. Above dimensions apply to both standard and high pressure versions.





Farris Aftermarket Services



FAST Track Turnaround

Farris Engineering is dedicated to making our FAST Program work for you, which is why we have the FAST Track Center at our headquarters in Brecksville, OH. For urgent service requirements, our FAST Track Center has a large inventory of spare parts, finished valves, and dedicated machining and material resources. Farris can provide quick turnaround on inventory and machined parts for both current and obsolete valve designs.

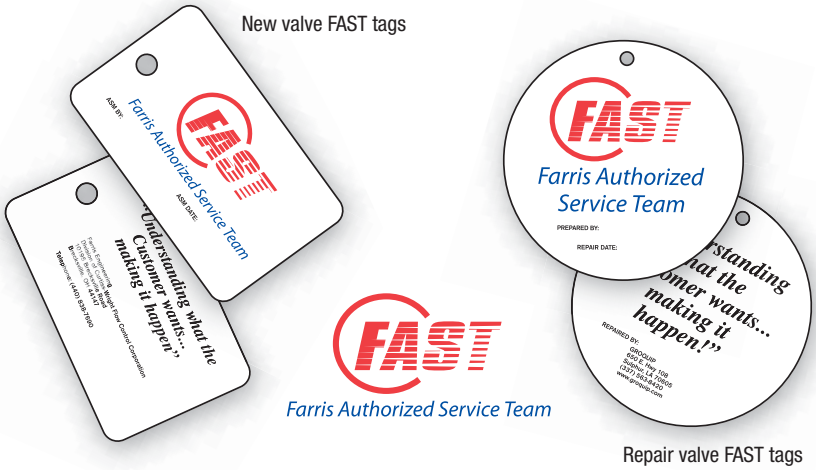
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11/10 3M R2

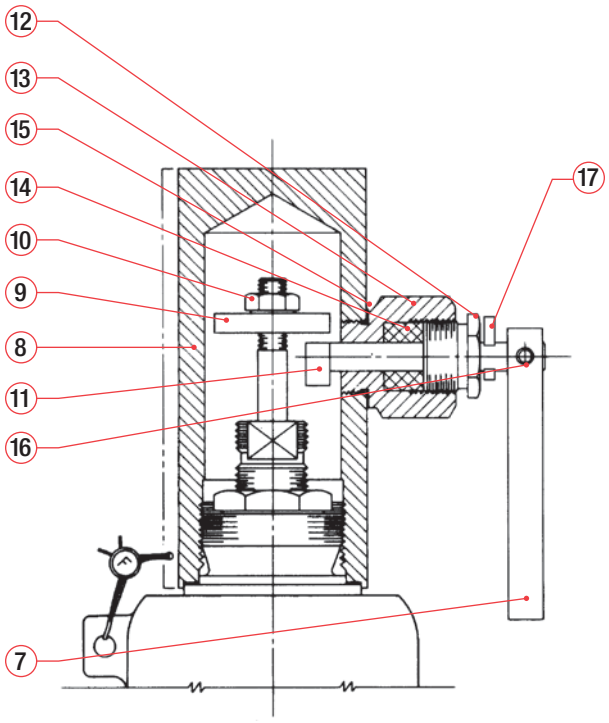
Series 2700

Maintenance Manual 197T R2 Addendum

Packed Lever Design Drawing Update

Bill of Materials

Cap Construction	Item No.	Part Name	Standard Materials
M40 Packed Lever	7	Test Lever	Steel
	8	Cap, Packed Lever	Steel
	9	Stem Test Washer	St. St.
	10	Stem Jam Nut	St. St.
	11	Cam	St. St.
	12	Gland	St. St.
	13	Gland Nut	St. St.
	14	Packing Ring	Graphite
	15	Gland Nut Gasket	Flexible Graphite
	16	Groove Pin	Steel Plt'd
	17	Retaining Ring	St. St.



Packed Lever Construction
Figure 1.6

Lifting Lever Assemblies

B. Packed Lifting Lever (Figure 1.6)

1. Remove groove pin from lever and slide lever off the cam.
2. Remove retaining ring from cam.
3. Remove gland from gland nut. Unscrew gland nut from cap and remove packing ring and cam. If any signs of leakage exist, replace packing ring.
4. Break wire seal and unscrew cap from bonnet. Holding stem with smooth jaw pliers, remove stem jam nut and stem test washer.
5. Reassemble in reverse order, making sure the cam lobe is pointing down. Stem test washer should be adjusted to ensure the cam will make contact with stem test washer and lift stem when lever is actuated.

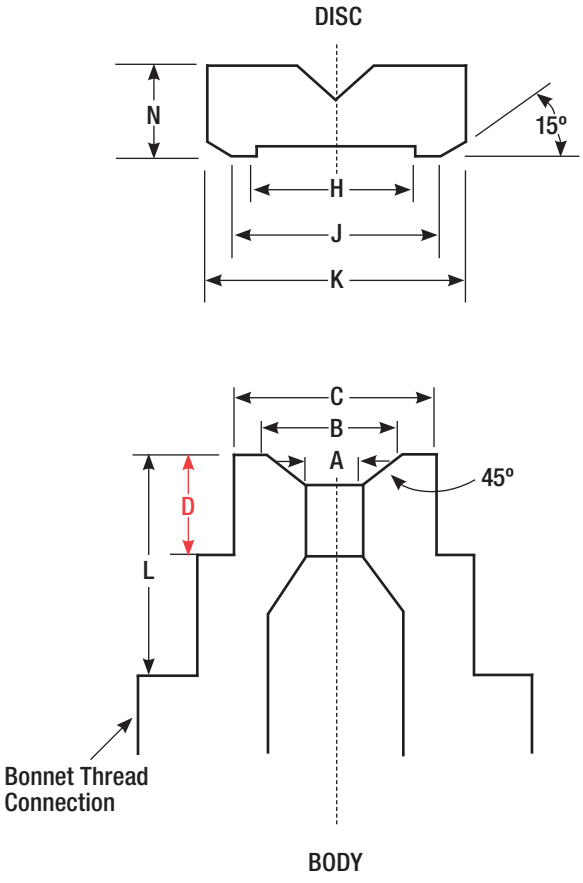
Appendix A correction

Critical Seat and Disc Dimensions

Use these dimensions when lapping and/or refacing is required. Parts must be replaced if the minimum dimension is reached as indicated in the drawings.

Orifice Letter	Size	Body Dimensions					Disc Dimensions			
		A Min.	B +.002 -.002	C +.000 -.002	D Min.	L Min.	H +.002 -.000	J +.005 -.005	K Min.	N Min.
C	1/2 x 1 3/4 x 1 1 x 1	0.295	0.475	0.561	0.246	0.985	0.503	0.530	0.560	0.344
D	1/2 x 1 3/4 x 1 1 x 1	0.399	0.499	0.561	0.246	0.985	0.503	0.530	0.560	0.344
E	1 x 1 1/2	0.533	0.665	0.746	0.516	0.821	0.685	0.715	0.747	0.363
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G	1 1/2 x 2 1/2	0.855	1.070	1.201	0.700	0.910	1.114	1.154	1.204	0.738

General Notes:
1. All dimensions are in inches.
2. Dimensions for body apply to both metal seat and O-ring seat designs.
3. Above dimensions apply to both standard and high pressure versions.



CURTISS-WRIGHT

Valve Group



Series 2700

Farris Engineering
Pressure Relief Valves

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CE ASME UV

General Notes:
1. Blowdown on liquid service may slightly exceed 15% in certain applications.

Teflon is a registered trademark of the DuPont Company.
Monel is a registered trademark of Inco Alloys International Inc.
Hastelloy and Hastelloy C are registered trademarks of Haynes International Inc.

Introduction

Designed to provide customers with the widest selection of sizes, orifices and construction materials, Series 2700 meets the exacting demands of the process industry.

Superior Design

- A single design handles air, steam, vapor and liquid services.
- Maximum interchangeability of parts affords easy maintenance and lower costs.
- Fixed blowdown design simplifies testing and repair. Maximum blowdown of 5% to 15% regardless of service.[1]
- A built-in lift stop ensures stable performance.
- Balanced design in “C” and “D” orifices nullifies the effects of back pressure on set point.

ASME Code Certification

- Manufactured in conformance to Section VIII of the ASME Boiler and Pressure Vessel Code for air, steam, and water service.
- Capacities certified by The National Board of Boiler and Pressure Vessel Inspectors.

Optional O-Ring Seat Design

- O-ring seat design available for maximum seat tightness.
- Teflon® available at higher pressures to provide the same zero bubbles per minute leakage as elastomer O-ring seats.

Comprehensive Product Line

- Set pressures from 15 psig to 6500 psig with orifice areas from 0.068 to 0.573 sq. in.
- Standard valves have MNPT inlet x FNPT outlet. Optional female inlet thread, flanged, socket weld, welding nipple, and sanitary connections available.

Maximum Selection of Materials

- Standard construction includes 316 stainless steel body, trim and spring, with carbon steel bonnet.
- Optional materials include Monel®, Hastelloy C®, and materials suitable for NACE service.

Warranty

All products manufactured by Farris Engineering are warranted free of defects in material and workmanship when used within the range recommended for a period of one year after installation or eighteen months from delivery. When authorized, any defective product may be returned to the factory and if found defective will be repaired or replaced free of charge, solely at the discretion of Farris Engineering, ex-works our factory. No charge for labor or other expense incurred will be allowed, as the liability of Farris Engineering is measured by the refund price of the defective product only. All warranties are based on the product being used within the range recommended and does not cover damages or defects due to normal wear and tear, misuse, alteration or neglect. The purchaser shall determine the suitability of the product for use and assumes all risks and liabilities in connection therewith.

This warranty does not cover the performance of valves tested at site on test equipment that is not to the same technical standard as that used by the manufacturer.

Numbering System

Selecting and specifying Farris pressure relief valves is simple using the numbering system that follows. Each digit of the type number has a distinct significance. The digits describe the basic valve series, orifice, seat design, inlet temperature range, body, bonnet and spring material, inlet type and pressure rating.

27	D	A	2	3	H –	M	2	0	/S4[4]
Series Number	**Orifice Area**	**Seat Construction[5]**	**Inlet Size[1]**	**Outlet Size[1]**	**Special Variations**	**Inlet Connections**	**Cap Construction**	**Test Gag[2]**	**Special Materials**
27	**US Customary Units Sq. In.** **C** 0.068 **D** 0.125 **E** 0.223 **F** 0.350 **G** 0.573 **Metric mm²** **C** 43.87 **D** 80.65 **E** 143.87 **F** 225.81 **G** 369.68	**A** Metal Seat **C** Soft Seat **T** Teflon Seat	**1** 1/2" **2** 3/4" **3** 1" **4** 1-1/2"	**3** 1" **4** 1-1/2" **5** 2" **6** 2-1/2"	**H** High pressure variations of standard types **B** Balanced design[3] **D** Heat transfer fluid standard pressure **E** Heat transfer fluid high pressure	**M** MNPT **F** FNPT **1** Flanged-150RF **2** Flanged-300RF **3** Flanged-600RF **4** Flanged-900RF **5** Flanged-1500RF **6** Flanged-2500RF **0** Special **S** Socket Weld **T** Sanitary **W** Welding Nipple	**2** Plain **4** Packed Lever **7** Open Lever	**0** No Gag **1** Test Gag	**S4** Complete 316 St. St. **N1** NACE Trim: Standard **N4** NACE Trim: All St. St. **M1** Monel Body & Disc **M2** Monel Internals **M4** Complete Monel **H1** Hastelloy C Body & Disc **H2** Hastelloy C Internals **H4** Complete Hastelloy C

Ordering Information

Please specify the following so that we may process your order as quickly as possible.

1. Quantity.*
2. Inlet and outlet sizes.
3. Farris type number.*
4. Inlet and outlet connections: MNPT, FNPT, flanged, socket weld, sanitary inlet or welding nipple.
5. Materials of construction if other than standard.
6. O-ring seat pressure seal material, if required.
7. Set pressure.*
8. Operating and relieving temperatures.*
9. Allowable overpressure.*
10. Fluid and fluid state.*
11. Backpressure, superimposed constant and/or variable, and built-up.*
12. Required capacity.*
13. Accessories: open or packed lever if required; test gag.
14. Code requirements, if any.

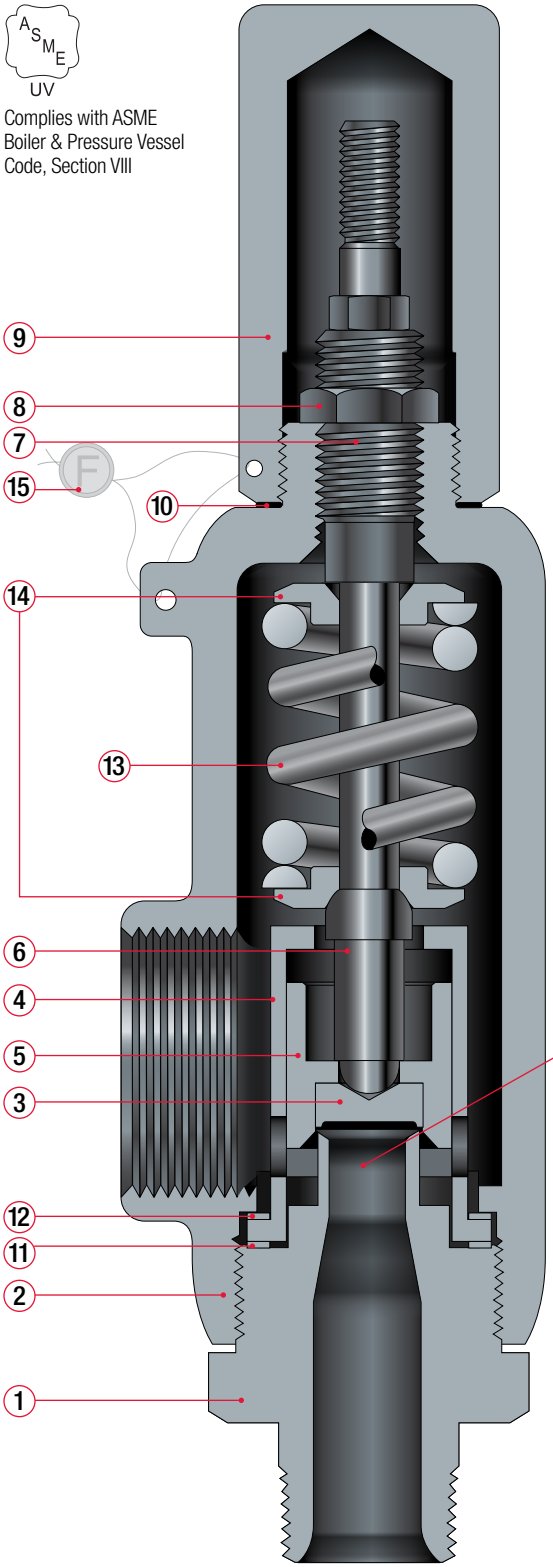
*As a customer service, we verify your selection and sizing. In order to do this, we must have this information.

General Notes:
1. Not all combinations of inlet and outlet sizes shown are available. Consult the selection tables of pages 4 and 5.
2. Test gag option is not available with open lever cap.
3. Available in O-ring seat design only. Consult the Farris Factory.
4. Duplex stainless steel available upon request, consult the factory.
5. Selection of proper soft good material is customer's responsibility.

2700 Series – Conventional

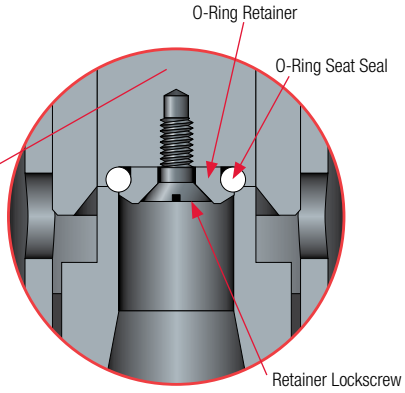
ASME UV

Complies with ASME Boiler & Pressure Vessel Code, Section VIII

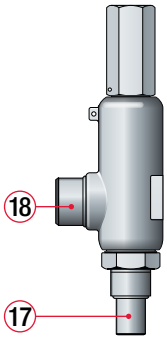


Bill of Materials – Conventional

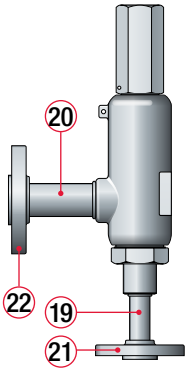
Item	Part Name	Standard Material
1	Body	SA-351 Gr. CF8M St. St. or SA-479 Type 316 St. St.
2	Bonnet	SA-216 Gr. WCB, Carb. St.
3	Disc	316 St. St.
4	Guide	316 St. St.
5	Disc Holder	316 St. St.
6	Stem	316 St. St.
7	Spring Adj. Screw	316 St. St.
8	Jam Nut	316 St. St.
9	Cap, Plain Screwed	Carbon Steel
10	Cap Gasket	316 St. St.
11	Body Gasket	316 St. St.
12	Guide Gasket	316 St. St.
13	Spring (-50°F to +750°F)	Stainless Steel
14	Spring Buttons	316 St. St.
15	Wire Seal	St. St. Wire / Lead Seal
16	Nameplate (Not Shown)	Stainless Steel
17	Welding Nipple (Inlet)	316 St. St.
18	Welding Nipple (Outlet)	Carbon Steel
19	Lap Joint Stub End (Inlet)	316 St. St.
20	Lap Joint Stub End (Outlet)	Carbon Steel
21	Lap Joint Flange (Inlet)	Carbon Steel
22	Lap Joint Flange (Outlet)	Carbon Steel



O-Ring Design (Optional)



Welded End Design (Optional)

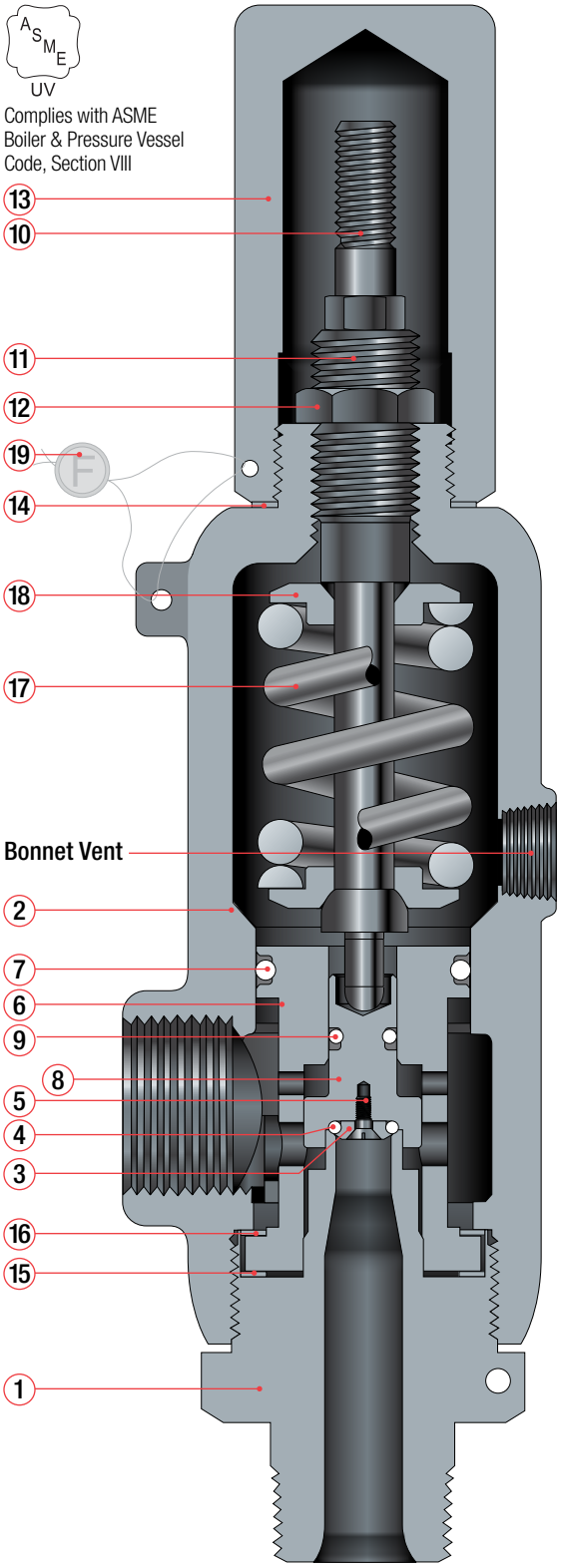


Flanged Design (Optional)

2700 Series – Balanced Design

UV

Complies with ASME Boiler & Pressure Vessel Code, Section VIII



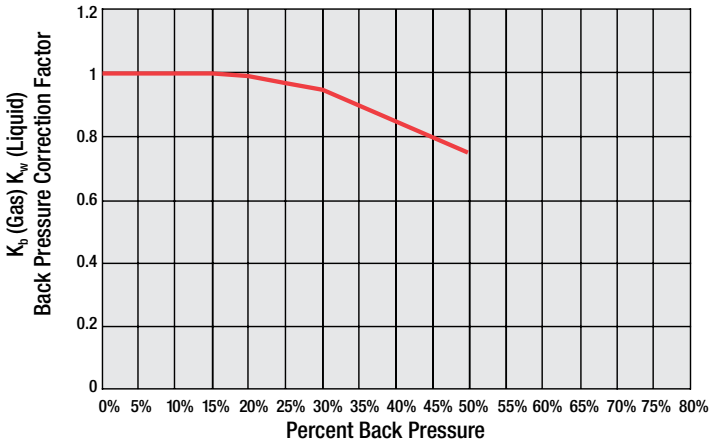
Do you have variable back pressure? Can't use a balanced bellows design? Farris has the solution with the Series 2700 Balanced Design pressure relief valve. The balanced effect is achieved by isolating the upper valve chamber and eliminating any back pressure build-up in the bonnet affecting valve set pressure.

These valves are available in 1/2", 3/4" and 1" inlet sizes with a 1" outlet and two orifice areas. Pressure ranges from 15 to 1480 psig, standard soft seat design. Flanged and welded inlet and outlet connections are available with the same material options as the standard design.

Bill of Materials – Balanced Design

Item	Part Name	Standard Material
1	Body	SA-351 Gr. CF8M St. St. or SA-479 Type 316 St. St.
2	Bonnet	SA-216 Gr. WCB, Carb. St.
3	O-ring Retainer	316 St. St.
4	O-ring Seat Seal	Viton®
5	Retainer Lock Screw	304 St. St.
6	Guide	316 St. St.
7	Guide Seal	Viton
8	Disc Holder	316 St. St.
9	Disc Holder Seal	Viton
10	Stem	316 St. St.
11	Spring Adj. Screw	316 St. St.
12	Jam Nut	316 St. St.
13	Cap, Plain Screwed	Carbon Steel
14	Cap Gasket	316 St. St.
15	Body Gasket	316 St. St.
16	Guide Gasket	316 St. St.
17	Spring	Stainless Steel
18	Spring Buttons	316 St. St.
19	Wire Seal	St. St. Wire/Lead Seal
20	Nameplate (Not Shown)	Stainless Steel

Series 2700 Back Pressure Correction Factor, Balanced Design



General Notes:
1. Other O-ring materials available. Consult the factory.
2. Flanged, socket weld, welding nipple and female inlet threaded designs available.
3. Temperature for balanced or O-ring seat design is limited by the elastomer selected. See page 4.

Viton is a registered trademark of DuPont Elastomers.

O-Ring Selection

The 2700 Series is available with an optional O-ring seat which minimizes fugitive emissions and costly product loss. This optional seat construction provides zero bubbles per minute leakage at 90% of set pressure per API Standard 527. The tables below list the set pressure and temperature range for both the elastomer and PTFE seat options.

O-Ring Seat Valve Pressure & Temperature Limits

Orifice	Pressure Range, psig[1]		Pressure Range, barg[1]	
	Elastomer Seat	PTFE Seat	Elastomer Seat	PTFE Seat
C High Pressure	15 to 1480 —	800 to 2500 2501 to 6500	1.0 to 102 —	55.1 to 172 172.1 to 345
D High Pressure	15 to 1480 —	800 to 1600 1601 to 6500	1.0 to 102 —	55.1 to 110 110.1 to 345
E	15 to 1480	600 to 2500	1.0 to 102	41.3 to 172
F	15 to 1480	600 to 1600	1.0 to 102	41.3 to 110
G	15 to 1000	200 to 1000	1.0 to 69	14 to 69

Material Availability

Material	Temperature Range[2]	
	°F	°C
Viton®[5]	-20° to +450°	-29° to +232°
Nitrile	-20° to +250°	-29° to +121°
EPDM	0° to +350°	-18° to +177°
Silicone	-150° to +450°	-101° to +232°
Kalrez®	-20° to +550°	-29° to +289°
PTFE	-300° to +500°	-184° to +260°

General Notes:
1. Maximum O-ring set pressure limit cannot exceed the pressure limit for a given type number and size as indicated in the metal seat selection tables.
2. Temperature range may vary depending on service fluid.
3. Ethylene propylene is suitable for steam service up to 350°F, PTFE up to 500°F.
4. Consult the Farris Factory for other materials.
5. We reserve the right to substitute comparable fluorocarbon materials from other manufacturers.

Selection Table – Conventional Design (see notes on page 5)

Threaded Connections – MNPT x FNPT, U.S. Customary Units

Orifice Area Sq. In.	Valve Size Inlet x Outlet	Type Number	Maximum Set Pressure, psig	Max. Back Pressure psig at 100°F	Materials	
			-50°F to 750°F		Body / Bonnet	Spring
0.068	1/2 x 1 3/4 x 1 3/4 x 1 1 x 1 1 x 1	27CA13-M20 27CA23-M20 27CA23H-M20 27CA33-M20 27CA33H-M20	1600 2500 5000 2500 6500	400	316 St. St./ Carb. St.	Stainless Steel
0.125	1/2 x 1 3/4 x 1 3/4 x 1 1 x 1 1 x 1	27DA13-M20 27DA23-M20 27DA23H-M20 27DA33-M20 27DA33H-M20	1600 1600 5000 1600 5000	400	316 St. St./ Carb St.	Stainless Steel
0.223	1 x 1-1/2	27EA34-M20	2500	400	316 St. St./ Carb. St.	Stainless Steel
0.350	1-1/2 x 2	27FA45-M20	1600	400	316 St. St./ Carb. St.	Stainless Steel
0.573	1-1/2 x 2-1/2	27GA46-M20	1000	400	316 St. St./ Carb. St.	Stainless Steel

Kalrez is a registered trademark of DuPont Elastomers.

Selection Table – Conventional Design

Flanged Connections, U.S. Customary Units

Orifice Area Sq. In.	Valve Size Inlet x Outlet	ANSI Flange Class		Type Number	Maximum Set Pressure, psig			Max. Back Pressure psig at 100°F	Materials	
		Inlet RF	Outlet RF		-50°F to 100°F	400°F	750°F		Body / Bonnet	Spring
0.068	1/2 x 1	150#	150#	27CA13-120	285	200	95	285	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27CA13-220	740	635	505	285		
		600#	150#	27CA13-320	1480	1270	1010	285		
		900#	300#	27CA13-420	2220	1900	1510	400		
		1500#	300#	27CA13H-520	3705	3170	2520	400		
		2500#	300#	27CA13H-620	5000	5000	4200	400		
	3/4 x 1	150#	150#	27CA23-120	285	200	95	285	316 St. St./ Carb St.	Stainless Steel
		300#	150#	27CA23-220	740	635	505	285		
		600#	150#	27CA23-320	1480	1270	1010	285		
		900#	300#	27CA23-420	2220	1900	1510	400		
		1500#	300#	27CA23H-520	3705	3170	2520	400		
		2500#	300#	27CA23H-620	5000	5000	4200	400		
	1 x 1	150#	150#	27CA33-120	285	200	95	285	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27CA33-220	740	635	505	285		
		600#	150#	27CA33-320	1480	1270	1010	285		
		900#	300#	27CA33-420	2220	1900	1510	400		
		1500#	300#	27CA33H-520	3705	3170	2520	400		
		2500#	300#	27CA33H-620	6170	5280	4200	400		
0.125	1/2 x 1	150#	150#	27DA13-120	285	200	95	285	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27DA13-220	740	635	505	285		
		600#	150#	27DA13-320	1480	1270	1010	285		
		900#	300#	27DA13H-420	2220	1900	1510	400		
	3/4 x 1	150#	150#	27DA23-120	285	200	95	285	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27DA23-220	740	635	505	285		
		600#	150#	27DA23-320	1480	1270	1010	285		
		900#	300#	27DA23H-420	2220	1900	1510	400		
		1500#	300#	27DA23H-520	3705	3170	2520	400		
		2500#	300#	27DA23H-620	5000	5000	4200	400		
	1 x 1	150#	150#	27DA33-120	285	200	95	285	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27DA33-220	740	635	505	285		
		600#	150#	27DA33-320	1480	1270	1010	285		
		900#	300#	27DA33H-420	2220	1900	1510	400		
		1500#	300#	27DA33H-520	3705	3170	2520	400		
		2500#	300#	27DA33H-620	6170	5280	4200	400		
0.223	1 x 1-1/2	150#	150#	27EA34-120	285	200	95	285	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27EA34-220	740	635	505	285		
		600#	150#	27EA34-320	1480	1270	1010	285		
		900#	300#	27EA34-420	2220	1900	1510	400		
0.350	1-1/2 x 2	150#	150#	27FA45-120	285	200	95	285	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27FA45-220	740	635	505	285		
		600#	150#	27FA45-320	1480	1270	1010	285		
0.573	1-1/2 x 2-1/2	150#	150#	27GA46-120	285	200	95	285	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27GA46-220	740	635	505	285		
		600#	150#	27GA46-320	1000	1000	1000	285		

General Notes:

1. Available with optional elastomer or Teflon seat design as illustrated. Change the fourth digit of the type number from "A" to "C" for soft seat, "A" to "T" for Teflon. Example: 27DC23-M20 for soft seat, 27DT23-M20 for Teflon. See Selection Table for pressure and temperature limits.
2. Above type numbers indicate standard materials of construction. To select corrosive or low temperature materials, add type number suffix as indicated on pages 1 and 7.
3. Available in materials suitable for sour gas (H_2S) service to NACE Standards MR0103 and MR0175 / ISO 15156. Add "N1" (standard materials) or "N4" (all stainless construction) to the type number. Example 27DA23-M20/N1 & 27DA23-M20/N4.
4. For open or packed levers, change the second digit of the type number suffix. Examples: 27FA45-M70 for open lever, 27GA46-M40 for packed lever.
5. For socket weld or welding nipple connections, change the first digit of the type number suffix to "S" for socket weld or "W" for welding nipple inlet and outlet. Examples: 27DC33-S20 for socket weld, 27DA33-W20 for welding nipple. Maximum set pressures are identical to the MNPT inlet up to 500°F. For Temperatures above 500°F, consult the factory.
6. Female threaded inlet available. Change first digit of the type number suffix to "F". Example: 27EA34-F20. Maximum set pressure for female inlet is identical to male inlet except for 1/2 x 1" C orifice which may be set to max set pressure of 2500 psig.
7. For set pressures below 15 psig, consult the Farris Factory.

Selection Tables – Balanced Design (see notes on page 5)

Threaded Connections – MNPT x FNPT, U.S. Customary Units

Orifice Area Sq. In.	Valve Size Inlet x Outlet	Type Number	Maximum Set Pressure, psig	Max. Back Pressure psig at 100°F	Materials	
			-20°F to 450°F		Body / Bonnet	Spring
0.068	1/2 x 1 3/4 x 1 1 x 1	27CC13B-M20 27CC23B-M20 27CC33B-M20	1480	400	316 St. St./ Carb. St.	Stainless Steel
0.125	1/2 x 1 3/4 x 1 1 x 1	27DC13B-M20 27DC23B-M20 27DC33B-M20	1480	400	316 St. St./ Carb St.	Stainless Steel

Flanged Connections, U.S. Customary Units

Orifice Area Sq. In.	Valve Size Inlet x Outlet	ANSI Flange Class		Type Number	Maximum Set Pressure, psig		Max. Back Pressure psig at 100°F	Materials	
		Inlet RF	Outlet RF		-20°F to 100°F	400°F		Body / Bonnet	Spring
0.068	1/2 x 1	150# 300# 600# 900#	150# 150# 150# 300#	27CC13B-120 27CC13B-220 27CC13B-320 27CC13B-420	285 740 1480 1480	200 635 1270 1270	285 285 285 400	316 St. St./ Carb. St.	Stainless Steel
	3/4 x 1	150# 300# 600# 900#	150# 150# 150# 300#	27CC23B-120 27CC23B-220 27CC23B-320 27CC23B-420	285 740 1480 1480	200 635 1270 1270	285 285 285 400	316 St. St./ Carb St.	Stainless Steel
	1 x 1	150# 300# 600# 900#	150# 150# 150# 300#	27CC33B-120 27CC33B-220 27CC33B-320 27CC33B-420	285 740 1480 1480	200 635 1270 1270	285 285 285 400	316 St. St./ Carb. St.	Stainless Steel
0.125	1/2 x 1	150# 300# 600#	150# 150# 150#	27DC13B-120 27DC13B-220 27DC13B-320	285 740 1480	200 635 1270	285 285 285	316 St. St./ Carb. St.	Stainless Steel
	3/4 x 1	150# 300# 600#	150# 150# 150#	27DC23B-120 27DC23B-220 27DC23B-320	285 740 1480	200 635 1270	285 285 285	316 St. St./ Carb. St.	Stainless Steel
	1 x 1	150# 300# 600#	150# 150# 150#	27DC33B-120 27DC33B-220 27DC33B-320	285 740 1480	200 635 1270	285 285 285	316 St. St./ Carb. St.	Stainless Steel

Special Materials

Corrosive & Low Temperature Service

Part Name	316 St. St.		Monel			Hastelloy C		
	N1 (NACE)	S4 & N4 (NACE)	M1	M2	M4	H1	H2	H4
	-50°F to 750°F	-450°F to 750°F[2]	-50°F to 600°F		-325°F to 600°F	-50°F to 500°F		-325°F to 500°F
Body			Monel	Monel	Monel	Hastelloy C	Hastelloy C	Hastelloy C
Bonnet		SA-351 Gr. CF8M St. St.			Monel			Hastelloy C
Disc			Monel	Monel	Monel	Hastelloy C	Hastelloy C	Hastelloy C
Guide				Monel	Monel		Hastelloy C	Hastelloy C
Disc Holder				Monel	Monel		Hastelloy C	Hastelloy C
Stem					Monel			Hastelloy C
Spring Adj. Screw					Monel			Hastelloy C
Jam Nut					Monel			Hastelloy C
Cap, Plain Screwed		316 St. St.			Monel			Hastelloy C
Cap Gasket					Monel			Hastelloy C
Body Gasket				Monel	Monel		Hastelloy C	Hastelloy C
Guide Gasket				Monel	Monel		Hastelloy C	Hastelloy C
Spring[6]	Inconel® X-750	316 St. St./ Inconel X-750		Inconel X-750	Inconel X-750		Inconel X-750	Hastelloy C
Spring Buttons					Monel			Hastelloy C
O-Ring Retainer[5]		316 St. St.	Monel	Monel	Monel	Hastelloy C	Hastelloy C	Hastelloy C
Retainer Lock Screw[5]		316 St. St.	Monel	Monel	Monel	Hastelloy C	Hastelloy C	Hastelloy C
O-Ring Seat Seal[5]								
Guide Seal[5]								
Disc Holder Seal[5]								
Wire Seal								
Nameplate (Not Shown)								
Welding Nipple (Inlet)			Monel	Monel	Monel	Hastelloy C	Hastelloy C	Hastelloy C
Welding Nipple (Outlet)		316 St. St.			Monel			Hastelloy C
Lap Joint Stub End (Inlet)			Monel	Monel	Monel	Hastelloy C	Hastelloy C	Hastelloy C
Lap Joint Stub End (Outlet)		316 St. St.			Monel			Hastelloy C
Lap Joint Flange (Inlet)[4]		316 St. St.			Monel			Hastelloy C
Lap Joint Flange (Outlet)[4]		316 St. St.			Monel			Hastelloy C

General Notes:
1. Any part where material field is blank is standard material.
2. For S4 trim, a 17-4 Ph. or 17-7 Ph. spring may be necessary for some pressures and temperatures.
3. For open and packed lever materials, see page 14.
4. Maximum set pressures for S4, M4, and H4 trim are the same as the carbon steel valves or the 316 St. St., Monel and Hastelloy C flange limits respectively, whichever is lower.
5. Temperature for balanced or O-ring seat design is limited by the elastomer selected. Consult chart on page 4.
6. Balanced design uses the same spring selection as the standard design. Where NACE compliant trim is specified, all trim classes for both conventional and balanced designs use springs made from Inconel X-750.

Inconel and Inconel X-750 are registered trademarks of Inco Alloys International. We reserve the right to substitute comparable material from other suppliers.

Capacity Tables – 2700 Series

U.S. Customary Units: ASME Pressure Vessel Code, Section VIII (UV) Stamp

AIR – 10% Overpressure Capacities in Standard Cubic Feet Per Minute at 60°F

Set Pressure (psig)	Orifice Area, Sq. In.				
	C	D	E	F	G
	0.068	0.125	0.223	0.350	0.573
15	35	65	117	183	301
20	41	75	135	212	347
30	52	95	171	268	439
40	64	117	210	330	540
50	76	140	249	392	642
60	88	162	288	454	743
70	100	184	328	515	844
80	112	206	368	577	946
90	124	228	407	639	1047
100	136	250	447	701	1148
150	196	361	644	1011	1655
200	256	471	841	1320	2161
250	316	582	1038	1630	2668
300	376	692	1235	1939	3175
350	436	803	1432	2248	3681
400	497	913	1630	2558	4188
450	557	1024	1827	2867	4695
500	617	1134	2024	3177	5201
550	677	1245	2221	3486	5708
600	737	1355	2418	3796	6215
650	797	1466	2615	4105	6721
700	857	1576	2813	4415	7228
750	917	1687	3010	4724	7735
800	978	1797	3207	5034	8241
850	1038	1908	3404	5343	8748
900	1098	2018	3601	5653	9255
950	1158	2129	3799	5962	9761
1000	1218	2240	3996	6272	10268
1050	1278	2350	4193	6581	
1100	1338	2461	4390	6891	
1150	1398	2571	4587	7200	
1200	1459	2682	4784	7509	
1250	1519	2792	4982	7819	
1300	1579	2903	5179	8128	
1350	1639	3013	5376	8438	
1400	1699	3124	5573	8747	
1450	1759	3234	5770	9057	
1500	1819	3345	5967	9366	
1550	1879	3455	6165	9676	
1600	1940	3566	6362	9985	
1650	2000	3676	6559		
1700	2060	3787	6756		
1750	2120	3897	6953		
1800	2180	4008	7151		
1850	2240	4118	7348		
1900	2300	4229	7545		
2000	2421	4450	7939		
2100	2541	4671	8334		
2200	2661	4892	8728		
2300	2781	5113	9122		
2400	2902	5334	9577		
2500	3022	5555	9911		
2600	3142	5776			
2700	3262	5997			
2800	3383	6218			
2900	3503	6439			
3000	3623	6661			
3500	4224	7766			
4000	4826	8871			
4500	5427	9976			
5000	6028	11081			
5500	6629				
6000	7231				
6500	7832				

STEAM – 10% Overpressure Capacities in Pounds Per Hour at Saturation Temperature

Set Pressure (psig)	Orifice Area, Sq. In.				
	C	D	E	F	G
	0.068	0.125	0.223	0.350	0.573
15	100	184	329	516	846
20	115	212	379	595	975
30	146	269	480	754	1234
40	180	331	591	927	1519
50	214	393	702	1101	1803
60	247	455	812	1275	2088
70	281	517	923	1449	2373
80	315	579	1034	1623	2657
90	349	641	1145	1797	2942
100	382	704	1255	1971	3227
150	551	1014	1809	2840	4650
200	720	1325	2363	3710	6073
250	889	1635	2917	4579	7497
300	1058	1946	3471	5448	8920
350	1227	2256	4025	6318	10344
400	1396	2567	4579	7187	11767
450	1565	2877	5133	8057	13190
500	1734	3188	5687	8926	14614
550	1903	3498	6241	9796	16037
600	2072	3809	6795	10665	17461
650	2241	4119	7349	11535	18884
700	2410	4430	7903	12404	20307
750	2578	4740	8457	13273	21731
800	2747	5051	9011	14143	23154
850	2916	5361	9565	15012	24578
900	3085	5672	10119	15882	26001
950	3254	5982	10673	16751	27424
1000	3423	6293	11227	17621	28848
1050	3592	6603	11781	18490	
1100	3761	6914	12335	19359	

General Notes:

1. Capacities at 30 psig and below are based on 3 psi overpressure.
2. For sizing purposes, the coefficients of discharge K are 0.878 for air, gas & steam; 0.676 for water.

Capacity Tables – 2700 Series

U.S. Customary Units: ASME Pressure Vessel Code, Section VIII (UV) Stamp

WATER – 10% Overpressure Capacities[3] in U.S. Gallons Per Minute at 70°F

Set Pressure (psig)	Orifice Area, Sq. In.				
	C	D	E	F	G
	0.068	0.125	0.223	0.350	0.573
15	7.4	13.6	24.3	38.1	62.4
20	8.3	15.3	27.4	43.1	70.5
30	10.0	18.4	32.9	51.6	84.5
40	11.5	21.2	37.9	59.6	97.6
50	12.9	23.8	42.4	66.6	109
60	14.1	26.0	46.5	73.0	119
70	15.3	28.1	50.2	78.8	129
80	16.3	30.1	53.7	84.3	138
90	17.3	31.9	56.9	89.4	146
100	18.3	33.6	60.0	94.2	154
150	22.4	41.2	73.5	115	189
200	25.9	47.6	84.9	133	218
250	28.9	53.2	94.9	149	244
300	31.7	58.3	104	163	267
350	34.2	63.0	112	176	288
400	36.6	67.3	120	188	308
450	38.8	71.4	127	200	327
500	40.9	75.3	134	210	345
550	42.9	78.9	140	221	362
600	44.8	82.4	147	230	378
650	46.7	85.8	153	240	393
700	48.4	89.0	158	249	408
750	50.1	92.2	164	258	422
800	51.8	95.2	169	266	436
850	53.4	98.1	175	274	450
900	54.9	101	180	282	463
950	56.4	103	185	290	475
1000	57.9	106	189	298	488
1050	59.3	109	194	305	
1100	60.7	111	199	312	
1150	62.1	114	203	319	
1200	63.4	116	208	326	
1250	64.7	119	212	333	
1300	66.0	121	216	339	
1350	67.3	123	220	346	
1400	68.5	126	224	352	
1450	69.7	128	228	359	
1500	70.9	130	232	365	
1550	72.1	132	236	371	
1600	73.2	134	240	377	
1650	74.4	136	244		
1700	75.5	138	247		
1750	76.6	140	251		
1800	77.7	142	254		
1850	78.7	144	258		
1900	79.8	146	261		
2000	81.9	150	268		
2100	83.9	154	275		
2200	85.9	157	281		
2300	87.8	161	288		
2400	89.7	164	294		
2500	91.5	168	300		
2600	93.4	171			
2700	95.1	174			
2800	96.9	178			
2900	98.6	181			
3000	100	184			
3500	108	199			
4000	115	212			
4500	122	225			
5000	129	238			
5500	135				
6000	141				
6500	147				

General Notes:
1. Capacities at 30 psig and below are based on 3 psi overpressure.
2. For sizing purposes, the coefficients of discharge K are 0.878 for air, gas & steam; 0.676 for water.
3. To determine capacity at 25% overpressure, multiply the capacity at 10% by 1.066.

Selection Tables – Conventional Design

Threaded Connections – MNPT x FNPT, Metric Units

Orifice Area mm²	Valve Size Inlet x Outlet	Type Number	Maximum Set Pressure, barg -45.6°C to 399°C	Max. Back Pressure barg at 37.8°C	Materials	
					Body / Bonnet	Spring
43.87	1/2 x 1 3/4 x 1 3/4 x 1 1 x 1 1 x 1	27CA13-M20 27CA23-M20 27CA23H-M20 27CA33-M20 27CA33H-M20	110 172 345 172 448	28	316 St. St./ Carb. St.	Stainless Steel
80.65	1/2 x 1 3/4 x 1 3/4 x 1 1 x 1 1 x 1	27DA13-M20 27DA23-M20 27DA23H-M20 27DA33-M20 27DA33H-M20	110 110 345 110 345	28	316 St. St./ Carb. St.	Stainless Steel
143.87	1 x 1-1/2	27EA34-M20	172	28	316 St. St./ Carb. St.	Stainless Steel
225.81	1-1/2 x 2	27FA45-M20	110	28	316 St. St./ Carb. St.	Stainless Steel
369.68	1-1/2 x 2-1/2	27GA46-M20	69	28	316 St. St./ Carb. St.	Stainless Steel

General Notes:

1. Available with optional elastomer or Teflon seat design as illustrated. Change the fourth digit of the type number from "A" to "C" for soft seat, "A" to "T" for Teflon. Examples: 27DC23-M20 for soft seat, 27DT23-M20 for Teflon. For O-ring pressure and temperature limits, see selection table on page 4.
2. Above type numbers indicate the standard materials of construction. To select corrosive or low temperature materials, add type number suffix as indicated on pages 1 and 7.
3. Available in materials suitable for sour gas (H_2S) service to NACE Standards MR0103 and MR0175 / ISO 15156. Add "N1" (standard materials) or "N4" (all stainless construction) to the type number. Example 27DA23-M20/N1 & 27DA23-M20/N4.
4. For open or packed levers, change the second digit of the type number suffix. Examples: 27FA45-M70 for open lever, 27GA46-M40 for packed lever.
5. For socket weld or welding nipple connections, change the first digit of the type number suffix to "S" for socket weld or "W" for welding nipple inlet and outlet. Examples: 27DA33-S20 for socket weld, 27DA33-W20 for welding nipple.
6. Female threaded inlet available. Change first digit of the type number suffix to "F". Example: 27EA34-F20. Maximum set pressure for female inlet is identical to male inlet except for 1/2 x 1" C orifice which may be set to 172 barg max set pressure.
7. For set pressures below 1 barg (15 psig), consult the Farris Factory.

Selection Tables – Conventional Design

Flanged Connections, Metric Units

Orifice Area mm²	Valve Size Inlet x Outlet	ANSI Flange Class		Type Number	Maximum Set Pressure, barg			Max. Back Pressure barg at 37.8°C	Materials	
		Inlet RF	Outlet RF		-45.6°C to 37.8°C	204°C	399°C		Body / Bonnet	Spring
43.87	1/2 x 1	150#	150#	27CA13-120	20	14	6	20	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27CA13-220	51	44	35	20		
		600#	150#	27CA13-320	102	88	69	20		
		900#	300#	27CA13-420	153	131	104	28		
		1500#	300#	27CA13H-520	255	218	174	28		
		2500#	300#	27CA13H-620	345	345	290	28		
	3/4 x 1	150#	150#	27CA23-120	20	14	6	20	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27CA23-220	51	44	35	20		
		600#	150#	27CA23-320	102	88	69	20		
		900#	300#	27CA23-420	153	131	104	28		
		1500#	300#	27CA23H-520	255	218	174	28		
		2500#	300#	27CA23H-620	345	345	290	28		
	1 x 1	150#	150#	27CA33-120	20	14	6	20	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27CA33-220	51	44	35	20		
		600#	150#	27CA33-320	102	88	69	20		
		900#	300#	27CA33-420	153	131	104	28		
		1500#	300#	27CA33H-520	255	218	174	28		
		2500#	300#	27CA33H-620	425	364	290	28		
80.65	1/2 x 1	150#	150#	27DA13-120	20	14	6	20	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27DA13-220	51	44	35	20		
		600#	150#	27DA13-320	102	88	69	20		
		900#	300#	27DA13H-420	153	131	104	28		
	3/4 x 1	150#	150#	27DA23-120	20	14	6	20	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27DA23-220	51	44	35	20		
		600#	150#	27DA23-320	102	88	69	20		
		900#	300#	27DA23H-420	153	131	104	28		
		1500#	300#	27DA23H-520	255	218	174	28		
		2500#	300#	27DA23H-620	345	345	290	28		
	1 x 1	150#	150#	27DA33-120	20	14	6	20	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27DA33-220	51	44	35	20		
		600#	150#	27DA33-320	102	88	69	20		
		900#	300#	27DA33H-420	153	131	104	28		
		1500#	300#	27DA33H-520	255	218	174	28		
		2500#	300#	27DA33H-620	425	364	290	28		
143.87	1 x 1-1/2	150#	150#	27EA34-120	20	14	6	20	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27EA34-220	51	44	35	20		
		600#	150#	27EA34-320	102	88	69	20		
		900#	300#	27EA34-420	153	131	104	28		
225.81	1-1/2 x 2	150#	150#	27FA45-120	20	14	6	20	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27FA45-220	51	44	35	20		
		600#	150#	27FA45-320	102	88	69	20		
369.68	1-1/2 x 2-1/2	150#	150#	27GA46-120	20	14	6	20	316 St. St./ Carb. St.	Stainless Steel
		300#	150#	27GA46-220	51	44	35	20		
		600#	150#	27GA46-320	69	69	69	20		

Selection Tables – Balanced Design

Threaded Connections – MNPT x FNPT, Metric Units

Orifice Area mm²	Valve Size Inlet x Outlet	Type Number	Maximum Set Pressure, barg	Max. Back Pressure barg at 37.8°C	Materials	
			-28.9°C to 232°C		Body / Bonnet	Spring
43.87	1/2 x 1 3/4 x 1 1 x 1	27CC13B-M20 27CC23B-M20 27CC33B-M20	102	28	316 St. St./ Carb. St.	Stainless Steel
80.65	1/2 x 1 3/4 x 1 1 x 1	27DC13B-M20 27DC23B-M20 27DC33B-M20	102	28	316 St. St./ Carb St.	Stainless Steel

Flanged Connections, Metric Units

Orifice Area mm²	Valve Size Inlet x Outlet	ANSI Flange Class		Type Number	Maximum Set Pressure, barg		Max. Back Pressure barg at 37.8°C	Materials	
		Inlet RF	Outlet RF		-28.9°C to 37.8°C	204°C		Body / Bonnet	Spring
43.87	1/2 x 1	150# 300# 600# 900#	150# 150# 150# 300#	27CC13B-120 27CC13B-220 27CC13B-320 27CC13B-420	20 51 102 102	14 44 88 88	20 20 20 28	316 St. St./ Carb. St.	Stainless Steel
	3/4 x 1	150# 300# 600# 900#	150# 150# 150# 300#	27CC23B-120 27CC23B-220 27CC23B-320 27CC23B-420	20 51 102 102	14 44 88 88	20 20 20 28	316 St. St./ Carb. St.	Stainless Steel
	1 x 1	150# 300# 600# 900#	150# 150# 150# 300#	27CC33B-120 27CC33B-220 27CC33B-320 27CC33B-420	20 51 102 102	14 44 88 88	20 20 20 28	316 St. St./ Carb. St.	Stainless Steel
80.65	1/2 x 1	150# 300# 600#	150# 150# 150#	27DC13B-120 27DC13B-220 27DC13B-320	20 51 102	14 44 88	20 20 20	316 St. St./ Carb. St.	Stainless Steel
	3/4 x 1	150# 300# 600#	150# 150# 150#	27DC23B-120 27DC23B-220 27DC23B-320	20 51 102	14 44 88	20 20 20	316 St. St./ Carb. St.	Stainless Steel
	1 x 1	150# 300# 600#	150# 150# 150#	27DC33B-120 27DC33B-220 27DC33B-320	20 51 102	14 44 88	20 20 20	316 St. St./ Carb. St.	Stainless Steel

Capacity Tables – 2700 Series

Metric Units: ASME Pressure Vessel Code, Section VIII (UV) Stamp

AIR – 10% Overpressure Capacities in Standard Cubic Meters Per Minute at 15.6°C

Set Pressure (barg)	Orifice Area mm²				
	C	D	E	F	G
	43.87	80.65	143.87	225.81	369.68
1	0.9	1.8	3.2	5.1	8.4
2	1.4	2.6	4.7	7.4	12.1
3	1.9	3.5	6.3	9.9	16.3
4	2.4	4.4	7.9	12.5	20.5
5	2.9	5.3	9.6	15.0	24.6
6	3.4	6.2	11.2	17.6	28.8
7	3.9	7.2	12.8	20.1	33.0
8	4.4	8.1	14.4	22.7	37.1
9	4.9	9.0	16.0	25.2	41.3
10	5.4	9.9	17.7	27.7	45.5
12	6.3	11.7	20.9	32.8	53.8
14	7.3	13.5	24.1	37.9	62.1
16	8.3	15.3	27.4	43.0	70.5
18	9.3	17.1	30.6	48.1	78.8
20	10.3	19.0	33.9	53.2	87.1
25	12.8	23.5	42.0	65.9	108
30	15.2	28.1	50.1	78.7	128
35	17.7	32.6	58.2	91.4	149
40	20.2	37.1	66.3	104	170
45	22.7	41.7	74.4	116	191
50	25.1	46.2	82.5	129	212
55	27.6	50.8	90.6	142	233
60	30.1	55.3	98.7	155	253
65	32.5	59.9	106	167	274
70	35.0	64.4	115	180	295
75	37.5	69.0	123	193	
80	40.0	73.5	131	205	
85	42.4	78.1	139	218	
90	44.9	82.6	147	231	
95	47.4	87.1	155	244	
100	49.9	91.7	163	256	
105	52.3	96.2	171	269	
110	54.8	100	179	282	
115	57.3	105	187		
120	59.7	109	196		
125	62.2	114	204		
130	64.7	119	212		
135	67.2	123	220		
140	69.6	128	228		
145	72.1	132	236		
150	74.6	137	244		
155	77.1	141	252		
160	79.5	146	260		
165	82.0	150	269		
170	84.5	155	277		
175	86.9	159			
180	89.4	164			
185	91.9	169			
190	94.4	173			
195	96.8	178			
200	99.3	182			
220	109	200			
240	119	218			
260	129	237			
280	138	255			
300	148	273			
320	158	291			
340	168	309			
360	178				
380	188				
400	198				
420	208				
440	218				
448	221				

General Notes:
1. Capacities at 2.0 barg set pressure and below are based on 0.2 bar overpressure.
2. For sizing purposes the coefficients of discharge Kd are 0.975 for Air, Gas, & Steam, 0.751 for liquids.

WATER – 10% Overpressure Capacities in Litres Per Minute at 21°C[3]

Set Pressure (barg)	Orifice Area mm²				
	C	D	E	F	G
	43.87	80.65	143.87	225.81	369.68
1	27.6	50.8	90.7	142	233
2	37.4	68.7	122	192	315
3	45.7	84.0	150	235	385
4	52.8	97.0	173	271	445
5	59.0	108	193	303	497
6	64.6	118	212	332	545
7	69.8	128	229	359	588
8	74.6	137	244	384	629
9	79.2	145	259	407	667
10	83.5	153	273	429	703
12	91.4	168	300	470	770
14	98.8	181	324	508	832
16	105	194	346	543	890
18	112	205	367	576	944
20	118	217	387	607	995
25	132	242	433	679	1112
30	144	265	474	744	1218
35	156	287	512	804	1316
40	167	307	547	859	1407
45	177	325	580	911	1492
50	186	343	612	961	1573
55	195	360	642	1008	1650
60	204	376	670	1052	1723
65	212	391	698	1095	1794
70	220	406	724	1137	1861
75	228	420	750	1177	
80	236	434	774	1215	
85	243	447	798	1253	
90	250	460	821	1289	
95	257	473	844	1324	
100	264	485	866	1359	
105	270	497	887	1392	
110	276	509	908	1425	
115	283	520	928		
120	289	531	948		
125	295	542	968		
130	301	553	987		
135	306	564	1006		
140	312	574	1024		
145	318	584	1042		
150	323	594	1060		
155	328	604	1078		
160	334	614	1095		
165	339	623	1112		
170	344	632	1129		
175	349	642			
180	354	651			
185	359	660			
190	364	669			
195	368	677			
200	373	686			
220	391	720			
240	409	752			
260	425	782			
280	441	812			
300	457	840			
320	472	868			
340	486	895			
360	501				
380	514				
400	528				
420	541				
440	553				
448	558				

General Notes:
1. Capacities at 2.0 barg set pressure and below are based on 0.2 bar overpressure.
2. For sizing purposes the coefficients of discharge Kd are 0.975 for Air, Gas, & Steam, 0.751 for liquids
3. To determine capacity at 25 % overpressure multiply the capacity at 10 % by 1.066.

Capacity Tables – 2700 Series

Metric Units: ASME Pressure Vessel Code, Section VIII (UV) Stamp

STEAM – 10% Overpressure Capacities in Kilograms Per Hour at Saturation Temperature

Set Pressure (barg)	Orifice Area mm²				
	C	D	E	F	G
	43.87	80.65	143.87	225.81	369.68
1	44.9	82.5	147	231	378
2	65.1	119	213	335	548
3	87.2	160	286	449	735
4	109	201	359	563	922
5	131	242	432	678	1110
6	154	283	505	792	1297
7	176	324	578	907	1485
8	198	364	651	1021	1672
9	220	405	723	1136	1860
10	243	446	796	1250	2047
12	287	528	942	1479	2422
14	332	610	1088	1708	2797
16	376	692	1234	1938	3172
18	421	773	1380	2167	3547
20	465	855	1526	2396	3922
25	576	1060	1891	2968	4860
30	688	1264	2256	3541	5797
35	799	1469	2621	4114	6735
40	910	1673	2986	4686	7672
45	1021	1878	3351	5259	8610
50	1133	2082	3715	5832	9547
55	1244	2287	4080	6404	10485
60	1355	2491	4445	6977	11422
65	1466	2696	4810	7550	12360
70	1578	2900	5175	8122	13298
75	1689	3105	5540	8695	14235

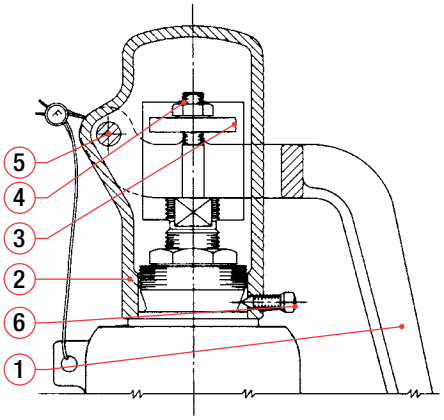
General Notes:
1. Capacities at 2.0 barg set pressure and below are based on 0.2 bar overpressure.
2. For sizing purposes the coefficients of discharge Kd are 0.975 for Air, Gas, & Steam, 0.751 for liquids.

Cap Constructions

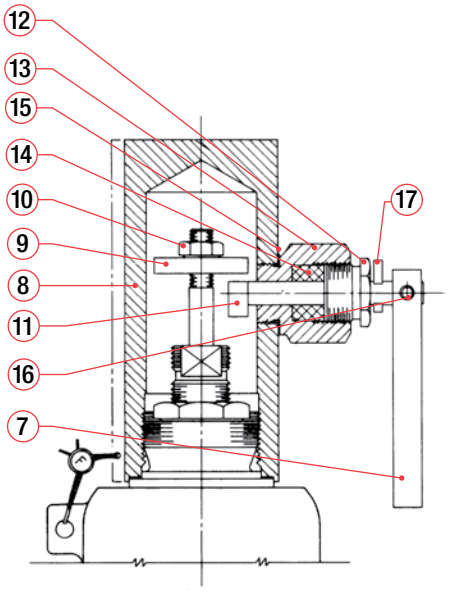
Cap Constructions

Cap Construction	Item No.	Part Name	Standard Materials	316 St. St.		Monel		Hastelloy C	
				S4[2] & N4	N1	M1 & M2	M4	H1 & H2	H4
M70 Open Lever	1	Test Lever	Iron						
	2	Cap, O.L.	Iron						
	3	Stem Test Washer	St. St.	316 St. St.			Monel		Hast. C
	4	Stem Jam Nut	St. St.	316 St. St.			Monel		Hast. C
	5	Button Head Rivet	Steel						
	6	Set Screw	Steel						
M40 Packed Lever	7	Test Lever	Steel						
	8	Cap, Packed	Steel	316 St. St.			Monel		Hast. C
	9	Stem Test Washer	St. St.	316 St. St.			Monel		Hast. C
	10	Stem Jam Nut	St. St.	316 St. St.			Monel		Hast. C
	11	Cam	St. St.	316 St. St.			Monel		Hast. C
	12	Gland	St. St.	316 St. St.			Monel		Hast. C
	13	Gland Nut	St. St.	316 St. St.			Monel		Hast. C
	14	Packing Ring	Graphite						
	15	Gland Nut Gasket	Flexible Graphite	PTFE, Filled	PTFE, Filled		PTFE, Filled		PTFE, Filled
	16	Groove Pin	Steel Plt'd						
	17	Retaining Ring	St. St.						

General Notes:
1. Any part where material field is blank is standard material.
2. "S4" trim suitable for cryogenic service.

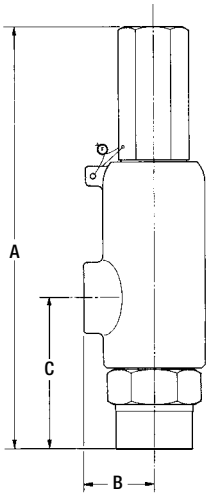


Open Lever Construction
Figure 1.5

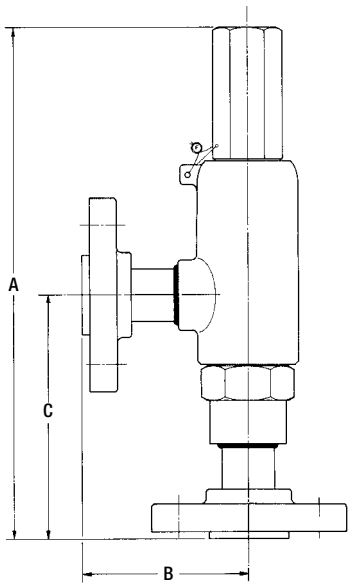


Packed Lever Construction
Figure 1.6

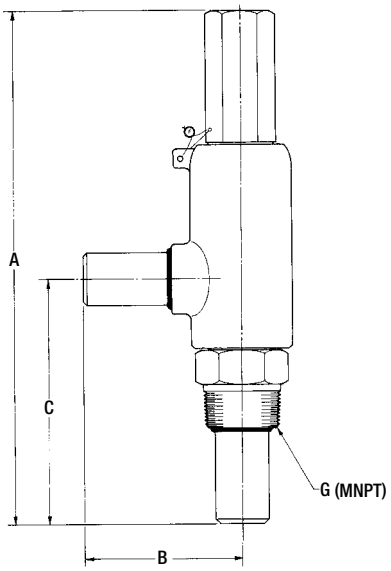
Dimensions & Weights



(MNPT, FNPT, & SW)



(FLANGED)



(WELDING NIPPLE)

Threaded Connections (MNPT x FNPT)

Valve Size[1]	US Customary Units (Inches)			Metric Units (millimeters)			Approx. Weight	
Inlet x Outlet	A (Max.) All Cap Const.	B	C	A (Max.) All Cap Const.	B	C	lb	kg
C and D Orifice								
1/2 x 1	11-1/4	1-3/4	3-9/16	282	45	91	8	3.6
3/4 x 1	11-1/4	1-3/4	3-9/16	286	45	91	8	3.6
3/4 x 1 H.P.	13-5/8	2-1/2	3-3/4	346	64	95	14	6.3
1 x 1	11-1/2	1-3/4	3-3/4	292	45	95	8	3.6
1 x 1 H.P.	13-5/8	2-1/2	3-3/4	346	64	95	14	6.3
E Orifice								
1 x 1-1/2	13-5/8	2-1/2	3-1/2	346	64	89	16	7.2
F Orifice								
1-1/2 x 2	14-9/16	3	3-7/8	370	76	98	17	7.7
G Orifice								
1-1/2 x 2-1/2	14-9/16	3	4-1/8	370	76	105	18	8.1

Socket Weld & FNPT x FNPT Connections

Valve Size[1]	US Customary Units (Inches)			Metric Units (millimeters)			Approx. Weight	
Inlet x Outlet	A (Max.) All Cap Const.	B	C	A (Max.) All Cap Const.	B	C	lb	kg
C and D Orifice								
1/2 x 1	11-7/16	1-3/4	3-11/16	291	45	94	8	3.6
1/2 x 1 H.P	13-5/8	2-1/2	3-3/4	346	64	95	14	6.3
3/4 x 1	11-7/16	1-3/4	3-11/16	291	45	94	8	3.6
3/4 x 1 H.P.	13-5/8	2-1/2	3-3/4	346	64	95	14	6.3
1 x 1	11-7/16	1-3/4	3-11/16	291	45	94	8	3.6
1 x 1 H.P.	13-5/8	2-1/2	3-3/4	346	64	95	14	6.3
E Orifice								
1 x 1-1/2	13-3/8	2-1/2	3-1/2	340	64	89	16	7.2
F Orifice								
1-1/2 x 2	14-9/16	3	3-7/8	370	76	98	17	7.7
G Orifice								
1-1/2 x 2-1/2	14-9/16	3	4-1/8	370	76	105	18	8.1

General Notes:
1. H.P. designates the high pressure version of a given inlet size.
2. Same pipe thread connections also used on socket weld models with corresponding inlet sizes.
3. Tolerance for “B” and “C” dimensions is ±1/8".

Dimensions & Weights

Flanged Connections

Orifice Area Sq. In.	Valve Size Inlet x Outlet	ANSI Flange Class		US Customary Units (Inches)			Metric Units (millimeters)			Weight	
		Inlet RF	Outlet RF	A (Max.)	B	C	A (Max.)	B	C	lb	kg
0.068 & 0.125	1/2 x 1	150# 300# 600# 900#	150# 150# 150# 300#	14	5-3/16	6-1/4	356	132	159	15	6.8
		1500# 2500#	300# 300#	16-1/8	5-15/16	6-1/4	410	151	159	22	9.9
	3/4 x 1	150# 300# 600# 900#	150# 150# 150# 300#	13-15/16	5-3/16	6-3/16	354	132	157	15	6.8
		900# 1500# 2500#	300# 300# 300#	16-1/8	5-15/16	6-1/4	410	151	159	22	9.9
	1 x 1	150# 300# 600# 900#	150# 150# 150# 300#	14 7/8	5-3/16	7-1/8	378	132	181	15	6.8
		900# 1500# 2500#	300# 300# 300#	17-1/16	5-15/16	7-3/16	433	151	183	22	9.9
0.223	1 x 1-1/2	150# 300# 600# 900#	150# 150# 150# 300#	16-13/16	5-13/16	6-15/16	427	148	176	26	11.7
0.350	1-1/2 x 2	150# 300# 600#	150# 150# 150#	17-7/8	8-3/16	7-3/16	454	208	183	30	13.6
0.573	1-1/2 x 2-1/2	150# 300# 600#	150# 150# 150#	17-1/8	8-3/16	7-7/16	435	208	189	32	14.5

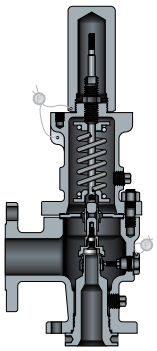
Welding Nipple Connections

Valve Size[1]	US Customary Units (Inches)				Metric Units (millimeters)			Approx. Weight	
Inlet x Outlet	A (Max.) All Cap Const.	B	C	G[4] (MNPT)	A (Max.) All Cap Const.	B	C	lb	kg
C and D Orifice									
1/2 x 1	13	3-3/16	5-1/4	1	330	81	133	9	4
1/2 x 1 H.P	15-3/16	3-15/16	5-5/16	1	386	100	135	15	6.8
3/4 x 1	12-15/16	3-3/16	5-3/16	1-1/4	329	81	132	9	4
3/4 x 1 H.P.	15-1/8	3-15/16	5-1/4	1-1/4	384	100	133	15	6.8
1 x 1	12-7/8	3-3/16	5-1/8	1-1/2	327	81	130	9	4
1 x 1 H.P.	15-1/16	3-15/16	5-3/16	1-1/2	383	100	132	15	6.8
E Orifice									
1 x 1-1/2	14-13/16	3-13/16	4-15/16	1-1/2	376	97	125	17	7.7
F Orifice									
1-1/2 x 2	15-7/8	5-3/16	5-3/16	2	403	132	132	18	8.1
G Orifice									
1-1/2 x 2-1/2	15-7/8	5-3/16	5-7/16	2	403	132	128	19	8.6

General Notes:
1. H.P. designates the high pressure version of a given inlet size.
2. Same pipe thread connections also used on socket weld models with corresponding inlet sizes.
3. Tolerance for “B” and “C” dimensions is ±1/8".
4. Standard U.S. MNPT pipe thread.

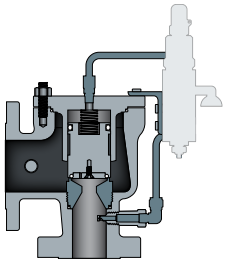
Farris Engineering Products

Process Pressure Relief Valves



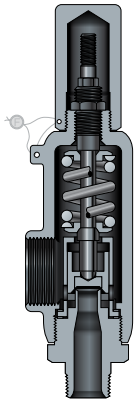
SERIES 2600/2600L

- ASME NB Certified: Air, Steam & Water
- Sizes: 1" x 2" to 20" x 24"
- Pressure Range: 15 psig to 6000 psig
- Temperature Range: -450°F to +1500°F
- Materials*: Carbon Steel, Stainless Steel, Monel & Hastelloy C
- Options: Balanced Bellows, O-Ring Seat, Open Bonnet
- CE Approved



SERIES 3800 Pilot Operated

- ASME NB Certified: Air, Steam & Water
- Sizes: 1" x 2" to 12" x 16"
- Pressure Range: 15 psig to 6170 psig
- Temperature Range: -450°F to +500°F
- Materials*: Carbon Steel, Stainless Steel, Monel & Hastelloy C
- Actuation: Snap and Modulating Controls
- Options: Field Test Connections, Reverse Flow Preventer, Remote Depressurizing & Auxiliary Filters
- CE Approved

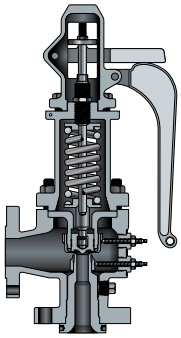


SERIES 2700

- ASME NB Certified: Air, Steam & Water
- Sizes: ½" x 1" to 1½" x 2½"
- Pressure Range: 15 psig to 6500 psig
- Temperature Range: -450°F to +750°F
- Materials*: Carbon Steel, Stainless Steel, Monel & Hastelloy C
- Options: Balanced Design, O-Ring Seats, Flanged, Socket Weld, Welding Nipple, & Sanitary Connections
- CE Approved

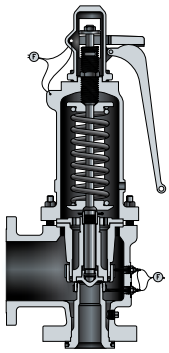
*Other materials available upon request. Please consult the factory.

Steam Safety Valves



SERIES 4200

- ASME NB Section I & VIII Certified: Steam & Air
- Sizes 1¼" x 1½" to 6" x 8"
- Pressure Range: 15 psig to 1000 psig
- Temperature Range: -20°F to +1000°F
- Materials: Carbon Steel, Stainless Steel, Chrome-Moly
- Options: Test Gag
- CE Approved



SERIES 6400

- ASME NB Section I & VIII Certified: Steam & Air
- Sizes: 1" x 2" to 4" x 6"
- Pressure Range: 15 psig to 1500 psig
- Temperature Range: -20°F to +1000°F
- Materials: Carbon Steel, Stainless Steel, Chrome-Moly
- Options: Closed Bonnet (6600) & Test Gag

Farris Engineering Products and Services

Process Pressure Relief Valves – ASME Code Section VIII

Series 2600	ASME NB Certified for Air, Steam
Series 2600S	ASME NB Certified for Air and Steam
Series 2600L	ASME NB Certified for Air, Steam and Water
Series 3800	ASME NB Certified for Air, Steam and Water
Series 2700	ASME NB Certified for Air, Steam and Water
Series 1890 / 1896M	ASME NB Certified for Air, Steam, & Water

Steam Safety Valves – ASME Code Section I & VIII

Series 4200	ASME NB Certified for Steam
Series 6400/6600	ASME NB Certified for Steam

Nuclear Pressure Relief Valves

Series 4700/4700L	ASME NB Section III, Division 1 Class I, II & III
Series 2700/3700	ASME NB Section III, Division 1 Class I, II & III
Series 2600/2600L	ASME NB Section III, Division 1 Class I, II & III
Series 3800	ASME NB Section III, Division 1 Class I, II & III

Certifications and Approvals:

- ASME V, UV, NV and NPT
- National Board Approval, NB
- ISO 9001-2008
- PED 97/23/EC (European Pressure Equipment Directive)
- ATEX 94/9/EC (European Potentially Explosive Atmospheres)
- CSA B51 (Canadian Registration)
- CSQL (China Safety Quality License)
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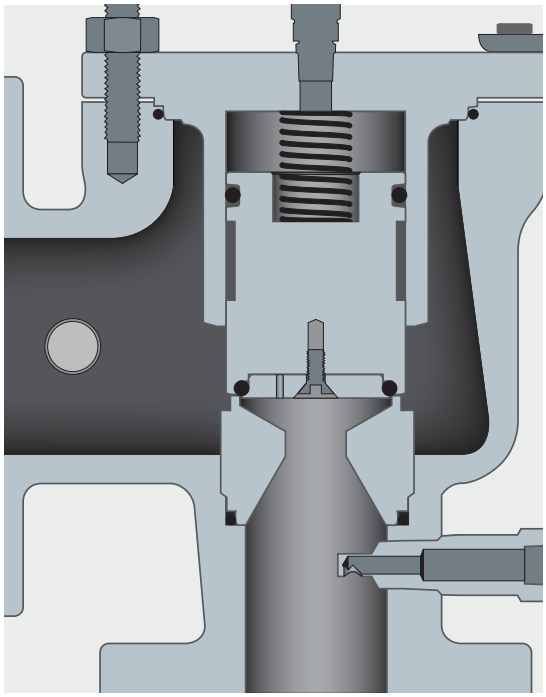
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Series 3800

Maintenance Manual







CURTISS WRIGHT
Flow Control Company
Farris Engineering

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Introduction

This Maintenance Manual is intended to present all the essential information you will need in order to keep your Farris valves in perfect operating condition. Generally, maintenance becomes necessary as a result of dirt or scale in the lines, exposure to service conditions, incorrect servicing, improper testing procedure, or improper installation.

This manual covers Series 3800 pilot-operated safety relief valves, which consist of two basic components: a pilot control and the main valve. The pilot control is a spring-loaded valve which senses the pressure and controls the opening and closing of the main valve.

Once the pilot-operated safety relief valve is isolated from the system pressure, it relieves the pressure from the inlet valve. Disconnect the pilot control from the main valve. Take particular note of the tubing connection orientation.

Follow pages 4 – 6 to perform maintenance on the main valve, pages 7 – 12 for the snap acting pilot controls, and pages 13 – 21 for the modulating pilot controls.

If a valve repair requires replacement of parts, only Farris components should be used. Use of parts from other than the original manufacturer will lead to potentially dangerous operating conditions. This valve is ASME Code certified. Unauthorized tampering and repair is in violation of the Code and will void certification that may apply to an ASME Code certified system. If faced with repairs exceeding the scope of this manual, you should contact the Farris Factory.

Safety Tips

- Make sure that the safety relief valve is isolated from the pressure source before it is removed.
- Stand clear and wear protective clothing when removing safety relief valve to prevent exposure to any types of deposits or corrosive debris which may have been trapped inside the valve.
- Do not stand near the discharge side of a safety relief valve when testing the valve.
- Always install a safety valve vertically as the internal parts are designed to operate in that position.
- Avoid hammer blows to the valve.
- Eliminate stress on the valve body whenever possible.
- Be careful when checking a safety valve for visible leakage.

Type Numbering System

The diagram below illustrates the Farris 3800 Series valve type numbering system. You will find this type of number on the nameplate of every Farris 3800 Series valve. The number found on each valve nameplate describes the valve with its construction and metallurgy. Valve types with numbers ending in "SP" are special valves. Example: 38DC12-120/S4/SP.

It may be necessary to contact the factory for assistance when replacement parts or maintenance is required on such valves.

Complete standard metallurgy details for individual parts in the 3800 Series valve line can be obtained by consulting a current sales catalog.

Example: Valve Type 38DC12X-120/S4

38	D	C	1	2	X –	1	2	0/	S4
Series Number	Orifice	Design	Temp Class	Inlet Class	Special Construction	Inlet Facing	Pilot Control	Options	Special Materials

Basic Series

3800

Design Type

C	Soft Seat & Seals
T	Teflon Seat*& Seals
*Main Valve Only	

Orifice

Letter	API Area	Actual Area
D	0.110	0.150
E	0.196	0.225
F	0.307	0.371
G	0.503	0.559
H	0.785	0.873
J	1.287	1.430
K	1.838	2.042
L	2.853	3.170
M	3.60	4.000
N	4.34	4.822
P	6.38	7.087
Q	11.05	12.27
R	16.00	17.78
T	26.00	28.94
A	-	0.719
1	-	1.767
2	-	2.953
3	-	6.605
4	-	11.50
6	-	26.07
8	-	45.66

Inlet Class

Desig.	ANSI Class
0	150
2	300
3	600
4	900
5	1500
6	2500

Special Construction

L	Liquid Service
X	Oversized Vapor Service
Y	Oversized Liquid Service
D	Dual Outlet (Vapor)
E	Dual Outlet (Liquid)
U	Non-Standard API (Vapor)
N	Non-Standard API (Vapor)

Temperature & Materials

Desig-nation	Temp. Range	Material	
		Body & Cover	Spring
1	-20 to 450	Carbon St.	St.St.
1	-450 to -20	Consult Factory	Consult Factory

Inlet Facing

Special	0
Raised Face	1
Ring Joint	9
RF Smooth Finish	H
63 to 83 AARH Outlet Only	J
63 to 82 AARH Inlet & Outlet	K
High Pressure Hub Connection	X

Pilot Control

Snap-Acting Control	2
Modulating Control	M
Steam Modulating Control	S

Options

No Options	0
Dual Pilot Options	2
Auxiliary Filter	3
Manual Depress.	4
Field Test Conn.	5
Reverse Flow Preventer	6
Pressure Spike Snubber	7
Remote Depress.	8
Four Auxiliary Functions (4, 5 or F, 6 & 8)	9
Combination of Options	C
Field Test Connection w/ Indicator	F
Remote Sensing	R
Discharge to Outlet	V
Combo (3 & 5 or F)	A
Combo (5 or F & 6)	B
Combo (3, 5 or F, & 6)	E

Special Materials

S4	Complete 316 SS Construction
S7	NACE Construction (Obsolete – Historical Designation)
M4	Complete Monel Construction
N1	NACE Carbon Body
N4	NACE All Stainless
H4	All Hastelloy C

Operational Principles

Pressure in the protected vessel is sensed through a pressure tap (remotely connected or on the main valve body). The pressure tap is piped to the pilot control sensing line port. The vessel pressure is transmitted to the dome from the pilot control dome port.

When vessel pressure is below pilot control set pressure, the relief seat of the pilot control is closed. Inlet pressure of the main valve is equal to the dome pressure. The difference in the main valve nozzle seat area (smaller) and the dome area (larger) guarantees the main valve to be closed.

When the vessel pressure reaches set pressure, the pilot control relief seat opens. The pilot control relieves the dome pressure to the atmosphere. The force of the pressure in the inlet of the main valve causes the piston to lift from its closed position to relieve excess vessel pressure.

When vessel pressure reaches re-seat pressure (typically 95% of set pressure), the spring force overcomes the pressure force on the lower seat of the pilot control. The relief seat closes instantaneously with the opening of the lower seat. Pressure re-enters the dome and develops the force to move the piston down and close the main valve.

Main Valve

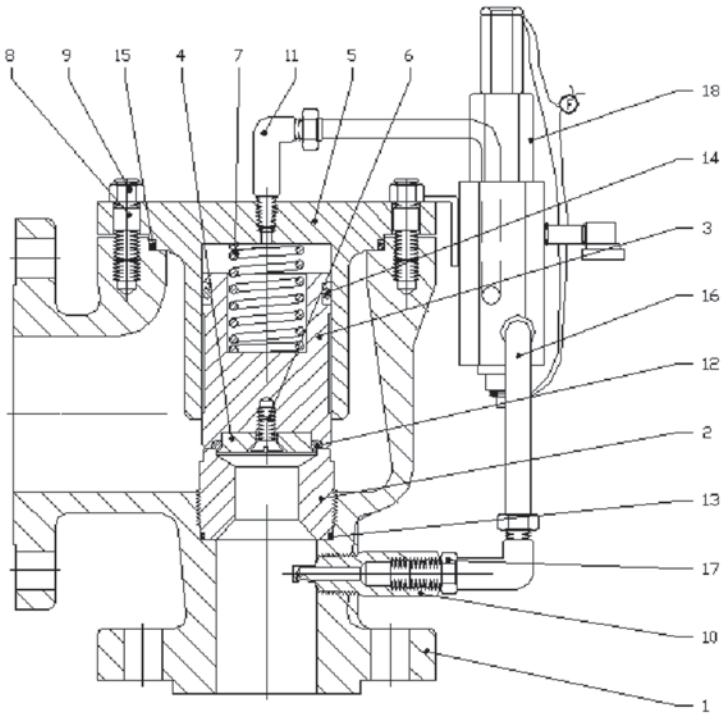


Figure 5.1 Main Valve (1", 1-1/2" & 2" Inlet)

Bill of Materials

Item	Part Name	Material
1	Body	SA-216, Gr. WCB, Carbon St.
2	Nozzle	316 St. St.
3	Piston	316 St. St.
4	Seat Retainer	316 St. St.
5	Guide / Cover	316 St. St.
6	Retainer Screw	316 St. St.
7	Preload Spring	316 St. St.
8	Body Stud	ASTM A193 Gr. B7 Alloy St.
9	Hex Nut (Body)	ASTM A194 Gr. 2H Alloy St.
10	Pressure Pickup	316 St. St.
11	Male Elbow	316 St. St.
12	Seat Seal	Viton
13	Nozzle Seal	Viton
14	Piston Seal	Viton
15	Guide Seal	Viton
16	Tubing	316 St. St.
17	Male Connector	316 St. St.
18	Pilot Control	316 St. St.

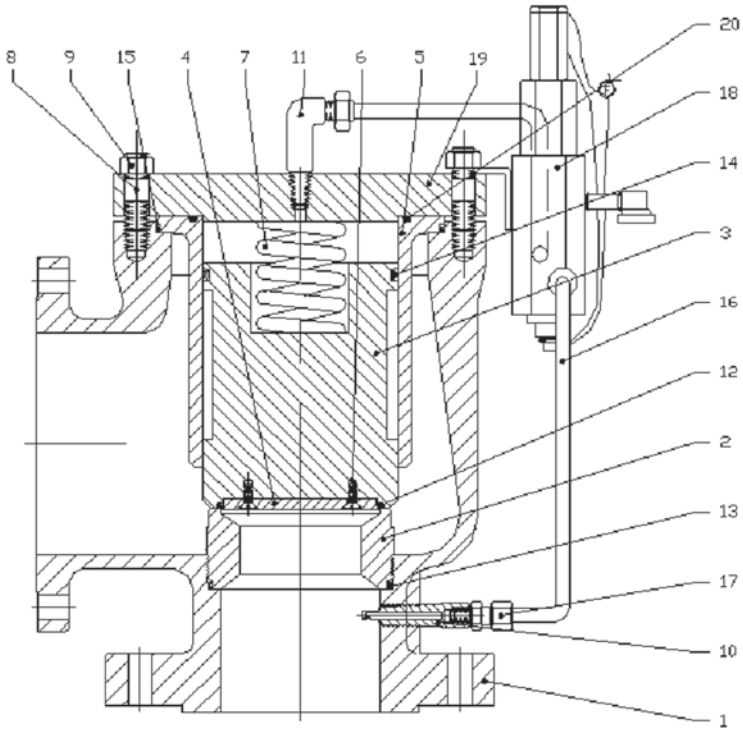


Figure 5.2 Main Valve (3" and larger Inlet)

Bill of Materials

Item	Part Name	Material
1	Body	SA-216, Gr. WCB, Carbon St.
2	Nozzle	316 St. St.
3	Piston	316 St. St.
4	Seat Retainer	316 St. St.
5	Guide	316 St. St.
6	Retainer Screw	316 St. St.
7	Preload Spring	316 St. St.
8	Body Stud	ASTM A193 Gr. B7 Alloy St.
9	Hex Nut (Body)	ASTM A194 Gr. 2H Alloy St.
10	Pressure Pickup	316 St. St.
11	Male Elbow	316 St. St.
12	Seat Seal	Viton
13	Nozzle Seal	Viton
14	Piston Seal	Viton
15	Guide Seal	Viton
16	Tubing	316 St. St.
17	Male Connector	316 St. St.
18	Pilot Control	316 St. St.
19	Cover	SA-105, Carbon St.
20	Cover Seal	Viton

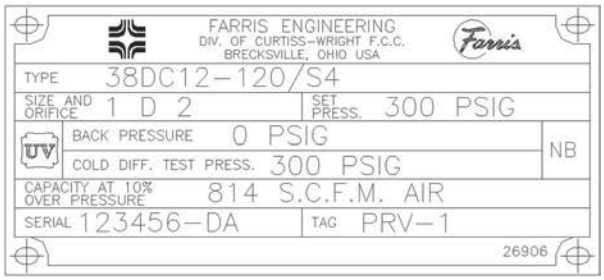


Figure 5.3 Sample Nameplate for Main Valve

Disassembly

Item	Tool Description	Sizes
1	Wrenches	1/2", 5/8", 3/4", 7/8", 1-1/4"
2	O-Ring Pick	
3	1" Square Drive Socket Spanner	1-5/8", 2-1/4", 2-7/16", 3-5/8"
4	1-1/2" Square Drive Socket Spanner	4-1/2"
5	Screw Driver	
6	Wire Cutter	
7	Extension Bar	9", 18"
8	C-Clamp	
9	Eye Bolt	3/8", 1/2"

*Special tool for 6" and 8" inlet size valves.

For 1", 1-1/2" and 2" inlet size (Figure 5.1):

1. Place valve on a clean and well-lit workbench.
2. Remove wire seal.
3. Remove pilot control, bracket and interconnecting tubing.
4. Do not remove sensing nipple from body.
5. Loosen body hex nuts and remove from cover.
6. Using a nipple in the guide connection, carefully lift the guide-piston assembly straight up. Avoid tilting or dropping, which could damage nozzle face.
7. Invert the guide-piston assembly and slide the piston and spring out.
8. Remove cover seal.
9. Remove seat retainer from piston by unscrewing the set screw.
10. Remove seat seal and piston seal with O-ring pick.
11. Unscrew nozzle from body with a socket spanner.
12. Remove nozzle seal.

For 3", 4", 6" and 8" inlet size (Figure 5.2):

1. Place valve on a clean and well-lit workbench.
2. Remove wire seal.
3. Remove pilot control, bracket and interconnecting tubing.
4. Do not remove sensing nipple from body.
5. Loosen body hex nuts and remove from cover.
6. Lift cover using eyebolts and lifting device.
7. Remove spring.
8. Remove cover seal from top of guide.
9. Remove piston from guide using eyebolt and lifting device. Guide may also be lifted along due to piston seal friction. Hold the guide so that it will not be lifted with the piston.
10. Remove guide and guide seal from body.
11. Unscrew set screw to remove seat retainer from piston.
12. Remove piston seal and seat seal.
13. Unscrew nozzle from body with socket spanner or special tool. Remove nozzle from body.
14. Remove nozzle seal from body.

Cleaning and Repairing

Clean all parts thoroughly. Replace all O-rings. Inspect all parts and replace any that are worn. NO REMACHINING IS ALLOWED. Polish guiding surfaces, if required. For O-ring purchasing, be sure to specify original compound. If in doubt, contact the Farris Factory.

Assembly

For 1", 1-1/2" and 2" inlet size:

1. Refer to Figure 5.1 for construction details.
2. Visually inspect all parts to be assembled. Replace any parts that are worn or damaged.
3. Lubricate all threaded and mating surfaces with Bostik Never Seez® or equivalent.
4. Lubricate all seals with grease compound that is compatible to the elastomer.
5. Insert nozzle seal into recess on bottom of nozzle.
6. Screw nozzle into body using socket spanner.
7. Position piston with the seat facing up. Place seat seal on piston, making sure it fits evenly and symmetrically.
8. Place seat retainer on piston and tighten set screw, making sure that seat retainer sits evenly and symmetrically on piston. Use C-clamp to hold the piston and retainer in order to tighten the set screw fully.
9. Insert piston seal into the groove around the circumference of the piston.
10. Place cover seal onto the body.
11. Invert piston so that the seat retainer faces down. Place spring on top of piston. Insert piston into guide with the spring in between. Check manually if there is interference between the guide and the piston. There may be some resistance due to the piston seal and the spring.

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Assembly (continued)

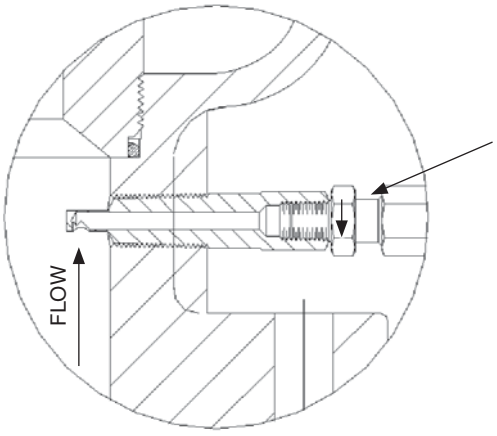
For 1", 1-1/2" and 2" inlet size (continued):

12. Carefully place the guide-piston assembly into the body.
13. Thread body hex nuts onto body studs and tighten.
14. If sensing nipple is removed from the body, thread it to the body and make sure the hole orientation is correct and agrees with the arrows marked (Refer to Figure 5.4).
15. The main valve is now ready for final assembly (See section on Final Assembly, page 22).

For 3", 4", 6" and 8" inlet size:

1. Refer to Figure 5.2 for construction details.
2. Follow steps 2-5 of the assembly procedure for 1", 1-1/2" and 2" main valves.
3. Screw nozzle into body with socket spanner. Use the special tool to tighten nozzle for 6" and 8" inlet size valves.
4. Place the guide seal onto the body.
5. Place guide into the body carefully. Make sure that guide is seated on the body evenly.
6. Position piston with the seat facing up. Place seat seal on piston, making sure it fits evenly.
7. Place seat retainer on piston and align the holes of retainer to the threaded holes on piston. Tighten set screws. Use C-clamp to hold the piston and retainer if necessary.
8. Insert piston seal into the groove around the circumference of the piston.
9. Invert piston so that the retainer faces down. Lift piston with eyebolt and lifting device, and lower it into the guide carefully. Push the piston into the guide if needed. There should not be any interference between the guide and the piston, but there may be some frictional resistance caused by the piston seal.
10. Place spring on top of piston.
11. Place cover seal on guide.
12. Lift cover with eyebolts and lifting device. Align the holes of the cover with the body studs. Lower cover over guide.
13. Thread body hex nuts onto body studs and tighten.
14. If sensing nipple is removed from the body, thread it to the body, making sure that hole orientation is correct and agrees with the arrow marked (Refer to Figure 5.4).
15. The main valve is now ready for final assembly (See section on Final Assembly, page 22).

Fig. 5.4 Sensing Nipple



Snap Acting Pilot Control

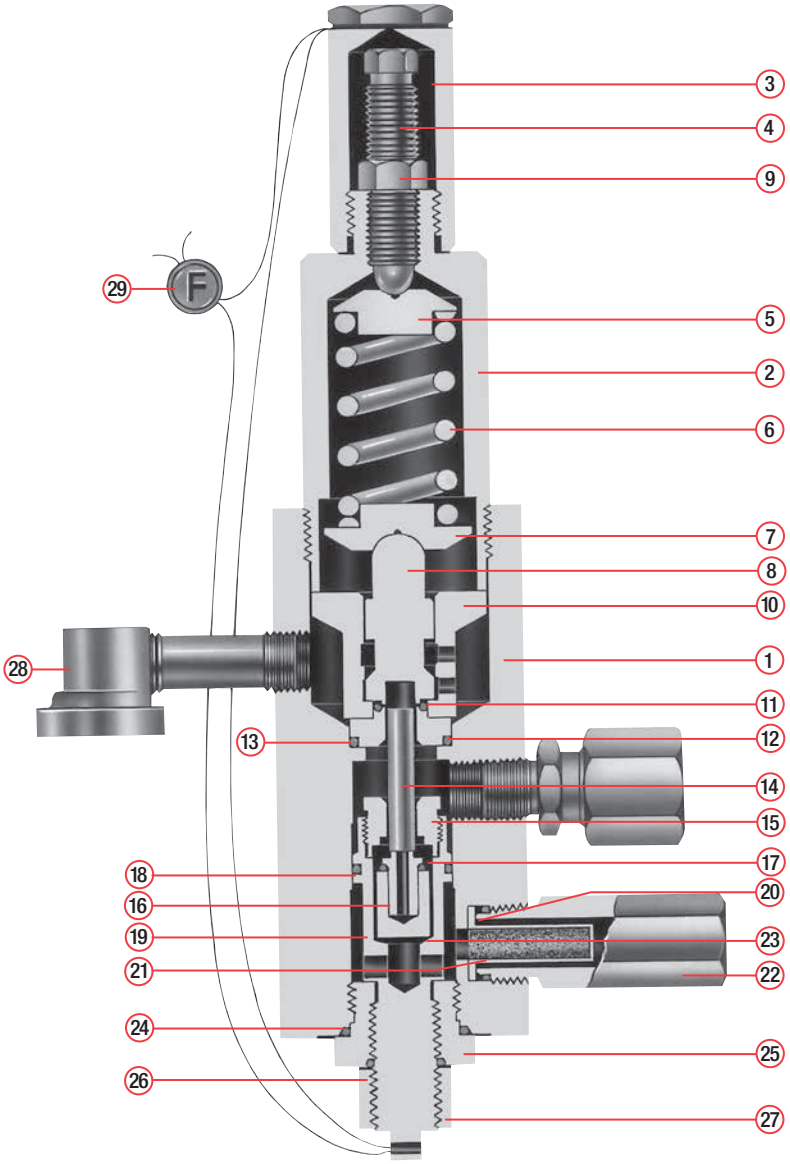


Figure 6.1 Snap Acting Pilot Control

Bill of Materials

Item No.	Part Name	Standard Material
1	Body	SA-479, 316 St. St.
2	Bonnet	SA-479, 316 St. St.
3	Cap	316 St. St.
4	Spring Adjusting Screw	316 St. St.
5	Upper Spring Button	316 St. St.
6	Spring - Standard	316 St. St.
	Spring - NACE	Inconel X750
7	Lower Spring Button	316 St. St.
8	Disc	316 St. St.
9	Jam Nut	18-8 St.
10	Guide	316 St. St.
11	Upper Seat Seal	Viton[1]
12	Upper Seat	316 St. St.
13	Static Seal, Body	Viton[1]
14	Blowdown Relay	316 St. St.
15	Lower Seat	316 St. St.
16	Retainer, Lower Seat Seal	316 St. St.
17	Lower Seat Seal	Viton[1]
18	Static Seal, Adjuster	Viton[1]
19	Blowdown Adjuster	A479, 316 St. St.
20	Static Seal, Filter	Viton[1]
21	Filter	300 Series St. St.
22	Filter Housing	316 St. St.
23	Poppet	316 St. St.
24	Adjuster Cap Seal	Viton[1]
25	Blowdown Adjuster Cap	316 St. St.
26	Thread Seal	Teflon
27	Blowdown Adjuster Lock Nut	18-8 St. St.
28	Bug Vent Housing	Commercial Grade
29	Wire Seal	St. St. Wire/Lead Seal
30	Nameplate (Not Shown)	Stainless Steel



Figure 6.1a
Sample Snap-Acting Control Nameplate

General Notes:
1. For NACE Service (S7 Trim), substitute ethylene propylene.

Disassembly

Like any other safety relief device, the snap acting pilot control requires maintenance on a regular basis. Scheduling of maintenance is the responsibility of the end-user.

The snap acting pilot control shall be taken off-line before any maintenance and service work can be performed. Arrangements for an alternate safety relief device shall be made, if system protection is to remain in effect. Only authorized repair facility with qualified personnel shall do any maintenance/repair.

It is necessary to have the right tools (Table 6.1) and a replacement elastomer kit.

Table 6.1

Item	Tool Description	Sizes
1	Soft Jaw Bench Vise	
2	Adjustable Wrenches	
3	Set Of Open Ended Wrenches	1/4, 7/16, 9/16, 5/8, 3/4, 1-1/8, 1-1/2 & 2 Inch Span
4	O-Ring Pick	
5	Wire Cutters	

Once the pilot control is out of service

1. Place the pilot control on a clean and well-lit workbench.
2. Make a note of the physical condition of the valve before disassembly.
3. Cut and discard lead seals.
4. Remove the strainer assembly, the fitting for the piston (dome) line, and the exhaust port attachment.
5. Clamp the body of the valve on a bench vise. Remove the cap by unscrewing it from the bonnet.
6. Relieve the spring compression by loosening the spring adjustment screw. Take note of the number of turns from the locked position to the point where spring resistance is not felt. This will aid in setting the valve to its original set pressure.
7. Remove the bonnet from the body to expose the internals of the upper sub-assembly. CAREFULLY pull each part and arrange neatly on top of the workbench.
8. Loosen the blow down adjuster. Take note of the number of turns from the locked position to the lowest position. This will be helpful when setting the valve to its original setting.
9. Remove the lower sub-assembly by unscrewing the bushing from the body.
10. Unscrew the seat insert from the adjuster to access the lower disc assembly.

Cleaning & Repairing

Clean all parts with solvent and blow dry with air, being particularly careful on seating surfaces.

Inspect all parts and seating surfaces for excessive wear and corrosion. Discard and replace as necessary. NO REMACHINING IS ALLOWED. Replace all seals. Identify each new elastomer piece from the kit by matching it with Figure 6.2. Be sure to replace with proper compound for the particular service. If in doubt, contact the Farris Factory giving the serial number on the nameplate.

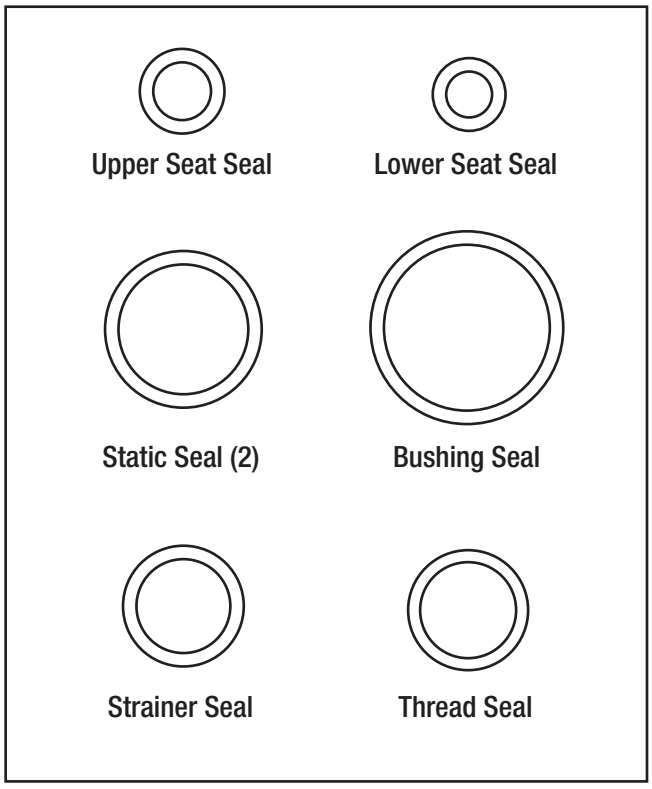


Figure 6.2
Seals for Snap Acting Pilot Control

Assembly

The upper and adjuster sub-assemblies have been identified in Figure 6.3 to help in distinguishing the vertical position of the snap acting control. Orientation of all the parts in each sub-assembly is likewise referred to in their vertical position.

Lubricate all threaded and mating surfaces with Bostik Never Seez (or equivalent).

A. Upper Sub-Assembly

1. Orient body with its length vertical, and the wider opening facing upward.
2. Place a static seal into the counter-bore of the body, via the upper opening.
3. Place the upper seat over the static seal, making sure the side with the bigger outside diameter protrusion faces downward.
4. Orient the guide with its flange upward. Insert the upper seat seal into the recess on the lower side of the guide.
5. Lower the guide onto the upper seat inside the body, making sure that the upper seat seal does not fall out and is in good contact with the upper seat and the guide. Also make sure that the two holes on the guide's side face the outlet (uppermost side-hole) of the body.
6. Slide disc into the guide, taking care not to damage the seats, and making sure that the upper disc rests fully on the upper seat seal. The correct orientation of the disc is with its rounded end facing upwards.
7. Place the two (2) spring buttons over the two ends of the spring. Hold the buttons over the ends of the spring with thumb and forefinger.
8. Match the lower spring button over the rounded top of the disc making sure that rounded top of the disc fits into the recess in the lower spring button.
9. Lower the bonnet over the spring button's subassembly and screw tightly into the body.
10. Screw the spring adjusting screw into the jam nut until the jam nut is about two thirds (2/3) up the spring adjusting screw.
11. Screw the spring adjusting screw – jam nut subassembly into the top of the bonnet. Stop as soon as resistance from the upper spring button is felt.

B. Adjuster Sub-Assembly

1. Position the lower seat seal on the retainer making sure it fits evenly and symmetrically.
2. Lower the retainer into the lower disc with the lower seat seal fitting snugly between the retainer and the lower seat.
3. Lower the lower seat – retainer sub-assembly into the adjuster with the lower disc entering the adjuster first.
4. Screw the seat insert into the adjuster and tighten.
5. Place the second static seal in the groove on the side of the adjuster, making sure it fits evenly.
6. Place the bushing seal on the bushing beyond the threads and against the flat back of the bushing's hex head.
7. Screw the bushing onto the adjuster with the hex head of the bushing facing downward.
8. Position a thread seal on the threads of the adjuster and against the hex head of the bushing.
9. Screw the lock nut onto the adjuster and tighten.
10. Place the spacer rod into the hole of the seat insert until it rests on the top of the retainer.
11. Insert the adjuster sub-assembly into the body through its lower end, making sure the spacer rod passes through the hole of the upper seat.

C. Strainer

1. Position the strainer into the inlet (lowest) port of the body, flange first.
2. Place the second thread seal into the inlet port, bottoming on the strainer flange.
3. Screw the strainer housing into the inlet port and tighten.

D. Connections

1. Connect the sensing line into the strainer housing in the sensing line port of the body.
2. Use the dome line port in the middle of the body to connect to the dome of the main valve.
3. Leave the exhaust port open to the atmosphere for exhaust, or connect it to an exhaust plenum. The snap acting pilot control is ready to be set and tested.

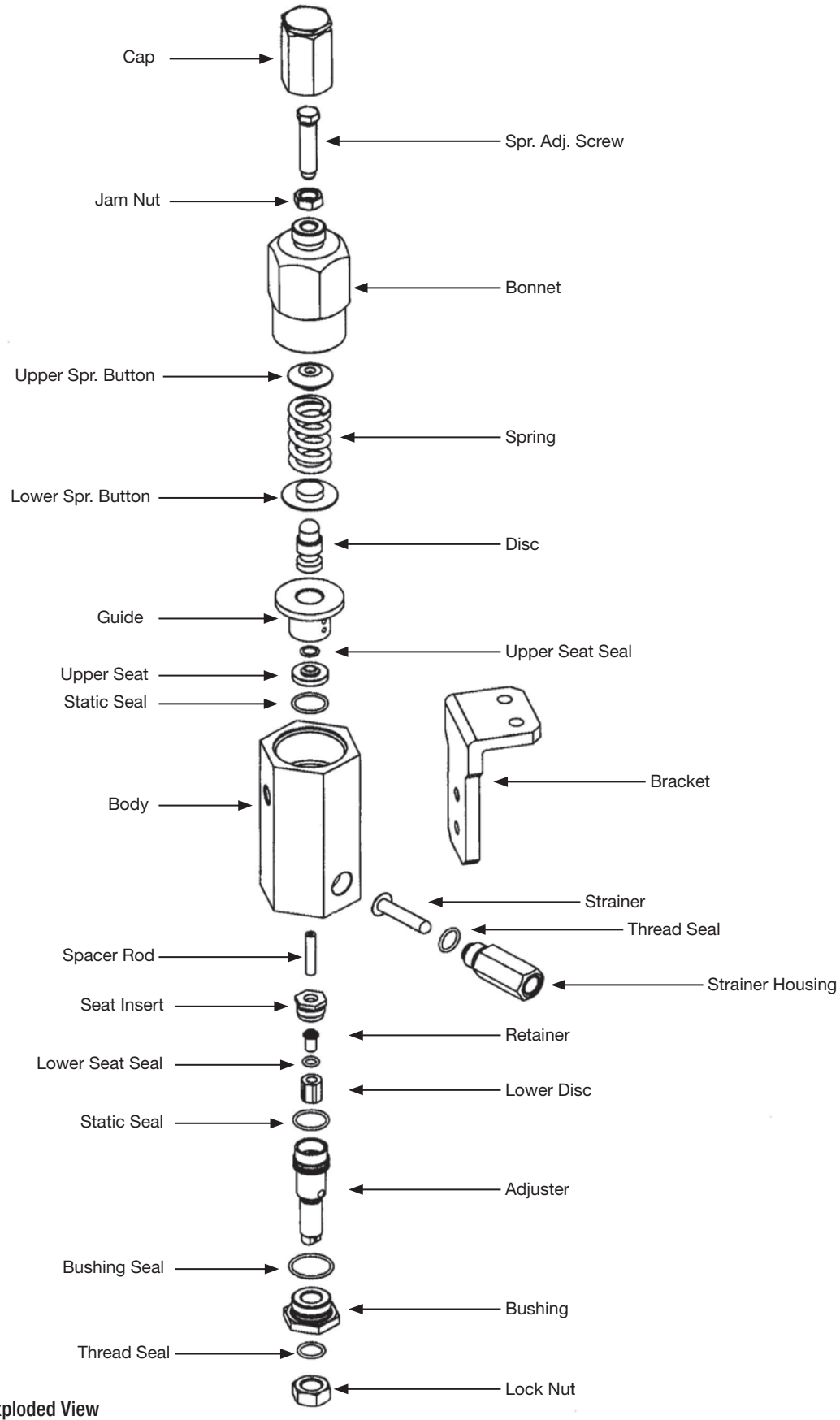


Figure 6.3
Snap-Acting Control Exploded View

Setting & Testing the Snap Acting Pilot Control

Testing of the snap acting pilot control will be performed only after correct assembly has been accomplished. Read the entire test procedure. Test should be conducted only by qualified personnel.

Connect the snap acting control to the test rig (see Test Stand Schematic, Figure 6.4).

A. Test Stand Schematic Description

- **V1 -** Isolation valve, normally open when test is in progress.
- **V2 -** Needle valve, regulates pressure into vessel.
- **V3 -** Vent valve, normally closed when going up on the receiver pressure; also used to dump pressure from vessel.
- **V4 -** Vent valve, normally closed when testing, used as an auxiliary pressure dump valve.
- **P1 -** Pressure gage, to read dome pressure.
- **P2 -** Pressure gage, to read vessel pressure.

Vessel Receiver – Test pressure receiver simulating a vessel.

Dome Receiver – Test pressure receiver simulating the dome/piston volume on the main valve.

In-Line Filter – Filters air going into the vessel.

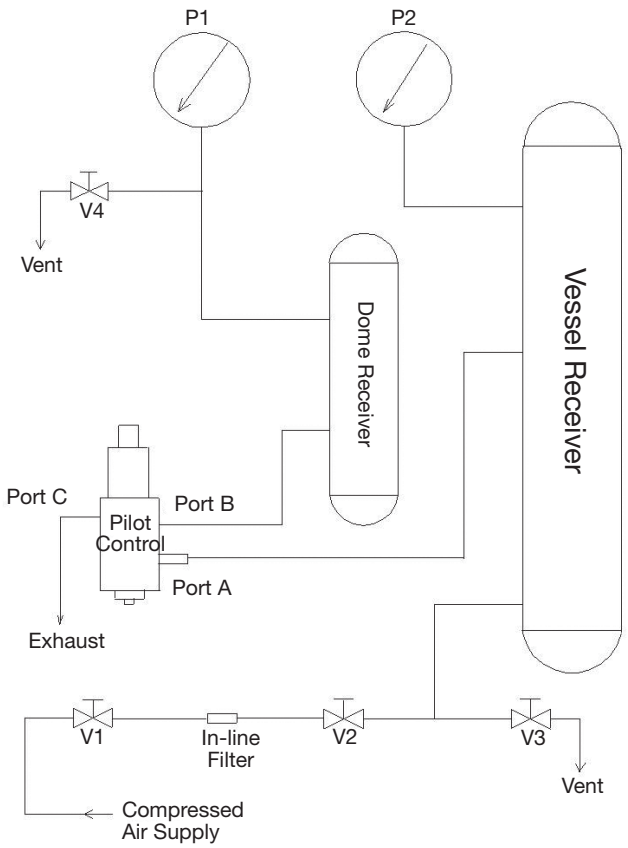


Figure 6.4 Test Stand Schematic

B. Port Identification and its Connections

Port A: Where the pilot control senses the vessel pressure. Connect this to vessel receiver.

Port B: Where the pilot control is connected to the dome or piston of the main valve. Connect this to the dome receiver.

Port C: The exhaust port, normally vented to the atmosphere (i.e. piped to the outlet of the main valve, with bug screen).

C. Set Pressure Testing

Setting the pilot control is similar to setting a spring loaded valve where the spring is being compressed to the desired set pressure. The set pressure is distinguished by the pop.

1. Refer to Table 6.2 (page 12) for the nominal number of turns on the spring adjusting screw required to set the valve. Start counting the number of turns when the spring adjusting screw approximately touches the upper spring button. This can be done by feel.
2. Set the blow down adjuster at its lowest position.
3. Pressurize the vessel receiver by slowly opening V2. Note: both pressure gages P1 and P2 shall have the same pressure reading.
4. Record pop (set) pressure. Note: After pop, P1 should drop to zero. If it does not, carefully turn the blow down adjuster up to equalize P1 and P2. Pop again to confirm zero pressure on P1. Overpressurize the vessel receiver to 10% or 3 psig, whichever is greater.
5. Fine tune the set pressure and blow down to requirement. Use Table 6.2 as a guide to the number of turns required.
6. When the set (pop) pressure on P2 is reached, P1 will read zero pressure (main valve is in the open or flowing mode).
7. Vent the vessel pressure slowly through V3 to determine the re-seat pressure of the valve. Proper re-seat (commonly there's a slurping sound) occurs when P1 and P2 read the same pressure.
8. When performance is satisfactory, tighten the lock nut, jam nut and cap.

D. Pilot Seat Tightness Testing

A 5/16" OD x 0.035" wall thickness copper tube or equivalent immersed no more than 1/2" deep in water shall be connected to the exhaust port. Raise the receiver pressure to the test pressure described below and observe for bubbles. No bubbles are allowed.

Test pressure:

- 90% of set pressure if set pressure is 50 psig or more OR
- 5 psig below set pressure if set pressure is less than 50 psig

Brush soap and water solution on joints internally exposed to pressure. Observe for leakage. No leakage at any joint is allowed.

E. Test Conclusion

Vent out pressure from the receiver tank. Unhook all test connections.

Go on to page 22 for final assembly.

Pilot Control Spring Chart & Spring Adjusting Screw / Blow Down Adjustments

Pilot Control Spring Chart & Spring Adjusting Screw / Blow Down Adjustments

Set Pressure (psig)	Spring Number	Spr. Adj Scr. (turns)	Blow Down Adjustment +/- 1/8	95 % of Set (psig)
15	B1106 SS	3-1/2	1/4	19
35		6	1/2	33
50		8-1/2	5/8	48
51	B0125 SS	3-1/2	1/4	48
65		4-1/2	3/8	62
80		5-1/2	3/8	76
100		7	1/2	95
101	B0530 SS	3-1/2	1/4	96
125		4-1/2	3/8	119
175		6	1/2	166
230		8-1/2	5/8	219
231	B0531 SS	3	1/4	219
280		3-1/2	1/4	266
330		4	1/4	314
380		5	3/8	361
430		5-1/2	3/8	409
480		6	1/2	456
530		7	1/2	504
600		8	5/8	570
601	B0533 SS	5	3/8	571
650		5-1/2	3/8	618
700		6	3/8	665
760		6-1/2	1/2	722
820		7	1/2	779
880		7-1/2	1/2	836
940		8	5/8	893
1000		8-1/2	5/8	950
1001	B0535 SS	5	3/8	951
1080		5-1/2	3/8	1026
1160		6	1/2	1102
1240		6-1/2	1/2	1178
1320		7	1/2	1254
1400		7-1/2	1/2	1330
1500		8	5/8	1425
1501	B0536 SS	5-3/4	1/2	1425
1600		6-1/4	1/2	1520
1700		6-3/4	1/2	1615

Pilot Control Spring Chart & Spring Adjusting Screw / Blow Down Adjustments

Set Pressure (psig)	Spring Number	Spr. Adj Scr. (turns)	Blow Down Adjustment +/- 1/8	95 % of Set (psig)
1800	B0536 SS	7	5/8	1710
1900		7-1/2	5/8	1805
2000		7-3/4	5/8	1900
2100		7-3/4	5/8	1900
2200		8-1/2	3/4	2090
2300		9	3/4	2185
2301	B0403 SS	4-1/2	3/8	2185
2400		4-3/4	3/8	2280
2500		5	3/8	2375
2600		5	3/8	2470
2700		5-1/4	3/8	2562
2800		5-1/2	1/2	2660
2900		5-3/4	1/2	2755
2901	B0404 SS	4	3/8	2755
3000		4	3/8	2850
3100		4-1/4	3/8	2945
3200		4-1/4	3/8	3040
3300		4-1/2	3/8	3135
3301	B0210 SS	3-1/2	1/4	3135
3400		3-1/2	1/4	3230
3500		3-1/2	1/4	3325
3600		3-3/4	1/4	3420
3700		3-3/4	3/8	3515
3800		4	3/8	3610
3900		4	3/8	3705
4000		4-1/4	3/8	3800
4001	B0327 SS	3	1/4	3801
4300		3-1/4	1/4	4085
4500		3-1/2	1/4	4275
4700		3-1/2	1/4	4465
4900		3-3/4	1/4	4655
5100		4	3/8	4845
5300		4	3/8	5035
5301	B0415 SS	3-1/4	1/4	5036
5500		3-1/4	1/4	5225
5700		3-1/2	1/4	5415
5900		3-1/2	1/4	5605
6100		3-3/4	1/4	5795

Modulating Pilot Control

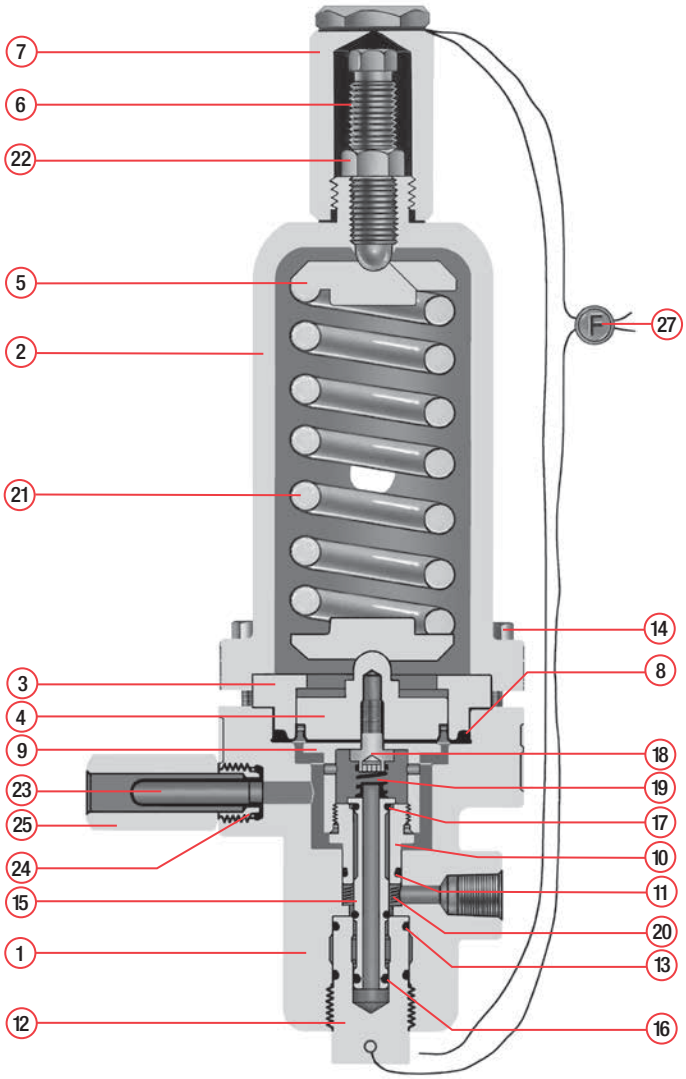
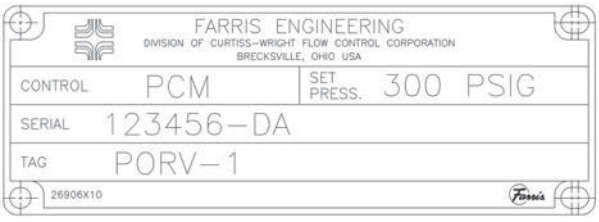


Figure 7.1 Modulating Pilot Control

Bill of Materials

Item No.	Part Name	Materials
1	Body	SA-351 GR. CF8M
2	Bonnet	SA-351 GR. CF8M
3	Guide	316 St. St.
4	Diaphragm Piston	316 St. St.
5	Spring Button	316 St. St.
6	Spring Adjusting Screw	316 St. St.
7	Cap	316 St. St.
8	Diaphragm	Fluorocarbon/Fiber Reinforced[1]
9	Diaphragm Retainer	316 St. St.
10	Inlet Seat	316 St. St.
11	Body Seal	Viton[1]
12	Spool Cap	316 St. St.
13	Spool Cap Seal	Viton[1]
14	Bonnet Cap Screw	Series 300 St. St.
15	Spool	316 St. St.
16	Spool Seal	Viton[1]
17	Seat Seal	Viton[1]
18	Retainer Screw	316 St. St.
19	Spool Return Spring	St. St[1]
20	Lower Return Spring	St. St.[1]
21	Spring	St. St.
22	Jam Nut	Series 300 St. St.
23	Filter	Series 300 St. St.
24	Filter Seal	Viton[1]
25	Filter Housing	316 St. St.
26	Bug Vent (not shown)	Commercial Grade
27	Wire Seal	St. St. Wire/Lead Seal
28	Name Plate (not shown)	St. St.

Figure 7.1a Sample PCM Nameplate



General Notes:
1. For NACE service (S7 trim), substitute ethylene propylene soft goods and Inconel® X for return springs.
   Inconel is a registered trademark of Special Metals Corporation.

Disassembly

Like any other safety relief device, the modulating pilot control requires maintenance on a regular basis. Scheduling of maintenance is the responsibility of the end-user.

The modulating pilot control shall be taken off-line before any maintenance and service work can be performed. Arrangements for an alternate safety relief device shall be made, if system protection is to remain in effect. Only authorized repair facility with qualified personnel shall do any maintenance/repair.

It is necessary to have the right tools (Table 7.1) and a replacement elastomer kit.

Table 7.1

Item	Tool Description	Sizes
1	Soft Jaw Bench Vise	
2	Adjustable Wrenches	
3	Set Of Open Ended Wrenches	1/4, 7/16, 9/16, 5/8, 3/4, 1-1/8, 1-1/2 & 2 Inch Span
4	O-Ring Pick	
5	Wire Cutters	

Once the pilot control is out of service:

1. Place the pilot control on a clean and well-lit workbench.
2. Make a note of the physical condition of the valve before disassembly.
3. Cut and discard lead seals.
4. Remove the strainer assembly, the fitting for the piston (dome) line, and the exhaust port attachment.
5. Clamp the body of the valve on a bench vise. Remove the cap by unscrewing it from the bonnet.
6. Relieve the spring compression by loosening the spring adjustment screw. Take note of the number of turns from the locked position to the point where spring resistance is not felt. This will aid in setting the valve to its original set pressure.
7. Remove the bonnet and piston guide from the body to expose the diaphragm/spool sub-assembly. CAREFULLY arrange each part neatly on top of the workbench.
8. Release the body from the vise, invert, and re-clamp.
9. Remove the spool/cap by unscrewing from the body.
10. Unscrew the seat insert from the adjuster to access the lower disc assembly.

Cleaning & Repairing

Clean all parts with solvent and blow dry with air, being particularly careful on seating surfaces.

Inspect all parts and seating surfaces for excessive wear and corrosion. Discard and replace as necessary. NO REMACHINING IS ALLOWED. Replace all seals. Identify each new elastomer piece from the kit by matching it with Figure 7.2. Be sure to replace with proper compound for the particular service. If in doubt, contact the Farris Factory giving the serial number on the nameplate.

Figure 7.2 within this specification shows the actual sizes of O-ring seals. Match seals to the drawing for ease of seal identification. Immediately following Figure 7.2 are additional seals that are present depending on the type of modulating pilot control being assembled.

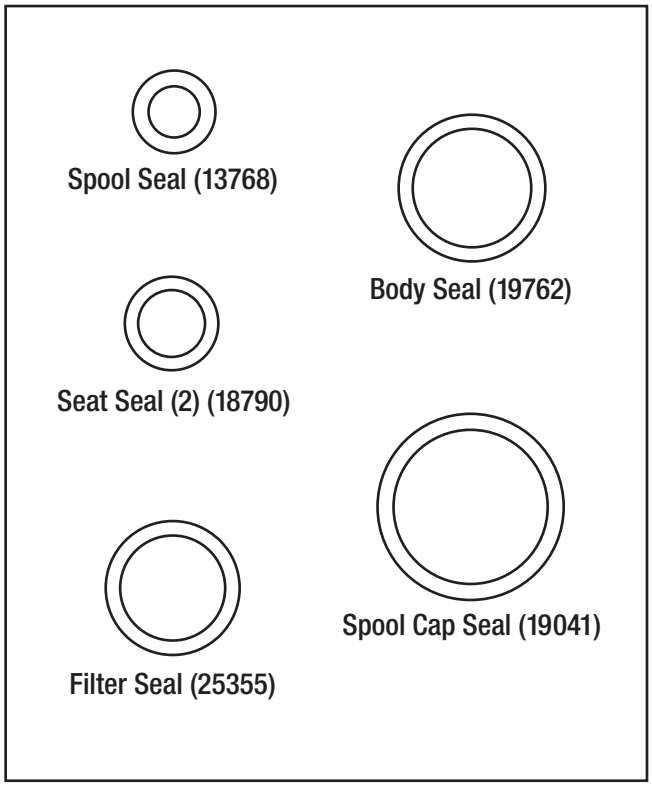


Figure 7.2
Seals for Modulating Pilot Control

Other seals specific to the modulating pilot type:

PCM – Diaphragm (26765)

HPCM – Piston Seal (7267), and Back-Up Ring (27106)

PCMS – Spring Energized Seal (27847), and Guide Seal (7272)

Assembly

A. Spool Sub-Assembly

Spool sub-assembly is identical between the PCM, HPCM, and PCMS.

1. Lay out the parts in sequence as shown in Figure 7.3a, on a clean and well-lit work area.
2. The spool uses three O-ring seals. The first (seat seal #1) is installed in the gland at the top near the flange, an intermediate one (seat seal #2) about midsection, and the lower ring (spool seal) at the bottom. Install seat seal #1 on the spool, starting from the bottom and working it to the flange end.
3. Insert the bottom of the spool through the top hole of the inlet seat. The bottom of the spool should protrude through the bottom end of the inlet seat.

s5. Install the spool seal on the bottom seal gland of the spool.

6. Install the body seal onto the seal gland located on the bottom of the inlet seat.
7. This sub-assembly (Figure 7.3b) is ready to be installed into the appropriate pilot control.

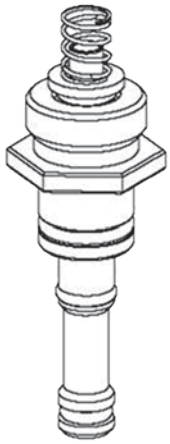


Figure 7.3b
Spool Sub–Assembly

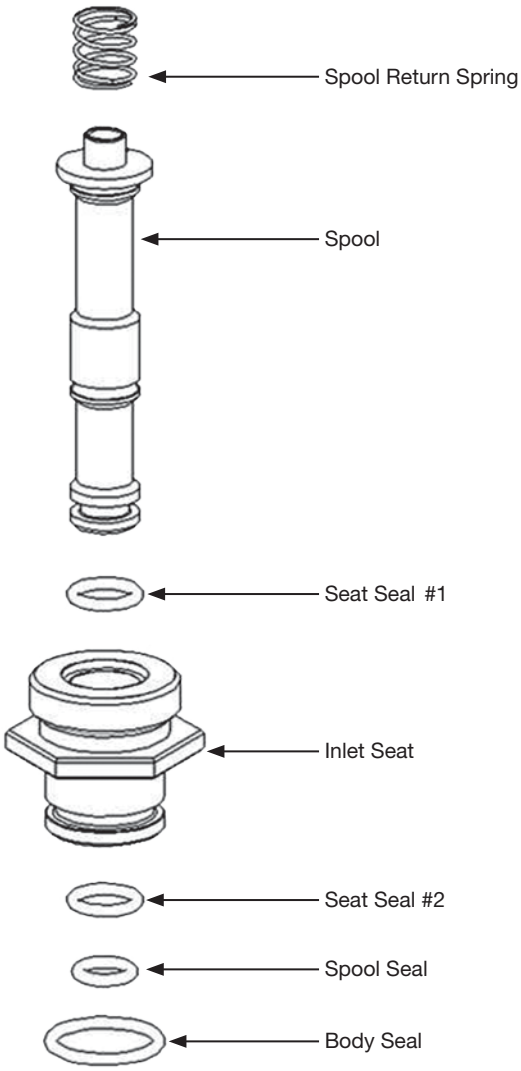


Figure 7.3a
Spool Sub–Assembly, Exploded

Assembly (continued)

B. Piston Sub-Assembly

Use the instructions for the appropriate type of modulating pilot control. Layout the components of the sub-assembly as shown in the corresponding figure.

PCM – Diaphragm Style

1. Lay out the parts in sequence as shown in Figure 7.4a, on a clean and well-lit work area.
2. Invert the diaphragm piston (threaded hole facing up) and clamp it on top of a bench vise using the milled flats provided.
3. Mate the diaphragm's back-side to the diaphragm piston. The back-side can be identified by two circular protrusions on its surface and is the non-pressurized side.
4. Align the axis of the diaphragm retainer with the hole on the diaphragm. Mate the diaphragm retainer to the flat surface of the diaphragm.
5. Install the retainer screw through the diaphragm retainer and diaphragm hole and into the diaphragm piston threads. Use a 3/16" hex key to tighten the retainer screw into the assembly.
6. Insert the spool return spring into the diaphragm retainer, bottoming one end of the spool return spring on the shoulder of the retainer screw.
7. Screw the inlet seat into the diaphragm retainer. The other end of the spool return spring should seat on the flange of the spool. Use a 1-1/8" and a 1" open end wrench on the wrenching flats of the diaphragm retainer and the inlet seat, respectively to tighten together.

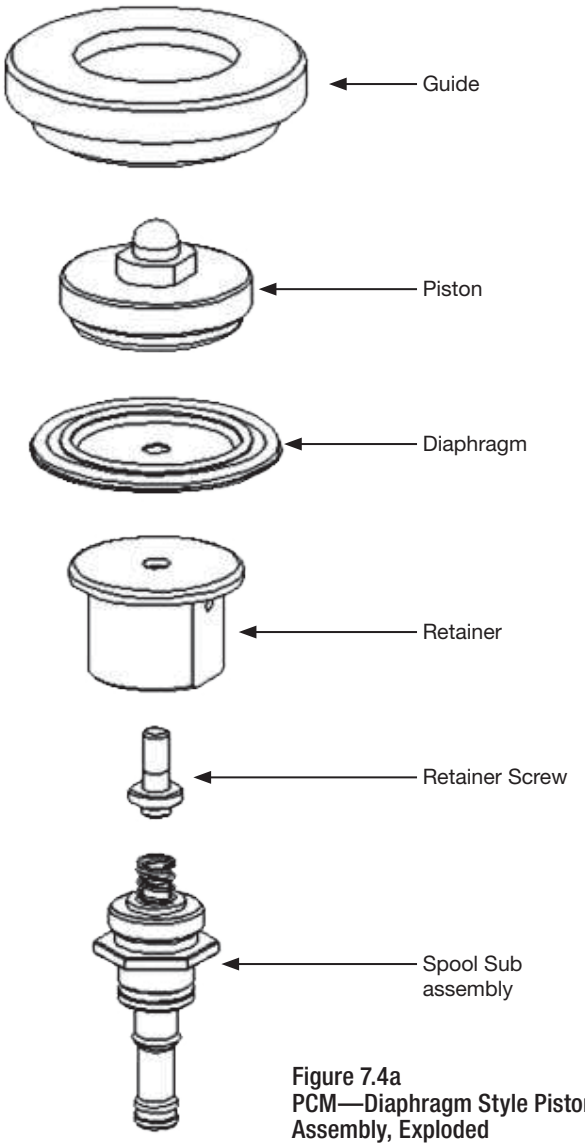


Figure 7.4a
PCM—Diaphragm Style Piston Assembly, Exploded

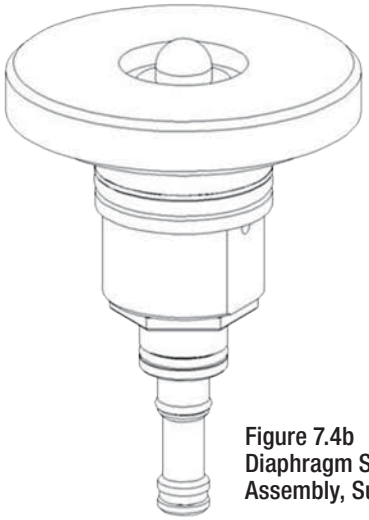


Figure 7.4b
Diaphragm Style Piston Assembly, Sub-Assembly

Assembly (continued)

B. Piston Sub-Assembly (continued)

HPCM – High Pressure Piston Style

1. Lay out the parts in sequence as shown in Figure 7.5, on a clean and well-lit work area.
2. Install the piston seal on the piston seal gland. Install the back-up ring on the gland. Note the ring to be in the upper part of the gland when the piston is oriented vertically.
3. Screw the inlet seat (with spool sub-assembly pre-assembled earlier) into the piston. One end of the spool return spring should seat in the counter bore inside the piston and the other end on the flange of the spool. Use a 1-1/8" and a 1" open end wrench on the wrenching flats of the retainer and the inlet seat, respectively to tighten together.

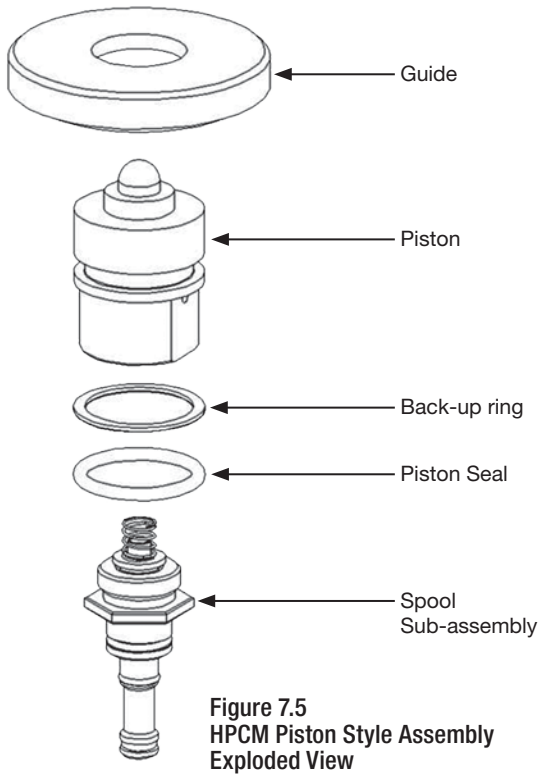


Figure 7.5
HPCM Piston Style Assembly
Exploded View

PCMS – Low and High Temperature Service Piston Style

1. Lay out the parts in sequence as shown in Figure 7.6, on a clean and well-lit work area.
2. Invert the piston (threaded hole facing up) and clamp it on top of a bench vise using the milled flats provided.
3. Install the spring-energized seal with spring exposed mating the bottom of the u-shaped seal with the piston outer ledge.
4. Align the axis of the retainer with the hole on the piston.
5. Install the retainer screw through the retainer and into the piston threads. Use a 3/16" hex key to tighten the retainer screw into the assembly.
6. Insert the spool return spring into the retainer, bottoming one end of the spool return spring on the shoulder of the retainer screw.
7. Screw the inlet seat (with spool sub-assembly pre-assembled earlier) into the retainer. The other end of the spool return spring should seat on the flange of the spool. Use a 1-1/8" and a 1" open end wrench on the wrenching flats of the retainer and the inlet seat, respectively to tighten together.

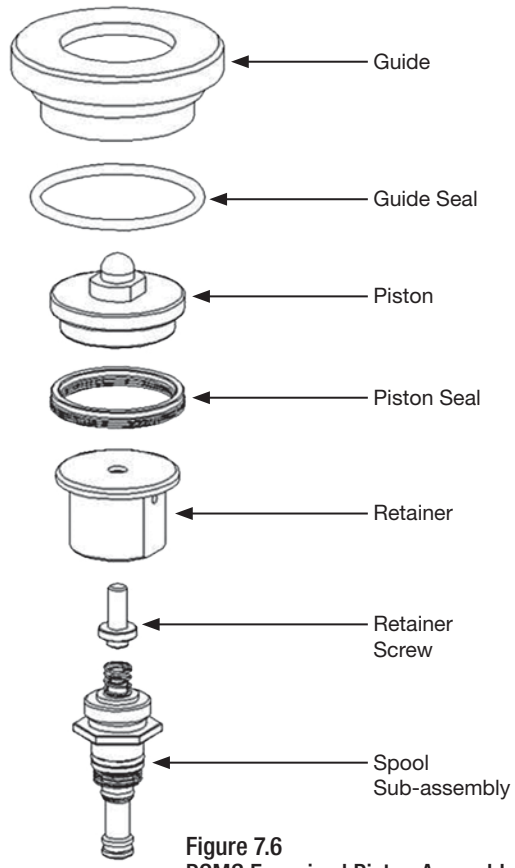


Figure 7.6
PCMS Energized Piston Assembly
Exploded View

Assembly (continued)

C. Body/Bonnet Assembly

1. Lay out the parts in sequence as shown in Figure 7.7, on a clean and well-lit work area.
2. Lightly lube the spool cap seals and install on the seal glands of the spool cap.
3. Insert the spool cap into the base of body and tighten.
4. Clamp the valve vertically in a vise by the body flange flats. Insert the lower return spring.
5. Lubricate the seals in the spool sub-assembly and insert into the body bore, as shown on Figure 7.7. Spool extension should fit into the hole of the spool cap. Apply a light amount of pressure on top of the internal sub-assembly to check for bottoming of seat seal #2 to the spool cap seat.
6. Install the guide over the spool sub-assembly and into the annular opening between the body bore and the diaphragm/piston circumference. For the PCMS the guide seal goes in before the guide.
7. With one spring button on each end of the spring, mate the bottom end to the top of the hemispherical radius on top of the diaphragm piston.
8. Install the bonnet over the spring and mate the bonnet counter bore surface to the guide. Orient the bonnet vent hole axis to the body exhaust port axis on the same plane.
9. Bolt down the bonnet using the bonnet cap screws through the bonnet flange holes and into the threaded holes of the body flange. Tighten the bolts in a crisscross pattern for uniform loading.
10. Screw the spring adjusting screw (SAS) into the jam nut and then into the bonnet until the SAS makes contact with the spring button.
11. Insert the filter; flange first, into the inlet port on the body. This port is closest to the body flange as shown in Figure 7.7. Install the filter seal over the filter and into the inlet port, bottoming on the filter flange inside the port.
12. Screw the filter housing into the body inlet port and tighten.

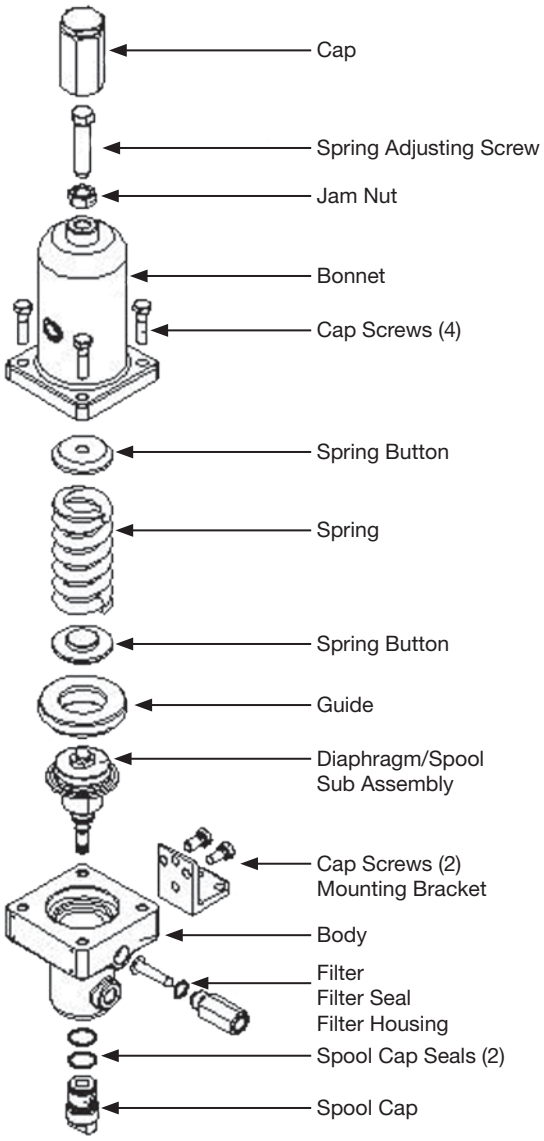


Figure 7.7

Setting & Testing the Modulating Pilot Control

Testing of the modulating control will be performed only after correct assembly has been accomplished. Read the entire test procedure. Test should be conducted only by qualified personnel.

Testing PORV as a Unit

A test stand typically used for conventional safety relief valve testing will be adequate to perform this test method.

1. Complete the assembly of the pilot control and the main valve.
2. Mount the main valve to the test stand.
3. Remove the modulating control cap to access the spring adjusting screw (SAS).
4. Using a wrench, rotate the SAS down (clockwise) a few turns to compress the modulating control spring.
5. Pressurize the test stand to the desired set pressure and let the pressure stabilize. If the main valve relieves before the desired set pressure, depressurize the test stand and turn the SAS down some more to compress the modulating control spring further.
6. When test stand pressure is at desired set point, unscrew the SAS (counterclockwise) slowly until the main valve piston starts to lift. For air testing, an audible leak on the main valve outlet is the common indication of the piston starting to lift. For liquid testing, the first visible flow of fluid from the main valve outlet is the common indication that the piston is starting to lift. The body bowl should be filled with water up to the lowest edge of the discharge outlet prior to testing to aid in determining first flow.
7. When test stand pressure is at desired set point, unscrew the SAS (counterclockwise) slowly until the main valve piston starts to lift. For air testing, an audible leak on the main valve outlet is the common indication of the piston starting to lift. For liquid testing, the first visible flow of fluid from the main valve outlet is the common indication that the piston is starting to lift. The body bowl should be filled with water up to the lowest edge of the discharge outlet prior to testing to aid in determining first flow.
8. The spring compression is close to the desired setting. Use the jam nut to lock the SAS in place.
9. Depressurize the test stand to approximately 80% of the desired set pressure.
10. To confirm the set point, slowly pressurize the test stand until the opening of the main valve is confirmed by either an audible opening of the piston (air), or a visible flow of water from the main valve outlet (liquid test). Fine tune setting by turning down (clockwise) the SAS to increase or unscrewing (counterclockwise) the SAS to decrease the set point. Tighten the jam nut to lock the SAS in place after final adjustments.
11. Install the modulating control cap and tighten before proceeding to Pilot Seat Tightness Testing, section D, in this procedure.

Testing the Modulating as a Separate Unit: (Alternate Method)

Connect the modulating control to the test rig (See Test Stand Schematic, Figure 7.5).

A. Test Stand Schematic Description

- **V1-** Isolation valve, normally open when test is in progress.
- **V2-** Needle valve, regulates pressure into vessel.
- **V3-** Vent valve, normally closed when going up on the receiver pressure; also used to dump pressure from vessel.
- **V4-** Vent valve, normally closed when testing, used as an auxiliary pressure dump valve.
- **P1-** Pressure gage, to read dome pressure.
- **P2-** Pressure gage, to read vessel pressure.

Vessel Receiver – Test pressure receiver simulating a vessel.

Dome Receiver – Test pressure receiver simulating the dome/piston volume on the main valve.

In-Line Filter – Filters air going into the vessel.

Setting & Testing (continued)

B. Port Identification and its Connections

Port A - is system pressure sensing port, it is the port on the filter housing.

Port B - is 180º from Port A, it connects to the main valve dome.

Port C - is the dome exhaust port, it is the lowest port in the body, 90º from Port A and Port B.

Port D - is the bonnet vent.

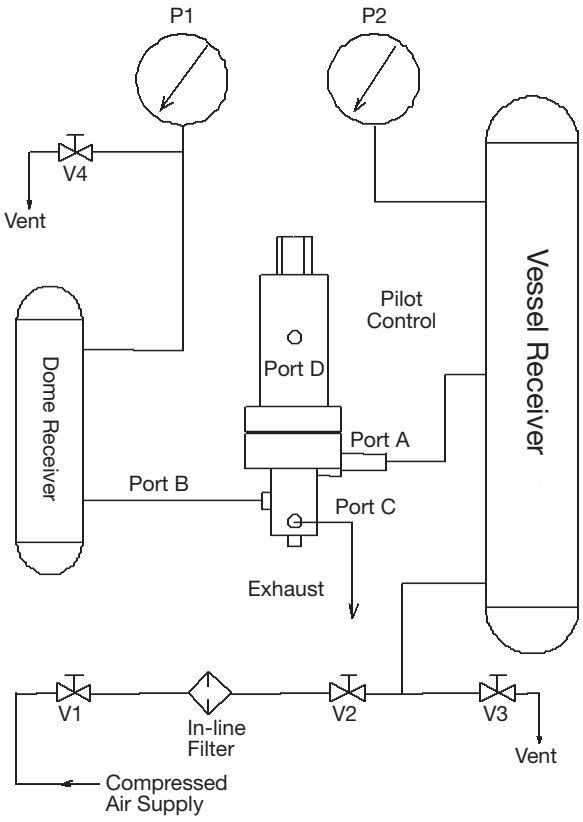


Figure 7.5 Test Stand Schematic

C. Set Pressure Testing

1. Mount the pilot control in the test stand following the port connections shown on the test stand schematic (Figure 7.5).
2. Compress the spring by turning the spring adjusting screw (SAS) clockwise, a few turns after coming in contact with the spring button.
3. Increase the pressure on the vessel receiver and observe the increase in pressure on the dome vessel. If the dome pressure does not increase along with the receiver pressure, stop and vent the pressure, increase the spring compression by turning the SAS clockwise and start over.
4. Increase the pressure on the vessel receiver to the desired set pressure. Dome pressure should read the same.
5. Decrease the spring compression by turning the SAS counterclockwise, to drop the pressure of the dome receiver. The valve is set once the pressure on the dome receiver drops down to the pressure (P_d) determined by the equation (eq. 1).
6. Verify the set point by decreasing the vessel receiver pressure to approximately 80% of the desired set and then increasing to the desired set. At the desired set pressure the dome receiver pressure should have dropped to the pressure (P_d) determined by the equation below (eq. 1).
7. Lock the spring adjusting screw with the jam nut and install the cap. Mount the pilot control to the main valve and connect the corresponding ports together. Proceed to Pilot Seat Tightness Testing Section D.

Equation to determine dome pressure at a given set pressure:

$$P_d = P_o \times m \qquad \text{(eq. 1)}$$

Where:

P_d = dome pressure at desired set pressure, tolerance = +/- 10% of value

P_o = desired set pressure

m = valve size multiplier, taken from table below

The piston vs. seat area ratio for the DX, DL and DM serial suffix valves vary by inlet size. The table below provides the correct multiplier, by inlet size, to allow the setting of a modulating pilot control, separate from the main valve.

The values for item 2 should only be used for the air, gas and vapor service valves, serial suffix DX and DM. The liquid service valves, serial suffix DL, should be converted to the current DA serial design for optimum performance.

Item	Serial Suffix	m Multiplier
1	DA (All Sizes)	0.70
2	DX, DL and DM	See Below
2a	1	0.41
2b	1-1/2	0.56
2c	2	0.60
2d	3 and 8	0.64
2e	4 and 6	0.69

Setting & Testing (continued)

D. Pilot Seat Tightness Testing

A 5/16" OD x 0.035" wall thickness copper tube or equivalent, immersed no more than 1/2" deep in water, shall be connected to the exhaust Port C and Bonnet Vent Port D. Raise the receiver pressure to the test pressure described below and observe for bubbles. No bubbles are allowed.

Test pressure:

- 90% of set pressure if set pressure is 50 psig or more OR
- 5 psig below set pressure if set pressure is less than 50 psig

Brush soap and water solution on joints internally exposed to pressure. Observe for leakage. No leakage at any joint is allowed.

Proceed to Final Assembly and Test.

Table 7.2 Modulating Pilot Control Spring Chart

Set Pressure (psig)	PCM & PCMS Spring Number	HPCM Spring Number
15 - 74	E3486PH	HPCM Control Not for use in these pressure ranges, consult factory
75 - 179	E3478PH	
180 - 349	E3487PH	
350 - 740	E3479PH	
740 - 1000	PCM/PCMS Control Not for use in these pressure ranges, consult factory	E3479PH
1001 - 1480		E3488PH
1481 - 2220		E3480PH
Return Springs – Spool		
15 - 1500	A3481SS	—
740 - 2220	—	A3496SS
Return Springs – Lower		
15 - 1500	A3489SS	—
740 - 2220	—	A3489SS

Final Assembly

The pilot control should have been tested and set prior to final assembly.

Assemble the pilot control to the main valve. Attach the mounting bracket securely to the pilot control. Bolt the mounting bracket to the main valve. Clear foreign matter in tubing by blowing compressed air through one end. The port connection and its orientation shall be exactly the same as the original configuration to guarantee valve operation. Refer to Figures 6.4 and 7.5 for port identification of the pilot control. Connect port A of the pilot control to the inlet of the main valve. Connect port B of the pilot control to the dome or piston of the main valve. Port C is the exhaust port, normally vented to the atmosphere.

Check all fittings for tightness. Pressurize the test stands to 95% of set pressure

Use Snoop or soap and water solution to check all tube fittings and joints internally exposed to pressure. No leaks are allowed on these joints. All leakage shall be corrected as necessary.

Test the assembled pilot valve for proper setting.

Main Valve Seat Tightness Test

Refer to Figure 8.1. Mount bubble test flange, tube, and cup on valve outlet. A tube of 5/16² OD X .035" wall submerged 1/2" below the water level shall be connected to the valve outlet. Apply nitrogen or air pressure to the valve inlet, equal to 90% of set pressure (if set pressure is 50 psig or more) or 5 psig below set pressure (if set pressure is less than 50 psig). This method tests for total leakage across valve seat plus piston seal leakage. No leakage is allowed.

The valve is now ready to be placed back in service.

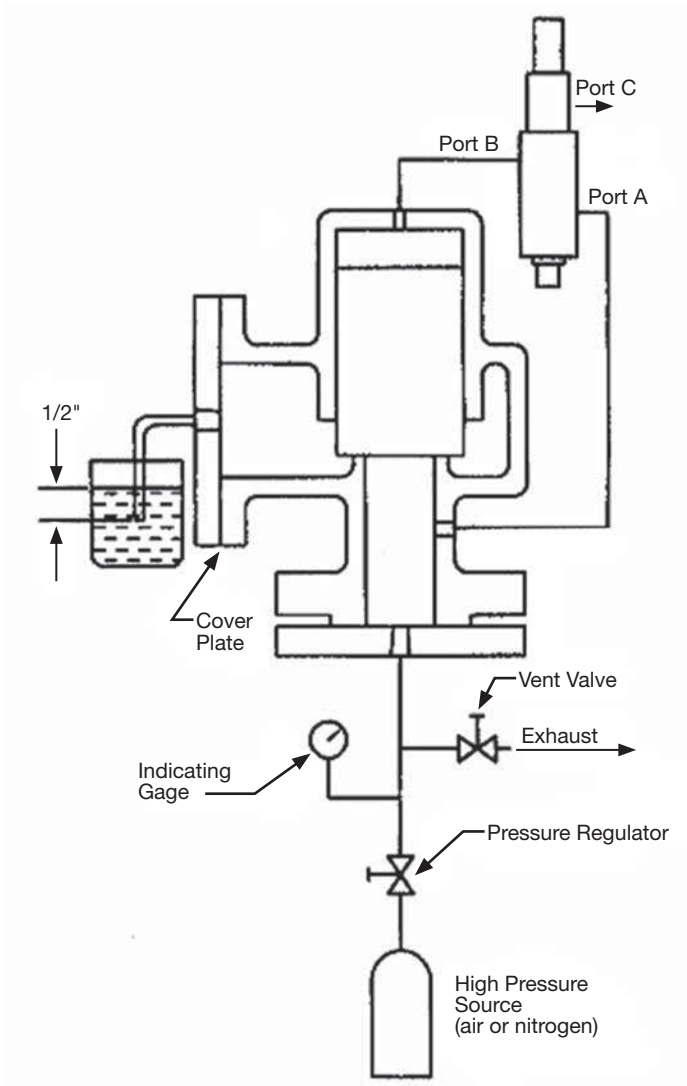


Fig. 8.1 Main Seat Tightness Test

Farris Aftermarket Services

Real Value Behind Every Valve.

Farris Engineering's aftermarket department and global FAST Center Network adds value to every Farris valve. At Farris, our work is never done. Once we sell you a valve, our FAST Team is there to keep your valves in service and your plant safe. Our FAST Centers are:



Responsive. Farris Engineering and its FAST Centers understand the need to quickly and efficiently respond to customer needs.

- **Global Access** - FAST Centers work with and in our extensive representative network, providing support to all global regions.
- **24/7 Valve Service and Replacement** - FAST Centers offer quick, localized testing and repair of valves, or the prompt installation of new Farris ASME certified valves.
- **Mobile Repair Units** - Available at select FAST Centers.

Experienced. Farris Engineering recognizes the value of having pressure relief valve experts as close to the customer as possible. This is accomplished through comprehensive training offered at the factory or on-site. FAST Center sales personnel and technicians are able to provide valuable experience to their customers.

- **Valve Expertise** - Every FAST Center is technically supported by Farris Engineering, a leader in valve design.
- **Factory Trained Technicians** - FAST technicians go through mandatory training consisting of classroom lecture and hands-on practical instruction on Farris Engineering pressure relief valves, repair procedures and applicable codes and standards. The result is a team of highly skilled technicians capable of handling both routine and complex pressure relief valve requirements around the world.
- **OEM parts** - FAST Centers use only OEM parts, restoring valves to OEM specifications. All valves are assembled and tested to ASME standards.

Dedicated. FAST Centers have committed to large investments in inventory, equipment and certifications to better support the customers in their territory.

- **Local Inventory** - Every FAST Center carries a large inventory of new pressure relief valves and spare parts, backed by a web-based global inventory to draw from.
- **ASME Certification** - FAST Centers carry all the required certifications to assemble, set and test Farris valves.
- **VR Certification** - FAST Centers have VR certification issued by The National Board of Boiler and Pressure Vessel Inspectors to effectively and efficiently repair all pressure relief valves where applicable.



CURTISS WRIGHT Flow Control Company
Farris Engineering

ASME UV

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Offices Worldwide: For a listing of our global sales network, visit our website at http://farris.cwfc.com.

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11/10 3M R2

Series 3800

Pilot Operated Pressure Relief Valves



CURTISS WRIGHT
Flow Control Company
Farris Engineering

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UV

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Monel is a registered trademark of Inco Alloys International, Inc.
Hastelloy is a registered trademark of Haynes International, Inc.

Piloting the Way to Precision Control

The innovative, integrally cast, flanged, semi-nozzle valves of the Series 3800 are self-contained units actuated by either the snap-acting or modulating style pilot controls. Valves in the series are certified under Section VIII of the ASME Code for Air, Gas, Vapor, Steam and Liquid Service.

Available in API Orifices D through T as well as full port models, Series 3800 valves are provided with raised face or ring joint inlet flanges from 150# through 2500# ANSI classes with 150#, 300# and selected 600# outlets. Set pressures range from 15 to 6170 psig with temperatures of -450°F to 450°F for standard options. For higher temperature and pressure requirements, please consult the Factory.

All Series 3800 valves have non-flowing pilot controls with 316 stainless steel primary components as standard. The main valve body is carbon steel with 316 stainless steel trim. The main valve is also available in a full 316 stainless steel “S4” option, a NACE standard MR0175 “N1” or “N4” option, Monel® “M4” option, Hastelloy® “H4”option, with other materials available upon request.

Viton® soft goods are standard in both pilot control and main valves. Buna-N, neoprene, ethylene propylene, silicone, PTFE® and Kalrez® soft goods are available as options; contact Factory for more information.

Warranty

All products manufactured by Farris Engineering are warranted free of defects in material and workmanship when used within the range recommended for a period of one year after installation or eighteen months from delivery. When authorized, any defective product may be returned to the factory and if found defective will be repaired or replaced free of charge, solely at the discretion of Farris Engineering, ex-works our factory. No charge for labor or other expense incurred will be allowed, as the liability of Farris Engineering is measured by the refund price of the defective product only. All warranties are based on the product being used within the range recommended and does not cover damages or defects due to normal wear and tear, misuse, alteration or neglect. The purchaser shall determine the suitability of the product for use and assumes all risks and liabilities in connection therewith.

This warranty does not cover the performance of valves tested at site on test equipment that is not to the same technical standard as that used by the manufacturer

Selection Table Matrix

3800 Series Pilot Control Application Summary

			PCF5 (2)	PCL (3)	PCM (4)	PCMS (5)	HPCM (6)
Type of Actuation	Snap-Acting		●	●			
	Modulating				●	●	●
Blowdown	Adjustable		●				
	Non-adjustable			●	●	●	●
Set Pressure Ranges psig (barg)	15 to 740 (1.03 to 51.03)		●	●	●	●	
	741 to 2220 (51.1 to 153.1)		●	●			●
	2221 to 6170 (153.2 to 425.5)		●	●			
Fluid Services	Gas/Vapor		●		●	●	●
	Liquid			●	●	●	●
	Steam					●	
Temp. Range °F (°C)	-50 to 500 (-45 to 260)		●	●	●	●	●
	-423 to -51 (-253 to -46)		●				
Soft Goods (O-Rings) °F (°C)	Fluorocarbon (Viton)	-20 to 450 (-29 to 232)	●	●	●	●	●
	Ethylene Propylene (EPDM)	-65 to 250 (-54 to 121)	●	●	●	●	●
	Nitrile (Buna-N)	-55 to 225 (-48 to 107)	●	●	●	●	●
	Aflas	-20 to 450 (-29 to 232)	●	●		●	●
	Kalrez	0 to 500 (-17 to 260)	●	●		●	●
	Kalrez Steam	212 to 500 (100 to 260)				●	

Soft Goods Disclaimer

All PORVs use soft goods for their seats and seals. In selecting a soft good, please note the following guidelines:

- Main valve and pilot control soft good selection is based upon set pressure and relieving temperature for non-fire cases. For fire case scenarios, base soft good selection on valve set pressure and operating temperature.
- Final soft goods selection should be chemically compatible with the process fluid.
- Selection of proper soft good material is customer's responsibility.

Principles of Operation – Snap Acting

Closed Valve Position

The pilot control valves use system pressure to keep the main valve closed. System pressure is transmitted through the pressure pickup from the inlet of the main valve, through the pilot control and into the dome of the main valve. The system pressure exerts force upon the top of the piston in the dome, holding the piston firmly against the seat on the nozzle in the main valve. The surface area of the piston in the dome of the main valve is greater than the seat area, so the greater the system pressure, the greater the force holding the piston onto the main valve seat. As a result, the pilot operated relief valve gets tighter as the system pressure approaches set pressure.

Relieving Cycle

As system pressure reaches set pressure, the force acts upon the surface area of the pilot control disc, overcoming the spring force in the pilot valve, and the pilot valve lifts. As the seat assembly in the pilot control begins to lift, it seals off the flow of pressure to both the vent and the main valve dome. At the same time, the pressure in the dome is released through the pilot vent. Once the pressure in the main valve's dome has been released, the system pressure, acting on the bottom of the piston, will lift the piston and relieve system pressure until normal process conditions are restored.

Re-Closing Cycle

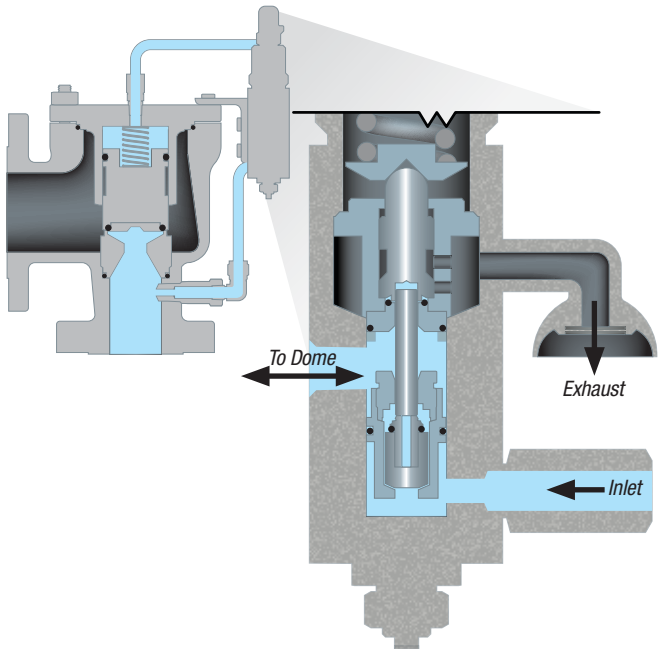
At the point where the system pressure blows down, the spring force in the pilot control overcomes the force of system pressure acting on the pilot control seat assembly, closing the upper seat and reopening the lower seat. This re-establishes flow through the pilot control, allowing system pressure to be redirected back into the main valve dome, closing the main valve. Blowdown can be precisely adjusted externally by raising or lowering the blowdown adjuster position in the pilot control.

Operating Advantages:

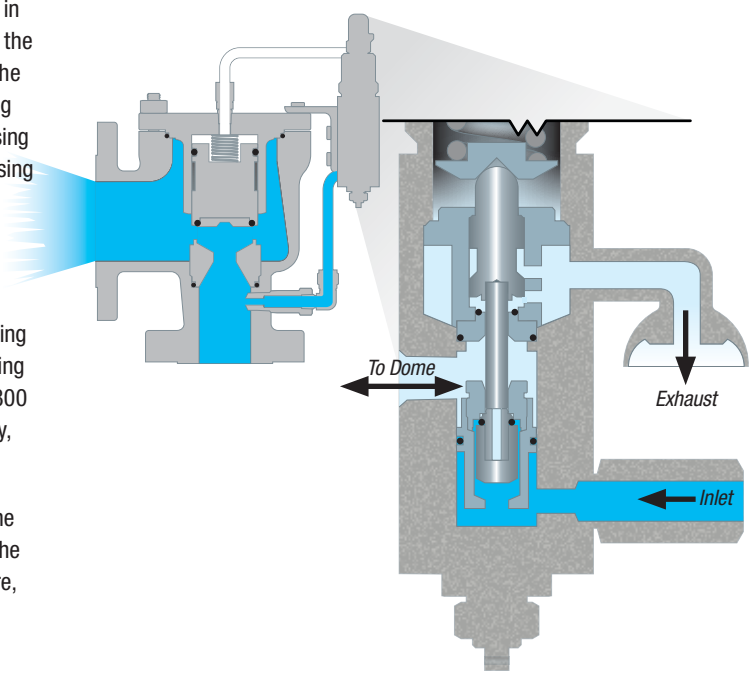
Bubble-tight closer to set pressure: Series 3800 valves operate bubble tight at higher operating pressure to set pressure ratios, allowing operators to run very close to the system's maximum allowable working pressure. While protecting the system from overpressure, Series 3800 allows maximum product throughput, increased system profitability, and reduced fugitive emissions.

Unaffected by back pressure: Unlike a direct spring loaded valve, the pilot operated valve's set pressure is not affected by back pressure. The pilot control valve, isolated from the influence of downstream pressure, controls the main valve's opening and closing.

Snap Acting Valve – Closed Position



Snap Acting Valve – Open Position



Principles of Operation – Modulating

Closed Valve Position

At normal operating system pressure, the modulating control performs the same as the snap acting control. The pressure pickup directs system pressure from the inlet of the main valve through to the pilot control inlet port and into the dome of the main valve. The pressure area of the piston in the dome of the main valve is greater than the nozzle seat area. The greater the system pressure, the greater the seating force holding the main valve piston onto the nozzle seat.

As system pressure increases and approaches the valve's set pressure, the force acting upward on the pilot control increases, overcoming the spring force of the pilot control causing the inlet seat to lift and seal against the floating spool. Pressure is maintained in the dome because the inlet and outlet seals remain closed.

Relieving Cycle

Any further incremental increase in system pressure near set pressure raises both the inlet seat and spool causing the outlet seat seal to crack open. This allows a partial venting of dome pressure in the event of an increase in system pressure. Similarly, any further decrease in system pressure near set pressure lowers both the inlet seat and spool causing the outlet seat seal to close. This allows for a re-pressurizing of the dome when the inlet seat opens at decrease in system pressure.

As the system pressure increases to set point, the modulating action of the pilot control, as described above, reduces the pressure in the main valve dome. The further decrease in dome pressure caused by increasing system pressure reduces the seating force to zero and opens the main valve seat to allow flow. The opening of the main valve responds gradually and proportionally to the rise in system pressure, either at or above the set pressure. The main valve will achieve full open and rated flow by 10% overpressure.

Re-Closing Cycle

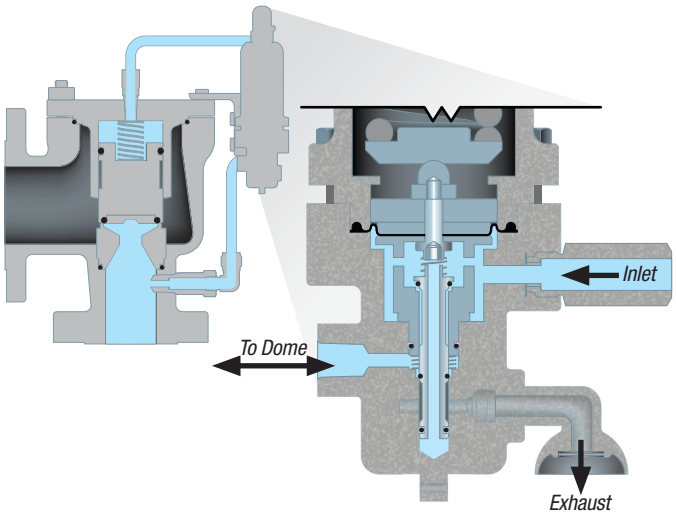
As the system pressure is decreased below set pressure, the spring force in the modulating pilot control overcomes the system pressure acting on the diaphragm/piston assembly and re-closes the outlet seat. The inlet seat then opens and allows system pressure back into the main valve dome, reseating the main valve.

Operating Advantages:

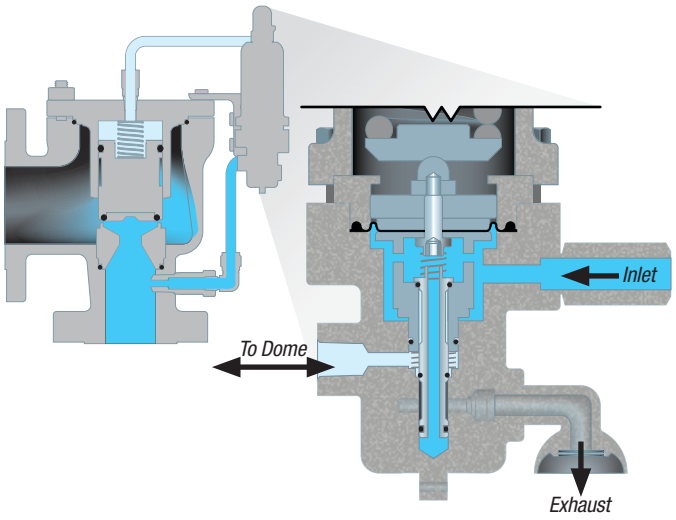
A pilot valve with a modulating control has the same operating advantages as a snap acting pilot control: operates bubble-tight close to set pressure and is unaffected by back pressure.

Minimizes product losses: In addition, the modulating control responds gradually and proportionately to the rise in over pressure, minimizing product losses and reducing reaction forces when the flow requirement is below the maximum rated flow of the valve.

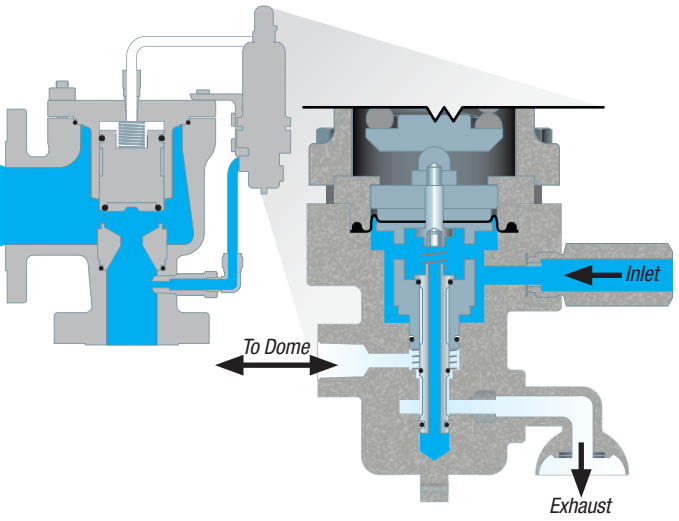
Modulating Valve – Closed Position



Modulating Valve – Partially Open Position



Modulating Valve – Fully Open Position



Numbering System

To simplify the selection and specifying of Farris pressure relief valves, use the following type numbering system. The type numbering system is ideal as the digits which comprise a specific type number have a distinct significance. The digits describe the basic valve series, orifice, seat and internal construction, inlet temperature range, body, and spring material, inlet flange class as well as Code liquid design.

38	D	C	1
Series Number	Orifice Area	Construction	Temperatures & Materials

38

Orifice Letter	Area, Sq. In.		Area, Sq. mm	
	API	Actual	API	Actual
D	0.110	0.150	71	97
E	0.196	0.225	126	145
F	0.307	0.371	198	239
G	0.503	0.559	325	361
H	0.785	0.873	506	563
J	1.287	1.430	830	923
K	1.838	2.042	1186	1317
L	2.853	3.170	1841	2045
M	3.60	4.000	2323	2581
N	4.34	4.822	2800	3111
P	6.38	7.087	4116	4572
Q	11.05	12.27	7129	7916
R	16.0	17.78	10323	11471
T	26.0	28.94	16774	18671
A	—	0.719	—	464
1	—	1.767	—	1140
2	—	2.953	—	1905
3	—	6.605	—	4261
4	—	11.50	—	7419
6	—	26.07	—	16819
8	—	45.66	—	29458

C Elastomer O-Ring Seat & Seals*

T PTFE O-Ring Seat & Seals (Main Valve Only)

*For set pressures above 1480 psig, main seat seal for all valves with 900#, 1500# and 2500# inlet flanges use PTFE.

Designation	Inlet Temperature Range °F	Material	
		Body & Cover	Piston
1	-20 to 450	Carbon Steel	Stainless Steel
2	-20 to + 520	Carbon Steel	PH St. St.
8*	-450 to -50*	Stainless Steel	Stainless Steel

*Use for cyrogenic applications, S4 special material suffix is not required.

Ordering Information

To properly process your order and avoid delay please specify the following:

1. Quantity
2. Inlet and Outlet Size
3. Farris Type Number*
4. Inlet and Outlet Flange Class and Facing
5. Materials of Construction, if other than Standard
6. O-Ring Seal Material (Viton is Standard)
7. Set Pressure*
8. Maximum Inlet Temperature*
9. Allowable Overpressure*
10. Fluid and Fluid State*
11. Backpressure, Superimposed Constant and/or Variable and Built-up*
12. Required Capacity*
13. Physical Properties of Fluid (Molecular Weight, Specific Gravity, etc.)*
14. Accessories, if any required such as:
    a) Manual or Remote Depressurizing
    b) Field Test Connection
    c) Reverse Flow Preventer
    d) Auxiliary Filter
    e) Any other
15. Code Requirements, if any required

*As a customer service we verify your selection and sizing. If this service is desired, you must include this information.

General Notes:
If valve modification or set pressure changes are required, consideration must be given to correct the nameplate and other data.

2	X -	1	2	0	/S4
Inlet Class	**Special Construction**	**Inlet Facing**	**Pilot Control**	**Options**	**Special Material[4]**

Designation	ANSI Nominal Inlet Flange Class
0	150
2	300
3	600
4	900
5	1500
6	2500

(If applicable)

- **L** Liquid Service (Standard Connections)
- **X** Air & Vapor Service (Oversize Connections)
- **Y** Liquid Service (Oversize Connections)
- **D** Air & Vapor Service (Dual Outlet)[1]
- **E** Liquid Service (Dual Outlet)[1]
- **U** Air & Vapor Service (Non-Standard API Connections)
- **N** Air & Vapor Service (Non-Standard API Connections)

- **0** Special[2]
- **1** Raised Face, ANSI Std. (125 to 160 AARH)
- **9** Ring Joint ANSI Std. (Octagonal)
- **H** 63 to 83 AARH Raised Face (Inlet only)

Although not applicable to the inlet facing only, the following first digit letters are also used:

- **J** 63 to 83 AARH (Outlet only)
- **K** 63 to 83 AARH (Inlet and outlet)
- **X** High Pressure Hub Connection[3]

- **2** PCF5 Snap Acting Control
- **3** PCL Liquid Snap Acting Control
- **4** PCM Modulating Control
- **5** PCMS Steam Modulating Control
- **6** HPCM High Pressure Modulating Control

- **0** No Options
- **1** Test Gag
- **2** Dual Pilot Controls
- **3** Auxiliary Filter
- **4** Manual Depressurizing
- **5** Field Test Connection
- **6** Reverse Flow Preventer
- **7** Pressure Spike Snubbers
- **8** Remote Depressurizing
- **F** Field Test Connection with Indicator
- **R** Remote Sensing
- **V** Pilot Control Discharge Connected to Main Valve Outlet

See table below for combinations

- **S3** Complete 316 St. St. PH St. St. Piston
- **S4** Complete 316 St. St.
- **N1** NACE Compliant Carbon St. Body
- **N3** NACE Compliant PH St. St. Piston
- **N4** NACE Compliant Complete 316 St. St.
- **M4*** Complete Monel®
- **H4*** Complete Hastelloy® C

*Add "N" for NACE
E.g. M4N, H4N, etc.

Parts Replacement

Valves: If an exact replacement valve is required, the valve type, size and serial number must be specified to assure proper dimensions and material being supplied. If a specific valve has become obsolete, a recommendation for the current equivalent, if any, will be made.

Spare Parts: When ordering parts, use part names as listed in the bills of material in this catalog. Specify valve type, size and serial number. If serial number is not available, the original Farris factory order number will assist in our supplying the proper part and material.

Springs: Order as an assembly to include spring with upper and lower spring buttons. Specify valve type, size, serial number, set pressure and back pressure, if any.

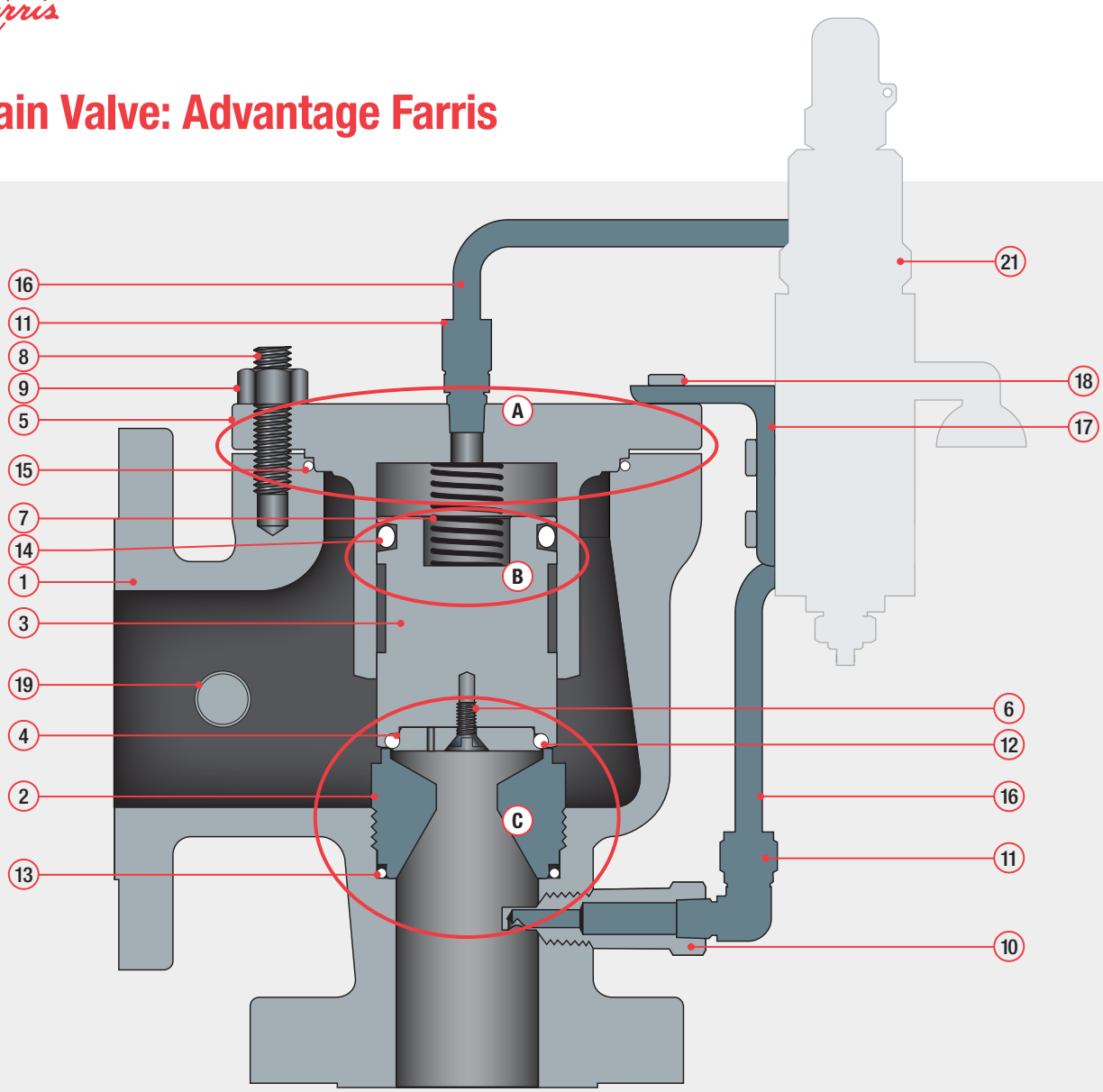
Codes for Common Accessory Combinations

9	Four Auxiliary Functions: Options 4, 5 or F*, 6 & 8
A	Combo – Auxiliary Filter (3) & Field Test Connection (5 or F)*
B	Combo – Field Test Connection (5 or F)* & Reverse Flow Preventer (6)
E	Combo – Auxiliary Filter (3), Field Test Connection (5 or F)* & Reverse Flow Preventer (6)
C	Designation for combinations of options not listed

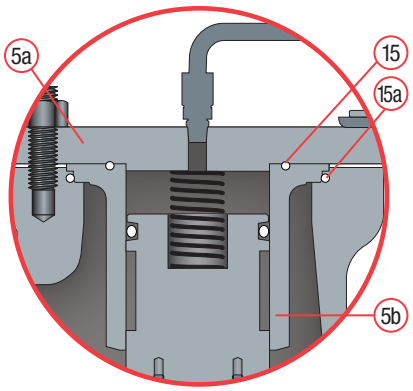
* For Modulating Controls, Field Test Connection w/ Indicator (F) is automatically supplied, unless specified otherwise.

General Notes:
1. Available on 6" and 8" inlet size valves only.
2. Historical designation for special inlet connections. This designation is obsolete.
3. Not available for all valve sizes or pressure classes. Please consult factory.
4. Duplex available upon request, contact factory.

Main Valve: Advantage Farris

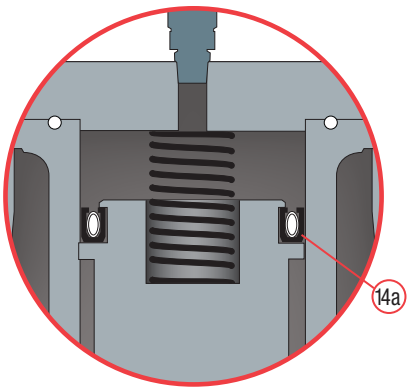


A Two Piece Cover and Guide



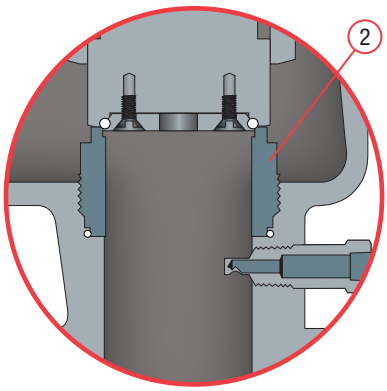
Valves with 3" inlet and larger

B Energized Piston Seal



Used for cyrogenic, steam and special service

C Full Port Nozzle



Not available for liquid service

ASME UV

Built in conformance to ASME Code Section VIII for Air, Gas, Steam, and Liquid Service.
ASME Code stamping not available on full port design in liquid service.

3800 Series Bill of Materials – Main Valve

Bill of Materials – Main Valve

Item No.	Part Name	Standard Material	S3/S4	N1 NACE	N3/N4 NACE	M4	H4
1	Body	SA-216 Gr. WCB Carbon St.	SA-351 Gr. CF8M St. St.	SA-216 Gr. WCB Carbon St.[2]	SA-351 Gr. CF8M St. St.[2]	SA-494 Gr. M35-1 Monel	SA-494 Gr. CW-12MW Hastelloy
2	Nozzle	316 St. St.	316 St. St.	316 St. St.[2]	316 St. St.[2]	Monel	Hastelloy C
3	Piston	316 St. St.	S3 = PH St. St. S4 = 316 St. St.	316 St. St.[2]	N3 = PH St. St. N4 = 316 St. St.	Monel	Hastelloy C
4	O-Ring Retainer	316 St. St.	316 St. St.	316 St. St.[2]	316 St. St.[2]	Monel	Hastelloy C
5	Cover/Guide	SA-351 Gr. CF8M St. St.	SA-351 Gr. CF8M St. St.	SA-351 Gr. CF8M St. St.[2]	SA-351 Gr. CF8M St. St.[2]	SA-494 Gr. M35-1 Monel	SA-494 Gr. CW-12MW Hastelloy
5a	Cover[1]	Carbon St.	316 St. St.	Carbon St.[2]	316 St. St.[2]	Monel	Hastelloy C
5b	Guide[1]	316 St. St.	316 St. St.	316 St. St.[2]	316 St. St.[2]	Monel	Hastelloy C
6	Retainer Screw	St. St.	St. St.	St. St.	St. St.	Monel	Hastelloy C
7	Return Spring	316 St. St.	316 St. St.	Inconel™ X750	Inconel X750	Inconel X750	Inconel X750
8	Body Stud	ASME SA-193 Gr. B7 Alloy St.	ASME SA-193 Gr. B8M St. St.	ASME SA-193 Gr. B7M Alloy Steel	ASME SA-193 Gr. B8MA St. St.	ASME SB-574 UNS N10276 Hastelloy	ASME SB-574 UNS N10276 Hastelloy
9	Hex Nut (Body)	ASME SA-194 Gr. 2H Alloy St.	ASME SA-194 Gr. 8M St. St.	ASME SA-194 Gr. 2HM Alloy St.	ASME SA-194 Gr. 8MA St. St.	ASME SB-574 UNS N10276 Hastelloy	ASME SB-574 UNS N10276 Hastelloy
10	Pressure Pickup	316 St. St.	316 St. St.	316 St. St.	316 St. St.	Monel	Hastelloy C
11	Tube Fittings	316 St. St.	316 St. St.	316 St. St.	316 St. St.	Monel	Hastelloy C
12	Main Seat Seal[4]	Viton[5]	Viton[5]	EPDM[6]	EPDM[6]	Viton[5]	Viton[5]
13	Nozzle Seal	Viton[5]	Viton[5]	EPDM[6]	EPDM[6]	Viton[5]	Viton[5]
14	Piston Seal	Viton[5]	Viton[5]	EPDM[6]	EPDM[6]	Viton[5]	Viton[5]
14a	Energized Piston Seal	PTFE / SS[7]	PTFE / SS[7]	PTFE / SS[7]	PTFE / SS[7]	PTFE / SS[7]	PTFE / SS[7]
15	Cover Seal	Viton[5]	Viton[5]	EPDM[6]	EPDM[6]	Viton[5]	Viton[5]
15a	Guide Seal[1]	Viton[5]	Viton[5]	EPDM[6]	EPDM[6]	Viton[5]	Viton[5]
16	Tubing	316 St. St.	316 St. St.	316 St. St.	316 St. St.	Monel	Hastelloy C
17	Bracket	St. St.	St. St.	St. St.	St. St.	St. St.	St. St.
18	Cap Screws, Mounting Bracket	Plated Steel	St. St.	Plated Steel	St. St.	St. St.	St. St.
19	Pipe Plug, Outlet	Carbon St.	St. St.	Carbon St.	St. St.	Monel	Hastelloy C
20	Pipe Plug, Body (not shown)	Carbon St.	St. St.	Carbon St.	St. St.	Monel	Hastelloy C
21	Pilot Control	St. St.	St. St.	St. St.	St. St.	Monel	Hastelloy C

Convertible Design: the unique convertible design minimizes the number of components and maximizes their interchangeability, reducing parts inventories and overall costs.

Convertible Nozzle: threaded convertible nozzles can be removed and replaced easily without factory service. They can be installed with common tools while the valve is in line, saving time and money.

Fewer Internal Components: the valve design requires no lift stops and the main valve opens fully at set pressure. The orifice area is controlled by the nozzle, eliminating the need for additional parts to restrict lift.

One Piece Body: integrally cast flanges assure the highest material integrity and eliminate problems that may occur with welding.

Full 316 Stainless Steel Trim: this trim is standard and includes nozzle, piston, retainer and guide for long and versatile service life.

Main Valve Soft Seat: unlike metal seated valves which require costly machining and lapping procedures, the main valve soft seat is easily maintained and repaired.

Less Weight, Lower Profile: system pressure provides the seating force in pilot operated relief valves so pilot valves are smaller in size and weight than direct spring loaded valves.

Suitable for NACE Service: for high quality materials of construction that meet NACE MR0103 or MR0175 service, refer to N1 trim for carbon steel body and N4 trim for stainless steel.

Full Port Option: the full port option provides maximum capacity per inlet size.

General Notes:
1. Part used on 3" inlet sizes and larger.
2. Materials certified in compliance with NACE specifications.
3. PTFE for seals required in main valve for temperatures below -20°F. Consult the Factory.
4. PTFE used for Main Seat Seal (item 12) for all valves with 900#, 1500#, and 2500# inlet flanges.
5. We reserve the right to substitute comparable fluorocarbon materials.
6. EPDM is standard offering for NACE; other materials can be selected. Please specify at time of order.
7. Graphite reinforced PTFE with stainless steel spring.
8. Duplex available upon request, contact factory.

Inconel is a registered trademark of Inco Alloys International, Inc.

Snap Acting Pilot Control Features

Snap-Acting, Non-Flowing: the PCF5 and PCL pilot controls are snap acting and non-flowing, minimizing the flow of process media through the pilot for reduced fugitive emissions and extended valve life.

Full 316 Stainless Steel Construction: resists corrosion and extends the life and versatility of the PCF5 and PCL controls.

Adjustable Blowdown: allows setting blowdown at 3% of set pressure so that product loss is minimized and fugitive emissions reduced.

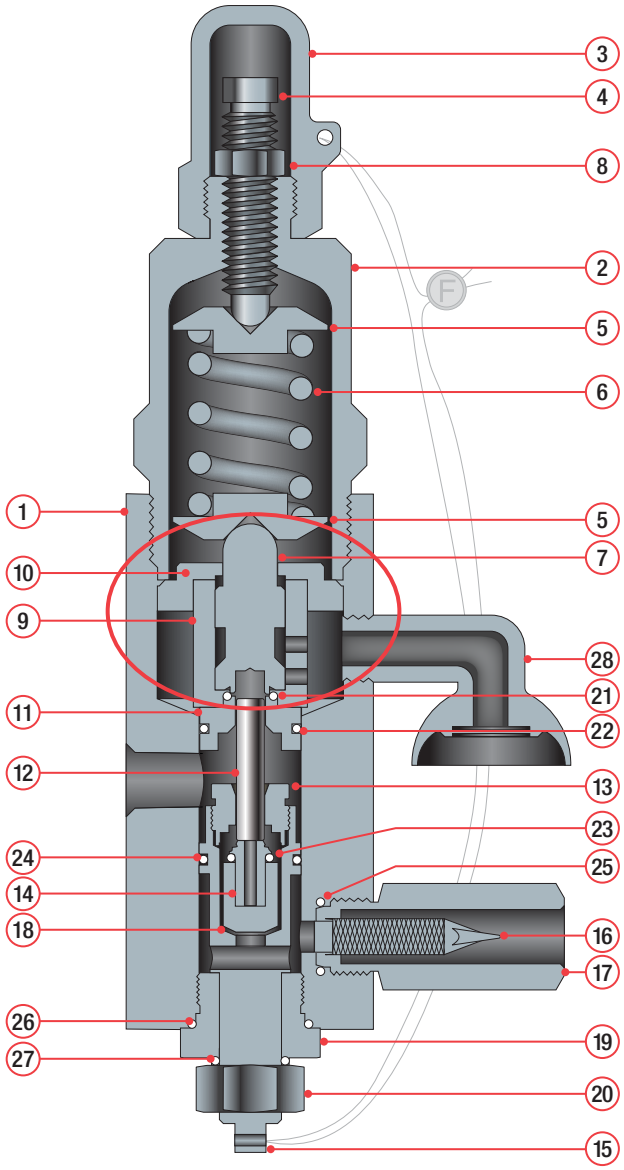
Viton Seats and Seals: these chemical-resistant seals and seats enhance a control's life. Neoprene, ethylene propylene, silicone, and Buna-N soft goods are optional and extend temperature ranges from -65°F to 450°F. Kalrez available when maximum resistance to chemical attack is required. Contact factory for more information.

Set Pressures and Blowdown Set at Pilot Control: in line service, settings and blowdown adjustments are completed quickly and easily without main valve intrusion. Subsequent reduction in product loss and fugitive emissions add to system profitability.

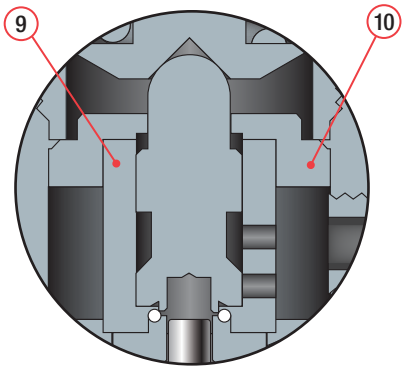
Field Test Capable: the use of a field test connection allows cycling the pilot control without interrupting system protection or removing the valve from the line. Field testing verifies system integrity in accordance with the requirements of the Code.

Remote Sensing Capable: when there is excessive inlet piping losses, or when the main valve must be installed at a different location on the protected system because of its service limitations, the pilot sensing line can be installed separate from the main valve.

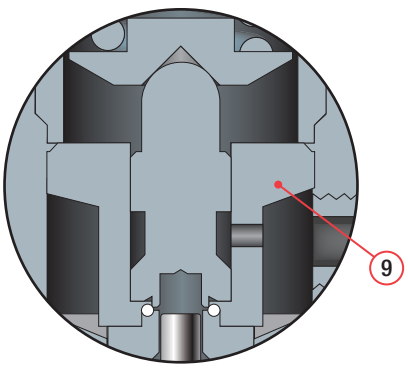
Suitable for NACE Service: for high quality materials of construction that meet NACE MR0103 or MR0175 service, refer to N1 trim for carbon steel body and N4 trim for stainless steel.



PCF5(2): Snap Acting Control – Air, Gas, Vapor Service



PCL(3): Snap Acting Control – Liquid Service



ASME UV

Built in conformance to ASME Code Section VIII for Air, Gas, and Liquid Service.
ASME Code stamping not available on full port design in liquid service.

3800 Series Bill of Materials – Snap Acting Control

Bill of Materials – PCF5 and PCL

Item No.	Part Name	Standard	NACE	Monel	Hastelloy
1	Body	316 St. St.	316 St. St.[2]	Monel	Hastelloy C
2	Bonnet	316 St. St.	316 St. St.	Monel	Hastelloy C
3	Cap	316 St. St.	316 St. St.	Monel	Hastelloy C
4	Spring Adjusting Screw	316 St. St.	316 St. St.	Monel	Hastelloy C
5	Spring Buttons	316 St. St.	316 St. St.	Monel	Hastelloy C
6	Spring	316 St. St.	Inconel X750	Inconel X750	Inconel X750
7	Disc	316 St. St.	316 St. St.	Monel	Hastelloy C
8	Jam Nut	316 St. St.	316 St. St.	Monel	Hastelloy C
9	Guide	316 St. St.	316 St. St.	Monel	Hastelloy C
10	Guide Flange[1]	316 St. St.	316 St. St.	Monel	Hastelloy C
11	Upper Seat	316 St. St.	316 St. St.	Monel	Hastelloy C
12	Blowdown Relay	316 St. St.	316 St. St.	Monel	Hastelloy C
13	Lower Seat	316 St. St.	316 St. St.	Monel	Hastelloy C
14	Retainer, Lower Seat Seal	316 St. St.	316 St. St.	Monel	Hastelloy C
15	Blowdown Adjuster	316 St. St.	316 St. St.	Monel	Hastelloy C
16	Filter	St. St.	St. St.	Monel	Monel
17	Filter Housing	316 St. St.	316 St. St.	Monel	Hastelloy C
18	Poppet	316 St. St.	316 St. St.	Monel	Hastelloy C
19	Blowdown Adjuster Cap	316 St. St.	316 St. St.	Monel	Hastelloy C
20	Blowdown Adjuster Lock Nut	316 St. St.	316 St. St.	Monel	Hastelloy C
21	Upper Seat Seal	Viton[3]	EPDM[4]	Viton[3]	Viton[3]
22	Static Seal, Body	Viton[3]	EPDM[4]	Viton[3]	Viton[3]
23	Lower Seat Seal	Viton[3]	EPDM[4]	Viton[3]	Viton[3]
24	Static Seal, Adjuster	Viton[3]	EPDM[4]	Viton[3]	Viton[3]
25	Static Seal, Filter	Viton[3]	EPDM[4]	Viton[3]	Viton[3]
26	Adjuster Cap Seal	Viton[3]	EPDM[4]	Viton[3]	Viton[3]
27	Thread Seal, O-Ring	PTFE	PTFE	PTFE	PTFE
28	Bug Vent	Aluminum	Aluminum	Aluminum	Aluminum

General Notes:
1. Part used on PCF5 only.
2. Materials certified in compliance with NACE specifications.
3. We reserve the right to substitute comparable fluorocarbon materials.
4. EPDM is standard offering for NACE; other materials can be selected. Please specify at time of order.
5. Duplex available upon request, consult factory.

Modulating Pilot Control Features

Modulating, Non-Flowing: the PCM, PCMS and HPCM pilot controls are modulating and non-flowing, minimizing the flow of process media through the pilot for reduced fugitive emissions and extended valve life.

Full 316 Stainless Steel Construction: resists corrosion and extends the operation and versatility of the modulating control.

Blowdown: The modulating controls are a fixed blowdown pilot control with no external adjustment. Depending on fluid service, a blowdown of 3% to 6% is typical.

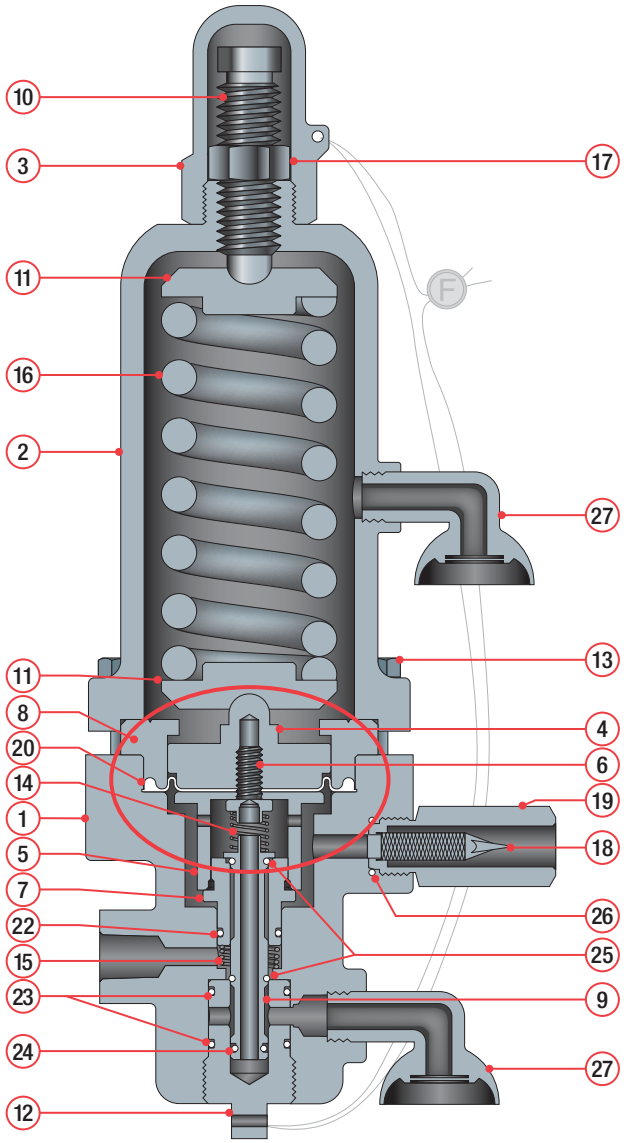
Viton Seats and Seals: have a wide spectrum of chemical compatibility and temperature range to meet most applications and enhance valve life. Buna-N and ethylene propylene soft goods are optional and extend temperature ranges from -65°F to 450°F. Contact the Farris Factory for more information on other construction materials.

Set Pressure Set at Pilot Control: in-line service and setting adjustments are done quickly and easily without main valve intrusion. Subsequent reduction in product loss and fugitive emissions adds to the system's profitability.

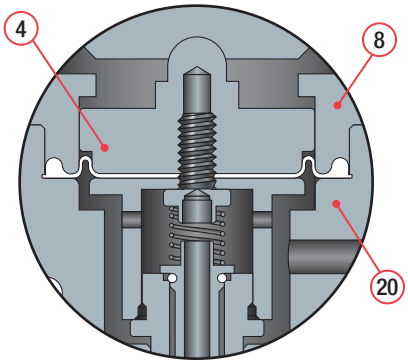
Field Test Capable: using a field test connection allows cycling the pilot control without interrupting system protection or removing the valve from the line. Field testing verifies system integrity in accordance with the ASME Code.

Remote Sensing Capable: when there is excessive inlet piping losses, or when the main valve must be installed at a different location on the protected system because of its service limitations, the pilot sensing line can be installed separate from the main valve.

Suitable for NACE Service: for high quality materials of construction that meet NACE MR0103 or MR0175 service, refer to N1 trim for carbon steel body and N4 trim for stainless steel.

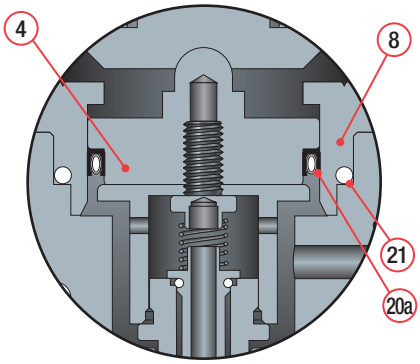


PCM(4): Modulating Control – 15 to 740 psig



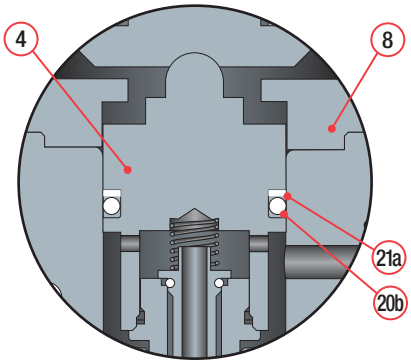
Air, Gas, Vapor and Liquid Service

PCMS(5): Modulating Control – 15 to 740 psig



Air, Gas, Vapor, Liquid and Steam Service

HPCM(6): Modulating Control – 740 to 2220 psig



Air, Gas, Vapor and Liquid Service

ASME UV

Built in conformance to ASME Code Section VIII for Air, Gas, Steam, and Liquid Service.
ASME Code stamping not available on full port design in liquid service.

3800 Series Bill of Materials – Modulating Control

Bill of Materials – PCM, PCMS and HPCM

Item No.	Part Name	Standard	NACE	Monel	Hastelloy
1	Body	316 St. St.	316 St. St.[2]	Monel	Hastelloy C
2	Bonnet	316 St. St.	316 St. St.	Monel	Hastelloy C
3	Cap	316 St. St.	316 St. St.	Monel	Hastelloy C
4	Piston	316 St. St.	316 St. St.	Monel	Hastelloy C
5	Retainer[1]	316 St. St.	316 St. St.	Monel	Hastelloy C
6	Retainer Screw[1]	316 St. St.	316 St. St.	Monel	Hastelloy C
7	Inlet Seat	316 St. St.	316 St. St.	Monel	Hastelloy C
8	Guide	316 St. St.	316 St. St.	Monel	Hastelloy C
9	Spool	316 St. St.	316 St. St.	Monel	Hastelloy C
10	Spring Adjusting Screw	316 St. St.	316 St. St.	Monel	Hastelloy C
11	Spring Buttons	316 St. St.	316 St. St.	Monel	Hastelloy C
12	Spool Cap	316 St. St.	316 St. St.	Monel	Hastelloy C
13	Bonnet Cap Screw	316 St. St.	316 St. St.	Monel	Hastelloy C
14	Spool Return Spring	316 St. St.	Inconel X750	Inconel X750	Inconel X750
15	Lower Return Spring	316 St. St.	Inconel X750	Inconel X750	Inconel X750
16	Spring	St. St.	St. St.	St. St.	St. St.
17	Jam Nut	316 St. St.	316 St. St.	316 St. St.	316 St. St.
18	Filter	St. St.	St. St.	Monel	Monel
19	Filter Housing	316 St. St.	316 St. St.	Monel	Hastelloy C
20	Diaphragm	Viton[3]	EPDM[6]	Viton[3]	Viton[3]
20a	Spring Energized Seal[4]	PTFE/HC[7]	PTFE/HC[7]	PTFE/HC[7]	PTFE/HC[7]
20b	Piston Seal[5]	Viton[3]	EPDM[6]	Viton[3]	Viton[3]
21	Guide Seal[4]	Viton[3]	EPDM[6]	Viton[3]	Viton[3]
21a	Backup Ring[5]	PTFE	PTFE	PTFE	PTFE
22	Body Seal	Viton[3]	EPDM[6]	Viton[3]	Viton[3]
23	Spool Cap Seal	Viton[3]	EPDM[6]	Viton[3]	Viton[3]
24	Spool Seal	Viton[3]	EPDM[6]	Viton[3]	Viton[3]
25	Seat Seal	Viton[3]	EPDM[6]	Viton[3]	Viton[3]
26	Filter Seal	Viton[3]	EPDM[6]	Viton[3]	Viton[3]
27	Bug Vent	Aluminum	Aluminum	Aluminum	Aluminum
28	Wire Seal	St. St.	St. St.	St. St.	St. St.

General Notes:
1. Part used on PCM and PCMS only.
2. Materials certified in compliance with NACE specifications.
3. We reserve the right to substitute comparable fluorocarbon materials.
4. Part used on PCMS only.
5. Part used on HPCM only.
6. EPDM is standard offering for NACE; other materials can be selected. Please specify at time of order.
7. Graphite reinforced PTFE with Hastelloy C spring.
8. Duplex available upon request, contact factory.

Selection Table – API

API – U.S. Customary and Metric

Orifice			Valve Size Inlet x Outlet	ANSI Flange Class		Type Number	Maximum Set Pressure				Maximum Back Pressure	
Letter	API Area Sq. In. (mm)	Actual Area Sq. In. (mm)		Inlet RF or RJ	Outlet RF		psig -20°F 100°F	psig 500°F (note 1)	barg -29°C 38°C	barg 260°C (note 1)	psig @ 100°F	barg @ 38°C
D	0.110 (71)	0.150 (97)	1 x 2	150# 300# 600#	150#	38DC10 38DC12 38DC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38DC14 38DC15 38DC16	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
			1-1/2 x 2	150# 300# 600#	150#	38DC10X 38DC12X 38DC13X	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38DC14X 38DC15X 38DC16X	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
E	0.196 (126)	0.225 (145)	1 x 2	150# 300# 600#	150#	38EC10 38EC12 38EC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38EC14 38EC15 38EC16	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
			1-1/2 x 2	150# 300# 600#	150#	38EC10X 38EC12X 38EC13X	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38EC14X 38EC15X 38EC16X	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
F	0.307 (198)	0.371 (239)	1 x 2	150# 300# 600#	150#	38FC10 38FC12 38FC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38FC14 38FC15 38FC16	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
			1-1/2 x 2	150# 300# 600#	150#	38FC10X 38FC12X 38FC13X	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38FC14X 38FC15X 38FC16X	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
G	0.503 (325)	0.559 (361)	1-1/2 x 3	150# 300# 600#	150#	38GC10 38GC12 38GC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38GC14 38GC15 38GC16	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
			2 x 3	150# 300# 600#	150#	38GC10X 38GC12X 38GC13X	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300/600# (note 2)	38GC14X 38GC15X 38GC16X	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	1480	102
H	0.785 (506)	0.873 (563)	1-1/2 x 3	150# 300# 600#	150#	38HC10 38HC12 38HC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38HC14 38HC15 38HC16	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
			2 x 3	150# 300# 600#	150#	38HC10X 38HC12X 38HC13X	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300/600# (note 2)	38HC14X 38HC15X 38HC16X	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	1480	102

General Notes:

1. Standard elastomer is Viton which is suitable to a maximum temperature of 450°F. For temperatures above 450°F the o-ring seals must be specified as Kalrez.
2. The 300# and 600# flanges have identical drilling with flange thickness equal to the 600# class.
3. For liquid service applications, add "L" to the end of the base type number for valves with standard size connections. Change the "X" to a "Y" for valves with oversize connections and change "D" to an "E" for valves with dual outlet. Examples: 38FC10L-120, 38FC10Y-120, 38TC10E-120.

Selection Table – API continued

API – U.S. Customary and Metric

Orifice			Valve Size Inlet x Outlet	ANSI Flange Class		Type Number	Maximum Set Pressure				Maximum Back Pressure	
Letter	API Area Sq. In. (mm)	Actual Area Sq. In. (mm)		Inlet RF or RJ	Outlet RF		psig -20°F 100°F	psig 500°F (note 1)	barg -29°C 38°C	barg 260°C (note 1)	psig @ 100°F	barg @ 38°C
J	1.287 (830)	1.430 (923)	2 x 3	150# 300# 600#	150#	38JC10 38JC12 38JC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300/600# (note 2)	38JC14 38JC15 38JC16	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	1480	102
			3 x 4	150# 300# 600#	150#	38JC10X 38JC12X 38JC13X	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500#	300#	38JC14X 38JC15X	2220 3705	1795 2995	153 255	124 206	740	51.0
K	1.838 (1186)	2.042 (1317)	3 x 4	150# 300# 600#	150#	38KC10 38KC12 38KC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500#	300#	38KC14 38KC15	2220 3705	1795 2995	153 255	124 206	740	51.0
L	2.853 (1841)	3.170 (2045)	3 x 4	150# 300# 600#	150#	38LC10 38LC12 38LC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500#	300#	38LC14 38LC15	2220 3705	1795 2995	153 255	124 206	740	51.0
			4 x 6	150# 300# 600#	150#	38LC10X 38LC12X 38LC13X	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500#	300#	38LC14X 38LC15X	2220 3705	1795 2995	153 255	124 206	740	51.0
M	3.60 (2323)	4.000 (2581)	4 x 6	150# 300# 600#	150#	38MC10 38MC12 38MC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500#	300#	38MC14 38MC15	2220 3705	1795 2995	153 255	124 206	740	51.0
N	4.34 (2800)	4.822 (3111)	4 x 6	150# 300# 600#	150#	38NC10 38NC12 38NC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500#	300#	38NC14 38NC15	2220 3705	1795 2995	153 255	124 206	740	51.0
P	6.38 (4116)	7.087 (4572)	4 x 6	150# 300# 600#	150#	38PC10 38PC12 38PC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500#	300#	38PC14 38PC15	2220 3080	1795 2995	153 212	124 206	740	51.0
Q	11.05 (7129)	12.27 (7916)	6 x 8	150# 300# 600#	150#	38QC10 38QC12 38QC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
			6 x 8 x 8	150# 300# 600#	150#	38QC10D 38QC12D 38QC13D	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
R	16.0 (10323)	17.78 (11471)	6 x 8	150# 300# 600#	150#	38RC10 38RC12 38RC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
			6 x 8 x 8	150# 300# 600#	150#	38RC10D 38RC12D 38RC13D	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
T	26 (16774)	28.94 (18671)	8 x 10	150# 300# 600#	150#	38TC10 38TC12 38TC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
			8 x 10 x 10	150# 300# 600#	150#	38TC10D 38TC12D 38TC13D	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6

General Notes Continued:
4. Valves with ring joint inlet connections available. Consult the Factory for final dimensions.
5. Dual outlet only available for 6" and 8" inlet valves.

Selection Table – Non Standard API

Non Standard API – U.S. Customary and Metric

Orifice			Valve Size Inlet x Outlet	ANSI Flange Class		Type Number	Maximum Set Pressure				Maximum Back Pressure	
Letter	API Area Sq. In. (mm)	Actual Area Sq. In. (mm)		Inlet RF or RJ	Outlet RF		psig -20°F 100°F	psig 500°F (note 1)	barg -29°C 38°C	barg 260°C (note 1)	psig @ 100°F	barg @ 38°C
G[5]	0.503 (325)	0.559 (361)	1 x 2	150# 300# 600#	150#	38GC10U 38GC12U 38GC13U	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38GC14U 38GC15U 38GC16U	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
			1-1/2 x 2	150# 300# 600#	150#	38GC10N 38GC12N 38GC13N	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38GC14N 38GC15N 38GC16N	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
H	0.785 (506)	0.873 (563)	1-1/2 x 2	150# 300# 600#	150#	38HC10N 38HC12N 38HC13N	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38HC14N 38HC15N 38HC16N	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
J	1.287 (830)	1.430 (923)	1-1/2 x 2	150# 300# 600#	150#	38JC10U 38JC12U 38JC13U	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38JC14U 38JC15U 38JC16U	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
			1-1/2 x 3	150# 300# 600#	150#	38JC10N 38JC12N 38JC13N	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38JC14N 38JC15N 38JC16N	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
K	1.838 (1186)	2.042 (1317)	2 x 3	150# 300# 600#	150#	38KC10N 38KC12N 38KC13N	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300/600# (note 2)	38KC14N 38KC15N 38KC16N	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	1480	102
M	3.60 (2323)	4.000 (2581)	3 x 4	150# 300# 600#	150#	38MC10N 38MC12N 38MC13N	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500#	300#	38MC14N 38MC15N	2220 3705	1795 2995	153 255	123.7 206	740	51.0
N	4.34 (2800)	4.822 (3111)	3 x 4	150# 300# 600#	150#	38NC10N 38NC12N 38NC13N	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500#	300#	38NC14N 38NC15N	2220 3705	1795 2995	153 255	124 206	740	51.0

General Notes:
1. Standard elastomer is Viton which is suitable to a maximum temperature of 450°F. For temperatures above 450°F the o-ring seals must be specified as Kalrez.
2. The 300# and 600# flanges have identical drilling with flange thickness equal to the 600# class.
3. Valves only certified for air, gas, vapor and steam service.
4. Valves with ring joint inlet connections available. Consult the Factory for final dimensions.
5. A 1" x 2" valve with an "G" orifice is only available when configured with a remote sensing option.

Selection Table – Full Port

Full Port – U.S. Customary and Metric

Orifice			Valve Size Inlet x Outlet	ANSI Flange Class		Type Number	Maximum Set Pressure				Maximum Back Pressure	
Letter	API Area Sq. In. (mm)	Actual Area Sq. In. (mm)		Inlet RF or RJ	Outlet RF		psig -20°F 100°F	psig 500°F (note 5)	barg -29°C 38°C	barg 260°C (note 5)	psig @ 100°F	barg @ 38°C
A[1]	—	0.719 (464)	1 x 2	150# 300# 600#	150#	38AC10 38AC12 38AC13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	38AC14 38AC15 38AC16	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
1	—	1.767 (1140)	1-1/2 x 2	150# 300# 600#	150#	381C10 381C12 381C13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	381C14 381C15 381C16	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
			1-1/2 x 3	150# 300# 600#	150#	381C10X 381C12X 381C13X	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300#	381C14X 381C15X 381C16X	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	740	51.0
2	—	2.953 (1905)	2 x 3	150# 300# 600#	150#	382C10 382C12 382C13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500# 2500#	300/600# (note 2)	382C14 382C15 382C16	2220 3705 6170	1795 2995 4990	153 255 425	124 206 344	1480	102
3	—	6.605 (4261)	3 x 4	150# 300# 600#	150#	383C10 383C12 383C13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500#	300#	383C14 383C15	2220 3705	1795 2995	153 255	124 206	740	51.0
4	—	11.50 (7419)	4 x 6	150# 300# 600#	150#	384C10 384C12 384C13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
				900# 1500#	300#	384C14 384C15	2220 3705	1795 2995	153 255	124 206	740	51.0
6	—	26.07 (16819)	6 x 8	150# 300# 600#	150#	386C10 386C12 386C13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
			6 x 8 x 8	150# 300# 600#	150#	386C10D 386C12D 386C13D	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
8	—	45.66 (29458)	8 x 10	150# 300# 600#	150#	388C10 388C12 388C13	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6
			8 x 10 x 10	150# 300# 600#	150#	388C10D 388C12D 388C13D	285 740 1480	170 600 1200	19.6 51.0 102	11.7 41.3 82.7	285	19.6

General Notes:
1. A 1" x 2" valve with an "A" orifice is only available when configured with a remote sensing option.
2. The 300# and 600# flanges have identical drilling with flange thickness equal to the 600# class.
3. Valves with ring joint inlet connections available. Consult the Factory for final dimensions.
4. Dual outlets only available for 6" and 8" inlet valves.
5. Standard elastomer is Viton which is suitable to a maximum temperature of 450°F. For temperatures above 450°F the o-ring seals must be specified as Kalrez.
6. Full port orifices require that inlet piping have a flow area equal to or greater than the full port orifice flow area.
7. Valves only certified for air, gas, vapor and steam service.

Air Capacities – 3800 Series: 10% Overpressure, API

ASME Pressure Vessel Code (UV) – Capacities in Standard Cubic Feet Per Minute at 60°F – U.S. Customary Units

Set Pressure (psig)	Orifice Letter Designation & Areas, Sq. Inches													
Areas	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**P**	**Q**	**R**	**T**
API	**0.110**	**0.196**	**0.307**	**0.503**	**0.785**	**1.287**	**1.838**	**2.853**	**3.600**	**4.34**	**6.38**	**11.05**	**16.00**	**26.0**
Actual	**0.150**	**0.225**	**0.371**	**0.559**	**0.873**	**1.43**	**2.042**	**3.170**	**4.000**	**4.822**	**7.087**	**12.27**	**17.78**	**28.94**
15	77	115	191	287	449	736	1051	1632	2059	2482	3649	6317	9155	14901
20	89	133	220	331	518	848	1212	1881	2374	2862	4207	7283	10554	17179
30	112	168	278	419	655	1074	1533	2380	3004	3621	5323	9215	13354	21736
40	138	207	342	516	806	1321	1887	2930	3697	4457	6550	11341	16434	26749
50	164	246	407	613	958	1569	2241	3479	4390	5292	7778	13466	19513	31762
60	190	285	471	710	1109	1817	2594	4028	5082	6127	9005	15591	22593	36774
70	216	324	535	807	1260	2064	2948	4577	5775	6962	10233	17717	25673	41787
80	242	363	599	903	1411	2312	3302	5126	6468	7797	11460	19842	28752	46800
90	268	402	664	1000	1562	2560	3655	5675	7161	8633	12688	21967	31832	51812
100	294	441	728	1097	1714	2807	4009	6224	7854	9468	13915	24092	34912	56825
150	424	636	1049	1581	2470	4046	5778	8969	11318	13644	20053	34719	50310	81889
200	554	831	1371	2065	3226	5284	7546	11715	14782	17820	26191	45345	65708	106952
250	684	1026	1692	2549	3982	6523	9315	14460	18246	21996	32328	55972	81107	132015
300	814	1221	2013	3034	4738	7761	11083	17205	21711	26172	38466	66598	96505	157079
350	944	1416	2335	3518	5494	9000	12851	19951	25175	30348	44604	77225	111903	182142
400	1073	1610	2656	4002	6250	10238	14620	22696	28639	34524	50741	87851	127302	207206
450	1203	1805	2977	4486	7006	11477	16388	25442	32103	38700	56879	98477	142700	232269
500	1333	2000	3298	4970	7762	12715	18157	28187	35567	42876	63017	109104	158098	257333
550	1463	2195	3620	5454	8518	13953	19925	30932	39032	47053	69154	119730	173497	282396
600	1593	2390	3941	5938	9274	15192	21694	33678	42496	51229	75292	130357	188895	307459
650	1723	2585	4262	6422	10030	16430	23462	36423	45960	55405	81430	140983	204293	332523
700	1853	2780	4584	6907	10786	17669	25231	39168	49424	59581	87567	151609	219692	357586
750	1983	2974	4905	7391	11542	18907	26999	41914	52888	63757	93705	162236	235090	382650
800	2113	3169	5226	7875	12299	20146	28768	44659	56352	67933	99843	172862	250488	407713
850	2243	3364	5548	8359	13055	21384	30536	47405	59817	72109	105981	183489	265887	432777
900	2373	3559	5869	8843	13811	22623	32305	50150	63281	76285	112118	194115	281285	457840
950	2502	3754	6190	9327	14567	23861	34073	52895	66745	80461	118256	204741	296683	482903
1000	2632	3949	6511	9811	15323	25099	35842	55641	70209	84637	124394	215368	312082	507967
1050	2762	4144	6833	10295	16079	26338	37610	58386	73673	88813	130531	225994	327480	533030
1100	2892	4339	7154	10780	16835	27576	39379	61131	77138	92989	136669	236621	342878	558094
1150	3022	4533	7475	11264	17591	28815	41147	63877	80602	97166	142807	247247	358277	583157
1200	3152	4728	7797	11748	18347	30053	42915	66622	84066	101342	148944	257873	373675	608221
1250	3282	4923	8118	12232	19103	31292	44684	69368	87530	105518	155082	268500	389073	633284
1300	3412	5118	8439	12716	19859	32530	46452	72113	90994	109694	161220	279126	404472	658348
1350	3542	5313	8761	13200	20615	33769	48221	74858	94459	113870	167357	289753	419870	683411
1400	3672	5508	9082	13684	21371	35007	49989	77604	97923	118046	173495	300379	435268	708474
1450	3802	5703	9403	14168	22127	36246	51758	80349	101387	122222	179633	311006	450667	733538
1500	3931	5897	9724	14653	22883	37484	53526	83094	104851	126398	185770			
1550	4061	6092	10046	15137	23639	38722	55295	85840	108315	130574	191908			
1600	4191	6287	10367	15621	24395	39961	57063	88585	111780	134750	198046			
1650	4321	6482	10688	16105	25152	41199	58832	91331	115244	138926	204183			
1700	4451	6677	11010	16589	25908	42438	60600	94076	118708	143103	210321			
1750	4581	6872	11331	17073	26664	43676	62369	96821	122172	147279	216459			
1800	4711	7067	11652	17557	27420	44915	64137	99567	125636	151455	222597			
1850	4841	7261	11974	18041	28176	46153	65906	102312	129101	155631	228734			
1900	4971	7456	12295	18525	28932	47392	67674	105057	132565	159807	234872			
2000	5231	7846	12938	19494	30444	49868	71211	110548	139493	168159	247147			
2100	5490	8236	13580	20462	31956	52345	74748	116039	146421	176511	259423			
2200	5750	8625	14223	21430	33468	54822	78285	121530	153350	184863	271698			
2300	6010	9015	14865	22398	34980	57299	81822	127020	160278	193216	283973			
2400	6270	9405	15508	23367	36492	59776	85359	132511	167207	201568	296249			
2500	6530	9795	16151	24335	38005	62253	88896	138002	174135	209920	308524			
2600	6789	10184	16793	25303	39517	64730	92433	143493	181063	218272	320799			
2700	7049	10574	17436	26271	41029	67207	95970	148983	187992	226624	333075			
2800	7309	10964	18078	27240	42541	69684	99506	154474	194920	234976	345350			
2900	7569	11354	18721	28208	44053	72161	103043	159965	201849	243329	357626			
3000	7829	11743	19364	29176	45565	74637	106580	165456	208777	251681	369901			
3500	9128	13692	22577	34017	53126	87022	124265	192909	243419	293442	431278			
4000	10427	15640	25790	38859	60686	99406	141950	220363	278061	335202	492655			
4500	11726	17589	29003	43700	68247	111791								
5000	13025	19538	32216	48541	75808	124175								
5500	14324	21486	35429	53382	83368	136560								
6000	15623	23435	38642	58223	90929	148944								
6170	16065	24097	39734	59869	93499	153155								

General Notes:

1. Capacities at 30 PSIG and below are based on 3 PSI overpressure.
2. For sizing purposes the effective coefficient of discharge, K_d for air, gas, and steam is 0.954 when sizing using the API effective areas. When sizing using the ASME actual areas, the certified coefficient of discharge K for air, gas, and steam service is 0.859.

Air Capacities – 3800 Series: 10% Overpressure, Full Port

ASME Pressure Vessel Code (UV) – Capacities in Standard Cubic Feet Per Minute at 60°F – U.S. Customary Units

Set Pressure (psig)	Orifice Letter Designation & Areas, Sq. Inches						
Areas	**A**	**#1**	**#2**	**#3**	**#4**	**#6**	**#8**
Actual	**0.719**	**1.767**	**2.953**	**6.605**	**11.50**	**26.07**	**45.66**
15	345	848	1417	3171	5521	12517	21923
20	398	978	1634	3656	6365	14431	25275
30	503	1237	2068	4626	8054	18259	31979
40	619	1522	2545	5692	9911	22469	39354
50	735	1808	3022	6759	11769	26680	46729
60	851	2093	3499	7826	13626	30891	54103
70	968	2379	3976	8893	15484	35101	61478
80	1084	2664	4452	9960	17341	39312	68853
90	1200	2949	4929	11026	19198	43523	76228
100	1316	3235	5406	12093	21056	47733	83602
150	1897	4662	7791	17427	30343	68787	120476
200	2477	6089	10176	22761	39630	89840	157350
250	3058	7516	12561	28095	48917	110894	194224
300	3639	8943	14945	33429	58204	131947	231097
350	4219	10370	17330	38763	67491	153000	267971
400	4800	11797	19715	44097	76778	174054	304845
450	5380	13224	22100	49431	86065	195107	341719
500	5961	14651	24484	54765	95352	216161	378592
550	6542	16078	26869	60099	104640	237214	415466
600	7122	17505	29254	65433	113927	258267	452340
650	7703	18932	31639	70767	123214	279321	489214
700	8284	20359	34024	76101	132501	300374	526087
750	8864	21786	36408	81435	141788	321428	562961
800	9445	23213	38793	86769	151075	342481	599835
850	10026	24640	41178	92103	160362	363534	636709
900	10606	26067	43563	97437	169649	384588	673582
950	11187	27494	45947	102771	178936	405641	710456
1000	11768	28920	48332	108105	188223	426695	747330
1050	12348	30347	50717	113439	197510	447748	784204
1100	12929	31774	53102	118773	206797	468801	821077
1150	13510	33201	55486	124107	216085	489855	857951
1200	14090	34628	57871	129441	225372	510908	894825
1250	14671	36055	60256	134775	234659	531962	931699
1300	15251	37482	62641	140110	243946	553015	968572
1350	15832	38909	65025	145444	253233	574069	1005446
1400	16413	40336	67410	150778	262520	595122	1042320
1450	16993	41763	69795	156112	271807	616175	1079194
1500	17574	43190	72180	161446	281094		
1550	18155	44617	74564	166780	290381		
1600	18735	46044	76949	172114	299668		
1650	19316	47471	79334	177448	308955		
1700	19897	48898	81719	182782	318242		
1750	20477	50325	84104	188116	327529		
1800	21058	51752	86488	193450	336817		
1850	21639	53179	88873	198784	346104		
1900	22219	54606	91258	204118	355391		
2000	23380	57460	96027	214786	373965		
2100	24542	60314	100797	225454	392539		
2200	25703	63168	105566	236122	411113		
2300	26864	66022	110336	246790	429687		
2400	28026	68876	115105	257458	448262		
2500	29187	71730	119875	268126	466836		
2600	30348	74584	124644	278794	485410		
2700	31509	77438	129414	289462	503984		
2800	32671	80292	134183	300130	522558		
2900	33832	83146	138953	310798	541132		
3000	34993	86000	143723	321466	559707		
3500	40800	100269	167570	374806	652577		
4000	46606	114539	191418	428146	745448		
4500	52413	128809	215265				
5000	58219	143079	239113				
5500	64026	157349	262961				
6000	69832	171619	286808				
6170	71806	176470	294916				

General Notes:

1. Capacities at 30 PSIG and below are based on 3 PSI overpressure.
2. For sizing purposes the coefficient of discharge, K for air, gas, and steam is 0.801
3. Full port orifices require that inlet piping have a flow area equal to or greater than the full port orifice flow area.

Steam Capacities – 3800 Series: 10% Overpressure, API

ASME Pressure Vessel Code (UV) – Capacities in Pounds Per Hour at Saturation Temperature – U.S. Customary Units

Set Pressure (psig)	Orifice Letter Designation & Areas, Sq. Inches													
Areas	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**P**	**Q**	**R**	**T**
API	**0.110**	**0.196**	**0.307**	**0.503**	**0.785**	**1.287**	**1.838**	**2.853**	**3.600**	**4.34**	**6.38**	**11.05**	**16.00**	**26.0**
Actual	**0.150**	**0.225**	**0.371**	**0.559**	**0.873**	**1.43**	**2.042**	**3.170**	**4.000**	**4.822**	**7.087**	**12.27**	**17.78**	**28.94**
15	216	325	536	808	1262	2068	2953	4585	5786	6975	10252	17749	25720	41864
20	250	375	618	932	1455	2384	3405	5286	6671	8042	11819	20463	29653	48265
30	316	474	782	1179	1842	3017	4308	6689	8440	10175	14954	25891	37518	61068
40	389	584	963	1451	2267	3713	5302	8231	10387	12521	18403	31862	46171	75151
50	462	693	1143	1723	2691	4409	6296	9774	12333	14868	21852	37833	54823	89234
60	535	803	1324	1995	3116	5105	7290	11317	14280	17214	25300	43804	63475	103317
70	608	912	1505	2267	3541	5801	8283	12859	16226	19561	28749	49775	72127	117400
80	681	1022	1685	2539	3966	6496	9277	14402	18173	21907	32198	55746	80779	131482
90	754	1131	1866	2811	4391	7192	10271	15944	20119	24254	35647	61717	89431	145565
100	827	1241	2046	3083	4815	7888	11264	17487	22066	26600	39095	67687	98084	159648
150	1192	1788	2949	4443	6940	11368	16233	25200	31798	38333	56339	97542	141344	230063
200	1557	2336	3852	5803	9064	14847	21201	32913	41531	50065	73582	127396	184605	300477
250	1922	2883	4754	7164	11188	18326	26170	40626	51263	61798	90826	157251	227866	370891
300	2287	3431	5657	8524	13312	21806	31138	48339	60996	73530	108069	187105	271127	441306
350	2652	3978	6560	9884	15436	25285	36106	56052	70728	85263	125313	216959	314388	511720
400	3017	4525	7462	11244	17560	28764	41075	63765	80460	96995	142556	246814	357649	582135
450	3382	5073	8365	12604	19684	32244	46043	71478	90193	108728	159800	276668	400909	652549
500	3747	5620	9268	13964	21808	35723	51012	79191	99925	120460	177043	306522	444170	722964
550	4112	6168	10170	15324	23932	39202	55980	86904	109658	132193	194287	336377	487431	793378
600	4477	6715	11073	16684	26057	42682	60949	94617	119390	143925	211530	366231	530692	863792
650	4842	7263	11976	18044	28181	46161	65917	102330	129123	155658	228774	396085	573953	934207
700	5207	7810	12878	19405	30305	49640	70885	110043	138855	167390	246017	425940	617214	1004621

Steam Capacities – 3800 Series: 10% Overpressure, Full Port

ASME Pressure Vessel Code (UV) – Capacities in Pounds Per Hour at Saturation Temperature – U.S. Customary Units

Set Pressure (psig)	Orifice Letter Designation & Areas, Sq. Inches						
Areas	**A**	**#1**	**#2**	**#3**	**#4**	**#6**	**#8**
Actual	**0.719**	**1.767**	**2.953**	**6.605**	**11.50**	**26.07**	**45.66**
15	969	2383	3983	8909	15512	35166	61591
20	1118	2748	4592	10271	17884	40543	71009
30	1414	3476	5810	12996	22628	51297	89845
40	1741	4278	7150	15993	27846	63127	110564
50	2067	5080	8490	18990	33065	74957	131282
60	2393	5882	9830	21988	38283	86786	152001
70	2719	6684	11170	24985	43501	98616	172720
80	3046	7485	12510	27982	48720	110446	193439
90	3372	8287	13850	30979	53938	122276	214158
100	3698	9089	15190	33976	59156	134105	234877
150	5329	13098	21890	48962	85248	193254	338472
200	6961	17107	28590	63947	111339	252402	442067
250	8592	21116	35290	78933	137431	311551	545662
300	10223	25125	41989	93919	163523	370699	649257
350	11855	29134	48689	108904	189614	429848	752852
400	13486	33143	55389	123890	215706	488996	856447
450	15117	37152	62089	138876	241797	548144	960042
500	16748	41161	68789	153861	267889	607293	1063637
550	18380	45170	75489	168847	293980	666441	1167231
600	20011	49179	82189	183832	320072	725590	1270826
650	21642	53188	88888	198818	346164	784738	1374421
700	23274	57197	95588	213804	372255	843887	1478016

General Notes:

1. Capacities at 30 PSIG and below are based on 3 PSI overpressure.
2. For sizing purposes the effective coefficient of discharge, K_d for air, gas, and steam is 0.954 when sizing using the API effective areas. When sizing using the ASME actual areas, the certified coefficient of discharge K for air, gas, and steam service is 0.859.
3. For full port sizing purposes the coefficient of discharge, K for air, gas, and steam is 0.801.
4. Full port orifices require that inlet piping have a flow area equal to or greater than the full port orifice flow area.

Water Capacities – 3800 Series: 10% Overpressure, API

ASME Pressure Vessel Code (UV) – Capacities in Gallons Per Minute at 70°F – U.S. Customary Units

Set Pressure (psig)	Orifice Letter Designation & Areas, Sq. Inches													
Areas	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**P**	**Q**	**R**	**T**
API	**0.110**	**0.196**	**0.307**	**0.503**	**0.785**	**1.287**	**1.838**	**2.853**	**3.600**	**4.34**	**6.38**	**11.05**	**16.00**	**26.0**
Actual	**0.150**	**0.225**	**0.371**	**0.559**	**0.873**	**1.43**	**2.042**	**3.170**	**4.000**	**4.822**	**7.087**	**12.27**	**17.78**	**28.94**
15	18.9	28.3	46.7	70.4	110	180	257	399	504	607	893	1546	2241	3648
20	21.3	32.0	52.8	79.6	124	203	291	451	570	687	1009	1748	2533	4124
30	25.6	38.4	63.3	95.4	149	244	348	541	682	823	1209	2094	3035	4940
40	29.5	44.3	73.1	110	172	281	402	624	788	950	1396	2418	3504	5704
50	33.0	49.5	81.7	123	192	315	450	698	881	1062	1561	2703	3918	6377
60	36.2	54.3	89.5	134	210	345	492	765	965	1164	1710	2962	4292	6986
70	39.1	58.6	96.7	145	227	372	532	826	1042	1257	1847	3199	4636	7546
80	41.8	62.7	103	155	243	398	569	883	1115	1344	1975	3420	4956	8067
90	44.3	66.5	109	165	258	422	603	937	1182	1425	2095	3627	5256	8556
100	46.7	70.1	115	174	272	445	636	987	1246	1502	2208	3824	5541	9019
150	57.2	85.8	141	213	333	545	779	1209	1526	1840	2705	4683	6786	11046
200	66.1	99.1	163	246	384	630	900	1397	1762	2125	3123	5407	7836	12755
250	73.9	110	182	275	430	704	1006	1562	1971	2376	3492	6046	8761	14260
300	80.9	121	200	301	471	771	1102	1711	2159	2602	3825	6623	9597	15621
350	87.4	131	216	325	509	833	1190	1848	2332	2811	4132	7154	10366	16873
400	93.4	140	231	348	544	891	1272	1975	2493	3005	4417	7648	11082	18038
450	99.1	148	245	369	577	945	1350	2095	2644	3187	4685	8111	11754	19132
500	104	156	258	389	608	996	1423	2209	2787	3360	4938	8550	12390	20167
550	109	164	271	408	638	1045	1492	2316	2923	3524	5179	8968	12995	21152
600	114	171	283	426	666	1091	1558	2419	3053	3681	5410	9366	13573	22092
650	119	178	294	444	693	1136	1622	2518	3178	3831	5631	9749	14127	22994
700	123	185	305	460	719	1179	1683	2613	3298	3976	5843	10117	14660	23862
750	128	192	316	477	745	1220	1742	2705	3414	4115	6048	10472	15175	24700
800	132	198	327	492	769	1260	1800	2794	3525	4250	6247	10815	15672	25510
850	136	204	337	507	793	1299	1855	2880	3634	4381	6439	11148	16155	26295
900	140	210	346	522	816	1336	1909	2963	3739	4508	6626	11472	16623	27057
950	144	216	356	536	838	1373	1961	3045	3842	4631	6807	11786	17079	27799
1000	147	221	365	550	860	1409	2012	3124	3942	4752	6984	12092	17522	28521
1050	151	227	374	564	881	1444	2062	3201	4039	4869	7156	12391	17955	29225
1100	155	232	383	577	902	1478	2110	3276	4134	4984	7325	12682	18378	29913
1150	158	237	392	590	922	1511	2158	3350	4227	5096	7490	12967	18791	30585
1200	161	242	400	603	942	1543	2204	3422	4318	5205	7651	13246	19195	31243
1250	165	247	408	615	961	1575	2250	3492	4407	5313	7808	13519	19591	31887
1300	168	252	416	628	980	1606	2294	3562	4494	5418	7963	13787	19979	32519
1350	171	257	424	640	999	1637	2338	3629	4580	5521	8115	14050	20359	33138
1400	174	262	432	651	1018	1667	2381	3696	4664	5622	8264	14308	20733	33747
1450	178	267	440	663	1036	1697	2423	3761	4746	5722	8410	14561	21100	34344
1500	181	271	447	674	1053	1726	2464	3826	4828	5820	8554			
1550	184	276	455	685	1071	1754	2505	3889	4907	5916	8695			
1600	186	280	462	696	1088	1782	2545	3951	4986	6011	8834			
1650	189	284	469	707	1105	1810	2585	4013	5063	6104	8971			
1700	192	289	476	718	1121	1837	2623	4073	5139	6196	9106			
1750	195	293	483	728	1138	1864	2662	4132	5214	6286	9239			
1800	198	297	490	739	1154	1890	2700	4191	5288	6375	9370			
1850	201	301	497	749	1170	1916	2737	4249	5361	6463	9499			
1900	203	305	503	759	1185	1942	2773	4306	5433	6550	9627			
2000	209	313	517	779	1216	1993	2846	4418	5575	6720	9877			
2100	214	321	529	798	1246	2042	2916	4527	5712	6886	10121			
2200	219	328	542	817	1276	2090	2984	4633	5847	7048	10359			
2300	224	336	554	835	1304	2137	3052	4738	5978	7207	10592			
2400	229	343	566	853	1332	2183	3117	4839	6107	7362	10820			
2500	233	350	578	871	1360	2228	3181	4939	6233	7513	11043			
2600	238	357	589	888	1387	2272	3245	5037	6356	7662	11262			
2700	242	364	600	905	1413	2315	3306	5133	6477	7808	11476			
2800	247	371	611	921	1439	2358	3367	5227	6596	7952	11687			
2900	251	377	622	938	1465	2399	3427	5320	6713	8092	11894			
3000	256	384	633	954	1490	2441	3485	5411	6828	8231	12097			
3500	276	414	684	1030	1609	2636	3764	5844	7375	8890	13066			
4000	295	443	731	1101	1720	2818	4024	6248	7884	9504	13969			
4500	313	470	775	1168	1825	2989								
5000	330	495	817	1231	1923	3151								
5500	346	520	857	1292	2017	3305								
6000	362	543	895	1349	2107	3452								
6170	367	550	908	1368	2137	3500								

General Notes:

1. Capacities at 30 PSIG and below are based on 3 PSI overpressure.
2. For sizing purposes the effective coefficient of discharge, K_d for liquids is 0.869 when sizing using the API effective areas. When sizing using the ASME actual areas, the certified coefficient of discharge K for water is 0.782.
3 Values in this table assume no backpressure.

Air Capacities – 3800 Series: 10% Overpressure, API

ASME Pressure Vessel Code (UV) – Capacities in Standard Cubic Meters Per Minute at 15.6°C – Metric Units

Set Pressure (barg)	Orifice Letter Designation & Areas, Sq. mm													
Areas	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**P**	**Q**	**R**	**T**
API	**71**	**126**	**198**	**325**	**506**	**830**	**1186**	**1841**	**2323**	**2800**	**4116**	**7129**	**10323**	**16774**
Actual	**97**	**145**	**239**	**361**	**563**	**923**	**1317**	**2045**	**2581**	**3111**	**4572**	**7916**	**11471**	**18671**
1	2.1	3.2	5.3	8.0	12.5	20.5	29.3	45.5	57.4	69.2	101	176	255	415
2	3.1	4.6	7.7	11.6	18.1	29.7	42.5	66.0	83.3	100	147	255	370	602
3	4.1	6.2	10.3	15.5	24.3	39.8	56.9	88.4	111	134	197	342	496	807
4	5.2	7.8	12.9	19.5	30.5	50.0	71.4	110	140	168	248	429	622	1013
5	6.3	9.4	15.6	23.5	36.7	60.2	86.0	133	168	203	298	516	749	1219
6	7.3	11.0	18.2	27.5	42.9	70.4	100	156	196	237	348	604	875	1425
7	8.4	12.6	20.9	31.5	49.2	80.5	115	178	225	271	399	691	1002	1630
8	9.0	14.2	23.5	35.4	55.4	90.7	129	201	253	306	449	778	1128	1836
9	10.5	15.8	26.1	39.4	61.6	100	144	223	282	340	500	866	1255	2042
10	11.6	17.4	28.8	43.4	67.8	111	158	246	310	374	550	953	1381	2248
12	13.7	20.6	34.1	51.3	80.2	131	187	291	367	443	651	1127	1634	2660
14	15.9	23.8	39.3	59.3	92.6	151	216	336	424	511	752	1302	1887	3072
16	18.0	27.0	44.6	67.2	105	172	245	381	481	580	853	1477	2140	3484
18	20.1	30.2	49.9	75.2	117	192	274	426	538	649	954	1651	2393	3895
20	22.3	33.4	55.2	83.2	129	212	303	471	595	717	1054	1826	2646	4307
22	24.4	36.6	60.5	91.1	142	233	333	516	652	786	1155	2000	2899	4719
24	26.5	39.8	65.7	99.1	154	253	362	562	709	854	1256	2175	3152	5131
26	28.7	43.0	71.0	107	167	273	391	607	766	923	1357	2350	3405	5543
28	30.8	46.2	76.3	115	179	294	420	652	823	992	1458	2524	3658	5954
30	32.9	49.4	81.6	122	192	314	449	697	879	1060	1559	2699	3911	6366
32	35.1	52.7	86.8	130	204	334	478	742	936	1129	1659	2873	4164	6778
34	37.2	55.9	92.1	138	216	355	507	787	993	1198	1760	3048	4417	7190
36	39.4	59.1	97.4	146	229	375	536	832	1050	1266	1861	3223	4670	7602
38	41.5	62.3	102	154	241	395	565	877	1107	1335	1962	3397	4923	8013
40	43.6	65.5	108	162	254	416	594	922	1164	1403	2063	3572	5176	8425
42	45.8	68.7	113	170	266	436	623	968	1221	1472	2164	3746	5429	8837
44	47.9	71.9	118	178	279	457	652	1013	1278	1541	2265	3921	5682	9249
46	50.0	75.1	123	186	291	477	681	1058	1335	1609	2365	4096	5935	9661
48	52.2	78.3	129	194	303	497	710	1103	1392	1678	2466	4270	6188	10072
50	54.3	81.5	134	202	316	518	739	1148	1449	1746	2567	4445	6441	10484
60	65.0	97.5	160	242	378	619	885	1373	1733	2090	3071	5318	7706	12543
70	75.6	113	187	282	440	721	1030	1599	2018	2433	3575	6191	8971	14602
80	86.3	129	213	321	502	823	1175	1825	2302	2776	4080	7064	10236	16661
90	97.0	145	239	361	564	925	1320	2050	2587	3119	4584	7937	11501	18720
100	107	161	266	401	626	1026	1466	2276	2872	3462	5088	8810	12766	20779
110	118	177	292	441	688	1128	1611	2501	3156	3805	5592			
120	129	193	319	480	751	1230	1756	2727	3441	4148	6097			
130	139	209	345	520	813	1331	1902	2952	3725	4491	6601			
140	150	225	371	560	875	1433	2047	3178	4010	4834	7105			
150	161	241	398	600	937	1535	2192	3403	4295	5177	7609			
160	171	257	424	639	999	1637	2337	3629	4579	5520	8113			
170	182	273	451	679	1061	1738	2483	3854	4864	5863	8618			
180	193	289	477	719	1123	1840	2628	4080	5148	6206	9122			
190	203	305	503	759	1185	1942	2773	4305	5433	6549	9626			
200	214	321	530	799	1247	2044	2919	4531	5717	6892	10130			
210	225	337	556	838	1310	2145	3064	4756	6002	7236	10634			
220	235	353	583	878	1372	2247	3209	4982	6287	7579	11139			
230	246	369	609	918	1434	2349	3354	5208	6571	7922	11643			
240	257	385	635	958	1496	2451	3500	5433	6856	8265	12147			
250	267	401	662	997	1558	2552	3645	5659	7140	8608	12651			
260	278	417	688	1037	1620	2654	3790	5884	7425	8951	13156			
270	289	433	715	1077	1682	2756								
280	299	449	741	1117	1744	2858								
290	310	465	767	1157	1806	2959								
300	321	481	794	1196	1869	3061								
310	331	497	820	1236	1931	3163								
320	342	513	847	1276	1993	3265								
330	353	529	873	1316	2055	3366								
340	363	545	899	1355	2117	3468								
350	374	561	926	1395	2179	3570								
370	395	593	979	1475	2303	3773								
390	417	625	1031	1554	2428	3977								
410	438	657	1084	1634	2552	4180								
425	454	681	1124	1693	2645	4333								

General Notes:

1. Capacities at 2.0 Barg set pressure and below are based on 0.2 Bar overpressure.
2. For sizing purposes the effective coefficient of discharge, K_d for air, gas, and steam is 0.954 when sizing using the API effective areas. When sizing using the ASME actual areas, the certified coefficient of discharge K for air, gas, and steam service is 0.859.

Air Capacities – 3800 Series: 10% Overpressure, Full Port

ASME Pressure Vessel Code (UV) – Capacities in Standard Cubic Meters Per Minute at 15.6°C – Metric Units

Set Pressure (barg)	Orifice Letter Designation & Areas, Sq. mm						
Areas	A	#1	#2	#3	#4	#6	#8
Actual	464	1140	1905	4261	7419	16819	29458
1	9.6	23.6	39.5	88.4	154	349	611
2	13.9	34.3	57.3	128	223	506	886
3	18.7	45.9	76.8	171	299	678	1187
4	23.4	57.6	96.4	215	375	851	1490
5	28.2	69.4	116	259	451	1024	1793
6	33.0	81.1	135	303	528	1197	2096
7	37.7	92.8	155	347	604	1370	2399
8	42.0	104	174	390	680	1542	2702
9	47.3	116	194	434	756	1715	3005
10	52.0	128	213	478	833	1888	3308
12	61.6	151	253	566	985	2234	3914
14	71.1	174	292	653	1138	2580	4519
16	80.7	198	331	741	1290	2926	5125
18	90.2	221	370	829	1443	3272	5731
20	99.7	245	409	916	1596	3618	6337
22	109	268	449	1004	1748	3964	6943
24	118	292	488	1092	1901	4310	7549
26	128	315	527	1179	2053	4656	8155
28	137	339	566	1267	2206	5002	8760
30	147	362	605	1354	2359	5348	9366
32	157	385	644	1442	2511	5693	9972
34	166	409	684	1530	2664	6039	10578
36	176	432	723	1617	2816	6385	11184
38	185	456	762	1705	2969	6731	11790
40	195	479	801	1793	3122	7077	12395
42	204	503	840	1880	3274	7423	13001
44	214	526	880	1968	3427	7769	13607
46	223	550	919	2056	3579	8115	14213
48	233	573	958	2143	3732	8461	14819
50	242	596	997	2231	3884	8807	15425
60	290	714	1193	2669	4647	10536	18454
70	338	831	1389	3107	5410	12266	21483
80	385	948	1585	3545	6173	13995	24512
90	433	1065	1781	3984	6936	15725	27541
100	481	1183	1977	4422	7699	17454	30571
110	529	1300	2173	4860	8462		
120	576	1417	2368	5298	9225		
130	624	1534	2564	5736	9988		
140	672	1651	2760	6175	10751		
150	719	1769	2956	6613	11514		
160	767	1886	3152	7051	12277		
170	815	2003	3348	7489	13040		
180	863	2120	3544	7927	13803		
190	910	2238	3740	8366	14566		
200	958	2355	3936	8804	15329		
210	1006	2472	4132	9242	16092		
220	1053	2589	4328	9680	16854		
230	1101	2707	4523	10118	17617		
240	1149	2824	4719	10557	18380		
250	1196	2941	4915	10995	19143		
260	1244	3058	5111	11433	19906		
270	1292	3175	5307				
280	1340	3293	5503				
290	1387	3410	5699				
300	1435	3527	5895				
310	1483	3644	6091				
320	1530	3762	6287				
330	1578	3879	6483				
340	1626	3996	6678				
350	1673	4113	6874				
360	1721	4230	7070				
370	1769	4348	7266				
380	1817	4465	7462				
390	1864	4582	7658				
400	1912	4699	7854				
410	1960	4817	8050				
420	2007	4934	8246				
425	2031	4992	8344				

General Notes:

1. Capacities at 2.0 Barg set pressure and below are based on 0.2 Bar overpressure.
2. For sizing purposes the coefficient of discharge, K_d for air, gas, and steam is 0.801.
3. Full port orifices require that inlet piping have a flow area equal to or greater than the full port orifice flow area.

Steam Capacities – 3800 Series: 10% Overpressure, API

ASME Pressure Vessel Code (UV) – Capacities in Kilograms Per Hour at Saturation Temperature – Metric Units

Set Pressure (barg)	Orifice Letter Designation & Areas, Sq. mm													
Areas	D	E	F	G	H	J	K	L	M	N	P	Q	R	T
API	71	126	198	325	506	830	1186	1841	2323	2800	4116	7129	10323	16774
Actual	97	145	239	361	563	923	1317	2045	2581	3111	4572	7916	11471	18671
1	96	145	239	361	564	924	1319	2048	2584	3116	4579	7929	11489	18701
2	140	210	347	523	818	1340	1913	2971	3749	4519	6642	11500	16664	27124
3	188	282	465	701	1095	1795	2563	3979	5021	6053	8897	15404	22321	36332
4	236	354	584	880	1375	2253	3217	4994	6302	7597	11166	19332	28013	45597
5	284	426	703	1059	1654	2710	3871	6009	7582	9141	13435	23260	33706	54862
6	332	498	822	1238	1934	3168	4524	7024	8863	10684	15703	27188	39398	64127
7	380	570	940	1417	2213	3626	5178	8039	10144	12228	17972	31117	45090	73392
8	428	642	1059	1596	2493	4084	5832	9054	11424	13772	20241	35045	50782	82657
9	476	714	1178	1775	2772	4542	6486	10068	12705	15316	22510	38973	56475	91923
10	524	786	1297	1954	3052	4999	7139	11083	13985	16860	24779	42901	62167	101188
12	620	930	1534	2312	3611	5915	8447	13113	16547	19947	29317	50758	73551	119718
14	716	1074	1772	2670	4170	6831	9754	15143	19108	23035	33855	58614	84936	138248
16	812	1218	2009	3028	4729	7746	11062	17173	21669	26122	38392	66471	96321	156779
18	908	1362	2247	3386	5288	8662	12369	19202	24230	29210	42930	74327	107705	175309
20	1004	1507	2484	3744	5847	9578	13677	21232	26791	32297	47468	82184	119090	193839
22	1100	1651	2722	4102	6406	10493	14984	23262	29353	35385	52006	90040	130474	212369
24	1196	1795	2960	4460	6965	11409	16292	25292	31914	38472	56544	97897	141859	230900
26	1292	1939	3197	4817	7524	12325	17599	27321	34475	41560	61082	105753	153243	249430
28	1388	2083	3435	5175	8083	13240	18907	29351	37036	44647	65619	113610	164628	267960
30	1484	2227	3672	5533	8642	14156	20214	31381	39597	47735	70157	121466	176012	286491
32	1580	2371	3910	5891	9201	15071	21522	33411	42159	50822	74695	129323	187397	305021
36	1773	2659	4385	6607	10319	16903	24137	37470	47281	56997	83771	145036	210166	342082
40	1965	2947	4860	7323	11437	18734	26752	41530	52403	63172	92846	160749	232935	379142
44	2157	3235	5335	8039	12555	20565	29367	45589	57526	69348	101922	176462	255704	416203
48	2349	3523	5810	8755	13673	22396	31982	49649	62648	75523	110997	192175	278473	453263

Steam Capacities – 3800 Series: 10% Overpressure, Full Port

ASME Pressure Vessel Code (UV) – Capacities in Kilograms Per Hour at Saturation Temperature – Metric Units

Set Pressure (barg)	Orifice Letter Designation & Areas, Sq. mm						
Areas	A	#1	#2	#3	#4	#6	#8
Actual	464	1140	1905	4261	7419	16819	29458
1	433	1064	1779	3980	6929	15709	27514
2	628	1544	2580	5772	10050	22784	39906
3	823	2023	3382	7565	13171	29860	52298
4	1018	2503	4183	9357	16292	36935	64689
5	1213	2982	4985	11150	19413	44010	77081
6	1408	3462	5786	12942	22534	51085	89473
7	1604	3942	6588	14735	25655	58161	101865
8	1799	4421	7389	16528	28777	65236	114257
9	1994	4901	8190	18320	31898	72311	126649
10	2189	5380	8992	20113	35019	79386	139041
12	2579	6339	10595	23698	41261	93537	163824
14	2969	7298	12198	27283	47503	107687	188608
16	3360	8258	13800	30868	53745	121838	213392
18	3750	9217	15403	34453	59987	135988	238175
20	4140	10176	17006	38038	66229	150139	262959
22	4531	11135	18609	41623	72471	164289	287743
24	4921	12094	20212	45208	78713	178440	312527
26	5311	13053	21815	48794	84955	192590	337310
28	5701	14012	23417	52379	91197	206741	362094
30	6092	14971	25020	55964	97439	220891	386878
32	6482	15930	26623	59549	103681	235042	411661
36	7262	17849	29829	66719	116165	263343	461229
40	8043	19767	33035	73889	128650	291644	510796
44	8823	21685	36240	81060	141134	319945	560364
48	9604	23603	39446	88230	153618	348246	609931

General Notes:

1. Capacities at 2.0 Barg set pressure and below are based on 0.2 Bar overpressure.
2. For sizing purposes the effective coefficient of discharge, K_d for air, gas, and steam is 0.954 when sizing using the API effective areas. When sizing using the ASME actual areas, the certified coefficient of discharge K for air, gas, and steam service is 0.859.
3. For full port sizing purposes the coefficient of discharge, K for air, gas, and steam is 0.801.
4. Full port orifices require that inlet piping have a flow area equal to or greater than the full port orifice flow area.

Water Capacities – 3800 Series: 10% Overpressure, API

ASME Pressure Vessel Code (UV) – Capacities in Liters Per Minute at 21°C – Metric Units

Set Pressure (barg)	Orifice Letter Designation & Areas, Sq. mm													
Areas	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**P**	**Q**	**R**	**T**
API	**71**	**126**	**198**	**325**	**506**	**830**	**1186**	**1841**	**2323**	**2800**	**4116**	**7129**	**10323**	**16774**
Actual	**97**	**145**	**239**	**361**	**563**	**923**	**1317**	**2045**	**2581**	**3111**	**4572**	**7916**	**11471**	**18671**
1	70.5	105	174	263	410	672	960	1491	1882	2269	3334	5773	8366	13617
2	95.4	143	236	355	555	909	1299	2017	2545	3068	4509	7807	11313	18414
3	116	175	288	434	679	1112	1588	2466	3112	3752	5514	9547	13834	22518
4	134	202	333	502	784	1284	1834	2848	3593	4332	6367	11024	15975	26002
5	150	226	372	561	876	1436	2051	3184	4018	4843	7119	12325	17860	29071
6	165	247	408	615	960	1573	2247	3488	4401	5306	7798	13502	19565	31846
7	178	267	440	664	1037	1699	2427	3767	4754	5731	8423	14584	21133	34397
8	190	285	471	710	1109	1817	2594	4027	5082	6127	9005	15590	22592	36772
9	202	303	500	753	1176	1927	2752	4272	5390	6498	9551	16536	23962	39003
10	213	319	527	794	1240	2031	2900	4503	5682	6850	10068	17431	25258	41113
12	233	350	577	869	1358	2225	3177	4933	6224	7504	11029	19094	27669	45037
14	252	378	623	939	1467	2403	3432	5328	6723	8105	11912	20624	29886	48645
16	269	404	666	1004	1568	2569	3669	5696	7187	8665	12735	22048	31950	52004
18	285	428	707	1065	1663	2725	3892	6041	7623	9190	13507	23386	33888	55159
20	301	452	745	1123	1753	2872	4102	6368	8036	9687	14238	24651	35721	58142
22	316	474	781	1177	1839	3013	4302	6679	8428	10160	14933	25854	37465	60980
24	330	495	816	1230	1921	3147	4494	6976	8803	10612	15597	27004	39130	63692
26	343	515	849	1280	1999	3275	4677	7261	9162	11045	16234	28106	40728	66293
28	356	534	881	1328	2075	3399	4854	7535	9508	11462	16847	29168	42266	68795
30	369	553	912	1375	2148	3518	5024	7800	9842	11865	17438	30191	43749	71210
32	381	571	942	1420	2218	3634	5189	8055	10165	12254	18010	31181	45184	73545
34	392	589	971	1464	2286	3745	5349	8303	10478	12631	18564	32141	46575	75809
36	404	606	1000	1506	2353	3854	5504	8544	10781	12997	19102	33073	47925	78006
38	415	623	1027	1548	2417	3960	5654	8778	11077	13353	19626	33979	49238	80144
40	426	639	1054	1588	2480	4063	5801	9006	11365	13700	20136	34862	50517	82226
42	436	655	1080	1627	2541	4163	5945	9229	11645	14038	20633	35723	51765	84257
44	446	670	1105	1665	2601	4261	6085	9446	11919	14369	21118	36564	52983	86239
46	457	685	1130	1703	2659	4357	6221	9658	12187	14692	21593	37385	54174	88178
48	466	700	1154	1739	2717	4450	6355	9866	12449	15008	22058	38189	55339	90074
50	476	714	1178	1775	2773	4542	6486	10069	12706	15317	22512	38977	56480	91932
60	521	782	1291	1945	3037	4976	7105	11031	13919	16779	24661	42697	61871	100706
70	563	845	1394	2101	3281	5374	7675	11914	15034	18124	26637	46118	66828	108775
80	602	904	1490	2246	3507	5745	8205	12737	16072	19375	28476	49302	71443	116285
90	639	958	1581	2382	3720	6094	8702	13510	17047	20550	30204	52293	75776	123339
100	673	1010	1666	2511	3921	6424	9173	14241	17969	21662	31837	55122	79875	130011
110	706	1060	1748	2633	4113	6737	9621	14936	18846	22719	33391			
120	738	1107	1825	2750	4296	7037	10049	15600	19684	23730	34876			
130	768	1152	1900	2863	4471	7324	10459	16237	20488	24699	36300			
140	797	1195	1972	2971	4640	7601	10854	16850	21262	25631	37671			
150	825	1237	2041	3075	4803	7868	11235	17441	22008	26531	38993			
160	852	1278	2108	3176	4960	8126	11603	18013	22730	27401	40272			
170	878	1317	2173	3274	5113	8376	11960	18568	23429	28244	41511			
180	904	1356	2236	3369	5261	8618	12307	19106	24109	29063	42715			
190	928	1393	2297	3461	5405	8855	12644	19629	24769	29859	43885			
200	952	1429	2357	3551	5546	9085	12973	20139	25413	30635	45025			
210	976	1464	2415	3639	5683	9309	13293	20637	26040	31392	46137			
220	999	1499	2472	3724	5817	9528	13606	21122	26653	32130	47223			
230	1021	1532	2527	3808	5947	9742	13912	21597	27252	32852	48284			
240	1043	1565	2582	3890	6075	9952	14211	22062	27838	33559	49323			
250	1065	1598	2635	3970	6201	10157	14504	22517	28412	34251	50340			
260	1086	1629	2687	4049	6323	10358	14791	22963	28975	34929	51337			
270	1107	1660	2738	4126	6444	10556								
280	1127	1691	2788	4202	6562	10749								
290	1147	1721	2838	4276	6678	10940								
300	1167	1750	2886	4349	6792	11127								
310	1186	1779	2934	4421	6905	11310								
320	1205	1808	2981	4492	7015	11491								
330	1224	1836	3027	4561	7124	11670								
340	1242	1863	3073	4630	7231	11845								
350	1260	1891	3118	4698	7337	12018								
370	1296	1944	3205	4830	7543	12357								
390	1330	1996	3291	4959	7745	12686								
410	1364	2046	3374	5084	7941	13008								
425	1389	2083	3435	5177	8085	13243								

General Notes:

1. Capacities at 2.0 Barg set pressure and below are based on 0.2 Bar overpressure.
2. For sizing purposes the effective coefficient of discharge, K_d for liquids is 0.869 when sizing using the API effective areas. When sizing using the ASME actual areas, the certified coefficient of discharge K for water is 0.782.
3. Values in this table assume no backpressure.

Optional Accessories

A full line of accessories is available to meet your service requirements.



Dual Pilot Controls



Auxiliary Filters



Manual Depressurizing

Dual Pilot Controls

The dual pilot arrangement permits switching from an active control to a back-up control, ensuring uninterrupted pressure relief protection. The original, active control can be removed from the main valve for checking or maintenance purposes.

The spare pilot can be in place during operation or be installed just prior to switch over. When the pilot controls are subjected to corrosive service that can require more frequent maintenance cycles, this option maximizes in-service time of the PORV and increases the integrity level of the valve. Select Option #2 from page 5.

Auxiliary Filters

All pilot controls are manufactured with an internal filter that reduces particles in the process stream, as these particles can impede the operation of the pilot valve. For services where particulates are present in the process media, additional filtration may be required. Auxiliary filters for the pilot valve sensing line are available to complement the internal filter. This filter is mounted upstream to the pilot's internal filter, reducing the amount of particles that can enter the pilot. As our pilot valves are non-flowing, the life cycle of the filter is dependent on the valve size, particle size and the valve usage. Select Option #3 from page 5.

Manual or Remote Depressurizing

Pilot operated relief valves potentially need an option to manually or remotely depressurize before the normal overpressure settings have been reached. In addition, this option allows for testing the main valve function without cycling the pilot control. It also allows for the pilot valve, in conjunction with other valves, to provide emergency reduction of system pressure due to potential safety situations. The main valve can be cycled to the open position by venting the pressure in the dome above the piston. A manual valve option will mount directly on the main valve, which allows for manual depressurizing of the dome. Alternately, a solenoid valve will cycle the main valve remotely. Neither the manual nor remote blowdown system will interfere with the normal overpressure protection provided by the main valve and pilot. Select Options #4 or #8 from page 5.



Remote Depressurizing



Field Test Connection



Field Test Connection with Indicator



Reverse Flow Preventer

Field Test Connection or Field Test Connection with Indicator

With the addition of a field test connection, the set pressure of Farris pilot operated relief valves can be verified without interrupting system protection and does not require overpressure of the system. An auxiliary source of pressure, such as a nitrogen bottle, is connected to the pilot sensing line through a stop valve. Increasing pressure is applied through the field test connection to the pilot control, simulating the increase in system pressure. A check valve restricts the source pressure from back flowing into the main valve inlet. When the applied pressure reaches set point, the pilot control reacts as if it were sensing overpressure via the main valve sensing line. When this occurs, the auxiliary pressure reading can be compared to the nameplate value to verify set pressure. For snap acting valves, both
the pilot and main valves will cycle at set pressure. For modulating valves, the modulating controls will crack slightly depending on current system pressure, the main valve may briefly cycle. To more accurately establish the modulating pilot relief valve's set pressure, a field test connection with indicator is recommended.

The field test connection with indicator provides positive verification that set pressure has been reached. The set pressure for the current modulating relief valves is defined as the point when dome pressure is reduced to 70% of set pressure. The field test indicator is activated when the applied pressure reaches the valve's set point and at this time, can be compared to nameplate value. Select Option #5 or F from page 5.

Reverse Flow Preventer

Reverse flow in a pilot relief valve can occur in systems where back pressure exceeds system pressure or where a vacuum can form at the inlet. In both cases a reverse differential pressure exists and it is possible for the main valve to open and allow flow from the discharge system to enter the inlet side.

A reverse flow preventer assures that the correct pressure differential is maintained and the main valve remains closed. A reverse flow preventer introduces outlet pressure into the dome of the main valve, keeping the piston firmly seated onto the nozzle, overcoming the effect of a reverse differential. This option also prevents reverse flow through the pilot control via the pilot sense line into the upstream side of the system. Select Option #6 from page 5.

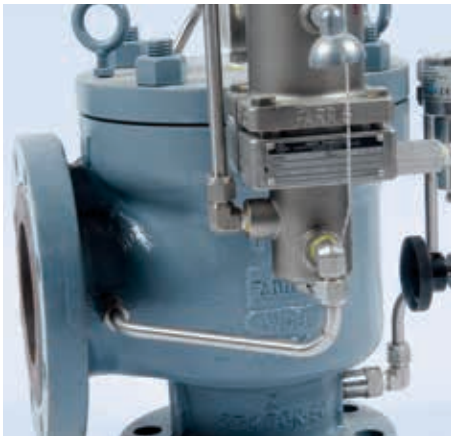
Remote Sensing (no photo)

One of the causes of excessive chatter in a PRV is significant pressure losses on the inlet side during a relief episode. Recommended practice is to limit the non-recoverable (friction) losses to less than 3% of set pressure. When this cannot be accomplished with piping design changes, a pilot operated relief valve equipped with a remote sense line can mitigate this issue. This arrangement allows connecting the pilot sensing line at a location close to the equipment being protected, yet not affected by the inlet pipe pressure drop, thereby avoiding chatter, damage and unstable relieving flow. Select Option R from page 5.

Optional Accessories, continued



Pressure Spike Snubbers



Discharge to Outlet



Valve Lift Indicator

Pressure Spike Snubbers

Rapid pressure spikes often occur in systems with positive displacement pumps or compressors. When these pressure spikes approach or exceed the set pressure of the valve, the pilot control may actuate and cause a valve to open prematurely. A pressure spike snubber installed in the pilot valve sensing line will eliminate the negative effects of pressure pulsation. It assures that the pilot valve is sensing and reacting to mean pressure and not to instantaneous pressure spikes. Select Option #7 from page 5.

Discharge to Outlet

In order for a pilot operated relief valve to open, the system pressure retained in the main valve dome needs to be released. This small volume of process fluid in the dome is typically released to the atmosphere via the pilot control discharge port. This is true whether it is a snap-acting or a modulating pilot control.

Normally, the end user can accept this small amount of product loss and fugitive emissions when the process fluid is gaseous. However, if the process fluid is a liquid, flammable, or possibly hazardous, then the release to atmosphere may need to be minimized and/or eliminated.

The conventional solution is to pipe the discharge of the pilot control to a safe location or atmospheric collection system. This is not always possible or practical. In these cases, piping the modulating pilot control discharge directly to the main valve outlet is the solution. The design of the modulating pilot control features a balanced relief chamber that neutralizes the effects of back pressure to set pressure similar to that of a bellows-style spring loaded valve. Therefore the discharge for a modulating pilot control can be piped directly to the main valve outlet and is recommended for liquid applications.

This option is only available with the modulating pilot control and must be specified at the time of order. Select Option V from page 5.

Valve Lift Indicator

A valve lift indicator allows the operator to know when the pilot operated relief valve has opened. This auxiliary option consists of a differential pressure switch as the indicator. The switch is mounted to the dome of the main valve. When the dome pressure is reduced sufficiently so that the main valve opens, the switch is actuated, allowing a signal to be sent to a remote location. In order to supply this option, please be prepared to supply information regarding the electrical source, switch contact style, and switch rating, enclosure and hazard rating. This option will be designated under SP – special construction.

Optional Accessory Availability Table

	Snap Acting Control All Services	Modulating Control	
		Air, Gas, Vapor and Liquid	Steam
Dual Pilots [2]	●	●	●
Auxillary Filter [3]	●	●	●
Manual Depressurizing [4]	●	●	●
Remote Depressurizing[2] [8]	●	●	●
Field Test Connection[3] [5]	●	●	●
Field Test Connection w/Indicator [F]		●	●
Reverse Flow Preventor [6]	●	●	●
Pressure Spike Snubber [7]	●	●	
Remote Sensing [R]	●	●	●
Valve Lift Indicator[4]	●	●	●
Discharge to Outlet[5] [V]		●	●

General Notes:
1. Materials of construction for the accessories will remain consistent with the main valve and pilot control constructions. Please consult factory for details.
2. Customer will need to provide supplemental information to specify this option.
3. Field test connection with indicator is the recommended option for modulating pilot control applications.
4. Complete details regarding electrical source, switch contact style, switch rating, enclosure and hazard rating must be provided by customer.
5. This option is recommended for modulating controls when process fluid is a liquid, flammable, or possibly hazardous.

Sizing Information

The following equations are presented in U.S. customary units. For metric equivalents please consult our sizing software, SizeMaster at **www.avrasoft.com/sizemaster.**

General Equations

Before beginning any calculations, it is necessary to establish the general category of the pressure relief valve to be used. This section covers pilot operated relief valves.

Given the rate of fluid flow to be relieved, the usual procedure is to first calculate the minimum area required in the valve orifice for the conditions contained in one of the following equations. In the case of steam, air or water, the selection of an orifice may be made directly from the capacity tables.

The second step is to select the specific type of valve that meets the pressure and temperature requirements.

General equations are given first, to identify the basic terms that correlate with ASME Pressure Vessel Code, Section VIII.

Since these equations are conservative, it is recommended that computations of relieving loads avoid cascading of safety factors or multiple contingencies beyond the reasonable flow needed to protect the pressure vessel.

Orifice Area Calculations	Constant Back Pressure
VAPORS or GASES – Lbs./hr.: $A = \frac{W\sqrt{T}\sqrt{Z}}{C K_d P \sqrt{M} K_b}$	K_b = 1 when back pressure is below 55% of abs. relieving pressure.
VAPORS or GASES – S.C.F.M.: $A = \frac{V\sqrt{G}\sqrt{T}\sqrt{Z}}{1.175\, C K_d P K_b}$	K_b = 1 when back pressure is below 55% of abs. relieving pressure.
STEAM – Lbs./hr.: $A = \frac{W_s}{51.5 K_d P K_b K_{sh} K_n}$	K_b = 1 when back pressure is below 55% of abs. relieving pressure. K_{sh} = 1 for Sat. Steam
AIR – S.C.F.M.: $A = \frac{V_a\sqrt{T}}{418 K_d P K_b}$	K_b = 1 when back pressure is below 55% of abs. relieving pressure.
LIQUIDS – 3800L Series, G.P.M., ASME Code: $A = \frac{V_L\sqrt{G}}{38.0 K_d\sqrt{\Delta P} K_u}$	K_u = 1 at normal viscosities

Nomenclature

A = Required orifice area in square inches. This value may be compared with the API effective areas included in this catalog and defined in ANSI/API Standard 526 or the ASME actual area.

W = Required vapor capacity in pounds per hour.

W_s = Required steam capacity in pounds per hour.

V = Required gas capacity in SCFM.

V_L = Required liquid capacity in U.S. gallons per minute.

G = Specific gravity of gas (air = 1) or specific gravity of liquid (water = 1) at actual discharge temperature.

M = Average molecular weight of vapor.

P = Relieving pressure in psia = set pressure + over pressure + 14.7 Minimum overpressure is 10% or 3 psi, whichever is greater.

P_1 = Set pressure at inlet, psig.

P_2 = Back pressure at outlet, psig.

ΔP = Set pressure + overpressure, psig – back pressure, psig. At 10% overpressure $\Delta P = 1.1P_1 - P_2$. Below 30 psig set, $\Delta P = P_1 + 3 - P_2$.

T = Inlet temperature absolute (°F+460).

Z = Compressibility factor corresponding to T and P (if this factor is not available, compressibility correction can be safely ignored by using a value of Z = 1.0).

C = Gas or vapor flow constant.

k = Ratio of specific heats, C_p/C_v. This value is constant for an ideal gas. If this ratio is unknown, the value k = 1.001, C = 315 will result in a safe valve size. Isentropic coefficient n maybe used instead of k.

K_b = Vapor or gas flow correction factor for back pressures above critical pressure. See curve.

K_u = Liquid viscosity correction factor.

K_{sh} = Steam superheat correction factor. $K_{sh} = 1$ for saturated steam.

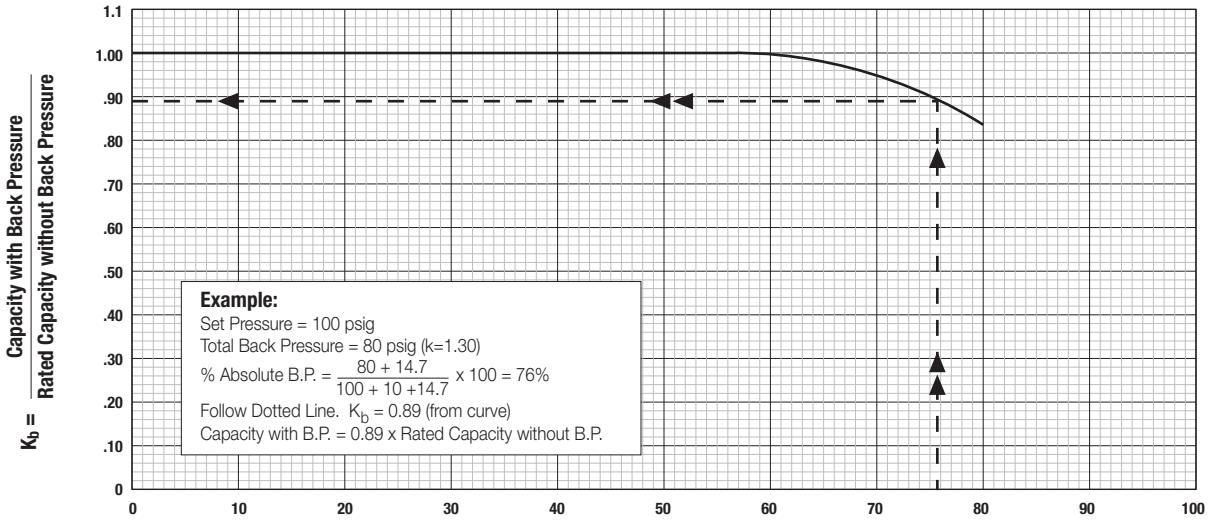
K_n = Napier steam correction factor for set pressures between 1500 and 2900 psig.

K_d = Coefficient of Discharge, where:

Service Fluid	K_d when sizing using	
	API Effective Areas	ASME Actual Areas
Air, Steam, Vapor & Gas (API nozzles)	0.954	0.859
Liquid (API nozzles)	0.869	0.782
Air, Steam, Vapor & Gas (Full Port nozzles)	n/a	0.801

Sizing Factors for Vapors and Gases

Back Pressure Sizing Factor K_b

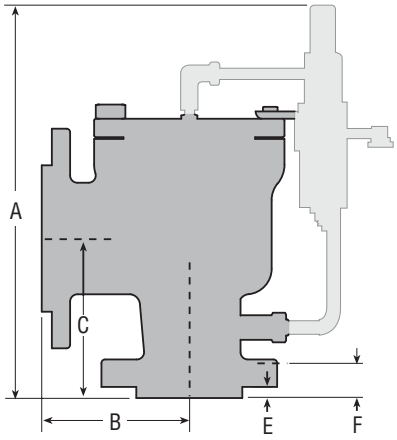


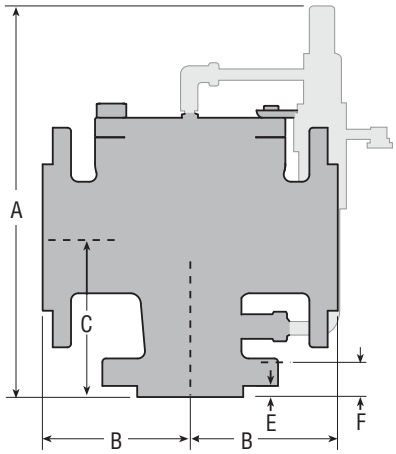
$$\% \text{ Absolute Back Pressure} = \frac{\text{Back Pressure, psia}}{\text{Set Pressure + Over Pressure, psia}} \text{ X } 100$$

Superheat Steam Correction Factor

Set Pressure psig	Saturated Steam Temp. °F	Total Temperature in Degrees Fahrenheit												
		280	300	320	340	360	380	400	420	440	460	480	500	520
15	250	1.00	1.00	1.00	.99	.99	.98	.98	.97	.96	.95	.94	.93	.92
20	259	1.00	1.00	1.00	.99	.99	.98	.98	.97	.96	.95	.94	.93	.92
40	287		1.00	1.00	1.00	.99	.99	.98	.97	.96	.95	.94	.93	.92
60	308			1.00	1.00	.99	.99	.98	.97	.96	.95	.94	.93	.92
80	324				1.00	1.00	.99	.99	.98	.97	.96	.94	.93	.92
100	338					1.00	1.00	.99	.98	.97	.96	.95	.94	.93
120	350					1.00	1.00	.99	.98	.97	.96	.95	.94	.93
140	361						1.00	1.00	.99	.98	.96	.95	.94	.93
160	371						1.00	1.00	.99	.98	.97	.95	.94	.93
180	380							1.00	.99	.98	.97	.96	.95	.93
200	388							1.00	.99	.99	.97	.96	.95	.93
220	395							1.00	1.00	.99	.98	.96	.95	.94
240	403								1.00	.99	.98	.97	.95	.94
260	409								1.00	.99	.98	.97	.96	.94
280	416								1.00	1.00	.99	.97	.96	.95
300	422									1.00	.99	.98	.96	.95
350	436									1.00	1.00	.99	.97	.96
400	448										1.00	.99	.98	.96
450	460											1.00	.99	.97
500	470											1.00	.99	.98
550	480												1.00	.99
600	489												1.00	.99
650	497													1.00
700	506													1.00

Dimensions & Weights: API Nozzle Design





API Nozzle Design

Valve Size Inlet x Outlet	Type Number	ANSI Flange Class		Dimensions, Inches					Approx. Wt. Lbs.	Dimensions, mm					Approx. Wt. Kg.
		Inlet RF	Outlet RF	A[3]	B	C	E	F[4]		A[3]	B	C	E	F[4]	
1 x 2	38 (D, E, F) C10	150#	150#	12-5/8	4-1/2	4-1/8	1/16	11/16	35	321	115	105	2	18	16
	38 (D, E ,F) C12	300#		12-7/8	4-1/2	4-3/8	1/4	15/16	36	328	115	112	7	24	17
	38 (D, E, F) C13	600#		12-7/8	4-1/2	4-3/8	1/4	15/16	36	328	115	112	7	24	17
	38 (D, E, F) C14	900#	300#	13 3/8	4-3/4	4-15/16	1/4	1-7/16	49	340	121	126	7	37	23
	38 (D, E, F) C15	1500#		13 3/8	4-3/4	4-15/16	1/4	1-7/16	49	340	121	126	7	37	23
	38 (D, E, F) C16	2500#		13-1/2	4-3/4	4-15/16	1/4	1-11/16	55	343	121	126	7	43	25
1 x 2[5]	38GC10U	150#	150#	12-5/8	4-1/2	4-1/8	1/16	11/16	35	321	115	105	2	18	16
	38GC12U	300#		12-7/8	4-1/2	4-3/8	1/4	15/16	36	328	115	112	7	24	17
	38GC13U	600#		12-7/8	4-1/2	4-3/8	1/4	15/16	36	328	115	112	7	24	17
	38GC14U	900#	300#	13-3/8	4-3/4	4-15/16	1/4	1-7/16	49	340	121	126	7	37	23
	38GC15U	1500#		13-3/8	4-3/4	4-15/16	1/4	1-7/16	49	340	121	126	7	37	23
	38GC16U	2500#		13-1/2	4-3/4	4-15/16	1/4	1-11/16	55	343	121	126	7	43	25
1-1/2 x 2	38 (D, E, F) C10X	150#	150#	14	4-3/4	4-7/8	1/16	1-1/8	48	356	121	124	2	29	22
	38 (D, E, F) C12X	300#		14	4-3/4	4-7/8	1/4	1-1/8	50	356	121	124	7	29	23
	38 (D, E, F) C13X	600#		14	4-3/4	4-7/8	1/4	1-1/8	50	356	121	124	7	29	23
	38 (D, E, F) C14X	900#	300#	15	5-1/2	5 7/8	1/4	1-9/16	71	381	140	150	7	40	33
	38 (D, E, F) C15X	1500#		15	5-1/2	5 7/8	1/4	1-9/16	71	381	140	150	7	40	33
	38 (D, E, F) C16X	2500#		15-1/8	5-1/2	5 7/8	1/4	2-1/8	85	385	140	150	7	54	39
1-1/2 x 2	38 (G, H) C10N	150#	150#	14	4-3/4	4-7/8	1/16	1-1/8	48	356	121	124	2	29	22
	38 (G, H) C12N	300#		14	4-3/4	4-7/8	1/4	1-1/8	50	356	121	124	7	29	23
	38 (G, H) C13N	600#		14	4-3/4	4-7/8	1/4	1-1/8	50	356	121	124	7	29	23
	38 (G, H) C14N	900#	300#	15	5-1/2	5 7/8	1/4	1-9/16	71	381	140	150	7	40	33
	38 (G, H) C15N	1500#		15	5-1/2	5 7/8	1/4	1-9/16	71	381	140	150	7	40	33
	38 (G, H) C16N	2500#		15-1/8	5-1/2	5 7/8	1/4	2-1/8	85	385	140	150	7	54	39
1-1/2 x 2	38JC10U	150#	150#	14	4-3/4	4-7/8	1/16	1-1/8	48	356	121	124	2	29	22
	38JC12U	300#		14	4-3/4	4-7/8	1/4	1-1/8	50	356	121	124	7	29	23
	38JC13U	600#		14	4-3/4	4-7/8	1/4	1-1/8	50	356	121	124	7	29	23
	38JC14U	900#	300#	15	5-1/2	5 7/8	1/4	1-9/16	71	381	140	150	7	40	33
	38JC15U	1500#		15	5-1/2	5 7/8	1/4	1-9/16	71	381	140	150	7	40	33
	38JC16U	2500#		15-1/8	5-1/2	5 7/8	1/4	2-1/8	85	385	140	150	7	54	39
1-1/2 x 3	38 (G, H) C10	150#	150#	14	4-7/8	5-1/8	1/16	1 3/16	50	356	124	131	2	31	23
	38 (G, H) C12	300#		14	4-7/8	5-1/8	1/4	1 3/16	52	356	124	131	7	31	24
	38 (G, H) C13	600#		14	4-7/8	5-1/8	1/4	1 3/16	52	356	124	131	7	31	24
	38 (G, H) C14	900#	300#	15-1/4	6-3/4	6-3/8	1/4	1-9/16	75	388	172	162	7	40	35
	38 (G, H) C15	1500#		15-1/4	6-3/4	6-3/8	1/4	1-9/16	75	388	172	162	7	40	35
	38 (G, H) C16	2500#		15-3/8	6-3/4	6-3/8	1/4	2-1/8	96	391	172	162	7	54	44
1-1/2 x 3	38JC10N	150#	150#	14	4-7/8	5-1/8	1/16	1-3/16	50	356	124	131	2	31	23
	38JC12N	300#		14	4-7/8	5-1/8	1/4	1-3/16	52	356	124	131	7	31	24
	38JC13N	600#		14	4-7/8	5-1/8	1/4	1-3/16	52	356	124	131	7	31	24
	38JC14N	900#	300#	15-1/4	6-3/4	6-3/8	1/4	1-9/16	75	388	172	162	7	40	35
	38JC15N	1500#		15-1/4	6-3/4	6-3/8	1/4	1-9/16	75	388	172	162	7	40	35
	38JC16N	2500#		15-3/8	6-3/4	6-3/8	1/4	2-1/8	96	391	172	162	7	54	44

Dimensions & Weights: API Nozzle Design continued

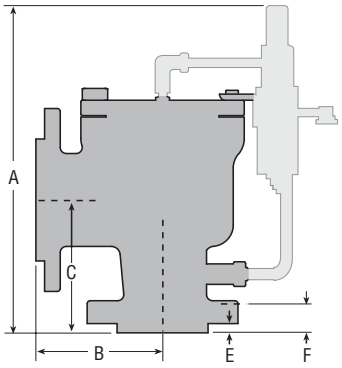
API Nozzle Design

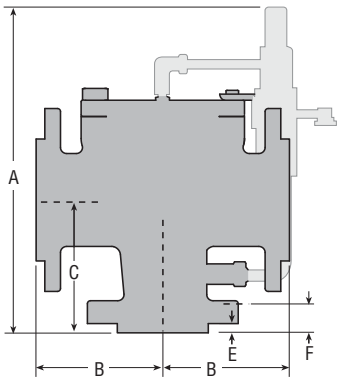
Valve Size Inlet x Outlet	Type Number	ANSI Flange Class		Dimensions, Inches					Approx. Wt. Lbs.	Dimensions, mm					Approx. Wt. Kg.
		Inlet RF	Outlet RF	A[3]	B	C	E	F[4]		A[3]	B	C	E	F[4]	
2 x 3	38 (G, H) C10X	150#	150#	15	4-7/8	5-3/8	1/16	1-1/4	65	381	124	137	2	32	30
	38 (G, H) C12X	300#		15	4-7/8	5-3/8	1/4	1-1/4	65	381	124	137	7	32	30
	38 (G, H) C13X	600#		15	4-7/8	5-3/8	1/4	1-1/4	65	381	124	137	7	32	30
	38 (G, H) C14X	900#	300#	16-1/8	6-3/4	6-9/16	1/4	1-7/8	102	410	172	167	7	48	47
	38 (G, H) C15X	1500#		16-1/8	6-3/4	6-9/16	1/4	1-7/8	102	410	172	167	7	48	47
	38 (G, H) C16X	2500#		16-3/4	6-3/4	7	1/4	2-3/8	130	426	172	178	7	61	59
2 x 3	38JC10	150#	150#	15	4-7/8	5-3/8	1/16	1-1/4	65	381	124	137	2	32	30
	38JC12	300#		15	4-7/8	5-3/8	1/4	1-1/4	65	381	124	137	7	32	30
	38JC13	600#		15	4-7/8	5-3/8	1/4	1-1/4	65	381	124	137	7	32	30
	38JC14	900#	300#	16-1/8	6-3/4	6-9/16	1/4	1-7/8	102	410	172	167	7	48	47
	38JC15	1500#		16-1/8	6-3/4	6-9/16	1/4	1-7/8	102	410	172	167	7	48	47
	38JC16	2500#		16-3/4	6-3/4	7	1/4	2-3/8	130	426	172	178	7	61	59
2 x 3	38KC10N	150#	150#	15	4-7/8	5-3/8	1/16	1-1/4	65	381	124	137	2	32	30
	38KC12N	300#		15	4-7/8	5-3/8	1/4	1-1/4	65	381	124	137	7	32	30
	38KC13N	600#		15	4-7/8	5-3/8	1/4	1-1/4	65	381	124	137	7	32	30
	38KC14N	900#	300#	16-1/8	6-3/4	6-9/16	1/4	1-7/8	102	410	172	167	7	48	47
	38KC15N	1500#		16-1/8	6-3/4	6-9/16	1/4	1-7/8	102	410	172	167	7	48	47
	38KC16N	2500#		16-3/4	6-3/4	7	1/4	2-3/8	130	426	172	178	7	61	59
3 x 4	38JC10X	150#	150#	17-5/8	6-3/8	6-1/8	1/16	1-1/4	135	448	162	156	2	32	62
	38JC12X	300#		17-5/8	6-3/8	6-1/8	1/16	1-1/4	140	448	162	156	2	32	64
	38JC13X	600#		17-7/8	6-3/8	6-3/8	1/4	1-1/2	140	455	162	162	7	39	64
	38JC14X	900#	300#	19-1/8	7-1/8	7-1/2	1/4	2-1/4	195	486	181	191	7	58	89
	38JC15X	1500#		19-1/8	7-1/8	7-1/2	1/4	2-1/4	204	486	181	191	7	58	93
3 x 4	38 (K, L) C10	150#	150#	17-5/8	6-3/8	6-1/8	1/16	1-1/4	135	448	162	156	2	32	62
	38 (K, L) C12	300#		17-5/8	6-3/8	6-1/8	1/16	1-1/4	140	448	162	156	2	32	64
	38 (K, L) C13	600#		17-7/8	6-3/8	6-3/8	1/4	1-1/2	140	455	162	162	7	39	64
	38 (K, L) C14	900#	300#	19-1/8	7-1/8	7-1/2	1/4	2-1/4	195	486	181	191	7	58	89
	38 (K, L) C15	1500#		19-1/8	7-1/8	7-1/2	1/4	2-1/4	204	486	181	191	7	58	93
3 x 4	38 (M, N) C10N	150#	150#	17-5/8	6-3/8	6-1/8	1/16	1-1/4	135	448	162	156	2	32	62
	38 (M, N) C12N	300#		17-5/8	6-3/8	6-1/8	1/16	1-1/4	140	448	162	156	2	32	64
	38 (M, N) C13N	600#		17-7/8	6-3/8	6-3/8	1/4	1-1/2	140	455	162	162	7	39	64
	38 (M, N) C14N	900#	300#	19-1/8	7-1/8	7-1/2	1/4	2-1/4	195	486	181	191	7	58	89
	38 (M, N) C15N	1500#		19-1/8	7-1/8	7-1/2	1/4	2-1/4	204	486	181	191	7	58	93
4 x 6	38LC10X	150#	150#	20-1/4	8-1/4	7-3/4	1/16	1-3/4	212	515	210	197	2	45	97
	38LC12X	300#		20-1/4	8-1/4	7-3/4	1/16	1-3/4	218	515	210	197	2	45	99
	38LC13X	600#		20-1/4	8-1/4	7-3/4	1/4	1-3/4	220	515	210	197	7	45	100
	38LC14X	900#	300#	22	9-3/16	9-13/16	1/4	2-1/2	320	559	234	250	7	64	146
	38LC15X	1500#		22	9-3/16	9-13/16	1/4	2-1/2	325	559	234	250	7	64	148
4 x 6	38 (M, N, P) C10	150#	150#	20-1/4	8-1/4	7-3/4	1/16	1-3/4	212	515	210	197	2	45	97
	38 (M, N, P) C12	300#		20-1/4	8-1/4	7-3/4	1/16	1-3/4	218	515	210	197	2	45	99
	38 (M, N, P) C13	600#		20-1/4	8-1/4	7-3/4	1/4	1-3/4	220	515	210	197	7	45	100
	38 (M, N, P) C14	900#	300#	22	9-3/16	9-13/16	1/4	2-1/2	320	559	234	250	7	64	146
	38 (M, N, P) C15	1500#		22	9-3/16	9-13/16	1/4	2-1/2	325	559	234	250	7	64	148
6 x 8	38 (Q, R) C10	150#	150#	24-5/8	9-1/2	9-7/16	1/16	1-7/8	465	626	242	240	2	48	211
	38 (Q, R) C12	300#		24-5/8	9-1/2	9-7/16	1/16	1-7/8	480	626	242	240	2	48	218
	38 (Q, R) C13	600#		24-7/8	9-1/2	9-11/16	1/4	2-1/8	500	632	242	247	7	54	227
6 x 8 x 8	38 (Q, R) C10D	150#	150#	24-5/8	9-1/2	9-7/16	1/16	1-7/8	504	626	242	240	2	48	229
	38 (Q, R) C12D	300#		24-5/8	9-1/2	9-7/16	1/16	1-7/8	519	626	242	240	2	48	236
	38 (Q, R) C13D	600#		24-7/8	9-1/2	9-11/16	1/4	2-1/8	539	632	242	247	7	54	245
8 x 10	38TC10	150#	150#	29	11	10-7/8	1/16	1-5/8	830	737	280	277	2	42	377
	38TC12	300#		29	11	10-7/8	1/16	1-5/8	835	737	280	277	2	42	379
	38TC13	600#		29-7/8	11	11-11/16	1/4	2-7/16	925	759	280	297	7	62	420
8 x 10 x 10	38TC10D	150#	150#	29	11	10-7/8	1/16	1-5/8	885	737	280	277	2	42	402
	38TC12D	300#		29	11	10-7/8	1/16	1-5/8	890	737	280	277	2	42	404
	38TC13D	600#		29-7/8	11	11-11/16	1/4	2-7/16	980	759	280	297	7	62	445

General Notes:

1. For liquid service valves with standard size connections (L in the type number), use the standard type number dimensions, i.e. 38HC10-120. For liquid service valves with oversize connections (Y in the type number), use the oversize type number dimensions, i.e. 38DC10X-120.
2. Valves with ring joint inlet connections available. Consult the Factory for final dimensions.
3. For modulating valves, add 2-1/2" (64 mm) to the A dimension.
4. F dimension meets or exceeds ANSI thickness requirement.
5. A 1" x 2" valve with a "G" orifice is only available with a remote sensing option.

Dimensions & Weights: Full Port Design





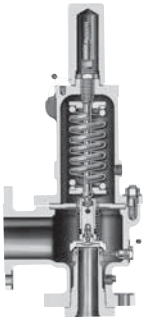
Full Port Design

Valve Size Inlet x Outlet	Type Number	ANSI Flange Class		Dimensions, Inches					Approx. Wt. Lbs.	Dimensions, mm					Approx. Wt. Kg.
		Inlet RF	Outlet RF	A[3]	B	C	E	F[4]		A[3]	B	C	E	F[4]	
1 x 2[1]	38AC10-12R	150#	150#	12-5/8	4-1/2	4-1/8	1/16	11/16	35	321	115	105	2	18	16
	38AC12-12R	300#		12-7/8	4-1/2	4-3/8	1/4	15/16	36	328	115	112	7	24	17
	38AC13-12R	600#		12-7/8	4-1/2	4-3/8	1/4	15/16	36	328	115	112	7	24	17
	38AC14-12R	900#	300#	13-3/8	4-3/4	4-15/16	1/4	1-7/16	49	340	121	126	7	37	23
	38AC15-12R	1500#		13-3/8	4-3/4	4-15/16	1/4	1-7/16	49	340	121	126	7	37	23
	38AC16-12R	2500#		13-1/2	4-3/4	4-15/16	1/4	1-11/16	55	343	121	126	7	43	25
1-1/2 x 2	381C10-120	150#	150#	14	4-3/4	4-7/8	1/16	1-1/8	48	356	121	124	2	29	22
	381C12-120	300#		14	4-3/4	4-7/8	1/4	1-1/8	50	356	121	124	7	29	23
	381C13-120	600#		14	4-3/4	4-7/8	1/4	1-1/8	50	356	121	124	7	29	23
	381C14-120	900#	300#	15	5-1/2	5-7/8	1/4	1-9/16	71	381	140	150	7	40	33
	381C15-120	1500#		15	5-1/2	5-7/8	1/4	1-9/16	71	381	140	150	7	40	33
	381C16-120	2500#		15-1/8	5-1/2	5-7/8	1/4	2-1/8	85	385	140	150	7	54	39
1-1/2 x 3	381C10X-120	150#	150#	14	4-7/8	5-1/8	1/16	1-3/16	50	356	124	131	2	31	23
	381C12X-120	300#		14	4-7/8	5-1/8	1/4	1-3/16	52	356	124	131	7	31	24
	381C13X-120	600#		14	4-7/8	5-1/8	1/4	1-3/16	52	356	124	131	7	31	24
	381C14X-120	900#	300#	15-1/4	6-3/4	6-3/8	1/4	1-9/16	75	388	172	162	7	40	35
	381C15X-120	1500#		15-1/4	6-3/4	6-3/8	1/4	1-9/16	75	388	172	162	7	40	35
	381C16X-120	2500#		15-3/8	6-3/4	6-3/8	1/4	2-1/8	96	391	172	162	7	54	44
2 x 3	382C10-120	150#	150#	15	4-7/8	5-3/8	1/16	1-1/4	65	381	124	137	2	32	30
	382C12-120	300#		15	4-7/8	5-3/8	1/4	1-1/4	65	381	124	137	7	32	30
	382C13-120	600#		15	4-7/8	5-3/8	1/4	1-1/4	65	381	124	137	7	32	30
	382C14-120	900#	300#	16-1/8	6-3/4	6-9/16	1/4	1 7/8	102	410	172	167	7	48	47
	382C15-120	1500#		16-1/8	6-3/4	6-9/16	1/4	1 7/8	102	410	172	167	7	48	47
	382C16-120	2500#		16-3/4	6-3/4	7	1/4	2 3/8	130	426	172	178	7	61	59
3 x 4	383C10-120	150#	150#	17-5/8	6-3/8	6-1/8	1/16	1-1/4	135	448	162	156	2	32	62
	383C12-120	300#		17-5/8	6-3/8	6-1/8	1/16	1-1/4	140	448	162	156	2	32	64
	383C13-120	600#		17-7/8	6-3/8	6-3/8	1/4	1-1/2	140	455	162	162	7	39	64
	383C14-120	900#	300#	19-1/8	7-1/8	7-1/2	1/4	2-1/4	195	486	181	191	7	58	89
	383C15-120	1500#		19-1/8	7-1/8	7-1/2	1/4	2-1/4	204	486	181	191	7	58	93
4 x 6	384C10-120	150#	150#	20-1/4	8-1/4	7-3/4	1/16	1-3/4	212	515	210	197	2	45	97
	384C12-120	300#		20-1/4	8-1/4	7-3/4	1/16	1-3/4	218	515	210	197	2	45	99
	384C13-120	600#		20-1/4	8-1/4	7-3/4	1/4	1-3/4	220	515	210	197	7	45	100
	384C14X-120	900#	300#	22	9-3/16	9-13/16	1/4	2-1/2	320	559	234	250	7	64	146
	384C15X-120	1500#		22	9-3/16	9-13/16	1/4	2-1/2	325	559	234	250	7	64	148
6 x 8	386C10-120	150#	150#	24-5/8	9-1/2	9-7/16	1/16	1-7/8	465	626	242	240	2	48	211
	386C12-120	300#		24-5/8	9-1/2	9-7/16	1/16	1-7/8	480	626	242	240	2	48	218
	386C13-120	600#		24-7/8	9-1/2	9-11/16	1/4	2-1/8	500	632	242	247	7	54	227
6 x 8 x 8	386C10D-120	150#	150#	24-5/8	9-1/2	9-7/16	1/16	1-7/8	504	626	242	240	2	48	229
	386C12D-120	300#		24-5/8	9-1/2	9-7/16	1/16	1-7/8	519	626	242	240	2	48	236
	386C13D-120	600#		24 7/8	9-1/2	9-11/16	1/4	2-1/8	539	632	242	247	7	54	245
8 x 10	388C10-120	150#	150#	29	11	10-7/8	1/16	1-5/8	830	737	280	277	2	42	377
	388C12-120	300#		29	11	10-7/8	1/16	1-5/8	835	737	280	277	2	42	379
	388C13-120	600#		29-7/8	11	11-11/16	1/4	2-7/16	925	759	280	297	7	62	420
8 x 10 x 10	388C10D-120	150#	150#	29	11	10-7/8	1/16	1 5/8	885	737	280	277	2	42	402
	388C12D-120	300#		29	11	10-7/8	1/16	1 5/8	890	737	280	277	2	42	404
	388C13D-120	600#		29-7/8	11	11-11/16	1/4	2 7/16	980	759	280	297	7	62	445

General Notes:
1. A 1" x 2" valve with an "A" orifice is only available when configured with a remote sensing option.
2. Valves with ring joint inlet connections available. Consult the Factory for final dimensions.
3. For modulating valves, add 2-1/2" (64 mm) to the A dimension.
4. F dimension meets or exceeds ANSI thickness requirement.
5. Full port orifices require that inlet piping have a flow area equal to or greater than the Full port orifice flow area.

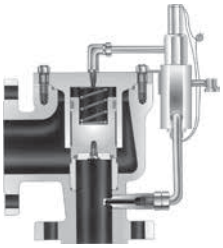
Farris Engineering Products

Process Pressure Relief Valves



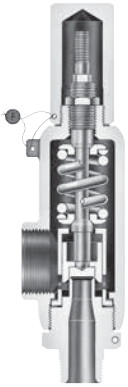
SERIES 2600/2600L

- ASME NB Certified: Air, Steam & Water
- Sizes: 1" x 2" to 20" x 24"
- Pressure Range: 15 psig to 6000 psig
- Temperature Range: -450°F to +1500°F
- Materials*: Carbon Steel, Stainless Steel, Monel & Hastelloy C
- Options: Balanced Bellows, O-Ring Seat, Open Bonnet
- CE Approved



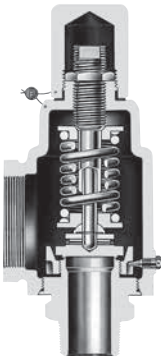
SERIES 3800 Pilot Operated

- ASME NB Certified: Air, Steam & Water
- Sizes: 1" x 2" to 12" x 16"
- Pressure Range: 15 psig to 6170 psig
- Temperature Range: -450°F to +500°F
- Materials*: Carbon Steel, Stainless Steel, Monel & Hastelloy C
- Actuation: Snap and Modulating Controls
- Options: Field Test Connections, Reverse Flow Preventer, Remote Depressurizing & Auxiliary Filters
- CE Approved



SERIES 2700

- ASME NB Certified: Air, Steam & Water
- Sizes: ½" x 1" to 1½" x 2½"
- Pressure Range: 15 psig to 6500 psig
- Temperature Range: -450°F to +750°F
- Materials*: Carbon Steel, Stainless Steel, Monel & Hastelloy C
- Options: Balanced Design, O-Ring Seats, Flanged, Socket Weld, Welding Nipple, & Sanitary Connections
- CE Approved

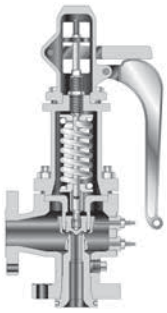


SERIES 2850/2856

- ASME NB Certified: Air & Steam
- Sizes: ¾" x 1" to 1½" x 2" (2850) ¾" x 1¼" to 2" x 3" (2856)
- Pressure Range: 15 psig to 300 psig
- Temperature Range: -20° F to +750°F (2850) -450° F to +400°F (2856)
- Materials: Stainless Steel Body & Trim Steel Bonnet (2850) Brass Body & Trim, Bronze Bonnet (2856)

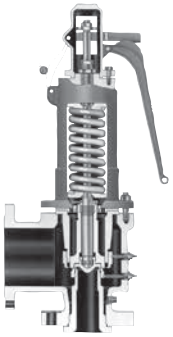
*Other materials available upon request. Please consult the factory.

Steam Safety Valves



SERIES 4200

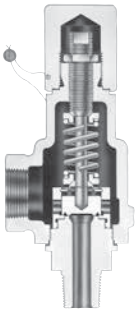
- ASME NB Section I & VIII Certified: Steam & Air
- Sizes 1¼" x 1½" to 6" x 8"
- Pressure Range: 15 psig to 1000 psig
- Temperature Range: -20°F to +1000°F
- Materials: Carbon Steel, Stainless Steel, Chrome-Moly
- Options: Test Gag
- CE Approved



SERIES 6400/6600

- ASME NB Section I & VIII Certified: Steam & Air
- Sizes: 1" x 2" to 4" x 6"
- Pressure Range: 15 psig to 1500 psig
- Temperature Range: -20°F to +1000°F
- Materials: Carbon Steel, Stainless Steel, Chrome-Moly
- Options: Closed Bonnet (6600) & Test Gag

Special Purpose Pressure Relief Valves



SERIES 1890/1896M

- ASME NB Certified: Air, Steam & Water
- Sizes: ½" x 1" & ¾" x 1" (1890) ½" x ¾" & ¾" x ¾" (1896M)
- Pressure Range: 15 psig to 800 psig (1890) 15 psig to 300 psig (1896M)
- Temperature Range: -20°F to +750°F (1890) -450°F to +400°F (1896M)
- Materials: Stainless Steel Body & Trim (1890) Brass Body & Trim, Bronze Bonnet (1896M)

Farris Engineering Products and Services



The following is a list of Farris approvals currently on record:

- ASME “V”, “UV” and “NV”
- National Board “NB” approval
- ISO 9001-2008
- US Coast Guard
- PED 97/23/EC (European Pressure Equipment Directive)
- ATEX 94/9/EC (European Potentially Explosive Atmospheres)
- B51 CRN
- China Safety Quality License
- Russian GOST-R and RTN (Russian Certification and Permits)
- First Point Assesment Limited
- Nuclear – 10 CFR 50 Appendix B, NCA-4000, NQA-1, N285.0

Process Pressure Relief Valves

Series 2600	ASME NB Certified for Air, Steam and Water
Series 3800	ASME NB Certified for Air, Steam and Water
Series 2700	ASME NB Certified for Air, Steam and Water
Series 1890/1896M	ASME NB Certified for Air, Steam and Water
Series 2850/2856	ASME NB Certified for Air and Steam
Series 88/89	ASME NB Certified for Air and Steam
Series 570	ASME NB Certified for Air and Steam
Series 69	Liquid Service
Series 140	Air Service

Steam Safety Valves

Series 4200	ASME NB Certified for Steam – Section I & VIII
Series 6400/6600	ASME NB Certified for Steam – Section I & VIII
Series 560	ASME NB Certified for Steam – Section I & VIII

Nuclear Pressure Relief Valves

Series 4700/4700L	ASME NB Section III, Division 1 Class I, II & III
Series 2700/3700	ASME NB Section III, Division 1 Class I, II & III
Series 2600/2600L	ASME NB Section III, Division 1 Class I, II & III
Series 3800	ASME NB Section III, Division 1 Class I, II & III

SizeMaster™ Mark IV

Pressure Relief Valve Engineering Software for Sizing and Selection

FAST Centers (Farris Authorized Service Team)

- Worldwide Network of Service Centers with Factory Trained Technicians
- Local Inventory with 24 hour a day / 7 day a week support
- Access to Worldwide Farris Inventory through the Web
- ASME/National Board approved Assembly & Test Facilities
- Application, Sizing & Selection Support

CURTISS WRIGHT
Flow Control Company
Farris Engineering

ASME UV

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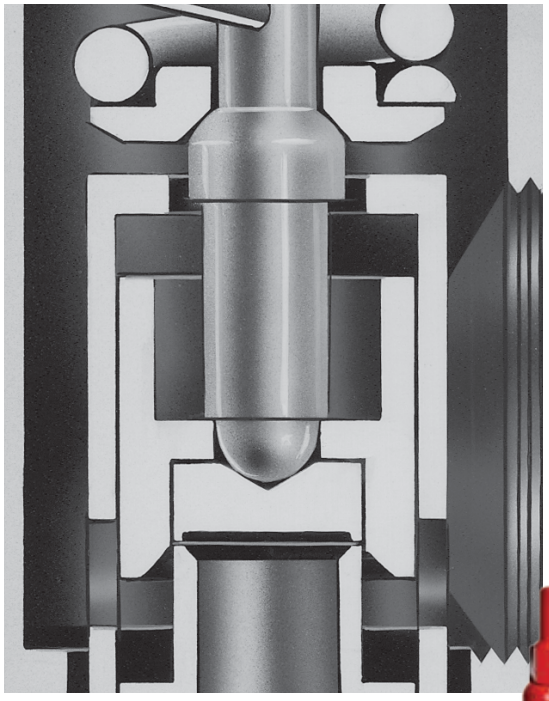
Facilities: Brecksville, Ohio, USA; Brantford, Ontario; Edmonton, Alberta, Canada; Corby, Northants, UK; Delhi, India; Tianjin, China

Offices Worldwide: For a listing of our global sales network, visit our website at http://farris.cwfc.com.

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General Installation and Maintenance Instructions







CURTISS WRIGHT
Flow Control Company
Farris Engineering

Table of Contents

These maintenance and installation instructions are applicable to Farris Series 2600, 2700, 2850, 2856, 1890, 1896M, 3800, 4200 and 6400 pressure relief valves.

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Farris Product Line Scope

Series	ASME Certification			Pressure Equipment Directive	
	Section	Test Fluids	Code Symbol	Compliance	Directive Mark
2600	Section VIII	Air, Steam & Water	UV	yes	CE
2600L	Section VIII	Water & Air	UV	yes	CE
2700	Section VIII	Air, Steam & Water	UV	yes	CE
3800	Section VIII	Air, Steam & Water	UV	yes	CE
4200	Sections I & VIII	Air & Steam	V UV	yes	CE
6400	Sections I & VIII	Air & Steam	V UV	no	Not Available
1890	Section VIII	Air, Steam, & Water	UV	no	
1896M	Section VIII	Air, Steam, & Water	UV	no	
2850*	Section VIII	Air & Steam	UV	no	
2856*	Section VIII	Air & Steam	UV	no	

*Available for non-ASME code liquid applications.

General Notes
1. All valves are stamped with the appropriate ASME Code “V” or “UV” stamp as noted above.
2. In addition to the appropriate ASME Code stamp, valves shipped into the European market are marked with the “CE” symbol indicating compliance with the Pressure Equipment Directive.
3. Valves may also be supplied to ASME Code Section III, “NV” stamp.

Safety Warning & Instruction System

You will find safety warnings and instruction labels in this manual. These have been included to ensure your safety and must be followed. Safety labels are vertically oriented rectangles as shown in the samples below. These labels consist of three panels inside a border. Each safety label will communicate the following three key pieces of information. This information is communicated using narrative and pictorials.

- The nature and severity of the hazard
- The consequence of the hazard, if not avoided
- The precautions and measures required to avoid the hazard.

The top panel of the safety label illustrates the signal word (DANGER, WARNING, or CAUTION) which communicates the severity of the hazard, per the explanations to the right. The center panel contains a pictorial which communicates the nature of the hazard, and the possible consequence of hazard if not avoided. In some cases, the pictorial may depict the precautions or measures required to avoid the hazard. The bottom panel will then contain the remaining narrative information needed to ensure all three key pieces of information have been conveyed.



DANGER:
Indicates hazards which, if not avoided, will result in serious injury or death.

WARNING:
Indicates hazards which, if not avoided, could result in serious injury or death.

CAUTION:
Indicates hazards which, if not avoided, could result in minor or moderate injury.

NOTICE:
"NOTICE" is reserved for instructions given to prevent property, product, or environmental harm.

SAFETY INSTRUCTIONS:
"SAFETY INSTRUCTIONS" indicates processes or procedures recommended to ensure safety.

General Safety Instructions

These general installation and maintenance instructions are provided by Farris Engineering, a Curtiss-Wright Flow Control Company, to its customers as general guidance for the handling, storage, and installation of Farris valves. Pressure relief valves are critical components in pressurized systems to ensure the safety of personnel and property. Always follow all manufacturer and industry standard recommendations relating to proper installation, testing, maintenance, and reconditioning.

This should not be considered an exhaustive manual and it does not cover the full maintenance and repair of valves. Certain configurations, applications, and usages may not be covered. All information presented in this manual is subject to change without notice. If there is specific information needed that is not covered in this manual, the customer is advised to contact Farris. The purchaser should also contact Farris regarding any possible changes in information or specifications. Please use the contact information on the back of this manual.

To ensure reliable and safe operation, installation, testing, maintenance, adjustment, and repair of Farris valves, these activities shall only be performed by qualified personnel having the required skills and training. No repair, assembly, adjustment or testing performed by individuals other than Farris-authorized representatives shall be covered by the warranty extended by Farris to its customers. All applicable regulations, directives, codes and standards shall be adhered to when performing these activities. Failure to follow proper test procedures or failure to use proper test equipment will lead to incorrect test results, damage to the valve and will invalidate the warranty.

Likewise, use of parts in any maintenance or repair activity other than factory-supplied OEM parts will invalidate the warranty extended by Farris to its customers. Incorrect selection or application of Farris valves on the part of the customer is not covered by the warranty extended by Farris to its customers.

These general instructions have been provided not only to ensure the proper installation and maintenance of Farris pressure relief valves, but also to provide for the safety of personnel who handle our products. Failure to follow these procedures could result in severe bodily harm or even death.

General Safety Instructions, cont.

All possible hazards may not be identified in this manual. Conduct your own safety risk assessment given your specific system, environment, and configuration, and ensure proper control procedures are in place to prevent personal injury or illness and property, product or environmental harm.

DANGER

- When the valve is under pressure, do not place any part of your body near or in the path of the outlet of the main valve or other discharge areas. Doing so will result in serious injury or death upon valve discharge.
- If a test gag is provided with the valve, it must be removed prior to installation. Failure to do so will result in equipment failure, serious injury or death in the instance of an overpressure event.

WARNING

- Never attempt to remove, adjust, maintain, or repair a pressure relief valve while it is installed in a pressurized system unless you have been properly trained to do so. Doing so may result in serious injury or death.
- Ensure proper isolation of any energy sources and residual pressures by complying with all local, state and country-specific regulations/ directives applying to energy control procedures (lockout/tagout).
- Ensure that the pressure relief valve and system is at an ambient temperature before inspecting, servicing, or repairing. The valve, system, and contents may be extremely hot or cold. Failure do so may result in serious injury.
- The discharge from the main valve outlet or any other vents, should be piped or vented to a safe location to eliminate the potential for serious injury or damage during relief operation.
- Prior to valve disassembly, ensure that proper controls are implemented to address potential exposures to hazardous substances, including gases, liquids, or process byproducts contained in or contaminating the valve. Consult applicable material safety data sheets (MSDSs) and established exposure limits for the substances expected to be present to ensure proper exposure controls are implemented. Failure to do so could result in serious injury or illness.
- To ensure the valve is free to operate, check the inlet and outlet piping for potential obstructions which may exist as a result of process fluid solidification, polymerization or other system problems. Failure to do so could render the valve inoperable, leading to serious injuries or damage in the event of system over-pressurization.
- Use extreme caution when inspecting a pressure relief valve for leakage. Always stay clear of the valve outlet during seat leakage testing as the valve can suddenly open fully causing serious injury. Doing so could result in serious burn, chemical or injection injury.
- Use all appropriate personal protective equipment to protect against process hazards, including but not limited to, pressurization, temperature extremes, noise, and chemical hazards. Failure to do so could result in serious injury or death.

CAUTION

- Always use the appropriate tools, and in the correct manner, for adjustment or servicing of valves. Failure to do so could result in injury.

SAFETY INSTRUCTIONS

- It is the responsibility of the customer and user of Farris valves to properly train their personnel on all required maintenance procedures and safety standards to prevent injuries.
- Farris can provide comprehensive training on the maintenance and repair of all Farris products. Contact your local Farris representative or the factory.

NOTICE

- Improper handling, storage, installation and maintenance of a PRV can cause damage to the valve and will invalidate the warranty. Please follow all recommended procedures.

Introduction

WARNING

These installation and maintenance instructions are being provided to ensure the proper installation, repair and safe operation of Farris pressure relief valves. Pressure relief valves are precision instruments and should only be installed and repaired by personnel who have been properly trained and qualified to provide this service. Correct installation is essential for plant, property, personnel and public safety. Failure of a pressure relief valve can lead to catastrophic overpressure of equipment and/or the release of effluent under pressure. Effluent may be hazardous and all precautions should be taken to ensure safe disposal.

Receiving Inspection, Storage & Handling

NOTICE



Failure to inspect, store and handle the PRV can cause improper functioning of the valve. Please read and follow these instructions.

WARNING

Cleanliness is essential to the satisfactory operation and tightness of a pressure relief valve. Prior to installation the following practices should be followed:

- Upon receipt, look for any shipping damage. Inspect packaging for evidence that the valve has been tipped over or dropped.
- Verify the nameplate data against ordering documents.
- Confirm that factory wire seals are in place and not broken.
- If it appears that the wire seal has been broken, the name plate information does not match documentation, or if the packaging or valve appear to have been damaged in transit, please contact your local Farris representative.
- Inlet & outlet covers should be left in place until the valve is installed.
- Valves should be moved and installed with the stem upright, in the vertical position.

  Note: Pilot operated relief valves should never be lifted or handled using the tubing, piping, pilot, or pilot brackets. Use the lifting eyes provided on the main valve body to move the valve.
- Care should be taken to keep the inlet and outlet clean and free of foreign material.
- Valves that are not immediately installed in service should be stored indoors, in the original container and in an area free of dirt and other contamination. The storage area should be at normal temperatures (50 to 100 °F/10 to 38 °C).

Pre-Installation Testing

NOTICE



Failure to follow proper test procedures or to use proper test equipment will lead to incorrect test results, damage to the valve and will void the warranty.

Before installation, it is important to confirm the set pressure and seat tightness. This testing should only be performed by trained and qualified personnel using proper test equipment.

When performing pre-installation testing please note the following:

- Testing must only be performed using the correct test fluids. Air, gas and vapor service valves must be tested using air as the test fluid. Liquid service valves should be tested on water and steam service valves must be tested on steam.

  Note: For pilot operated relief valves on liquid service, introducing liquid into the dome area of the main valve and pilot assembly during pre-installation testing may later cause problems when the valve is placed into service. An air test may be substituted to confirm valve functions, but set pressures may vary from actual setting due to the difference in test media.
- Set pressure testing must be performed first, followed by seat leakage testing. Seat leakage testing is performed at 90% of set pressure. For valves set at 50 psig (3.45 barg) or below, the test pressure is 5 psig (0.35 barg) below the set pressure.
- If qualified personnel and proper test equipment are not available the pre-installation testing should be skipped.

Installation

WARNING

Pressure relief valve performance can be adversely affected by improper installation. To ensure good performance and safe operation of the valve these guidelines should be followed. Failure to do so could result in valve failure, serious injury or death.

- Pressure relief valves may contain sharp surfaces. Proper personal protective equipment (PPE) should be used.
- Before installing a valve, depressurize the system.
- Always install valves upright with the stem in the vertical position and the inlet at the bottom. Remove the optional test gag, if supplied.
- Install valves close to the pressure source so that inlet pressure loss is no more than 3% of set pressure.
- To avoid reducing the valve's actual capacity, be sure piping connected to the valve's inlet/outlet connections is equal to or larger than the valve connections.
- Avoid installing valves close to equipment that can cause pressure fluctuations, such as compressor discharge lines.

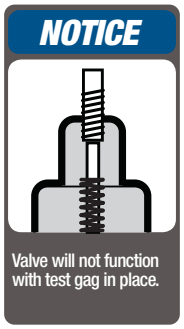
- Install valves away from equipment that may cause turbulence, such as reducing stations, orifice plates/nozzles, and other valves and fittings.
- Make sure all inlet and outlet piping is properly supported to avoid putting excessive load on the valve. Provide drainage from the discharge piping or valve body.
- On valves with bellows, remove plastic shipping plugs from the bonnet and vent in a safe direction. Do not pipe bonnet vents to a pressurized system that would introduce backpressure.
- Clean inlet and outlet flange surfaces and valve interior cavity to remove rust inhibitors.
- Remove the inlet and outlet flange protectors and any extraneous packing or documentation materials inside the valve body or nozzle.
- Test levers are provided on some valves to allow the user to manually verify that the valve trim is free to move. Test levers should only be pulled when system pressure is greater than 75% of set pressure in order to avoid potential damage to the valve. In addition the valve should never be carried by the test lever as this can move the disc off the seat resulting in damage to both parts.
- Tighten all inlet and outlet flange bolts evenly. Leave enough room to allow for in-line maintenance and adjustments.

Additional Instructions for Pilot Valve:

- Pilot valves are equipped with bug vent(s) on the pilot control bonnet and/or body. Check to be sure vents have not been plugged.
- The pilot control discharge is vented to atmosphere since the volume released when the valve opens is small. If a release to atmosphere is not permitted, then vent the discharge to a safe location. Do not pipe discharge to a pressurized system that would introduce backpressure unless it is a balanced pilot control design.
- On pilot valves supplied with field test connections, remove the plastic shipping plug from the isolation valve and assure that it is partially open.

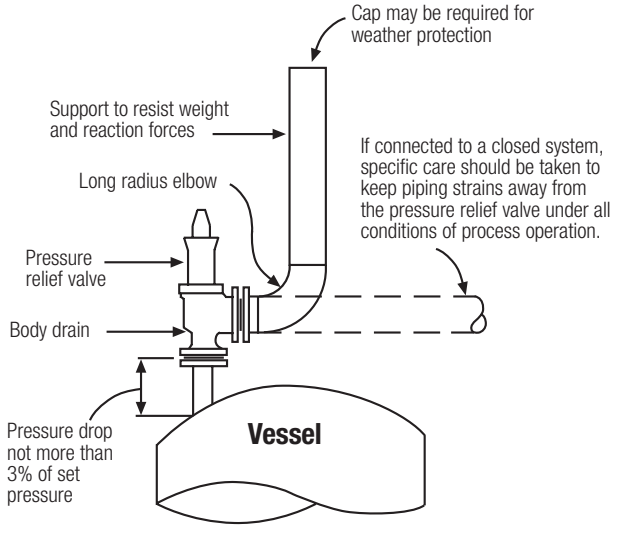
System Start Up and Testing:

It is recommended that the valve be isolated during pressure testing of the system either by blanking, closing a stop valve or using a test tag. If a test gag is used, exercise extreme caution to avoid damaging the valve stem or seat by over tightening the gag screw. Gag screws should be installed hand tight and should always be removed after system testing has been completed. Remove the optional test gag, if supplied.



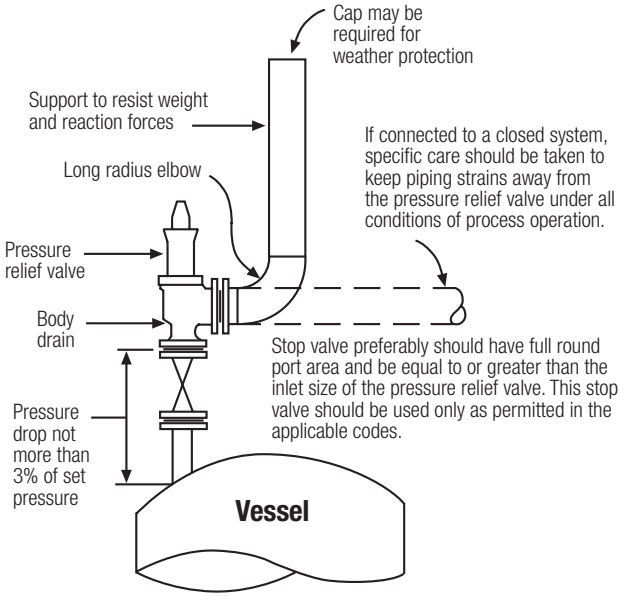
Typical PRV Installation

API RP 520, Part II Installation



Recommended Typical Pressure Relief Valve Installation Without Shutoff Valve

Figure 1.1



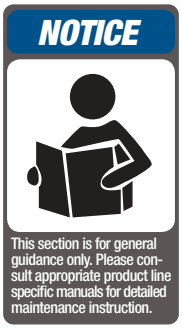
Recommended Typical Pressure Relief Valve Installation With Shutoff Valve

Figure 1.2

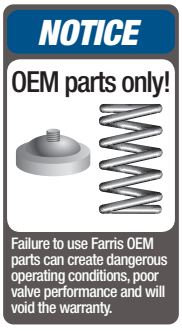
Maintenance Basics

WARNING Pressure relief valve maintenance should only be performed by trained and qualified personnel using proper test equipment. Repairs by unqualified personnel or use of improper test equipment may lead to poor valve performance.

These basic instructions apply to all Farris valve series. They do not provide information specific to product lines. For more detailed maintenance instructions, please consult the appropriate manuals for the valve under consideration. As a general rule, these procedures apply to all pressure relief valves:



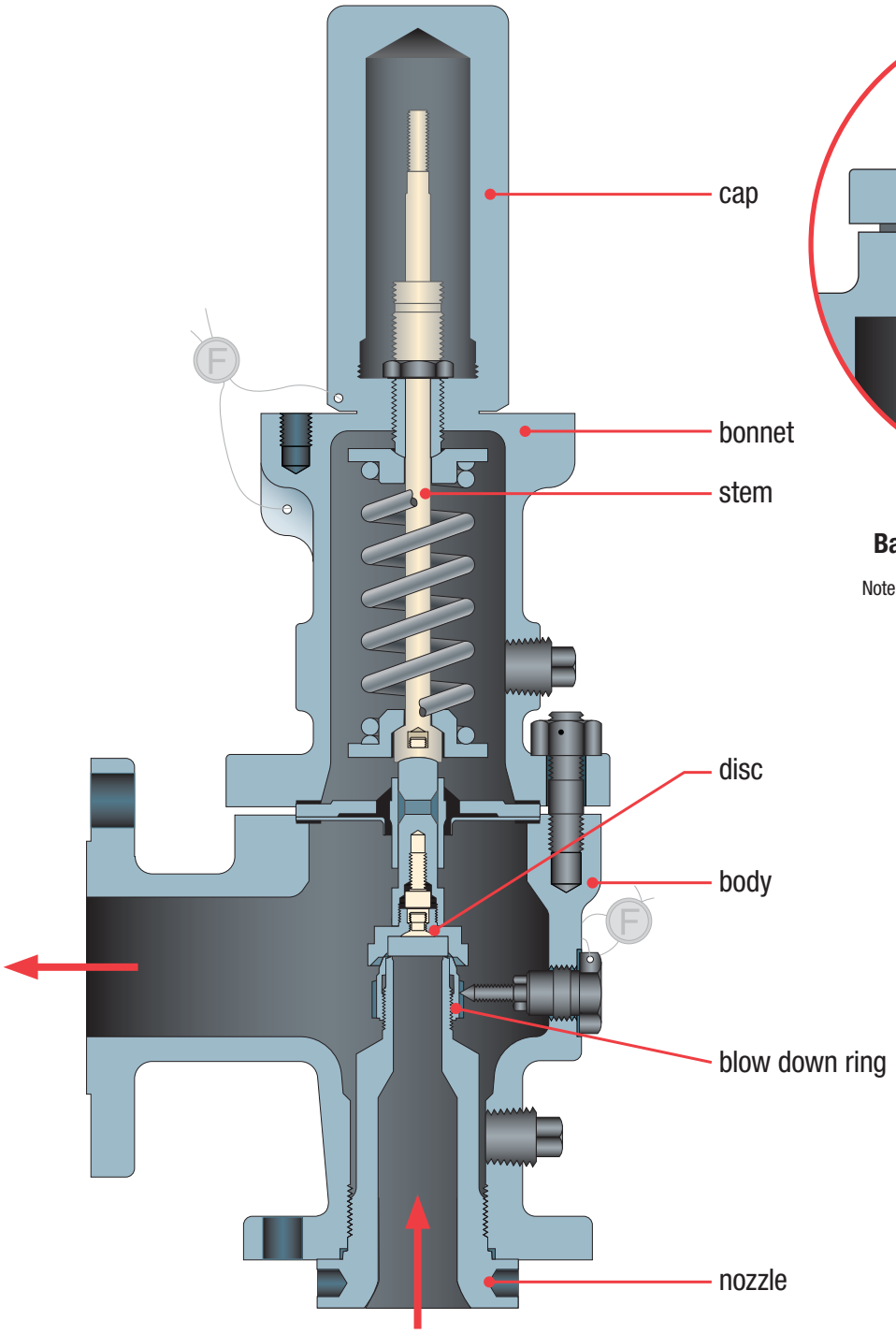
- Proper personal protective equipment (PPE) should be used.
- Before repairing or servicing a valve depressurize the system.
- For valves, that have been in service, a review of the material safety data sheet (MSDS) of process effluent should be done prior to disassembly. Proper controls should be in place to address potential exposures to hazardous substances, including gases, liquids, process media, or process by-products contained in the valve.
- External surfaces of the valve, including flange face surfaces and threaded connections, should be examined for any signs of damage or rough handling.
- Completely disassemble the valve and thoroughly clean all parts.
- Parts should be examined for signs of corrosion or excessive wear. Particular attention should be given to ensuring all threads are clean and free of burrs.
- Examine stem to ensure it is straight.
- Lap the nozzle seat and disc seating surfaces to a flat mirror finish.
- Reassemble valve making sure to lubricate all threaded and bearing surfaces.
- Standard repair procedure requires that all gaskets and soft goods such as O-ring seals be replaced with new parts.



- Valve should be calibrated to the set pressure indicated on the nameplate unless a new pressure is required. When the set pressure is being changed maintenance personnel must confirm if the existing spring is acceptable or if a new spring is required.
- Testing must only be performed using the correct test fluids. Air, gas and vapor service valves must be tested using air as the test fluid, liquid service valves should be tested on water, and steam service valves must be tested on steam.

  Note: For pilot operated relief valves on liquid service, introducing liquid into the dome area of the main valve and pilot assembly during maintenance testing may cause problems when placed in service. The setting and testing of the pilot control may be done separately from the main valve on the proper fluid. An air test may be substituted to confirm valve functions, but set pressures may vary from actual setting due to the difference in test media.
- Set pressure testing must be performed first, followed by seat leakage testing. Seat leakage testing is performed at 90% of set pressure. For valves set at 50 psig (3.45 barg) or below, the test pressure is 5 psig (0.35 barg) below the set pressure.
- After the repair has been completed, all external adjustments should be wire-sealed to prevent tampering. Inlet and outlet openings should be sealed until the valve is ready for installation in order to prevent foreign material from entering the valve.

Farris Valve – 2600 Series



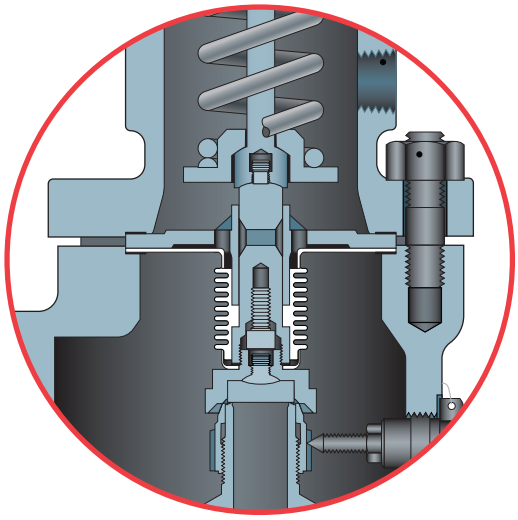
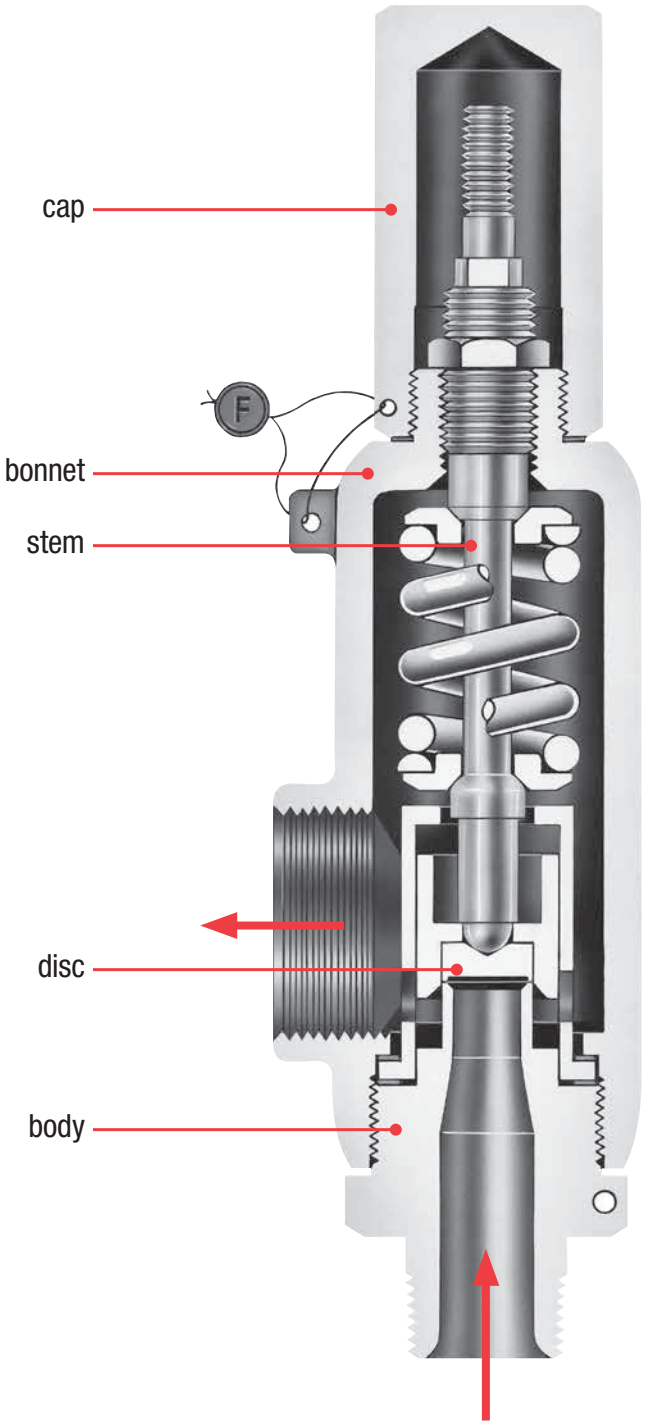


Figure 1.6
BalanSeal® Bellows Safety Valve

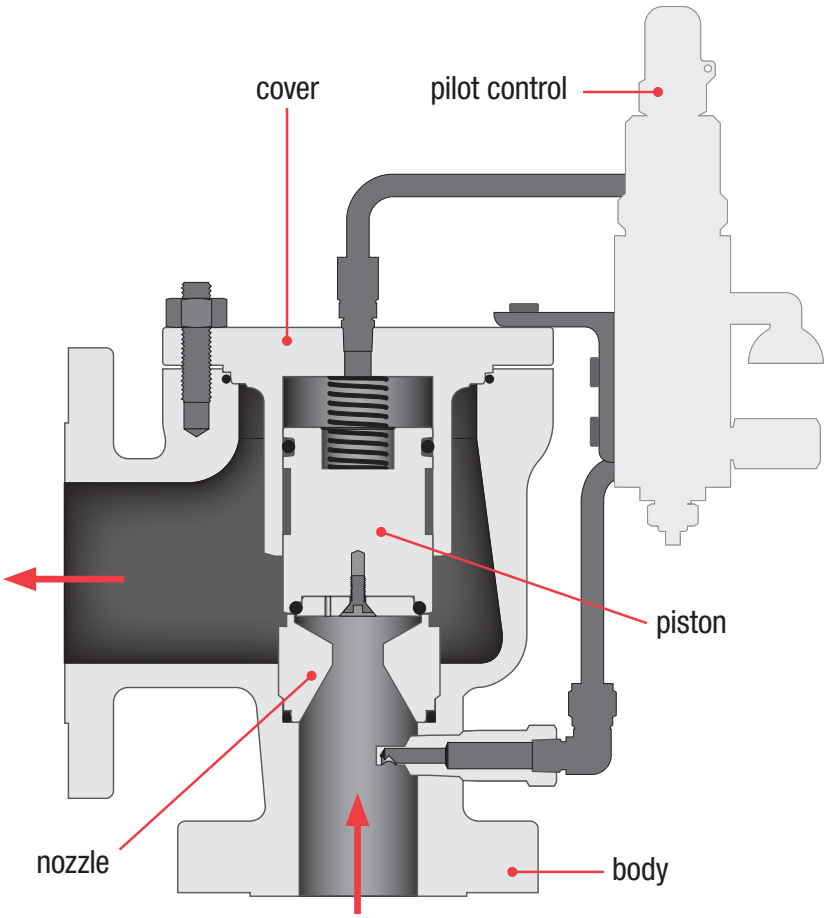
Note: Bonnet vent must be open on bellows design.

Farris Valve – 2700 Series

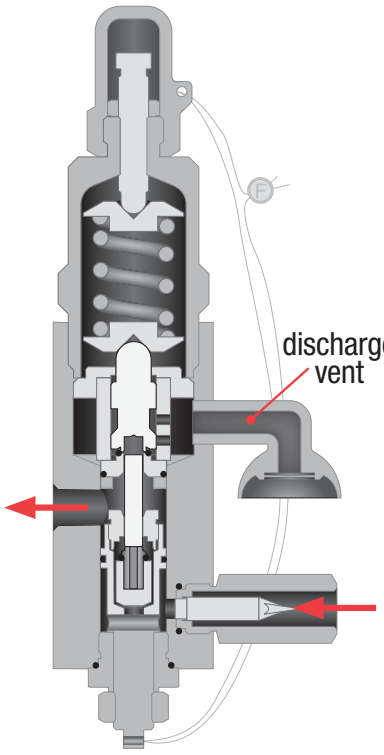


direction of flow

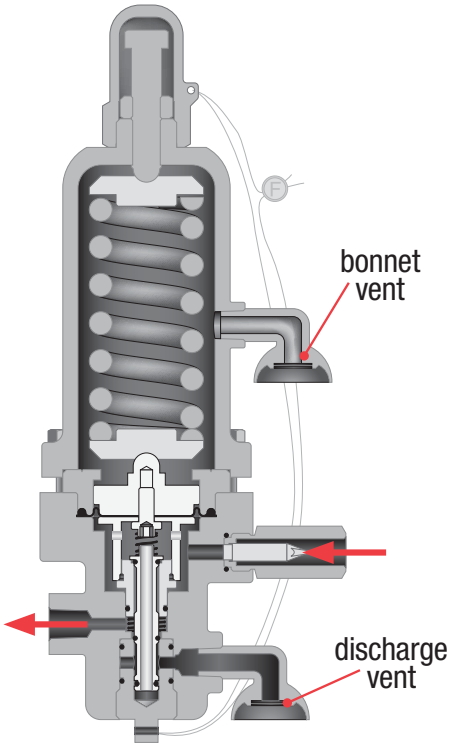
Farris Valve – 3800 Series



3800 Series
Main Valve



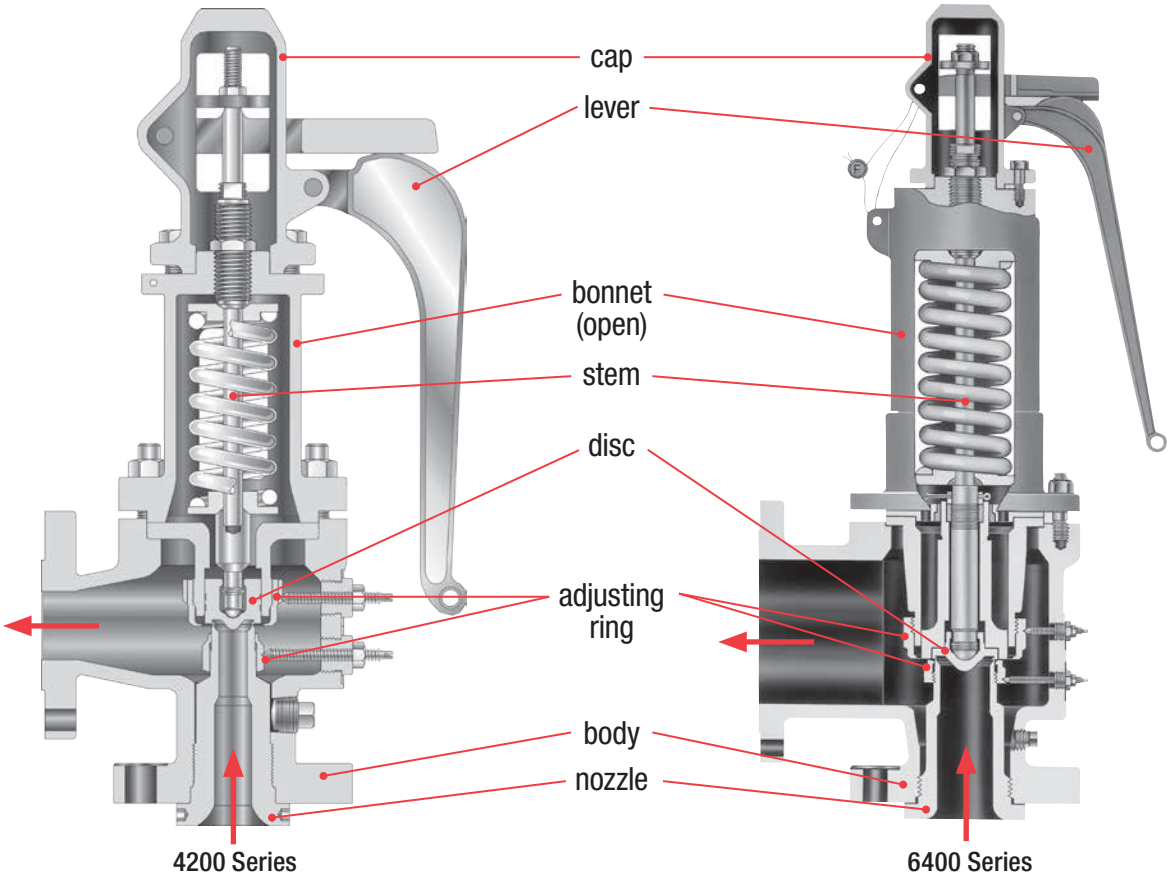
3800 Series
Snap-Acting Control



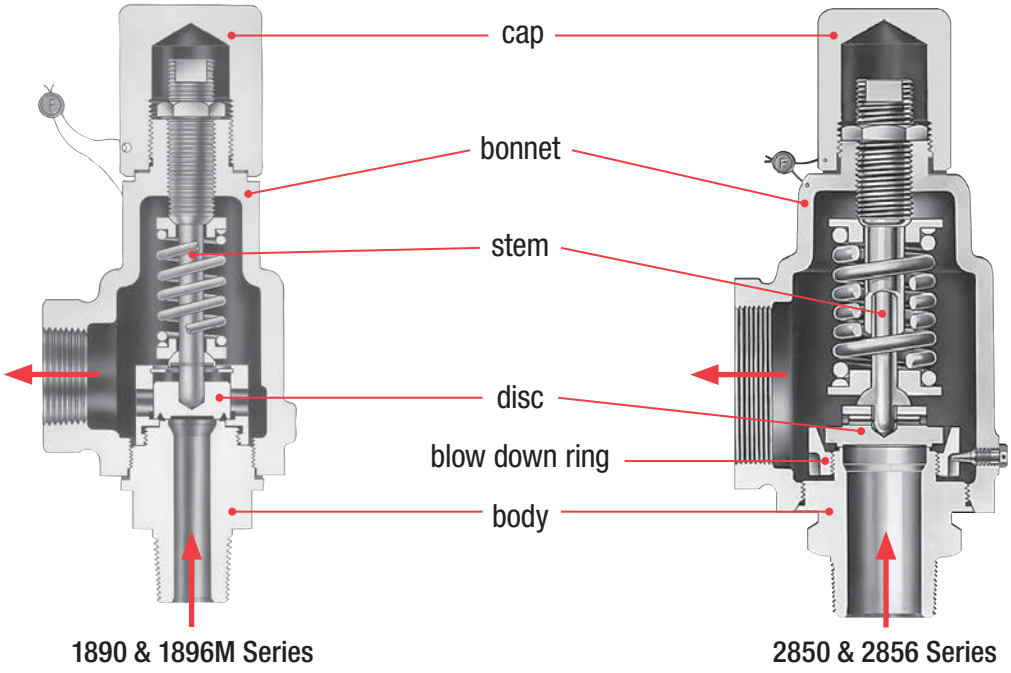
3800 Series
Modulating Control

direction of flow

Farris Valves – 4200, 6400/6600 Series Steam Valves



Farris Valves – 1890/1896, 2850/2856 Series



direction of flow

Farris Aftermarket Services

FAST Track Turnaround

Farris Engineering is dedicated to making our FAST Program work for you, which is why we have the FAST Track Center at our headquarters in Brecksville, OH. For urgent service requirements, our FAST Track Center has a large inventory of spare parts, finished valves, and dedicated machining and material resources. Farris can provide quick turnaround on inventory and machined parts for both current and obsolete valve designs.

FAST Centers

Our FAST Centers are a global network of independently owned and operated valve repair facilities offering:

- Total valve replacement, service and repair any hour, any day: 24/7 – 365
- Local pressure relief valve inventories, plus a Web-accessible global inventory
- Factory trained, ASME and VR approved facilities
- Asset management solutions to keep plants safe

Look for the FAST tag, your assurance for quality and safety.





FAST tags

In the US or Canada contact 1-877-FARRIS1 or 1-877-327-7471 to find the location of your nearest FAST Center, or for a global listing go to ***http://farris.cwfc.com/Services/spokes/fast_centers.asp***

CURTISS WRIGHT Flow Control Company
Farris Engineering

10195 Brecksville Road, Brecksville, OH 44141 USA • Telephone: 440-838-7690 • Fax: 440-838-7699 • http://farris.cwfc.com

Facilities: Brecksville, Ohio, USA; Brantford, Ontario, Edmonton, Alberta, Canada; Bridport, Dorset, UK; Delhi, India; Tianjin, Beijing, China; Dubai, U.A.E.

Offices Worldwide: For a listing of our global sales network, visit our website at http://farris.cwfc.com.

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10/12 20M R2

CAMERON

GROVE
B4, B5, and B7 Side-Entry Ball Valves

TECHNOLOGY



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GROVE B4, B5, & B7 Side-entry Ball Valves

FEATURES AND BENEFITS

Cameron's Valves & Measurement business segment is a leading provider of valves, valve automation, and measurement systems to the oil and gas industry.

We provide large-diameter valves for use in natural gas, LNG, crude oil, and refined products transmission lines as well as in many other general industrial applications.

Rigorously tested, field-proven, and backed by our services team, Cameron's GROVE® valves are among the best known valves in the world.

Applications



GROVE split-body side-entry ball valves are manufactured in a wide range of diameters and pressure classes.

In the standard versions, the valves are specified for transmission pipelines, pumping, compression and reinjection units, offshore platforms, onshore terminals, pig traps, measuring stations, and surge-relief skids.

These valves also can be built for speciality applications, such as subsea installations and LNG plants.

Split-body construction allows the use of forged materials in various grades of carbon steel, stainless steel, and high alloys, equipping the valves for some of the most severe service conditions.

Size		ASME CLASS						
(in.)	(mm)	150	300	400	600	900	1500	2500
1-1/2	(40)	●	●	●	●	●	●	▲
2	(50)	●	●	●	●	●	●	▲
3	(80)	●	●	●	●	●	●	▲
4	(100)	●	●	●	●	●	●	▲
6	(150)	■	■	■	■	■	■	▲
8	(200)	■	■	■	■	■	■	◆
10	(250)	■	■	■	■	■	■	◆
12	(300)	■	■	■	■	■	■	◆
14	(350)	■	■	■	■	■	■	◆
16	(400)	■	■	■	■	■	■	◆
18	(450)	■	■	■	■	■	■	◆
20	(500)	■	■	■	■	■	■	◆
22	(550)	■	■	■	■	■	■	
24	(600)	■	■	■	■	■	■	
26	(650)	■	■	■	■	■	■	
28	(700)	■	■	■	■	■	■	
30	(750)	■	■	■	■	■	■	
32	(800)	■	■	■	■	■	■	
34	(850)	■	■	■	■	■	■	
36	(900)	■	■	■	■	■	■	
40	(1000)	■	■	■	■	■		
42	(1050)	■	■	■	■	■		
46	(1150)	■	■	■	■	■		
48	(1200)	■	■	■	■	■		
56	(1400)	■	■	■	■			
60	(1500)	■	■	■	■			

B4 ● B5 ■ B7.1 ▲ B7.B ◆

GROVE B4

DESIGN FEATURES

Standard Features

The standard design valve code is B4.D.

- Double-barrier stem seals (the upper seal can be replaced with the valves in-line, under pressure, with the ball in the closed position)
- Short coupled trunnions reduce unit bearing loads and operating torque
- Factory-positioned external stops
- Stem separated from the ball; anti-blowout design; side load on stem
- Plastic polymer insert for seat sealing
- Self-relieving seats for ASME Classes 150 and 300
- Metal-backed, self-lubricating PTFE sleeve bearing and thrust washers reduce torque and extend service life
- Nickel plating for trim parts
- Fire-safe graphite rings for protection against external leakage



Options

According to the design impact of the optional features, the valve code may change to B4.B, B4.C, etc.

B4 – ALL TYPES

- PTFE various grades of reinforced gaskets, spring energized, for stem and seat sealing
- Antistatic device
- Metal-to-metal seats
- Double-sealing barrier in both directions (DPE) for ASME Classes 600, 900, and 1500; body relief valve for overpressure due to liquid thermal expansion
- Double block-and-bleed capabilities
- Explosive decompression-resistant seals

B4.B TYPE

When the valve design includes one or more of the following variations with respect to the standard design, the denomination becomes B4.B.

- Triple-barrier stem seals; upper stem seal O-ring replaceable with pressure in-line with the ball in the closed position
- Self-relieving seats

B4.C TYPE

This version of the B4 valves (in ASME Classes 600, 900, and 1500) features:

- O-ring seat seal
- Double-sealing barrier in both directions (DPE) and body pressure relief valve



Body Construction

The body is made of three forged parts, and the bolted construction allows disassembly in the field for repairs. The body drain is located in the lowest part of the body cavity and consists of a 1/4" NPT drain valve with safety plug. Graphite rings are provided for compliance with API 6FA and BS 6755 Part 2 fire-safe standards.

Stem Construction

The stem function is to transmit torque and to absorb the line pressure thrust together with the trunnion. The stem of Cameron's GROVE B4 valves has an anti-blowout design and incorporates a double-barrier system. The pressure thrust on the stem is supported by a thrust washer in antifriction material.

Seat Seal

The soft sealing between the seat and the ball is achieved by a plastic insert on B4.B, B4.D valves and by an O-ring on B4.C valves.

The block-and-bleed and double block-and-bleed capabilities are available as per API 6D definition on all types of B4 valves.

Self-relieving seats are standard on all B4.B, B4.C, and B4.D ASME Classes 150 and 300.

Independent sealing on upstream and downstream seats is available on B4.C and B4.D ASME Classes 600, 900, and 1500.

Ball Position

For valves normally mounted with lever, the ball open and closed positions are ensured by corresponding stops on the bearing housing. The lever position parallel to the line flow means the valve is open. For valves with gears or actuators, the stops are set at the factory as primary stops. An “open/closed” indicator also is provided.









MATERIALS SPECIFICATIONS

Materials Selection

The design of the valve also depends on the materials of construction selected.

After examination of service conditions, the selection criteria are based on the verification of the physical and chemical characteristics of the materials or product.

For the soft sealing (O-rings, inserts, and lip seal gaskets), the guidelines to be followed are relevant for hardness, tensile strength, modulus, compression set, swelling, and fluid suitability.

The process is qualified so that the final thickness after machining can verify the chemical composition as per the relevant ASTM standard. The final check is carried out by the liquid penetrant method.

Weld Overlays

Sealing areas and other critical parts of the valve can be weld overlayed in case of corrosive service.

More frequently used materials are AISI 316L and Alloy 625.



Duplex Stainless Steels Metallurgy

On duplex (22 Cr to 2 Ni) and superduplex (25 Cr to 5 Ni) stainless steels, corrosion-resistance qualification check can be as follows:

- Chloride corrosion as per ASTM G48 (104° F or 40° C, 72 hours)
- Cracking as per ASTM G36 (302° F or 150° C, 500 hours)
- Pitting corrosion PRE = 33 min. for duplex, 40 min. for superduplex
- Ferrite content 40% to 60%, as per ASTM E562

NACE Requirements

On request, GROVE side-entry ball valves can be supplied in accordance with NACE MR0175.

Severe Wet Sour Gas Service

In addition to NACE MR0175, the additional qualifications can be:

- Sulfur ≤ 0.015%
- Hydrogen-induced cracking as per NACE TM-02-84 (96 hours)
- Sulfide stress corrosion cracking as per NACE TM-01-77 (720 hours)



OPTIONAL FEATURES

Metal-to-Metal Seats

The contact area between the seats and the ball can be completely metallic. This feature is required when tight sealing is needed and the standard soft seal is no longer suitable due to the unfavorable combination of pressure, temperature, and chemical composition of the medium and/or when solid particles are present and when operating conditions prevail.

In case of metal-to-metal seats, the ball and seats coating can be obtained by means of various materials and processes, such as:

- Electroless nickel plating
- High-velocity application of carbide powder

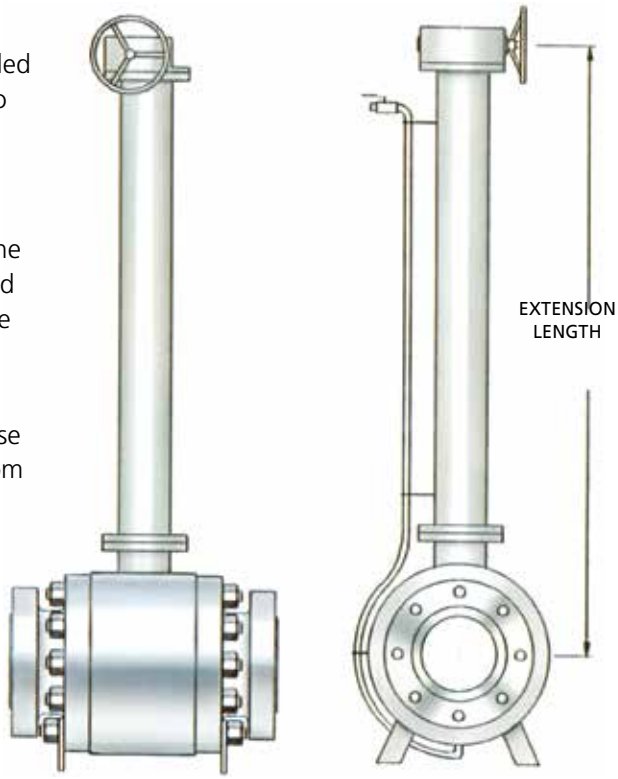
When utilizing the metallic seats, it is necessary to verify the structure of the stem/ball coupling and the actuator choice, as there is an increase in the valve torque.

Stem Extensions

GROVE ball valves can be provided with optional stem extensions to permit buried or underground installations in remote or inaccessible areas.

When used for buried service, the stem extensions can be furnished watertight, and the piping of the grease injection system also will be extended.

When ordering extensions, please specify the distance required from the valve centerline to the handwheel centerline.



Transition Pieces

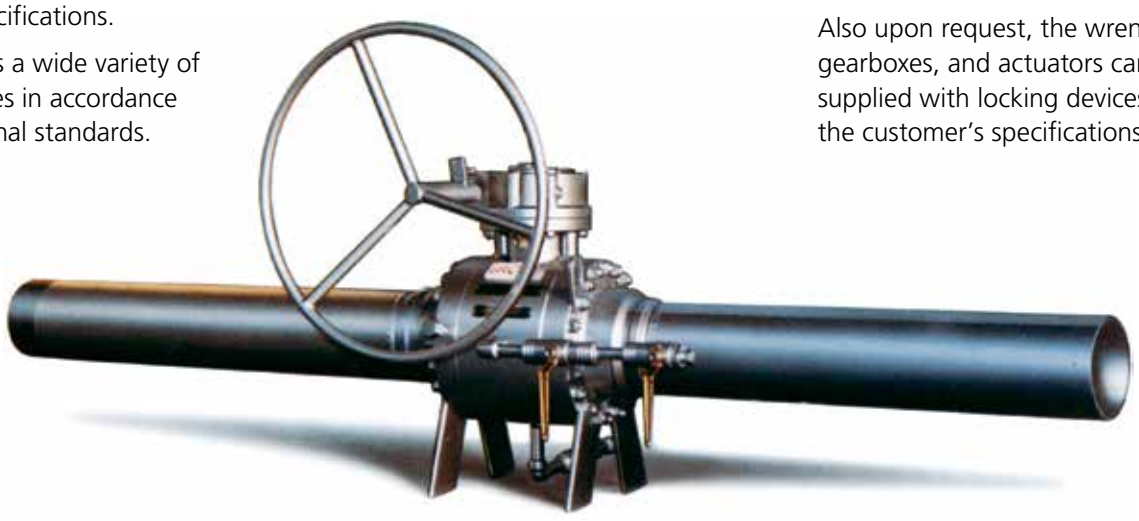
Cameron can weld transition pieces to the valve during the manufacturing process. Transition can be supplied by the customer or by Cameron to suit the customer's specifications.

Cameron offers a wide variety of weld procedures in accordance with international standards.

Other

Upon request, the valve can be furnished with specific adjustments for the installation with the horizontal stem.

Also upon request, the wrenches, gearboxes, and actuators can be supplied with locking devices to suit the customer's specifications.



SPECIAL APPLICATIONS

"S" Design for Subsea Service

The "S" valves are the subsea versions of the B4, B5, and B7 ball valves, specifically designed to suit subsea service conditions.

The "S" design takes into consideration the restrictive criteria used in the definition of safety coefficients relative to both pressure-retaining components and the stem connection between the valve and actuator, making the "S" valve suitable for EDS service.

The critical internal sealing surfaces are protected from corrosion resistance by the overlay, generally dictated by customer specifications and checked by chemical analysis of test specimens and the part(s).

The body is coated with special products and the body/bonnet bolts are protected with special protective coatings and special sealing caps. The stem and external sealing areas are protected with additional seawater sealing gaskets.

The "S" valve is designed to be reliable and to provide optimum service with reduced maintenance. It usually is installed on modular rigs placed on the seafloor, complete with necessary components. When necessary, substitution or complete removal of these modules is possible.

"L" Design For Low-temperature Service

For certain gas treatment processes (e.g., LNG) and blowdown conditions, the valve must be able to limit the leakage within specified value and to ensure the maneuverability at a low temperature. The B4-L, B5-L, and B7-L valves are suitable for temperatures down to -184° F (-120° C).

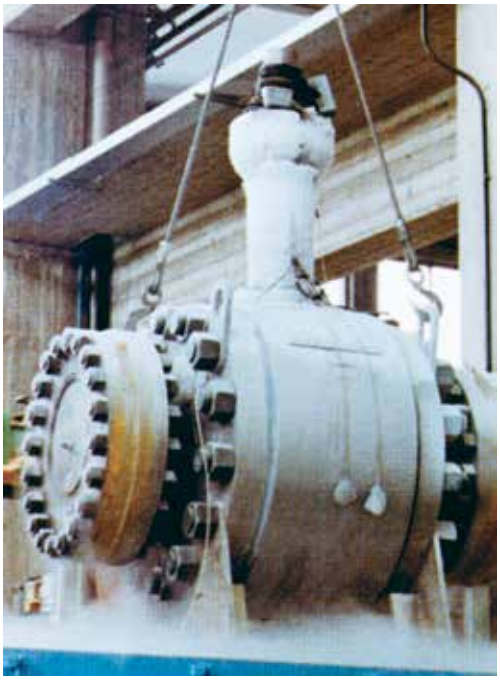
The valves are referred to the respective standard types, but materials, parts dimensions, surface finishing, gaskets, and stem connections are specifically designed to suit low temperatures.

Epoxy-Phenolic Internal Coating

Cameron has developed a technology for anti-corrosive internal coatings. The products have been designed for oil brine, seawater and drinking water service, sour and corrosive applications.

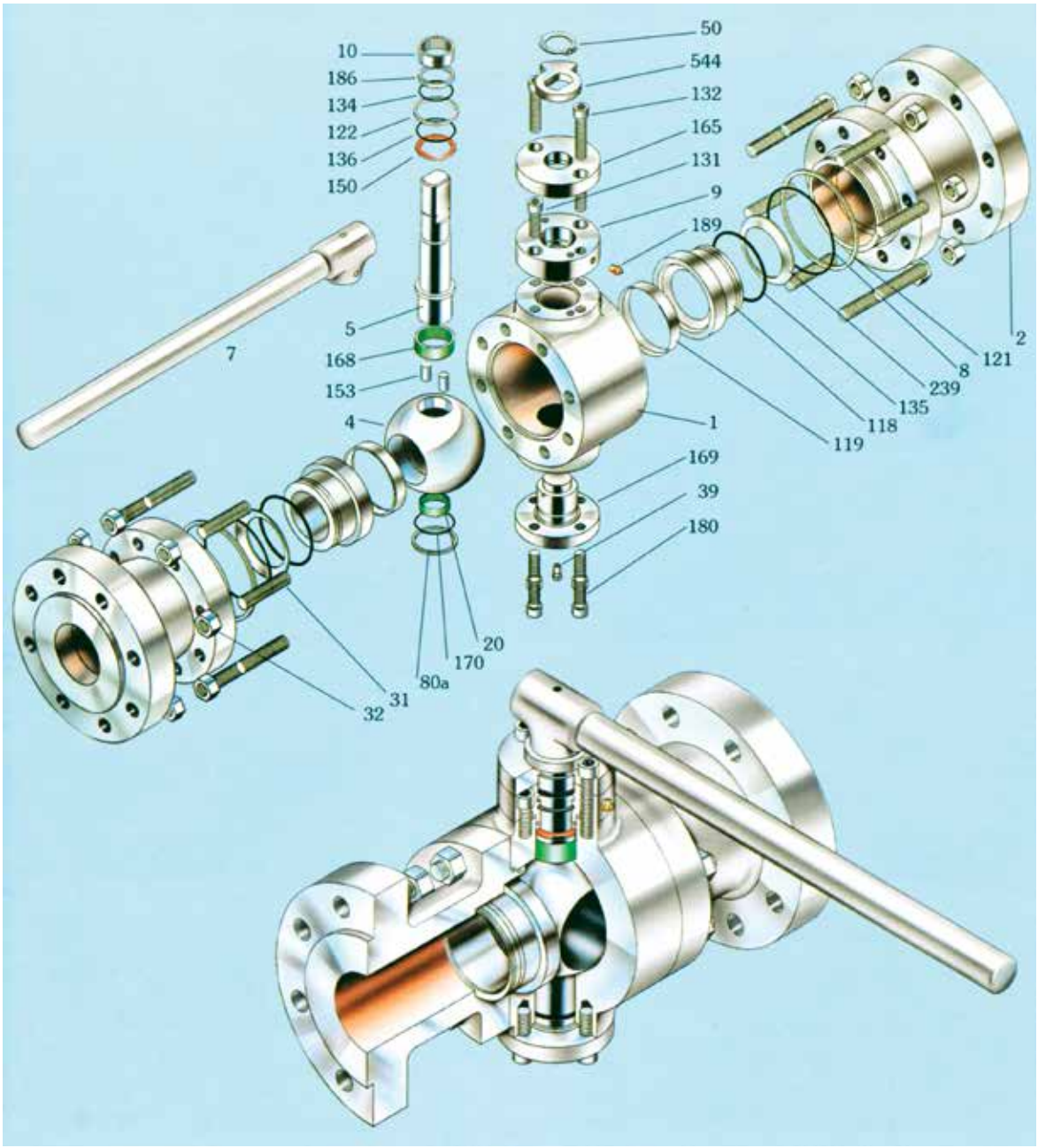
The final thickness can be 180 to 350 microns. Hydrostatic shell testing is conducted before and after coating and thickness and holiday testing records are maintained.





GROVE B4-B4.D

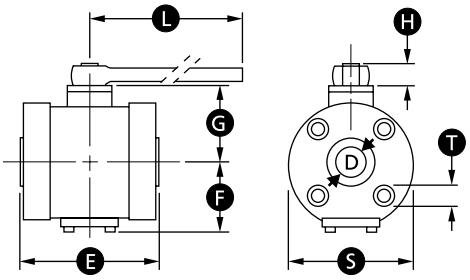
VALVE ASSEMBLY AND CROSS SECTION



Item	Description	Item	Description	Item	Description
1	Body	39	Drain Valve	150	Upper Thrust Washer
2	Closure	50	Seeger Ring	153	Drive Pin
4	Ball	80a	Lower Trunnion Fire-safe Seal	165	Bearing Housing
5	Stem	118	Standard Seat Ring	168	Stem Bearing
7	Wrench Unit	119	Seat Insert	169	Lower Trunnion
8	Closure O-ring	121	Closure Fire-safe Seal	170	Trunnion O-ring
9	Gland Plate	122	Gland Plate Fire-safe Seal	180	Lower Trunnion Capscrew
10	Gland Bushing	131	Gland Plate Capscrew	186	Stem Fire-safe Packing
20	Trunnion Bearing	132	Bearing Housing Capscrew	189	Gland Vent
31	Body Stud	134	Stem O-ring	239	Spring Washer
32	Body Stud Nut	135	Seat Gasket O-ring	544	Stop Collar
		136	Gland Plate O-ring		

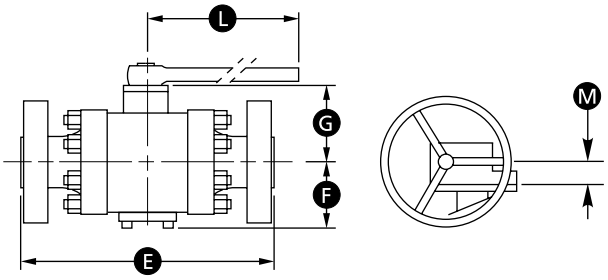
DIMENSIONS AND WEIGHTS

ASME CLASS 150



Size (in.)	Thread	T (in.) Depth	Flange Holes (No.)
1-1/2	1/2 UNC	13/16	4
2	5/8 UNC	15/16	4
3	5/8 UNC	15/16	4
4	5/8 UNC	15/16	8

ASME CLASS 300



ASME CLASS 150

SIZE in. (mm)	D	E WE	E RF	E RTJ	F	G	S	H	L	A	K	M	WEIGHT lb (kg) WE	WEIGHT lb (kg) RF/RTJ
1-1/2 (40)	1-1/2 (38)	7-1/2 (191)	6-1/2 (165)	7 (178)	3-7/8 (98)	4-1/4 (108)	5 (127)	7/8 (22)	10-3/4 (273)	-	-	-	29 (13)	31 (14)
2 x 1-1/2 x 2 (50 x 40 x 50)	1-1/2 (38)	8-1/2 (216)	7 (178)	7-1/2 (191)	3-7/8 (98)	4-1/4 (108)	5 (127)	7/8 (22)	10-3/4 (273)	-	-	-	31 (14)	40 (18)
2 (50)	2 (51)	8-1/2 (216)	7 (178)	7-1/2 (191)	4-1/8 (105)	4-5/8 (118)	5-5/8 (143)	7/8 (22)	12-5/8 (321)	-	-	-	37 (17)	51 (23)
3 x 2 x 3 (80 x 50 x 80)	2 (51)	11-1/8 (283)	8 (203)	8-1/2 (216)	4-1/8 (105)	4-5/8 (118)	5-5/8 (143)	7/8 (22)	12-5/8 (321)	-	-	-	53 (24)	60 (27)
3 (80)	3 (76)	11-1/8 (283)	8 (203)	8-1/2 (216)	5-1/8 (130)	5-5/8 (143)	7-3/4 (197)	1-1/8 (28)	16-1/2 (419)	-	-	-	84 (38)	95 (43)
4 x 3 x 4 (100 x 80 x 100)	3 (76)	12 (305)	9 (229)	9-1/2 (241)	5-1/8 (130)	5-5/8 (143)	7-3/4 (197)	1-1/8 (28)	16-1/2 (419)	-	-	-	86 (39)	104 (47)
4 (100)	4 (102)	12 (305)	9 (229)	9-1/2 (241)	6-1/8 (155)	6-5/8 (168)	9-3/8 (238)	1-1/8 (28)	20-1/4 (514)	-	-	-	123 (56)	146 (66)
6 x 4 x 6 (150 x 100 x 150)	4 (102)	18 (457)	15-1/2 (394)	16 (406)	6-1/8 (155)	6-5/8 (168)	9-3/8 (238)	1-1/8 (28)	20-1/4 (514)	-	-	-	152 (69)	161 (73)

ASME CLASS 300

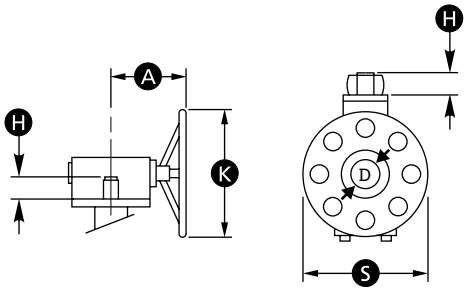
SIZE in. (mm)	D	E WE	E RF	E RTJ	F	G	S	H	L	A	K	M	WEIGHT lb (kg) WE	WEIGHT lb (kg) RF/RTJ
1-1/2 (40)	1-1/2 (38)	7-1/2 (191)	7-1/2 (191)	8 (203)	3-7/8 (98)	4-1/4 (108)	5 (127)	7/8 (22)	10-3/4 (273)	-	-	-	29 (13)	40 (18)
2 x 1-1/2 x 2 (50 x 40 x 50)	1-1/2 (38)	8-1/2 (216)	8-1/2 (216)	9-1/8 (232)	3-7/8 (98)	4-1/4 (108)	5 (127)	7/8 (22)	10-3/4 (273)	-	-	-	31 (14)	44 (20)
2 (50)	2 (51)	8-1/2 (216)	8-1/2 (216)	9-1/8 (232)	4-1/8 (105)	4-5/8 (118)	5-5/8 (143)	7/8 (22)	14-5/8 (372)	-	-	-	37 (17)	51 (23)
3 x 2 x 3 (80 x 50 x 80)	2 (51)	11-1/8 (283)	11-1/8 (283)	11-3/4 (298)	4-1/8 (105)	4-5/8 (118)	5-5/8 (143)	7/8 (22)	14-5/8 (372)	-	-	-	53 (24)	75 (34)
3 (80)	3 (76)	11-1/8 (283)	11-1/8 (283)	11-3/4 (298)	5-1/8 (130)	5-5/8 (143)	7-3/4 (197)	1-1/8 (28)	22-3/8 (568)	-	-	-	88 (40)	117 (53)
4 x 3 x 4 (100 x 80 x 100)	3 (76)	12 (305)	12 (305)	12-5/8 (321)	5-1/8 (130)	5-5/8 (143)	7-3/4 (197)	1-1/8 (28)	22-3/8 (568)	-	-	-	90 (41)	123 (56)
4 (100)	4 (102)	12 (305)	12 (305)	12-5/8 (321)	6-1/8 (155)	6-5/8 (168)	9-3/8 (238)	1-1/8 (28)	26-1/8 (664)	-	-	-	128 (58)	170 (77)
6 x 4 x 6 (150 x 100 x 150)	4 (102)	18 (457)	15-7/8 (403)	16-1/2 (419)	6-1/8 (155)	6-5/8 (168)	9-3/8 (238)	1-1/8 (28)	26-1/8 (664)	-	-	-	165 (75)	223 (101)

Flanges in accordance with ASME B16.5
Shaded bore sizes (D) according to API 6D
Shaded end-to-end dimensions (E) according to API 6D

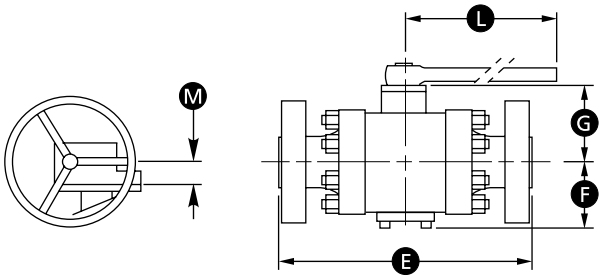
Butt welding ends according to ASME B16.25
Outlined end-to-end dimensions (E) according to ASME B16.10

DIMENSIONS AND WEIGHTS (CONT.)

ASME CLASS 400



ASME CLASS 600



ASME CLASS 400

SIZE in. (mm)	D	E WE	E RF	E RTJ	F	G	S	H	L	A	K	M	WEIGHT WE	WEIGHT lb (kg) RF/RTJ
1-1/2	1-1/2	9-1/2	9-1/2	9-1/2	3-7/8	4-1/4	5	7/8	10-3/4	-	-	-	30	43
(40)	(38)	(241)	(241)	(241)	(98)	(108)	(127)	(22)	(273)	-	-	-	(13)	(20)
2 x 1-1/2 x 2	1-1/2	11-1/2	11-1/2	11-5/8	3-7/8	4-1/4	5	7/8	10-3/4	-	-	-	33	49
(50 x 40 x 50)	(38)	(292)	(292)	(295)	(98)	(108)	(127)	(22)	(273)	-	-	-	(15)	(22)
2	2	11-1/2	11-1/2	11-5/8	4-1/8	4-5/8	5-5/8	7/8	14-5/8	-	-	-	41	56
(50)	(51)	(292)	(292)	(295)	(105)	(118)	(143)	(22)	(372)	-	-	-	(19)	(25)
3 x 2 x 3	2	14	14	14-1/8	4-1/8	4-5/8	5-5/8	7/8	14-5/8	-	-	-	56	80
(80 x 50 x 80)	(51)	(356)	(356)	(359)	(105)	(118)	(143)	(22)	(372)	-	-	-	(25)	(36)
3	3	14	14	14-1/8	5-1/8	5-5/8	7-3/4	1-1/8	22-3/8	-	-	-	93	123
(80)	(76)	(356)	(356)	(359)	(130)	(143)	(197)	(28)	(568)	-	-	-	(42)	(56)
4 x 3 x 4	3	16	16	16-1/8	5-1/8	5-5/8	7-3/4	1-1/8	22-3/8	-	-	-	103	146
(100 x 80 x 100)	(76)	(406)	(406)	(410)	(130)	(143)	(197)	(28)	(568)	-	-	-	(47)	(47)
4	4	16	16	16-1/8	6-1/8	6-5/8	9-3/8	1-1/8	26-1/8	-	-	-	146	198
(100)	(102)	(406)	(406)	(410)	(155)	(168)	(238)	(28)	(664)	-	-	-	(66)	(90)
6 x 4 x 6	4	19-1/2	19-1/2	19-5/8	6-1/8	6-5/8	9-3/8	1-1/8	26-1/8	-	-	-	179	279
(150 x 100 x 150)	(102)	(495)	(495)	(499)	(155)	(168)	(238)	(28)	(664)	-	-	-	(81)	(127)

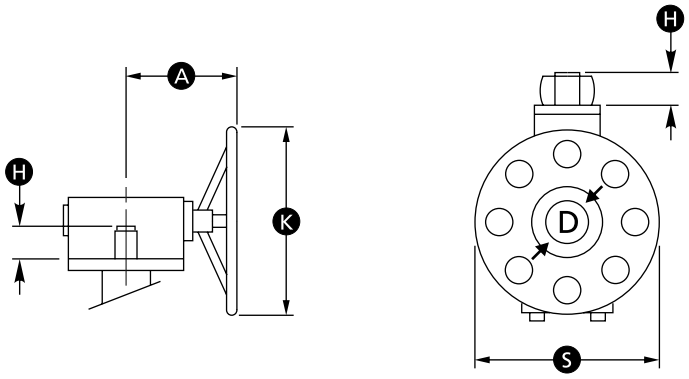
ASME CLASS 600

SIZE in. (mm)	D	E WE	E RF	E RTJ	F	G	S	H	L	A	K	M	WEIGHT WE	WEIGHT lb (kg) RF/RTJ
1-1/2	1-1/2	9-1/2	9-1/2	9-1/2	3-7/8	4-1/4	5	7/8	11-7/8	-	-	-	31	46
(40)	(38)	(241)	(241)	(241)	(98)	(108)	(127)	(22)	(302)	-	-	-	(14)	(21)
2 x 1-1/2 x 2	1-1/2	11-1/2	11-1/2	11-5/8	3-7/8	4-1/4	5	7/8	11-7/8	-	-	-	35	53
(50 x 40 x 50)	(38)	(292)	(292)	(295)	(98)	(108)	(127)	(22)	(302)	-	-	-	(16)	(24)
2	2	11-1/2	11-1/2	11-5/8	4-1/8	4-5/8	5-5/8	7/8	16-7/8	-	-	-	44	62
(50)	(51)	(292)	(292)	(295)	(105)	(118)	(143)	(22)	(429)	-	-	-	(20)	(28)
3 x 2 x 3	2	14	14	14-1/8	4-1/8	4-5/8	5-5/8	7/8	16-7/8	-	-	-	60	86
(80 x 50 x 80)	(51)	(356)	(356)	(359)	(105)	(118)	(143)	(22)	(429)	-	-	-	(27)	(39)
3	3	14	14	14-1/8	5-1/8	5-5/8	7-3/4	1-1/8	26-1/4	-	-	-	97	130
(80)	(76)	(356)	(356)	(359)	(130)	(143)	(197)	(28)	(667)	-	-	-	(44)	(59)
4 x 3 x 4	3	17	17	17-1/8	5-1/8	5-5/8	7-3/4	1-1/8	26-1/4	-	-	-	115	168
(100 x 80 x 100)	(76)	(432)	(432)	(435)	(130)	(143)	(197)	(28)	(667)	-	-	-	(52)	(76)
4	4	17	17	17-1/8	6-1/8	6-5/8	9-3/8	1-1/8	30-1/8	-	-	-	192	335
(100)	(102)	(432)	(432)	435)	(155)	(168)	(238)	(28)	(765)	-	-	-	(87)	(152)
6 x 4 x 6	4	22	22	22-1/8	6-1/8	6-5/8	9-3/8	1-1/8	30-1/8	-	-	-	192	335
(150 x 100 x 150)	(102)	(559)	(559)	(562)	(155)	(168)	(238)	(28)	(765)	-	-	-	(87)	(152)

Flanges in accordance with ASME B16.5
Shaded bore sizes (D) according to API 6D
Shaded end-to-end dimensions (E) according to API 6D

Butt welding ends according to ASME B16.25
Outlined end-to-end dimensions (E) according to ASME B16.10

ASME CLASS 900 AND 1500



ASME CLASS 900

SIZE in. (mm)	D	E WE	E RF	E RTJ	F	G	S	H	L	A	K	M	WEIGHT WE	WEIGHT lb (kg) RF/RTJ
1-1/2 (40)	1-1/2 (38)	12 (305)	12 (305)	12 (305)	4 (102)	4-1/2 (114)	5-1/8 (130)	7/8 (22)	13-1/2 (343)	- -	- -	- -	44 (20)	68 (31)
2 x 1-1/2 x 2 (50 x 40 x 50)	1-1/2 (38)	14-1/2 (368)	14-1/2 (368)	14-5/8 (372)	4 (102)	4-1/2 (114)	5-1/8 (130)	7/8 (22)	13-1/2 (343)	- -	- -	- -	49 (22)	95 (43)
2 (50)	2 (51)	14-1/2 (368)	14-1/2 (368)	14-5/8 (372)	4-1/2 (114)	4-7/8 (124)	6-3/8 (162)	7/8 (22)	22 (559)	- -	- -	- -	77 (35)	130 (59)
3 x 2 x 3 (80 x 50 x 80)	2 (51)	15 (381)	15 (381)	15-1/8 (359)	4-1/2 (114)	4-7/8 (124)	6-3/8 (162)	7/8 (22)	22 (559)	- -	- -	- -	108 (49)	143 (65)
3 (80)	3 (76)	15 (381)	15 (381)	15-1/8 (359)	5-5/8 (143)	6-1/8 (156)	8-3/8 (213)	1-1/8 (28)	35-7/8 (911)	- -	- -	- -	157 (71)	187 (85)
4 x 3 x 4 (100 x 80 x 100)	3 (76)	18 (457)	18 (457)	18-1/8 (460)	5-5/8 (143)	6-1/8 (156)	8-3/8 (213)	1-1/8 (28)	35-7/8 (911)	- -	- -	- -	159 (72)	240 (109)
4 (100)	4 (102)	18 (457)	18 (457)	18-1/8 (460)	6-7/8 (175)	7-1/2 (191)	11-1/2 (292)	2-1/8 (54)	- -	10-7/8 (276)	23-5/8 (600)	1-3/4 (44)	353 (160)	390 (177)
6 x 4 x 6 (150 x 100 x 150)	4 (102)	24 (610)	24 (610)	24-1/8 (613)	6-7/8 (175)	7-1/2 (191)	10-1/4 (260)	2-1/8 (54)	- -	10-7/8 (276)	23-5/8 (600)	1-3/4 (44)	357 (162)	489 (222)

ASME CLASS 1500

SIZE in. (mm)	D	E WE	E RF	E RTJ	F	G	S	H	L	A	K	M	WEIGHT WE	WEIGHT lb (kg) RF/RTJ
1-1/2 (40)	1-1/2 (38)	12 (305)	12 (305)	12 (305)	4 (102)	4-1/2 (114)	5-1/8 (130)	7/8 (22)	15-7/8 (403)	- -	- -	- -	44 (20)	68 (31)
2 x 1-1/2 x 2 (50 x 40 x 50)	1-1/2 (38)	14-1/2 (368)	14-1/2 (368)	14-5/8 (372)	4 (102)	4-1/2 (114)	5-1/8 (130)	7/8 (22)	15-7/8 (403)	- -	- -	- -	49 (22)	95 (43)
2 (50)	2 (51)	14-1/2 (368)	14-1/2 (368)	14-5/8 (372)	4-1/2 (114)	4-7/8 (124)	6-3/8 (162)	7/8 (22)	24-1/4 (616)	- -	- -	- -	77 (35)	130 (59)
3 x 2 x 3 (80 x 50 x 80)	2 (51)	18-1/2 (470)	18-1/2 (470)	18-5/8 (473)	4-1/2 (114)	4-7/8 (124)	6-3/8 (162)	7/8 (22)	24-1/4 (616)	- -	- -	- -	108 (49)	168 (76)
3 (80)	3 (76)	18-1/2 (470)	18-1/2 (470)	18-5/8 (473)	5-5/8 (143)	6-1/8 (156)	8-3/8 (213)	2-1/8 (54)	- -	6-3/4 (171)	11-3/4 (298)	1-1/4 (32)	179 (81)	240 (109)
4 x 3 x 4 (100 x 80 x 100)	3 (76)	21-1/2 (546)	21-1/2 (546)	21-5/8 (549)	5-5/8 (143)	6-1/8 (156)	8-3/8 (213)	2-1/8 (54)	- -	6-3/4 (171)	11-3/4 (298)	1-1/4 (32)	185 (84)	311 (141)
4 (100)	4 (102)	21-1/2 (546)	21-1/2 (546)	21-5/8 (549)	6-7/8 (175)	7-1/2 (191)	12-1/4 (311)	2-1/8 (54)	- -	10-7/8 (276)	23-5/8 (600)	1-3/4 (44)	355 (161)	399 (181)
6 x 4 x 6 (150 x 100 x 150)	4 (102)	27-3/4 (705)	27-3/4 (705)	28 (711)	6-7/8 (175)	7-1/2 (191)	10-1/4 (260)	2-1/8 (54)	- -	10-7/8 (276)	23-5/8 (600)	1-3/4 (44)	366 (166)	628 (285)

Flanges in accordance with ASME B16.5
Shaded bore sizes (D) according to API 6D
Shaded end-to-end dimensions (E) according to API 6D

Butt welding ends according to ASME B16.25
Outlined end-to-end dimensions (E) according to ASME B16.10

GROVE B5

DESIGN FEATURES

Standard Features

- Double-barrier stem seals
- Stem separated from the ball; anti-blowout design; no side load on the stem
- Bearing blocks absorb the pressure load on the ball
- Primary metal-to-metal seal and secondary protected synthetic O-ring seal
- Double-sealing barrier in both directions (DPE)
- Body relief valve for overpressure due to liquid thermal expansion
- Built-in sealant injection system for emergency seat seal
- Metal-backed, self-lubricating PTFE sleeve bearing and thrust washers reduce torque and extend service life
- Nickel plating for trim parts
- Trunnion mounted ball for ease of operation at high pressure
- Large-diameter, short coupled trunnions to reduce unit bearing loads and operating torque
- Bolted construction permits disassembly in the field for repairs
- Integral stop in the adapter plate for a permanent reference to open and closed position
- Antistatic device

Options

- Triple-barrier stem seals
- Emergency grease fitting for stem
- Self-relieving seats
- Plastic polymer O-ring or insert for primary seat sealing
- Double block-and-bleed capabilities
- PTFE various grades of reinforced gaskets, spring energized, for stem and seat sealing
- Metal-to-metal seat
- Explosive decompression-resistant seal





DESIGN FEATURES (CONT.)

Body Construction

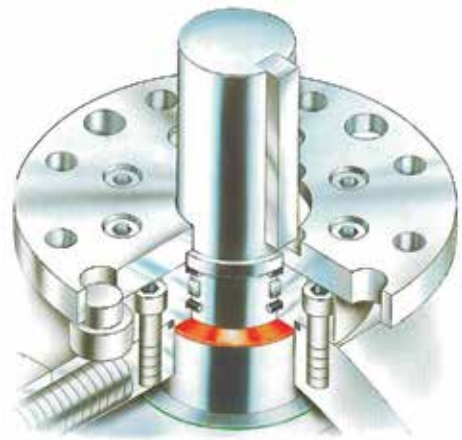
The body is made of three forged parts, and the bolted construction allows disassembly in the field for repairs. The bolts threads areas are per ISO metric or ASME imperial, depending on the market request. The tightening of the bolts is made by hydraulic tools with a predetermined torque. The body drain is located in the lowest part of the body cavity and consists of an NPT drain valve with safety plug.

Stem Construction

The stem of Cameron's GROVE B5 valve is separated from the ball and is connected to the upper ball trunnion by steel pins. Bearing blocks are located on the upper and lower ball trunnions, which absorb all the pressure load on the ball.

The stem is a free member and carries no side thrust.The absence of this side load and friction drag on the stem ensures lower operating torque and long service life.

The stem is sealed by means of two O-rings. If leakage should ever occur through both stem seals, the outer O-ring can be replaced with the valve in the line, under pressure with the ball in the closed position. With no pressure in-line, it is possible to remove the gland plate for replacement of both primary and outer stem O-rings. The stem also can be removed and replaced if necessary.



Torque

Cameron's GROVE B5 valve's low operating torque is due to a combination of factors:

- The design of the stem, which is separated from the ball
- The side loads, brought on by differential pressure, are absorbed by two (upper and lower) rigid bearing retainers and large-diameter, short coupled trunnions to reduce unit bearing loads
- The metal-backed, self-lubricating sleeve bearing and the thrust washers reduce the torque and extend service life

Ball Position

The ball's open and closed positions are ensured by corresponding stops on the adapter plate.

The valve normally is mounted with the actuator stops or the gear stops set at the factory as primary stops.
An “open/closed” indicator also is provided.





Seat Seals

The GROVE B5 seat design ensures double-barrier sealing in both directions (the normal self-relieving seats are a simple barrier of sealing). The sealing is performed by both a primary metal-to-metal seal and a secondary protected O-ring seal.

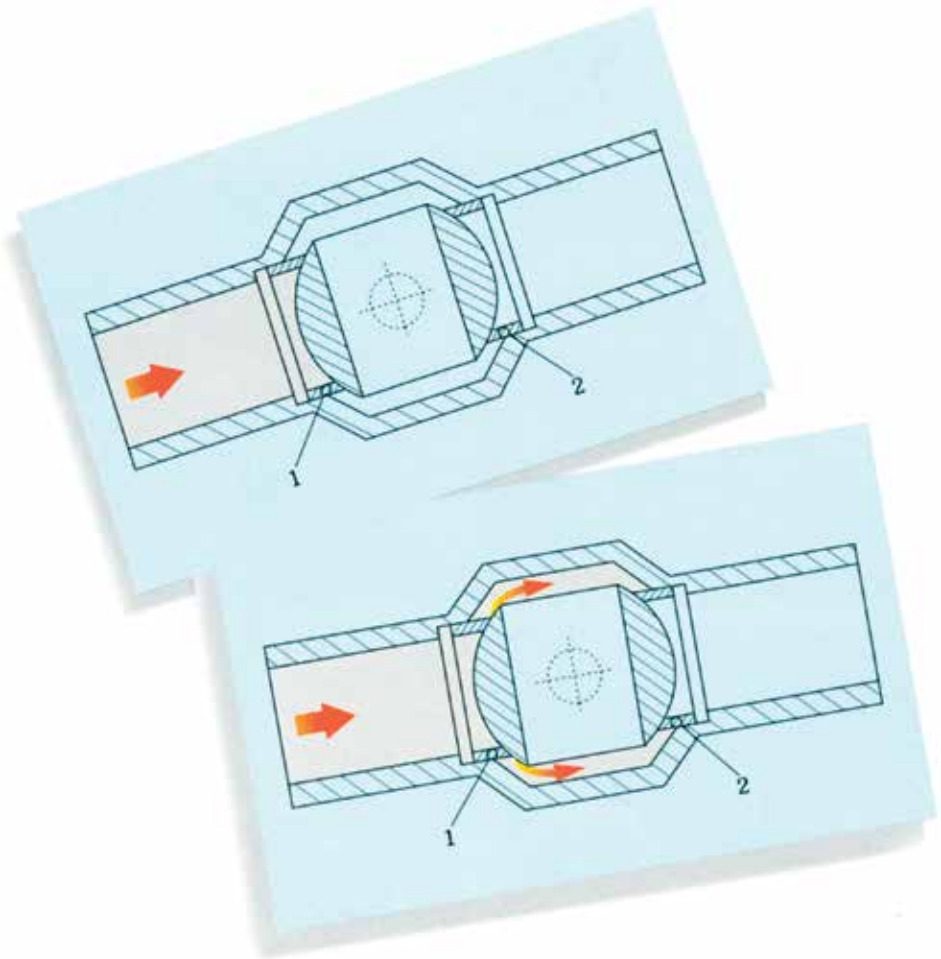
Double Piston Effect (DPE)

The DPE seat design was invented and patented by Cameron's GROVE team. The DPE seat design allows for both seats to seal with pressure acting from the same side of the valve. In the event one seat becomes damaged, the user has the added advantage of the opposite seat sealing. By means of this double barrier, the sealing is ensured regardless of the direction of the flow through the valve.

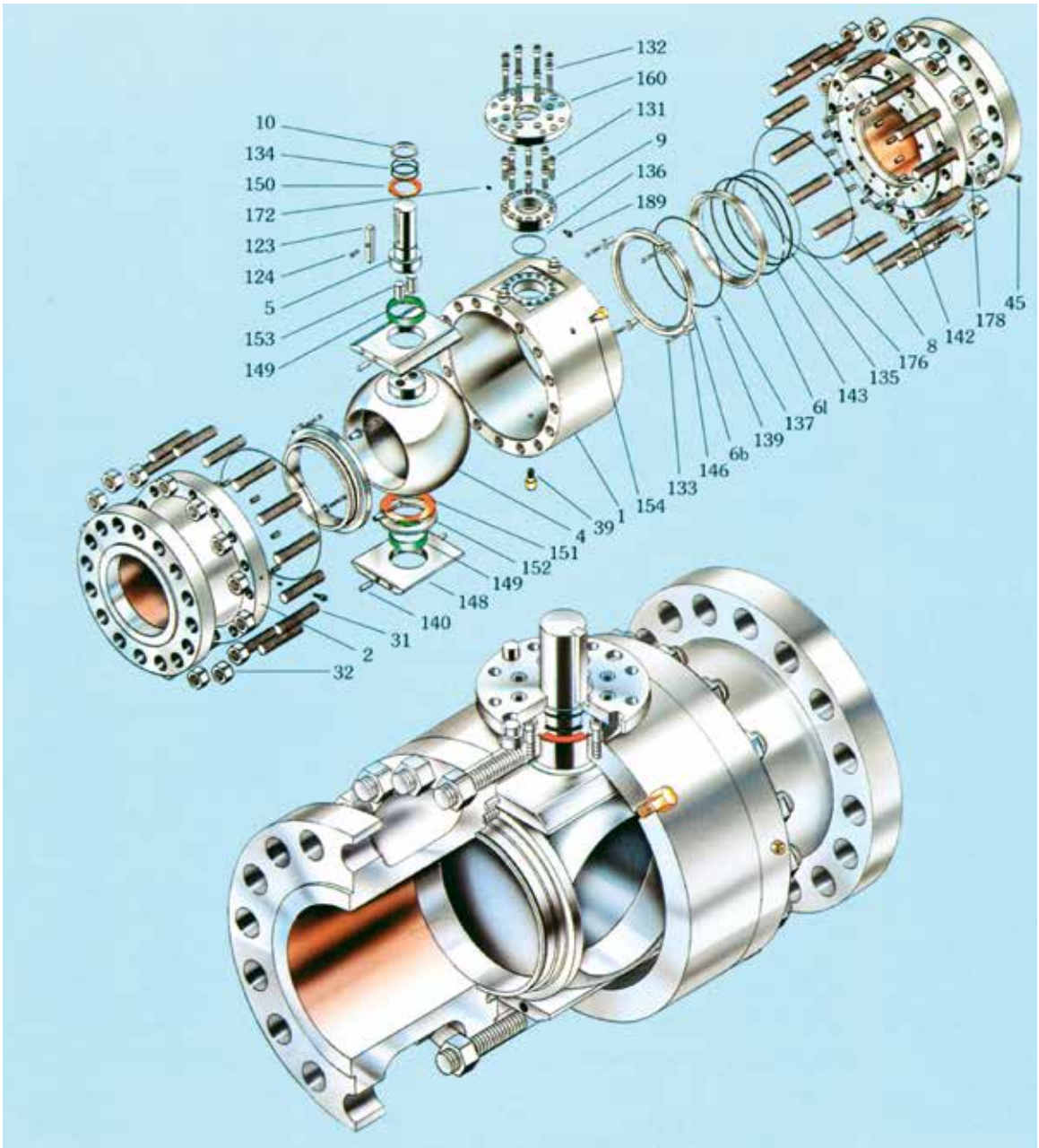
If the upstream seat (1) becomes damaged and leaks, the pressure entering the body cavity acts on the downstream seat (2), sealing the downstream seat tightly against the ball.

Note: The DPE feature and the double block-and-bleed feature are not to be confused with one another.

The initial seal, at extremely low pressure differential or vacuum conditions, is obtained with spring-loaded floating seats, which are free to move slightly along the longitudinal axis of the valve. Line pressure behind the seat ring supplements the seat spring load to force the seat tightly against the ball.



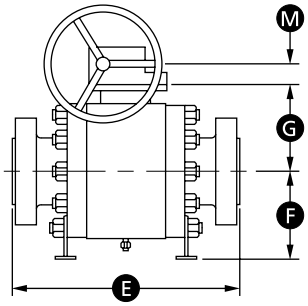
VALVE ASSEMBLY AND CROSS SECTION

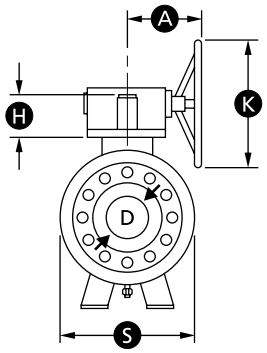


Item	Description	Item	Description	Item	Description
1	Body	45	Grease Fitting	146	Puller Bushing
2	Closure	123	Stem Key	148	Bearing Retainer
4	Ball	124	Stem Key Capscrew	149	Bearing
5	Stem	131	Gland Plate Capscrew	150	Upper Thrust Washer
6b	Outer Seat Ring	132	Adapter Plate Capscrew	151	Lower Thrust Washer
6l	Inner Seat Ring	134	Stem O-ring	152	Spacer
8	Body O-ring	135	Seat O-ring	153	Drive Pin
9	Gland Plate	136	Gland Plate O-ring	154	Relief Valve
10	Gland Bushing	137	Seal O-ring	160	Adapter Plate
31	Body Stud	139	Seat Spring Pin	172	Vent Plug
32	Body Stud Nut	140	Bearing Retainer Pin	176	U-cup Packing
39	Drain Valve	142	Spring	178	Check Valve
		143	Seat Lock Ring	189	Gland Vent

DIMENSIONS AND WEIGHTS

ASME CLASS 150





ASME CLASS 150

SIZE in. (mm)	D	E WE	E RF	E RTJ	F	G	S	H	L	A	K	M	WEIGHT WE	lb (kg) RF/RTJ
6 (150)	6 (152)	18 457)	15-1/2 (394)	16 (406)	11-7/8 (302)	8-1/2 (108)	11-7/8 (302)	2-3/4 (70)	-	8-3/4 (222)	13-3/4 (349)	2-5/8 (67)	440 (200)	520 (236)
8 (200)	8 (203)	20-1/2 (521)	18 (457)	18-1/2 (470)	13-3/8 (340)	9-7/8 (108)	15-5/8 (397)	2-3/4 (70)	-	8-3/4 (222)	13-3/4 (349)	2-5/8 (67)	720 (327)	850 (386)
10 (250)	10 (254)	22 (559)	21 (533)	21-1/2 (546)	14-7/8 (378)	11-5/8 (118)	18-1/4 (464)	2-3/4 (70)	-	8-3/4 (222)	13-3/4 (349)	2-5/8 (67)	1050 (476)	1250 (567)
12 (300)	12 (305)	25 (635)	24 (610)	24-1/2 (622)	16-3/8 (416)	13-1/2 (118)	21-5/8 (549)	2-3/4 (70)	-	8-3/4 (222)	13-3/4 (349)	2-5/8 (67)	1450 (658)	1740 (789)
14 (350)	13-1/4 (337)	30 (762)	27 (686)	27-1/2 (699)	18-3/8 (467)	14-5/8 (143)	23 (584)	3-3/4 (95)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	1800 (816)	2160 (980)
16 (400)	15-1/4 (387)	33 (838)	30 (762)	30-1/2 (775)	19-7/8 (505)	16-1/4 (143)	26-3/8 (670)	3-3/4 (95)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	2160 (980)	2570 (1166)
18 (450)	17-1/4 (438)	36 (914)	34 (864)	34-1/2 (876)	21-1/2 (546)	18 (168)	29-7/8 (759)	4-1/2 (114)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	3020 (1370)	3610 (1637)
20 (500)	19-1/4 (489)	39 (991)	36 (914)	36-1/2 (927)	23-1/8 (587)	19-3/8 (168)	32-7/8 (835)	4-1/2 (114)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	4050 (1837)	4850 (2200)
22 (550)	21-1/4 (540)	(1)	(1)	(1)	24-7/8 (632)	21-1/8 (537)	36-1/4 (921)	4-1/2 (114)	-	15-3/4 (400)	23-5/8 (600)	4-3/8 (111)	5020 (2277)	6010 (2726)
24 (600)	23-1/4 (591)	45 (1143)	42 (1067)	42-1/2 (1080)	26-3/8 (670)	22-1/2 (572)	38-7/8 (988)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	6010 (2726)	7200 (3266)
26 (650)	25 (635)	49 (1245)	45 (1143)	(1)	28-1/4 (718)	24-1/2 (622)	41-3/4 (1060)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	7600 (3447)	9120 (4137)
28 (700)	27 (686)	53 (1346)	49 (1245)	(1)	29-5/8 (753)	25-7/8 (657)	44-3/4 (1137)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	8700 (3946)	10440 (4736)
30 (750)	29 (737)	55 (1397)	51 (1295)	(1)	31-3/4 (806)	27-1/2 (699)	48-5/8 (1235)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	10,420 (4726)	12,500 (5670)
32 (800)	30-3/4 (781)	60 (1524)	54 (1372)	(1)	33-1/4 (845)	29 (737)	51 (1295)	8-1/8 (206)	-	21-5/8 (549)	23-5/8 (600)	5-3/8 (137)	11,860 (5380)	14,210 (6446)
34 (850)	32-3/4 (832)	64 (1626)	58 (1473)	(1)	34-3/8 (873)	30-7/8 (784)	53-3/8 (1356)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	14,500 (6577)	17,390 (7888)
36 (900)	34-1/2 (876)	68 (1727)	60 (1524)	(1)	35-3/4 (908)	32-3/8 (822)	56-3/4 (1441)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	16,880 (7657)	20,260 (9190)
40 (1000)	38-1/2 (978)	(1)	(1)	(1)	39-3/8 (1000)	35-5/8 (905)	63-7/8 (1623)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	21,560 (9779)	25,850 (11,725)
42 (1050)	40-1/4 (1022)	(1)	(1)	(1)	40-3/4 (1035)	38-1/8 (968)	67-3/8 (1711)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	25,390 (11,517)	30,460 (13,816)
46 (1150)	44 (1118)	(1)	(1)	(1)	44-5/8 (1134)	42-1/2 (1080)	74-1/2 (1892)	8-1/8 (206)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	30,860 (13,998)	37030 (16,797)
48 (1200)	46 (1168)	(1)	(1)	(1)	46-3/8 (1178)	44-3/8 (1127)	77-1/2 (1969)	8-1/8 (206)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	35270 (15,998)	42320 (19,196)
56 (1400)	54-1/2 (1384)	(1)	(1)	(1)	52-3/4 (1321)	50-3/8 (1280)	89-3/4 (2280)	9-5/8 (245)	-	-	-	-	54010 (24,499)	64810 (29,397)
60 (1500)	57-1/2 (1461)	(1)	(1)	(1)	56-3/8 (1432)	55-1/8 (1400)	96-3/8 (2448)	9-5/8 (245)	-	-	-	-	66130 (29,996)	79,360 (35,997)

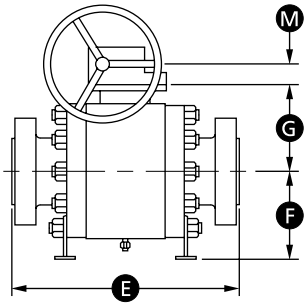
(1) Upon request

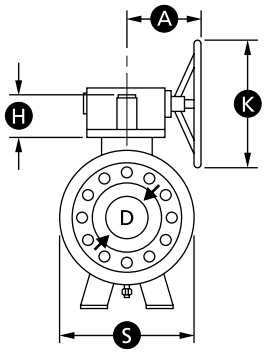
Flanges in accordance with ASME B16.5

Shaded bore sizes (D) according to API 6D
Shaded end-to-end dimensions (E) according to API 6D
Butt welding ends according to ASME B16.25

Larger sizes available on request
Reduced-bore valves also available

ASME CLASS 300





ASME CLASS 300

SIZE in. (mm)	D	E WE	E RF	E RTJ	F	G	S	H	L	A	K	M	WEIGHT lb (kg) WE	WEIGHT lb (kg) RF/RTJ
6 (150)	6 (152)	18 (457)	15-7/8 (403)	16-1/2 (419)	11-7/8 (302)	8-1/2 (108)	12 (305)	2-3/4 (70)	-	8-3/4 (222)	13-3/4 (349)	2-5/8 (67)	460 (209)	550 (249)
8 (200)	8 (203)	20-1/2 (521)	19-3/4 (502)	20-3/8 (518)	13-3/8 (340)	9-7/8 (108)	15-7/8 (403)	2-3/4 (70)	-	8-3/4 (222)	13-3/4 (349)	2-5/8 (67)	740 (336)	880 (399)
10 (250)	10 (254)	22 (559)	22-3/8 (568)	23 (584)	14-7/8 (378)	11-5/8 (118)	18-3/8 (467)	3-3/4 (95)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	1100 (499)	1320 (599)
12 (300)	12 (305)	25 (635)	25-1/2 (648)	26-1/8 (664)	16-3/8 (416)	13-1/2 (118)	21-3/4 (552)	3-3/4 (95)	-	11-1/2 (222)	13-3/4 (349)	3 (67)	1520 (689)	1800 (816)
14 (350)	13-1/4 (337)	30 (762)	30 (762)	30-5/8 (778)	18-3/8 (467)	14-5/8 (143)	23-1/4 (591)	4-1/2 (114)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	1890 (857)	2270 (1030)
16 (400)	15-1/4 (387)	33 (838)	33 (838)	33-5/8 (854)	19-7/8 (505)	16-1/4 (143)	26-3/4 (679)	4-1/2 (114)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	2240 (1016)	2680 (1216)
18 (450)	17-1/4 (438)	36 (914)	36 (914)	36-5/8 (930)	21-1/2 (546)	18 (168)	30-1/4 (768)	4-1/2 (114)	-	15-3/4 (400)	23-5/8 (600)	4-3/8 (111)	3150 (1429)	3760 (1706)
20 (500)	19-1/4 (489)	39 (991)	39 (991)	39-3/4 (1010)	23-1/8 (587)	16-7/8 (429)	33-1/4 (845)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	4250 (1928)	5090 (2309)
22 (550)	21-1/4 (540)	43 (1092)	43 (1092)	43-7/8 (1115)	24-7/8 (632)	21-1/8 (537)	36-5/8 (930)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	5260 (2386)	6300 (2858)
24 (600)	23-1/4 (591)	45 (1143)	45 (1143)	45-7/8 (1165)	26-3/8 (670)	22-1/2 (572)	39-1/4 (997)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	6300 (2858)	7560 (3429)
26 (650)	25 (635)	49 (1245)	49 (1245)	50 (1270)	28-1/4 (718)	24-1/2 (622)	42-1/8 (1070)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	7980 (3620)	9560 (4336)
28 (700)	27 (686)	53 (1346)	53 (1346)	54 (1372)	29-5/8 (753)	25-7/8 (657)	45-1/4 (1149)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	9120 (4137)	10,930 (4958)
30 (750)	29 (737)	55 (1397)	55 (1397)	56 (1422)	31-3/4 (806)	27-1/2 (699)	49-1/8 (1248)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	10,930 (4958)	13,110 (5947)
32 (800)	30-3/4 (781)	60 (1524)	60 (1524)	61-1/8 (1553)	33-1/4 (845)	29 (737)	51-1/2 (1308)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	12,430 (5638)	14,900 (6759)
34 (850)	32-3/4 (832)	64 (1626)	64 (1626)	65-1/8 (1654)	34-3/8 (873)	30-7/8 (784)	53-7/8 (1369)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	15,210 (6899)	18,250 (8278)
36 (900)	34-1/2 (876)	68 (1727)	68 (1727)	69-1/8 (1756)	35-3/4 (908)	32-3/8 (822)	57-3/8 (1457)	8-1/8 (206)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	17,720 (8038)	21,250 (9639)
40 (1000)	38-1/2 (978)	(1)	(1)	(1)	39-3/8 (1000)	35-5/8 (905)	64-1/2 (1638)	8-1/8 (206)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	22,610 (10,256)	27,130 (12,306)
42 (1050)	40-1/4 (1022)	(1)	(1)	(1)	40-3/4 (1035)	38-1/8 (968)	68-1/8 (1730)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	26,650 (12,088)	31,960 (14,497)
46 (1150)	44 (1118)	(1)	(1)	(1)	44-5/8 (1134)	42-1/2 (1080)	75-1/4 (1911)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	32,400 (14,696)	38,880 (17,636)
48 (1200)	46 (1168)	(1)	(1)	(1)	46-3/8 (1178)	44-3/8 (1127)	78-1/4 (1988)	9-5/8 (245)	-	25-5/8 (651)	47-1/4 (1200)	6-5/8 (168)	37,030 (16,797)	44,440 (20,158)
56 (1400)	54-1/2 (1384)	(1)	(1)	(1)	52-3/4 (1321)	50-3/8 (1280)	90-3/4 (2305)	9-5/8 (245)	-	-	-	-	56,700 (25,719)	68,030 (30,858)
60 (1500)	57-1/2 (1461)	(1)	(1)	(1)	56-3/8 (1432)	55-1/8 (1400)	97-1/2 (2477)	9-5/8 (245)	-	-	-	-	69,440 (31,497)	83,330 (37,798)

(1) Upon request

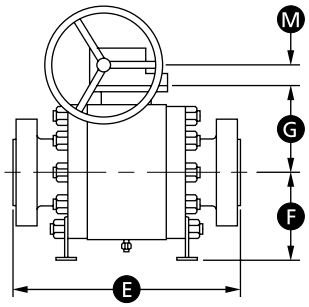
Flanges in accordance with ASME B16.5

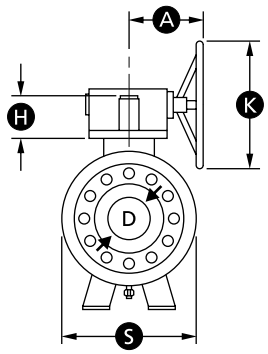
Shaded bore sizes (D) according to API 6D
Shaded end-to-end dimensions (E) according to API 6D

Butt welding ends according to ASME B16.25

DIMENSIONS AND WEIGHTS (CONT.)

ASME CLASS 400





ASME CLASS 400

SIZE in. (mm)	D	E WE	E RF	E RTJ	F	G	S	H	L	A	K	M	WEIGHT WE	lb (kg) RF/RTJ
6 (150)	6 (152)	19-1/2 (495)	19-1/2 (495)	19-5/8 (499)	12-1/8 (308)	8-1/2 (108)	12-1/8 (308)	2-3/4 (70)	-	8-3/4 (222)	13-3/4 (349)	2-5/8 (67)	520 (236)	610 (277)
8 (200)	8 (203)	23-1/2 (597)	23-1/2 (597)	23-5/8 (600)	13-5/8 (346)	9-7/8 (108)	16 (406)	3-3/4 (95)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	850 (386)	1010 (458)
10 (250)	10 (254)	26-1/2 (673)	26-1/2 (673)	26-5/8 (676)	15-1/4 (387)	11-5/8 (118)	18-5/8 (473)	3-3/4 (95)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	1250 (567)	1490 (676)
12 (300)	12 (305)	30 (762)	30 (762)	30-1/8 (765)	16-3/4 (425)	13-1/2 (118)	22 (559)	3-3/4 (95)	-	11-1/2 (292)	13-3/4 (349)	3 (67)	1740 (789)	2070 (939)
14 (350)	13-1/4 (337)	32-1/2 (826)	32-1/2 (826)	32-5/8 (829)	18-3/4 (476)	14-5/8 (143)	23-1/2 (597)	4-1/2 (114)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	2160 (980)	2570 (1166)
16 (400)	15-1/4 (387)	35-1/2 (902)	35-1/2 (902)	35-5/8 (905)	20-3/8 (518)	16-1/4 (143)	27 (686)	4-1/2 (114)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	2570 (1166)	3080 (1397)
18 (450)	17-1/4 (438)	38-1/2 (978)	38-1/2 (978)	38-5/8 (981)	21-7/8 (556)	18 (168)	30-1/2 (775)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	3610 (1637)	4320 (1960)
20 (500)	19-1/4 (489)	41-1/2 (1054)	41-1/2 (1054)	41-3/4 (1056)	23-1/2 (597)	19-3/8 (492)	33-1/2 (851)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	4870 (2209)	5840 (2649)
22 (550)	21-1/4 (540)	45 (1143)	45 (1143)	45-3/8 (1153)	25-3/8 (645)	21-1/8 (537)	37 (940)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	6040 (2740)	7230 (3279)
24 (600)	23-1/4 (591)	48-1/2 (1232)	48-1/2 (1232)	48-7/8 (1242)	26-7/8 (683)	22-1/2 (572)	39-5/8 (1007)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	7230 (3279)	8660 (3928)
26 (650)	25 (635)	51-1/2 (1308)	51-1/2 (1308)	51 (1295)	28-7/8 (734)	24-1/2 (622)	42-1/2 (1080)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	9170 (4159)	11,000 (4990)
28 (700)	27 (686)	55 (1397)	55 (1397)	55-1/2 (1410)	30-1/4 (768)	25-7/8 (657)	45-5/8 (1159)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	10,490 (4758)	12,580 (5706)
30 (750)	29 (737)	60 (1524)	60 (1524)	60-1/2 (1537)	32-3/8 (822)	27-1/2 (699)	49-5/8 (1261)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	12,560 (5697)	15,070 (6836)
32 (800)	30-3/4 (781)	65 (1651)	65 (1651)	65-5/8 (1667)	33-7/8 (861)	29 (737)	52 (1321)	8-1/8 (206)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	14,280 (6477)	17,120 (7766)
34 (850)	32-3/4 (832)	70 (1778)	70 (1778)	70-5/8 (1794)	35-1/8 (892)	30-7/8 (784)	54-1/2 (1384)	8-1/8 (206)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	17,480 (7929)	20,960 (9507)
36 (900)	34-1/2 (876)	74 (1880)	74 (1880)	74-5/8 (1896)	36-1/2 (927)	32-3/8 (822)	58 (1473)	8-1/8 (206)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	20,370 (9240)	24,420 (11,077)
40 (1000)	38-1/2 (978)	(1)	(1)	(1)	40-1/8 (1019)	35-5/8 (905)	65-1/8 (1654)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	25,990 (11,789)	31,170 (14,138)
42 (1050)	40-1/4 (1022)	(1)	(1)	(1)	41-1/2 (1054)	38-1/8 (968)	68-3/4 (1746)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	30,640 (13,898)	36,770 (16,679)
46 (1150)	44 (1118)	(1)	(1)	(1)	45-5/8 (1159)	42-1/2 (1080)	76 (2007)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	37,250 (16,896)	44,700 (20,276)
48 (1200)	46 (1168)	(1)	(1)	(1)	47-3/8 (1203)	44-3/8 (1127)	79 (1988)	9-5/8 (245)	-	25-5/8 (651)	47-1/4 (1200)	6-5/8 (168)	42,590 (19,319)	51,100 (23,179)
56 (1400)	54-1/2 (1384)	(1)	(1)	(1)	53-3/4 (1365)	50-3/8 (1280)	91-5/8 (2327)	11 (279)	-	-	-	-	65,180 (29,565)	78,210 (35,475)
60 (1500)	57-1/2 (1461)	(1)	(1)	(1)	57-1/2 (1461)	55-1/8 (1400)	98-3/8 (2499)	11 (279)	-	-	-	-	79,850 (36,219)	95,810 (43,459)

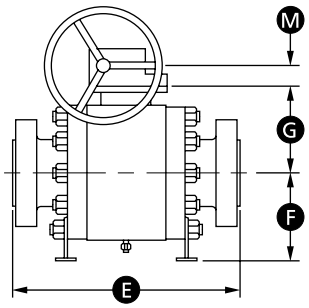
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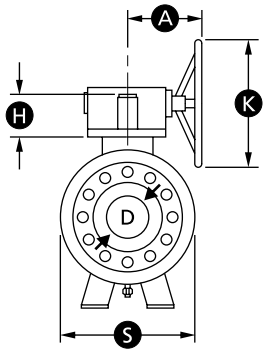
Flanges in accordance with ASME B16.5

Shaded bore sizes (D) according to API 6D
Shaded end-to-end dimensions (E) according to API 6D

Butt welding ends according to ASME B16.25

ASME CLASS 600





ASME CLASS 600

SIZE in. (mm)	D	E WE	E RF	E RTJ	F	G	S	H	L	A	K	M	WEIGHT WE	lb (kg) RF/RTJ
6 (150)	6 (152)	22 (559)	22 (559)	22-1/8 (562)	12-1/4 (311)	8-1/2 (108)	12-1/4 (311)	2-3/4 (70)	-	8-3/4 (222)	13-3/4 (349)	2-5/8 (67)	570 (259)	680 (308)
8 (200)	8 (203)	26 (660)	26 (660)	26-1/8 (664)	13-3/4 (349)	9-7/8 (108)	16-1/8 (410)	3-3/4 (95)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	920 (417)	1100 (500)
10 (250)	10 (254)	31 (787)	31 (787)	31-1/8 (790)	15-3/8 (391)	11-5/8 (118)	18-7/8 (480)	3-3/4 (95)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	1360 (617)	1630 (739)
12 (300)	12 (305)	33 (838)	33 (838)	33-1/8 (841)	16-7/8 (429)	13-1/2 (118)	22-1/4 (565)	3-3/4 (95)	-	11-1/2 (292)	13-3/4 (349)	3 (67)	1890 (857)	2270 (1030)
14 (350)	13-1/4 (337)	35 (889)	35 (889)	35-1/8 (892)	18-7/8 (480)	14-5/8 (143)	23-3/4 (603)	4-1/2 (114)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	2330 (1057)	2790 (1266)
16 (400)	15-1/4 (387)	39 (991)	39 (991)	39-1/8 (994)	20-1/2 (521)	16-1/4 (143)	27-1/4 (692)	4-1/2 (114)	-	15-3/4 (400)	23-5/8 (600)	4-3/8 (111)	2790 (1266)	3350 (1520)
18 (450)	17-1/4 (438)	43 (1092)	43 (1092)	43-1/8 (1095)	22-1/8 (562)	18 (168)	30-7/8 (784)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	3920 (1778)	4690 (2127)
20 (500)	19-1/4 (489)	47 (1194)	47 (1194)	47-1/4 (1200)	23-3/4 (603)	19-3/8 (492)	33-7/8 (861)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	5290 (2400)	6340 (2876)
22 (550)	21-1/4 (540)	51 (1295)	51 (1295)	51-3/8 (1305)	25-5/8 (651)	21-1/8 (537)	37-3/8 (949)	8-1/8 (206)	-	21-5/8 (549)	23-5/8 (600)	5-3/8 (137)	6560 (2976)	7870 (3570)
24 (600)	23-1/4 (591)	55 (1397)	55 (1397)	55-3/8 (1407)	27-1/8 (689)	22-1/2 (572)	40-1/8 (1019)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	7870 (3570)	9430 (4277)
26 (650)	25 (635)	57 (1448)	57 (1448)	57-1/2 (1461)	29-1/8 (740)	24-1/2 (622)	43 (1092)	8-1/8 (206)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	9980 (4527)	11,970 (5430)
28 (700)	27 (686)	61 (1549)	61 (1549)	61-1/2 (1562)	30-1/2 (775)	25-7/8 (657)	46-1/8 (1172)	8-1/8 (206)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	11,410 (5175)	13,690 (6210)
30 (750)	29 (737)	65 (1651)	65 (1651)	65-1/2 (1664)	32-5/8 (829)	27-1/2 (699)	50-1/8 (1273)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	13,690 (6210)	16,420 (7448)
32 (800)	30-3/4 (781)	70 (1778)	70 (1778)	70-5/8 (1794)	34-1/4 (870)	29 (737)	52-1/2 (1334)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	15,560 (7058)	18,670 (8469)
34 (850)	32-3/4 (832)	76 (1930)	76 (1930)	76-5/8 (1946)	35-3/8 (899)	30-7/8 (784)	55 (1397)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	19,040 (8636)	22,830 (10,356)
36 (900)	34-1/2 (876)	82 (2083)	82 (2083)	82-5/8 (2099)	36-7/8 (937)	32-3/8 (822)	58-1/2 (1486)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	22,200 (10,070)	26,630 (12,079)
40 (1000)	38-1/2 (978)	(1)	(1)	(1)	40-1/2 (1029)	35-5/8 (905)	65-7/8 (1673)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	28,320 (12,846)	33,990 (15,418)
42 (1050)	40-1/4 (1022)	(1)	(1)	(1)	42 (1067)	38-1/8 (968)	69-1/2 (1765)	9-5/8 (245)	-	25-5/8 (651)	47-1/4 (1200)	6-5/8 (168)	33,390 (15,145)	40,070 (18,175)
46 (1150)	44 (1118)	(1)	(1)	(1)	46-1/8 (1171)	42-1/2 (1080)	76-3/4 (1949)	9-5/8 (245)	-	25-5/8 (651)	47-1/4 (1200)	6-5/8 (168)	40,600 (18,416)	48,720 (22,099)
48 (1200)	46 (1168)	85-7/8 (2181)	85-7/8 (2181)	(1)	47-7/8 (1216)	44-3/8 (1127)	79-7/8 (2029)	9-5/8 (245)	-	25-5/8 (651)	47-1/4 (1200)	6-5/8 (168)	46,400 (21,047)	55,680 (25,256)
56 (1400)	54-1/2 (1384)	(1)	(1)	(1)	54-3/8 (1381)	50-3/8 (1280)	92-5/8 (2353)	11 (279)	-	-	-	-	71,050 (32,228)	85,250 (38,669)
60 (1500)	57-1/2 (1461)	(1)	(1)	(1)	58-1/8 (1476)	55-1/8 (1400)	99-3/8 (2524)	11 (279)	-	-	-	-	87,010 (39,467)	104,400 (47,355)

(1) Upon request

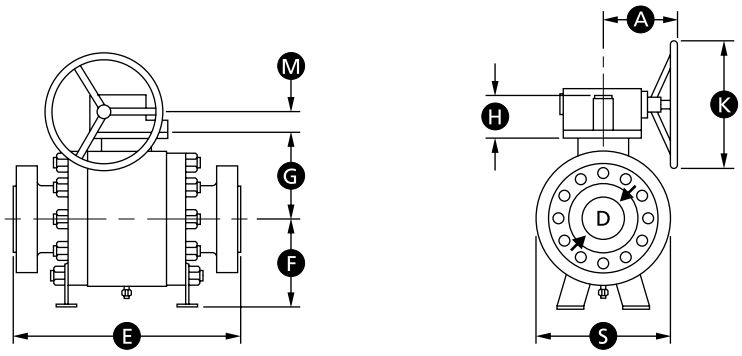
Flanges in accordance with ASME B16.5

Shaded bore sizes (D) according to API 6D
Shaded end-to-end dimensions (E) according to API 6D

Butt welding ends according to ASME B16.25

DIMENSIONS AND WEIGHTS (CONT.)

ASME CLASS 900



ASME CLASS 900

SIZE in. (mm)	D	E WE	E RF	E RTJ	F	G	S	H	L	A	K	M	WEIGHT lb (kg) WE	WEIGHT lb (kg) RF/RTJ
6 (150)	6 (152)	24 (610)	24 (610)	24-1/8 (613)	9-7/8 (251)	9-1/2 (241)	13-1/4 (337)	3-3/4 (95)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	720 (327)	850 (386)
8 (200)	8 (203)	29 (737)	29 (737)	29-1/8 (740)	11-3/8 (289)	10-7/8 (276)	16-1/2 (419)	3-3/4 (95)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	1190 (540)	1410 (640)
10 (250)	10 (254)	33 (838)	33 (838)	33-1/8 (841)	13-5/8 (346)	12-1/2 (318)	20-1/8 (511)	4-1/2 (114)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	1760 (798)	2110 (957)
12 (300)	12 (305)	38 (965)	38 (965)	38-1/8 (968)	15-3/8 (391)	14-3/8 (365)	23-5/8 (600)	4-1/2 (114)	-	11-1/2 (292)	13-3/4 (349)	3 (67)	2440 (1107)	2930 (1329)
14 (350)	12-3/4 (324)	40-1/2 (1029)	40-1/2 (1029)	40-7/8 (1038)	17-3/4 (451)	15-3/8 (391)	26-3/4 (679)	4-1/2 (114)	-	15-3/4 (400)	23-5/8 (600)	4-3/8 (111)	3020 (1370)	3610 (1637)
16 (400)	14-3/4 (375)	44-1/2 (1130)	44-1/2 (1130)	44-7/8 (1140)	19-5/8 (499)	16-7/8 (429)	30-3/8 (772)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	3630 (1647)	4360 (1978)
18 (450)	16-3/4 (425)	48 (1219)	48 (1219)	48-1/2 (1232)	21-5/8 (549)	19-1/8 (486)	33-1/2 (851)	7-1/8 (181)	-	21-5/8 (549)	31-1/2 (800)	5-3/8 (137)	5090 (2309)	6100 (2767)
20 (500)	18-5/8 (473)	52 (1321)	52 (1321)	52-1/2 (1334)	23-1/4 (591)	20-7/8 (530)	36-1/4 (921)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	6-1/4 (159)	6870 (3116)	8240 (3738)
22 (550)	20-5/8 (524)	(1)	(1)	(1)	25-3/4 (654)	21-7/8 (556)	40-1/2 (1029)	8-1/8 (206)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	8530 (3869)	10,220 (4636)
24 (600)	22-1/2 (572)	61 (1549)	61 (1549)	61-3/4 (1568)	27-1/2 (699)	24-3/8 (619)	43-3/4 (1111)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	10,220 (4636)	12,250 (5557)
26 (650)	24-3/8 (619)	(1)	(1)	(1)	29-7/8 (759)	26-1/4 (667)	47-1/4 (1200)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	12,960 (5879)	15,540 (7049)
28 (700)	26-1/4 (667)	(1)	(1)	(1)	31-7/8 (810)	27-7/8 (708)	50-3/4 (1289)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	14,830 (6727)	17,790 (8069)
30 (750)	28-1/8 (715)	(1)	(1)	(1)	32-3/4 (832)	29-5/8 (753)	53-3/8 (1356)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	17,790 (8069)	21,340 (9680)
32 (800)	30 (762)	(1)	(1)	(1)	35-7/8 (911)	31-7/8 (810)	57-1/2 (1461)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	20,210 (9167)	24,250 (11,000)
34 (850)	31-7/8 (810)	(1)	(1)	(1)	37-3/4 (959)	33-3/8 (848)	61 (1549)	9-5/8 (245)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	24,750 (11,226)	29,690 (13,467)
36 (900)	33-3/4 (857)	(1)	(1)	(1)	40-1/8 (1019)	34-3/4 (883)	64-3/8 (1635)	11 (279)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	28,850 (13,086)	34,610 (15,699)
40 (1000)	37-5/8 (956)	(1)	(1)	(1)	44-1/8 (1121)	38-1/4 (972)	71-1/4 (1810)	11 (279)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	36,810 (16,697)	44,170 (20,035)
42 (1050)	39-5/8 (1007)	(1)	(1)	(1)	47-1/4 (1200)	41-3/4 (1060)	74-3/4 (1888)	11 (279)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	43,400 (19,686)	52,070 (23,619)
46 (1150)	43-3/8 (1102)	(1)	(1)	(1)	50-3/8 (1280)	43-3/4 (1111)	81-1/2 (2070)	11 (279)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	52,770 (23,936)	63,310 (28,717)
48 (1200)	45-1/4 (1149)	(1)	(1)	(1)	52-3/8 (1330)	45-1/4 (1149)	85 (2159)	11 (279)	-	25-5/8 (651)	47-1/4 (1200)	6-5/8 (168)	60,310 (27,356)	72,370 (32,826)

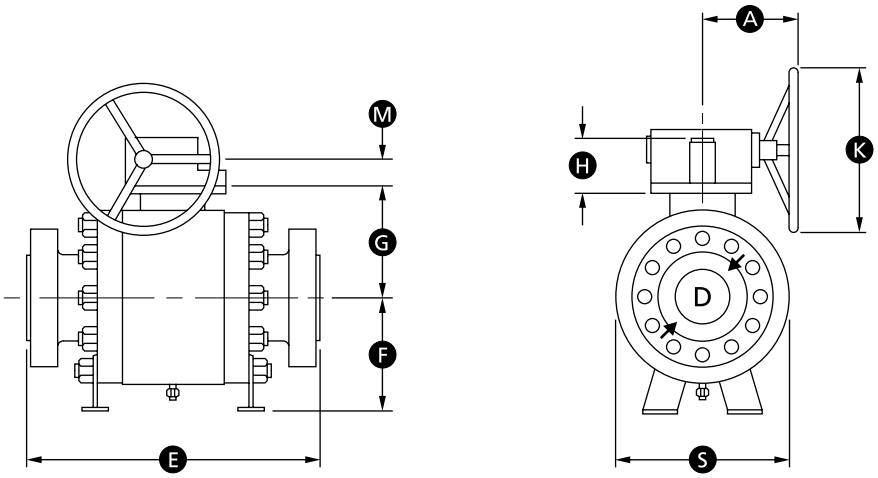
(1) Upon request

Shaded bore sizes (D) according to API 6D
Shaded end-to-end dimensions (E) according to API 6D

Flanges in accordance with ASME B16.5

Butt welding ends according to ASME B16.25

ASME CLASS 1500



ASME CLASS 1500

SIZE in. (mm)	D	E			F	G	S	H	L	A	K	M	WEIGHT lb (kg)	
		WE	RF	RTJ									WE	RF/RTJ
6	5-3/4	27-3/4	27-3/4	28	12-5/8	11	16-7/8	3-3/4	-	11-1/2	13-3/4	3	850	1010
(150)	(146)	(705)	(705)	(711)	(321)	(279)	(429)	(95)	-	(292)	(349)	(76)	(386)	(458)
8	7-5/8	32-3/4	32-3/4	33-1/8	14-5/8	12-7/8	21-1/8	4-1/2	-	11-1/2	13-3/4	3	1410	1670
(200)	(194)	(832)	(832)	(841)	(372)	(327)	(537)	(114)	-	(292)	(349)	(76)	(640)	(757)
10	9-1/2	39	39	39-3/8	17-3/8	15-3/8	25-3/4	4-1/2	-	11-1/2	13-3/4	3	2110	2530
(250)	(241)	(991)	(991)	(1000)	(441)	(391)	(654)	(114)	-	(292)	(349)	(76)	(957)	(1148)
12	11-3/8	44-1/2	44-1/2	45-1/8	19-5/8	16-5/8	30-1/4	4-1/2	-	11-1/2	13-3/4	3	2930	3500
(300)	(289)	(1130)	(1130)	(1146)	(499)	(422)	(768)	(114)	-	(292)	(349)	(67)	(1329)	(1610)
14	12-1/2	49-1/2	49-1/2	50-1/4	22-5/8	19-5/8	34-1/4	7-1/8	-	15-3/4	23-5/8	4-3/8	3610	4320
(350)	(318)	(1257)	(1257)	(1276)	(575)	(499)	(870)	(181)	-	(400)	(600)	(111)	(1637)	(1960)
16	14-1/4	54-1/2	54-1/2	55-3/8	25-1/4	22	38-3/4	7-1/8	-	21-5/8	31-1/2	4-3/8	4360	5220
(400)	(362)	(1384)	(1384)	(1407)	(641)	(559)	(984)	(181)	-	(549)	(800)	(111)	(1978)	(2368)
18	16-1/4	(1)	(1)	(1)	27-3/4	23-1/4	42-7/8	8-1/8	-	21-5/8	31-1/2	4-3/8	6100	7310
(450)	(413)				(705)	(591)	(1089)	(206)	-	(549)	(800)	(111)	(2767)	(3316)
20	18	(1)	(1)	(1)	29-7/8	28-1/2	46-3/8	9-5/8	-	21-3/4	23-5/8	5-3/8	8240	9870
(500)	(457)				(759)	(724)	(1178)	(245)	-	(552)	(600)	(137)	(3738)	(4477)
22	19-3/4	(1)	(1)	(1)	33	30-1/4	51-7/8	9-5/8	-	22-7/8	23-5/8	6-1/4	10,220	12,250
(550)	(502)				(838)	(768)	(1318)	(245)		(581)	(600)	(159)	(4636)	(5557)
24	21-5/8	(1)	(1)	(1)	35-1/8	32	55-7/8	9-5/8	-	22-7/8	23-5/8	6-1/4	12,250	14,700
(600)	(549)				(892)	(813)	(1419)	(245)		(581)	(600)	(159)	(5557)	(6668)
26	23-1/2	(1)	(1)	(1)	38-1/4	35-1/2	60-1/2	11	-	-	-	-	15,540	18,650
(650)	(597)				(972)	(902)	(1537)	(279)					(7049)	(8459)
28	25-1/4	(1)	(1)	(1)	40-7/8	37	65	11	-	-	-	-	17,790	21,340
(700)	(641)				(1038)	(940)	(1651)	(279)					(8069)	(9680)
30	27	(1)	(1)	(1)	42	40-3/4	68-3/8	11	-	-	-	-	21,340	25,590
(750)	(686)				(1067)	(1035)	(1737)	(279)					(9680)	(11,607)
32	28-3/4	(1)	(1)	(1)	45-7/8	41-3/4	73-5/8	11	-	-	-	-	24,250	29,100
(800)	(730)				(1165)	(1060)	(1870)	(279)					(11,000)	(31,200)
34	30-1/2	(1)	(1)	(1)	48-3/8	44-7/8	78-1/8	11	-	-	-	-	29,690	35,620
(850)	(775)				(1229)	(1137)	(1984)	(279)					(13,467)	(16,157)
36	32-1/4	(1)	(1)	(1)	51-3/8	46-1/2	82-3/8	11	-	-	-	-	34,610	41,530
(900)	(819)				(1305)	(1181)	(2092)	(279)					(15,699)	(18,838)

(1) Upon request

Shaded bore sizes (D) according to API 6D
Shaded end-to-end dimensions (E) according to API 6D

Flanges in accordance with ASME B16.5

Butt welding ends according to ASME B16.25

GROVE B7
DESIGN FEATURES

Standard Features

B7.1

- Triple-barrier stem seals
- Factory-positioned external stops
- Emergency grease fitting for stem
- Stem separated from the ball; anti-blowout design
- Plastic polymer insert for seat sealing
- Self-relieving seats
- Metal-backed, self-lubricating bearings/washers
- Nickel plating for trim parts
- Fire-safe graphite rings
- Antistatic device

B7.B

- Triple-barrier stem seals
- Stem separate from the ball; anti-blowout design
- Ball load on the bearing blocks
- Double-barrier sealing in both directions (DPE)
- Body relief valve for overpressure
- Sealant injection system for emergency seal
- Metal-backed, self-lubricating bearings/washers
- Nickel plating for trim parts
- Trunnion mounted ball

Options

B7.1

- PTFE various grades of reinforced gaskets, spring energized, for stem and seat sealing
- Metal-to-metal seats
- Double-barrier sealing in both directions (DPE)
- Body relief valve for overpressure
- Double block-and-bleed capabilities

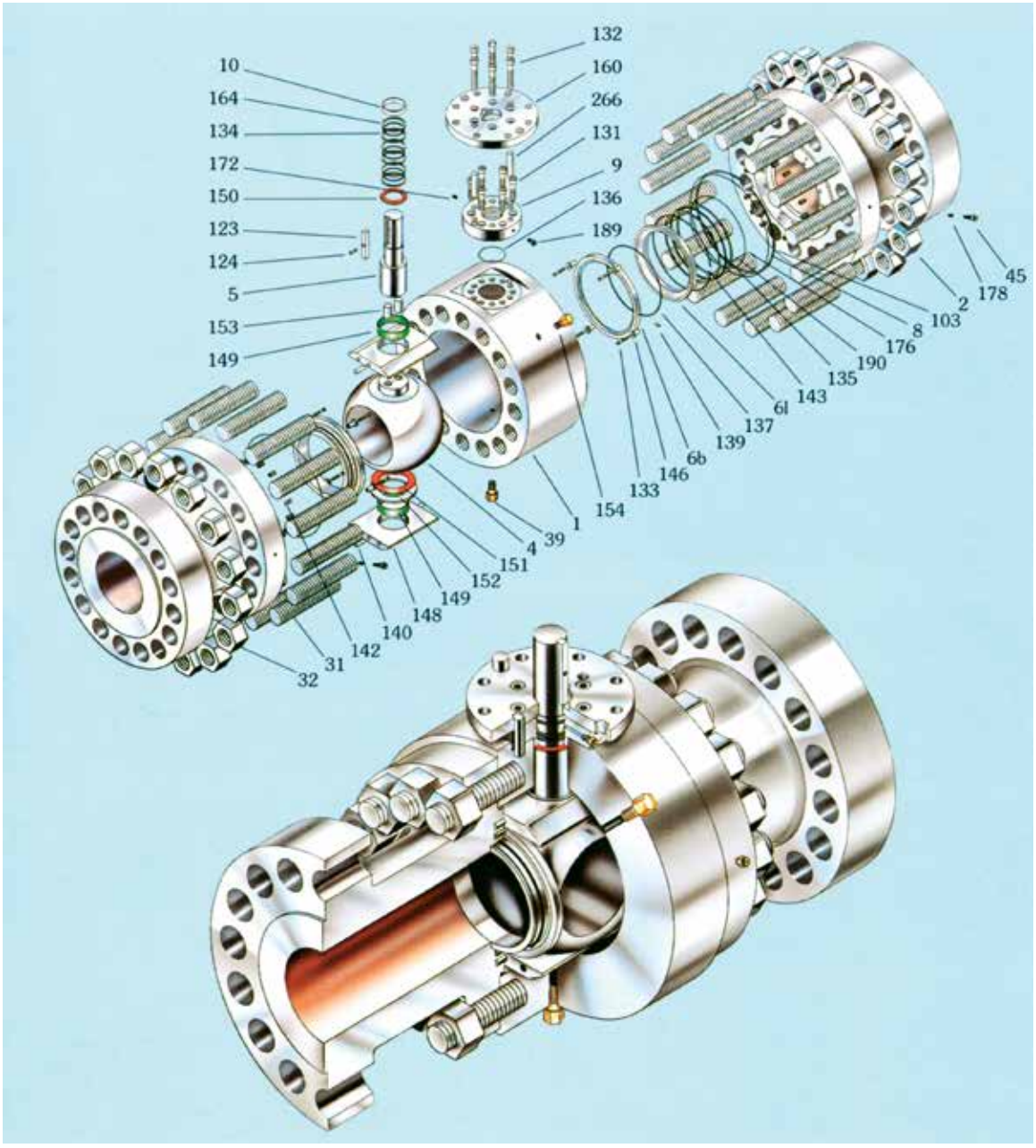
Valve Construction

The B7 denomination identifies the side-entry ball valve ASME Class 2500.

Due to the high pressure and strong force involved, the materials selection is carried out by paying particular attention to the anti-extrusion features of the gaskets and to the resistance of the ball and stem materials.

GROVE B7.B

VALVE ASSEMBLY AND CROSS SECTION

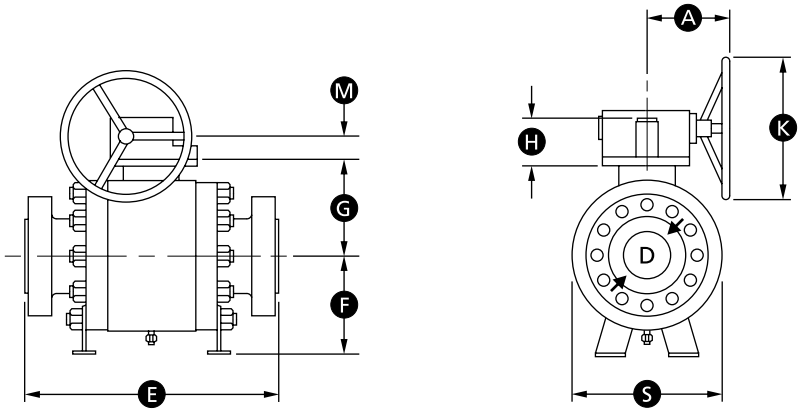


Item	Description	Item	Description	Item	Description
1	Body	123	Stem Key	149	Bearing
2	Closure	124	Stem Key Capscrew	150	Upper Thrust Washer
4	Ball	131	Gland Plate Capscrew	151	Lower Thrust Washer
5	Stem	132	Adapter Plate Capscrew	152	Spacer
6b	Outer Seat Ring	133	Puller Bushing Capscrew	153	Drive Pin
6l	Inner Seat Ring	134	Stem O-ring	154	Relief Valve
8	Body O-ring	135	Seat O-ring	160	Adapter Plate
9	Gland Plate	136	Gland Plate O-ring	164	Stem Backup Ring
10	Gland Bushing	137	Seal O-ring	172	Vent Plug
31	Body Stud	139	Seat Spring Pin	176	U-cup Packing
32	Body Stud Nut	140	Bearing Retainer Pin	178	Check Valve
39	Drain Valve	142	Spring	189	Gland Vent
45	Grease Fitting	143	Seat Lock Ring	190	Seat Backup Ring
103	Closure Backup Ring	146	Puller Bushing	299	Stop Spring Pin
		148	Bearing Retainer		

GROVE B7.1 and B7.B

DIMENSIONS AND WEIGHTS

ASME CLASS 2500



ASME CLASS 2500 – B7.1

SIZE in. (mm)	D	E WE	E RF	E RTJ	F	G	S	H	L	A	K	M	WEIGHT WE	lb (kg) RF/RTJ
1-1/2 (40)	1-1/4 (32)	15-1/8 (384)	15-1/8 (384)	15-1/4 (387)	3-7/8 (98)	5-1/2 (140)	6-7/8 (175)	2-3/8 (60)	-	7-1/2 (191)	7-7/8 (200)	1-3/4 (44)	80 (36)	130 (59)
2 x 1-1/2 x 2 (50 x 40 x 50)	1-1/4 (32)	17-3/4 (451)	17-3/4 (451)	17-7/8 (454)	3-7/8 (98)	5-1/2 (140)	6-7/8 (175)	2-3/8 (60)	-	7-1/2 (191)	7-7/8 (200)	1-3/4 (44)	90 (41)	180 (82)
2 (50)	1-3/4 (44)	17-3/4 (451)	17-3/4 (451)	17-7/8 (454)	4-3/8 (111)	6-1/4 (159)	7-7/8 (200)	2-3/8 (60)	-	7-1/2 (191)	7-7/8 (200)	1-3/4 (44)	150 (68)	260 (118)
3 x 2 x 3 (80 x 50 x 80)	1-3/4 (44)	22-3/4 (578)	22-3/4 (578)	23 (584)	4-3/8 (111)	6-1/4 (159)	7-7/8 (200)	2-3/8 (60)	-	7-1/2 (191)	7-7/8 (200)	1-3/4 (44)	210 (95)	330 (150)
3 (80)	2-1/2 (64)	22-3/4 (578)	22-3/4 (578)	23 (584)	5-1/2 (140)	7-1/8 (181)	9-7/8 (251)	2-1/2 (64)	-	8-3/4 (222)	13-3/4 (349)	2-5/8 (67)	350 (159)	480 (218)
4 x 3 x 4 (100 x 80 x 100)	2-1/2 (64)	26-1/2 (673)	26-1/2 (673)	26-7/8 (683)	5-1/2 (140)	7-1/8 (181)	9-7/8 (251)	2-1/2 (64)	-	8-3/4 (222)	13-3/4 (349)	2-5/8 (67)	370 (168)	620 (281)
4 (100)	3-1/2 (89)	26-1/2 (673)	26-1/2 (673)	26-7/8 (683)	9-7/8 (251)	7-7/8 (200)	14-5/8 (372)	3 (76)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	700 (318)	790 (358)
6 x 4 x 6 (150 x 100 x 150)	3-1/2 (89)	36 (914)	36 (914)	36-1/2 (927)	9-7/8 (251)	7-7/8 (200)	14-58 (372)	3 (76)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	730 (331)	1250 (567)
6 (150)	5-1/4 (133)	36 (914)	36 (914)	36-1/2 (927)	11-3/8 (289)	9-1/4 (235)	16-7/8 (429)	4-5/8 (118)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	1480 (671)	1650 (748)
8 x 6 x 8 (200 x 150 x 200)	5-1/4 (133)	40-1/4 (1022)	40-1/4 (1022)	40-7/8 (1038)	11-3/8 (289)	9-1/4 (235)	16-7/8 (429)	4-5/8 (118)	-	11-1/2 (292)	13-3/4 (349)	3 (76)	1890 (857)	2180 (989)

ASME CLASS 2500 – B7.B

SIZE in. (mm)	D	E WE	E RF	E RTJ	F	G	S	H	L	A	K	M	WEIGHT WE	lb (kg) RF/RTJ
8 (200)	7-1/8 (181)	40-1/4 (1022)	40-1/4 (1022)	40-7/8 (1038)	15-1/8 (384)	15-1/2 (394)	26 (660)	4-5/8 (118)	-	15-3/4 (400)	23-5/8 (600)	4-3/8 (111)	3650 (1656)	4340 (1969)
10 (250)	8-7/8 (226)	50 (1270)	50 (1270)	50-7/8 (1292)	17-1/8 (435)	18-1/4 (464)	31-1/8 (790)	5-1/2 (140)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	5480 (2486)	6590 (2989)
12 (300)	10-1/2 (267)	56 (1422)	56 (1422)	56-7/8 (1445)	19-5/8 (499)	20-1/2 (521)	34-1/4 (870)	5-1/2 (140)	-	21-5/8 (549)	31-1/2 (800)	4-3/8 (111)	7600 (3447)	9100 (4128)
14 (350)	12-1/4 (311)	(1)	(1)	(1)	22-7/8 (581)	24-3/4 (629)	39 (991)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	9390 (4259)	11,220 (5089)
16 (400)	13-7/8 (353)	(1)	(1)	(1)	26-3/8 (670)	28-3/8 (721)	43-1/4 (1099)	8-1/8 (206)	-	21-3/4 (552)	23-5/8 (600)	5-3/8 (137)	11,330 (5139)	13,580 (6160)
18 (450)	15-5/8 (397)	(1)	(1)	(1)	29-1/8 (740)	31-7/8 (810)	47-7/8 (1216)	11 (279)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	15,870 (7199)	19,020 (8627)
20 (500)	17-1/4 (438)	(1)	(1)	(1)	32-1/2 (826)	35-3/8 (899)	52-1/8 (1324)	11 (279)	-	22-7/8 (581)	23-5/8 (600)	6-1/4 (159)	21,420 (9716)	25,660 (11,639)

Flanges in accordance with ASME B16.5
Shaded bore sizes (D) according to API 6D
Shaded end-to-end dimensions (E) according to API 6D

Butt welding ends according to ASME B16.25
Outlined end-to-end dimensions (E) according to ASME B16.10

Quality System



Quality Assurance Program

ISO 9001:2000 and API Q1 Standards

All valves are designed in accordance with the most stringent industry procedures and standards and are built according to the European Directives PED and ATEX upon request.

Approvals

Cameron is an authorized licensee to use the American Petroleum Institute (API) monogram for specification API 6D and API 6A.

Certifications

- ISO 10423/API 6A
- ISO 14313/API 6D
- ISO 17423/API 6DSS

Inspection

Inspection is done per the Quality System requirements based on ISO 9001:2000 and API Q1. Cameron verifies all processes from material receipt to final customer inspection, including the liaison with third-party inspection and certifying authorities.

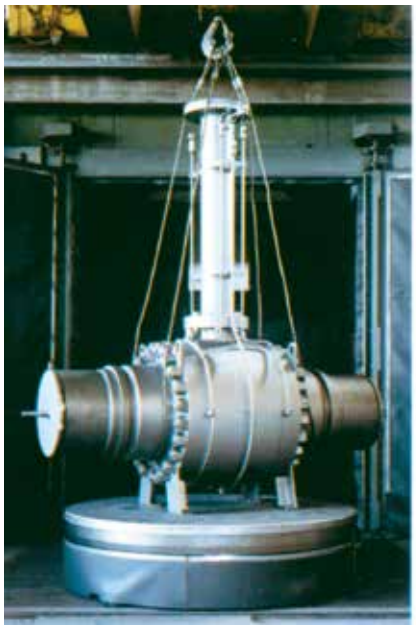
All products can be supplied with certified test reports, which include pressure testing, NDT, and chemical and physical analysis, along with any other specified special test requirements.

The material certification of the valve parts can be furnished in accordance with DIN 50049-EN 10204 3.1 (at least) or 3.2.

Special Process

Cameron operates its own in-house electroless nickel plating (ENP) facility.

ASTM B656 and ASTM B733 are the reference standards for plating process and control. Strict quality control procedures for critical process conditions and for the plated components maintain plating consistency.





Qualification Testing

Research and Development Lab

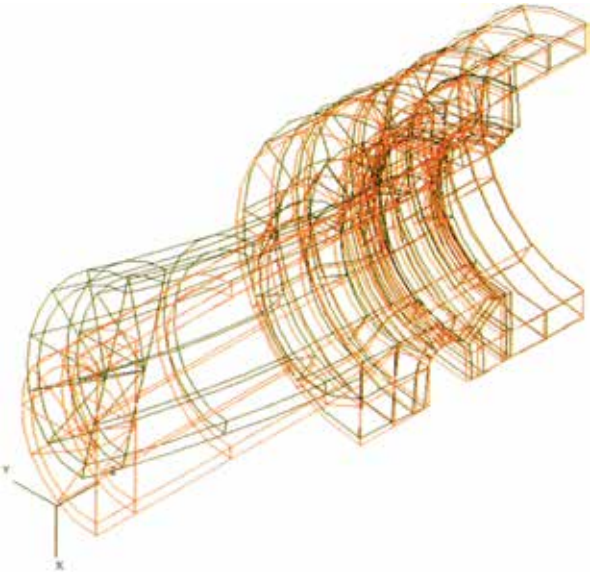
Cameron's GROVE valves are designed in accordance with the applicable or requested codes and are subjected to full in-house qualification testing. Our in-house testing facilities, with the participation of the major oil and gas companies' R&D programs, allow Cameron to supply high-quality products.

Hydraulic and gas sealing tests, functional tests, and cycling and torque tests all are carried out on prototype valves. These test procedures ensure that the design safety factors, the maximum allowable leakage rates, and the expected valve service life are achieved.

Structural Verification

Cameron's engineering department operates an advanced 3D CAD system and conducts finite element analysis (FEA) to simulate various load conditions to determine a component's suitability for the intended service.





Fire-Safe Tests and Certifications

Cameron conducts in-house fire-safe testing, and its GROVE valves are certified in compliance with API 6FA and BS 6755 Part 2 fire-safe standards.

A complete reference list of qualified and certified valves can be made available upon customer's request.

Cycle Testing Under Flow Conditions

Through its in-house flow facility, Cameron verifies the behavior of valves subjected to cycle testing under dynamic flow conditions with the presence of abrasive particles. This test loop has the capacity to test valves up to 6" nominal bore with a maximum service pressure of 2900 psi (200 bar).

The main test parameters are PC entered and recorded for future design reference.

High-Pressure Gas Testing

Customers' specifications may dictate more severe testing in addition to conventional hydrostatic testing.

Cameron is fully equipped to carry out enhanced gas testing at ambient, low and high temperatures using specially equipped bunkers. External leakage rates (if any) are verified by means of a mass spectrometer. Leakage through the seats (if any) is verified by means of calibrated flow meters.

For low- and high-temperature service, gas testing can be performed to customer-specified critical dimensions. Cameron has test facilities for various valve dimensions. Testing can be performed at a range of temperatures from -184° F to 752° F (-120° C to 400° C).

Services for Valves and Actuation

WE BUILD IT. WE BACK IT.

Global Network and Local Support

Cameron is well-positioned to deliver total aftermarket support, quickly and efficiently, with unmatched OEM expertise. Our highly skilled engineers and technicians are available around the clock, seven days a week to respond to customer queries, troubleshoot problems and offer reliable solutions.

Easily Accessible Parts and Spare Valves

- OEM spare valves, actuators and parts (including non-Cameron brands)
- Handling, storage, packaging and delivery
- Dedicated stocking program

Comprehensive Services Portfolio

- Parts and spare valves
- Repair
- Field services
- Preventative maintenance
- Equipment testing and diagnostics
- Remanufacturing
- Asset preservation
- Customer property management
- Training and recertification services
- Warranty

Customized Total Valve Care℠ (TVC) Programs

Customized asset management plans that optimize uptime, availability and dedicated services.

- Engineering consultancy
- Site management
- Flange management
- Startup and commissioning
- Spare parts and asset management
- Operational support







Trademark Information

GROVE is a registered trademark of Cameron.

This document contains references to registered trademarks or product designations, which are not owned by Cameron.

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For more information on GROVE ball valves:
www.c-a-m.com/GROVE
GROVE@c-a-m.com

HSE Policy Statement
At Cameron, we are committed ethically, financially and personally to a working environment where no one gets hurt and nothing gets harmed.

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Honeywell

SmartLine Pressure Transmitters
ST 700 User's Manual

34-ST-25-44
Revision 8.0
December 2016

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Revision 8.0, December 2016

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Honeywell Process Solutions
1250 W Sam Houston Pkwy S
Houston, TX 77042

About This Manual

This manual is a detailed *how to* reference for installing, piping, wiring, configuring, starting up, operating, maintaining, calibrating, and servicing Honeywell's family of ST 700 SmartLine Pressure Transmitters, Standard and Basic models.
Users who have a Honeywell ST 700 SmartLine Pressure Transmitter configured for HART protocol or Honeywell's Digitally Enhanced (DE) are referred to the *ST 700 Series HART/DE Option User's Manual*, Document # 34-ST-25-47.
Users who have a Honeywell ST 700 SmartLine Pressure Transmitter configured for Fieldbus operation are referred to the *ST 700 Series Fieldbus Option User's Manual*, Document # 34-ST-25-48.

The configuration of your Transmitter depends on the mode of operation and the options selected for it with respect to operating controls, displays and mechanical installation. This manual provides detailed procedures to assist first-time users, and it further includes keystroke summaries, where appropriate, as quick reference or refreshers for experienced personnel.

To digitally integrate a Transmitter with one of the following systems:

- For the Experion PKS, you will need to supplement the information in this document with the data and procedures in the *Experion Knowledge Builder.*
- For Honeywell's TotalPlant Solutions (TPS), you will need to supplement the information in this document with the data in the *PM/APM SmartLine Transmitter Integration Manual*, which is supplied with the TDC 3000 book set. (TPS is the evolution of the TDC 3000).

Release Information

ST 700 SmartLine Pressure Transmitter User Manual, Document # 34-ST-25-44,
Revision 1, February, 2013

Revision 2, May, 2013 – Updates to Parts list, Explosionproof Seal class, Fail Safe and Comms Module procedures.

Revision 3, July 2013 – Control Drawing updated to Rev.D

Revision 4, December 2013 – STG73P Flush Mount

Revision 5, December 2014 – MID and MARINE Approvals added

Revision 6, March 2016 – Standard Display added

Revision 7, May 2016 – Approval updates and EU cert.

Revision 8, December 2016 – Basic models added.

References

The following list identifies publications that may contain information relevant to the information in this document.

SmartLine Pressure Transmitter ST 800/ST700 Standard Quick Start Guide, Document # 34-ST-25-36

SmartLine Pressure Transmitter ST 700 Basic Quick Start Guide, Document # 34-ST-25-57

ST 800 & ST 700 Pressure Transmitter with HART Safety Manual, # 34-ST-25-37

ST 700 SmartLine Pressure Transmitter HART/DE Option User's Manual, Document # 34-ST-25-47

ST 700 FF Transmitter with FOUNDATION Fieldbus Option Installation & Device Reference Guide, Document # 34-ST-25-48

MC Tookit User Manual, for 400 or later, Document # 34-ST-25-20

PM/APM Smartline Transmitter Integration Manual, Document # PM 12-410

ST 800 & ST 700 Series Pressure, Analog, HART and DE Communications form, Honeywell drawing 50049892

Smart Field Communicator Model STS 103 Operating Guide, Document # 34-ST-11-14

Patent Notice

The Honeywell ST 700 SmartLine Pressure Transmitter family is covered by one or more of the following U. S. Patents: 5,485,753; 5,811,690; 6,041,659; 6,055,633; 7,786,878; 8,073,098; and other patents pending.

Support and Contact Information

For Europe, Asia Pacific, North and South America contact details, refer to the back page of this manual or the appropriate Honeywell Solution Support web site:

Honeywell Corporate	www.honeywellprocess.com
Honeywell Process Solutions	www.honeywellprocess.com/pressue-transmitters/
Training Classes	http://www.honeywellprocess.com/en-US/training

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Telephone and Email Contacts

Area	Organization	Phone Number
United States and Canada	Honeywell Inc.	1-800-343-0228 Customer Service 1-800-423-9883 Global Technical Support
Global Email Support	Honeywell Process Solutions	hfs-tac-support@honeywell.com

Symbol Descriptions and Definitions

The symbols identified and defined in the following table may appear in this document.

Symbol	Definition
	**ATTENTION: Identifies information that requires special consideration.**
	**TIP: Identifies advice or hints for the user, often in terms of performing a task.**
CAUTION	**Indicates a situation which, if not avoided, may result in equipment or work (data) on the system being damaged or lost, or may result in the inability to properly operate the process.**
	**CAUTION: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.** **CAUTION symbol on the equipment refers the user to the product manual for additional information. The symbol appears next to required information in the manual.**
	**WARNING: Indicates a potentially hazardous situation, which, if not avoided, could result in serious injury or death.** **WARNING symbol on the equipment refers the user to the product manual for additional information. The symbol appears next to required information in the manual.**
	**WARNING, Risk of electrical shock: Potential shock hazard where HAZARDOUS LIVE voltages greater than 30 Vrms, 42.4 Vpeak, or 60 VDC may be accessible.**
	**ESD HAZARD: Danger of an electro-static discharge to which equipment may be sensitive. Observe precautions for handling electrostatic sensitive devices.**
	**Protective Earth (PE) terminal: Provided for connection of the protective earth (green or green/yellow) supply system conductor.**
	**Functional earth terminal: Used for non-safety purposes such as noise immunity improvement. Note: This connection shall be bonded to Protective Earth at the source of supply in accordance with national local electrical code requirements.**
	**Earth Ground: Functional earth connection. Note: This connection shall be bonded to Protective Earth at the source of supply in accordance with national and local electrical code requirements.**
	**Chassis Ground: Identifies a connection to the chassis or frame of the equipment shall be bonded to Protective Earth at the source of supply in accordance with national and local electrical code requirements.**
continued	

Symbol	Description
	The Factory Mutual®: Approval mark means the equipment has been rigorously tested and certified to be reliable.
	The Canadian Standards mark means the equipment has been tested and meets applicable standards for safety and/or performance.
	The Ex mark means the equipment complies with the requirements of the European standards that are harmonised with the 94/9/EC Directive (ATEX Directive, named after the French "ATmosphere EXplosible").

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1. ST 700 Transmitter Series

1.1 Overview

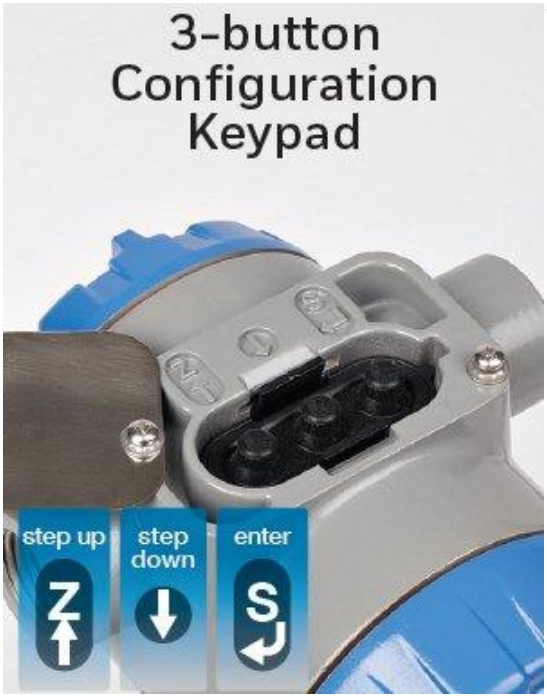
SmartLine Pressure Transmitter ST 700 family conists of a series of ST 700 Standard Transmitter models and a series of ST 700 Basic Transmitter models.

The entire manual is broadly classified in two sections.
The first half of this manual, Sections **2** through **9**, are for ST 700 Standard Transmitter model series and the second half, Sections **10** through **17,** are applicable only to ST 700 Basic Transmitter model series.

Which type of transmitter do I have?
To determine which version you have:
Look at the nameplate on top of the unit shown in Figure 3. Refer to the Model number
If you have a ST 700 Standard Transmitter use Sections **2** through **9**.
If you have a ST 700 Basic Transmitter go straight to Sections **10** through **17.**
Appendix A - PRODUCT CERTIFICATIONS is applicable for both ST 700 Standard and Basic Transmitters.

Table 1 below to identify which type of Transmitter you have; Standard or Basic.

The Standard transmitter will have a three button assembly (see Figure 17), the basic Transmitter with have two button assembly (see Figure 18)



3-button Standard ST 700 Transmitter



2-button Basic ST 700 Transmitter

Table 1 – ST 700 Standard andf Basic model types

Transmitter Configuration	Smart Line Pressure ST700	
	Standard Models	Basic Models
Dual head DP	STD720/730/770	STD725/735/775
Dual head GP	STG730/740/770	STG735/745/775
Inline GP	STG73L/74L/77L/78L/79L	STG73S/74S/77S/78S/79S
Inline flush GP	STG73P	STG73SP
Dual head AP	STA722/740	STA725/745
Inline AP	STA72L/74L/77L	STA72S/74S/77S
Flush flanged level	STF724/732	STF725/735
Pseudo flanged level	STF72F/73F	STF72P/73P
Remote seal DP/GP	STR73D/74G	STR735D/745G

,

2. Introduction to the ST 700 Standard Transmitter

This section is an introduction to the physical and functional characteristics Honeywell's family of the ST 700 Standard Transmitters.

2.1 Features and Options

The ST 700 Standard Transmitter is available in a variety of models for measuring Differential Pressure (DP), Gauge Pressure (GP), and Absolute Pressure (AP). Table 2 lists the protocols, human interface (HMI), materials, approvals, and mounting bracket options.

Table 2 – Features and Options_ST 700 Standard transmitter

Feature/Option	Standard/Available Options
Communication Protocols	HART® version 7, Digitally Enhanced (DE), Fieldbus
Human-Machine Interface (HMI) Options (Basic Display/Standard Display)	**Basic Digital Display:** • Three-button programming (optional) • Basic display language: English only
	Standard Display (HART® only): • Two-button programming (optional) • Standard display language: English only • Two-mode operations: PV display and Menu Navigation
Calibration	Single
Approvals for details go to page 130	FM, CSA, ATEX, IECEx, SAEx, INMETRO, NEPSI, GOST and MARINE
Mounting Brackets	Angle/flat carbon steel/304 and 316 stainless steel, Marine 304 stainless steel, 316 Stainless Steel
Integration Tools	Experion

	The three-button option is available for the Basic Display. The two-button option is available for the Standard Display. Also, for the Basic Display, the three button reed switch is used only for span & zero correction and not for the Display navigation.

2.1.1 Physical Characteristics

As shown in Figure 1, the ST 700 Standard is packaged in two major assemblies: the Electronics Housing and the Meter Body. The elements in the Electronic Housing respond to setup commands and execute the software and protocol for the different pressure measurement types. Figure 2 shows the assemblies in the Electronics Housing with available options.

The Meter Body provides connection to a process system. Several physical interface configurations are available, as determined by the mounting and mechanical connections, all of which are described in the **Installation** section of this manual.

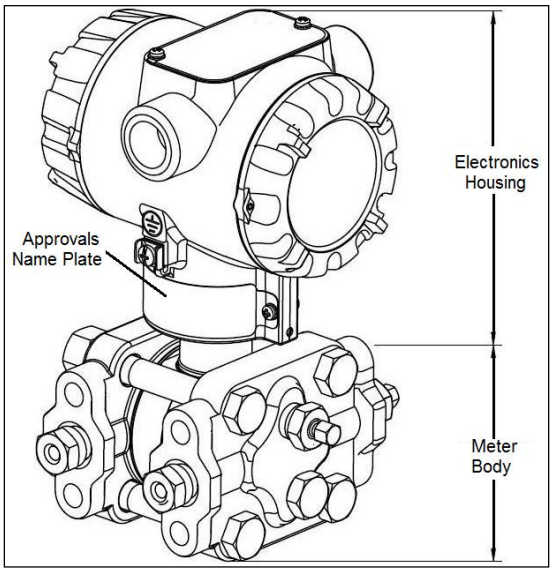


Figure 1 – ST 700 Standard Transmitter Major Assemblies

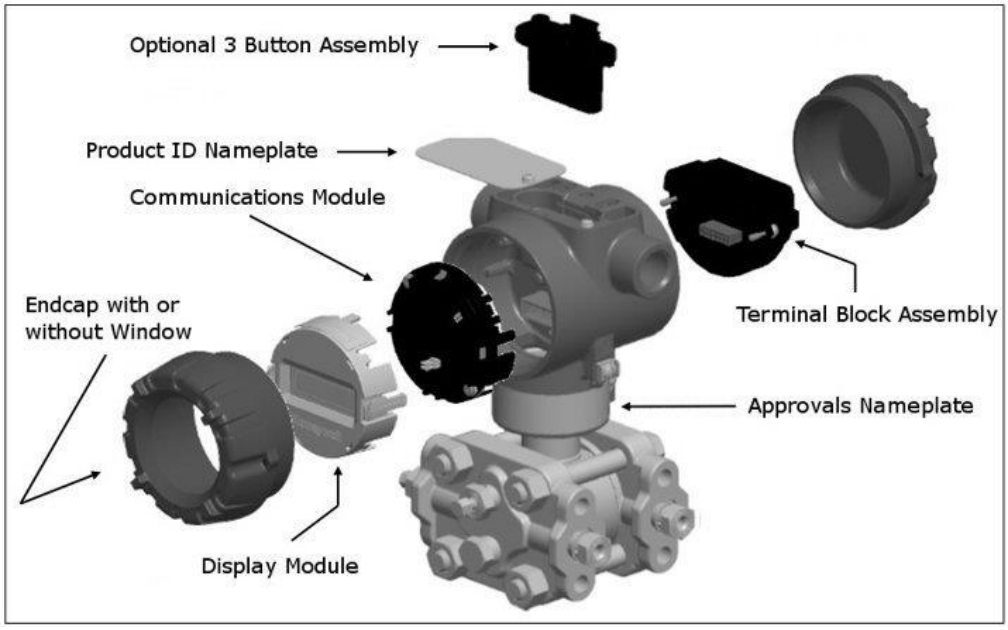


Figure 2 – ST 700 Standard Transmitter Electronics Housing Components

2.1.2 Functional Characteristics

The ST 700 Standard Transmitter measures process pressure and provides a proportional analog 4 to 20mA output to the measured process variable (PV). Available output communication protocols include Honeywell Digitally Enhanced (DE), HART®, and FOUNDATION™ Fieldbus.

The Standard display is only available on HART transmitters.

An optional 3-button assembly is available to set up and make adjustments to the Transmitter. In addition, a Honeywell Multi-Communication (MC) Toolkit (not supplied with the Transmitter) can facilitate setup and adjustment procedures. Certain adjustments can be made through an Experion Station or a Universal Station if the Transmitter is digitally integrated with Honeywell's Experion or TPS/TDC 3000 control system.

The Standard Display Menu is implemented as one long single-level menu and will "wrap around" when it reaches the start or end of the menu. The Standard Display uses an optional two-button assembly to set up and make adjustments to the Transmitter.

2.2 ST 700 Standard Transmitter Nameplate

The Transmitter nameplate mounted on the bottom of the electronics housing (see Figure 1) lists its model number, physical configuration, electronics options, accessories, certifications, and manufacturing specialties. Figure 3 is an example of a typical Gauge Pressure (GP) or Atmospheric Pressure (AP) Transmitter name plate. The model number format consists of a Key Number with several table selections. The Differential Pressure (DP), Absolute Pressure (AP), and Gauge Pressure (GP) name plates are essentially the same. The DP model provides one additional entry (7 vs. 6) in the Meter Body Selections (Table I) to accommodate the static pressure rating.

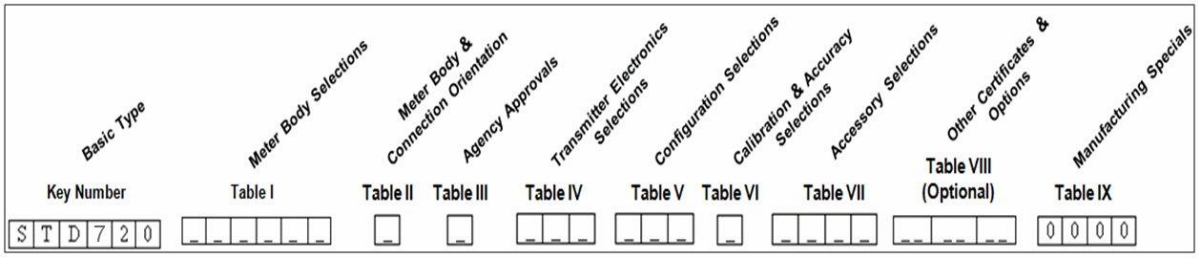


Figure 3 –ST 700 Standard Transmitter - Typical Name Plate

You can readily identify the series and basic Transmitter type from the third and fourth digits in the key number. The letter in the third digit represents one of these basic transmitter types:

- A = Absolute Pressure
- D = Differential Pressure
- F = Flange Mounted
- G = Gauge Pressure
- R = Remote Seals

For a complete selection breakdown, refer to the appropriate Specification and Model Selection Guide provided as a separate document.

2.3 Safety Certification Information

An “approvals” name plate is located on the bottom of the Electronics Assembly; see Figure 1for exact location. The approvals name plate contains information and service marks that disclose the Transmitter compliance information.
Refer to Section Appendix A in this document for safety certification requirements and details.

2.4 Transmitter Adjustments

Zero and Span adjustments are possible in ST 700 Standard Transmitter with the optional 3 button and two-button assemblies.

You can also use the Honeywell MC Toolkit or other third-party hand-held configurator to make adjustments to the ST 700 Standard Transmitter. Alternately, certain adjustments can be made through the Experion or Universal Station, if the Transmitter is digitally integrated with a Honeywell Experion or TPS system.

2.5 Display Options –Standard Display

Table 3 – Available Display Characteristics

Basic Display	• Suitable for basic process needs • 360^{o} rotation in 90^{o} Increments • 2 lines, 16 characters • Standard units of measurement: Pa, KPa, MPa, KGcm2, TORR, ATM, inH2O, mH2O, bar, mbar, inHg, FTH2O, mmH2O, MMHG, & PSI • Diagnostic messaging • Square root output indications
Standard Display	• 360^{o} rotation in 90^{o} Increments • 2 lines, 8 characters • Standard units of measurement: Pa, KPa, MPa, KGcm2, TORR, ATM, inH2O, mH2O, bar, mbar, inHg, FTH2O, mmH2O, MMHG, Flow Units (DP models only) ,PSI , cmH2O and mH2O • Diagnostic messaging

2.6 Optional Integrated Two-Button Assembly (Standard Display)

The Standard Display does not support all the transmitter configuration parameters and has limited features.
The optional Integrated two-Button Assembly for the Standard Display provides the following features and capabilities:

- Menu and enter key functionality.
- With the menu-driven display:
  - Comprehensive on-screen menu for navigation.
  - Transmitter configuration: enter LRV, enter URV and Loop Test.
  - Transmitter calibration
  - Display configuration (contrast only)
  - Set zero and span parameters.

	If you are using the optional external two-button assembly with the Standard Display then you can perform all the above operations without removing external glass cap using the external buttons

	**Lower range value (LRV):** A display parameter (Standard display), which allows users to enter the measuring value for which the analog output will be scaled to 4mA. **Upper range value (URV):** A display parameter (Standard display), which allows users to enter the measuring value for which the analog output will be scaled to 20mA.

3. Application Design for the ST 700 Standard Transmitter

3.1 Overview

This section discusses the considerations involved with deploying a Honeywell ST 700 Standard Transmitter in a process system. The following areas are covered:

- Safety
- Input and output data
- Reliability
- Environmental limits
- Installation considerations
- Operation and maintenance\
- Repair and replacement

3.2 Accuracy

The ST 700 Standard Transmitter measures the gauge, differential, or absolute pressure of a process and reports the measurement to a receiving device.

3.2.1 Diagnostic Messages

Transmitter standard diagnostics are reported in the two basic categories listed in Table 4. Problems detected as critical diagnostics drive the analog output to the programmed burnout level. Problems detected as non-critical diagnostics may affect performance without driving the analog output to the programmed burnout level. Informational messages (not listed in Table 4) report various Transmitter status or setting conditions. The messages listed in Table 4 are specific to the Transmitter, exclusive of those associated with HART and DE protocols. HART and DE diagnostic messages are listed and described in the *ST 700 SmartLine Pressure Transmitter HART/DE Option User Manual*, Document # 34-ST-25-47.

	**The Standard Display is only available on HART transmitters**

	**The Standard Display only displays critical diagnostics (Meter Body Fault, Electronics Module Fault and Meter Body Communication Fault). Non-critical diagnostics are not displayed.**

Table 4 – ST 700 Standard transmitter - Basic Display Diagnostics Messages

Critical Diagnostics (Failure Conditions)	Non-Critical Diagnostics (Warning Conditions)	
Sensor Comm Timeout	No DAC Compensation	No DAC Calibration
Meter Body Critical Failure	No Factory Calibration	Tamper Alarm
Electronic Module Diag Failure	PV Out of Range	Meter Body Unreliable Comm
Config Data Corrupt	Fixed Current Mode	Loop Current Noise
Meter Body NVM Corrupt	Sensor Over Temperature	AO Out of Range
Electronic Module DAC Failure	Meter Body Excess Correct	URV Set Error – Span Config Button
	Local Display	LRV Set Error – Span Config Button
	Low Supply Voltage	

3.3 Safety

3.3.1 Safety Integrity Level (SIL)

The ST 700 Standard transmitter has met manufacturer design process requirements of Safety Integrity Level (SIL) 3. These are intended to achieve sufficient integrity against systematic errors of design by the manufacturer.

A Safety Instrumented Function (SIF) designed with this product must not be used at a SIL level higher than the statement, without "prior use" justification by the end user or diverse technology redundancy in the design.

Refer to the *Honeywell SmartLine Safety Manual*, Document # 34-ST-25-37, for additional information.

4. Installation and Startupfor the ST 700 Standard Transmitter

4.1 Installation Site Evaluation

Evaluate the site selected for the ST 700 Standard Transmitter installation with respect to the process system design specifications and Honeywell's published performance characteristics for your particular model. Some parameters that you may want to include in your site evaluation are:

- Environmental Conditions:
  - Ambient Temperature
  - Relative Humidity
- Potential Noise Sources:
  - Radio Frequency Interference (RFI)
  - Electromagnetic Interference (EMI)
- Vibration Sources
  - Pumps
  - Motorized System Devices (e.g., pumps)
  - Valve Cavitation
- Process Parameters
  - Temperature
  - Maximum Pressure Rating

4.2 Honeywell MC Toolkit

In preparation for post-installation processes, refer to the *MC Tookit User Manual,* Document # 34-ST-25-20, for battery conditioning and device operation and maintenance information.

4.3 Display Installation Precautions

Temperature extremes can affect display quality. The display can become unreadable at temperature extremes; however, this is only a temporary condition. The display will again be readable when temperatures return to within operable limits.

The display update rate may become slower at cold temperature extremes, but as with readability, normal updating resumes when temperatures are within limits for full operability.

	The ST 700 Standard Transmitter should not be operated without the endcap covers on. Covers can be removed temporarily for configuration with buttons or during maintenance/wiring. The static voltage must be discharged before removing the cover.

4.4 Mounting ST 700 Standard Transmitters

4.4.1 Summary

The ST 700 Standard transmitter models, except flush mounts and those with integral flanges, can be attached to a two-inch (50 millimeters) vertical or horizontal pipe using Honeywell's optional angle or flat mounting bracket; alternately you can use your own bracket. Flush-mount models are attached directly to a process pipe or tank by a one-inch weld nipple. Models with integral flanges are supported by the flange connection.

Figure 4 shows a typical bracket-mounted and flange-mounted transmitter installations.

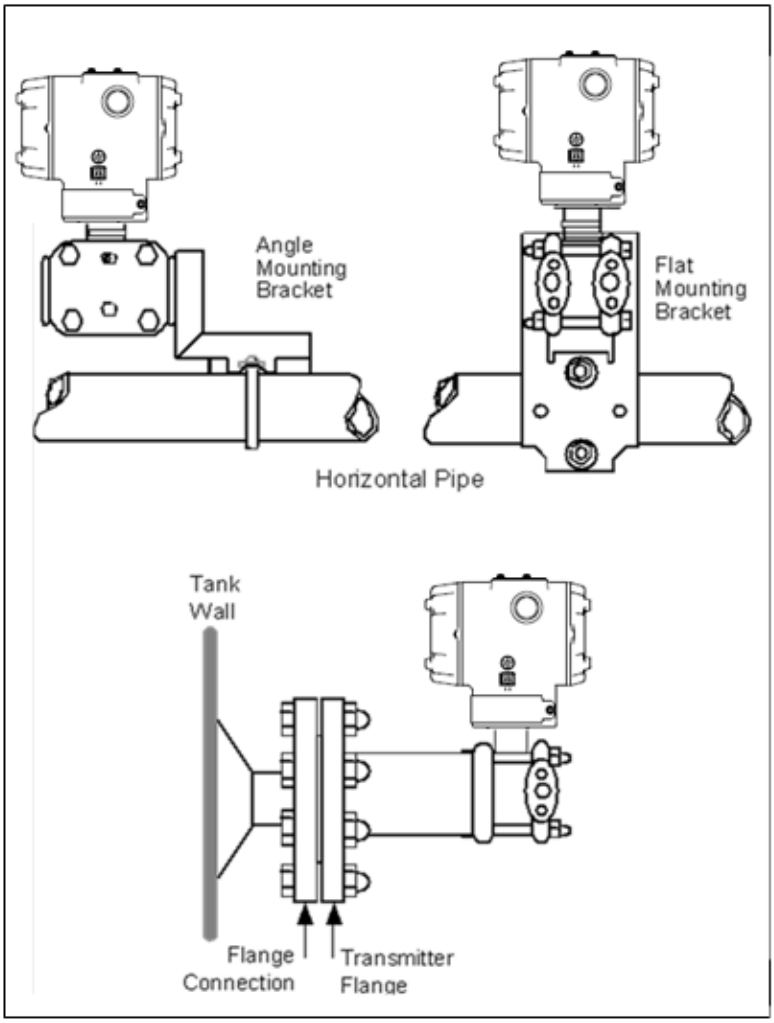


Figure 4 – ST 700 Standard Transmitter - Typical Bracket and Flange Mounted Installations

4.4.2 Flush mounting - ST 700 Standard Transmitter

To mount a flush mounted model, cut a hole for a 1" standard pipe in the tank or pipe where the transmitter is to be mounted. Weld the 1" mounting sleeve to the wall of the tank or to the hole cut on the pipe. Insert the meter body of the transmitter into the mounting sleeve and secure with the locking bolt. Tighten the bolt to a torque of 6,4 Nm +/- 0,30 Nm (4.7 ft-lbs +/- 0.2 ft.-lbs.). Figure 5 shows a typical installation for a transmitter with a flush mount on a pipe.

Once the transmitter is mounted, the electronics housing can be rotated to the desired position. See Figure 8 for details.

ATTENTION: On insulated tanks, remove enough insulation to accommodate the mounting sleeve.

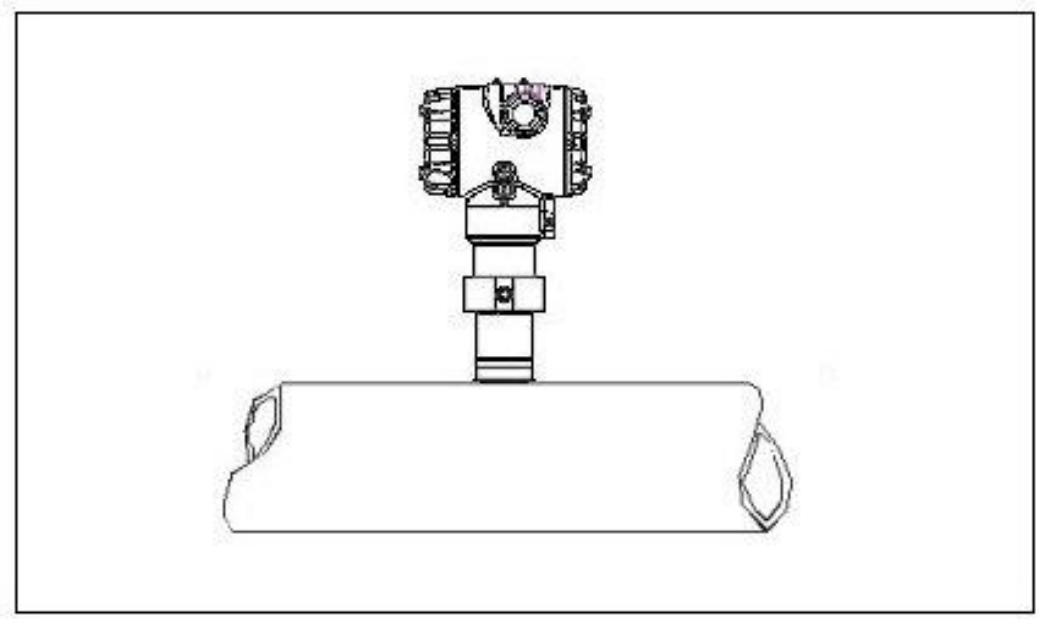


Figure 5 - ST 700 Standard Transmitter - Typical Flush Mounted Installation

4.4.3 Mounting Dimensions

Refer to Honeywell drawing number 50049930 (Dual Head), 50049931 (In-Line), 50049932 (Flange Mount) 50049933 (Extended Flange), 50049934 (Remote Seal) and 50049936 (Flush Mount Pressure Transmitter) for detailed dimensions. Abbreviated overall dimensions are also shown on the Specification Sheets for the transmitter models. This section assumes that the mounting dimensions have already been taken into account and the mounting area can accommodate the Transmitter.

4.4.4 Bracket Mounting Procedure

If you are using an optional bracket, start with Step 1. For an existing bracket, start with Step 2.

1. Refer to Figure 6. Position the bracket on a 2-inch (50.8mm nominal diameter, 2.38" (60.4mm) actual OD) for a horizontal or vertical pipe, and install a "U" bolt around the pipe and through the holes in the bracket. Secure the bracket with the nuts and lock washers provided.

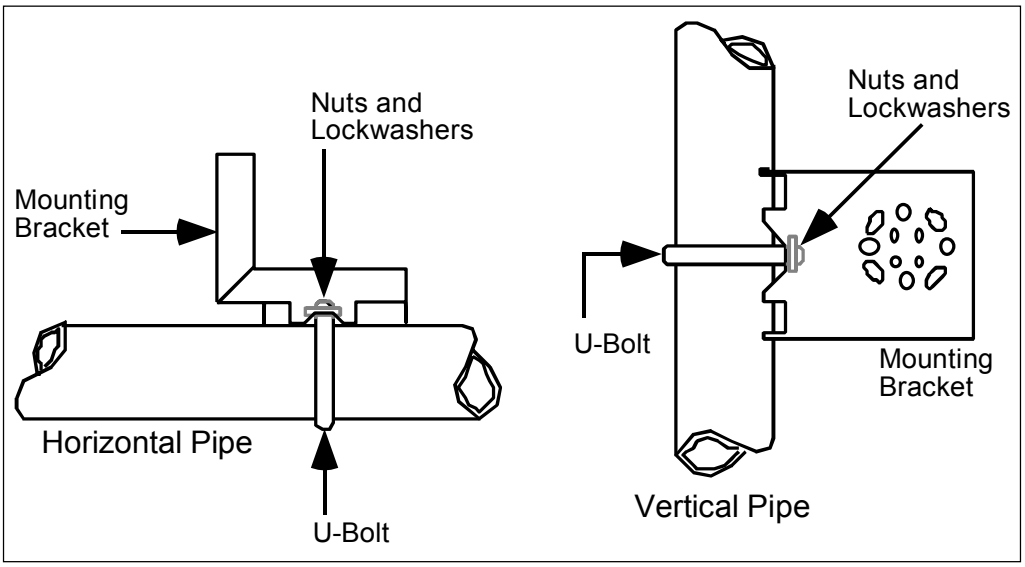


Figure 6 – ST 700 Standard Transmitter - Angle Mounting Bracket Secured to a Horizontal or Vertical Pipe

2. Align the appropriate mounting holes in the Transmitter with the holes in the bracket. Use the bolts and washers provided to secure the Transmitter to the bracket; see the following variations.

Table 5 - ST 700 Standard Transmitter - Mounting Bracket procedure

Transmitter Type	Use Hardware
DP with double-ended process heads and/or remote seals	Alternate mounting holes in the ends of the heads
ST 700 Standard transmitter models only. In-line GP: STG7x0 and STG7xL AP models: STA7xL and STA72x, STA740	The smaller "U" bolt provided to attach the meter body to the bracket. See the following example.
Dual-head GP and AP	Mounting holes in the end of the process head.

Example: Inline model mounted to an optional angle bracket. See Figure 7**.**

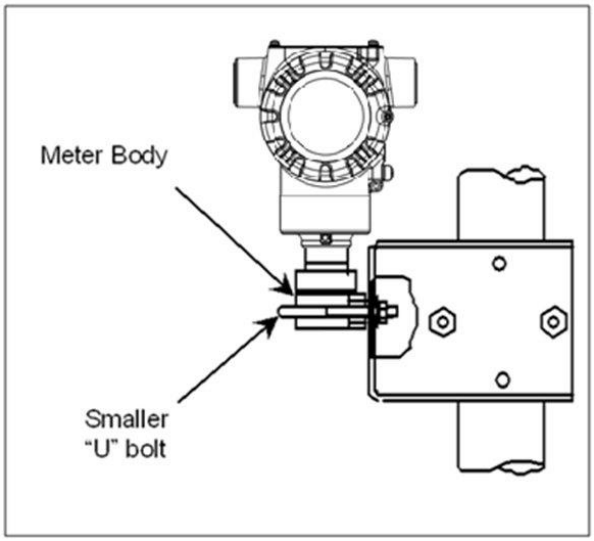


Figure 7 – ST 700 Standard Transmitter - Inline Model Mounted to an Optional Bracket

3. Loosen the set screw on the outside neck of the Transmitter one (1) full turn.

4. Rotate the Electronics housing a maximum of 180° left or right from the center to the position you require, and tighten the set screw using a 4mm metric socket head wrench. See the following example and Figure 8.

   Example: Rotating the Electronics Housing

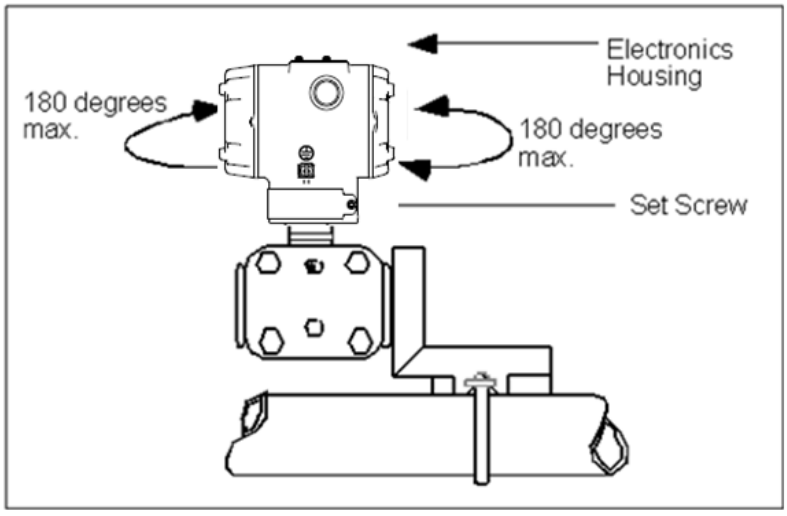


Figure 8 – ST 700 Standard Transmitter - Rotating the Electronics Housing

The mounting position of AP models STA722 and STA72L becomes critical as the Transmitter spans become smaller. A maximum zero shift of 2.5mmHg for these models can result from a mounting position that is rotated 90o from the vertical.
A typical zero-shift of 0.12mmHg or 0.20 inH_2O can occur for a five (5)-degree rotation from the vertical.

4.4.5 Mounting Transmitters with Small Absolute or Differential Pressure Spans

To minimize positional effects on calibration (zero shift), take the appropriate mounting precautions for the respective Transmitter model. Ensure that the Transmitter is vertical when mounting models STA722 and STA72L. You do this by leveling the Transmitter side-to-side and front-to-back. **Figure 9** shows how to level a Transmitter using a spirit level.

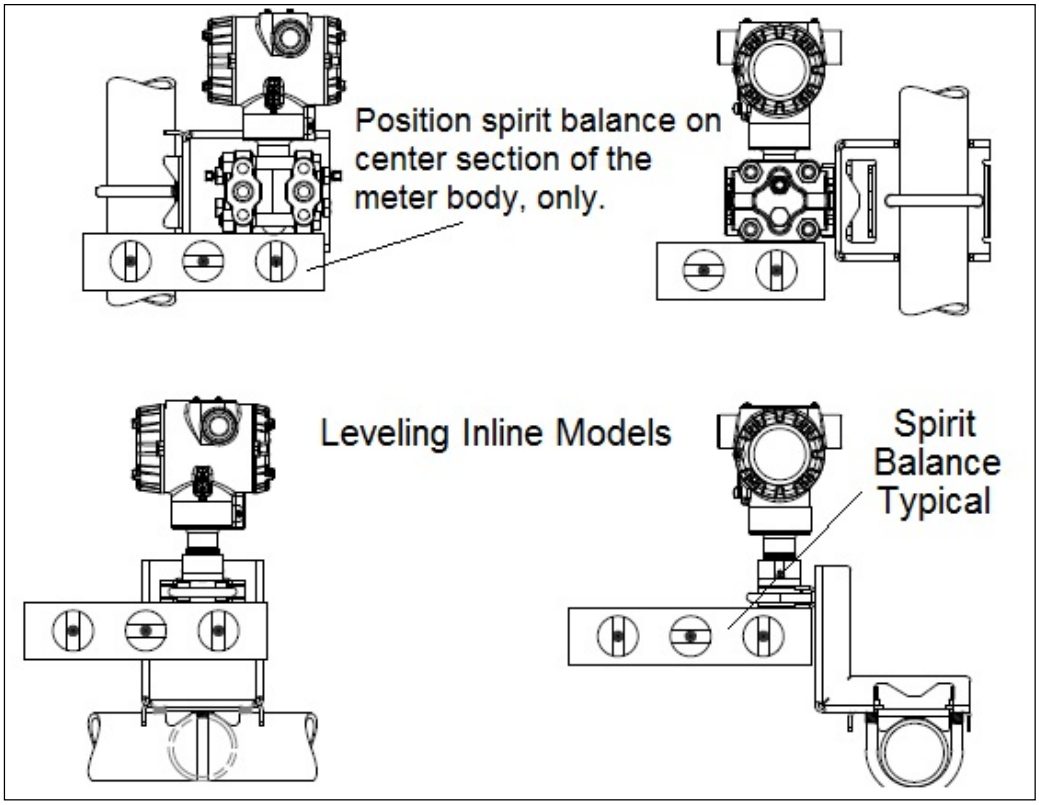


Figure 9 – ST 700 Standard Transmitter - Using a Spirit Balance to Level a Transmitter

4.4.6 Flange Mounting

Figure 10 shows a typical tank-flange mount installation, with the Transmitter flange mounted to the pipe on the wall of the tank.

On insulated tanks, remove enough insulaiton to accommodate the flange extension.

When flange-mounting to a tank, note the following:

- The End User is responsible for providing a flange gasket and mounting hardware suitable for the Transmitter service conditions.
- To avoid degrading performance in flush-mounted flanged Transmitters, exercise care to ensure that the internal diameter of the flange gasket does not obstruct the sensing diaphragm.
- To prevent performance degradation in extended-mount flanged Transmitters, ensure that sufficient clearance exists in front of the sensing diaphragm body.

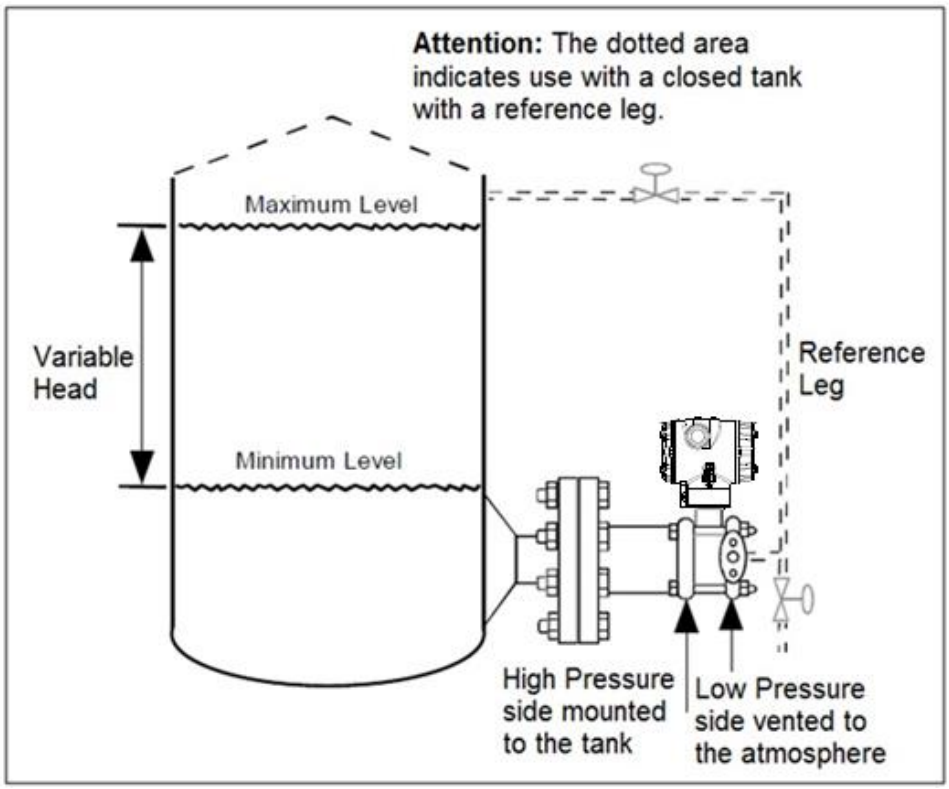


Figure 10 – ST 700 Standard Transmitter - Tank-Flange Mounted Transmitter

4.4.7 Remote Diaphragm Seal Mounting Information

The combination of tank vacuum and high pressure capillary head effect should not exceed nine (9) psi (300mmHg) absolute. For insulated tanks, be sure to remove enough insulation to accommodate the flange extension. The end user is responsible for supplying a flange gasket and mounting hardware suitable for the service condition of the Transmitter.

Mount the Transmitter flanges within the limits in **Table 6** for the fill fluid in the capillary tubes, with a tank at one (1) atmosphere.

Table 6 – ST 700 Standard Transmitter - Flange Mounting Guidelines

Fill Fluid	Mount the Flange…
Silicone 200 Oil	≤22 feet (6.7 meters) below the Transmitter
Chlorotrifluorethylene (CTFE)	≤11 feet (3.4 meters) below the Transmitter

Refer to Figure 11 for a representative remote diaphragm seal installation. Mount the Transmitter at a remote distance determined by the length of the capillary tubing.

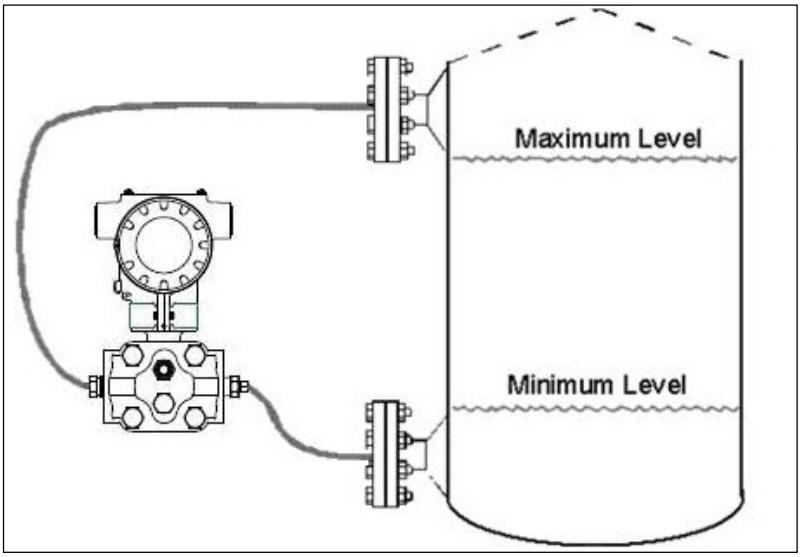


Figure 11 – ST 700 Standard Transmitter - Representative Remote Diaphragm Seal Transmitter Installation

Depending on Transmitter model, connect the remote seal to the tank according to Table 7.

Table 7 – ST 700 Standard Transmitter - Remote Diaphragm Mounting Details

Transmitter Model	Connect the Remote Seal on ….	
	Variable Head	Fixed or Constant Head
STR73D	Transmitter High Pressure (HP) Side to tank wall lower flange mounting.	Transmitter Low Pressure (LP) side to tank wall upper flange.

4.5 Piping the ST 700 Standard Transmitter

4.5.1 Piping Arrangements

Piping arrangements vary depending upon process measurement requirements and the Transmitter model. For example, a differential pressure transmitter comes with double-ended process heads with ¼-inch NPT connections, which can be modified to accept ½-inch NPT through optional flange adapters. Gauge pressure transmitters are available with various connections for direct mounting to a process pipe.

A ½-inch, schedule 80, steel pipe is commonly used for Transmitter integration into a process system. Many piping arrangements use a three-valve manifold to connect the process piping to the Transmitter. A manifold makes it easy to install and remove or re-zero a Transmitter without interrupting the process. A manifold also accommodates the installation of blow-down valves to clear debris from pressure lines. Figure 12 represents a typical piping arrangement using a three-valve manifold and blow-down lines for a differential pressure transmitter being used to measure flow.

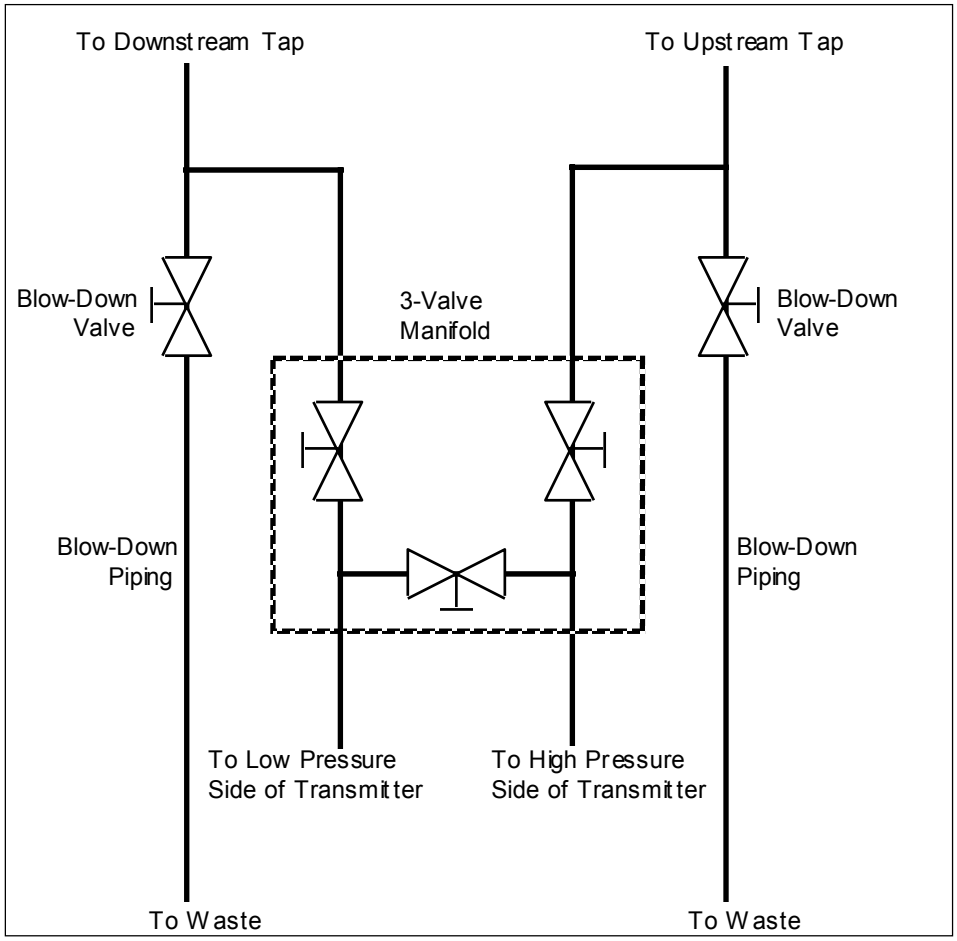


Figure 12 – ST 700 Standard Transmitter - Typical 3-Valve Manifold with Blow-Down Piping

4.5.2 Transmitter Location

The following are suggested connections based on what is being processed by the system.

Table 8 – ST 700 Standard Transmitter - Suggested Connection Locations

Process	Suggested Location	Description
Gases	Above the gas line.	The condensate drains away from the Transmitter.
Liquids	Below but near the elevation of the process connection.	This minimizes that static head effect of the condensate.
	Level with or above the process connection.	This requires a siphon to protect theTransmitter from process steam. The siphon retains water as a *fill fluid*.

1. For liquid or steam, the piping should slope a minimum of 25.4mm (1 inch) per 305mm (1 foot).
2. Slope the piping down toward the Transmitter if it is below the process connection to allow the bubbles to rise back into the piping through the liquid.
3. If the transmitter is located above the process connection, the piping should rise vertically above the Transmitter. In this case, slope down toward the flow line with a vent valve at the high point.
4. For gas measurement, use a condensate leg and drain at the low point (freeze protection may be required here).

ATTENTION Care must be taken when installing transmitters on hot processes. The operating temperature limits for the device (as outlined in Table 5) must not be exceeded. Impulse piping may be used to reduce the temperature of the process that comes into contact with the transmitter meter body. As a general rule there is a 56°C drop (100°F) in the temperature of the process for every foot of ½ inch uninsulated piping.

4.5.3 General Piping Guidelines

- When measuring fluids that contain suspended solids, install permanent valves at regular intervals to blow-down piping.
- Blow-down all lines on new installations with compressed air or steam, and flush them with process fluids (where possible) before connecting these lines to the Transmitter Meter body.
- Verify that the valves in the blow-down lines are closed tightly after the initial blow-down procedure and each maintenance procedure thereafter.

4.5.4 Procedure to Install Flange Adapters

The following procedure provides the steps for removing and replacing an optional flange adapter on the process head. Refer to Figure 13.

This procedure does not require that the Meter body be removed from the Electronics Housing. If flange adapters are being replaced with parts from other kits (for example, process heads), follow the procedures for the kits and incorporate the following procedure.

The threaded hole in each Flange Adapter is offset from center. To ensure proper orientation for re-assembly, note the orientation of the offset relative to each Process Head **before removing the adapter**.

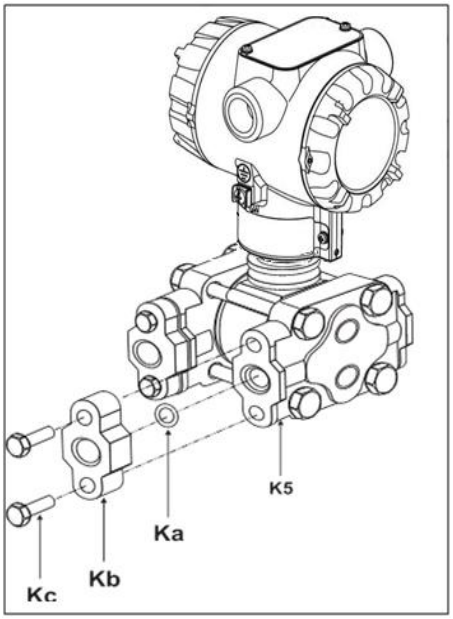


Figure 13 – ST 700 Standard Transmitter - Flange Adapter Removal and Replacement

Refer to the instructions included with the kit for removal and replacement procedures.

4.6 Wiring the ST 700 Standard Transmitter

4.6.1 Overview

The transmitter is designed to operate in a two-wire power/current loop with loop resistance and power supply voltage within the operating range shown in Figure 14.

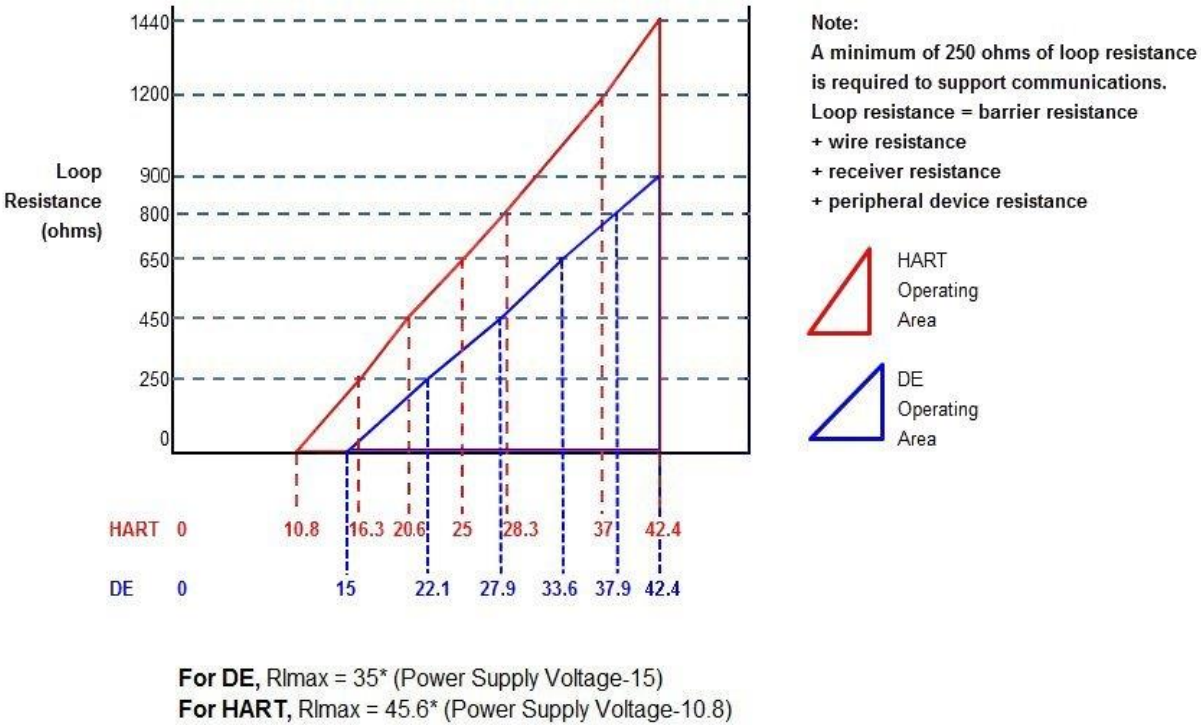


Figure 14 – ST 700 Standard Transmitter - Operating Ranges

Loop wiring is connected to the Transmitter by simply attaching the positive (+) and negative (–) loop wires to the positive (+) and negative (–) terminals on the Transmitter terminal block in the Electronics Housing shown in Figure 15.

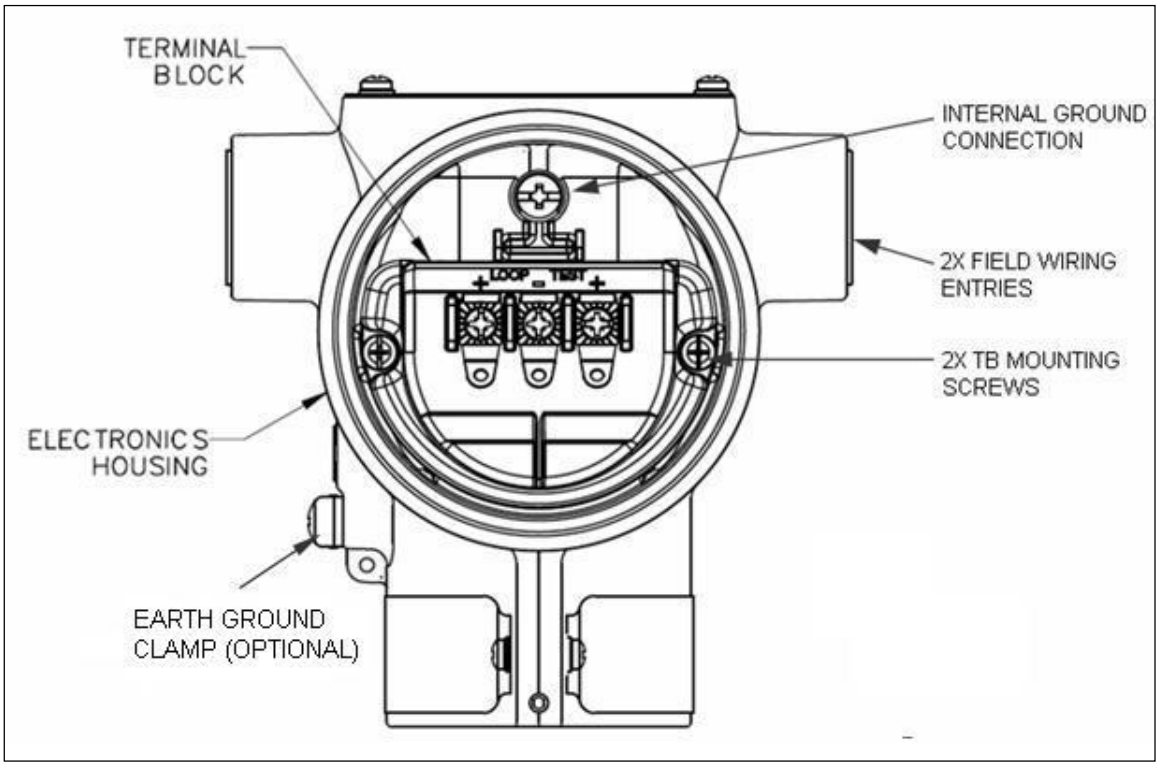


Figure 15 – ST 700 Standard Transmitter - 3-Screw Terminal Board and Grounding Screw

As shown in Figure 15, each Transmitter has an internal terminal to connect it to earth ground. Optionally, a ground terminal can be added to the outside of the Electronics Housing. While it is not necessary to ground the Transmitter for proper operation, doing so tends to minimize the possible effects of noise on the output signal and affords protection against lightning and static discharge. An optional lightning terminal block can be installed in place of the non-lightning terminal block for Transmitters that will be installed in an area that is highly susceptible to lightning strikes.

Wiring must comply with local codes, regulations and ordinances. Grounding may be required to meet various approval body certification, for example CE conformity. Refer to Appendix A of this document for details.

Note: The right hand terminal is for loop test and is not applicable for the Fieldbus option.

The Transmitter is designed to operate in a two-wire power/current loop with loop resistance and power supply voltage within the operating range; see

Figure 14. With optional lightning protection and/or a remote meter, the voltage drop for these options must be added to the basic 10.8-volt supply requirements to determine the required Transmitter voltage (V_{XMTR}) and maximum loop resistance ($R_{LOOP\ MAX}$). Additional consideration is required when selecting intrinsic safety barriers to ensure that they will supply at least minimum

Transmitter voltage ($V_{XMTR\ MIN}$), including the required 250 ohms of resistance (typically within the barriers) needed for digital communications.

Transmitter loop parameters are as follows:
$R_{LOOP\ MAX}$ = maximum loop resistance (barriers plus wiring) that will allow proper Transmitter operation and is calculated as $R_{LOOP\ MAX} = (V_{SUPPLY\ MIN} - V_{XMTR\ MIN}) \div 21.8mA$.

In this calculation:

$V_{XMTR\ MIN} = 10.8V + V_{LP} + V_{SM}$
$V_{LP} = 1.1V$, lightning protection option, LP
$V_{SM} = 2.3V$, remote meter

Note that V_{SM} should only be considered if a remote meter will be connected to the transmitter.
The positive and negative loop wires are connected to the positive (+) and negative (–) terminals on the terminal block in the Transmitter Electronics Housing.

Barriers can be installed per Honeywell's instructions for Transmitters to be used in intrinsically safe applications.

4.6.2 Digital System Integration Information

Transmitters that are to be digitally integrated to Honeywell's Total Plant Solution (TPS) system will be connected to the Pressure Transmitter Interface Module in the Process Manager, Advanced Process Manager or High Performance Process Manager through a Field Termination Assembly. Details about the TPS system connections are given in the *PM/APM SmartLine Transmitter Integration Manual*, PM12-410, which is part of the TDC 3000^X system bookset.

If you are digitally integrating a Transmitter in an Allen Bradley Programmable Logic Controller (PLC) process system, the same Field Terminal Assembly (FTA) and wiring procedures used with Honeywell's TPS system are also used with the Allen-Bradley 1771 and 1746 platforms.

4.6.3 Wiring Variations

The above procedures are used to connect power to a Transmitter. For loop wiring and external wiring, detailed drawings are provided for Transmitter installation in non-intrinsically safe areas and for intrinsically safe loops in hazardous area locations.

If you are using the Transmitter with Honeywell's TPS system, see *PM/APM Smartline Transmitter Integration Manual*, PM12-410, which is part of the TDC 3000^X system bookset.

4.6.4 Wiring Procedure

1. See Figure 15, above, for parts locations. Loosen the end cap lock using a 1.5mm Allen wrench.
2. Remove the end cap cover from the terminal block end of the Electronics Housing.
3. Feed loop power leads through one end of the conduit entrances on either side of the Electronics Housing. The Transmitter accepts up to 16AWG wire.
4. Plug the unused conduit entrance with the appropriate plug for the environment.
5. Connect the positive loop power lead to the positive (+) terminal and the negative loop power lead to the negative (-) terminal. Note that the Transmitter is <u>not</u> polarity-sensitive.
6. Replace the end cap, and secure it in place.

4.6.5 Lightning Protection

If your Transmitter includes the optional lightning protection, connect a wire from the Earth Ground Clamp (see Figure 15) to Earth Ground to make the protection effective. Use a size 8 AWG or (8.37mm^2) bare or green covered wire for this connection.

4.6.6 Supply Voltage Limiting Requirements

If your Transmitter complies with the ATEX 4 directive for self-declared approval per 94/9EC, the power supply has to include a voltage-limiting device. Voltage must be limited such that it does not exceed 42V DC. Consult the process design system documentation for specifics.

4.6.7 Process Sealing

The ST 700 SmartLine Pressure Transmitter is CSA-certified as a Dual Seal device in accordance with ANSI/ISA–12.27.01–2003, "Requirements for Process Sealing Between Electrical Systems and Flammable, or Combustible Process Fluids."

4.6.8 Explosion-Proof Conduit Seal

 When installed as explosion proof in a Division 1 Hazardous Location, keep covers tight while the Transmitter is energized. Disconnect power to the Transmitter in the non-hazardous area prior to removing end caps for service.

When installed as non-incendive equipment in a Division 2 hazardous location, disconnect power to the Transmitter in the non-hazardous area, or determine that the location is non-hazardous before disconnecting or connecting the Transmitter wires.

Transmitters installed as explosion proof in Class I, Division 1, Group A Hazardous (classified) locations in accordance with ANSI/NFPA 70, the US National Electrical Code, with 1/2 inch conduit do not require an explosion-proof seal for installation. If 3/4 inch conduit is used, a LISTED explosion-proof seal to be installed in the conduit, within 18 inches (457.2mm) of the Transmitter.

4.7 Startup – ST 700 Standard Transmitter

4.7.1 Overview

This section identifies typical start up tasks associated with several generic pressure measurement applications. It also includes the procedure for running an optional analog output check.

4.7.2 Startup Tasks

After completing the installation and configuration tasks for a Transmitter, you are ready to start up the process loop. Startup usually includes:

- Checking zero input
- Reading inputs and outputs
- Applying process pressure to the transmitter.

You can also run an optional output check to *wring out* an analog loop and check out individual Process Variable (PV) outputs in Digitally Enhanced (DE) mode before startup.

The actual steps in a startup procedure vary based on the type of Transmitter and the measurement application. In general, the procedures in this section are based on using Honeywell MC Toolkit to check the Transmitter input and output under static process conditions, and make adjustments as required initiating full operation with the running process. Note that similar checks can be made using the optional three-button assembly, where the Transmitter is equipped. Operation with the three-button assembly is discussed in the Operation section.

When the Standard Display is connected, the two-button assembly for the Standard Display is present. The buttons will function 1 second after powering up.

4.7.3 Output Check Procedures

The Output Check comprises the following procedures:

- The Loop Test procedure checks for continuity and the condition of components in the output current loop.
- The Trim DAC Current procedure calibrates the output of the Digital-to-Analog converter for minimum (0%) and maximum (100%) values of 4mA and 20mA, respectively. This procedure is used for Transmitters operating online in analog mode to ensure proper operation with associated circuit components (for example, wiring, power supply, control equipment). Precision test equipment (an ammeter or a voltmeter in parallel with precision resistor) is required for the Trim DAC Current procedure.
- The Apply Values procedure uses actual Process Variable (PV) input levels for calibrating the range of a Transmitter. To measure a liquid level for example, a sight-glass can be used to determine the minimum (0%) and maximum (100%) level in a vessel. The PV is carefully adjusted to stable minimum and maximum levels, and the LRV and URV are then set by commands from the MC Toolkit.



The Transmitter does not measure the given PV input or update the PV output while it operates in the Output mode.

4.7.4 Constant Current Source Mode Procedure

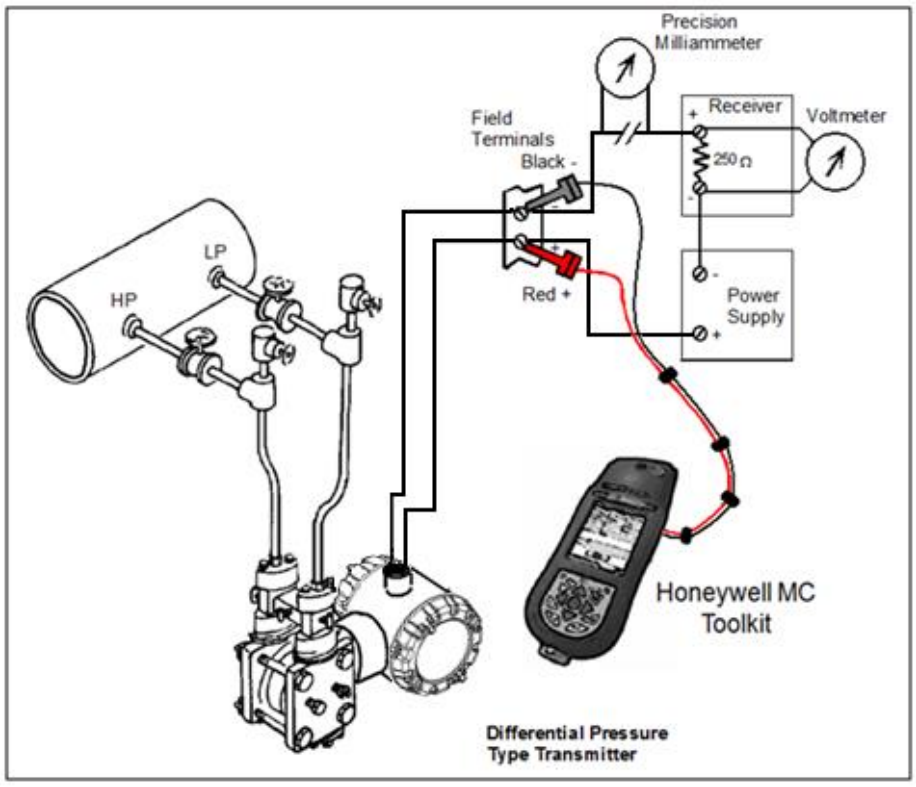


Figure 16 – ST 700 Standard Transmitter - Current Loop Test Connections

1. Refer to Figure 16 for test connections. Verify the integrity of electrical components in the output current loop.
2. Establish communication with the Transmitter. For these procedures, the values of components in the current loop are not critical if they support reliable communication between the Transmitter and the Toolkit.
3. On the Toolkit, display the **Output Calibration** box.
4. In the Output Calibration box, select the **Loop Test** button; the **LOOP TEST** box will be displayed.
5. Select the desired constant-level Output: 0%, 100%, or Other (any between 0% - 100%).
6. Select the Set button. A box will be displayed asking **Are you sure you want to place the transmitter in output mode?**

With the Transmitter in Analog mode, you can observe the output on an externally-connected meter or on a local meter. In DE mode, you can observe the output on the local meter or on the Toolkit Monitor display.

7. Select the **Yes** button. Observe the output current at the percentage you selected in Step 5.
8. To view the monitor display, navigate back from the **LOOP TEST** display, and select the **MONITOR** display. A **Confirm** popup will be displayed.
9. Select **Yes** to continue. This concludes the Startup procedure.

5. Operation_ST 700 Standard Transmitter

5.1 Overview

This section provides the information and processes involved for both Digitally Enhanced (DE) and HART operation using the three-button Basic and two-button Standard options for the ST 700 Standard transmitter.

5.2 Three-Button Operation

The ST 700 Standrad transmitter has optional three-button interface that provides a user interface and operation capability without opening the transmitter. Figure 17 shows the location of the three-button option and the labels for each button.

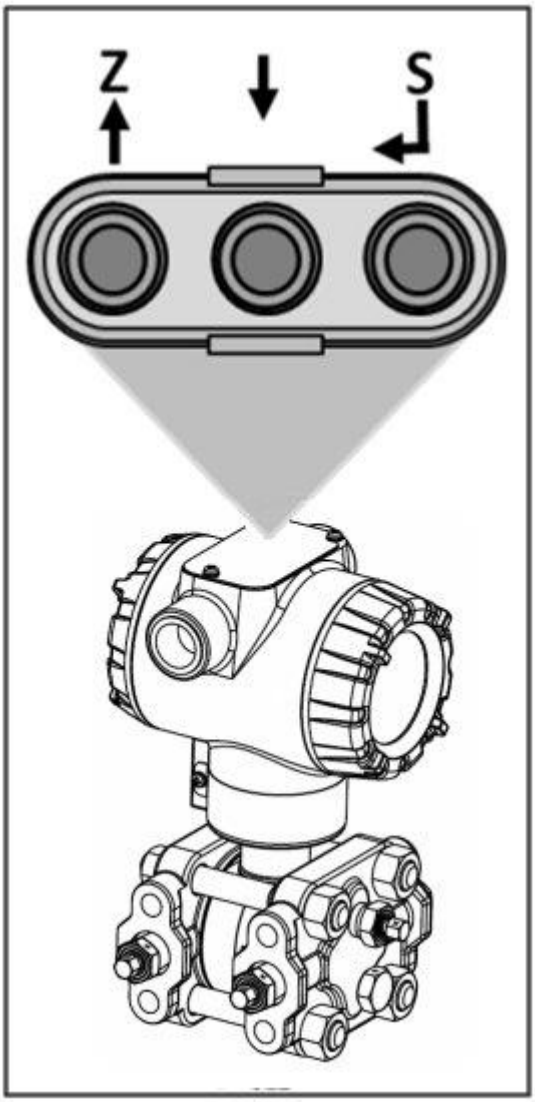


Figure 17 – ST 700 Standard Transmitter - Three-Button Option

Table 9 – Three-Button Option Functions

Physical Button	Basic Display	Action
Left ↑	Increment Previous Menu Item	Scroll to previous menu item in an active list. Scroll through alphanumeric list to desired character (ex. for entering Tag names or numeric values)
Center ↓	Decrement Next Menu Item	Scroll to next menu item in an active list. Scroll through alphanumeric list to desired character (ex. for entering Tag names or numeric values)
Right ↵	Select displayed menu item for activation or editing	Call up the Main Menu. Select an item for data entry. Confirm a data entry operation Activate the service associated with a selected menu item.

5.2.1 The Basic Display Menu

The Basic Display Menu is implemented as one long single-level menu and will "wrap around" when it reaches the start or end of the menu. Operation is as follows:

Press the ↵ button to call up the Menu.

1. Select **<Exit Menu>** and press ↵ to exit the Menu.
2. Use the ↑ and ↓ buttons to scroll through the list of menu items.
3. Press the ↵ button to select an item for data entry or activation. When an item is selected for data entry or activation, the cursor will jump to the lower line of the LCD to allow editing of the value. No action is taken against a menu item until the user presses the ↵ button.
4. If you want to abort a data entry operation, simply refrain from pushing any buttons for 10 seconds; the data entry operation will time out and the original value of the selected item will be preserved.

Table 10 – The Basic Display Menus

LCD Contrast	»»»»»»	Adjust the LCD contrast level. Range from » (1) to »»»»»»»»»» (9) Default: »»»»»»»»(7)		Press ↵ to enter menu selection ↑ and ↓ to select level. ↵ to enter
PV Display	Pressure	Pressure Units	Select Process Variable (PV) to be shown on the display from list.	
	Percent Output	%		
	Loop Output	mA		
PV Decimal	None	Select the PV decimal resolution to be shown on selected screen from list.		
	X.X			
	X.XX			
	X.XXX			
Pressure Units	atm, bar ftH2O @ 68ºF gf/cm2 inH2O @ 39ºF inH2O @ 60ºF inH2O @ 68ºF inHg @ 0ºC kgf/cm2, kPa mbar, mmH2O @ 4ºC, mmH2O @ 68ºF, mmHg @ 0ºC, MPa, Pa, psi Torr, mHg @ 0ºC	Choose appropriate engineering units from list		Press ↵ to enter menu selection ↑ and ↓ to select from list ↵ to enter
Zero Correct	Do Correct	Executing this selection corrects the Zero based on the input pressure		Press ↵ to enter menu selection Press ↵ to initiate action
LRV Correct	Do Correct	Executing this selection corrects the LRV based on the input pressure		
URV Correct	Do Correct	Executing this selection corrects the LRV based on the input pressure		
Reset Corrects	Do Correct	Executing this selection Resets the Zero, LRV, and URV Corrects back to Factory values		
DAC Zero Trim Note: Loop must be removed from Automatic Control	DAC Zero Trim	This selection allows the loop zero output 4mA value to be trimmed. Note: You must connect a current meter to the transmitter to monitor the loop output.		Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to the next digit to the right
DAC Span Trim Note: Loop must be removed from Automatic Control	DAC Span Trim	This selection allows the loop span output 20mA value to be trimmed. Note: You must connect a current meter to the transmitter to monitor the loop output.		

Loop Test Note: Loop must be removed from Automatic Control	Loop Test 12.000	This selection allows the user to force the DAC output to any value between 3.8 and 20.8 mA. Note: This selection will put the DAC into Fixed Output Mode, as indicated by the flashing output value. Navigation away from this menu item will return the loop to Normal (Automatic) Mode.	
LRV URV	#. ## #. ##	The limits are: 2X the Lower Range Limit (LRL) of the Meter body and 2X the Upper Range Limit (URL) of the Meter body	Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to the next digit to the right
Damping	#. ##	Selection applies digital filtering to suppress noise effects on the PV. The limits for this value are 0.0 to 32.0 seconds	
NAMUR	Enabled Disabled	Disabling sets the loop output and burnout levels to the Honeywell levels	Press ↵ to enter menu selection ↑ and ↓ to select from list ↵ to enter
Filter Perf	Fast SOR Standard SOR	Fast Speed of Response Standard Speed of Response	
Transfer Function (only available for DP Transmitters)	Linear	The loop output of the transmitter is a linear representation of the differential pressure	Press ↵ to enter menu selection ↑ and ↓ to select Alphanumeric ↵ to enter and shift to next character to the right.
	Square Root	The loop output of the transmitter represents %Flow as defined by the DP Square Root flow equation.	
Flow Cutoff	Single Breakpt	Allows the user to specify a single breakpoint as the low flow cutoff point. This item is only available when the Transfer Function is set to Square Root.	
	Dual Slope	Uses a dual slope formula to determine the low flow cutoff point. This item is only available when the Transfer Function is set to Square Root.	

Flow Breakpoint	##. #%	Enter the low flow cutoff point when Single Breakpt is selected. Range: 0 to 25.0 %Flow.	
Tag ID	□□□□□□□□	Enter Tag ID name up to 8 characters long. □ = any Alphanumeric value	Press ↵ to enter menu selection ↑ and ↓ to select Alphanumeric ↵ to enter and shift to next character to the right.
Device ID	Unique for each device		Read Only
PV Units	Units of transmitted PV		
Install Date	DD MM YYYY	This selection allows the user to enter the date a transmitter is installed. The Install Date is entered in sequence of Day, Month, and Year, followed by the new date and the prompt Write Date to confirm the entry. **CAUTION**: The Install Date can only be written once in the life of the Transmitter. You cannot erase or overwrite the Install Date once it has been written.	Press ↵ to enter menu selection ↑ and ↓ to select number ↵ to enter and shift to next digit to the right. Read Only after entered
Firmware	Display Electronics Meterbody	Menu item shows the current Firmware versions of the Display, Electronics Module and the Meter body	Read Only Parameter
Protocol	HART DE	Menu item shows the communications protocol	
Model Key		Identifies the type and range of the transmitter	Read Only Parameter
<Exit Menu>			

5.2.2 Data Entry

Data entry is performed from left to right. Select a character / digit by pressing ↑ or ↓ buttons, and then press ↵ to advance to the next character position to the right. Select the cross-hatch character ▒ to terminate the entry or if the final character is already a space character, just press **<<** again.

All numeric entries are clamped at the low or high limit if needed. You can determine the low and high limit for a parameter by selecting either the **H** or **L** character while the cursor is positioned over the left-most digit and press ↵ button. The Display will show the selected limit.

Table 11 – Three-Button Data Entry

Screen Symbol	Numeric data entry	Text entry
H	Display the high limit for this parameter. This symbol only appears in the left-most position of the data entry field.	Not Available
L	Display the low limit for this parameter. This symbol only appears in the left-most position of the data entry field.	Not Available
<<	Terminate the numeric entry	Terminate the text entry
0 thru 9, Minus, Decimal	These characters are used to enter numeric values. The minus sign only appears in the left-most digit.	These characters can be used to enter the Tag ID

5.2.3 Editing a Numeric value

Editing of a numeric value is a digit-by-digit process, starting with the left-most digit.

1. Press ↵ to begin the edit process.
2. The Basic Display will show the current value of the item on the lower line, left justified. The
3. Press the ↑ or ↓ buttons to select the desired digit, and then press ↵ to advance to the next digit to the right.
4. After the last digit has been entered, press ↵ one more time to write the new value to the transmitter.

5.2.4 Selecting a new setting from a list of choices

Use the procedure described below to select a new setting for parameters that present a list of choices (e.g., PV Display, Pressure Units, etc.).

1. Press ↵ to begin the edit process.
    a. The Basic Display will show the current setting of the item on the lower line, left justified.
2. Press the ↑ or ↓ buttons to scroll through the list of choices.

Press ↵ to make your selection. The new selection will be stored in the transmitter and will be displayed on the lower line, right justified.

5.3 Two-Button Operation

The ST 700 Standrad transmitter has an optional two-button interface that provides a user interface and operation capability without opening the transmitter. Figure 18 shows the location of the two-button option and the labels for the buttons.

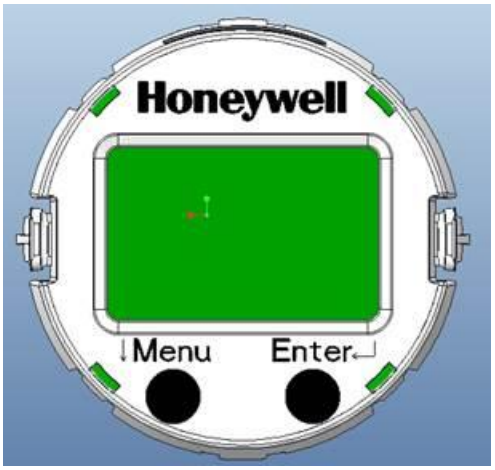


Figure 18 – ST 700 Standard Transmitter - Two-Button Option

5.3.1 The Standard Display Menu

The ST 700 Standard Display Menu is implemented as one long single-level menu and will "wrap around" when it reaches the end of the menu. Operation is as follows:

1. Select <**Exit Menu**> and press ↵ to exit the Menu.
2. Use the ↓ buttons to scroll through the list of menu items.
3. Press the ↵ button to select an item for data entry or activation. When an item is selected for data entry or activation, the cursor will jump to the lower line of the LCD to allow editing of the value. No action is taken against a menu item until the user presses the ↵ button.
4. If you want to abort a data entry operation, simply refrain from pushing any buttons for 10 seconds; the data entry operation will time out and the original value of the selected item will be preserved.
5. If you want to abort a menu operation, simply refrain from pushing any buttons for 60 seconds; the menu operation will time out and the exit from menu & it will show PV value.

Note: The abort option is not available for Loop test parameter.

Table 12 – The Standard Display Menus

<table>
<tr><td rowspan="5">PV Display [SEL PV]</td><td>Pressure (PRESURE)</td><td>Pressure Units</td><td rowspan="5">Select Process Variable (PV) to be shown on the display from list.</td><td rowspan="6">Press ↵ to enter menu selection

↓Menu to select from list
↵ to enter</td></tr>
<tr><td>Percent Output (% OUT)</td><td>%</td></tr>
<tr><td>Loop Output (LOOPOUT)</td><td>mA</td></tr>
<tr><td>Flow (FLOW)
Note: Before selecting PV type as Flow, please ensure the LRV/URV values in (pressure unit) are as per application. For PV type Flow the pressure unit will not be visible.</td><td>Flow unit</td></tr>
<tr><td>Pressure Units [UNITS]
(Visible for all PV except Flow)</td><td>atm, bar
ftH2O @ 68ºF
gf/cm2
inH2O @ 39ºF
inH2O @ 60ºF
inH2O @ 68ºF
inHg @ 0ºC
kgf/cm2, kPa
mbar,
mmH2O @ 4ºC,
mmH2O @ 68ºF,
mmHg @ 0ºC,
MPa, Pa,
psi
Torr,
mHg @ 0ºC</td><td colspan="2">Choose appropriate engineering units from list</td></tr>
<tr><td>Flow Units [FLUNIT]
(Visible if PV is Flow)</td><td>Cubic meter/hour[m3/hr] Kg/hour [Kg/hr]
Metric Ton/Hour [MT/hr]
Liter per second [L/sec]
Liters/hour [L/hr]
Standard Cubic feet per hour[SCFH]
Cubic feet per hour[CFH]
Gallons/hour[gal/hr]
Barrel/hours [bbl/hr]
Imperial Gallons/hours[Igal/hr]
Percentage[%]</td><td colspan="2">Choose appropriate engineering units from list</td><td>Press ↵ to enter menu selection

↓Menu to select from list
↵ to enter</td></tr>
</table>

Scaling Low [SCLLOW] Scaling High [SCLHIG] (Visible if PV is Flow)	#. ## #. ##	The limits are: -999999 to 999999	Press ↵ to enter menu selection ↓ Menu to select number. ↵ to enter and shift to the next digit to the right
Enter LRV [ENTLRV] Enter URV [ENTURV]	#. ## #. ##	The limits are: 2X the Lower Range Limit (LRL) of the Meter body and 2X the Upper Range Limit (URL) of the Meter body. The LRV/URV value will be available in Pressure Units (Standard Display pressure unit)	Press ↵ to enter menu selection ↓ Menu to select number. ↵ to enter and shift to the next digit to the right
DAC Zero Trim [ZEROTR] Note: Loop must be removed from Automatic Control	DAC Zero Trim	This selection allows the loop zero output 4mA value to be trimmed. Note: You must connect a current meter to the transmitter to monitor the loop output.	Press ↵ to enter menu selection ↓ Menu to select number. ↵ to enter and shift to the next digit to the right
DAC Span Trim [SPANTR] Note: Loop must be removed from Automatic Control	DAC Span Trim	This selection allows the loop span output 20mA value to be trimmed. Note: You must connect a current meter to the transmitter to monitor the loop output.	
Loop Test [LPTEST] Note: Loop must be removed from Automatic Control	Loop Test 12.000	This selection allows the user to force the DAC output to any value between 3.8 and 20.8 mA. Note: This selection will put the DAC into Fixed Output Mode, as indicated by the flashing output value. Navigation away from this menu item will return the loop to Normal (Automatic) Mode.	Press ↵ to enter menu selection ↓ to select number. ↵ to enter and shift to the next digit to the right

Set LRV [SETLRV]	Set LRV	Executing this selection performing for Zero operation.	Press ↵ to enter menu selection Press ↵ to initiate action
Set URV [SETURV]	Set URV	Executing this selection for Span operation	
Contrast [CNTRST]	»»»»»»	Adjust the LCD contrast level. Range from » (1) to »»»»»»»»»» (7) Default: »»»»»»»»»(7)	Press ↵ to enter Menu selection Menu to select level. ↵ to Enter
<Exit Menu>			

5.3.2 Standard Display Abbreviations:

Table 13 – The Standard Display abbreviations

Abbreviation	Meaning
OOR	Out of Range
PRSPAN	Push reduce span
Wrng Mo	Wrong Mode
Illegal	Illegal Value
Wrt Err	NVM write error
Too Hi	Value/Parameter Too High
Too Lo	Value/Parameter Too Low
LRV Hi	LRV too High
LRV Lo	LRV too Low
LargeSP	Span too large
SmallSP	Span too small
Locked	Device is locked
Multidr	Device in multidrop mode
Wrt Prt	Device in write protect mode
NotSprt	Not supported
Hi LMT	Value is greater than high Limit value
Low LMT	Value is less than low Limit value

5.3.3 Data Entry

Data entry is performed from left to right. Select a character / digit by pressing ↓ buttons, and then press ↵ to advance to the next character position to the right. Select the cross-hatch character ▒ to terminate the entry or if the final character is already a space character, just press **<<** again.

All numeric entries are clamped at the low or high limit if needed. You can determine the low and high limit for a parameter by selecting either the **H** or **L** character while the cursor is positioned over the left-most digit and press ↵ button. The Display will show the selected limit.
For numeric entry sign is required to be entered only for negative numbers. For positive number, select space and move ahead.

Table 14 –Two-Button Data Entry

Screen Symbol	Numeric data entry
H	Display the high limit for this parameter. This symbol only appears in the left-most position of the data entry field.
L	Display the low limit for this parameter. This symbol only appears in the left-most position of the data entry field.
<<	Terminate the numeric entry
0 thru 9, Minus, Decimal	These characters are used to enter numeric values. The minus sign only appears in the left-most digit.

5.3.4 Editing a Numeric value

Editing a numeric value is a digit-by-digit process, starting with the left-most digit.

1. Press ↵ to begin the edit process.
2. The Standard Display will show the current value of the item on the lower line, left justified.
3. Press the ↓ buttons to select the desired digit, and then press ↵ to advance to the next digit to the right.
4. After the last digit has been entered, press ↵ one more time to write the new value to the transmitter.

5.3.5 Selecting a new setting from a list of choices

Use the procedure described below to select a new setting for parameters that present a list of choices (e.g. PV Display, Pressure Units, and so forth.).

1. Press ↵ to begin the edit process.
    a. The Standard Display will show the current setting of the item on the lower line
2. Press the ↓ buttons to scroll through the list of choices.
3. Press ↵ to make your selection. The new selection will be stored in the transmitter and will be displayed on the lower line

5.4 Basic and Standard Display Operations

5.4.1 Editing a Numeric value

Editing of a numeric value is a digit-by-digit process, starting with the left-most digit.

1. Press ↵ to begin the edit process:
   - The Basic and Standard Display will display the current value of the item on the lower line, left justified.
   - **Basic Display:** Press the ↑ or ↓ buttons to select the relevant digit, and then press ↵ to advance to the next digit to the right.
   - **Standard Display:** Press the ↓ button to select the relevant digit, and then press ↵ (both button simultaneously) to advance to the next digit on the right.
2. Basic and Simply Displays: After the last digit has been entered, press ↵ one more time to write the new value to the transmitter.

5.4.2 Selecting a new setting from a list of choices

Use the procedure described below to select a new setting for parameters that present a list of choices (e.g. PV Display, Pressure Units, etc.).

1. Press ↵ to begin the edit process.
   a. The Basic Display will show the current setting of the item on the lower line, left justified.
2. Press the ↑ or ↓ buttons to scroll through the list of choices.

   Press ↵ to make your selection. The new selection will be stored in the transmitter and will be displayed on the lower line, right justified.

5.5 Three Button Operation with no Display Installed

When there is no Display installed, the buttons can be used to perform a Zero or Span adjustment of the ST 700 Standard Transmitter. Caution should be taken to insure these adjustments are only made when the correct input pressures are applied.

5.5.1 Zero Adjustment

This adjustment is the same as performing a Set LRV using the Display.

1. Connect a current meter or voltmeter as shown in Figure 16 to monitor the PV output of the Transmitter.
2. Using an accurate pressure source, apply pressure equivalent to the Transmitter LRV.
3. Press the Down (↓) and Zero (↑) buttons together to set the Zero.
4. Verify that the output is now 4 mA.

5.5.2 Span Adjustment

This adjustment is the same as performing a Set URV using the Display.

1. Connect a current meter or voltmeter as shown in Figure 16 to monitor the PV output of the Transmitter.
2. Using an accurate pressure source, apply pressure equivalent to the desired Upper Range Value of the transmitter.
3. Press the **Down (↓)** and **Span (↵**) buttons together to set the span.
4. Verify that the PV output is now 20mA.


You can also use the MCT 202 Toolkit to make any adjustments to an ST 700 SmartLine Pressure Transmitter. Alternately, certain adjustments are possible through an Experion Station or Universal Station, if the ST 700 is digitally integrated with either of these stations.

5.6 Changing the Default Failsafe Direction

Transmitters are shipped with a default failsafe direction of upscale. This means that the Transmitter output will set the current output to upscale failsafe (maximum output) upon detection of a critical status. You can change the direction from upscale failsafe to downscale failsafe (minimum output) by moving the top jumper located in the Electronics module.

5.6.1 DE and Analog Differences

Failsafe operation is different between DE and analog operation:

- **Analog operation** – Upscale failsafe drives the Transmitter output to 21.8mA. Downscale failsafe drives the Transmitter output to 3.8mA.
- **DE operation** – Upscale failsafe causes the Transmitter to generate a **+ infinity** digital signal. Downscale failsafe causes the Transmitter to generate a **– infinity** digital signal.

The Transmitter electronics module interprets either signal as *not-a-number* and initiates its own configured failsafe action for the control system.

5.6.2 Procedure to Establish Failsafe Operation

The failsafe direction display accessible via the Toolkit shows only the state of the jumper as it correlates to analog Transmitter operation. Failsafe action for the DE control system may be configured to operate in a manner different from analog, as indicated by the state of the Transmitter jumper.

The integrated circuits in the Transmitter PWA are vunerable to damage by stray static discharges when removed from the Electronics Housing. Minimize the possibility of static discharge damage when handling the PWA as follows:

Do not touch terminals, connectors, component leads, or circuits when handling the PWA.

When removing or installing the PWA, handle it by its edges or bracket section only. If you need to touch the PWA circuits, be sure you are grounded by staying in contact with a grounded surface or by wearing a grounded wrist strap.

When the PWA is removed from the Transmitter, put it in an electrically conductive bag, or wrap it in aluminum foil to protect it.

The following procedure outlines the steps for positioning the write protect and failsafe jumpers on the electronics module. See Figure 19 for the locations of the failsafe and write protect jumpers.

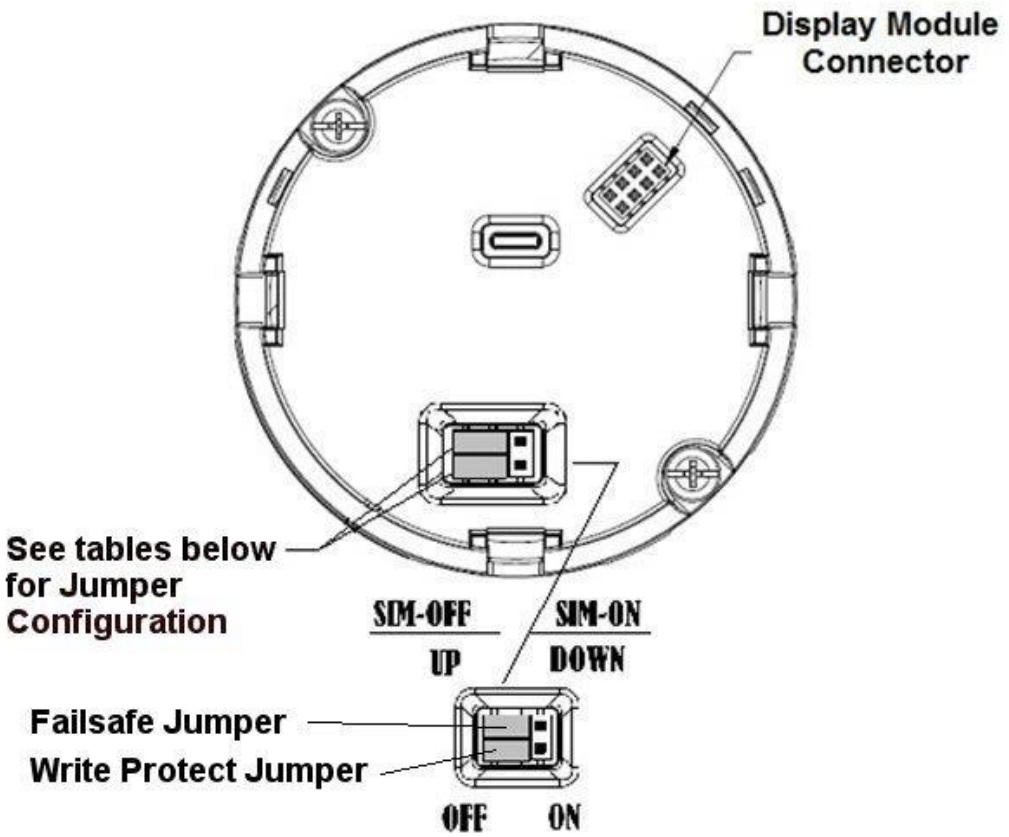


Figure 19 – ST 700 Standard Transmitter - Locating the Failsafe and Write Protect Jumpers

Table 15 – ST 700 Standard Transmitter - Hart and DE Failsafe and Write Protect Jumpers

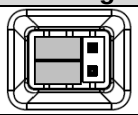
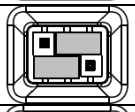
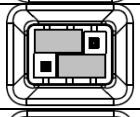
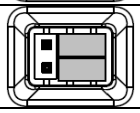
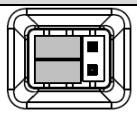
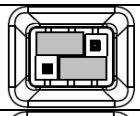
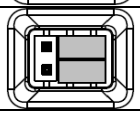
Jumper Arrangements	Description
	Failsafe = UP (High) Write Protect = OFF (Not Protected)
	Failsafe = DOWN (Low) Write Protect = OFF (Not Protected)
	Failsafe = UP (High) Write Protect = ON (Protected)
	Failsafe = Down (Low) Write Protect = On (Protected)

Table 16 – ST 700 Standard Transmitter - Fieldbus Simulation and Write Protect Jumpers

Image	Description
	Fieldbus Simulation Mode = OFF Write Protect = OFF (Not Protected)
	Fieldbus Simulation Mode = OFF Write Protect = ON (Protected)
	Fieldbus SIM Mode = ON Write Protect = OFF (Not Protected)

1. Turn OFF Transmitter power (Power removal is only required in accordance with area safety approvals. Power removal is only required in Class 1 Div 1 Explosionproof and Class 1 Div 2 environments).

2. Loosen the end cap lock, and unscrew the end cap from the electronics side of the Transmitter housing.

3. If equipped with a Display module, carefully depress the two tabs on the sides of the Display Module, and pull it off.

4. If necessary, unplug the interface connector from the Communication module. Do not discard the connector.

5. Set the Failsafe Jumper (top jumper) to the desired position (UP or DOWN). See Table 15 and Table 16 for jumper positioning.

6. If applicable, re-install the Display module as follows:

    - Orient the display as desired.
    - Install the Interface Connector in the Display module such that it will mate with the socket for the display in the Communication module.
    - Carefully line up the display, and snap it into place. Verify that the two tabs on the sides of the display latch.

    Note: Installing a Display Module into a powered transmitter may cause a temporary upset to the loop output value.

    Orient the Display for proper viewing through the end cap window. You can rotate the meter mounting orientation in 90° increments.

7. Restore transmitter power if removed.

5.7 Monitoring the Basic and Standard Displays for the ST 700 Standard Transmitter

This section describes the information shown on the operator screens of the Basic and Standard Displays.

5.7.1 Basic Display_ST 700 Standard Transmitter -

Figure 20 illustrates the Basic Display format with Process Variable (PV).

- The PV value is user-configurable. This field has 7 characters. The maximum allowable numeric value is 9999999 or -999999. If fractional decimals are configured, the fractional positions will be dropped, as required. If the PV value exceeds the above limits, it is divided by 1000 and "K" is appended to the result, allowing a maximum value with multiplier of 999999K or -99999K.
- Process Variable Tag is user-configurable from a HART Host. This field has 14 characters.
- Engineering Units, this field is user-configurable. This field has 8 characters.

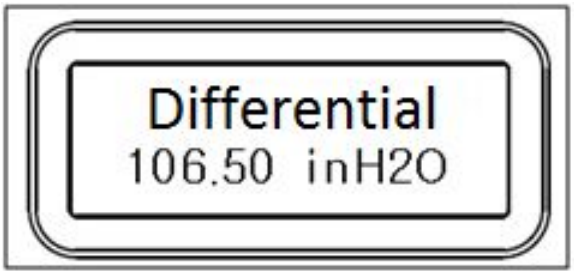


Figure 20 – ST 700 Standard Transmitter - Basic Display with Process Variable Format

5.7.2 Standard Display_ST 700 Standard Transmitter -

- The PV value is user-configurable. This field has 6 characters. The maximum allowable numeric value is 999999 or -999999.
    - If fractional decimals are configured, the fractional positions will be dropped, as required.
    - If the PV value exceeds the above limits, it is divided by 1000 and "K" is appended to the result, allowing a maximum value with multiplier of 99999K or -99999K.

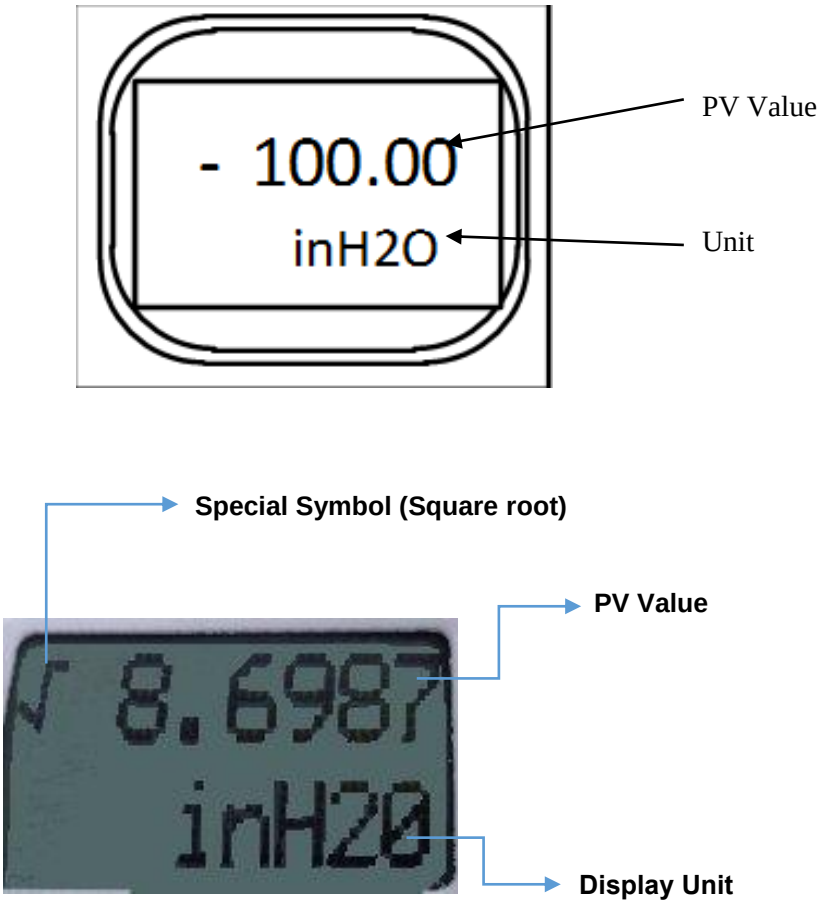


Figure 21 – ST 700 Standard Transmitter - Standard Display with Process Variable Format

6. Maintenance_ST 700 Standard Transmitter

6.1 Overview

This section provides information about preventive maintenance and replacing damaged parts. The topics covered in this section are:

- Preventive maintenance of the meter body barrier diaphragms and process piping to the Transmitter.
- Replacement of damaged parts such as the Transmitter Printed Wiring Assembly (PWA) and meter body

6.2 Preventive Maintenance Practices and Schedules

The ST 700 Transmitter does not require any specific maintenance at regularly scheduled intervals. However, it is recommended that you perform these typical inspection and maintenance routines on a schedule that is dictated by the characteristics of the process medium and if blow-down facilities or purge systems are being used.

- Check piping for leaks.
- Clear piping of sediment or other foreign matter.
- Clean the Transmitter process heads, including the barrier diaphragms.

6.3 Inspecting and Cleaning Barrier Diaphragms

Depending on the characteristics of the process medium, sediment or other foreign particles may collect in the process head cavity/chamber and cause faulty measurement. In addition, the barrier diaphragm(s) in the Transmitter meter body may become coated with residue from the process medium. The latter is also true for external diaphragms on flange-mount and remote seal type Transmitters.

In many cases, you can readily remove the process head(s) from the Transmitter meter body to clean the process head cavity and inspect the barrier diaphragm(s). For flange-mount and remote seal diaphragms, you may only need to run a purge line in the tank to rinse off the face of the diaphragm(s).

The following procedure comprises the general steps for inspecting and cleaning barrier diaphragms. You may have to modify these steps to meet your particular process or transmitter model requirements. Figure 22 shows an exploded view of a Differential Pressure (DP) Transmitter meter body for reference. For disassembly/reassembly purposes, Gauge Pressure (GP) and Absolute Pressure (AP) Transmitters are similar.


It is recommended that you remove the Transmitter from service and move it to a clean area before disassembling it.

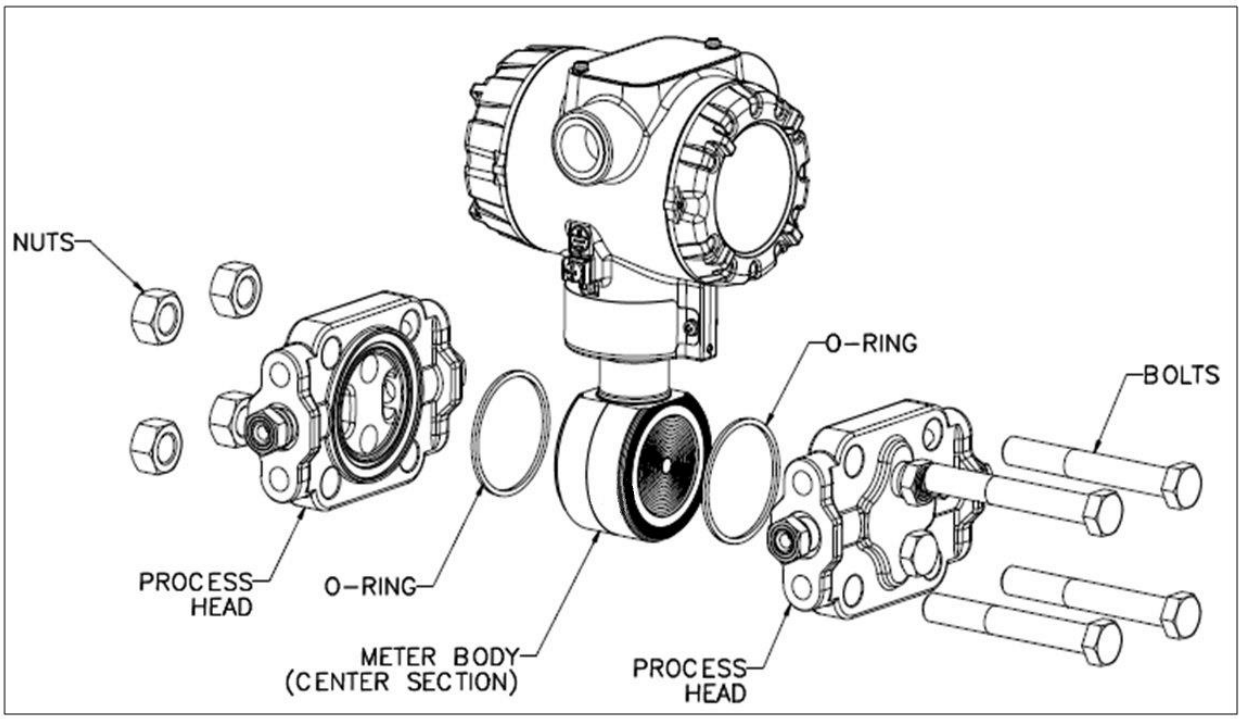


Figure 22 – ST 700 Standard Transmitter - DP Transmitter Head Disassembly

1. Close all valves to isolate the Transmitter from the process.
2. Open the vent in the process head to drain fluid from the Transmitter meter body, as necessary.
3. Remove the Transmitter from the process.
4. Loosen the nuts in the sequence shown in Figure 23.
5. Remove the nuts from the bolts that hold the process head(s) to the meter body.
6. Remove the process heads and bolts.
7. Remove the gasket/ O-ring, and clean the interior of the process head using a soft bristle brush and an approved solvent.
8. Inspect the barrier diaphragm for signs of deterioration, corrosion, and distortion.
9. If the diaphragm is distorted contact Honeywell for assistance.
10. Install a new gasket/O-ring in each process head.
11. Coat threads on the process head bolts with a suitable anti-seize compound, such as "Neverseize," or equivalent.
12. Using a torque wrench, gradually tighten the nuts in the sequence shown in Figure 23. Tighten head bolts in stages of 1/3-full torque, 2/3-full torque, and full torque. Refer to the values in Table 17 for torque requirements versus Transmitter type and model.

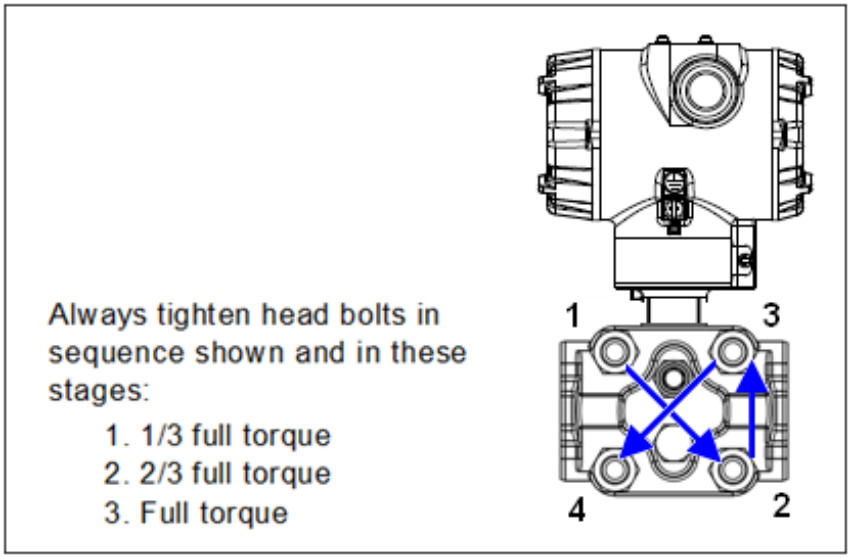


Figure 23 – ST 700 Standard Transmitter - Head Bolt Tightening Sequence

Table 17 – Head Bolt Torque Values

BOLTING TYPE	B7M BOLTING TABLE III B7 OPTION BOLT 51452557-004 NUT 51452559-003	PTFE COATED B7M BOLTING Y SPECIAL OPTION BOLT 51452557-007 NUT 51452559-007	MONEL K 500 BOLTING Y SPECIAL OPTION BOLT 51452557-005 NUT 51452559-005	25% CHROMIUM SUPER DUPLEX BOLTING Y SPECIAL OPTION BOLT 51452557-006 NUT 51452559-006	316 STAINLESS STEEL BOLTING TABLE III SS OPTION BOLT 51452557-003 NUT 51452557-003 BOLT 51452559-004	NACE CR BOLTING TABLE III CR OPTION BOLT 51452557-002 NUT 51452559-02	ALL GRADE 660 CLASS D BOLTING Y SPECIAL OPTION BOLT 51452557-001 NUT 51452559-008	CARBON STEEL BOLTING STANDARD OPTION BOLT 51452557-001 NUT 51452559-001	ALL GRADE 660 CLASS D BOLTING Y SPECIAL 6 KPSI OPTION BOLT 51452557-202 NUT 51452559-008
50049713XXXX, EXCEPT XXX5 ALL TRANSMITTERS EXCEPT DRAFT RANGE	48,8 N•M +/- 2,4 N•M (36.0 Lb-Ft +/- 1.8 Lb-Ft)				56,9 N•M +/- 2,8 N•M (42.0 Lb-Ft +/- 2.1 Lb-Ft)			67,8 N•M +/- 3,4 N•M (50.0 Lb-Ft +/- 2.5 Lb-Ft)	
50049713XXX5 DRAFT RANGE TRANSMITTER ONLY	20,3 N•M +/- 1,0 N•M (15.0 Lb-Ft +/- 0.8 Lb-Ft)								

6.4 Replacing the Communication Module

The Communication module includes a connector to the sensor ribbon cable and a connector to the optional Display module. This section includes the procedure to replace the Communication module.

The transmitter does not have to be removed from service to replace the Comm Module

Please take appropriate steps to avoid ESD damage when handling the Communication and Display Module assemblies

Refer to Figure 24 for parts locations.

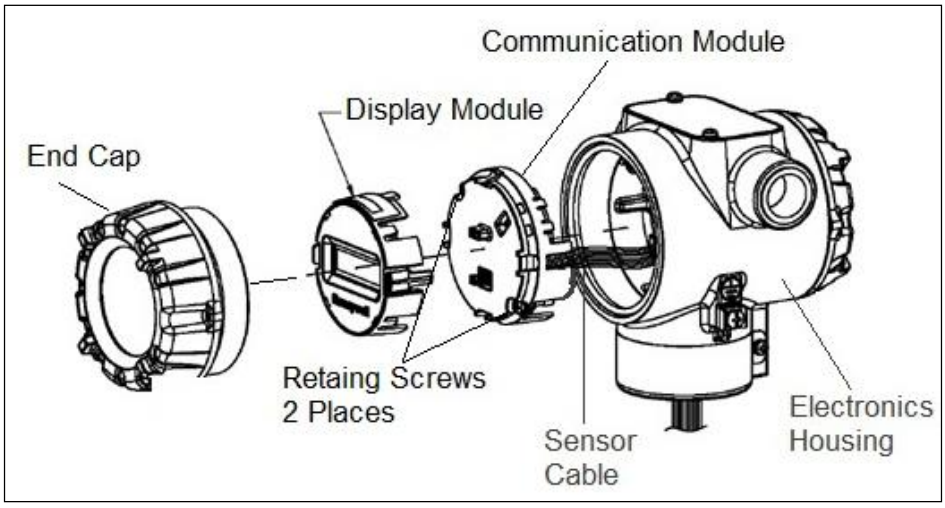


Figure 24 – ST 700 Standard Transmitter - PWA Replacement

1. Turn OFF Transmitter power (Power removal is only required in accordance with area safety approvals. Power removal is only required in Class 1 Div 1 Explosion-proof and Class 1 Div 2 environments).
    - When removing the Communications Module with power applied, the loop will go to 0V. Likewise, installing a Communications Module into a transmitter with power applied will cause the loop output value to go to 12ma for several seconds then the loop output value will go to the configured value based on the PV input.
    - Installing a Display Module into a powered transmitter may cause a temporary upset to the loop output value.
2. Loosen the end cap lock, and unscrew the end cap from the electronics side of the Transmitter housing.
3. If equipped with a Display module, carefully depress the two tabs on the sides of the Display Module, and pull it off.
4. If necessary, unplug the interface connector from the Communication module. **Do not discard the connector**.
5. Loosen the two retaining screws, and carefully pull the Communication module from the Electronics compartment.

6. Carefully align and connect the Sensor Ribbon Cable to the connector "J4" at the bottom of the Communication module. When installing the Communication module in the next step, be careful not to pinch the Sensor Ribbon Cable.

7. Carefully, insert the Communication module into the Electronics compartment. Ensure that the Sensor Ribbon Cable is not pinched.

8. Tighten the two Communication module retaining screws.

9. Refer to the SmartLine User's Manual to change the FAILSAFE, READ/WRITE, and SIM-OFF/SIM-ON (Fieldbus Only) configuration settings.

10. If applicable, re-install the Display module as follows:

    a. Orient the display as desired.

    b. Install the Interface Connector in the Display module such that it will mate with the socket for the display in the Communication module.

    c. Carefully line up the display, and snap it into place. Verify that the two tabs on the sides of the display latch.

Orient the Display for proper viewing through the end cap window. You can rotate the meter mounting orientation in 90 º increments.

11. Apply Parker Super O-ring Lubricant or equivalent to the end cap O-ring before installing the end cap. Reinstall the End Cap and tighten the End Cap locking screw.

12. Installing Optional External Configuration Button Assembly.

    a. Loosen (Do Not Remove) both top nameplate screws and pivot nameplate 90°.

    b. Align the protrusion on the button assembly with the matching opening in the housing and snap the button assembly into the housing.

    c. Rotate the nameplate back to the original position, and tighten the nameplate screws.

(Steps 13 - 16 required for Field Upgrades Only)

13. Loosen the End Cap locking screw and unscrew the End Cap from the Field Wiring side of the transmitter housing.

14. Select the proper Communication/External Configuration upgrade kit label from the label strip provided and adhere to the inside of the Field Wiring compartment End Cap.

15. Apply Parker Super O-ring Lubricant or equivalent to the end cap o-ring before installing the end cap. Reinstall the End Cap and tighten the end cap locking screw.

16. Install external upgrade label (e.g. DEVICE MODIFIED…..) provided on outside of housing as shown in Figure 24.

17. Restore power if removed.

18. Check the settings of the Transmitter Setup and Display Setup parameters to make sure that the transmitter is configured correctly for your application. See the HART/DE User's Manual (ST 800 #34-ST-25-38, ST 700 #34-ST-25-44) for details on HART and DE transmitters. Refer to manual #34-ST-25-39 for additional information about Fieldbus transmitters.

19. If applicable, verify External Button Configuration operation. The transmitter is now available for use.

6.5 Replacing the Meter Body

You can replace the complete meter body, including the process heads, or the meter body only on certain Differential Pressure (DP), Gauge Pressure (GP), and Atmospheric Pressure (AP) Transmitters by using the existing process head(s). Use the following procedure for meter body-only replacement.

1. Save or record device configuration data.
2. Turn off Transmitter power.
3. Remove the Transmitter from service, and move it to a clean area before disassembling it.
4. Refer to Figure 25. Loosen the End Cap Lock, and unscrew the End Cap from the electronics side of the Transmitter housing.

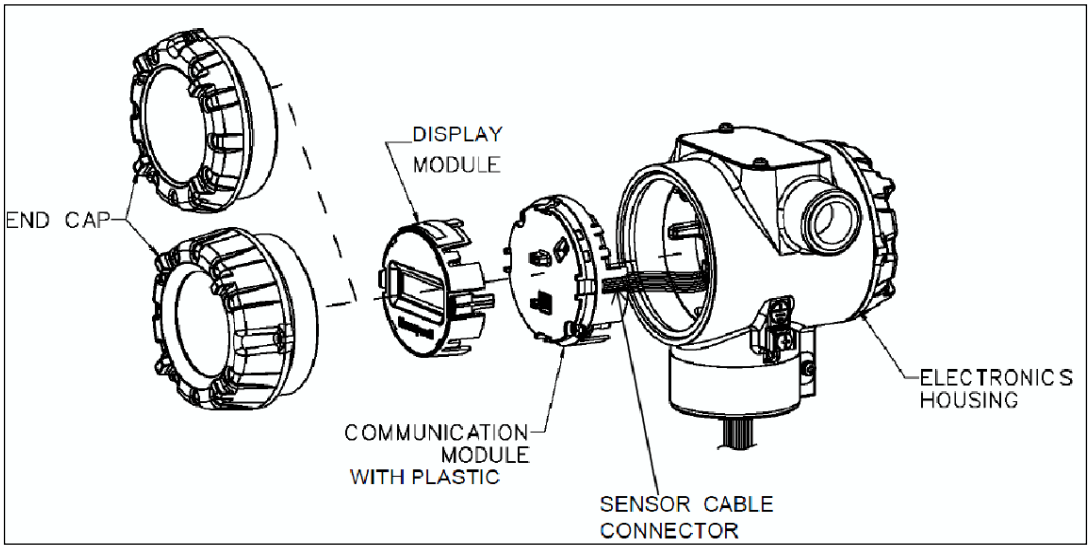


Figure 25 – ST 700 Standard Transmitter - Disassembly for Meter Body Replacement

Please take appropriate steps to avoid ESD damage when handling the Communication and Display Module assemblies

5. If a display is present, press the two snaps along the side, and remove it from the communication module assembly.
   Note: Do not discard or misplace the Display/Communication connector, it will be required to reassemble the Display Module
6. Loosen the two retaining screws, and remove the Communications Module assembly, and remove the Communication Module assembly from the electronics housing.

7. Disconnect the Sensor Cable from the Communications Board.
8. Refer to Figure 26. Use a 2mm hex wrench to completely loosen the set screw on the outside of the housing to permit rotating the meter body.

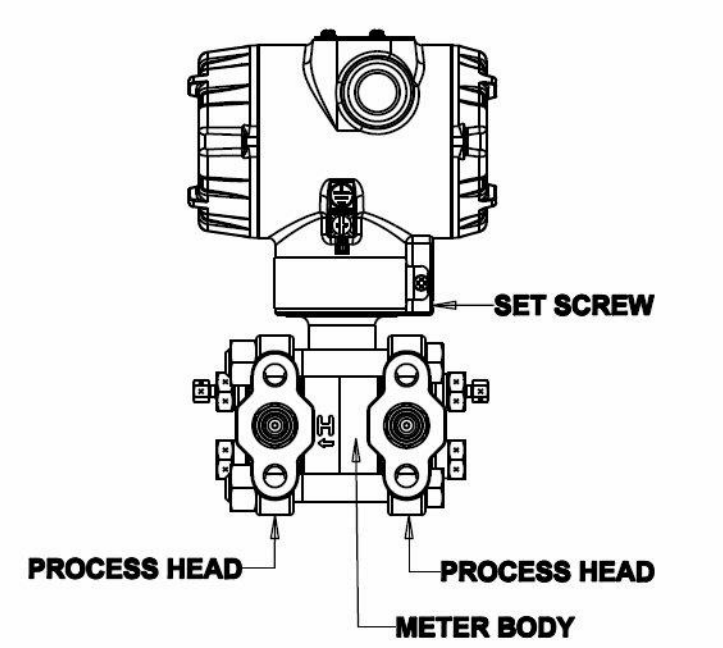


Figure 26 – ST 700 Standard Transmitter - Hardware Location to Remove the Meter Assembly

9. Carefully turn the complete meter body counterclockwise to unscrew it from the electronics housing.
10. Remove the nuts from bolts that hold the process head(s) to the Meter Body.
11. Remove process heads and bolts.
12. Remove the gaskets or O-rings from the process heads.
13. Clean the interior of the process head(s) with a soft bristle brush and suitable solvent.

CAUTION: To prevent damage to the diaphragm in the Meter Body, use extreme care when handling or placing the Meter Body on any surface. Carefully assemble gaskets or O-rings to the meter body. If installing O-rings, lubricate with water or leave dry.

14. Coat threads on process head bolts with anti-seize compound such as “Neverseize” or equivalent.
15. Refer to Figure 27. Apply Dow Corning #33 silicone grease to the meter body adapter O-ring and carefully assemble the O-ring to the meter body. Assemble the process head(s) and bolts to the new meter body. For now, make the bolts only finger-tight.

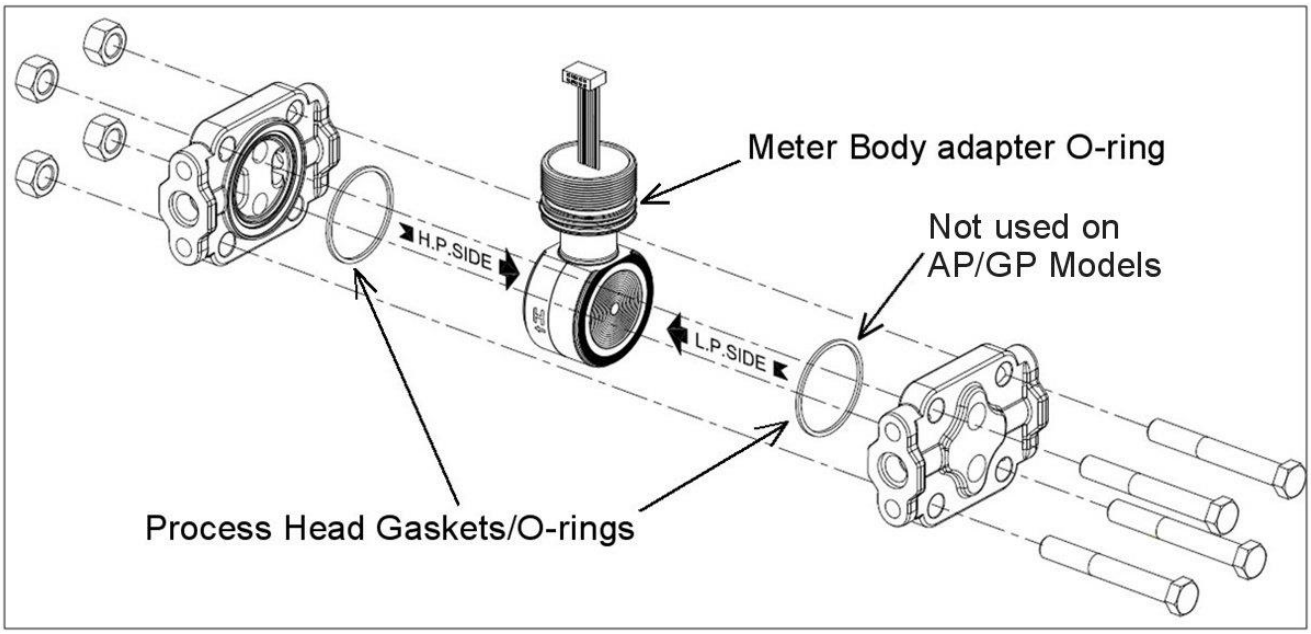


Figure 27 – ST 700 Standard Transmitter - Meter Body Reassembly

16. Use a torque wrench to gradually tighten nuts to torque rating in sequence shown in Figure 28. Tighten head bolts in stages of 1/3 full torque, 2/3 full torque, and then full torque.

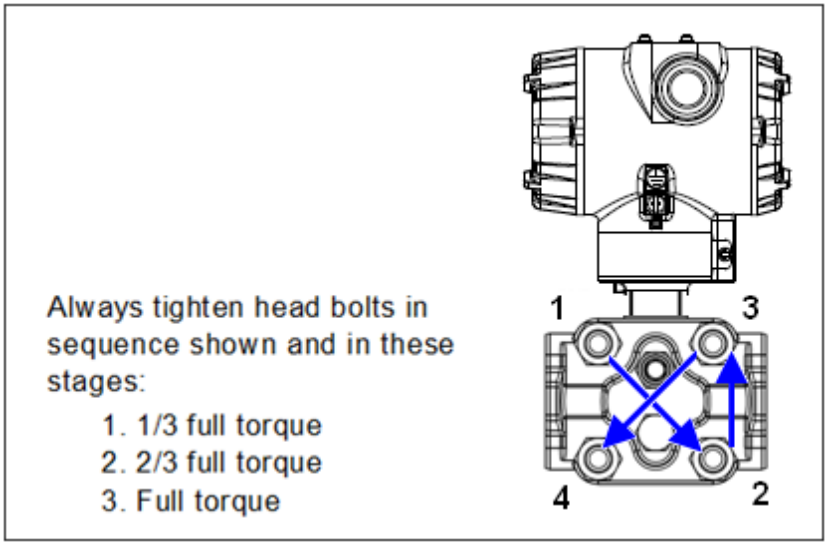


Figure 28 – ST 700 Standard Transmitter - Head Bolt Tightening Sequence

17. Feed the ribbon cable on the new meter body through the neck of the housing.

CAUTION: To prevent damage to the ribbon cable, use care when assembling the Meter Body to the electronics housing.

18. Screw the new meter body into the housing until the bottom of the Meter Body adapter is flush with the neck of the electronics housing.
19. Tighten the outside set screw to be sure it is fully seated in the slot in the header.

20. Loosen the set screw ½- turn.
21. Rotate the housing to the desired position (Max. 180^{o} in either direction), and tighten the set screw.
22. Carefully align and connect the Sensor Ribbon Cable to connector "J4" at the bottom of the Communication module board. When installing the Communication module in the next step, be careful not to pinch the Sensor Ribbon Cable.
23. Carefully, insert the Communication module into the Electronics compartment. Ensure that the Sensor Ribbon Cable is not pinched.
24. Tighten the two Communication module retaining screws.
25. If applicable, re-install the Display module as follows:
    a. Orient the display as desired.
    b. Install the Interface Connector in the Display module such that it will mate with the socket for the display in the Communication module.
    c. Carefully line up the display, and snap it into place. Verify that the two tabs on the sides of the display latch.

Orient the Display for proper viewing through the end cap window.
You can rotate the meter mounting orientation in 90 o increments.

26. Connect the bracket to the Transmitter housing.
27. Recalibrate the Transmitter per section 7 Calibration, of this document.
28. Return the Transmitter to service, and turn ON power
29. Verify the Transmitter configuration data. Restore the saved database if necessary.
30. Lubricate the end-cap O-ring with Parker Super O-ring silicone lubricant or equivalent before replacing the end caps.

7. Calibration for the ST 700 Standard Transmitter

7.1 Recommendations for Transmitter Calibration

The ST 700 Standard Transmitter does not require periodic calibration to maintain accuracy. Typically, calibration of a process-connected Transmitter will degrade, rather than augment the capability of a smart Transmitter. For this reason, it is recommended that a Transmitter be removed from service before calibration. Moreover, calibration will be accomplished in a controlled, laboratory-type environment, using certified precision equipment.

7.2 Calibration Procedures

For a Transmitter operating in analog mode, you must calibrate its output signal measurement range using any compatible hand-held communicator or a local display.

One calibration option is to use the Honeywell Smart Field Communicator (SFC). Refer to the *Smart Field Communicator Operating Guide,* Document # 34-ST-11-14 for calibration procedures.

Calibration information and procedures for a Transmitter operating in the HART/DE mode are provided in the *ST 700 Series HART/DE Option User's Manual*, Document # 34-25-25-47.

8. Troubleshooting on the ST 700 Standard Transmitter

8.1 Overview

Troubleshooting involves responding to error messages, primarily displayed by the MC Toolkit. Error messages that may occur on the Transmitter's local display are fairly self-explanatory and intuitive. However, this section covers the diagnostic messages that indicate critical conditions. Other than the critical conditions, additional detail is not provided. If you require assistance, contact your distributor or Honeywell Technical Support. All other messages are covered by the MC Toolkit Users' Manual.

8.2 Critical Diagnostics Screens

The Basic Display will display the message CRITCAL FAULT on the top line of the LCD and the appropriate diagnostic text on the lower line.

A description of the diagnostic conditions is given in Table 18 and Table 19 along with suggested actions for resolving the problem.

8.2.1 Fault Conditions and Recommended Corrective Actions – Basic Display

Table 18 – ST 700 Standard Transmitter - Fault Conditions and Recommended Corrective Actions.

Condtion	Analysis	Recommended Corrective Action
Fault. A critical failure has been detected in the Meter body	Use a HART, DE, or FF communicator to read the detailed status information from the transmitter. Refer to the appropriate communicator manual to get more information about the possible causes of the failure.	Cycle power to the Transmitter. If the problem continues to occur, replace the Meter body.
Electronics Module Fault. A critical failure has been detected on the HART, DE, or FF Electronics Module.	Use a HART, DE, or FF communicator to read the detailed status information from the transmitter. Refer to the appropriate communicator manual for more information about the possible failure causes.	Cycle power to the transmitter. If the problem continues to occur replace the Electronics Module.
Meter body Comm fault. Communications between the Meter body and the Electronics Module has failed.	This could be the result of a failure on either of these modules or the cable that connects them. Use a HART, DE, or FF communicator to read the detailed status information from the transmitter. Refer to the appropriate communicator manual to get more information about the possible causes of the failure.	Check the ribbon cable that connects the Meter body to the Electronics Module. Make sure that the cable is securely plugged into the Electronics Module. Make sure that all pins are plugged into the connector (e.g., make sure that the connector is not offset in a way that leaves some pins unconnected). Cycle power to the transmitter. If the problem continues to occur replace the Electronics Module. If

Condtion	Analysis	Recommended Corrective Action
		this does not fix the problem, replace the Meter body.

8.2.2 Fault Conditions and Recommended Corrective Actions – Standard Display

The Standard Display will display the message FAULT on the top line of the LCD and the appropriate diagnostic text on the lower line.

Table 19 – ST 700 Standard Transmitter - Fault Conditions and Recommended Corrective Actions.

Condtion	Analysis	Recommended Corrective Action
Mbd Com (Meter body Comm fault)	Communications between the Meter body and the Electronics Module has failed.	Check the ribbon cable that connects the Meter body to the Electronics Module. Ensure that the cable is securely plugged into the Electronics Module. Ensure that all pins are plugged into the connector (e.g. ensure that the connector is not offset in a way that leaves some pins unconnected). Cycle power to the transmitter. If the problem continues to occur replace the Electronics Module. If this does not fix the problem, replace the Meter body.
Comm El (Communication Board fault)	A critical failure has been detected on the HART Electronics Module.	Cycle power to the transmitter. If the problem continues to occur replace the Electronics Module.
Mtrbody (Sensor Board Fault)	A critical failure has been detected in the Meter body	Cycle power to the transmitter. If the problem continues to occur replace the Electronics Module.

9. Parts List_ST 700 Standard Transmitter

9.1 Overview

Individually saleable parts for the various Transmitter models are listed in this section. Some parts are illustrated for identification. Parts are identified and listed in the corresponding tables as follows:

- Individually saleable parts are indicated in each figure by key number callout.
- Parts that are supplied in kits are indicated in each illustration by key number callout with the letter K prefix.

Table 20 is a list of recommended spare parts.

Table 20 – ST 700 Standard Transmitter - Summary List of Recommended Spare Parts

Part Number	Description	Figure No.	Key No.	1-10 Units	10-100 Units	100-1000 Units
Electronics Housing Assembly						
50049849-501 50049849-502 50049849-503 50049849-504 50049849-509 50049849-510	HART Electronics Module Without REED Sensor PWA HART Electronics Module With REED Sensor PWA DE Electronics Module Without REED Sensor PWA DE Electronics Module With REED Sensor PWA Fieldbus Electronics Module Without REED Sensor PWA FIeldbus Electronics Module With REED Sensor PWA	Figure 31	5	1	1-2	2-4
51452865-201 51452865-202 51452865-203 51462865-204	**Meter Body Seal kit (includes O-rings)** Glass Filled PTFE VITON 100% PTFE GRAPHITE	Figure 33	K1	1	1-2	2-4
50075472-531 50075472-532 50075472-533 50075472-534	HART/DE Terminal Block Assy Without Lightning Protection HART/DE Terminal Block Assy With Lightning Protection FieldBus Terminal Block Assy Without Lightning Protection FieldBus Terminal Block Assy With Lightning Protection	Figure 31	3	1	1-2	2-4

Process head gasket kit		Figure No.	Key No.	1-10 Units	10-100 Units	100-1000 Units
51452868-501	Gasket only, Process Head (12 PTFE packs)	Figure 33	Ka	12	12-24	24-48
51452868-502	Gasket only, Process Head (6 Viton Head O'Rings)			6	6-12	12-24
51452868-507	Gasket only, Process Head Graphite Gasket (replacement only for existing graphite gasket)			6	6-12	12-24
Meter Body						
Specify complete model number from nameplate	DP Models GP/AP HEAD Models LGP/LAP Models Flush Mount Models Flange Mount Models	Figure 32		1	1-2	2-4

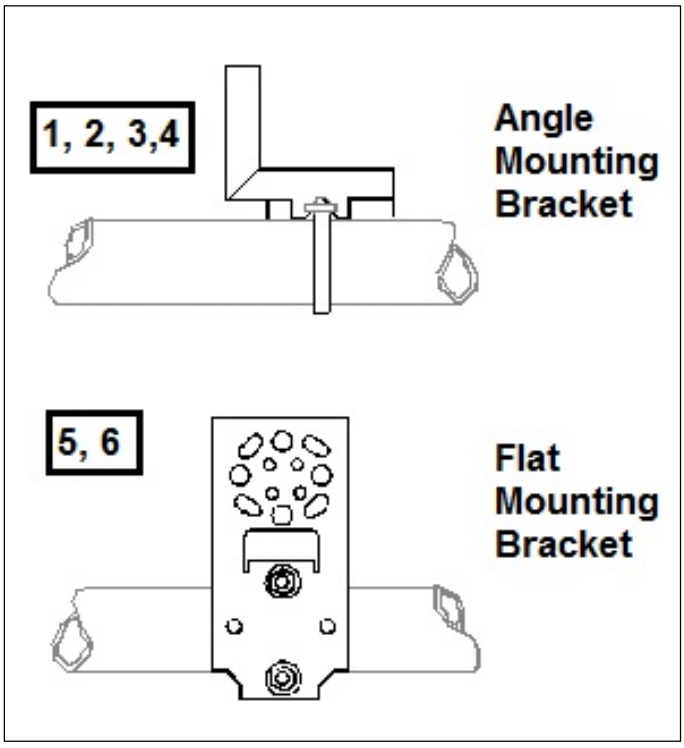


Figure 29 – ST 700 Standard Transmitter - Angle and Flat Bracket Parts

Table 21 – ST 700 Standard Transmitter - Angle and Flat Bracket Parts

(Refer to Figure 29)

Key No.	Part Number	Description	Quantity Per Unit
1	30752770-103	SS 304 Angle Bracket Mounting kit for all models except In-line and Flush mount transmitters	1
2	30752770-104	SS 304 Angle Bracket Mounting kit for all In-Line and Flush mount transmitters	1
3	30752770-303	Marine Approved Angle Bracket for all models except In-line and Flush mount transmitters	1
4	30752770-304	Marine Approved Angle Bracket for all In-line and Flush mount transmitters	1
5	51196557-005	SS 304 Flat Bracket Mounting kit for all models except In-line and Flush mount transmitters	1
6	51196557-006	SS 304 Flat Bracket Mounting kit for all In-line transmitters and Flush mount transmitters	1
7	30752770-403	SS 316 Angle Bracket Mounting kit for all In-line transmitters except In-Line and Flush mount transmitters	1
8	30752770-404	SS 316 Angle Bracket Mounting kit for all In-Line and Flush mount transmitters	1
9	51196557-008	SS 316 Flat Bracket Mounting kit for all In-line transmitters except In-Line and Flush mount transmitters	1
10	51196557-009	SS 316 Flat Bracket Mounting kit for all In-Line and Flush mount transmitters	1

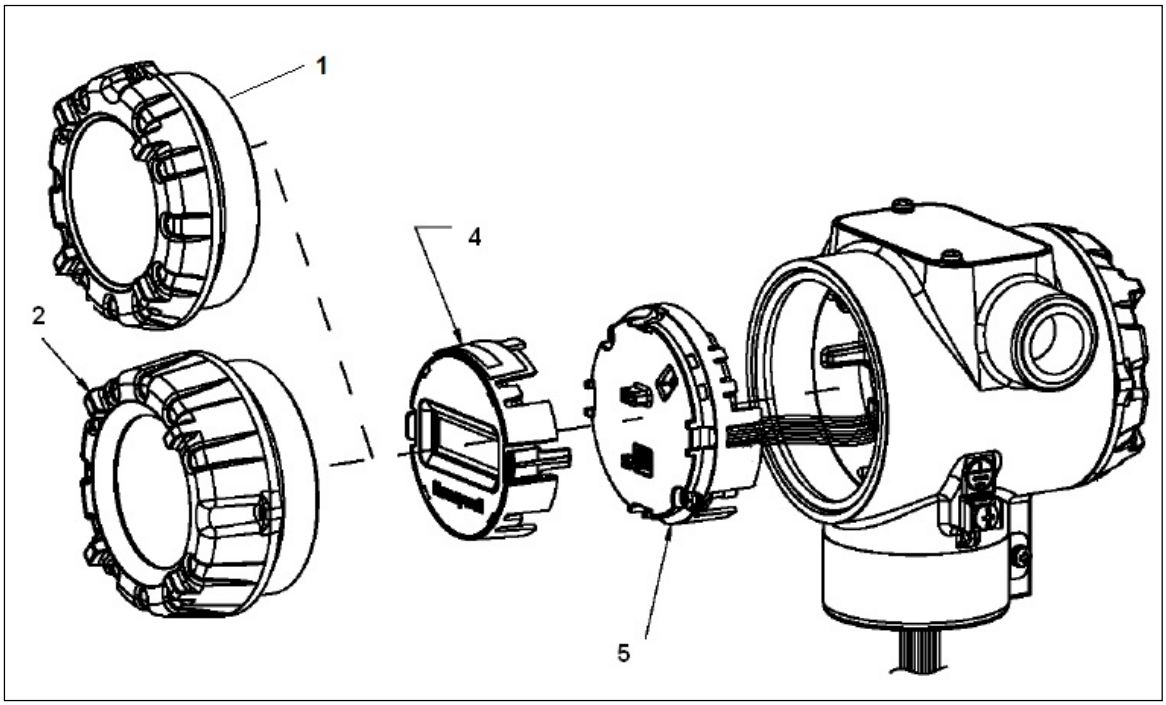


Figure 30 – ST 700 Standard Transmitter - Electronic Housing, Display End

Table 22 – ST 700 Standard Transmitter Major Assemblies

(Refer to Figure 29, Figure 31 and Figure 32)

Key No.	Part Number	Description	Quantity Per Unit
1	50049858-501 50049858-521	End Cap (Aluminum) End Cap (Stainless Steel)	1
2	50049832-501 50049832-521	End Cap, Display (Aluminum) End Cap, Display (Stainless Steel)	1
3	50075472-531 50075472-532 50075472-533 50075472-534	Terminal Assy HART/DE without Lightning protection Terminal Assy HART/DE with Lightning protection Terminal Assy FF/PB without Lightning protection Terminal Assy FF/PB with Lightning protection	1
4	50049911-501 50126003-501	Basic Display Standard Display	1
5	50049849-501 50049849-502 50049849-503 50049849-504 50049849-509 50049849-510	HART Electronics Module Assembly (PWA) without Reed sensor HART Electronics Module Assembly (PWA) with Reed sensor DE Electronics Module Assembly (PWA) without Reed sensor DE Electronics Module Assembly (PWA) with Reed sensor FF Electronics Module Assembly (PWA) without Reed sensor FF Electronics Module Assembly (PWA) with Reed sensor	1
6	50049915-501 50131077-501	External Zero, Span & Config Buttons (3- button Assembly) External Zero, Span & Config Buttons (2- button Assembly)	1
K1	30757503-005	Electronics housing seals kit (includes O-rings)	2

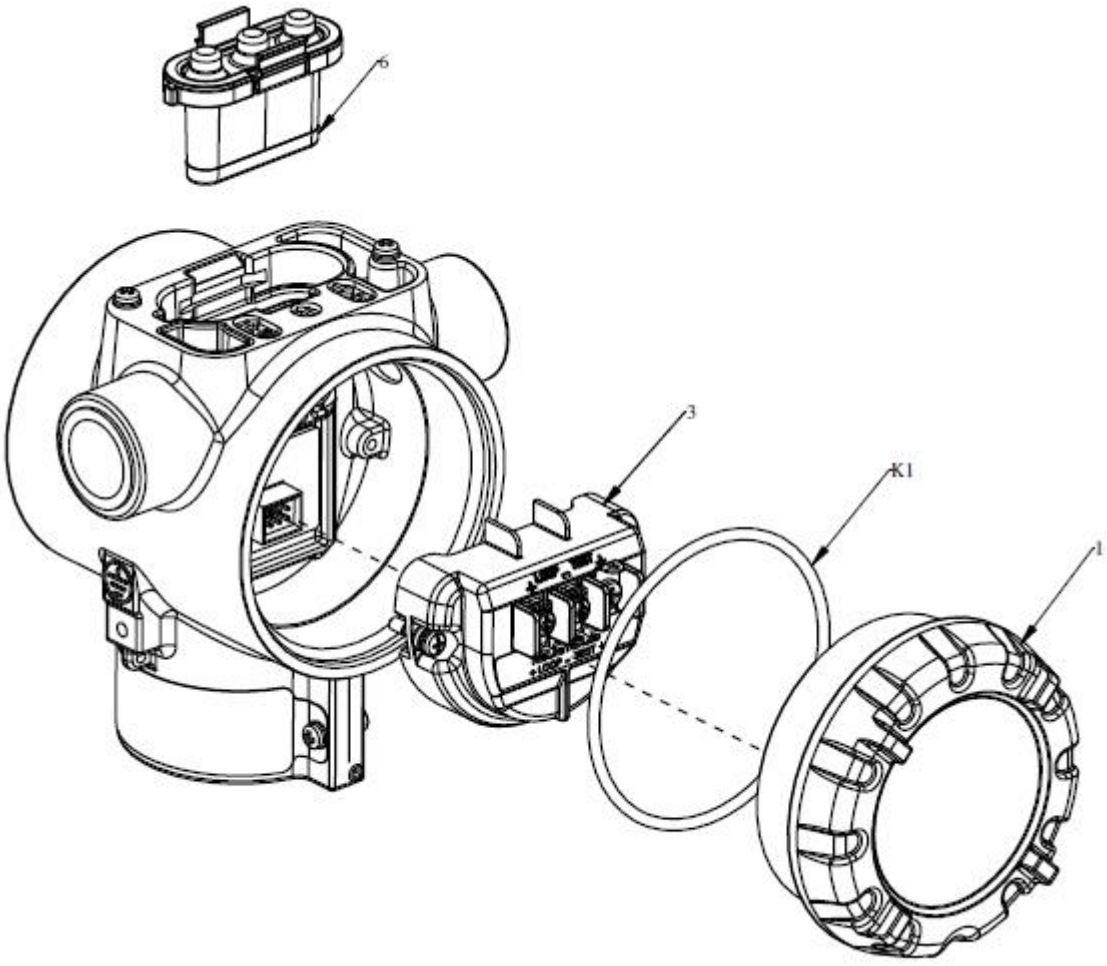


Figure 31 – ST 700 Standard Transmitter - Electronic Housing, Terminal Block End

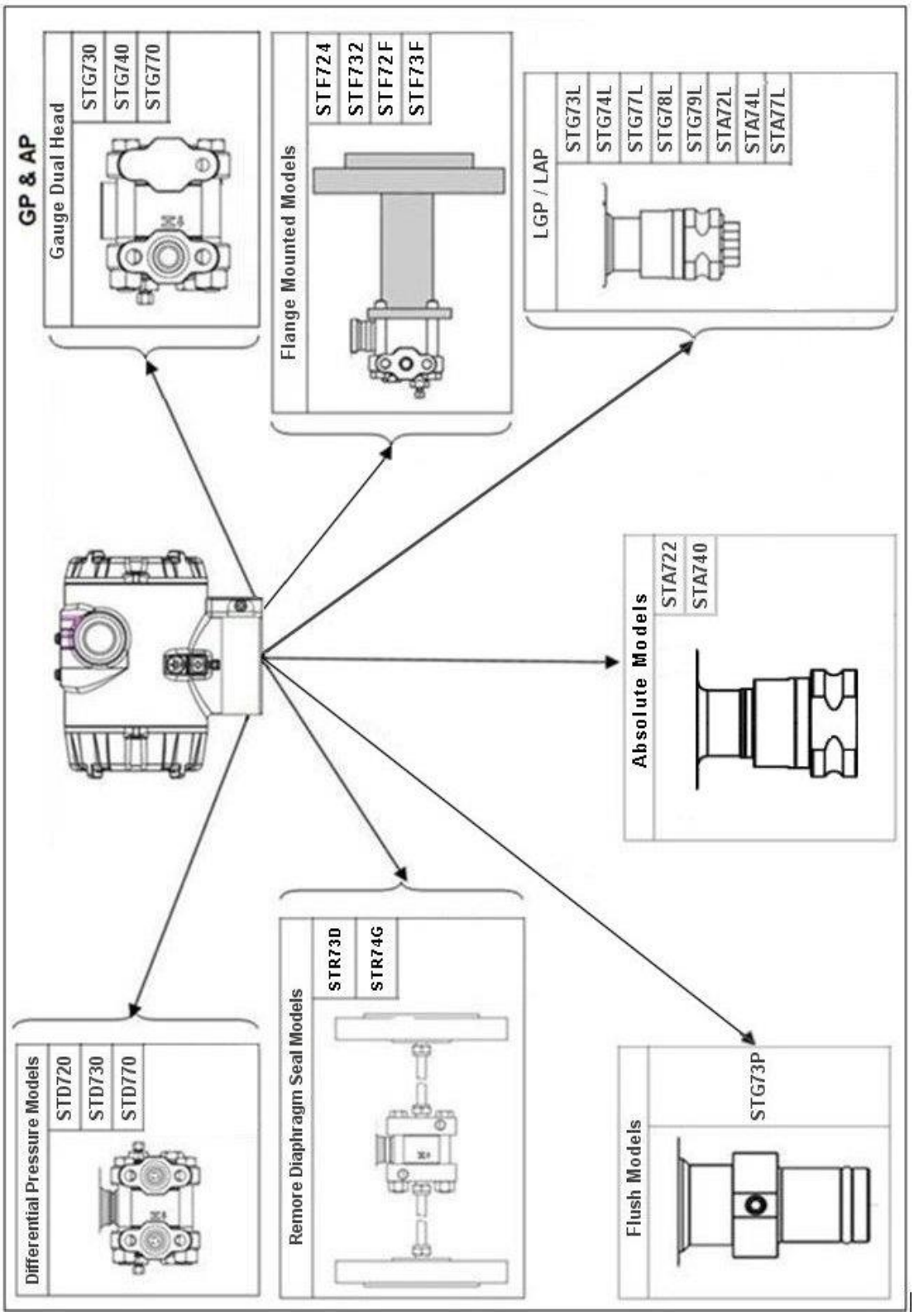


Figure 32 – ST 700 Standard Transmitter - Major Assemblies

Table 23 – ST 700 Standard Transmitter Models STD720, 730 & 770

(Refer to Figure 33)

Key No.	Part Number	Description	Qty/ Unit
		Vent and Plug Kits	
	30753785-001 30753787-001 30753786-001	Drain and Plug Kit, stainless steel Drain and Plug Kit, Monel Drain and Plug Kit, Hastelloy C **Each Drain and Plug Kit includes:**	
K1		Pipe Plug	4
K2		Vent Plug	2
K3		Vent Bushing	2
		Meter Body Gasket Kits	
	 51452865-201 51452865-202 51452865-203 51452865-204	Each Meter Body Gasket Kit includes: Glass Filled PTFE VITON 100% PTFE GRAPHITE	
K6		Gasket, Process Head	6
Ka		Gasket, Flange Adapter	6
K7		O-Ring, Meter Body to Electronics Housing	3
		K7 Process Head Gasket Kits	
K6 K6 K6	51452868-501 51452868-502 51452868-507	Gasket only, Process Head (12 PTFE Gaskets/pack) Gasket only, Process Head (6 Viton Head O-Rings) Gasket only, Process Head Graphite Gasket (use only as replacement of existing graphite gasket)	12 6 6
		Flange Adapter Gasket Kits	
Ka Ka Ka	51452868-504 51452868-505 51452868-508	Gasket only, Flange Adapter, 6 PTFE Adapter Gaskets Gasket only, Flange Adapter, 6 VITON Adapter O-Rings Gasket only, Flange Adapter Graphite Gasket (use only as replacement of existing graphite gasket)	6 6 6
		½-inch NPT Flange Adapter Kits	
	 51452867-110 51452867-210 51452867-310 51452867-410 51452867-150 51452867-350 51452867-130 51452867-330	Flange Adapter Kit, with: SS Flange Adapters and with carbon steel bolts SS Flange Adapters and with A286 SS (NACE) bolts SS Flange Adapters and with 316 SS (non-NACE) bolts SS Flange Adapters and with B7M alloy steel bolts Monel Flange Adapters and with carbon steel bolts Monel Flange Adapters and with 316 SS (non-NACE) bolts Hastelloy C Flange Adapters and with carbon steel bolts Hastelloy C Flange Adapters and with 316 SS (non-NACE) bolts	
		Each ½-inch NPT Flange Adapter Kit includes:	
Ka		Gasket, Flange Adapter	2
Kb		½-inch NPT Flange Adapter	2
Kc		Bolt, hex head, 7/16-20 UNF, 1.50 inches long	4

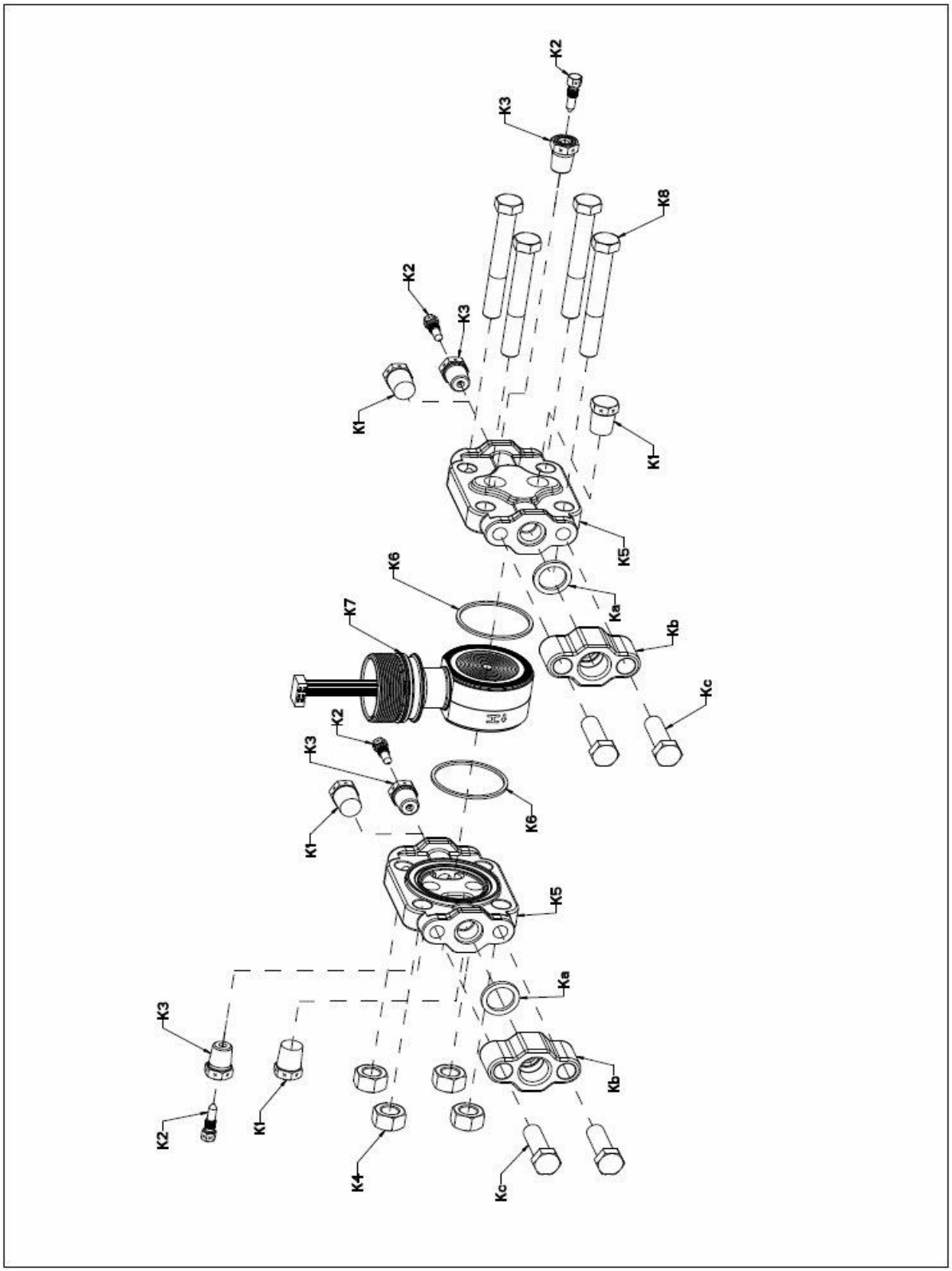


Figure 33 - ST 700 Standard Transmitter - ST 700 Models STD720, 730, 770

(Refer to Table 23)

Table 24 – ST 700 Standard Transmitter - Parts for STG730, 740, 770 and STA722, 740 Transmitter Body

(Refer to Figure 34)

Key No.	Part Number	Description	Qty/Unit
Process Head Assembly Kits with PTFE Gaskets			
	51452864-010 51452864-012 51452864-020 51452864-022 51452864-030 51452864-032 51452864-040 51452864-042 51452864-050 51452864-052	Carbon steel head (zinc plated) without side vent/drain Carbon steel head (zinc plated) with side vent/drain Stainless steel head without side vent/drain Stainless steel head with side vent/drain Hastelloy C head without side vent/drain Hastelloy C head with side vent/drain Monel head without side vent/drain Monel head with side vent/drain Carbon steel head (nickel plated) without side vent/drain Carbon steel head (nickel plated) with side vent/drain	
Process Head Assembly Kits with PTFE Gaskets			
	51452864-110 51452864-112 51452864-120 51452864-122 51452864-130 51452864-132 51452864-140 51452864-142 51452864-150 51452864-152	Carbon steel head (zinc plated) without side vent/drain Carbon steel head (zinc plated) with side vent/drain Stainless steel head without side vent/drain Stainless steel head with side vent/drain Hastelloy C head without side vent/drain Hastelloy C head with side vent/drain Monel head without side vent/drain Monel head with side vent/drain Carbon steel head (nickel plated) without side vent/drain Carbon steel head (nickel plated) with side vent/drain	
Each process head assembly kit includes:			
K1		Pipe Plug (See notes 1 & 2)	1
K2		Vent Plug (See note 1)	1
K3		Vent Bushing (See note 1.)	1
K5		Process Head	1
K6		Gasket (PTFE), Process Head	1
Ka		Gasket (PTFE), Flange Adapter	1
	Notes		
	Note 1: This item is made of the same material as the Process Heads, except for Kits with carbon steel Process Heads, which include stainless steel Pipe Plug, Vent Plug, and Vent Bushing. Note 2: The Kit for Process Heads without side vent/drain does not include Pipe Plugs (K1).		
Reference Head			
K9 K9	51452951-201 51452951-101	Carbon Steel Blind Reference Head 316 SS Blind Reference Head	1 1

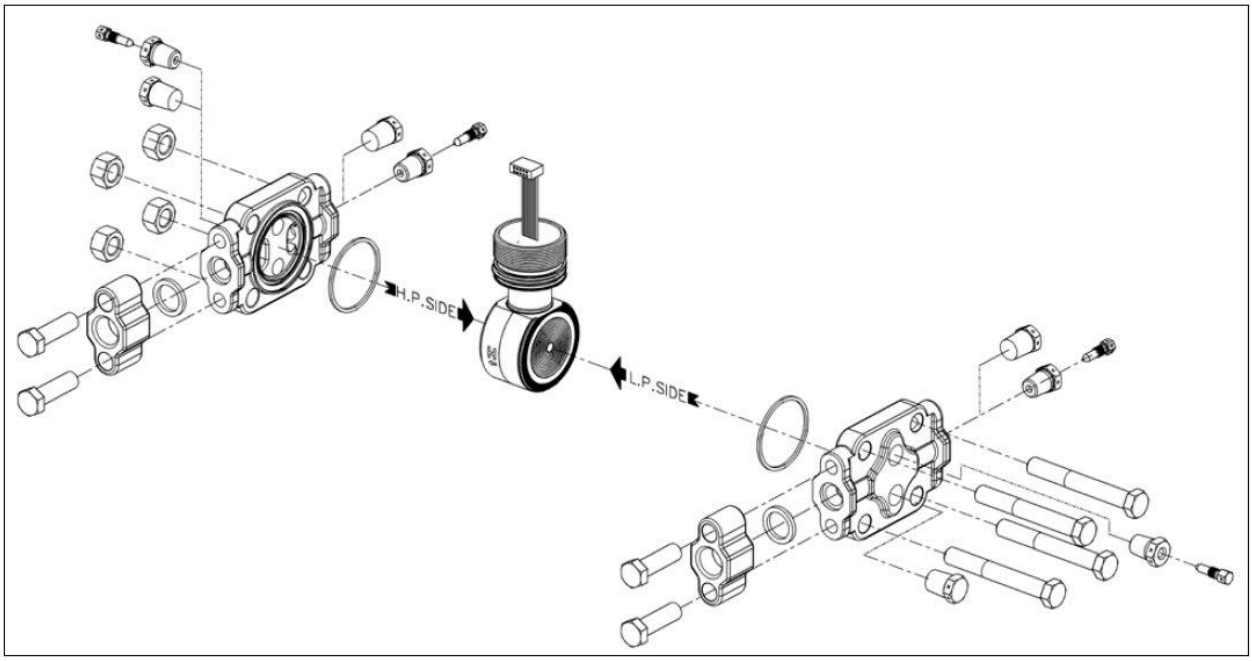


Figure 34 – ST 700 Standard Transmitter - STG730, 740, 770 and STA722, 740 Transmitter Body

Table 25 - ST 700 Standard Transmitter - Inline Gauge and Inline Atmospheric Meter Body Parts

(See Figure 35)

Key No.	Part Number	Description	Qty/Unit
	Specify complete model number from nameplate	ST Series replacement meter body (LAP/LGP model)	1

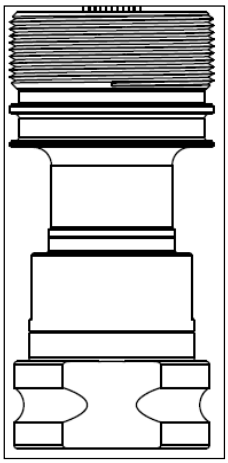


Figure 35 – ST 700 Standard Transmitter - Inline Gauge and Inline Atmospheric Meter Body Bodies

Table 26 – ST 700 Standard Transmitter - Flange-Mounted Meter Body Parts – STF724, 732

(Refer to Figure 36 and Figure 37)

Key No.	Part Number	Description	Qty/Unit
1	Specify complete model number from nameplate	ST Series 700 replacement meter body	1
	30749372-005	O-ring seal	1
	30749372-001	O-ring seal	1
Optional Flange Adapter - Not Shown			
	30754419-006	Flange adapter kit (st. steel flange adapter with carbon steel bolts)	
	30754419-008	Flange adapter kit (Monel flange adapter with carbon steel bolts)	
	30754419-022	Flange adapter kit (st. steel flange adapter with 316 st. steel bolts)	
	30754419-024	Flange adapter kit (Monel with 316 st. steel bolts)	
		Bolt, hex head, 7/16-20 UNF, 1.375 inches lg.	2
		Flange adapter	1
		Gasket	1
		Filter screen	1
	30754419-007	Flange adapter kit (Hastelloy C flange adapter with carbon steel bolts)	
	30754419-023	Flange adapter kit (Hastelloy C flange adapter with 316 st. steel bolts)	
		Bolt, hex head, 7/16-20 UNF, 1.375 inches lg.	2
		Flange adapter	1
		Gasket	1
	30757503-005	Housing seal kit	1

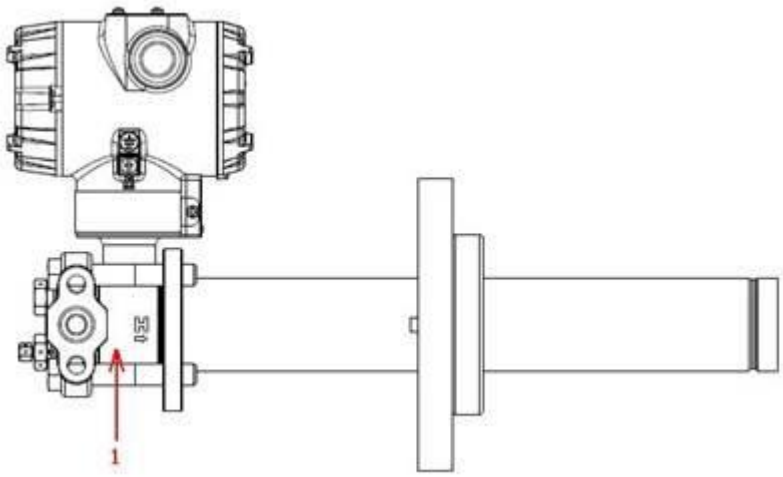


Figure 36 – ST 700 Standard Transmitter - Extended Flange Design

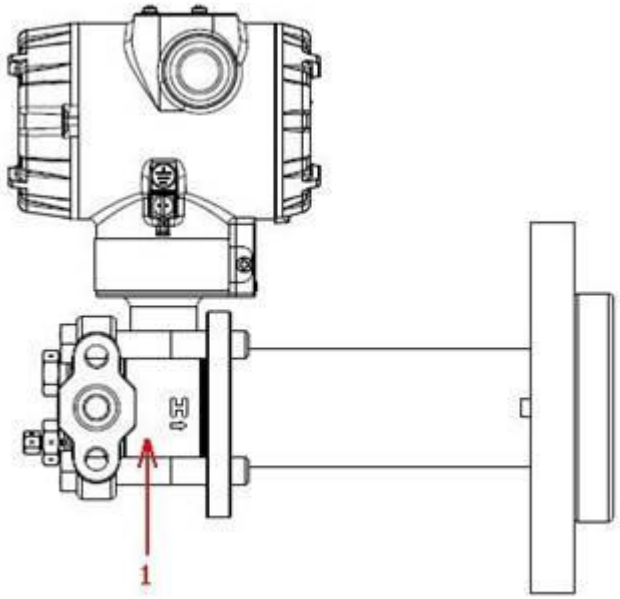


Figure 37 - ST 700 Standard Transmitter - Flush Flange Design

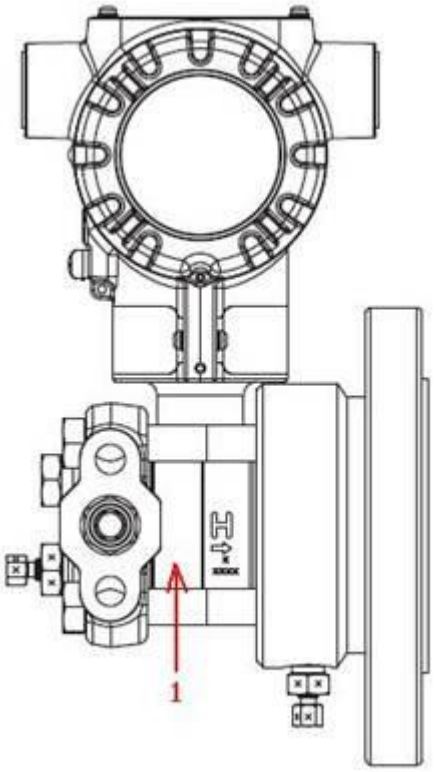


Figure 38 - ST 700 Standard Transmitter - Pseudo Flange Design

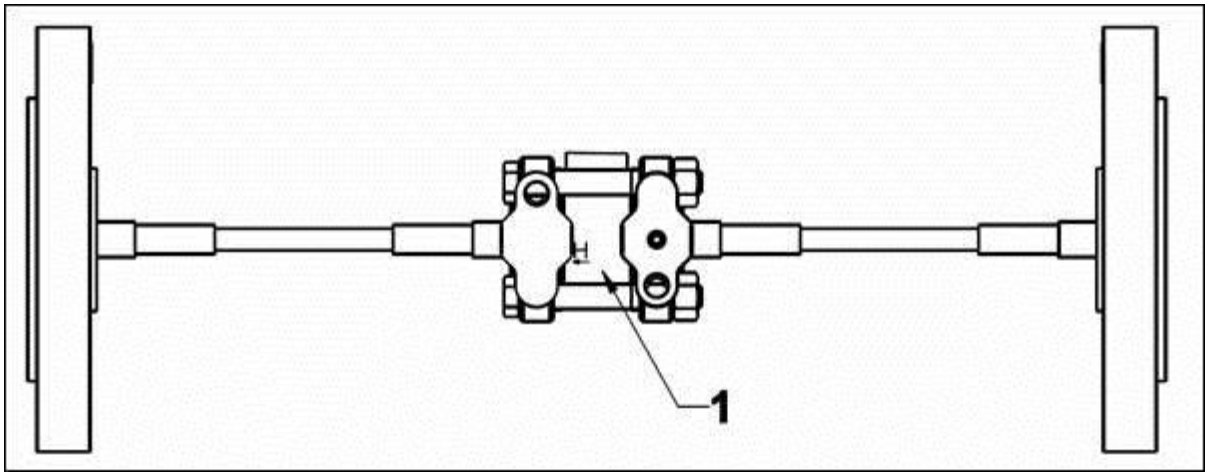


Figure 39 – ST 700 Standard Transmitter - Remote Seal Diaphragm

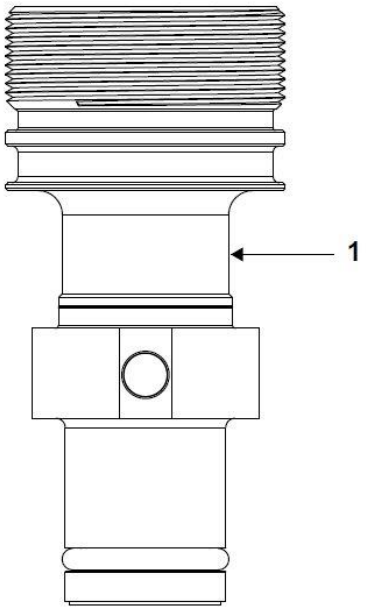


Figure 40 - ST 700 Standard Transmitter - Flush Mount Meter Body.

Table 27 – ST 700 Standard Transmitter - Flush Mount Meter Body Parts

(Refer to Figure 40)

Key No.	Part Number	Description	Qty/Unit
1	Specify complete model number from nameplate	Replacement meter body (Flush Mount model)	1
	30756445-508	Gasket Kit (0-rings)	
	51204496-001	316L SS Mounting Sleeve Kit	
	51204497-001	Calibration Sleeve Kit	

Refer to Appendix A for Product Certifications and Approvals for the ST 700 Standard and Basic Transmitter.

10. Introduction_ST 700 Basic Transmitter

10.1 Overview

This section is an introduction to the physical and functional characteristics Honeywell's family of the ST 700 Basic SmartLine Pressure Transmitters.

If you are not sure which type of ST 700 you have, Standrad or Basic, please refer to Section 1 of this manual

If you have a ST 700 Standard Transmitter use Sections **2** through **9**.
If you have a ST 700 Basic Transmitter go straight to Section **10** through **17.**

10.2 Features and Options

The ST 700 Basic transmitter is available in a variety of models for measuring Differential Pressure (DP), Gauge Pressure (GP), and Absolute Pressure (AP). Table 28 lists the protocols, human interface (HMI), materials, approvals, and mounting bracket options for the ST 700.

Table 28 – ST 700 Basic Transmitter - Features and Options

Feature/Option	Basic/Available Options
Communication Protocols	HART® version 7
Human-Machine Interface (HMI) Options (Standard Display/External Two buttons)	
	Standard Display (HART® only): • Two-button programming (optional) • Standard display language: English only • Two-mode operations: PV display and Menu Navigation
Calibration	Single
Approvals See section 0 for details.	FM, CSA, ATEX, IECEx, SAEx, INMETRO, NEPSI, GOST
Mounting Brackets	Angle/flat carbon steel/304 and 316 stainless steel,
Integration Tools	Experion

	The 2-button option is available for the Standard Display. The External 2-buttons option is available in this model.This is used for navigation of standard display or for setting zero, span and zero correct where standard display is not connected.

10.2.1 Physical Characteristics

As shown in Figure 41 the ST 700 Basic transmitter is packaged in two major assemblies: the Electronics Housing and the Meter Body. The elements in the Electronic Housing respond to setup commands and execute the software and protocol for the different pressure measurement types. Figure 42 shows the assemblies in the Electronics Housing with available options.

The Meter Body provides connection to a process system. Several physical interface configurations are available, as determined by the mounting and mechanical connections, all of which are described in the **Installation** section of this manual.

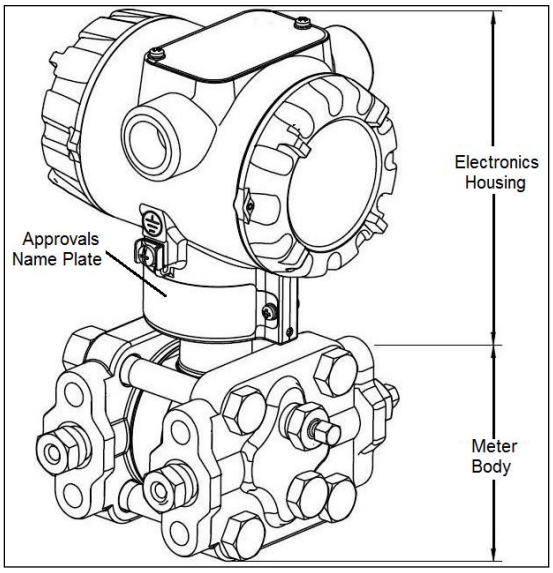


Figure 41 – ST 700 Basic Transmitter - Major Assemblies

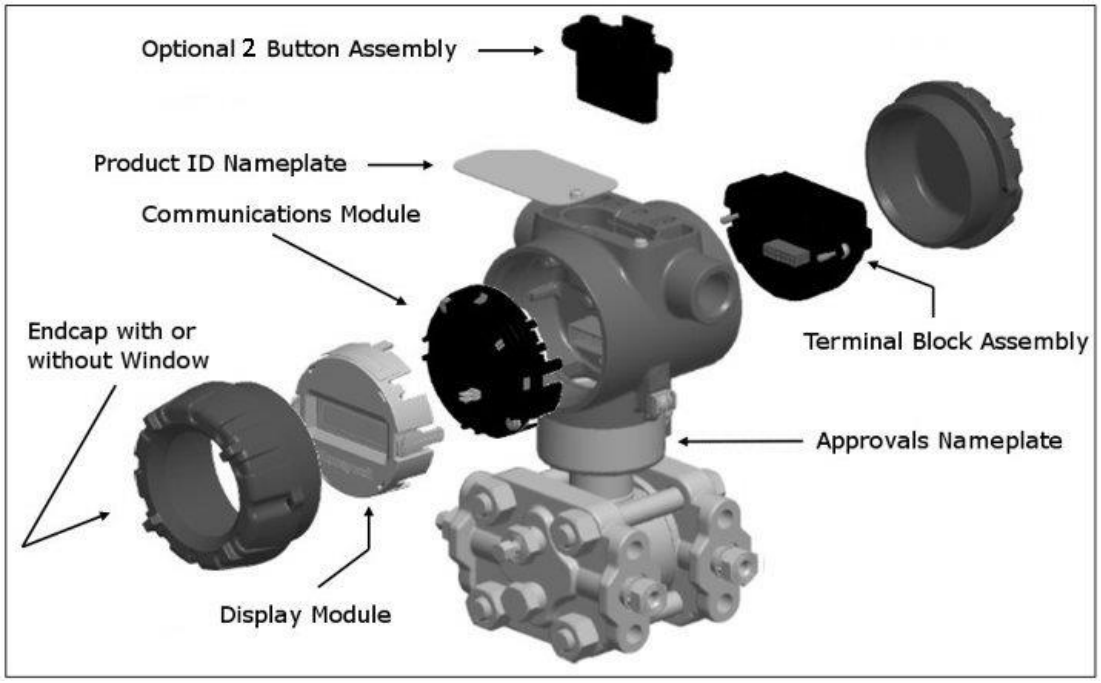


Figure 42 – ST 700 Basic transmitter Electronics Housing Components

10.2.2 Functional Characteristics

The Transmitter measures process pressure and provides a proportional analog 4 to 20mA output to the measured process variable (PV). Available output communication protocols include HART®.

The Standard display is only available on HART transmitters.

An optional external 2-button assembly is available to set up and make adjustments to the Transmitter. In addition, a Honeywell Multi-Communication (MC) Toolkit (not supplied with the Transmitter) can facilitate setup and adjustment procedures. Certain adjustments can be made through an Experion Station if the Transmitter is digitally integrated with Honeywell's Experion.

The Standard Display Menu is implemented as one long single-level menu and will "wrap around" when it reaches the start or end of the menu. The Standard Display uses an optional 2-button assembly to set up and make adjustments to the Transmitter.

10.3 ST 700 Transmitter Nameplate

The Transmitter nameplate mounted on the bottom of the electronics housing (see Figure 42) lists its model number, physical configuration, electronics options, accessories, certifications, and manufacturing specialties. Figure 43 is an example of a typical Gauge Pressure (GP) or Atmospheric Pressure (AP) Transmitter name plate. The model number format consists of a Key Number with several table selections. The Differential Pressure (DP), Absolute Pressure (AP), and Gauge Pressure (GP) name plates are essentially the same. The DP model provides one additional entry (7 vs. 6) in the Meter Body Selections (Table I) to accommodate the static pressure rating.

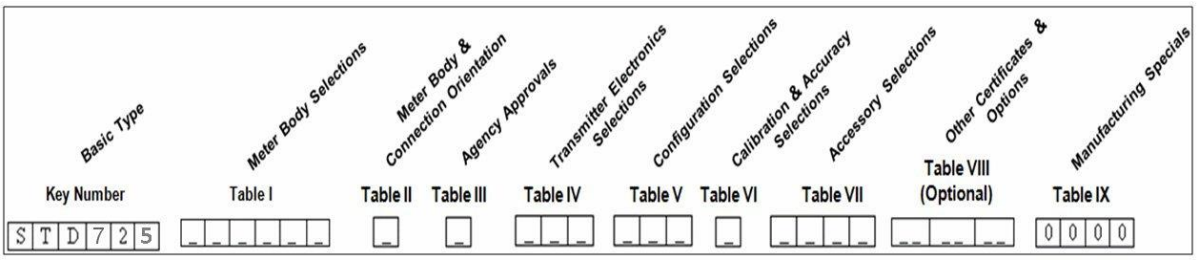


Figure 43 – ST 700 Basic Transmitter - Name Plate

You can readily identify the series and basic Transmitter type from the third and fourth digits in the key number. The letter in the third digit represents one of these basic transmitter types:

- A = Absolute Pressure
- D = Differential Pressure
- F = Flange Mounted
- G = Gauge Pressure
- R = Remote Seals

For a complete selection breakdown, refer to the appropriate Specification and Model Selection Guide provided as a separate document.

10.4 Safety Certification Information

An "approvals" name plate is located on the bottom of the Electronics Assembly; see Figure 42 exact location. The approvals name plate contains information and service marks that disclose the Transmitter compliance information.
See section 0 of this document for safety certification requirements and details.

10.5 Transmitter Adjustments

Zero and Span adjustments are possible in ST 700 Basic Transmitter with the optional external 2-button and integrated two-button assemblies. See Figure 42 for the external 2-button assembly.

You can also use the Honeywell MC Toolkit or other third-party hand-held configurator to make adjustments to the ST 700 Basic Transmitter. Alternately, certain adjustments can be made through the Experion or Universal Station, if the Transmitter is digitally integrated with a Honeywell Experion or TPS system.

10.6 Display Options –Standard Display

Table 29 – ST 700 Basic Transmitter - Available Display Characteristics

Standard Display	• 360° rotation in 90° Increments • 2 lines, 8 characters • Standard units of measurement: Pa, KPa, MPa, KGcm2, TORR, ATM, inH2O, mH2O, bar, mbar, inHg, FTH2O, mmH2O, MMHG, Flow Units (DP models only) ,PSI , cmH2O and mH2O • Diagnostic messaging

10.7 Optional Integrated two-Button Assembly (Standard Display)

The Standard Display does not support all the transmitter configuration parameters and has limited features. The optional Integrated Two-Button Assembly for the Standard Display provides the following features and capabilities:

- Menu and enter key functionality.
- With the menu-driven display:
  - Comprehensive on-screen menu for navigation.
  - Transmitter configuration: enter LRV, enter URV and Loop Test.
  - Transmitter calibration
  - Display configuration (contrast only)
  - Set zero and span parameters.

	If you are using the optional external 2-button assembly with the Standard Display then you can perform all the above operations without removing external glass cap using the external buttons

	**Lower range value (LRV):** A display parameter (Standard display), which allows users to enter the measuring value for which the analog output will be scaled to 4mA. **Upper range value (URV):** A display parameter (Standard display), which allows users to enter the measuring value for which the analog output will be scaled to 20mA.

11. Application Design_ST 700 Basic Transmitter

11.1 Overview

This section discusses the considerations involved with deploying a Honeywell ST 700 Basic Transmitter in a process system. The following areas are covered:

- Safety
- Input and output data
- Reliability
- Environmental limits
- Installation considerations
- Operation and maintenance
- Repair and replacement

11.2 Accuracy

The ST 700 Basic Transmitter measures the gauge, differential, or absolute pressure of a process and reports the measurement to a receiving device.

11.2.1 Diagnostic Messages

Transmitter standard diagnostics are reported in the two basic categories listed in Table 4. Problems detected as critical diagnostics drive the analog output to the programmed burnout level. Problems detected as non-critical diagnostics may affect performance without driving the analog output to the programmed burnout level. Informational messages (not listed in Table 4 report various Transmitter status or setting conditions.

	**The Standard Display is only available on HART transmitters**

	**The Standard Display only displays critical diagnostics (Meter Body Fault, Electronics Module Fault and Meter Body Communication Fault). Non-critical diagnostics are not displayed.**

11.3 Safety

11.3.1 Safety Integrity Level (SIL)

The ST 700 Basic Transmitter has met manufacturer design process requirements of Safety Integrity Level (SIL) 3. These are intended to achieve sufficient integrity against systematic errors of design by the manufacturer.

A Safety Instrumented Function (SIF) designed with this product must not be used at a SIL level higher than the statement, without "prior use" justification by the end user or diverse technology redundancy in the design.

Refer to the *Honeywell SmartLine Safety Manual*, Document # 34-ST-25-37, for additional information.

12. Installation and Startup_ST 700 Basic Transmitter

12.1 Installation Site Evaluation

Evaluate the site selected for the ST 700 Basic Transmitter installation with respect to the process system design specifications and Honeywell's published performance characteristics for your particular model. Some parameters that you may want to include in your site evaluation are:

- Environmental Conditions:
  - Ambient Temperature
  - Relative Humidity
- Potential Noise Sources:
  - Radio Frequency Interference (RFI)
  - Electromagnetic Interference (EMI)
- Vibration Sources
  - Pumps
  - Motorized System Devices (e.g., pumps)
  - Valve Cavitation
- Process Parameters
  - Temperature
  - Maximum Pressure Rating

12.2 Honeywell MC Toolkit

In preparation for post-installation processes, refer to the *MC Tookit User Manual*, Document # 34-ST-25-20, for battery conditioning and device operation and maintenance information.

12.3 Display Installation Precautions

Temperature extremes can affect display quality. The display can become unreadable at temperature extremes; however, this is only a temporary condition. The display will again be readable when temperatures return to within operable limits.

The display update rate may become slower at cold temperature extremes, but as with readability, normal updating resumes when temperatures are within limits for full operability.

	The Transmitter should not be operated without the endcap covers on. Covers can be removed temporarily for configuration with buttons or during maintenance/wiring. The static voltage must be discharged before removing the cover.

12.4 Mounting_ST 700 Basic Transmitter

12.4.1 Summary

ST 700 Basic Transmitter models, except flush mounts and those with integral flanges, can be attached to a two-inch (50 millimeters) vertical or horizontal pipe using Honeywell's optional angle or flat mounting bracket; alternately you can use your own bracket. Flush-mount models are attached directly to a process pipe or tank by a one-inch weld nipple. Models with integral flanges are supported by the flange connection.

Figure 44 shows a typical bracket-mounted and flange-mounted transmitter installations.

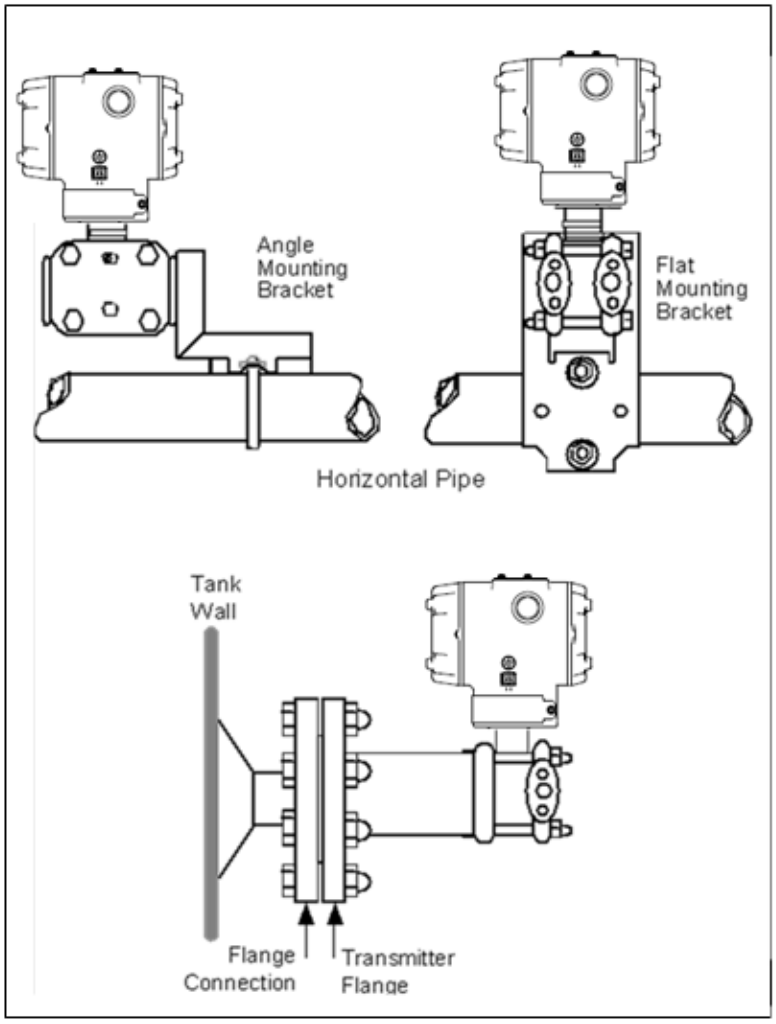


Figure 44 – ST 700 Basic Transmitter - Typical Bracket Mounted and Flange Mounted Installations

12.5 Flush mounting_ST 700 Basic Transmitter

To mount a flush mounted model, cut a hole for a 1" standard pipe in the tank or pipe where the transmitter is to be mounted. Weld the 1" mounting sleeve to the wall of the tank or to the hole cut on the pipe. Insert the meter body of the transmitter into the mounting sleeve and secure with the locking bolt. Tighten the bolt to a torque of 6,4 Nm +/- 0,30 Nm (4.7 ft-lbs +/- 0.2 ft.-lbs.). Figure 45 shows a typical installation for a transmitter with a flush mount on a pipe.

Once the transmitter is mounted, the electronics housing can be rotated to the desired position. See Figure 48 for details.

ATTENTION: On insulated tanks, remove enough insulation to accommodate the mounting sleeve.

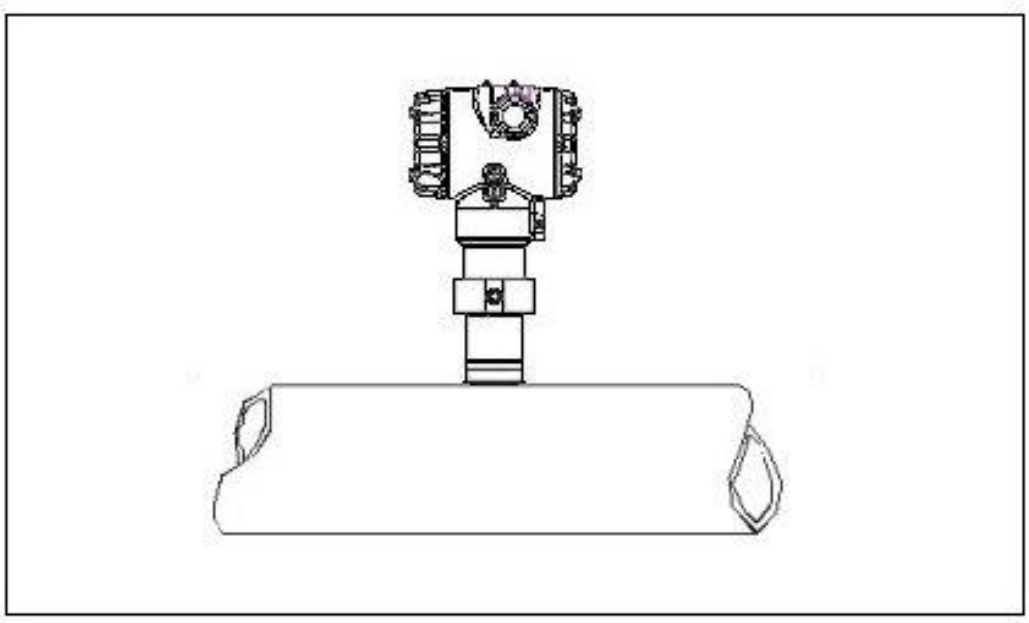


Figure 45 - ST 700 Basic Transmitter - Typical Flush Mounted Transmitter Installation

12.5.1 Mounting Dimensions, ST 700 Basic Transmitter

Refer to Honeywell drawing number 50049930 (Dual Head), 50049931 (In-Line), 50049932 (Flange Mount) 50049933 (Extended Flange), 50049934 (Remote Seal) and 50049936 (Flush Mount Pressure Transmitter) for detailed dimensions. Abbreviated overall dimensions are also shown on the Specification Sheets for the transmitter models. This section assumes that the mounting dimensions have already been taken into account and the mounting area can accommodate the Transmitter.

12.5.2 Bracket Mounting Procedure for ST 700 Basic Transmitter,

If you are using an optional bracket, start with Step 1. For an existing bracket, start with Step 2.

5. Refer to Figure 46 for position of the bracket on a 2-inch (50.8mm) nominal, 2.38-inch (60.4mm) actual, horizontal or vertical pipe, and install a "U" bolt around the pipe and through the holes in the bracket. Secure the bracket with the nuts and lock washers provided.

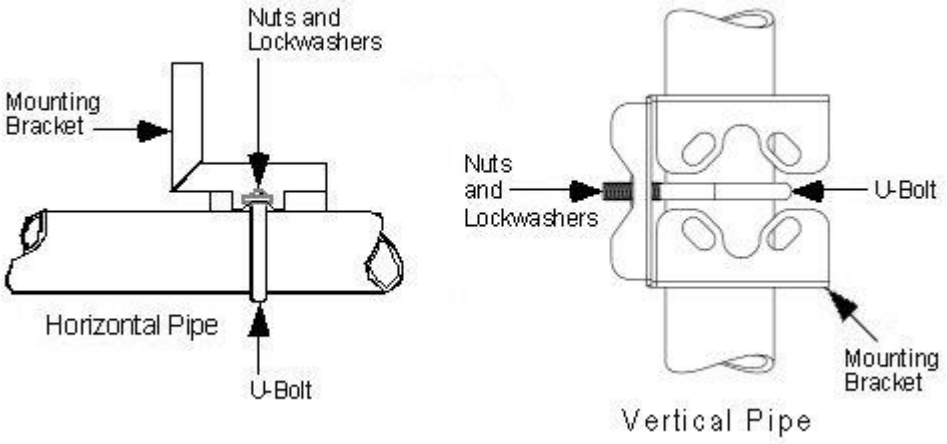


Figure 46 – ST 700 Basic Transmitter - Angle Mounting Bracket Secured to a Horizontal or Vertical Pipe

6. Align the appropriate mounting holes in the Transmitter with the holes in the bracket. Use the bolts and washers provided to secure the Transmitter to the bracket; see the following variations.

Table 30 - ST 700 Basic Transmitter - Mounting Bracket procedure

Transmitter Type	Use Hardware
DP with double-ended process heads and/or remote seals	Alternate mounting holes in the ends of the heads
In-line GP and AP models (STG7xS and STA7xS)	The smaller "U" bolt provided to attach the meter body to the bracket. See the following example.
Dual-head GP and AP	Mounting holes in the end of the process head.

Example: Inline model mounted to an optional angle bracket. See Figure 47.

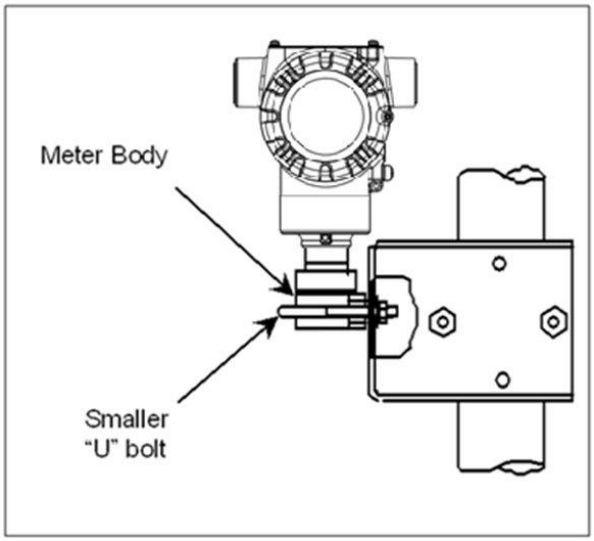


Figure 47 – ST 700 Basic Transmitter - Inline Model Mounted to an Optional Bracket

7. Loosen the set screw on the outside neck of the Transmitter one (1) full turn.

8. Rotate the Electronics housing a maximum of 180º left or right from the center to the position you require, and tighten the set screw using a 4mm metric socket head wrench. See the following example and Figure 48.

   Example: Rotating the Electronics Housing

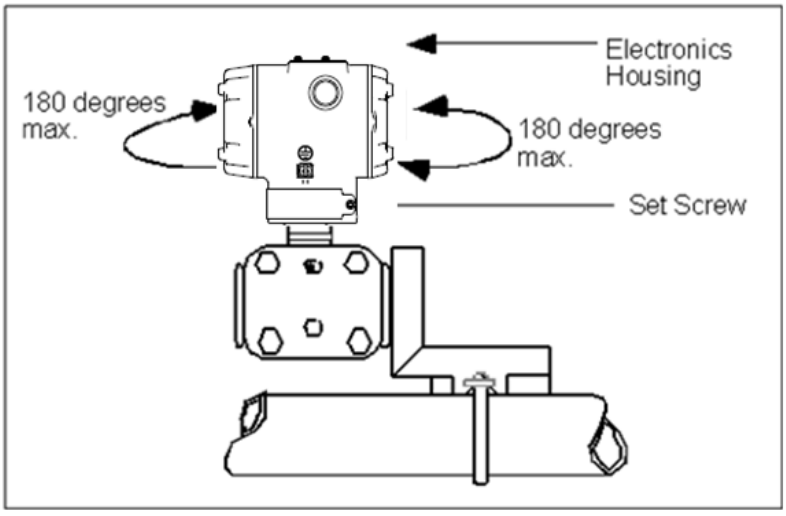


Figure 48 – ST 700 Basic Transmitter - Rotating the Electronics Housing

The mounting position of AP models STA725, STA745, STA72S, STA74S and STA77S becomes critical as the Transmitter spans become smaller. A maximum zero shift of 2.5mmHg for these models can result from a mounting position that is rotated 90o from the vertical.
A typical zero-shift of 0.12mmHg or 0.20 inH_2O can occur for a five (5)-degree rotation from the vertical.

12.5.3 Mounting Transmitters with Small Absolute or Differential Pressure Spans

To minimize positional effects on calibration (zero shift), take the appropriate mounting precautions for the respective Transmitter model. Ensure that the Transmitter is vertical when mounting models STA725, STA745, STA72S, STA74S and STA77S . You do this by leveling the Transmitter side-to-side and front-to-back.

Figure 49 shows how to level a Transmitter using a spirit level.

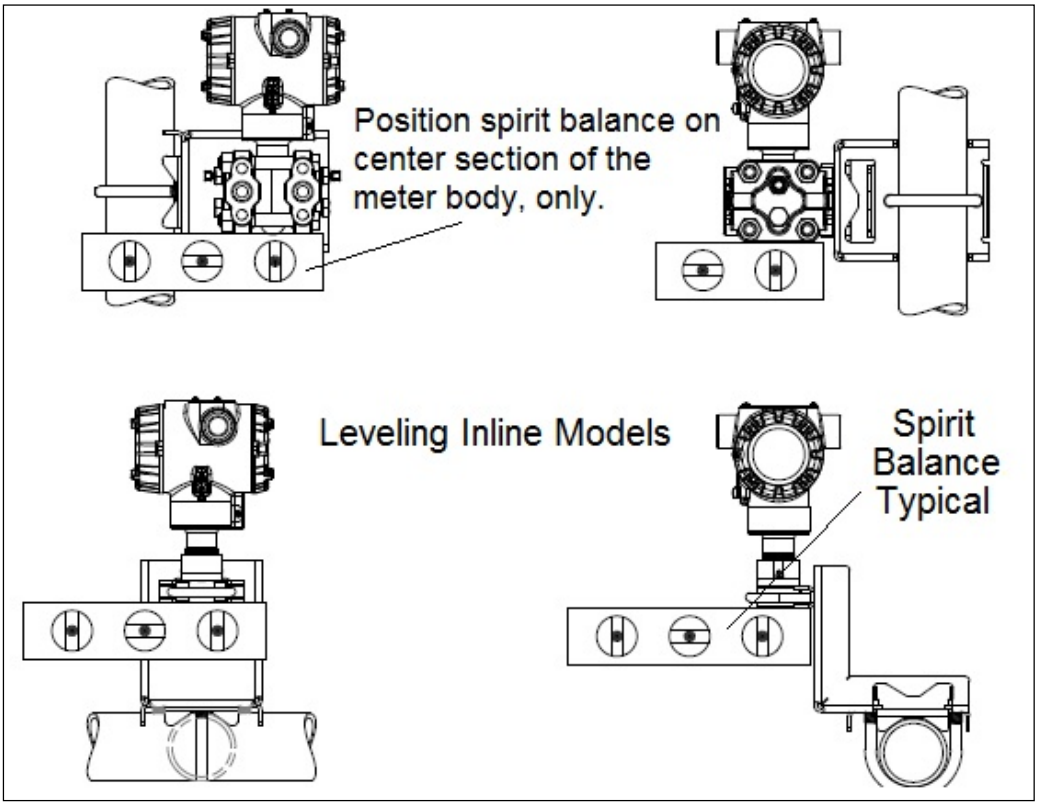


Figure 49 – ST 700 Basic Transmitter, using a Spirit Balance to Level a Transmitter

12.5.4 Flange Mounting_ST 700 Basic Transmitter

Figure 50 shows a typical tank-flange mount installation, with the Transmitter flange mounted to the pipe on the wall of the tank.

On insulated tanks, remove enough insulaiton to accommodate the flange extension.

When flange-mounting to a tank, note the following:

- The End User is responsible for providing a flange gasket and mounting hardware suitable for the Transmitter service conditions.
- To avoid degrading performance in flush-mounted flanged Transmitters, exercise care to ensure that the internal diameter of the flange gasket does not obstruct the sensing diaphragm.
- To prevent performance degradation in extended-mount flanged Transmitters, ensure that sufficient clearance exists in front of the sensing diaphragm body.

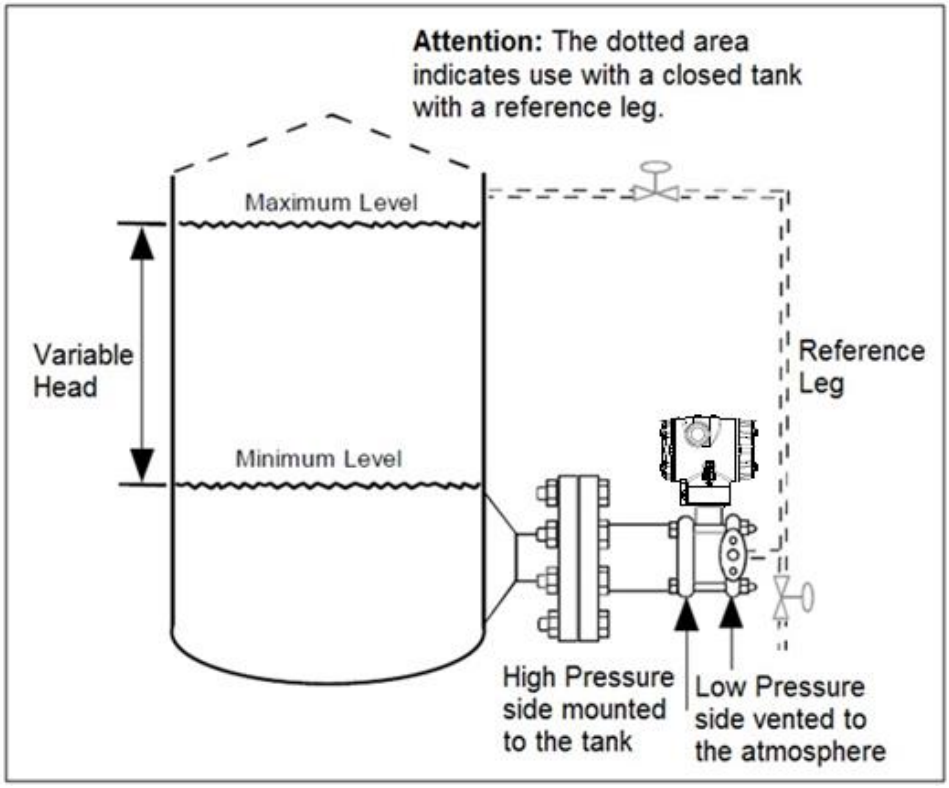


Figure 50 – ST 700 Basic Transmitter, Tank-Flange Mounted Transmitter

12.5.5 Remote Diaphragm Seal Mounting Information_ST 700 Basic Transmitter,

The combination of tank vacuum and high pressure capillary head effect should not exceed nine (9) psi (300mmHg) absolute. For insulated tanks, be sure to remove enough insulation to accommodate the flange extension. The end user is responsible for supplying a flange gasket and mounting hardware suitable for the service condition of the Transmitter.

Mount the Transmitter flanges within the limits in **Table 31**Table 6 for the fill fluid in the capillary tubes, with a tank at one (1) atmosphere.

Table 31 – ST 700 Basic Transmitter, Flange Mounting Guidelines

Fill Fluid	Mount the Flange…
Silicone 200 Oil	≤22 feet (6.7 meters) below the Transmitter
Chlorotrifluorethylene (CTFE)	≤11 feet (3.4 meters) below the Transmitter

Refer to Figure 51 for a representative remote diaphragm seal installation. Mount the Transmitter at a remote distance determined by the length of the capillary tubing.

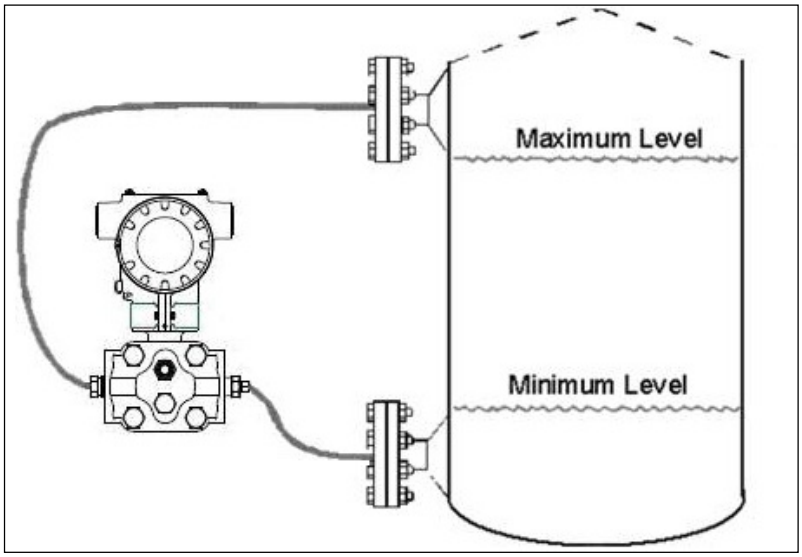


Figure 51 – ST 700 Basic Transmitter - Representative Remote Diaphragm Seal Transmitter Installation

Depending on Transmitter model, connect the remote seal to the tank according to Table 32

Table 32 – ST 700 Basic Transmitter - Remote Diaphragm Mounting Details

Transmitter Model	Connect the Remote Seal on ….	
	Variable Head	Fixed or Constant Head
STR735D	Transmitter High Pressure (HP) Side to tank wall lower flange mounting.	Transmitter Low Pressure (LP) side to tank wall upper flange.

12.6 Piping the ST 700 Basic Transmitter

12.6.1 Piping Arrangements

Piping arrangements vary depending upon process measurement requirements and the Transmitter model. For example, a differential pressure transmitter comes with double-ended process heads with ¼-inch NPT connections, which can be modified to accept ½-inch NPT through optional flange adapters. Gauge pressure transmitters are available with various connections for direct mounting to a process pipe.

A ½-inch, schedule 80, steel pipe is commonly used for Transmitter integration into a process system. Many piping arrangements use a three-valve manifold to connect the process piping to the Transmitter. A manifold makes it easy to install and remove or re-zero a Transmitter without interrupting the process. A manifold also accommodates the installation of blow-down valves to clear debris from pressure lines. Figure 52 represents a typical piping arrangement using a three-valve manifold and blow-down lines for a differential pressure transmitter being used to measure flow.

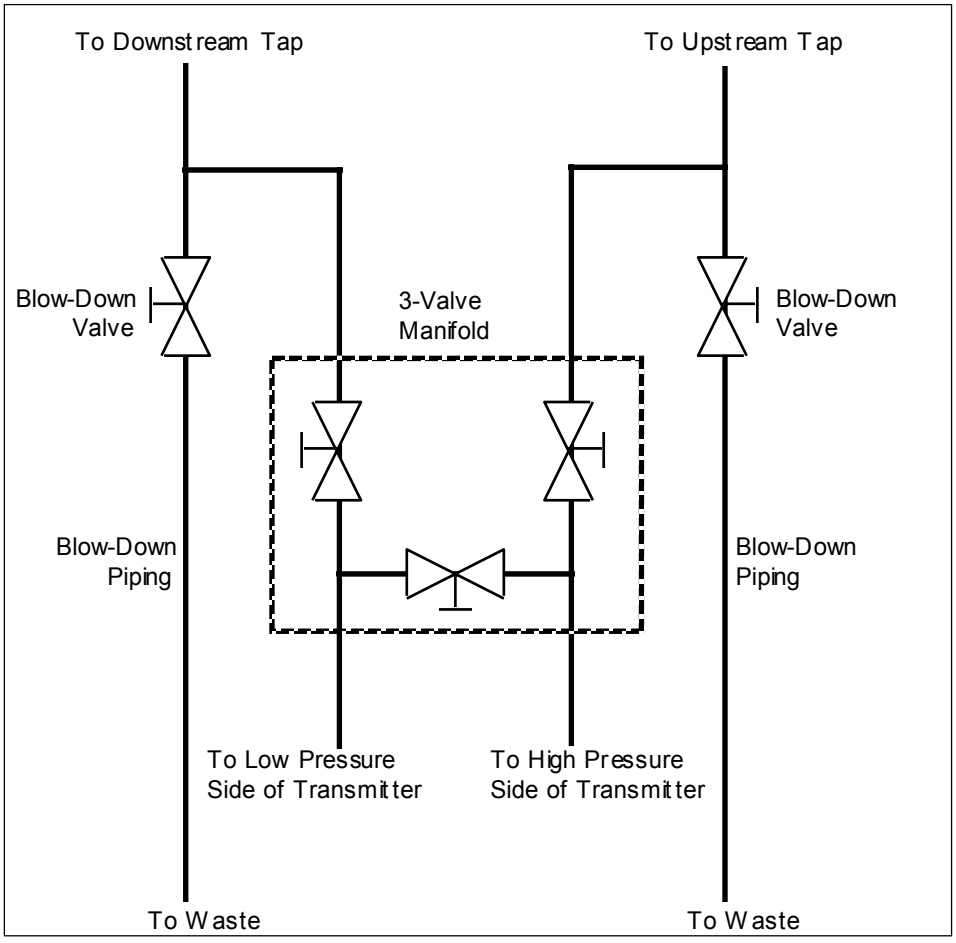


Figure 52– ST 700 Basic Transmitter - Typical 3-Valve Manifold with Blow-Down Piping

12.6.2 Suggestions for Transmitter Location

The following are suggested connections based on what is being processed by the system.

Table 33 – ST 700 Basic Transmitter - Suggested Connection Locations

Process	Suggested Location	Description
Gases	Above the gas line.	The condensate drains away from the Transmitter.
Liquids	Below but near the elevation of the process connection.	This minimizes that static head effect of the condensate.
	Level with or above the process connection.	This requires a siphon to protect theTransmitter from process steam. The siphon retains water as a *fill fluid*.

5. For liquid or steam, the piping should slope a minimum of 25.4mm (1 inch) per 305mm (1 foot).
6. Slope the piping down toward the Transmitter if it is below the process connection to allow the bubbles to rise back into the piping through the liquid.
7. If the transmitter is located above the process connection, the piping should rise vertically above the Transmitter. In this case, slope down toward the flow line with a vent valve at the high point.
8. For gas measurement, use a condensate leg and drain at the low point (freeze protection may be required here).

ATTENTION Care must be taken when installing transmitters on hot processes. The operating temperature limits for the device (as outlined in Table 5) must not be exceeded. Impulse piping may be used to reduce the temperature of the process that comes into contact with the transmitter meter body. As a general rule there is a 56°C drop (100°F) in the temperature of the process for every foot of ½ inch uninsulated piping.

12.6.3 General Piping Guidelines

- When measuring fluids that contain suspended solids, install permanent valves at regular intervals to blow-down piping.
- Blow-down all lines on new installations with compressed air or steam, and flush them with process fluids (where possible) before connecting these lines to the Transmitter Meter body.
- Verify that the valves in the blow-down lines are closed tightly after the initial blow-down procedure and each maintenance procedure thereafter.

12.6.4 Procedure to Install Flange Adapters

The following procedure provides the steps for removing and replacing an optional flange adapter on the process head. Refer to Figure 53.

This procedure does not require that the Meter body be removed from the Electronics Housing. If flange adapters are being replaced with parts from other kits (for example, process heads), follow the procedures for the kits and incorporate the following procedure.

The threaded hole in each Flange Adapter is offset from center. To ensure proper orientation for re-assembly, note the orientation of the offset relative to each Process Head **before removing the adapter**.

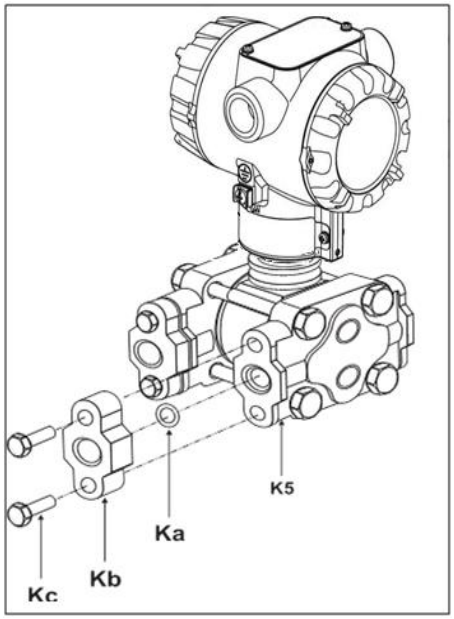


Figure 53 – ST 700 Basic Transmitter - Flange Adapter Removal and Replacement

Refer to the instructions included with the kit for removal and replacement procedures.

12.7 Wiring an ST 700 Basic Transmitter

12.7.1 Overview

The ST 700 basic transmitter is designed to operate in a two-wire power/current loop with loop resistance and power supply voltage within the operating range shown in Figure 54

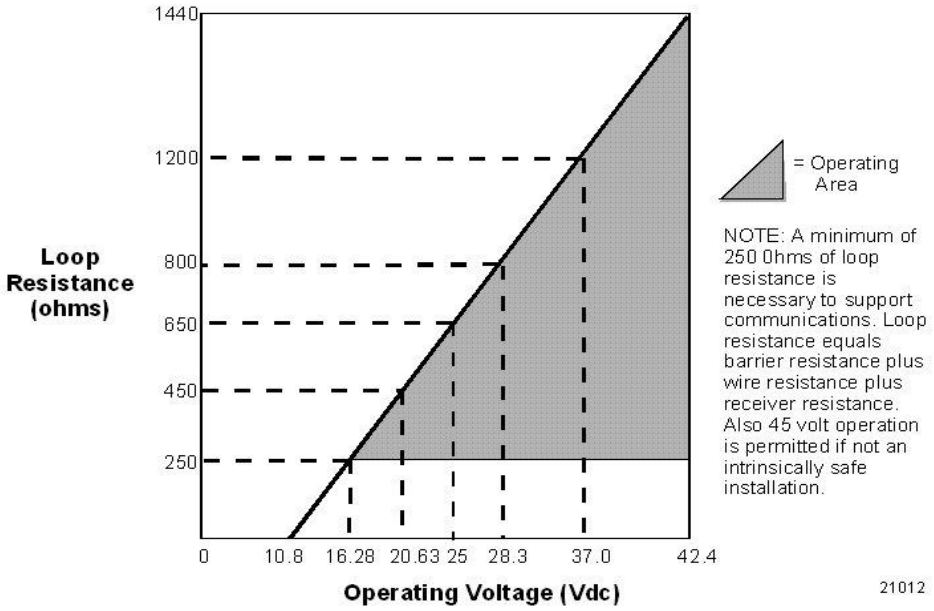


Figure 54 – ST 700 Basic Transmitter - Operating Ranges

Loop wiring is connected to the Transmitter by simply attaching the positive (+) and negative (–) loop wires to the positive (+) and negative (–) terminals on the Transmitter terminal block in the Electronics Housing shown in Figure 55

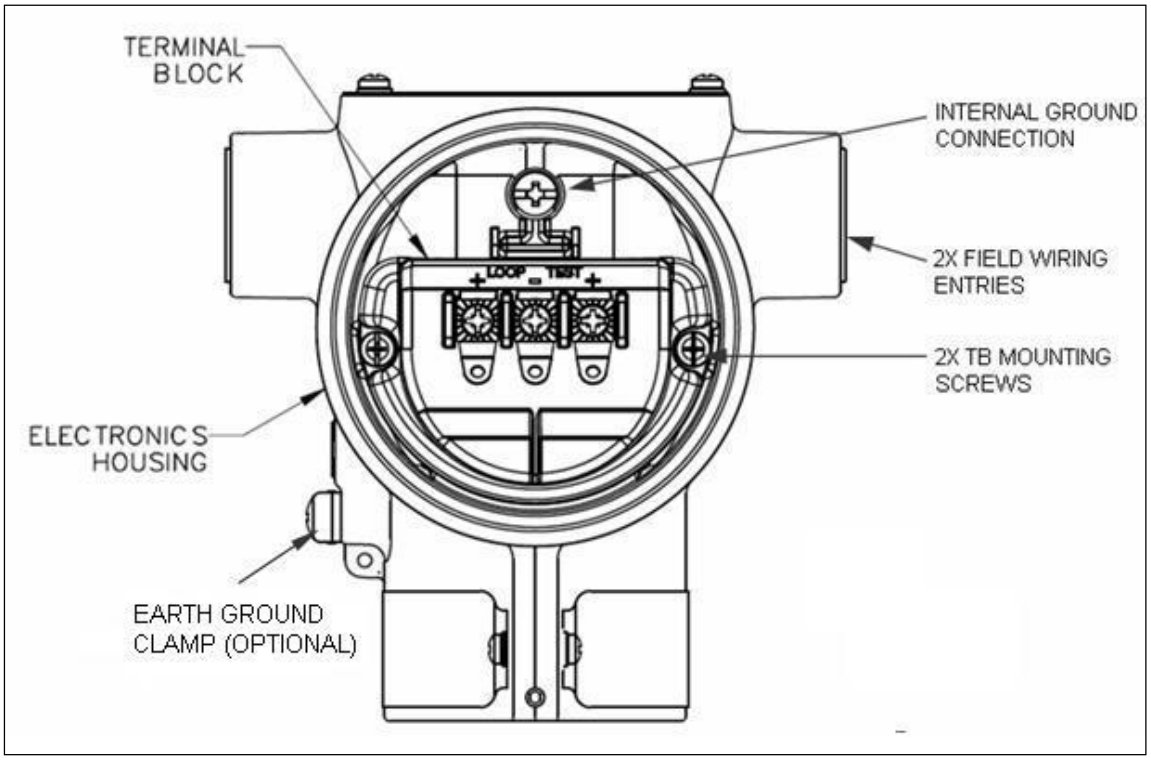


Figure 55 – ST 700 Basic Transmitter - 3-Screw Terminal Board and Grounding Screw

As shown in Figure 55 each Transmitter has an internal terminal to connect it to earth ground. Optionally, a ground terminal can be added to the outside of the Electronics Housing. While it is not necessary to ground the Transmitter for proper operation, doing so tends to minimize the possible effects of noise on the output signal and affords protection against lightning and static discharge. An optional lightning terminal block can be installed in place of the non-lightning terminal block for Transmitters that will be installed in an area that is highly susceptible to lightning strikes.

Wiring must comply with local codes, regulations and ordinances. Grounding may be required to meet various approval body certification, for example CE conformity. Refer to Appendix A of this document for details.

The Transmitter is designed to operate in a two-wire power/current loop with loop resistance and power supply voltage within the operating range; see Figure 54. With optional devices such as remote meter, the voltage drop for these options must be added to the basic 10.8-volt supply requirements to determine the required Transmitter voltage (V_{XMTR}) and maximum loop resistance ($R_{LOOP\ MAX}$). Additional consideration is required when sel*ecting* intrinsic safety barriers to ensure that they will supply at least minimum Transmitter voltage ($V_{XMTR\ MIN}$), including the required 250 ohms of resistance (typically within the barriers) needed for digital communications.

Transmitter loop parameters are as follows:
$R_{LOOP\ MAX}$ = maximum loop resistance (barriers plus wiring) that will allow proper Transmitter operation and is calculated as $R_{LOOP\ MAX} = (V_{SUPPLY\ MIN} - V_{XMTR\ MIN}) \div 21.8mA$.

In this calculation:

$V_{XMTR\ MIN} = 10.8V + V_{LP} + V_{SM}$
$V_{LP} = 0V$ for Honeywell supplied lightning protection option, LP
$V_{SM} = 2.3V$, remote meter

Note that V_{SM} should only be considered if a remote meter will be connected to the transmitter.

The positive and negative loop wires are connected to the positive (+) and negative (–) terminals on the terminal block in the Transmitter Electronics Housing.

Barriers can be installed per Honeywell's instructions for Transmitters to be used in intrinsically safe applications.

12.7.2 Digital System Integration Information

Transmitters that are to be digitally integrated to Honeywell's Total Plant Solution (TPS) system will be connected to the Pressure Transmitter Interface Module in the Process Manager, Advanced Process Manager or High Performance Process Manager through a Field Termination Assembly. Details about the TPS system connections are given in the *PM/APM SmartLine Transmitter Integration Manual*, PM12-410, which is part of the TDC 3000^X system bookset.

If you are digitally integrating a Transmitter in an Allen Bradley Programmable Logic Controller (PLC) process system, the same Field Terminal Assembly (FTA) and wiring procedures used with Honeywell's TPS system are also used with the Allen-Bradley 1771 and 1746 platforms.

12.7.3 Wiring Variations

The above procedures are used to connect power to a Transmitter. For loop wiring and external wiring, detailed drawings are provided for Transmitter installation in non-intrinsically safe areas and for intrinsically safe loops in hazardous area locations.

If you are using the Transmitter with Honeywell's TPS system, see *PM/APM Smartline Transmitter Integration Manual*, PM12-410, which is part of the TDC 3000^X system bookset.

12.7.4 Wiring Procedure

7. See Figure 55 above, for parts locations. Loosen the end cap lock using a 1.5mm Allen wrench.
8. Remove the end cap cover from the terminal block end of the Electronics Housing.
9. Feed loop power leads through one end of the conduit entrances on either side of the Electronics Housing. The Transmitter accepts up to 16AWG wire.
10. Plug the unused conduit entrance with the appropriate plug for the environment.
11. Connect the positive loop power lead to the positive (+) terminal and the negative loop power lead to the negative (-) terminal. Note that the Transmitter is <u>not</u> polarity-sensitive.
12. Replace the end cap, and secure it in place.

12.7.5 Lightning Protection

If your Transmitter includes the optional lightning protection, connect a wire from the Earth Ground Clamp (see Figure 15) to Earth Ground to make the protection effective. Use a size 8 AWG or ($8.37mm^2$) bare or green covered wire for this connection.

12.7.6 Supply Voltage Limiting Requirements

If your Transmitter complies with the ATEX 4 directive for self-declared approval per 94/9EC, the power supply has to include a voltage-limiting device. Voltage must be limited such that it does not exceed 42V DC. Consult the process design system documentation for specifics.

12.7.7 Process Sealing

The ST 700 SmartLine Pressure Transmitter is CSA-certified as a Dual Seal device in accordance with ANSI/ISA–12.27.01–2003, "Requirements for Process Sealing Between Electrical Systems and Flammable, or Combustible Process Fluids."

12.7.8 Explosion-Proof Conduit Seal

 When installed as explosion proof in a Division 1 Hazardous Location, keep covers tight while the Transmitter is energized. Disconnect power to the Transmitter in the non-hazardous area prior to removing end caps for service.

When installed as non-incendive equipment in a Division 2 hazardous location, disconnect power to the Transmitter in the non-hazardous area, or determine that the location is non-hazardous before disconnecting or connecting the Transmitter wires.

Transmitters installed as explosion proof in Class I, Division 1, Group A Hazardous (classified) locations in accordance with ANSI/NFPA 70, the US National Electrical Code, with 1/2 inch conduit do not require an explosion-proof seal for installation. If 3/4 inch conduit is used, a LISTED explosion-proof seal to be installed in the conduit, within 18 inches (457.2mm) of the Transmitter.

12.8 Startup

12.8.1 Overview

This section identifies typical start up tasks associated with several generic pressure measurement applications. It also includes the procedure for running an optional analog output check.

12.8.2 Startup Tasks

After completing the installation and configuration tasks for a Transmitter, you are ready to start up the process loop. Startup usually includes:

- Checking zero input
- Reading inputs and outputs
- Applying process pressure to the transmitter.

The actual steps in a startup procedure vary based on the type of Transmitter and the measurement application. In general, the procedures in this section are based on using Honeywell MC Toolkit to check the Transmitter input and output under static process conditions, and make adjustments as required initiating full operation with the running process. Note that similar checks can be made using the optional external 2-button assembly, where the Transmitter is equipped. Operation with the 2-button assembly is discussed in the Operation section.

When the Standard Display is connected, the two-button assembly for the Standard Display is present. The buttons will function 1 second after powering up.

12.8.3 Output Check Procedures

The Output Check comprises the following procedures:

- The Loop Test procedure checks for continuity and the condition of components in the output current loop.
- The Trim DAC Current procedure calibrates the output of the Digital-to-Analog converter for minimum (0%) and maximum (100%) values of 4mA and 20mA, respectively. This procedure is used for Transmitters operating online in analog mode to ensure proper operation with associated circuit components (for example, wiring, power supply, control equipment). Precision test equipment (an ammeter or a voltmeter in parallel with precision resistor) is required for the Trim DAC Current procedure.
- The Apply Values procedure uses actual Process Variable (PV) input levels for calibrating the range of a Transmitter. To measure a liquid level for example, a sight-glass can be used to determine the minimum (0%) and maximum (100%) level in a vessel. The PV is carefully adjusted to stable minimum and maximum levels, and the LRV and URV are then set by commands from the MC Toolkit.



The Transmitter does not measure the given PV input or update the PV output while it operates in the Output mode.

12.8.4 Constant Current Source Mode Procedure

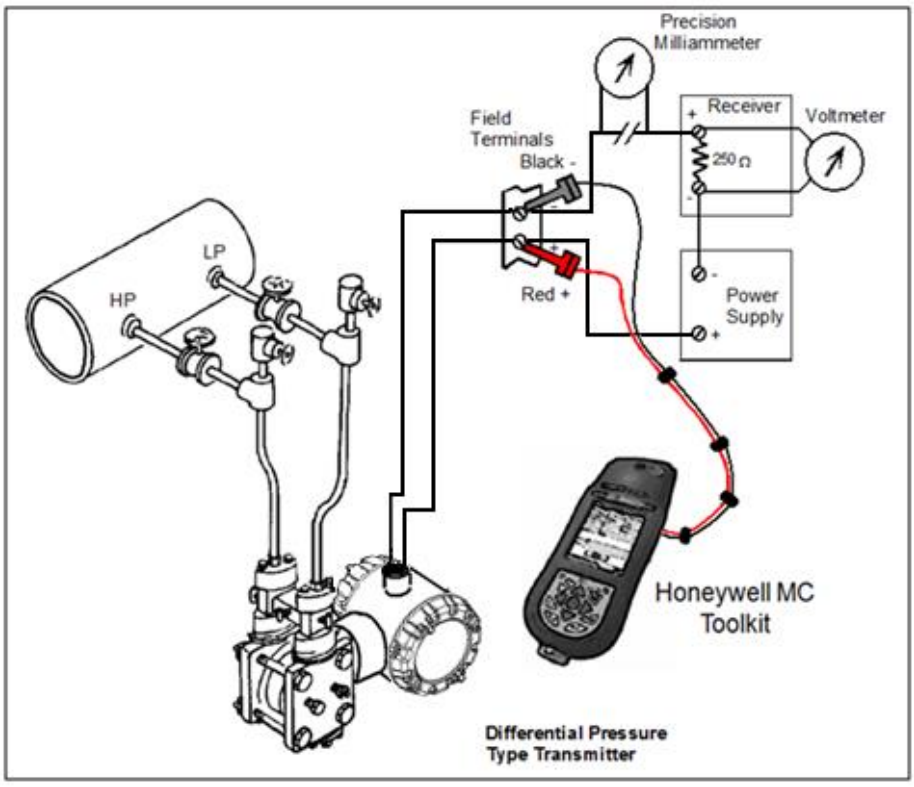


Figure 56 – ST 700 Basic Transmitter - Current Loop Test Connections

10. Refer to Figure 56 for test connections. Verify the integrity of electrical components in the output current loop.
11. Establish communication with the Transmitter. For these procedures, the values of components in the current loop are not critical if they support reliable communication between the Transmitter and the Toolkit.
12. On the Toolkit, display the **Output Calibration** box.
13. In the Output Calibration box, select the **Loop Test** button; the **LOOP TEST** box will be displayed.
14. Select the desired constant-level Output: 0%, 100%, or Other (any between 0% - 100%).
15. Select the Set button. A box will be displayed asking **Are you sure you want to place the transmitter in output mode?**

With the Transmitter in Analog mode, you can observe the output on an externally-connected meter or on a local meter. In DE mode, you can observe the output on the local meter or on the Toolkit Monitor display.

16. Select the **Yes** button. Observe the output current at the percentage you selected in Step 5.
17. To view the monitor display, navigate back from the **LOOP TEST** display, and select the **MONITOR** display. A **Confirm** popup will be displayed.
18. Select **Yes** to continue. This concludes the Startup procedure.

13. Operation_ST 700 Basic Transmitter

13.1 Overview

This section provides the information and processes involved for operation of ST 700 Basic Transmitter using the external two-button options.

13.2 External Two-Button Operation

The ST 700 Basic Transmitter optional external two-button interface provides a user interface and operation capability without opening the transmitter. Figure 57 shows the location of the two-button option and the labels for each button. See Table 37 for button operation.

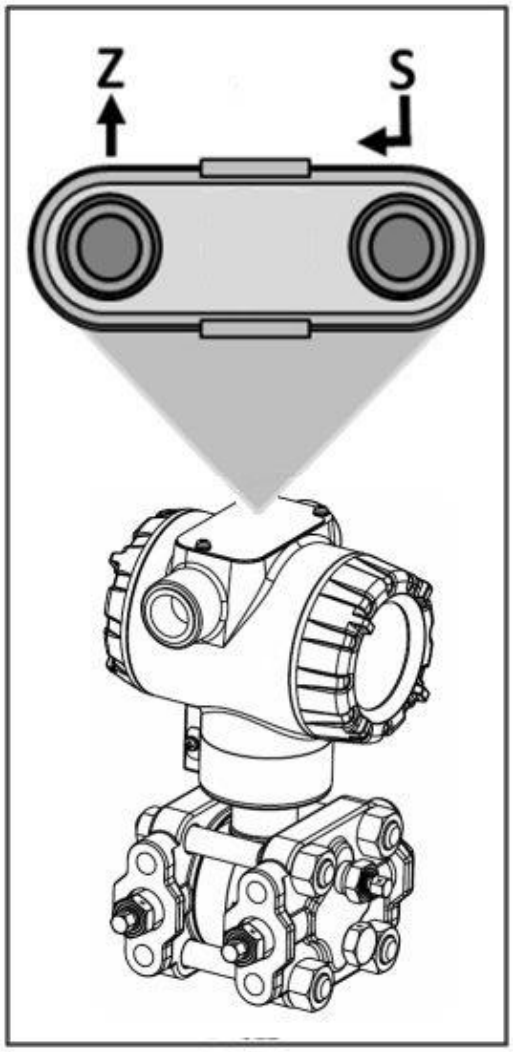


Figure 57 – ST 700 Basic Transmitter - Two-Button Option

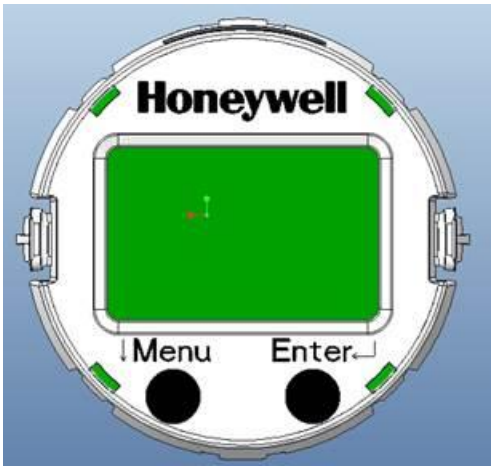


Figure 58 – ST 700 Basic Transmitter - Two-Button Option

13.2.1 The Standard Display Menu

The Standard Display Menu is implemented as one long single-level menu, after entering into Menu mode, and will "wrap around" when it reaches the end of the menu. To enter Menu mode select ↵ in PV display mode. Operation is as follows:

6. Select <**Exit Menu**> and press ↵ to exit the Menu.
7. Use the ↓ buttons to scroll through the list of menu items.
8. Press the ↵ button to select an item in Menu mode for data entry or activation. When an item is selected for data entry or activation, the cursor will jump to the lower line of the LCD to allow editing of the value. No action is taken against a menu item until the user presses the ↵ button.
9. If you want to abort a data entry operation, simply refrain from pushing any buttons for more than 10 seconds; the data entry operation will time out and the original value of the selected item will be preserved.
10. If you want to abort a menu operation, simply refrain from pushing any buttons for more than 60 seconds; the menu operation will time out and the exit from menu & it will show PV value.

The menu is divided into Standard Menu and Extended menu which can be enabled and disabled by Extended Menu Enable/Disable operation.

Note: The abort option is not available for Loop test parameter. The timeout for the DAC trim operation is more to enable user to calculate the loop current value to enter.

Table 34 – ST 700 Basic Transmitter: Standard Display Menus

<table>
<tr><td rowspan="4">PV Display [1SEL PV]</td><td>Pressure (PRESURE)</td><td>Pressure Units</td><td rowspan="4">Select Process Variable (PV) to be shown on the display from list.</td><td rowspan="4">Press ↵ to enter Menu Mode

Press ↵ to enter menu selection

Press ↵ to initiate action

Press ↓Menu to Exit to Menu</td></tr>
<tr><td>Percent Output (% OUT)</td><td>%</td></tr>
<tr><td>Loop Output (LOOPOUT)</td><td>mA</td></tr>
<tr><td>Flow (FLOW)
Note: Before seleting PV type as Flow, please ensure the LRV/URV values in (pressure unit) are as per application. For PV type Flow the pressure unit will not be visible.</td><td>Flow unit</td></tr>
<tr><td>Pressure Units [2UNITS]
(Visible for all PV except Flow)</td><td>atm, bar
ftH2O @ 68ºF
gf/cm2
inH2O @ 39ºF
inH2O @ 60ºF
inH2O @ 68ºF
inHg @ 0ºC
kgf/cm2, kPa
mbar,
mmH2O @ 4ºC,
mmH2O @ 68ºF,
mmHg @ 0ºC,
MPa, Pa,
psi
Torr,
mH2O @ 4ºC
cmH2O @ 4ºC
mHg @ 0ºC</td><td colspan="2">Choose appropriate engineering units from list</td></tr>
<tr><td>Flow Units [3FLUNIT]</td><td>Cubic meter/hour[m3/hr] Kg/hour [Kg/hr]
Metric Ton/Hour [MT/hr]
Liter per second [L/sec]
Liters/hour [L/hr]
Standard Cubic feet per hour[SCFH]
Cubic feet per hour[CFH]
Gallons/hour[gal/hr]
Barrel/hours [bbl/hr]
Imperial Gallons/hours[Igal/hr]
Percentage[%]</td><td colspan="2">Choose appropriate engineering units from list</td></tr>
</table>

Scaling Low [4SCLLOW] Scaling High [5SCLHIG]	#. ## #. ##	The limits are: -999999 to 999999	Press ↵ to enter Menu Mode Press ↵ to enter menu selection ↓ Menu to select number. ↵ to enter and shift to the next digit to the right After complete value is Entered Press ↓Menu to Exit to Menu
Enter LRV [6ENTLRV] Enter URV [7ENTURV]	#. ## #. ##	The limits are: 2X the Lower Range Limit (LRL) of the Meter body and 2X the Upper Range Limit (URL) of the Meter body. The LRV/URV value will be available in Pressure Units (Standard Display pressure unit)	
Zero Correct [8SETZRO]	Zero Correct	Executing this selection performing for Zero Correct operation	Press ↵ to enter Menu Mode Press ↵ to enter menu selection Press ↵ to initiate action Press ↓Menu to Exit to Menu

Table 35 – ST 700 Basic Transmitter - Extended Display Menu

DAC Zero Trim [9ZEROTR] Note: Loop must be removed from Automatic Control	DAC Zero Trim	This selection allows the loop zero output 4mA value to be trimmed. Note: You must connect a current meter to the transmitter to monitor the loop output.	Press ↵ to enter Menu Mode Press ↵ to enter menu selection ↓ Menu to select number. ↵ to enter and shift to the next digit to the right After complete value is Entered Press ↓Menu to Exit to Menu
DAC Span Trim [10SPANTR] Note: Loop must be removed from Automatic Control	DAC Span Trim	This selection allows the loop span output 20mA value to be trimmed. Note: You must connect a current meter to the transmitter to monitor the loop output.	
Loop Test [11LPTEST] Note: Loop must be removed from Automatic Control	Loop Test 12.000	This selection allows the user to force the DAC output to any value between 3.8 and 20.8 mA. Note: This selection will put the DAC into Fixed Output Mode, as indicated by the flashing output value. Navigation away from this menu item will return the loop to Normal (Automatic) Mode.	
Set LRV [12SETLRV]	Set LRV	Executing this selection performing for Zero operation.	Press ↵ to enter Menu Mode Press ↵ to enter menu selection Press ↵ to initiate action
Set URV [13SETURV]	Set URV	Executing this selection for Span operation	
Contrast [14CNTRST]	»»»»»»	Adjust the LCD contrast level. Range from » (1) to »»»»»»»»»» (7) Default: »»»»»»»»(7)	
Enable Extended Menu [EXDMNU]	Enable/Disable	Enable the extended Menu.The default is disabled	Press ↵ toto Enter the Menu Mode Press ↵ to enter Menu selection Menu to Enable or disable the Extended Menu ↵ to Enter Press ↓Menu to Exit to Menu
	Exit Menu		

13.2.2 Standard Display Abbreviations:

Table 36 – ST 700 Basic Transmitter - The Standard Display abbreviations

Abbreviation	Meaning
OOR	Out of Range
PRSPAN	Push reduce span
Wrng Mo	Wrong Mode
Illegal	Illegal Value
Wrt Err	NVM write error
Too Hi	Value/Parameter Too High
Too Lo	Value/Parameter Too Low
LRV Hi	LRV too High
LRV Lo	LRV too Low
LargeSP	Span too large
SmallSP	Span too small
Locked	Device is locked
Multidr	Device in multidrop mode
Wrt Prt	Device in write protect mode
NotSprt	Not supported
Hi LMT	Value is greater than high Limit value
Low LMT	Value is less than low Limit value

13.2.3 Data Entry

Data entry is performed from left to right. Select a character / digit by pressing ↓ buttons, and then press ↵ to advance to the next character position to the right. Select the cross-hatch character ▒ to terminate the entry or if the final character is already a space character, just press **<<** again.

All numeric entries are clamped at the low or high limit if needed. You can determine the low and high limit for a parameter by selecting either the **H** or **L** character while the cursor is positioned over the left-most digit and press ↵ button. The Display will show the selected limit.
For numeric entry sign is required to be entered only for negative numbers. For positive number, select space and move ahead.

Table 37 – ST 700 Basic Transmitter - Two-Button Data Entry

Screen Symbol	Numeric data entry
H	Display the high limit for this parameter. This symbol only appears in the left-most position of the data entry field.
L	Display the low limit for this parameter. This symbol only appears in the left-most position of the data entry field.
<<	Terminate the numeric entry
0 thru 9, Minus, Decimal	These characters are used to enter numeric values. The minus sign only appears in the left-most digit.

13.2.4 Editing a Numeric value

Editing a numeric value is a digit-by-digit process, starting with the left-most digit.

1. Press ↵ to begin the edit process.
2. The Standard Display will show the current value of the item on the lower line, left justified.
3. Press the ↓ buttons to select the desired digit, and then press ↵ to advance to the next digit to the right.
4. After the last digit has been entered, press ↵ one more time to write the new value to the transmitter.

13.2.5 Selecting a new setting from a list of choices

Use the procedure described below to select a new setting for parameters that present a list of choices (e.g. PV Display, Pressure Units, and so forth.).

1. Press ↵ to begin the edit process.
    a. The Standard Display will show the current setting of the item on the lower line
2. Press the ↓ buttons to scroll through the list of choices.
3. Press ↵ to make your selection. The new selection will be stored in the transmitter and will be displayed on the lower line

13.3 Two Button Operation with no Display Installed

When there is no Display installed, the buttons can be used to perform a Zero or Span adjustment and zero correction of the ST 700 Basic Transmitter. Caution should be taken to insure these adjustments are only made when the correct input pressures are applied.

13.3.1 Zero Adjustment

This adjustment is the same as performing a Set LRV using the Display.

1. Connect a current meter or voltmeter as shown in Figure 56 to monitor the PV output of the Transmitter.
2. Using an accurate pressure source, apply pressure equivalent to the Transmitter LRV.
3. Press the Zero (↑) button for more than 2 seconds to set the Zero.
4. Verify that the output is now 4 mA.

Note: Pressing the zero button for more than 5 seconds will ignore the button press.

13.3.2 Span Adjustment

This adjustment is the same as performing a Set URV using the Display.

1. Connect a current meter or voltmeter as shown in Figure 56 to monitor the PV output of the Transmitter.
2. Using an accurate pressure source, apply pressure equivalent to the desired Upper Range Value of the transmitter.
3. Press the **Span** (↵) button for more than 2 secondsr to set the span.
4. Verify that the PV output is now 20mA.

Note: Pressing the zero button for more than 5 seconds will ignore the button press.

13.3.3 Zero Correction

This adjustment is the same as performing a Zero correct using the Display.

1. Connect a current meter or voltmeter as shown in Figure 56 to monitor the PV output of the Transmitter.
2. Using an accurate pressure source, apply pressure equivalent to the zero Value of the transmitter.
3. Press the Zero (↑) and **Span** (↵) buttons together for more than 5 sec to set the span.
4. Verify that the PV is set to 0 value.

Note: Pressing the SPAN button for more than 10 seconds will ignore the button press

You can also use the MCT Toolkit to make any adjustments to an ST 700 SmartLine Pressure Transmitter. Alternately, certain adjustments are possible through an Experion Station , if the ST 700 is digitally integrated with either of these stations.

13.4 Changing the Default Failsafe Direction

ST 700 Basic Transmitters are shipped with a default failsafe direction of upscale. This means that the Transmitter output will set the current output to upscale failsafe (maximum output) upon detection of a critical status. You can change the direction from upscale failsafe to downscale failsafe (minimum output) by moving the top jumper located in the Electronics module.

13.4.1 Procedure to Establish Failsafe Operation

The failsafe direction display accessible via the Toolkit shows only the state of the jumper as it correlates to analog Transmitter operation.

The integrated circuits in the Transmitter PWA are vunerable to damage by stray static discharges when removed from the Electronics Housing. Minimize the possibility of static discharge damage when handling the PWA as follows:

Do not touch terminals, connectors, component leads, or circuits when handling the PWA.

When removing or installing the PWA, handle it by its edges or bracket section only. If you need to touch the PWA circuits, be sure you are grounded by staying in contact with a grounded surface or by wearing a grounded wrist strap.

When the PWA is removed from the Transmitter, put it in an electrically conductive bag, or wrap it in aluminum foil to protect it.

The following procedure outlines the steps for positioning the write protect and failsafe jumpers on the electronics module. See Figure 59 for the locations of the failsafe and write protect jumpers.

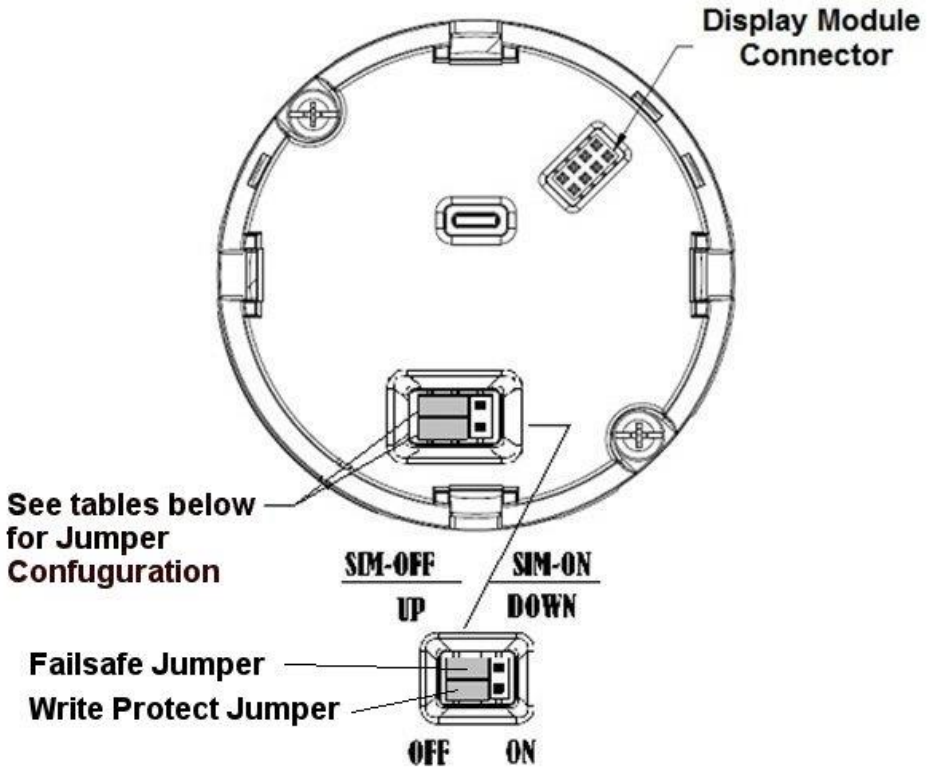
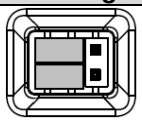
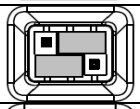
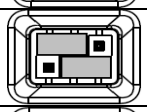
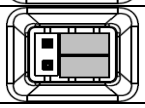


Figure 59 – ST 700 Basic Transmitter - Locating the Failsafe and Write Protect Jumpers

Table 38 – ST 700 Basic Transmitter - HART Failsafe and Write Protect Jumpers

Jumper Arrangements	Description
	Failsafe = UP (High) Write Protect = OFF (Not Protected)
	Failsafe = DOWN (Low) Write Protect = OFF (Not Protected)
	Failsafe = UP (High) Write Protect = ON (Protected)
	Failsafe = Down (Low) Write Protect = On (Protected)

1. Turn OFF Transmitter power (Power removal is only required in accordance with area safety approvals. Power removal is only required in Class 1 Div 1 Explosionproof and Class 1 Div 2 environments).

2. Loosen the end cap lock, and unscrew the end cap from the electronics side of the Transmitter housing.

3. If equipped with a Display module, carefully depress the two tabs on the sides of the Display Module, and pull it off.

4. If necessary, unplug the interface connector from the Communication module. Do not discard the connector.

5. Set the Failsafe Jumper (top jumper) to the desired position (UP or DOWN). See Figure 59? and Table 38 for jumper positioning.

6. If applicable, re-install the Display module as follows:

    - Orient the display as desired.
    - Install the Interface Connector in the Display module such that it will mate with the socket for the display in the Communication module.
    - Carefully line up the display, and snap it into place. Verify that the two tabs on the sides of the display latch.

    Note: Installing a Display Module into a powered transmitter may cause a temporary upset to the loop output value.

    Orient the Display for proper viewing through the end cap window. You can rotate the meter mounting orientation in 90° increments.

7. Restore transmitter power if removed.

13.5 Monitoring the Standard Displays

This section describes the information shown on the operator screens of the Standard Display.

13.5.1 Standard Display

- The PV value is user-configurable. This field has 6 characters. The maximum allowable numeric value is 999999 or -999999.
    - If fractional decimals are configured, the fractional positions will be dropped, as required.
    - If the PV value exceeds the above limits, it is divided by 1000 and "K" is appended to the result, allowing a maximum value with multiplier of 99999K or -99999K.

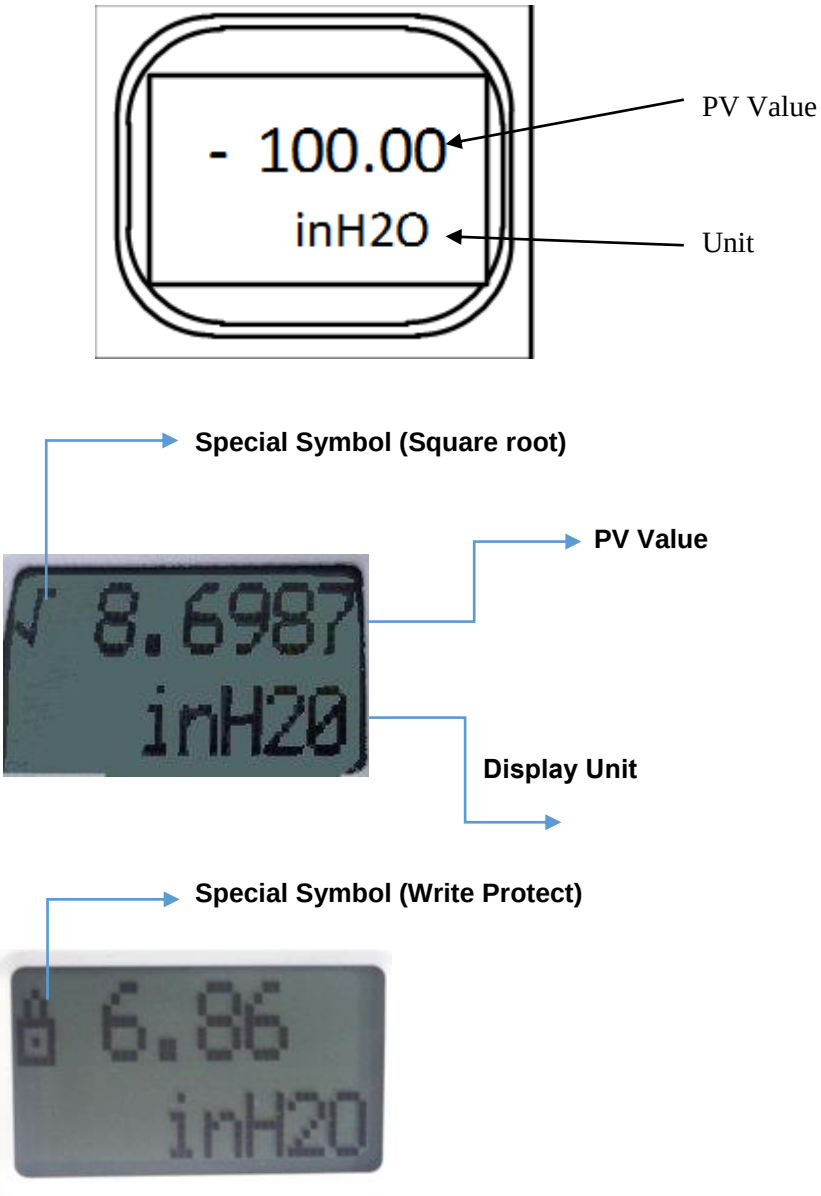


Figure 60 – ST 700 Basic Transmitter - Standard Display with Process Variable Format

14. Maintenance_ST 700 Basic Transmitter

14.1 Overview

This section provides information about preventive maintenance and replacing damaged parts. The topics covered in this section are:

- Preventive maintenance of the meter body barrier diaphragms and process piping to the Transmitter.
- Replacement of damaged parts such as the Transmitter Printed Wiring Assembly (PWA) and meter body

14.2 Preventive Maintenance Practices and Schedules

The ST 700 Basic Transmitter does not require any specific maintenance at regularly scheduled intervals. However, it is recommended that you perform these typical inspection and maintenance routines on a schedule that is dictated by the characteristics of the process medium and if blow-down facilities or purge systems are being used.

- Check piping for leaks.
- Clear piping of sediment or other foreign matter.
- Clean the Transmitter process heads, including the barrier diaphragms.

14.3 Inspecting and Cleaning Barrier Diaphragms

Depending on the characteristics of the process medium, sediment or other foreign particles may collect in the process head cavity/chamber and cause faulty measurement. In addition, the barrier diaphragm(s) in the Transmitter meter body may become coated with residue from the process medium. The latter is also true for external diaphragms on flange-mount and remote seal type Transmitters.

In many cases, you can readily remove the process head(s) from the Transmitter meter body to clean the process head cavity and inspect the barrier diaphragm(s). For flange-mount and remote seal diaphragms, you may only need to run a purge line in the tank to rinse off the face of the diaphragm(s).

The following procedure comprises the general steps for inspecting and cleaning barrier diaphragms. You may have to modify these steps to meet your particular process or transmitter model requirements. Figure 61 shows an exploded view of a Differential Pressure (DP) Transmitter meter body for reference. For disassembly/reassembly purposes, Gauge Pressure (GP) and Absolute Pressure (AP) Transmitters are similar.


It is recommended that you remove the Transmitter from service and move it to a clean area before disassembling it.

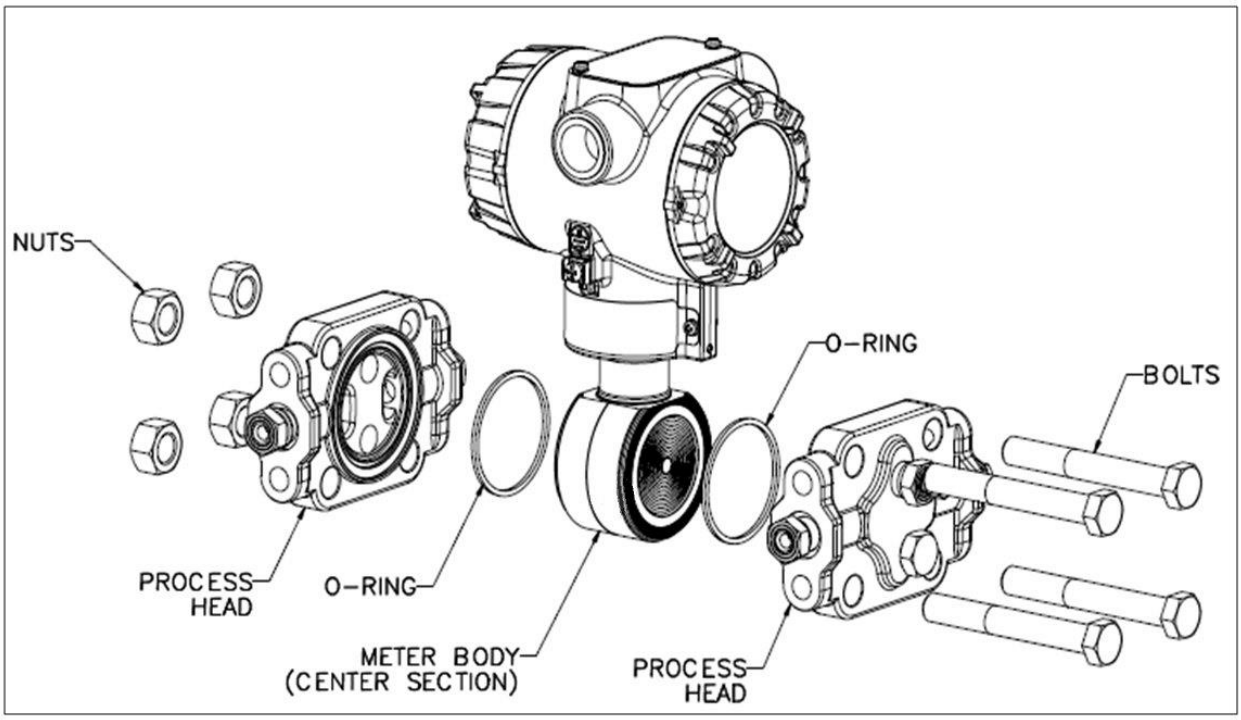


Figure 61 – ST 700 Basic Transmitter - DP Transmitter Head Disassembly

13. Close all valves to isolate the Transmitter from the process.
14. Open the vent in the process head to drain fluid from the Transmitter meter body, as necessary.
15. Remove the Transmitter from the process.
16. Loosen the nuts in the sequence shown in Figure 62
17. Remove the nuts from the bolts that hold the process head(s) to the meter body.
18. Remove the process heads and bolts.
19. Remove the gasket/ O-ring, and clean the interior of the process head using a soft bristle brush and an approved solvent.
20. Inspect the barrier diaphragm for signs of deterioration, corrosion, and distortion.
21. If the diaphragm is distorted contact Honeywell for assistance.
22. Install a new gasket/O-ring in each process head.
23. Coat threads on the process head bolts with a suitable anti-seize compound, such as "Neverseize," or equivalent.
24. Using a torque wrench, gradually tighten the nuts in the sequence shown in Figure 62
25. Tighten head bolts in stages of 1/3-full torque, 2/3-full torque, and full torque. See Table 39 or torque requirements versus Transmitter type and model.

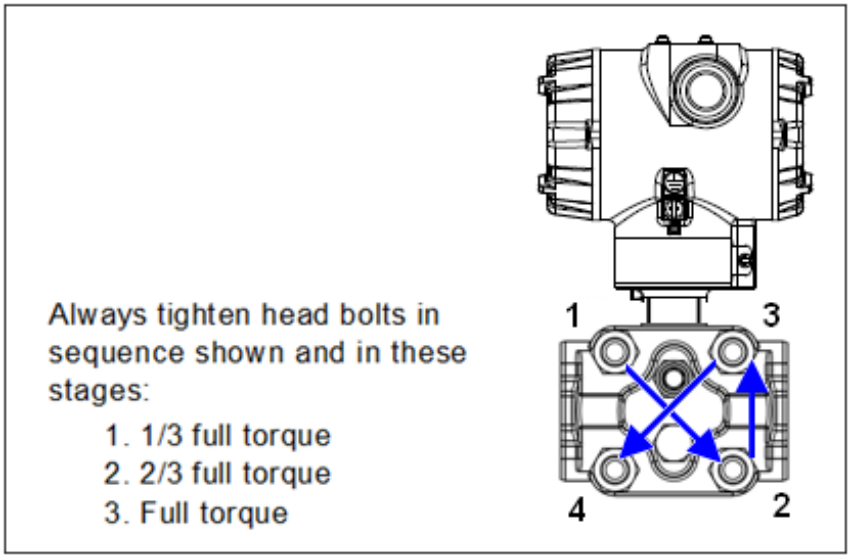


Figure 62 – ST 700 Basic Transmitter - Head Bolt Tightening Sequence

Table 39 – Head Bolt Torque Values

Bolting Type	**50049713XXXX all transmitters except draft range (XXX5)**	**50049713XXX5 Draft Range Transmitter only**
Super Duplex Bolting Option Bolt 514452557-006 Nut 51452559-006	48,8 N-M +/- 2,4 N-M (36.0 Lb-Ft +/- 1.8 Lb-Ft)	
316 Stainless Steel Bolting Option Bolt 51452557-003 Nut 51452559-004	56,9 N-M +/- 2,8 N-M (42.0 Lb-Ft +/- 2.1 Lb-Ft)	
Grade 660 NACE Bolts/NACE 304 Nuts Option Bolt 51452557-002 Nut 51452559-002		20,3 N-M (16.0 Lb-Ft +/- 0.8 Lb-Ft)
Grade 660 NACE Bolting Option Bolt 51452557-002 Nut 51452559-008	67,8 N-M +/- 3,4 N-M (50.0 Lb-Ft +/- 2.5 Lb-Ft)	
Carbon Steel Bolting Option Bolt 51452557-001 Nut 51452559-001		

14.4 Replacing the Communication Module

The Communication module includes a connector to the sensor ribbon cable and a connector to the optional Display module. This section includes the procedure to replace the Communication module.

The transmitter does not have to be removed from service to replace the Comm Module

Please take appropriate steps to avoid ESD damage when handling the Communication and Display Module assemblies

Refer to Figure 63 for parts locations.

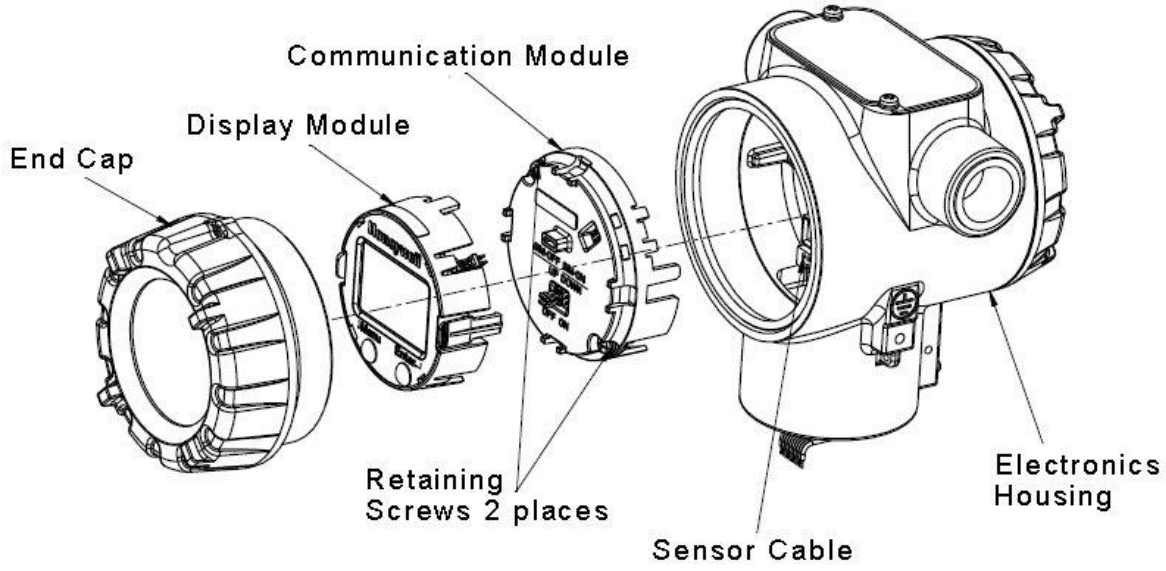


Figure 63 – ST 700 Basic Transmitter - PWA Replacement

1. Turn OFF Transmitter power (Power removal is only required in accordance with area safety approvals. Power removal is only required in Class 1 Div 1 Explosion-proof and Class 1 Div 2 environments).
    - When removing the Communications Module with power applied, the loop will go to 0V. Likewise, installing a Communications Module into a transmitter with power applied will cause the loop output value to go to 12ma for several seconds then the loop output value will go to the configured value based on the PV input.

    - Installing a Display Module into a powered transmitter may cause a temporary upset to the loop output value.

2. Loosen the end cap lock, and unscrew the end cap from the electronics side of the Transmitter housing.
3. If equipped with a Display module, carefully depress the two tabs on the sides of the Display Module, and pull it off.

4. If necessary, unplug the interface connector from the Communication module. **Do not discard the connector**.
5. Loosen the two retaining screws, and carefully pull the Communication module from the Electronics compartment.

6. Carefully align and connect the Sensor Ribbon Cable to the connector "J4" at the bottom of the Communication module. When installing the Communication module in the next step, be careful not to pinch the Sensor Ribbon Cable.

7. Carefully, insert the Communication module into the Electronics compartment. Ensure that the Sensor Ribbon Cable is not pinched.

8. Tighten the two Communication module retaining screws.

9. Refer to the SmartLine User's Manual to change the FAILSAFE, READ/WRITE configuration settings.

10. If applicable, re-install the Display module as follows:

    d. Orient the display as desired.

    e. Install the Interface Connector in the Display module such that it will mate with the socket for the display in the Communication module.

    f. Carefully line up the display, and snap it into place. Verify that the two tabs on the sides of the display latch.

Orient the Display for proper viewing through the end cap window. You can rotate the meter mounting orientation in 90 º increments.

11. Apply Parker Super O-ring Lubricant or equivalent to the end cap O-ring before installing the end cap. Reinstall the End Cap and tighten the End Cap locking screw.

12. Installing Optional External Configuration Button Assembly.

    d. Loosen (Do Not Remove) both top nameplate screws and pivot nameplate 90°.

    e. Align the protrusion on the button assembly with the matching opening in the housing and snap the button assembly into the housing.

    f. Rotate the nameplate back to the original position, and tighten the nameplate screws.

14.5 Replacing the Meter Body

You can replace the complete meter body, including the process heads, or the meter body only on certain Differential Pressure (DP), Gauge Pressure (GP), and Atmospheric Pressure (AP) Transmitters by using the existing process head(s). Use the following procedure for meter body-only replacement.

1. Save or record device configuration data.
2. Turn off Transmitter power.
3. Remove the Transmitter from service, and move it to a clean area before disassembling it.
4. Refer to Figure 64. Loosen the End Cap Lock, and unscrew the End Cap from the electronics side of the Transmitter housing.

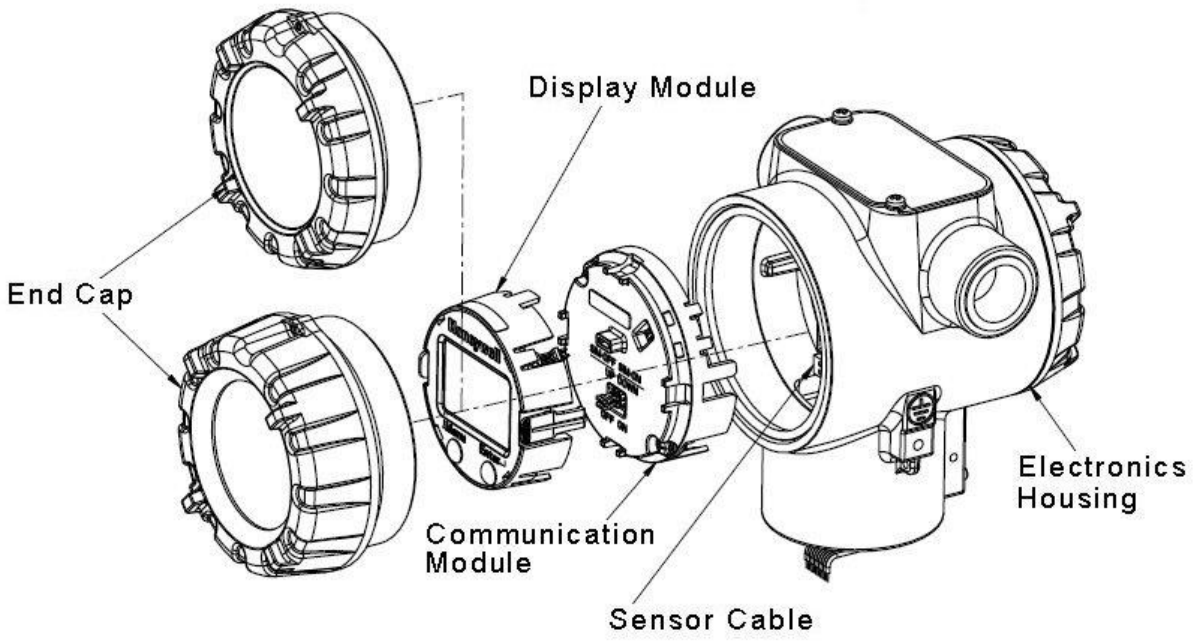


Figure 64 – ST 700 Basic Transmitter - Disassembly for Meter Body Replacement

Please take appropriate steps to avoid ESD damage when handling the Communication and Display Module assemblies

5. If a display is present, press the two snaps along the side, and remove it from the communication module assembly.
   Note: Do not discard or misplace the Display/Communication connector, it will be required to reassemble the Display Module
6. Loosen the two retaining screws, and remove the Communications Module assembly, and remove the Communication Module assembly from the electronics housing.
7. Disconnect the Sensor Cable from the Communications Board.
8. Refer to Figure 66. Use a 2mm hex wrench to completely loosen the set screw on the outside of the housing to permit rotating the meter body.

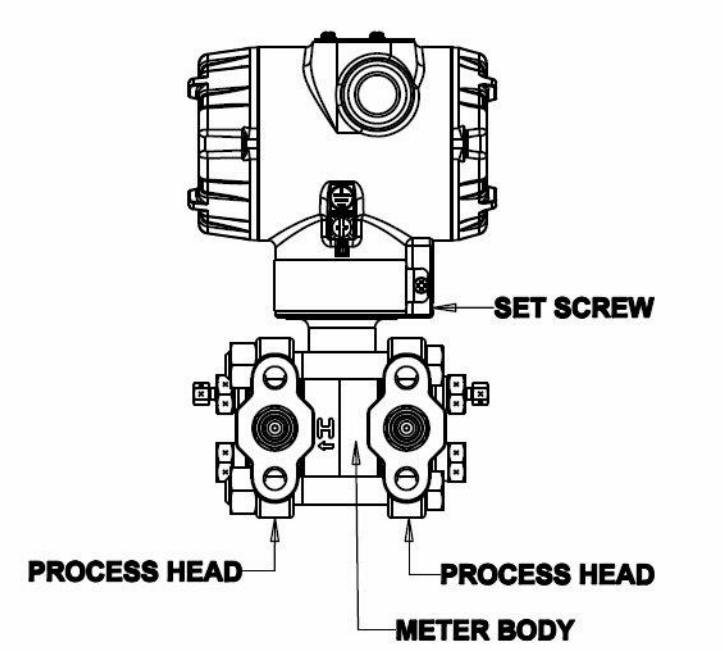


Figure 65 – ST 700 Basic Transmitter - Hardware Location to Remove the Meter Assembly

9. Carefully turn the complete meter body counterclockwise to unscrew it from the electronics housing.
10. Remove the nuts from bolts that hold the process head(s) to the Meter Body.
11. Remove process heads and bolts.
12. Remove the gaskets or O-rings from the process heads.
13. Clean the interior of the process head(s) with a soft bristle brush and suitable solvent.

CAUTION: To prevent damage to the diaphragm in the Meter Body, use extreme care when handling or placing the Meter Body on any surface. Carefully assemble gaskets or O-rings to the meter body. If installing O-rings, lubricate with water or leave dry.

14. Coat threads on process head bolts with anti-seize compound such as "Neverseize" or equivalent.
15. Refer to Figure 66. Apply Dow Corning #33 silicone grease to the meter body adapter O-ring and carefully assemble the O-ring to the meter body. Assemble the process head(s) and bolts to the new meter body. For now, make the bolts only finger-tight.

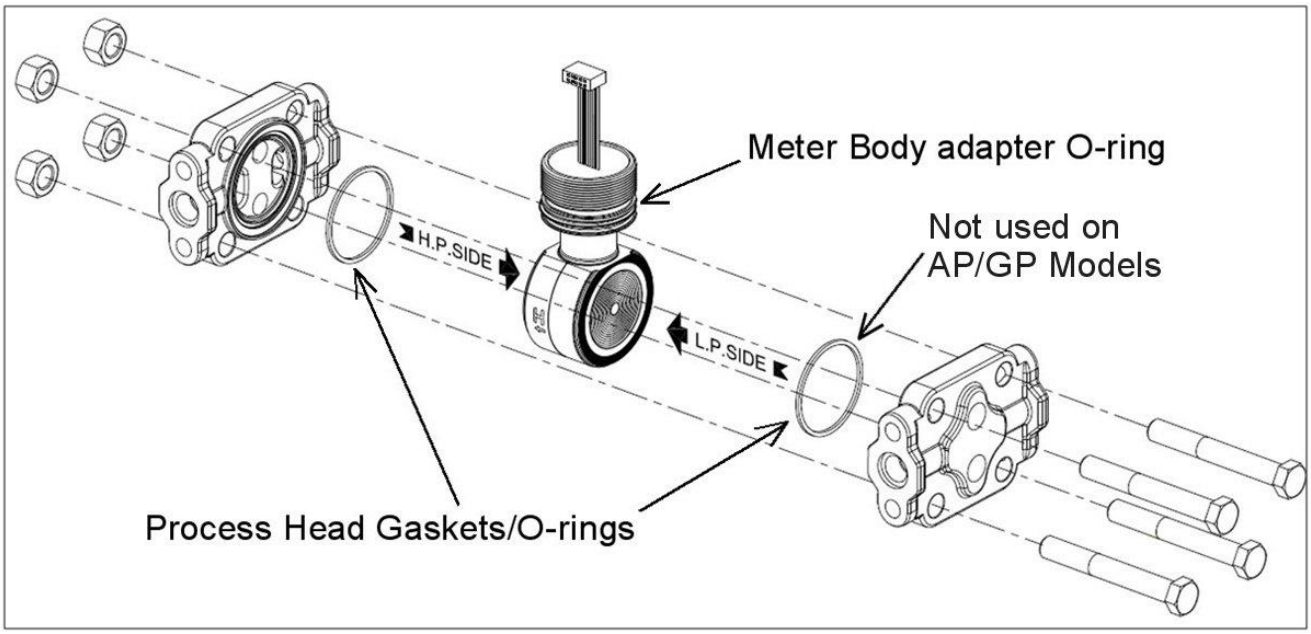


Figure 66 – ST 700 Basic Transmitter - Meter Body Reassembly

16. Use a torque wrench to gradually tighten nuts to torque rating in sequence shown in Figure 67. Tighten head bolts in stages of 1/3 full torque, 2/3 full torque, and then full torque as per Table 39.

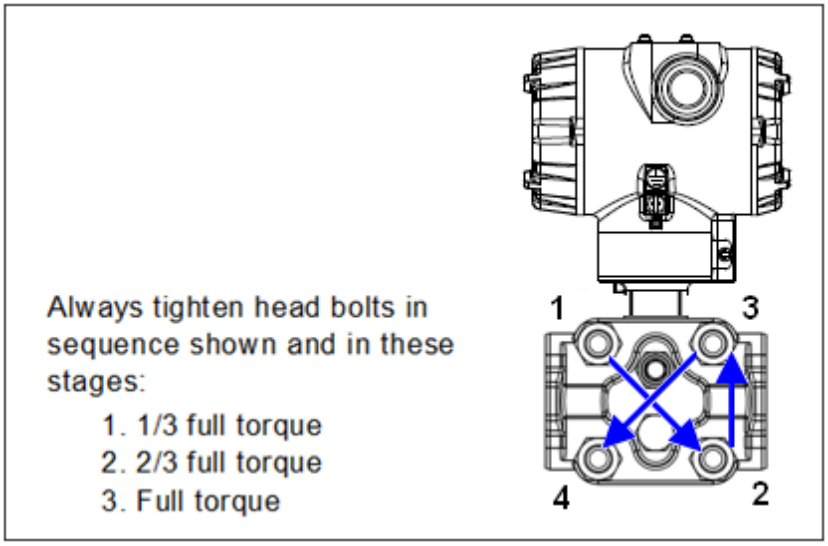


Figure 67 – ST 700 Basic Transmitter - Head Bolt Tightening Sequence

17. Feed the ribbon cable on the new meter body through the neck of the housing.

CAUTION: To prevent damage to the ribbon cable, use care when assembling the Meter Body to the electronics housing.

18. Screw the new meter body into the housing until the bottom of the Meter Body adapter is flush with the neck of the electronics housing.

19. Tighten the outside set screw to be sure it is fully seated in the slot in the header.
20. Loosen the set screw ½- turn.
21. Rotate the housing to the desired position (Max. 180^{o} in either direction), and tighten the set screw.
22. Carefully align and connect the Sensor Ribbon Cable to connector "J4" at the bottom of the Communication module board. When installing the Communication module in the next step, be careful not to pinch the Sensor Ribbon Cable.
23. Carefully, insert the Communication module into the Electronics compartment. Ensure that the Sensor Ribbon Cable is not pinched.
24. Tighten the two Communication module retaining screws.
25. If applicable, re-install the Display module as follows:
    d. Orient the display as desired.
    e. Install the Interface Connector in the Display module such that it will mate with the socket for the display in the Communication module.
    f. Carefully line up the display, and snap it into place. Verify that the two tabs on the sides of the display latch.

Orient the Display for proper viewing through the end cap window.
You can rotate the meter mounting orientation in 90 o increments.

26. Connect the bracket to the Transmitter housing.
27. Recalibrate the Transmitter per section Calibration_ST 700 Basic Transmitter, of this document.
28. Return the Transmitter to service, and turn ON power
29. Verify the Transmitter configuration data. Restore the saved database if necessary.
30. Lubricate the end-cap O-ring with Parker Super O-ring silicone lubricant or equivalent before replacing the end caps.

15. Calibration_ST 700 Basic Transmitter

15.1 Recommendations for Transmitter Calibration

The ST 700 Basic Transmitter does not require periodic calibration to maintain accuracy. Typically, calibration of a process-connected Transmitter will degrade, rather than augment the capability of a smart Transmitter. For this reason, it is recommended that a Transmitter be removed from service before calibration. Moreover, calibration will be accomplished in a controlled, laboratory-type environment, using certified precision equipment.

15.2 Calibration Procedures

For a transmitter operating in analog mode, you must calibrate its output signal measurement range using any compatible hand-held communicator or a local display.

One calibration option is to use the Honeywell Smart Field Communicator (SFC). Refer to the *Smart Field Communicator Operating Guide,* Document # 34-ST-11-14 for calibration procedures.

Calibration information and procedures for a Transmitter operating in the HART/DE mode are provided in the *ST 700 Series HART/DE Option User's Manual*, Document # 34-25-25-47.

16. Troubleshooting_ST 700 Basic Transmitter

16.1 Overview

Troubleshooting involves responding to error messages, primarily displayed by the MC Toolkit. Error messages that may occur on the Transmitter's local display are fairly self-explanatory and intuitive. However, this section covers the diagnostic messages that indicate critical conditions. Other than the critical conditions, additional detail is not provided. If you require assistance, contact your distributor or Honeywell Technical Support. All other messages are covered by the MC Toolkit Users' Manual.

16.2 Critical Diagnostics Screens

The Standard Display will display the fault message on the top line of the LCD .

16.2.1 Fault Conditions and Recommended Corrective Actions – Standard Display

The Standard Display will display the message FAULT on the top line of the LCD and the appropriate diagnostic text on the lower line.

Table 40 – ST 700 Basic Transmitter - Fault Conditions and Recommended Corrective Actions.

Condtion	Analysis	Recommended Corrective Action
Mbd Com (Meter body Comm fault)	Communications between the Meter body and the Electronics Module has failed.	Check the ribbon cable that connects the Meter body to the Electronics Module. Ensure that the cable is securely plugged into the Electronics Module. Ensure that all pins are plugged into the connector (e.g. ensure that the connector is not offset in a way that leaves some pins unconnected). Cycle power to the transmitter. If the problem continues to occur replace the Electronics Module. If this does not fix the problem, replace the Meter body.
Comm El (Communication Board fault)	A critical failure has been detected on the HART Electronics Module.	Cycle power to the transmitter. If the problem continues to occur replace the Electronics Module.
Mtrbody (Sensor Board Fault)	A critical failure has been detected in the Meter body	Cycle power to the transmitter. If the problem continues to occur replace the Electronics Module.

17. Parts List_ST 700 Basic Transmitter

17.1 Overview

Individually saleable parts for the various Transmitter models are listed in this section. Some parts are illustrated for identification. Parts are identified and listed in the corresponding tables as follows:

- Individually saleable parts are indicated in each figure by key number callout.
- Parts that are supplied in kits are indicated in each illustration by key number callout with the letter K prefix.

Table 41 is a list of recommended spare parts.

Table 41 – ST 700 Basic Transmitter - Summary List of Recommended Spare Parts

Part Number	Description	Figure No.	Key No.	1-10 Units	10-100 Units	100-1000 Units
Electronics Assembly						
50129828-501 50129828-502	HART Comm Assembly without external 2 button support HART Comm Assembly with external 2 button support	Figure 69	5	1	1-2	2-4
51452865-201 51452865-202 51452865-203 51462865-204	Meter Body Seal kit (includes O-rings) Glass Filled PTFE VITON 100% PTFE GRAPHITE	Figure 72	K1	1	1-2	2-4
50129832-501 50129832-502	HART Terminal Block Assy Without Lightning Protection HART Terminal Block Assy With Lightning Protection	Figure 69	3	1	1-2	2-4

Process head gasket kit		Figure No.	Key No.	1-10 Units	10-100 Units	100-1000 Units
51452868-501	Gasket only, Process Head (12 PTFE packs)	Figure 72	Ka	12	12-24	24-48
51452868-502	Gasket only, Process Head (6 Viton Head O'Rings)			6	6-12	12-24
51452868-507	Gasket only, Process Head Graphite Gasket (replacement only for existing graphite gasket)			6	6-12	12-24
Meter Body						
Specify complete model number from nameplate	DP Models GP/AP HEAD Models LGP/LAP Models Flush Mount Models Flange Mount Models	Figure 71		1	1-2	2-4

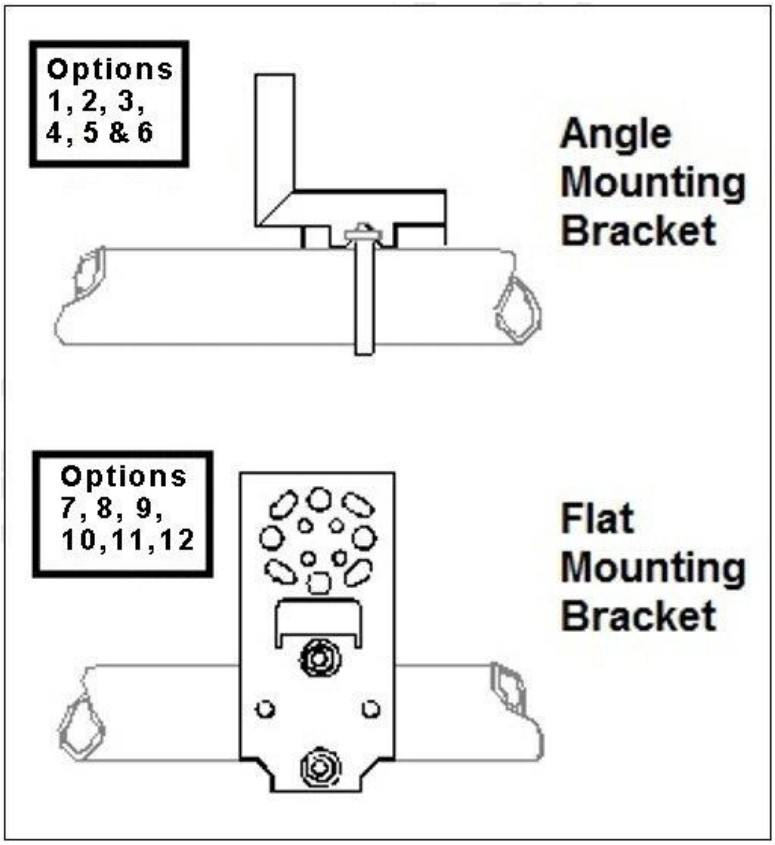


Figure 68 – ST 700 Basic Transmitter - Angle and Flat Bracket Parts (refer to Table 42)

Table 42 – ST 700 Basic Transmitter - Angle and Flat Bracket Parts

(Refer to Figure 68)

Key No.	Part Number	Description	Quantity Per Unit
1	50132311-511	Carbon Steel Angle Bracket for all models **except** In-line and Flush mount transmitters (CHINA MARKET ONLY)	1
2	50132311-521	Carbon Steel Angle Bracket for all In-line and Flush mount transmitters (CHINA MARKET ONLY)	1
3	51196557-001	Carbon Steel Flat Bracket Mounting kit for all models **except** In-line and Flush mount transmitters	1
4	51196557-002	Carbon Steel Flat Bracket Mounting kit for all In-line transmitters and Flush mount transmitters	1
5	30752770-103	SS 304 Angle Bracket Mounting kit for all models **except** In-line and Flush mount transmitters	1
6	30752770-104	SS 304 Angle Bracket Mounting kit for all In-Line and Flush mount transmitters	1
7	51196557-005	SS 304 Flat Bracket Mounting kit for all models **except** In-line and Flush mount transmitters	1
8	51196557-006	SS 304 Flat Bracket Mounting kit for all In-line transmitters and Flush mount transmitters	1
9	50132311-513	SS 316 Angle Bracket Mounting kit for all In-line transmitters and Flush mount transmitters (CHINA MARKET ONLY)	1
10	50132311-523	SS 316 Angle Bracket Mounting kit for all models **except** In-line and Flush mount transmitters (CHINA MARKET ONLY)	1
11	51196557-008	SS 316 Flat Bracket Mounting kit for all In-line transmitters **except** In-Line and Flush mount transmitters	1
12	51196557-009	SS 316 Flat Bracket Mounting kit for all In-Line and Flush mount transmitters	1
1	50132311-511	Carbon Steel Angle Bracket for all models **except** In-line and Flush mount transmitters (CHINA MARKET ONLY)	1
2	50132311-521	Carbon Steel Angle Bracket for all In-line and Flush mount transmitters (CHINA MARKET ONLY)	1

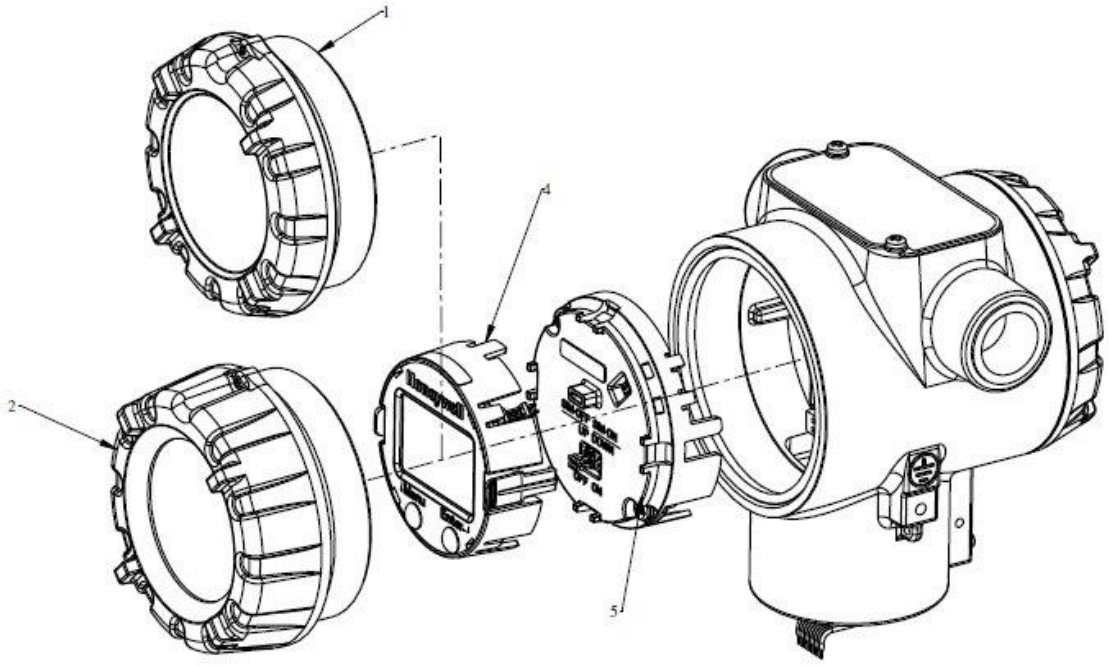


Figure 69 – ST 700 Basic Transmitter - Electronic Housing, Display End

Table 43 – ST 700 Basic Transmitter - Major Assemblies

(Refer to Figure 69, Figure 70 and Figure 72)

Key No.	Part Number	Description	Quantity Per Unit
1	50049858-501 50049858-521	End Cap (Aluminum) End Cap (Stainless Steel)	1
2	50049832-501 50049832-521	End Cap, Display (Aluminum) End Cap, Display (Stainless Steel)	1
3	50129832-501 50129832-502	Terminal Assy HART without Lightning protection Terminal Assy HART with Lightning protection	1
4	50049911-501 50126003-501	Basic Display Standard Display	1
5	50129828-501 50129828-502	HART Electronics Module Assembly (PWA) without MR sensor HART Electronics Module Assembly (PWA) with MR sensor	1
6	50131077-501	External Zero, Span & Config Buttons (2- button Assembly)	1
K1	30757503-005	Electronics housing seals kit (includes O-rings)	2

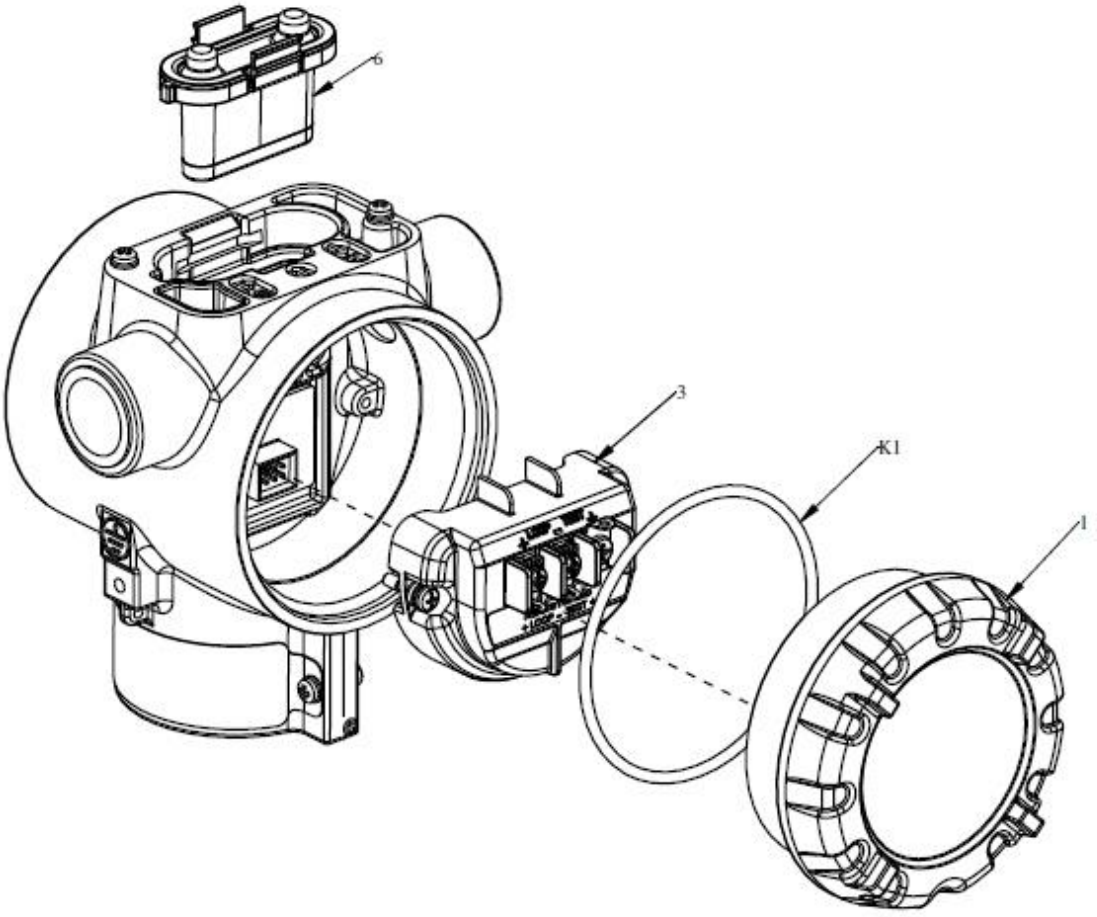


Figure 70 – ST 700 Basic Transmitter - Electronic Housing, Terminal Block End

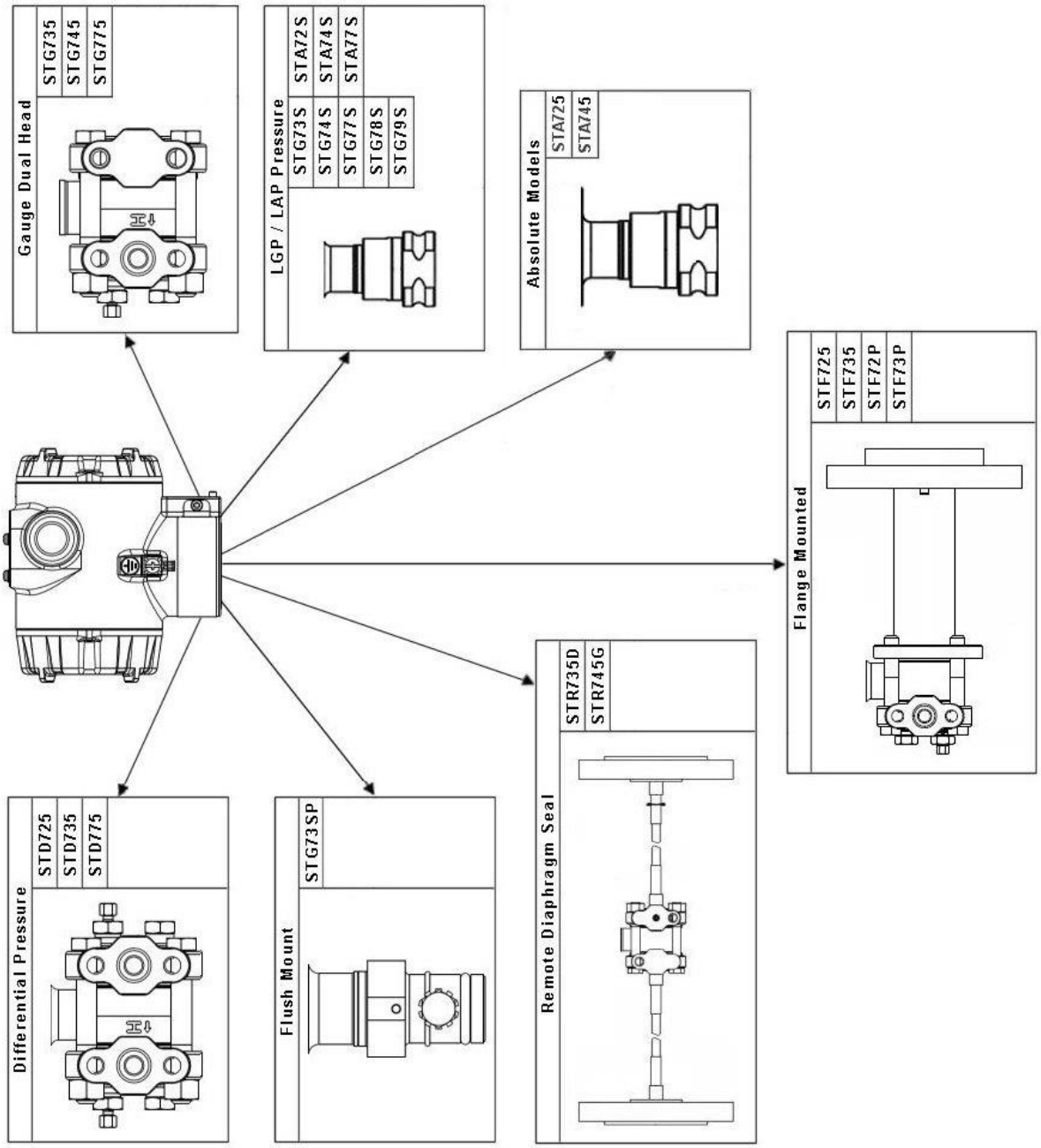


Figure 71 – ST 700 Basic Transmitter - Major Assemblies

Table 44 – ST 700 Basic Transmitter Models STD720, 725, 730, 735, 770, 775 & STG774

(Refer to Figure 72)

Key No.	Part Number	Description	Qty/ Unit
		Vent and Plug Kits	
	30753785-001 30753787-001 30753786-001	Drain and Plug Kit, stainless steel Drain and Plug Kit, Monel Drain and Plug Kit, Hastelloy C **Each Drain and Plug Kit includes:**	
K1		Pipe Plug	4
K2		Vent Plug	2
K3		Vent Bushing	2
		Meter Body Gasket Kits	
	 51452865-201 51452865-202 51452865-203 51452865-204	Each Meter Body Gasket Kit includes: Glass Filled PTFE VITON 100% PTFE GRAPHITE	
K6		Gasket, Process Head	6
Ka		Gasket, Flange Adapter	6
K7		O-Ring, Meter Body to Electronics Housing	3
		K7 Process Head Gasket Kits	
K6 K6 K6	51452868-501 51452868-502 51452868-507	Gasket only, Process Head (12 PTFE Gaskets/pack) Gasket only, Process Head (6 Viton Head O-Rings) Gasket only, Process Head Graphite Gasket (use only as replacement of existing graphite gasket)	12 6 6
		Flange Adapter Gasket Kits	
Ka Ka Ka	51452868-504 51452868-505 51452868-508	Gasket only, Flange Adapter, 6 PTFE Adapter Gaskets Gasket only, Flange Adapter, 6 VITON Adapter O-Rings Gasket only, Flange Adapter Graphite Gasket (use only as replacement of existing graphite gasket)	6 6 6
		½-inch NPT Flange Adapter Kits	
	 51452867-110 51452867-210 51452867-310 51452867-410 51452867-150 51452867-350 51452867-130 51452867-330	Flange Adapter Kit, with: SS Flange Adapters and with carbon steel bolts SS Flange Adapters and with A286 SS (NACE) bolts SS Flange Adapters and with 316 SS (non-NACE) bolts SS Flange Adapters and with B7M alloy steel bolts Monel Flange Adapters and with carbon steel bolts Monel Flange Adapters and with 316 SS (non-NACE) bolts Hastelloy C Flange Adapters and with carbon steel bolts Hastelloy C Flange Adapters and with 316 SS (non-NACE) bolts	
		Each ½-inch NPT Flange Adapter Kit includes:	
Ka		Gasket, Flange Adapter	2
Kb		½-inch NPT Flange Adapter	2
Kc		Bolt, hex head, 7/16-20 UNF, 1.50 inches long	4

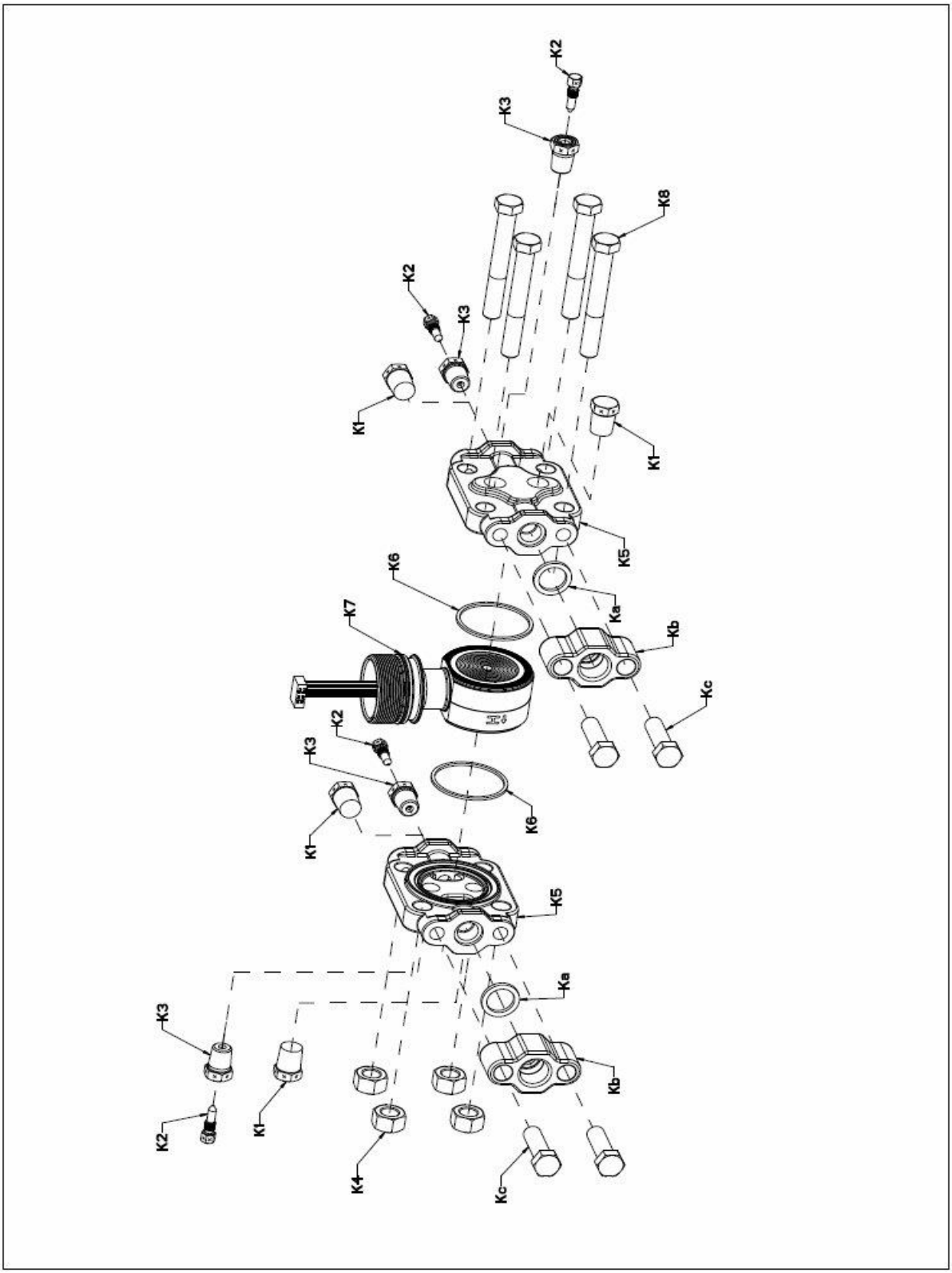


Figure 72 - ST 700 Basic Transmitter Models STD725, 735, 775

(Refer to

Table 44)

Table 45 – ST 700 Basic Transmitter - Parts for STG725, 735, 745, 775, 745 Transmitter Body

(Refer to Figure 73)

Key No.	Part Number	Description	Qty/Unit
Process Head Assembly Kits with PTFE Gaskets			
	51452864-010 51452864-012 51452864-020 51452864-022 51452864-030 51452864-032	Carbon steel head (zinc plated) without side vent/drain Carbon steel head (zinc plated) with side vent/drain Stainless steel head without side vent/drain Stainless steel head with side vent/drain Hastelloy C head without side vent/drain Hastelloy C head with side vent/drain	
Process Head Assembly Kits with Viton® or Fluorocarbon Elastomer Gaskets			
	51452864-110 51452864-112 51452864-120 51452864-122 51452864-130 51452864-132	Carbon steel head (zinc plated) without side vent/drain Carbon steel head (zinc plated) with side vent/drain Stainless steel head without side vent/drain Stainless steel head with side vent/drain Hastelloy C head without side vent/drain Hastelloy C head with side vent/drain	
Each process head assembly kit includes:			
K1		Pipe Plug (See notes 1 & 2)	1
K2		Vent Plug (See note 1)	1
K3		Vent Bushing (See note 1.)	1
K5		Process Head	1
K6		Gasket (PTFE), Process Head	1
Ka		Gasket (PTFE), Flange Adapter	1
	Notes		
	Note 1: This item is made of the same material as the Process Heads, except for Kits with carbon steel Process Heads, which include stainless steel Pipe Plug, Vent Plug, and Vent Bushing. Note 2: The Kit for Process Heads without side vent/drain does not include Pipe Plugs (K1).		
Reference Head			
K9 K9	51452951-201 51452951-101	Carbon Steel Blind Reference Head 316 SS Blind Reference Head	1 1

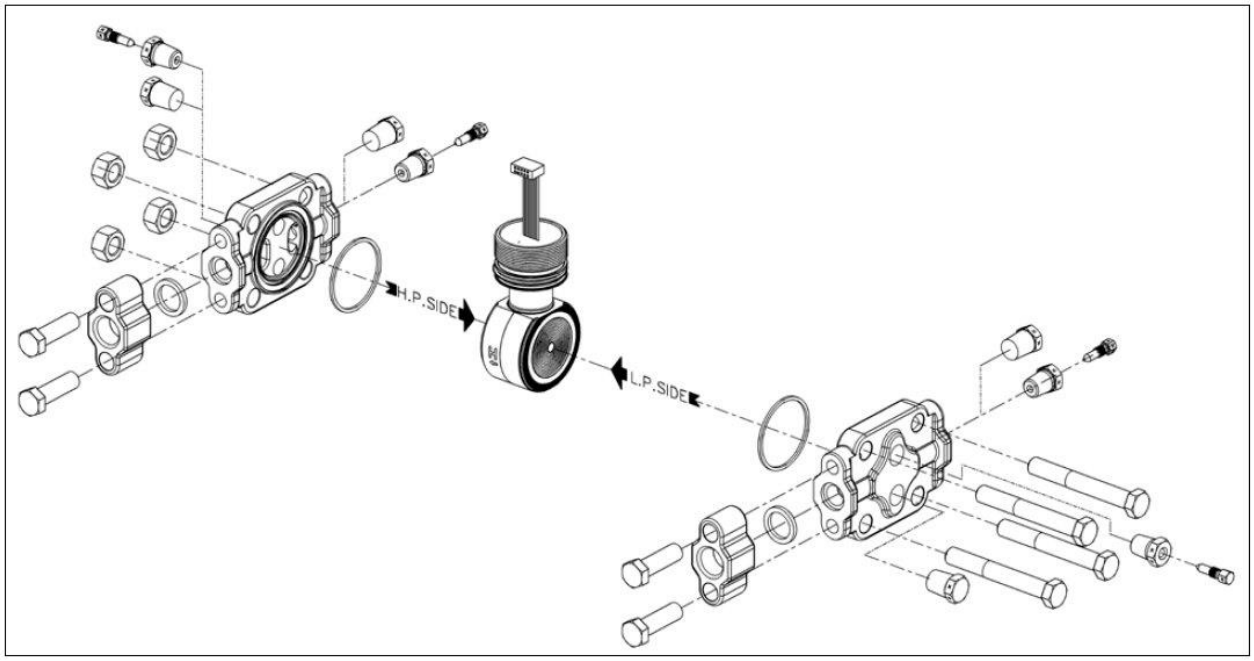


Figure 73 – ST 700 Basic Transmitter - STG730, 735, 740, 745, 770, 775 and STA722, 725, 745 Transmitter Body

Table 46 - ST 700 Basic Transmitter - Inline Gauge and Inline Atmospheric Meter Body Parts

(Figure 74)

Key No.	Part Number	Description	Qty/Unit
	Specify complete model number from nameplate	ST Series replacement meter body (LAP/LGP model)	1

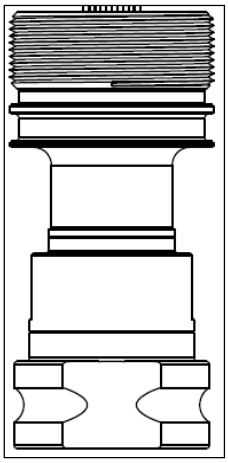


Figure 74 – ST 700 Basic Transmitter - Inline Gauge and Inline Atmospheric Meter Body Bodies

Table 47 – ST 700 Basic Transmitter - Flange-Mounted Meter Body Parts

(Refer to Figure 75 and Figure 76)

Key No.	Part Number	Description	Qty/Unit
1	Specify complete model number from nameplate	ST Series 700 replacement meter body	1
	30749372-005	O-ring seal	1
	30749372-001	O-ring seal	1
Optional Flange Adapter - Not Shown			
	30754419-006	Flange adapter kit (st. steel flange adapter with carbon steel bolts)	
	30754419-022	Flange adapter kit (st. steel flange adapter with 316 st. steel bolts)	
		Bolt, hex head, 7/16-20 UNF, 1.375 inches lg.	2
		Flange adapter	1
		Gasket	1
		Filter screen	1
	30754419-007	Flange adapter kit (Hastelloy C flange adapter with carbon steel bolts)	
	30754419-023	Flange adapter kit (Hastelloy C flange adapter with 316 st. steel bolts)	
		Bolt, hex head, 7/16-20 UNF, 1.375 inches lg.	2
		Flange adapter	1
		Gasket	1
	30757503-005	Housing seal kit	1

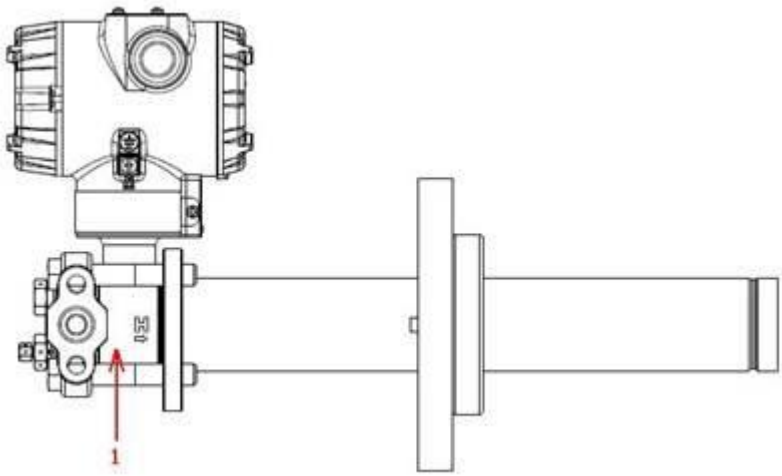


Figure 75 – ST 700 Basic Transmitter - Extended Flange Design

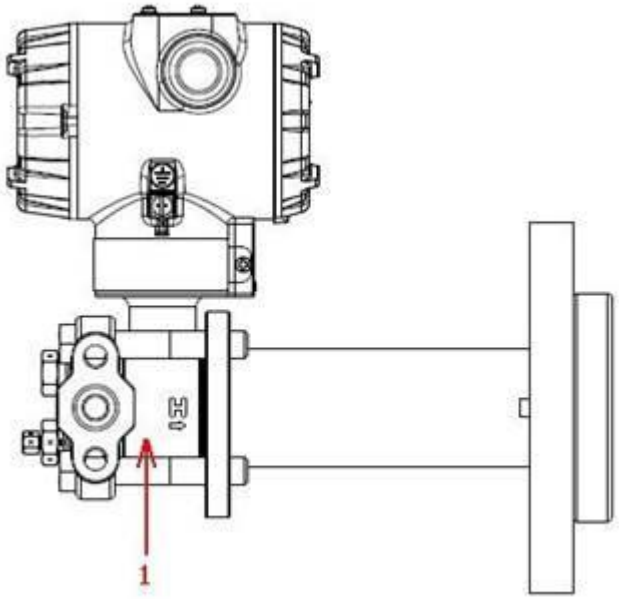


Figure 76 - ST 700 Basic Transmitter - Flush Flange Design

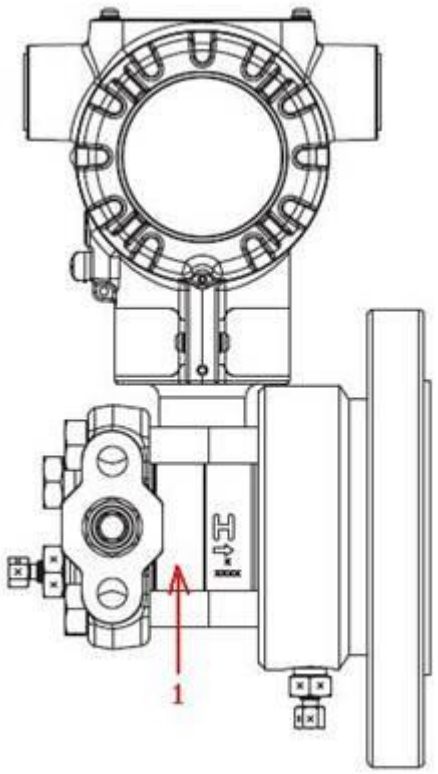


Figure 77 - ST 700 Basic Transmitter - Pseudo Flange Design

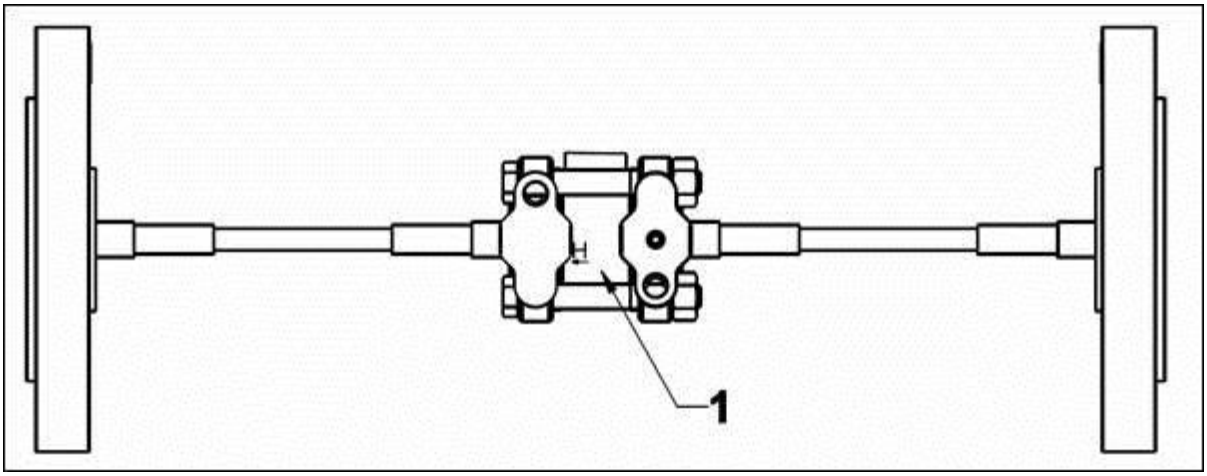


Figure 78 – ST 700 Basic Transmitter - Remote Seal Diaphragm

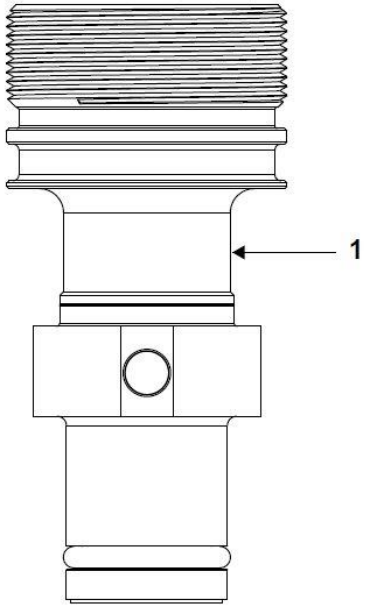


Figure 79 - ST 700 Basic Transmitter - Series 700 Flush Mount Meter Body.

Table 48 – ST 700 Basic Transmitter - Flush Mount Meter Body Parts

(Refer to Figure 79**)**

Key No.	Part Number	Description	Qty/Unit
1	Specify complete model number from nameplate	Replacement meter body (Flush Mount model)	1
	30756445-508	Gasket Kit (0-rings)	
	51204496-001	316L SS Mounting Sleeve Kit	
	51204497-001	Calibration Sleeve Kit	

Appendix A - PRODUCT CERTIFICATIONS for the ST 700 Standard and Basic Transmitter

A.1 Safety Instrumented Systems (SIS) Installations

For Safety Certified Installations, please refer to the ST 800 and ST 700 Safety Manual 34-ST-25-37 for installation procedure and system requirements.

SIL 2/3 Certification	IEC 61508 SIL 2 for non-redundant use and SIL 3 for redundant use under the following standards: IEC61508-1: 2010; IEC 61508-2: 2010; IEC61508-3: 2010.

A.2 European Directive Information (CE Mark)

CE Honeywell

50080030
Revision: Q

EU DECLARATION OF CONFORMITY

We,
Honeywell International Inc.
Honeywell Field Solutions
512 Virginia Drive
Fort Washington, PA 19034 USA

declare under our sole responsibility that the following products,

ST 800 – Smart Series Pressure Transmitter
And
ST 700- Smart Series Pressure Transmitter

to which this declaration relates, is in conformity with the provisions of the European Community Directives, including the latest amendments, as shown in the attached schedule.

Assumption of conformity is based on the application of the harmonized standards and when applicable or required, a European Community notified body certification, as shown in the attached schedule.

The authorized signatory to this declaration, on behalf of the manufacturer, and the Responsible Person is identified below.

Owen J. Murphy
Product Safety & Approvals Engineering
Issue Date: 2 December 2016
Fort Washington, PA 19034, USA

SCHEDULE
50080030
Revision: Q

EMC Directive (2014/30/EU)

EN 61326-1:2013	Electrical Equipment for Measurement, Control and Laboratory Use – EMC Requirements.
IEC 61326-3-1:2008	Electrical Equipment for Measurement, Control and Laboratory Use- Part 3-1: Immunity Requirements for safety related systems and equipment intended to perform safety-related functions.

Summary of Tests Performed:

PORT	TEST	STANDARD	CRITERIA (IEC 61326-1)	CRITERIA (IEC 61326-3-1)	RESULTS
Enclosure	Radiated Emission	CISPR 11	Group1, Class A 30 – 230 MHz: 40 dB 230 – 1000 MHz: 47 dB	Group1, Class A 30 – 230 MHz: 40 dB 230 – 1000 MHz: 47 dB	PASS
	ESD Immunity	IEC61000-4-2	+/- 4KV Contact +/- 8KV Air	+/- 6KV Contact +/- 8KV Air	PASS
	EM Field- RF Radiated Susceptibility	IEC61000-4-3	10 V/m- 80 MHz to 1GHz 3 V/m - 1.4 GHz to 2.0 GHz 1 V/m- 2.0 GHz to 2.7 GHz	20 V/m- 80MHz to 1GHz 10 V/m - 1.4GHz to 2.0 GHz 3 V/m- 2.0GHz to 2.7GHz	PASS PASS PASS
	50Hz/60Hz Magnetic Field Immunity	IEC 6100-4-8	30 A/m	30 A/m	N/A 1
DC Power	EFT(B) Immunity	IEC61000-4-4	+/- 1KV	+/- 2KV	PASS
	Surge Immunity	IEC61000-4-5	+/- 1KV	+/- 2KV	PASS
	RF Conducted Susceptibility	IEC61000-4-6	3V	3 V Except the following: 10 V 3.39 to 3.410MHz 10 V 6.765 to 6.795MHz 10 V 13.553 to 13.567MHz 10 V 26.957 to 27.283MHz 10 V 40.66 to 40.70MHz	PASS
I/O Signal/ Control (Including Earth Lines)	EFT(Burst) Immunity	IEC61000-4-4	+/- 1KV	+/- 2KV	2
	Surge Immunity	IEC61000-4-5	+/- 1KV	+/- 2KV	2
	RF Conducted Susceptibility	IEC61000-4-6	3V	3 V Except the following: 10 V 3.39 to 3.410MHz	2

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PORT	TEST	STANDARD	CRITERIA (IEC 61326-1)	CRITERIA (IEC 61326-3-1)	RESULTS
				10 V 6.765 to 6.795MHz 10 V 13.553 to 13.567MHz 10 V 26.957 to 27.283MHz 10 V 40.66 to 40.70MHz	
AC Power	Voltage Dip	IEC61000-4-11	0% during 1 Cycle 40% during 10-12 Cycles 70% during 25-30 Cycles		N/A[3]
	Short Interruptions	IEC61000-4-11	0% during 250-300 Cycles		N/A[3]
	EFT(Burst) Immunity	IEC61000-4-4	2KV		N/A[3]
	Surge Immunity	IEC61000-4-5	1KV/ 2KV		N/A[3]
	RF Conducted Susceptibility	IEC61000-4-6	3V		N/A[3]

1. There is no magnetic sensitive circuitry.
2. Done as part of the DC Power Testing.
3. Product is DC Powered.

SCHEDULE
50080030
Revision: Q

ATEX Directive (2014/34/EU)

EC-Type Examination Certificate No: FM12ATEX0029X Protection : Flameproof and Dust
Equipment Group II Category 1/ 2 G and Group II Caegrory 2 D
Ex db IIC T5 Ga/Gb (Ta= -50°C TO 85°C)
Ex db IIC T6 Ga/Gb (Ta= -50°C TO 65°C)
Ex tb IIIC T95°C Db (Ta= -50°C TO 85°C)

Standards:
EN 60079-0: 2012+A11 : 2013 EN 60079-1: 2014
EN 60079-26: 2015 EN 60079-31: 2014 EN 60529: 1991 + A1:2000

EC-Type Examination Certificate No: Sira12ATEX2233X Protection: Intrinsically Safe
Equipment Group II Category 1 G
Ex ia IIC T4 Ga (Ta= -50°C TO 70°C)
Ex ia IIC T4 Ga (Ta= -50°C TO 70°C)
FISCO Field Device

Standards:
EN 60079-0: 2012+A11 : 2013 EN 60079-11: 2012

Type Examination Certificate No: Sira12ATEX4234X Protection : Non Sparking
Equipment Group II Category 3 G
Ex nA IIC T4 Gc (Ta= -50°C TO 70°C)
Ex ic IIC T4 Ga (Ta= -50°C TO 70°C)
FISCO Field Device

Standards:
EN 60079-0: 2012+A11 : 2013 EN 60079-11: 2012
EN 60079-15: 2010

ATEX Notified Body for EC Type Certificates

FM Approvals Ltd. [Notified Body Number: 1725]
1 Windsor Dials,
Windsor, Berkshire, SL4 1RS
England

Sira Certifcation Service [Notified Body Number: 0518]
Unit 6, Hawarden Industrial Park,
Hawarden, CH5 3US
United Kingdom

ATEX Notified Body for Quality Assurance

DEKRA Certification B.V. [Notified Body Number: 0344]
Meander 1051
6825 MJ Arnhem
The Netherlands

SCHEDULE
50080030
Revision: Q

Pressure Equipment Directive (PED) (2014/68/EU)

ASME Boiler and Pressure Vessel Code Section VIII 'Rules for Construction of Pressure Vessels: 2000

Pressure Transmitter	PED Module
Absolute Pressure	
STA822/ STA722/ STA725	Sound Engineering Practice (SEP)
STA 82L/ STA72L/ STA72S	
STA 840/ STA740/ STA745	
STA 84L/ STA74L/ STA74S	
STA87L/ STA77L/ STA77S	Module A
Differential Pressure	
STD 810	Module A
STD820/ STD720/ STD725	
STD825	
STD830/ STD730/ STD735	
STD870/ STD770/ STD775	
Gauge Pressure	
STG830/ STG730/ STG735	Sound Engineering Practice (SEP)
STG840/ STG740/ STG745	
STG83L/ STG73L/ STG73S	
STG84L/ STG74L/ STG74S	
STG870/ STG770/ STG77S	Module A
STG87L/ STG77L/ STG78S	
STG88L/ STG78L/ STG78S	
STG89L/ STG79L/ STG79S	
Flange Mounted	
STF828/ STF728/ STF725	Sound Engineering Practice (SEP)
STF832/ STF732/ STF735	
STF82F/ STF72F/ STF72P	
STF83F/ STF73F/ STF72P	
Remote Diaphragm	
STR82D/ STR73D/ STR735D	Sound Engineering Practice (SEP)
STR83D	
STR84G/ STR74G/ STR745G	
STR87G	
STR84A	

SCHEDULE
50080030
Revision: Q

Measuring Instruments Directive (MID) (2014/32/EU)

NMI Evaluation Certificate: TC7948

Model	Range
STA 84L	1 to 35 Bara
STA87L	1 to 100 Bara
STG 84L	1 to 35 Barg
STG87L	1 to 100 Barg
STD 820	0 to 1Barg
STD830	0 to 7 Barg
STD870	0 to 100 Barg

WELMEC Guide 8.8 OIML R117-1: 2007(E) EN 12405-1/A1: 2006

MID Notified Body for Parts Certificates

NMi Certin B.V.
Hugo de Grootplein 1
3300 AJ Dordrecht
The Netherlands

A3. Hazardous Locations Certifications

MSG CODE	AGENCY	TYPE OF PROTECTION	COMM OPTION	Electrical Parameters	Ambient Temperature
A	FM-USA	**Explosion proof:** Class I, Division 1, Groups A, B, C, D **Dust Ignition Proof:** Class II, III, Division 1, Groups E, F, G Class I, Zone 0/1, AEx db IIC Ga/Gb Class II, Zone 21, AEx tb IIIC T 95°C Db	DE/HART /FF	Note 1	T5: -50 °C to 85°C T6: -50 °C to 65°C
		Intrinsically Safe: Class I, II, III, Division 1, Groups A, B, C, D, E, F, G Class I Zone 0 AEx ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC Ga	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non-Incendive Class I, Division 2, Groups A, B, C, D Class I Zone 2 AEx nA IIC Gc Class I Zone 2 AEx ic IIC Gc	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Enclosure: Type 4X/ IP66/ IP67	ALL	ALL	ALL
		Standards: FM 3600:2011; ANSI/ ISA 60079-0: 2009 FM 3615:2006; ANSI/ ISA 60079-1 : 2009 FM 3616 : 2011 ; ANSI/ ISA 60079-31 : 2009 FM 3610:2010; ANSI/ ISA 60079-11 : 2011 FM 3810 : 2005 ; ANSI/ ISA 60079-26 : 2008 FM 3611:2004; ANSI/ ISA 60079-15 : 2009 ; FM 3810 : 2005 ; NEMA 250 : 2003 ; ANSI/ IEC 60529 : 2004			
B	CSA-Canada	**Explosion proof:** Class I, Division 1, Groups A, B, C, D **Dust Ignition Proof:** Class II, III, Division 1, Groups E, F, G Zone 0/1, Ex db IIC Ga/Gb Ex tb IIIC T 95°C Db	DE/HART /FF	Note 1	T5: -50 °C to 85°C T6: -50 °C to 65°C
		Intrinsically Safe: Class I, II, III, Division 1, Groups A, B, C, D, E, F, G; Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC Ga	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non-Incendive Class I, Division 2, Groups A, B, C, D Ex nA IIC Gc Ex ic IIC Gc	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Enclosure: Type 4X/ IP66/ IP67	ALL	ALL	ALL

MSG CODE	AGENCY	TYPE OF PROTECTION	COMM OPTION	Electrical Parameters	Ambient Temperature
		Standards: ANSI/ ISA 60079-0: 2009 ; CAN/ CSA-C22.2 No. 0-M91:2006; CAN/ CSAE60079-0:2002; ANSI/ UL 913 : 2010 ; ANSI/ ISA 60079-11 : 2009; CAN/ CSA-C22.2 No.157-92: 1992; CAN/CSA-E 60079-11: 2002; ANSI/ ISA 60079-26 : 2008; ANSI/ ISA 12.12.01 : 2007 ; ANSI/ ISA 60079-15 : 2009 ; C22.2 No. 213-M1987; CAN/CSA-E60079-15: 2002; ANSI/ UL 50 : 2007 ; ANSI/ IEC 60529 : 2004			
C	ATEX	**Flameproof:** FM12ATEX0029X II 1/2 G Ex d IIC Ga/Gb II 2 D Ex tb IIIC T 95°C Db	DE/HART /FF	Note 1	T5: -50 °C to 85°C T6: -50 °C to 65°C
		Standards: EN 60079-0: 2012+A11: 2013 EN 60079-1 : 2014 EN 60079-31 : 2014 EN 60079-26 : 2015 EN 60529 : 2000 + A1			
		Intrinsically Safe: **Sira12ATEX2233X** II 1 G Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non Sparking: Sira12ATEX4234X II 3 G Ex nA IIC Gc II 3 G Ex ic IIC Gc	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Standards: EN 60079-0: 2012+A11: 2013 EN 60079-11 : 2012 EN 60079-15 : 2010 IEC 60529 : 2009 with Corr 3			
		Enclosure: IP66/ IP67	ALL	ALL	ALL
D	IECEx	**Intrinsically Safe:** SIRA 12.0100 Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC Ga	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non Sparking: SIRA 12.0100 Ex nA IIC Gc Ex ic IIC Gc	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Standards: IEC 60079-0: 2011 IEC 60079-11 : 2011 IEC 60079-15 : 2011 IEC 60529 : 2009 with Corr 3			
		Flameproof: Ex d IIC Ga/Gb Ex tb IIIC Db T 95°C	DE/HART /FF	Note 1	T5: -50 °C to 85°C T6: -50 °C to 65°C
		Standards: IEC 60079-0: 2011 IEC 60079-1 : 2007 IEC 60079-31 : 2008 IEC 60079-26 : 2006 IEC 60529 : 2009 with Corr 3			
		Enclosure: IP66/ IP67	ALL	ALL	ALL
E	SAEx (South Africa)	**Intrinsically Safe:** Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC Ga	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non Sparking: Ex nA IIC Gc	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Flameproof: Ex d IIC Ga/Gb Ex tb IIIC T 95°C Db	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Enclosure: IP66/ IP67	ALL	ALL	ALL

MSG CODE	AGENCY	TYPE OF PROTECTION	COMM OPTION	Electrical Parameters	Ambient Temperature
F	INMETRO	**Intrinsically Safe:** Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC Ga	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non Sparking: Ex nA IIC Gc	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Flameproof: Ex d IIC Ga/Gb Ex tb IIIC T 95°C Db	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Enclosure: IP66/ IP67	ALL	ALL	ALL
G	NEPSI (CHINA)	**Intrinsically Safe:** Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC Gc	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non Sparking: Ex nA IIC Ga	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Flameproof: 1 Ex d IIC Ga/Gb Ex tb IIIC Db T 95°C Db	All	Note 1	T4: -50 °C to 85°C
		Enclosure: IP66/ IP67	ALL	ALL	ALL
-------	GOST	**Intrinsically Safe:** 0 Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC	DE/ HART/ FF	Note 2	T4: -50 °C to 70°C
		Enclosure : IP 66/67	All	All	

Notes

1. Operating Parameters:

DE/HART	Voltage= 11 to 42 V	Current= 4-20 mA Normal (3.8 – 23 mA Faults)
Foundation Fieldbus	Voltages = 9 to 23 V	Current = 25 mA

2. Intrinsically Safe Entity Parameters

For details see Control Drawing on page 140.

3. Marking ATEX Directive

General:

The following information is provided as part of the labeling of the transmitter:

- Name and Address of the manufacturer
- Notified Body identification: DEKRA Quality B.V., Arnhem, the Netherlands
- For complete model number, see the Model Selection Guide for the particular model of pressure transmitter.
- The serial number of the transmitter is located on the Meter Body data-plate. The first two digits of the serial number identify the year (02) and the second two digits identify the week of the year (23); for example, 0223xxxxxxxx indicates that the product was manufactured in 2002, in the 23 rd week.

Apparatus Marked with Multiple Types of Protection

The user must determine the type of protection required for installation the equipment. The user shall then check the box [ ] adjacent to the type of protection used on the equipment certification nameplate. Once a type of protection has been checked on the nameplate, the equipment shall not then be reinstalled using any of the other certification types.

4. WARNINGS and Cautions:

Intrinsically Safe and Non-Incendive Equipment:
WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR USE IN HAZARDOUS LOCATIONS.
Explosion-Proof/ Flameproof:
WARNING: DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE MAY BE PRESENT
Non-Incendive Equipment:
WARNING: DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE MAYBE PRESENT
WARNING: FOR CONNECTION IN AMBIENTS ABOVE 60ºC USE WIRE RATED 105oC

5. Conditions of Use for Ex Equipment, "Hazardous Location Equipment" or "Schedule of Limitations":

Painted surface of the ST800 may store electrostatic charge and become a source of ignition in applications with a low relative humidity less than approximately30% relative humidity where the painted surface is relatively free of surface contamination such as dirt, dust or oil. Cleaning of the painted surface should only be done with a damp cloth.

Flame-proof Installations: The Transmitter can installed in the boundary wall between an area of EPL Ga/ Class I Zone 0/ Category 1 and the less hazardous area, EPL Gb/ Class I Zone 1/ Category 2. In this configuration, the process connection is installed in EPL Ga/ Class I Zone 0/ Category 1, while the transmitter housing is located in EPL Gb/ Class I Zone 1/ Category 2.

The applicable temperature class, ambient temperature range and maximum process temperature of the equipment is as follows;
T5 for -50°C < Ta < 85°C
T6 for -50°C < Ta < 65°C
Maximum process temperature = 125°C

Consult the manufacturer for dimensional information on the flameproof joints for repair.

The Transmitter can be installed in the boundary wall between an area of Category 1 and the less hazardous area, Category 2. In this configuration, the process connection is installed in Category 1 while the transmitter housing is installed in Category 2.

Intrinsically Safe: Must be installed per drawing 50049892

Division 2: This equipment is suitable for use in a Class I, Division 2, Groups A, B, C, D; T4 or Non-Hazardous Locations Only.

The enclosure is manufactured from low copper aluminum alloy. In rare cases, ignition sources due to impact and friction sparks could occur. This shall be considered during Installation, particularly if equipment is installed a Zone 0 location.
If a charge-generating mechanism is present, the exposed metallic part on the enclosure is capable of storing a level of electrostatic that could become incendive for IIC gases. Therefore, the user/ installer shall implement precautions to prevent the buildup of electrostatic charge, e.g. earthing the metallic part. This is particularly important if equipment is installed a Zone 0 location.

A4. Control Drawing

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PRE REL		
ISS	REVISION & DATE	APPD
G	06/20/2016 ECN 2016-3397	DGG

ST 800/ ST 700 Series Pressure,
ANALOG, HART/DE and FF/ PA Communications

1. Intrinsically safe installation shall be in accordance with
   a. FM (USA): ANSI/NFPA 70, NEC® Articles 504 and 505.
   b. CSA (Canada): Canadian Electrical Code (CEC), part I, section 18.
   c. ATEX: Requirements of EN 60079-14, 12.3 (See also 5.2.4).
   d. IECEx: Requirements of IEC 60079-14, 12.3 (See also 5.2.4).
2. ENTITY approved equipment shall be installed in accordance with the manufacturer's Intrinsic Safety Control Drawing.
3. The Intrinsic Safety ENTITY concept allows the interconnection of two ENTITY Approved Intrinsically safe devices with ENTITY parameters not specifically examined in combination as a system when:

   Uo, Voc, or Vt ≤ Ui or Vmax; Io, Isc, or It ≤ Ii or Imax; Ca or Co ≥ Ci + Ccable, La or Lo ≥ Li + Lcable, Po ≤ Pi. Where two separate barrier channels are required, one dual-channel or two single-channel barriers may be used, where in either case, both channels have been Certified for use together with combined entity parameters that meet the above equations.
4. System Entity Parameters:

   ST 800/ ST 700 Transmitter: Vmax Voc or Uo, Imax Isc or Io;
   ST 800/ ST 700 Transmitter: Ci + Ccable ≤ Control Apparatus Ca,
   ST 800/ ST 700 Transmitter: Li + Lcable ≤ Control Apparatus La.
5. When the electrical parameters of the cable are unknown, the following values may be used:

   Capacitance: 197pF/m (60 pF/ft)
   Inductance: 0.66µH/m (0.020µH/ft).
6. Control equipment that is connected to Associated Equipment must not use or generate more than 250 V.
7. Associated equipment must be FM, CSA ATEX or IECEx (depending on location) listed. Associated equipment may be installed in a Class I, Division 2 or Zone 2 Hazardous (Classified) location if so approved.
8. Non-Galvanically isolated equipment (grounded Zener Barriers) must be connected to a suitable ground electrode per:
   a. FM (USA): NFPA 70, Article 504 and 505. The resistance of the ground path must be less than 1.0 ohm.
   b. CSA (Canada): Canadian Electrical Code (CEC), part I, section 10.
   c. ATEX: Requirements of EN 60079-14, 12.2.4.
   d. IECEx: Requirements of IEC 60079-14, 12.2.4.
9. Intrinsically Safe DIVISION 1/ Zone 0 WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR USE IN HAZARDOUS LOCATIONS.
10. Division 2/ Zone 2: WARNING: DO NOT OPEN WHEN AN EXPLOSIVE GAS ATMOSPHERE IS PRESENT.
11. NO REVISION OF THIS CONTROL DRAWING IS PERMITTED WITHOUT AUTHORIZATION FROM THE AGENCIES listed.
12. For release approvals see ECO # 0094464.

DRAWN	KP	1/9/2015	Honeywell
CHECKED			CONTROL DRAWING ST 800/ ST 700 SERIES PRESSURE TRANSMITTER DIVISIONS 1 & 2 / ZONE 0 & 2
DEV ENG			
MFG ENG			
QA ENG			
TOLERANCE UNLESS NOTED			A/A4 — 50049892
MASTER FILE TYPE: MS WORD	ANGULAR DIMENSION		SCALE: None — USED ON — SH. 1 OF 5

Output Protocol: H=HART or D=DE

All Models of ST800 and the following Models of the ST700: STA722, STA740, STA72L, STA74L, STA77L, STD720, STD730, STD770, STG730, STG740, STG770, STG73L, STG74L, STG77L, STG78L, STG79L, STF724, STF732, STF72F, STF73F, STR73D, STR74G, STR73D, and STR74G

ENTITY PARAMETERS	Associated Apparatus
Ui or Vmax ≤ 30V	Uo, Voc or Vt ≤ 30V
Ii or Imax ≤ 105 mA	Io (Isc or It) ≤ 105 mA
Pi or Pmax = 0.9W	Po ≤ 0.9 W
Ci= 3.9 nF	Ca or Co ≥ C_{cable} + $C_{ST\ 800/\ ST\ 700}$
Li= 984 µH	La or Lo ≥ L_{cable} + $L_{ST\ 800/\ ST\ 700}$

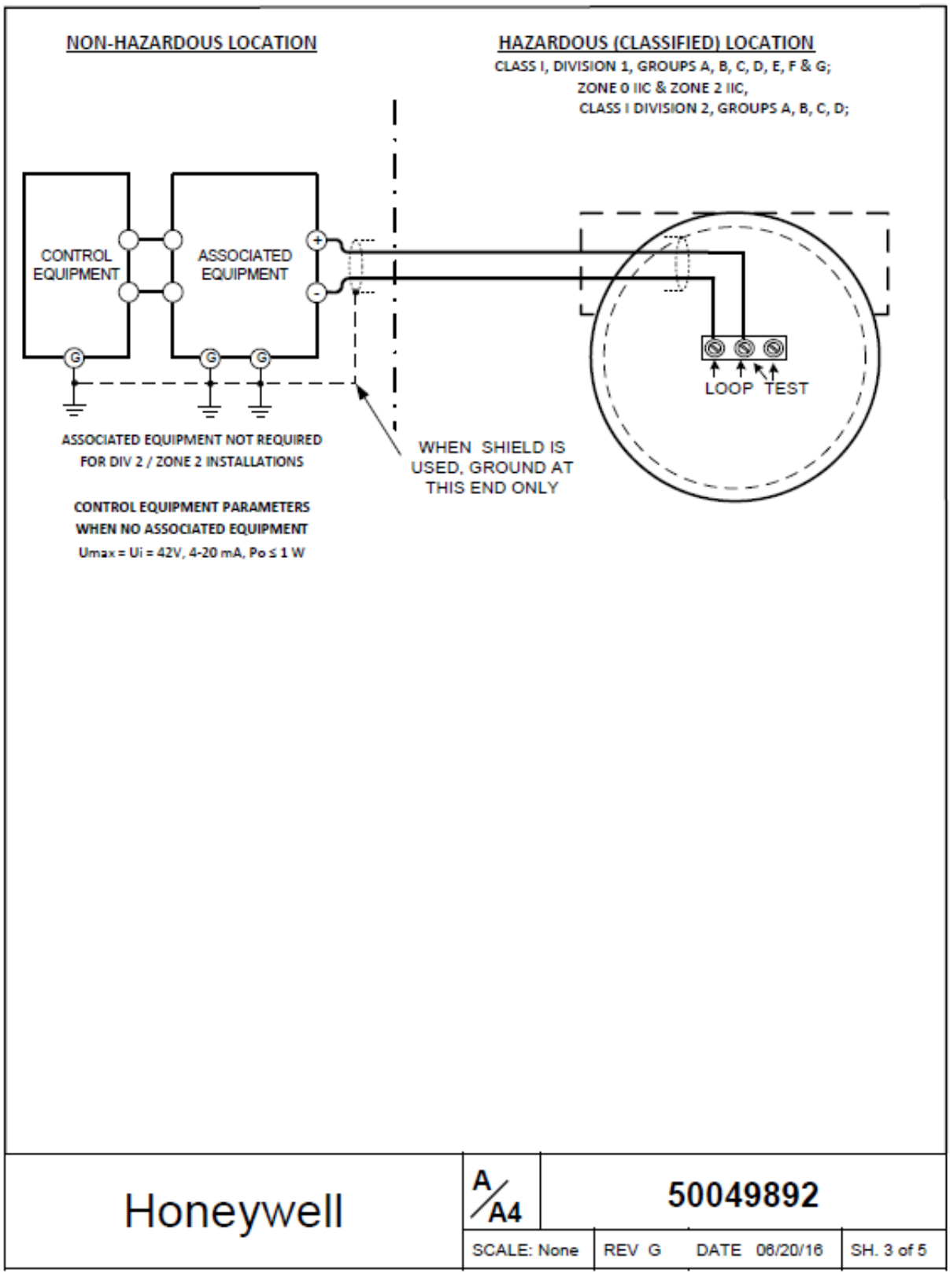
After 9/27/2013 (TERMINAL MODULE REVISION E OR LATER)

NOTE: THE REVISION IS ON THE LABEL THAT IS ON THE MODULE. THERE WILL BE TWO LINES OF TEXT ON THE LABEL:
- FIRST IS THE MODULE PART #: 50049839-001 OR 50049839-002
- SECOND LINE HAS THE SUPPLIER INFORMATION, ALONG WITH THE REVISION: XXXXXXX-EXXXX, THE "X" IS PRODUCTION RELATED, THE POSITION OF THE "E" IS THE REVISION.

Additionally for the ST700 Models: STA725, STA745, STA72S, STA74S, STA77S, STD725, STD735, STD775, STG735, STG745, STG775, STG73S, STG74S, STG77S, STG78S, STG79S, STF725, STF735, STF72P, STF73P, STR735D, and STR745G

ENTITY PARAMETERS (Divisions and Zones Ex ia and Ex ic)	Associated Apparatus
Ui or Vmax ≤ 30V	Uo, Voc or Vt ≤ 30V
Ii or Imax ≤ 225 mA	Io (Isc or It) ≤ 225 mA
Pi or Pmax = 0.9W	Po ≤ 0.9 W
Ci= 3.9 nF	Ca or Co ≥ C_{cable} + $C_{ST\ 800/\ ST\ 700}$
Li= 0 µH	La or Lo ≥ L_{cable} + $L_{ST\ 800/\ ST\ 700}$

Honeywell	A/A4	50049892		
	SCALE: None	REV G	DATE 06/20/16	SH. 2 of 5


NON-HAZARDOUS LOCATION
HAZARDOUS (CLASSIFIED) LOCATION
CLASS I, DIVISION 1, GROUPS A, B, C, D, E, F & G;
ZONE 0 IIC & ZONE 2 IIC,
CLASS I DIVISION 2, GROUPS A, B, C, D;
CONTROL EQUIPMENT
ASSOCIATED EQUIPMENT
+
-
G
G
G
LOOP TEST
ASSOCIATED EQUIPMENT NOT REQUIRED FOR DIV 2 / ZONE 2 INSTALLATIONS
WHEN SHIELD IS USED, GROUND AT THIS END ONLY
CONTROL EQUIPMENT PARAMETERS WHEN NO ASSOCIATED EQUIPMENT
Umax = Ui = 42V, 4-20 mA, Po ≤ 1 W
Honeywell
A/A4
50049892
SCALE: None
REV G
DATE 06/20/16
SH. 3 of 5

Output Protocol: F=Foundation Fieldbus or P= PROFIBUS

All Models of ST800 and the following Models of the ST700: STA722, STA740, STA72L, STA74L, STA77L, STD720, STD730, STD770, STG730, STG740, STG770, STG73L, STG74L, STG77L, STG78L, STG79L, STF724, STF732, STF72F, STF73F, STR73D, STR74G, STR73D, and STR74G

ENTITY PARAMETERS	Associated Apparatus
Ui or Vmax ≤ 30V	Uo, Voc or Vt ≤ 30V
Ii or Imax ≤ 180 mA	Io (Isc or It) ≤ 180 mA
Pi or Pmax = 1W	Po ≤ 1 W
Ci= 0 nF	Ca or Co ≥ C_{cable} + $C_{ST\ 800/\ ST\ 700}$
Li= 984 µH	La or Lo ≥ L_{cable} + $L_{ST\ 800/\ ST\ 700}$

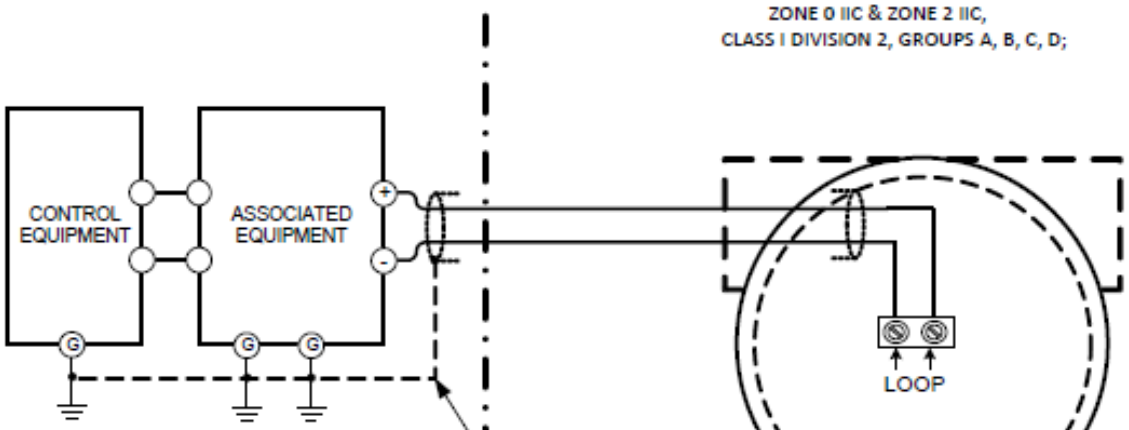
Terminal Module Revision F or Later

NOTE: THE REVISION IS ON THE LABEL THAT IS ON THE MODULE. THERE WILL BE TWO LINES OF TEXT ON THE LABEL:
- FIRST IS THE MODULE PART #: 50049839-003 OR 50049839-004
- SECOND LINE HAS THE SUPPLIER INFORMATION, ALONG WITH THE REVISION: XXXXXXX-FXXXX, THE "X" IS PRODUCTION RELATED; THE POSITION OF THE "F" IS THE REVISION.

ENTITY PARAMETERS	Associated Apparatus
Ui or Vmax ≤ 30V	Uo, Voc or Vt ≤ 30V
Ii or Imax ≤ 225 mA	Io (Isc or It) ≤ 225 mA
Pi or Pmax = 1W	Po ≤ 1 W
Ci= 0 nF	Ca or Co ≥ C_{cable} + $C_{ST\ 800/\ ST\ 700}$
Li= 0 µH	La or Lo ≥ L_{cable} + $L_{ST\ 800/\ ST\ 700}$

NON-HAZARDOUS LOCATION

HAZARDOUS (CLASSIFIED) LOCATION
CLASS I, CLASS II, DIVISION 1, GROUPS A, B, C, D, E, F & G;
ZONE 0 IIC & ZONE 2 IIC,
CLASS I DIVISION 2, GROUPS A, B, C, D;



ASSOCIATED EQUIPMENT NOT REQUIRED FOR DIV 2 / ZONE 2 INSTALLATIONS

WHEN SHIELD IS USED, GROUND AT THIS END ONLY

CONTROL EQUIPMENT PARAMETERS WHEN NO ASSOCIATED EQUIPMENT
Umax=Ui= 32V, 25 mA, Po ≤ 1 W

Honeywell	A/A4	50049892	
	SCALE: None	REV G DATE 06/20/16	SH. 4 of 5

Output Protocol: F=Foundation Fieldbus

All Models of ST800 and the following Models of the ST700: STA722, STA740, STA72L, STA74L, STA77L, STD720, STD730, STD770, STG730, STG740, STG770, STG73L, STG74L, STG77L, STG78L, STG79L, STF724, STF732, STF72F, STF73F, STR73D, STR74G, STR73D, and STR74G

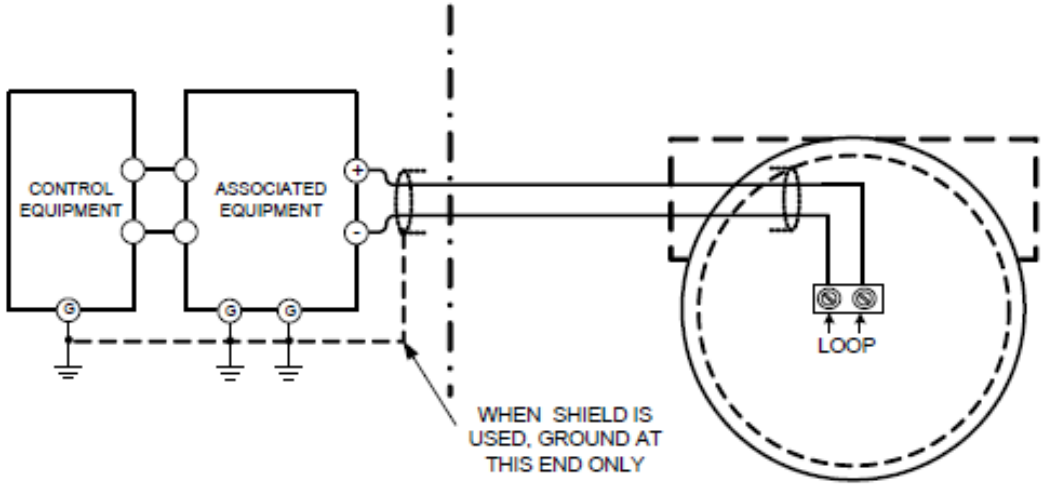
FISCO Terminal Module Revision F or Later

NOTE: THE REVISION IS ON THE LABEL THAT IS ON THE MODULE. THERE WILL BE TWO LINES OF TEXT ON THE LABEL:
- FIRST IS THE MODULE PART #: 50049839-003 OR 50049839-004
- SECOND LINE HAS THE SUPPLIER INFORMATION, ALONG WITH THE REVISION: XXXXXXX-FXXXX, THE "X" IS PRODUCTION RELATED, THE POSITION OF THE "F" IS THE REVISION.

ENTITY PARAMETERS (Ex ia and Ex ic)	Associated Apparatus
Ui or Vmax ≤ 18	Uo, Voc or Vt ≤ 18V
Ii or Imax ≤ 380 mA	Io (Isc or It) ≤ 380 mA
Pi or Pmax = 5.32W	Po ≤ 5.32 W
Ci= 0 nF	Ca or Co ≥ C_{cable} + $C_{ST\ 800/\ ST\ 700}$
Li= 0 µH	La or Lo ≥ L_{cable} + $L_{ST\ 800/\ ST\ 700}$

NON-HAZARDOUS LOCATION

HAZARDOUS (CLASSIFIED) LOCATION
ZONE 0 IIC & ZONE 2 IIC,



Honeywell	A/A4	50049892	
	SCALE: None	REV G DATE 06/20/16	SH. 5 of 5

A5. Marine Approvals

American Bureau of Shipping (ABS)

Certificate Number: 14-HS1265317

ABS Rules: Rules for Conditions of Classification, Part 1 - 2014 Steel Vessel Rules 1-1-4/7.7, 1-1-A3, 1-1-A4 which Covers the following: Steel Vessels 4-6-2/5.15, 4-8-3/13, 4-8-4/27.5.1, 4-9-8/13; Offshore Support Vessels 4-8-3/13, 4-8-4/29.5.1, 4-9-8/13; High Speed Craft 4-6-3/9.1.1(a), 4-7-9/15.1; Rules for Conditions of Classification, Part 1 - 2014 Offshore Units and Structures 1-1-4/9.7, 1-1-A2, 1-1-A3

Bureau Veritas (BV)

Certificate Number: 39542/A0 BV

Requirements: Bureau Veritas Rules for the Classification of Steel Ships

EC Code: 41S

Det Norske Veritas (DNV)

Certificate Number: A-13982

Application/ Location Classes:

Temperature D	Humidity: B
Vibration: A	EMC: B

Enclosure: C

For salt spray exposure; enclosure of 316 SST or 2-part epoxy protection with 316 SST bolts to be applied.

Korean Register of Shipping (KR)

Appl. No: DLN-T0044-14

Lloyd's Register (LR)

Certificate Number: 14/60017

Application: For use in environmental categories ENV1, ENV2, ENV3 adn ENV5 as defined by Lloyd's Register Test specification No. 1, 2013

Glossary

AP	Absolute Pressure
AWG	American Wire Gauge
DE	Digital Enhanced Communications Mode
DP	Differential Pressure
d1	Inside diameter of pipe
d2	Orifice plate bore diameter at flowing temperature
do	Inside diameter of orifice
EMI	Electromagnetic Interference
FTA	Field Termination Assembly
GP	Gauge Pressure
HP	High Pressure (also, High Pressure side of a Differential Pressure Transmitter)
Hz	Hertz
inH_2O	Inches of Water
LGP	In-Line Gauge Pressure
LP	Low Pressure (also, Low Pressure side of a Differential Pressure Transmitter)
LRL	Lower Range Limit
LRV	Lower Range Value
mAdc	Milliamperes Direct Current
mmHg	Millimeters of Mercury
mV	Millivolts
Nm	Newton·meters
NPT	National Pipe Thread
NVM	Non-Volatile Memory
Pa	Measured static pressure in PV4 algorithm
Pc	Absolute critical pressure of the gas
Pd	Static pressure at downstream point
Pdp	Measured differential pressure in Pascals in PV4 algorithm
Pf	Absolute pressure of flowing gas
Pr	Reduced pressure
Pu	Static pressure at upstream point
PM	Process Manger
PSI	Pounds per Square Inch
PSIA	Pounds per Square Inch Absolute
PV	Process Variable
PWA	Printed Wiring Assembly
RFI	Radio Frequency Interference
RTD	Resistance Temperature Detector
SFC	Smart Field Communicator
STIM	Pressure Transmitter Interface Module
STIMV IOP	Pressure Transmitter Interface Multivariable Input/Output Processor
T/C	Thermocouple
URL	Upper Range Limit
URV	Upper Range Value
US	Universal Station
Vac	Volts Alternating Current
Vdc	Volts Direct Current

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Sales and Service

For application assistance, current specifications, pricing, or name of the nearest Authorized Distributor, contact one of the offices below.

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(TAC) hfs-tac-support@honeywell.com

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Toll Free 1300-36-39-36
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1300-36-04-70

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Fax: (86-21) 6237-2826

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hfs-tac-support@honeywell.com

AMERICAS

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215/641-3610
(Sales) 1-800-343-0228

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FP-Sales-Apps@Honeywell.com
or
(TAC)
hfs-tac-support@honeywell.com

Specifications are subject to change without notice.

For more information
To learn more about SmartLine Transmitters,
visit www.honeywellprocess.com
Or contact your Honeywell Account Manager

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Houston, TX 77042

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Shanghai, China 20061

www.honeywellprocess.com

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Honeywell

ST 800
SmartLine Pressure Transmitters
User's Manual

34-ST-25-35
Revision 10.0
July 2016

Honeywell Process Solutions

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Revision 10, July 2016

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Honeywell Process Solutions
1250 W Sam Houston Pkwy S
Houston, TX 77042

About This Manual

This manual is a detailed *how to* reference for installing, piping, wiring, configuring, starting up, operating, maintaining, calibrating, and servicing Honeywell's family of ST 800 SmartLine Pressure Transmitters. Users who have a Honeywell ST 800 SmartLine Pressure Transmitter configured for HART protocol or Honeywell's Digitally Enhanced (DE) are referred to the *ST 800 Series HART/DE Option User's Manual*, document number 34-ST-25-38. Users who have a Honeywell ST 800 SmartLine Pressure Transmitter configured for Fieldbus operation are referred to the *ST 800 Series Fieldbus Option User's Manual*, document number (34-ST-25-39).

The configuration of your Transmitter depends on the mode of operation and the options selected for it with respect to operating controls, displays and mechanical installation. This manual provides detailed procedures to assist first-time users, and it further includes keystroke summaries, where appropriate, as quick reference or refreshers for experienced personnel.

To digitally integrate a Transmitter with one of the following systems:

For the Experion PKS, you will need to supplement the information in this document with the data and procedures in the *Experion Knowledge Builder.*

For Honeywell's TotalPlant Solutions (TPS), you will need to supplement the information in this document with the data in the *PM/APM SmartLine Transmitter Integration Manual*, which is supplied with the TDC 3000 book set. (TPS is the evolution of the TDC 3000).

Release Information:

ST 800 SmartLine Pressure Transmitter User Manual, Document # 34-ST-25-35,

Rev. 1, October, 2012 – First Release
Rev. 2, January 2013 – Document # reference and meter body updates
Rev. 3, February 2013 – Parts list updates
Rev. 4, May 2013 – Updates to Parts list, Explosionproof Seal class, Fail Safe and Comms Module procedures.
Rev. 5, July 2013 – Control Drawing updated to Rev.D
Rev. 6, Feb 2014 - Advanced display updates. Approvals FISCO & GOST added. PILD, Dual and Triple Calibration added.
Rev.7, May 2014 – PILD, Basic Display and High Pass Frequency updates
Rev.8, July 2014 – PILD update referencing the Option upgrade instructions
Rev.9, December 2014 – MID and Marine Approvals added
Rev.10, July 2016 – DE added to voltage chart, Approval updates and EU cert.

References

The following list identifies publications that may contain information relevant to the information in this document.

ST 800 Smart Pressure Transmitter Quick Start Installation Guide, Document # 34-ST-25-36

ST 800 & ST 700 Smart Pressure Transmitter with HART Communications Options Safety Manual, # 34-ST-25-37

ST 800 SmartLine Pressure Transmitter HART/DE Option User's Manual, Document # 34-ST-25-38

ST 800 FF Transmitter with FOUNDATION Fieldbus Option Installation & Device Reference Guide, Document # 34-ST-25-39

MC Tookit User Manual, for 400 or later, Document # 34-ST-25-20

PM/APM Smartline Transmitter Integration Manual, Document # PM 12-410

ST 800 Series Pressure, Analog, HART and DE Communications form, Honeywell drawing 50049892

Smart Field Communicator Model STS 103 Operating Guide, Document # 34-ST-11-14

Patent Notice

The Honeywell ST 800 SmartLine Pressure Transmitter family is covered by one or more of the following U. S. Patents: 5,485,753; 5,811,690; 6,041,659; 6,055,633; 7,786,878; 8,073,098; and other patents pending.

Support and Contact Information

For Europe, Asia Pacific, North and South America contact details, refer to the back page of this manual or the appropriate Honeywell Solution Support web site:

Honeywell Corporate	www.honeywellprocess.com
Honeywell Process Solutions	www.honeywellprocess.com/pressure-transmitters/
Training Classes	http://www.honeywellprocess.com/en-US/training

---

Telephone and Email Contacts

Area	Organization	Phone Number
United States and Canada	Honeywell Inc.	1-800-343-0228 Customer Service 1-800-423-9883 Global Technical Support
Global Email Support	Honeywell Process Solutions	hfs-tac-support@honeywell.com

Symbol Descriptions and Definitions

The symbols identified and defined in the following table may appear in this document.

Symbol	Definition
	**ATTENTION: Identifies information that requires special consideration.**
	**TIP: Identifies advice or hints for the user, often in terms of performing a task.**
CAUTION	**Indicates a situation which, if not avoided, may result in equipment or work (data) on the system being damaged or lost, or may result in the inability to properly operate the process.**
	**CAUTION: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.** **CAUTION symbol on the equipment refers the user to the product manual for additional information. The symbol appears next to required information in the manual.**
	**WARNING: Indicates a potentially hazardous situation, which, if not avoided, could result in serious injury or death.** **WARNING symbol on the equipment refers the user to the product manual for additional information. The symbol appears next to required information in the manual.**
	**WARNING, Risk of electrical shock: Potential shock hazard where HAZARDOUS LIVE voltages greater than 30 Vrms, 42.4 Vpeak, or 60 VDC may be accessible.**
	**ESD HAZARD: Danger of an electro-static discharge to which equipment may be sensitive. Observe precautions for handling electrostatic sensitive devices.**
	**Protective Earth (PE) terminal: Provided for connection of the protective earth (green or green/yellow) supply system conductor.**
	**Functional earth terminal: Used for non-safety purposes such as noise immunity improvement. NOTE: This connection shall be bonded to Protective Earth at the source of supply in accordance with national local electrical code requirements.**
	**Earth Ground: Functional earth connection. NOTE: This connection shall be bonded to Protective Earth at the source of supply in accordance with national and local electrical code requirements.**
	**Chassis Ground: Identifies a connection to the chassis or frame of the equipment shall be bonded to Protective Earth at the source of supply in accordance with national and local electrical code requirements.**
continued	

Symbol	Description
	The Factory Mutual® Approval mark means the equipment has been rigorously tested and certified to be reliable.
	The Canadian Standards mark means the equipment has been tested and meets applicable standards for safety and/or performance.
	The Ex mark means the equipment complies with the requirements of the European standards that are harmonised with the 94/9/EC Directive (ATEX Directive, named after the French "ATmosphere EXplosible").

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1 Introduction

1.1 Overview

This section is an introduction to the physical and functional characteristics Honeywell's family of ST 800 SmartLine Pressure Transmitters.

1.2 Features and Options

The ST 800 SmartLine Pressure Transmitter is available in a variety of models for measuring Differential Pressure (DP), Gauge Pressure (GP), and Absolute Pressure (AP). Table 1 lists the protocols, human interface (HMI), materials, approvals, and mounting bracket options for the ST 800.

Table 1 – Features and Options

Feature/Option	Standard/Available Options
Communication Protocols	HART version 7, Digitally Enhanced (DE), Fieldbus
Human-Machine Interface (HMI) Options (Basic and Advanced Display)	Basic and Advanced Digital Display
	Three-button programming (optional)
	Basic display language: English only
	Advanced display languages: English, German, French, Italian, Spanish, Turkish, Chinese and Russian
Calibration	Single, Dual/Triple Cal
Approvals (See Appendix C for details.)	FM, CSA, ATEX, IECEx, SAEx, INMETRO, NEPSI, GOST, MARINE and MID
Mounting Brackets	Angle/flat carbon steel/304 stainless steel, Marine 304 stainless steel, 316 Stainless Steel
Integration Tools	Experion
Configuration	Plugged Impulse Line Detection (PILD)

1.2.1 Physical Characteristics

As shown in Figure 1, the ST 800 is packaged in two major assemblies: the Electronics Housing and the Meter Body. The elements in the Electronic Housing respond to setup commands and execute the software and protocol for the different pressure measurement types. Figure 2 shows the assemblies in the Electronics Housing with available options.

The Meter Body provides connection to a process system. Several physical interface configurations are available, as determined by the mounting and mechanical connections, all of which are described in the "Installation" section of this manual.

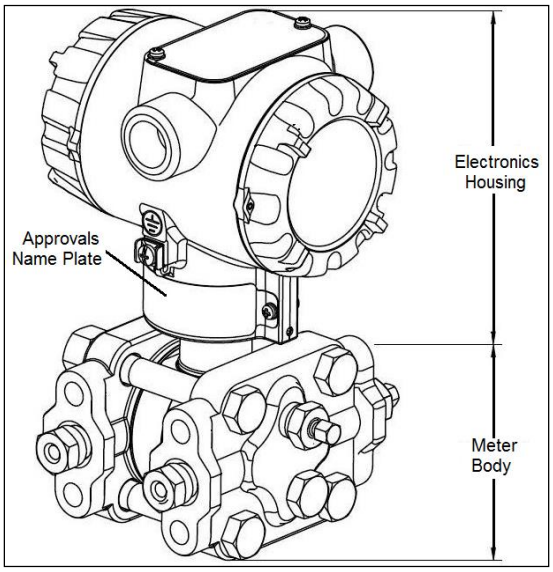


Figure 1 – ST 800 Major Assemblies

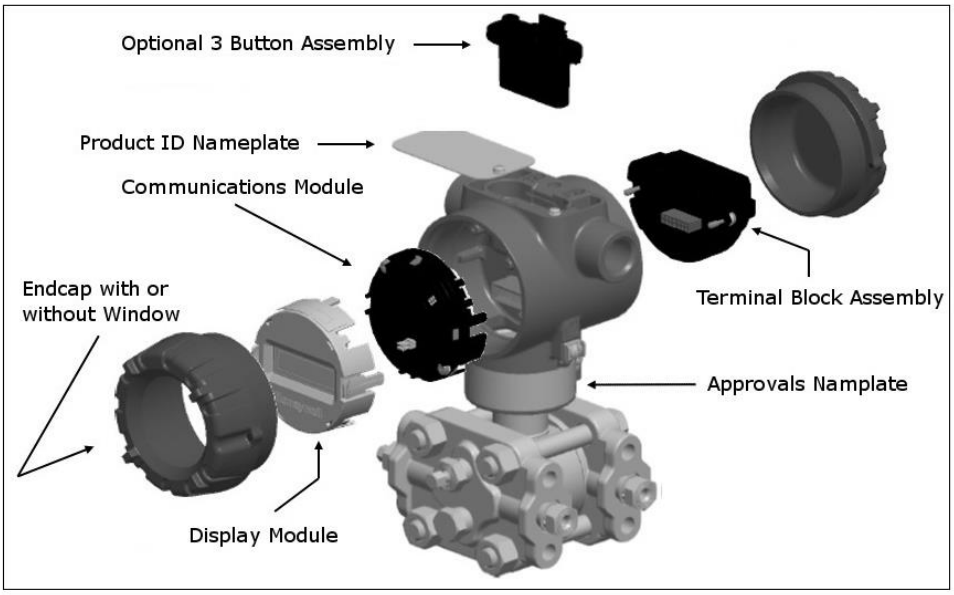


Figure 2 – Electronics Housing Components

1.2.2 Functional Characteristics

Functionally, the Transmitter can measure process pressure and provides a proportional analog 4 to 20 mA output to the measured process variable (PV). Available output communication protocols include Honeywell Digitally Enhanced (DE), HART, and FOUNDATION Fieldbus.

An optional 3-button assembly is available to set up and make adjustments to the Transmitter. In addition, a Honeywell Multi-Communication (MC) Toolkit (not supplied with the Transmitter) can facilitate setup and adjustment procedures. Certain adjustments can be made through an Experion Station or a Universal Station if the Transmitter is digitally integrated with Honeywell's Experion or TPS/TDC 3000 control system.

1.3 ST 800 Transmitter Name Plate

The Transmitter nameplate mounted on the bottom of the electronics housing (see Figure 1) lists its model number, physical configuration, electronics options, accessories, certifications, and manufacturing specialties. Figure 3 is an example of a typical Gauge Pressure (GP) or Atmospheric Pressure (AP) Transmitter name plate. The model number format consists of a Key Number with several table selections. The Differential Pressure (DP), Absolute Pressure (AP), and Gauge Pressure (GP) name plates are essentially the same. However, the DP provides one additional entry (7 vs. 6) in the Meter Body Selections (Table I) to accommodate the static pressure rating.

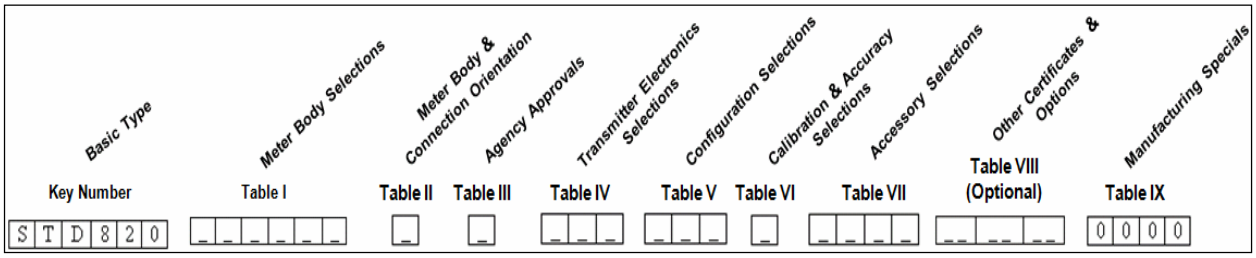


Figure 3 –Typical ST 800 Name Plate

You can readily identify the series and basic Transmitter type from the third and fourth digits in the key number. The letter in the third digit represents one of these basic transmitter types:

- A = Absolute Pressure
- D = Differential Pressure
- F = Flange Mounted
- G = Gauge Pressure
- R = Remote Seals

For a complete selection breakdown, refer to the appropriate Specification and Model Selection Guide provided as a separate document.

1.4 Safety Certification Information

An “approvals” name plate is located on the bottom of the Electronics Assembly; see Figure 1 for exact location. The approvals name plate contains information and service marks that disclose the Transmitter compliance information. Refer to Appendix C of this document for safety certification requirements and details.

1.5 Transmitter Adjustments

Zero and Span adjustments are possible in ST 800 SmartLine Pressure Transmitters with the optional three-button assembly located at the top of the Electronic Housing (see Figure 2).

You can also use the Honeywell MC Toolkit or other third-party hand-held zero to make any adjustments to an ST 800 SmartLine Pressure Transmitter. Alternately, certain adjustments can be made through the Experion or Universal Station, if the Transmitter is digitally integrated with a Honeywell Experion or TPS system.

1.6 Display Options

The ST 800 SmartLine Pressure Transmitter has two display options: Basic and Advanced; see **Error! Reference ource not found.**.

Table 2 – Available Display Characteristics

Basic Display	• Suitable for basic process needs • 360° rotation in 90° Increments • 2 lines, 16 characters • Standard units-of-measurement: Pa, KPa, MPa, KGcm2, TORR, ATM, inH2O, mH2O, bar, mbar, inHg, FTH2O, mmH2O, MMHG, & PSI • Diagnostic messaging • Square root output indications • Supports optional 3-Button configuration and calibration

Advanced Display	• 360° rotation in 90° increments
	• Three (3) configurable screen formats with configurable rotation timing
	  o Large process variable (PV)
	  o PV with bar graph
	  o PV with trend (1-24 hours, configurable)
	• Eight (8) screens with 3-30 seconds rotation timing
	• Standard and custom engineering units
	• Diagnostic alerts and diagnostic messaging
	• Multiple language support:
	  o EN, FR, GE, SP, RU, IT & TK
	  o EN, CH (Kanji), JP
	• Square root output indication
	• Supports 3-button configuration and calibration
	• Supports transmitter messaging, and maintenance mode indications

1.7 Optional 3-Button Assembly

The optional 3-Button Assembly provides the following features and capabilities:

- Increment, decrement, and enter key functions.
- With the menu-driven display:
  - Comprehensive on-screen menu for navigation.
  - Transmitter configuration.
  - Transmitter calibration
  - Display configuration.
  - Set zero and span parameters.

2 Application Design

2.1 Overview

This section discusses the considerations involved with deploying a Honeywell ST 800 SmartLine Pressure Transmitter in a process system. The following areas are covered:

- Safety
- Input and output data
- Reliability
- Environmental limits
- Installation considerations
- Operation and maintenance\
- Repair and replacement

2.2 Safety

2.2.1 Accuracy

The ST 800 SmartLine Pressure Transmitter (Transmitter) measures the gauge, differential, or absolute pressure of a process and reports the measurement to a receiving device.

2.2.2 Diagnostic Messages

Transmitter standard diagnostics are reported in the two basic categories listed in Table 3. Problems detected as critical diagnostics drive the analog output to the programmed burnout level. Problems detected as non-critical diagnostics may affect performance without driving the analog output to the programmed burnout level. Informational messages (not listed in Table 3) report various Transmitter status or setting conditions. The messages listed in Table 3 are specific to the Transmitter, exclusive of those associated with HART and DE protocols. HART and DE diagnostic messages are listed and described in the *ST 800 SmartLine Pressure Transmitter HART/DE Option User Manual*, document number 34-ST-25-38.

Table 3 - ST 800 Standard Diagnostics Messages

Critical Diagnostics (Failure Conditions)	Non-Critical Diagnostics (Warning Conditions)	
Electronic Module DAC Failure	No DAC Compensation	Loop Current Noise
Meter Body NVM Corrupt	No Factory Calibration	AO Out of Range
Config Data Corrupt	PV Out of Range	URV Set Err. Span Config Button
Electronic Module Diag Failure	Fixed Current Mode	LRV Set Err. Zero Config Button
Meter Body Critical Failure	Sensor Over Temperature	PILD Blockage Detected
Sensor Comm Timeout	Meter Body Excess Correct	
	Local Display	
	Low Supply Voltage	
	No DAC Calibration	
	Tamper Alarm	
	Meter Body Unreliable Comm	

2.2.3 Safety Integrity Level (SIL)

The ST800 is intended to achieve sufficient integrity against systematic errors by the manufacturer's design. A Safety Instrumented Function (SIF) designed with this product must not be used at a SIL level higher than the statement, without "prior use" justification by the end user or diverse technology redundancy in the design. Refer to the *ST 800 & ST 700 Safety Manual*, 34-ST-25-37, for additional information.

2.2.4 Plugged Impulse Line detection (PILD)

STA, STD, STG, and STF800 models are offered with a PILD option which provide indication of a plugged impulse line or process connection. When used in conjunction with a basic or advanced display, a non-critical diagnostic indication appears on the integral display. For units without an integral display, an indication can be seen via the host or hand held device when HART Protocol is utilized.

This diagnostic detects clogged or plugged impulse lines. Plugged impulse line detection (PILD) is based on statistical models which continuously compare baseline, or normal, operating noise patterns to check for statistically significant changes when one or both (DP) impulse lines become clogged. See Section 5.6 for details on PILD Option licensing.

3 Installation and Startup

3.1 Installation Site Evaluation

Evaluate the site selected for the ST 800 Transmitter installation with respect to the process system design specifications and Honeywell's published performance characteristics for your particular model. Some parameters that you may want to include in your site evaluation are:

- Environmental Conditions:
  - Ambient Temperature
  - Relative Humidity
- Potential Noise Sources:
  - Radio Frequency Interference (RFI)
  - Electromagnetic Interference (EMI)
- Vibration Sources
  - Pumps
  - Motorized System Devices (e.g., pumps)
  - Valve Cavitation
- Process Parameters
  - Temperature
  - Maximum Pressure Rating

3.2 Honeywell MC Toolkit

In preparation for post-installation processes, refer to the *MC Tookit User Manual*, Document # 34-ST-25-20, for battery conditioning and device operation and maintenance information.

3.3 Display Installation Precautions

Temperature extremes can affect display quality. The display can become unreadable at temperature extremes; however, this is only a temporary condition. The display will again be readable when temperatures return to within operable limits.

The display update rate may increase at cold temperature extremes, but as with readability, normal updating resumes when temperatures are within limits for full operability.

3.4 Mounting ST 800 SmartLine Pressure Transmitters

3.4.1 Summary

Transmitter models, except flush mounts and those with integral flanges, can be attached to a two-inch (50 millimeter) vertical or horizontal pipe using Honeywell's optional angle or flat mounting bracket; alternately you can use your own bracket. Flush-mount models are attached directly to a process pipe or tank by a one-inch weld nipple. Models with integral flanges are supported by the flange connection.

Figure 4 shows typical bracket-mounted and flange-mounted transmitter installations.

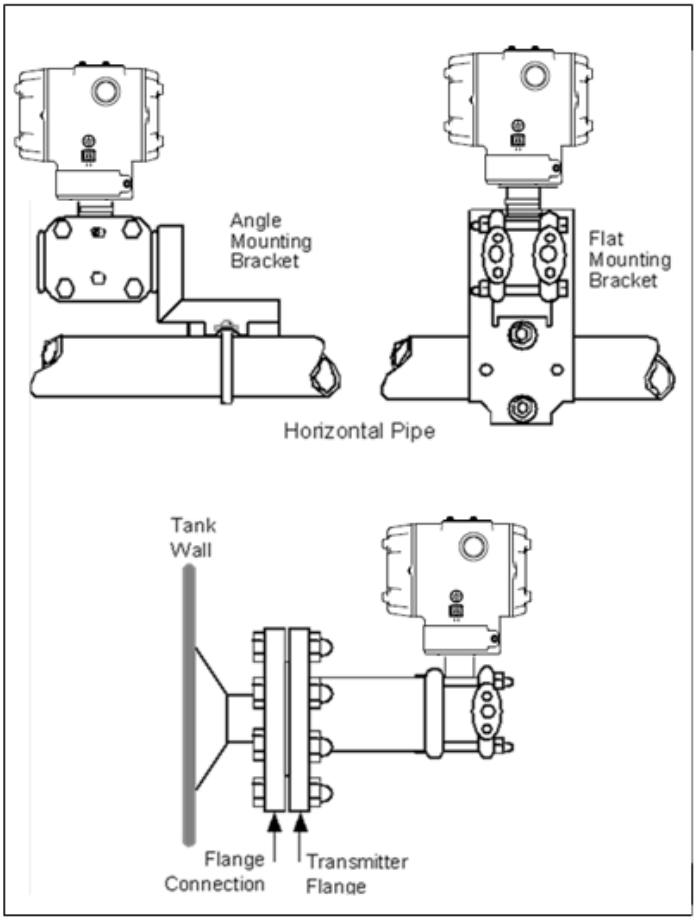


Figure 4 – Typical Bracket Mounted and Flange Mounted Installations

3.4.2 Mounting Dimensions

Refer to Honeywell drawing number 50049930 (Dual Head), 50049931 (In-Line), 50049932 (Flange Mount) 50049933 (Extended Flange), and 50049934 (Remote Seal) for detailed dimensions. Abbreviated overall dimensions are also shown on the Specification Sheets for the transmitter models. This section assumes that the mounting dimensions have already been taken into account and the mounting area can accommodate the Transmitter.

3.4.3 Bracket Mounting Procedure

If you are using an optional bracket, start with Step 1. For an existing bracket, start with Step 2.

1. Refer to Figure 5. Position the bracket on a 2-inch (50.8 mm) horizontal or vertical pipe, and install a "U" bolt around the pipe and through the holes in the bracket. Secure the bracket with the nuts and lock washers provided.

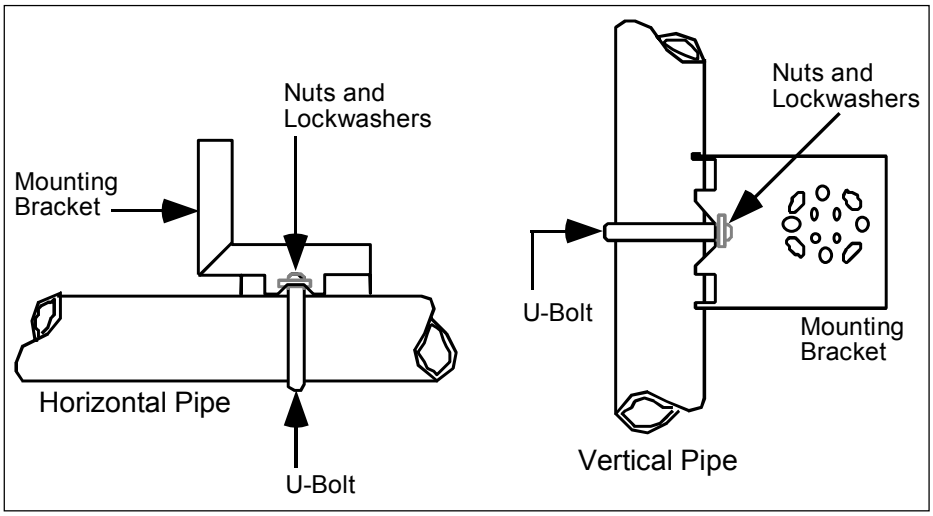


Figure 5 – Angle Mounting Bracket Secured to a Horizontal or Vertical Pipe

2. Align the appropriate mounting holes in the Transmitter with the holes in the bracket. Use the bolts and washers provided to secure the Transmitter to the bracket; see the following variations.

Transmitter Type	Use Hardware
DP with double-ended process heads and/or remote seals	Alternate mounting holes in the ends of the heads
In-line GP and AP (STGxxL and STAxxL)	The smaller "U" bolt provided to attach the meter body to the bracket. See the following example.
Dual-head GP and AP	Mounting holes in the end of the process head.

EXAMPLE: Inline model mounted to an optional angle bracket. See Figure 6**.**

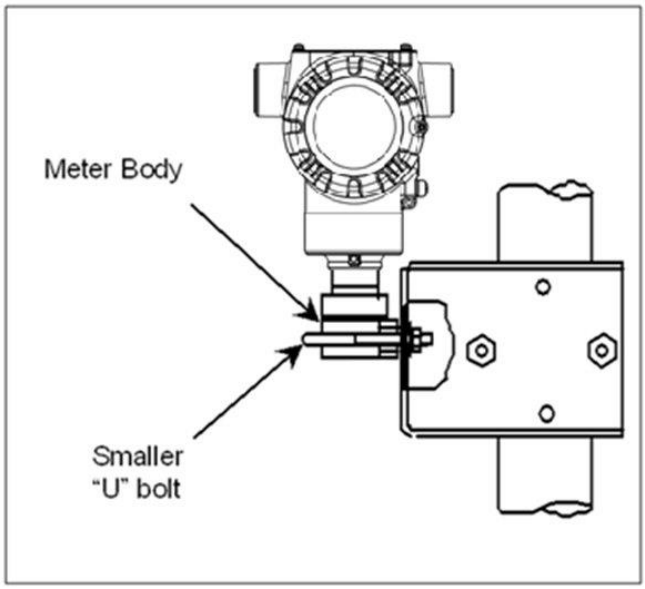


Figure 6 – Inline Model Mounted to an Optional Bracket

3. Loosen the set screw on the outside neck of the Transmitter one (1) full turn.

4. Rotate the Electronics housing a maximum of 180° left or right from the center to the position you require, and tighten the set screw 8.9 to 9.7 pound-inches (1.40 to 1.68 Newton meters), using a 4mm metric socket head wrench. See the following example and Figure 7.

   EXAMPLE: Rotating the Electronics Housing

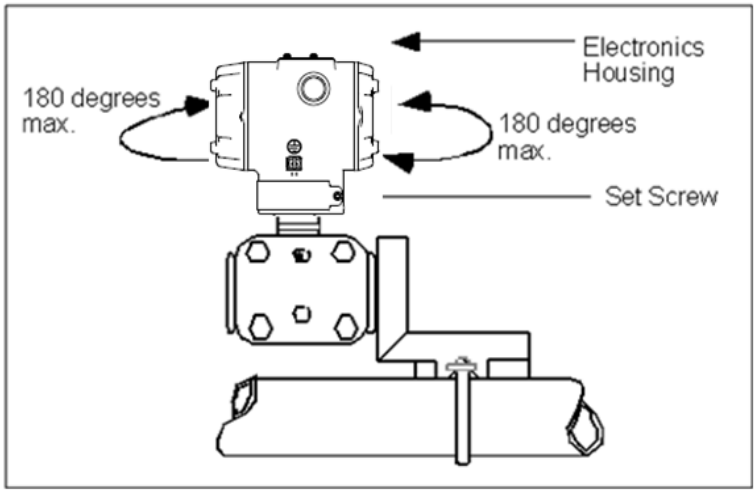


Figure 7 – Rotating the Electronics Housing

The mounting position of absolute pressure models STA822, STA82L, or a draft range model STD810 is critical as the Transmitter spans become smaller.
A maximum zero shift of 2.5 mmHg for an Absolute Transmitter or 1.5 inches of water (inH_2O) for a Draft Range Transmitter can result from a mounting position that is rotated 90° from the vertical. A typical zero-shift of 0.12 mmHg or 0.20 inH_2O can occur for a five (5)-degree rotation from the vertical.

3.4.4 Mounting Transmitters with Small Absolute or Differential Pressure Spans

To minimize positional effects on calibration (zero shift), take the appropriate mounting precautions for the respective Transmitter model. For a model STA822 or STA82L, ensure that the Transmitter is vertical when mounting it. You do this by leveling the Transmitter side-to-side and front-to-back. Figure 8 shows how to level a Transmitter using a spirit level.

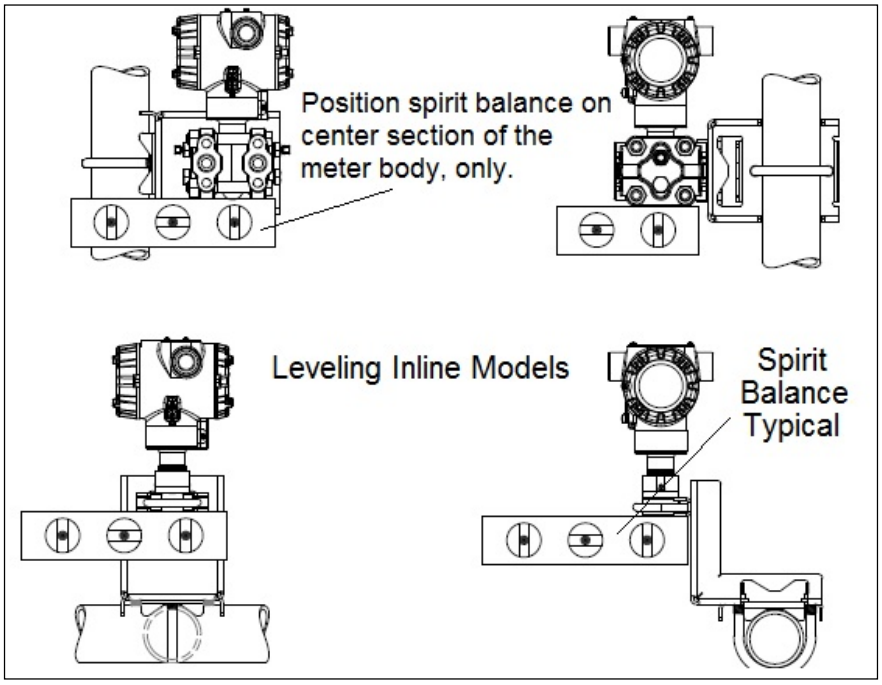


Figure 8 – Using a Spirit Balance to Level a Transmitter

3.4.5 Flange Mounting

Figure 9 shows a typical tank-flange mount installation, with the Transmitter flange mounted to the pipe on the wall of the tank.

On insulated tanks, remove enough insulaiton to accommodate the flange extension.

When flange-mounting to a tank, note the following:

- The End User is responsible for providing a flange gasket and mounting hardware suitable for the Transmitter service conditions.
- To avoid degrading performance in flush-mounted flanged Transmitters, exercise care to ensure that the internal diameter of the flange gasket does not obstruct the sensing diaphragm.
- To prevent performance degradation in extended-mount flanged Transmitters, ensure that sufficient clearance exists in front of the sensing diaphragm body.

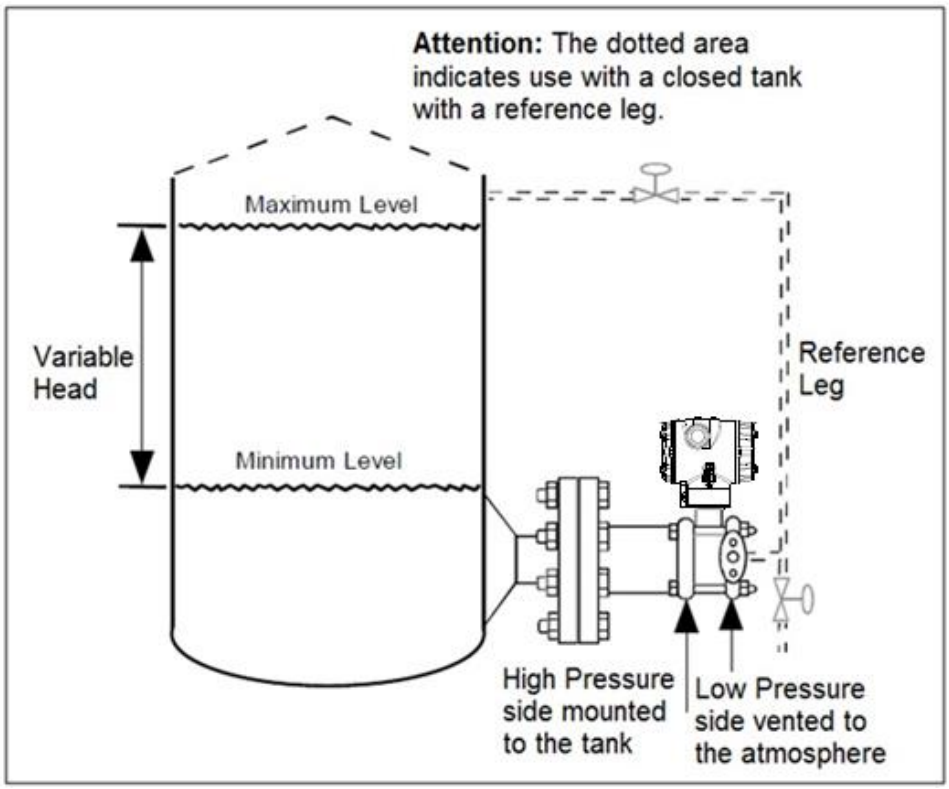


Figure 9 – Tank-Flange Mounted Transmitter

3.4.6 Flush Mounting Procedure

After the Transmitter is mounted, the Electronics Housing can be rotated to the desired position. For insulated tanks, remove enough insulation to accommodate the mounting sleeve and/or the flange extension.

Mount the Transmitter flanges within the limits Table 4 for the fill fluid in the capillary tubes, with a tank at one (1) atmosphere.

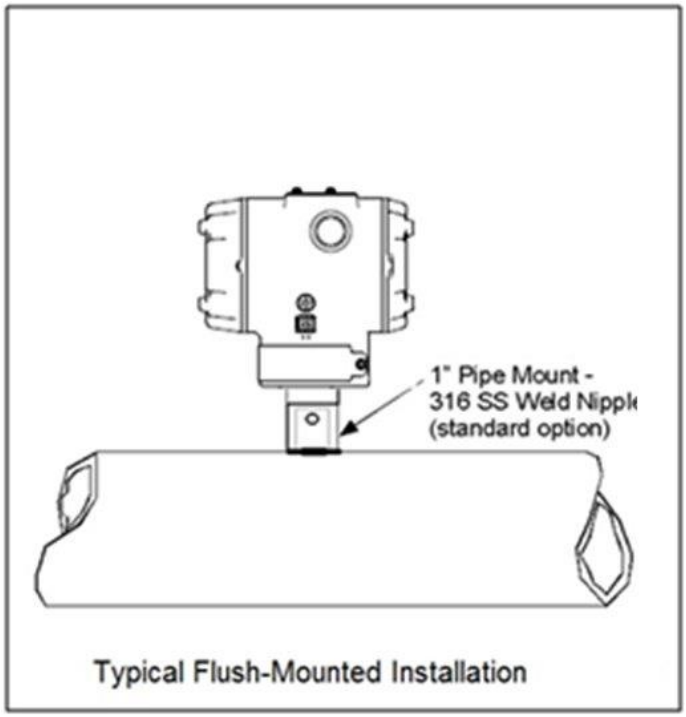


Figure 10 – Typical Flush and Flange Mounted Installations

1. Refer to Figure 10 for a representative flush-mounted Transmitter installation. Cut a hole for a one (1) inch standard pipe in the tank or pipe at the Transmitter mounting site.
2. Weld the 1-inch mounting sleeve to the tank wall or to the hole you cut in the pipe.
3. Insert the Transmitter Meter Body into the mounting sleeve, and secure it with the locking bolt.
4. Tighten the bolt to a torque of 4 Nm $\pm$0.3 Nm (4.7 pound-feet $\pm$0.2 pound-feet).

3.4.7 Remote Diaphragm Seal Mounting Information

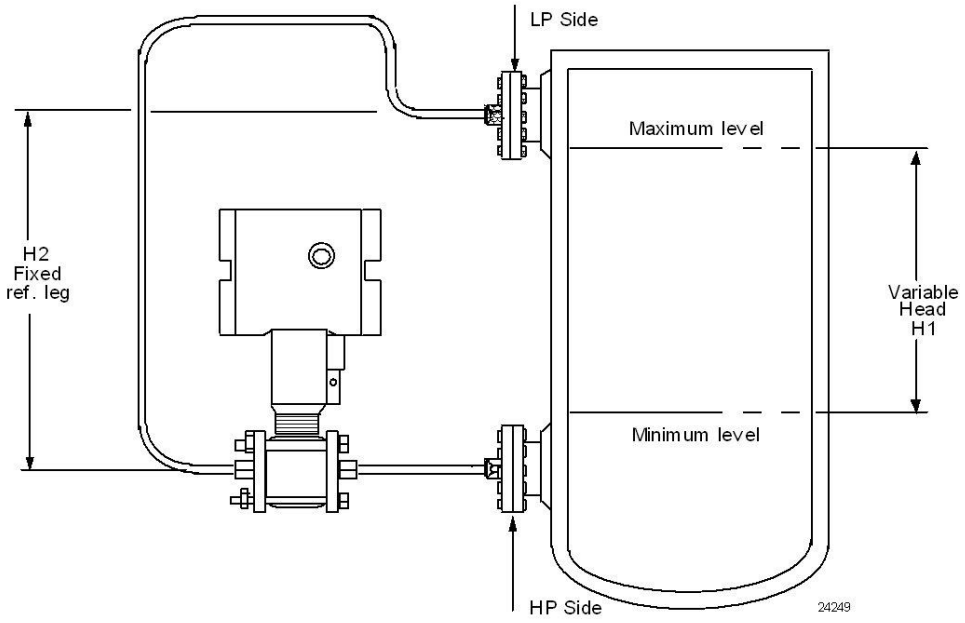
The combination of tank vacuum and high pressure capillary head effect should not exceed nine (9) psi (300 mmHg) absolute. For insulated tanks, be sure to remove enough insulation to accommodate the flange extension. The end user is responsible for supplying a flange gasket and mounting hardware suitable for the service condition of the Transmitter.

Mount the Transmitter flanges within the limits in for the fill fluid in the capillary tubes, with a tank at one (1) atmosphere.

Table 4 – Flange Mounting Guidelines

Fill Fluid	Mount the Flange…
Silicone 200 Oil	≤22 feet (6.7 meters) below the Transmitter
Chlorotrifluorethylene (CTFE)	≤11 feet (3.4 meters) below the Transmitter

Refer to Figure 11 for a representative remote diaphragm seal installation. Mount the Transmitter at a remote distance determined by the length of the capillary tubing.



NOTE: Lower flange seal should not be mounted over 22 feet below or above the transmitter for silicone fill fluid (11 feet for CTFE fill fluid) with tank at one atmosphere. The combination of tank vacuum and high pressure capillary head effect should not exceed 9 psi vacuum (300 mmHg absolute).

Figure 11 – Representative Remote Diaphragm Seal Transmitter Installation

Depending on Transmitter model, connect the remote seal to the tank according to

Table 5

Table 5 – Remote Diaphragm Mounting Details

Transmitter Model	Connect the Remote Seal on ….	
	Variable Head	Fixed or Constant Head
STR82D	Transmitter High Pressure (HP) Side to tank wall lower flange mounting.	Transmitter Low Pressure (LP) side to tank wall upper flange.
STR83D	Transmitter Low Pressure (LP) Side to tank wall lower flange mounting.	Transmitter Low Pressure (LP) side to tank wall upper flange. **OR** High Pressure (HP) side to tank wall upper flange

3.5 Piping the ST 800 Transmitter

3.5.1 Piping Arrangements

Piping arrangements vary depending upon process measurement requirements and the Transmitter model. For example, a differential pressure transmitter comes with double-ended process heads with ¼-inch NPT connections, which can be modified to accept ½-inch NPT through optional flange adapters. Gauge pressure transmitters are available with various connections for direct mounting to a process pipe.

A ½-inch, schedule 80, steel pipe is commonly used for Transmitter integration into a process system. Many piping arrangements use a three-valve manifold to connect the process piping to the Transmitter. A manifold makes it easy to install and remove or re-zero a Transmitter without interrupting the process. A manifold also accommodates the installation of blow-down valves to clear debris from pressure lines. Figure 12 represents a typical piping arrangement using a three-valve manifold and blow-down lines for a differential pressure transmitter being used to measure flow.

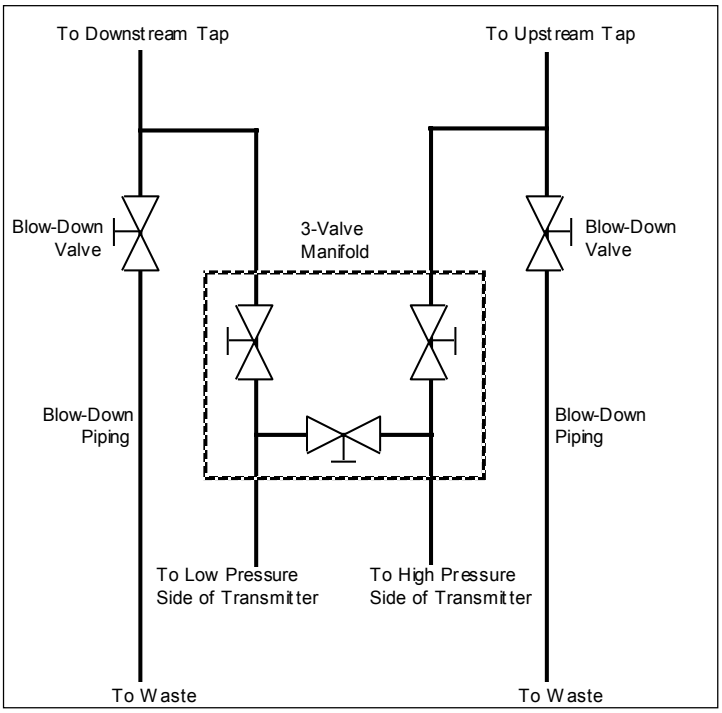


Figure 12 – Typical 3-Valve Manifold with Blow-Down Piping

3.5.2 Suggestions for Transmitter Location

Suggests connections based on what is being processed by the system.

Table 6 – Suggested Connection Locations

Process	Suggested Location	Description
Gases	Above the gas line.	The condensate drains away from the Transmitter.
Liquids	Below but near the elevation of the process connection.	This minimizes that static head effect of the condensate.
	Level with or above the process connection.	This requires a siphon to protect. the Transmitter from process steam. The siphon retains water as a *fill fluid*.

1. For liquid or steam, the piping should slope a minimum of 25.4 mm (1 inch) per 305 mm (1 foot).
2. Slope the piping down toward the Transmitter if it is below the process connection to allow the bubbles to rise back into the piping through the liquid.
3. If the transmitter is located above the process connection, the piping should rise vertically above the Transmitter. In this case, slope down toward the flow line with a vent valve at the high point.
4. For gas measurement, use a condensate leg and drain at the low point (freeze protection may be required here).

ATTENTION Care must be taken when installing transmitters on hot processes. The operating temperature limits for the device (as outlined in Table 5) must not be exceeded. Impulse piping may be used to reduce the temperature of the process that comes into contact with the transmitter meter body. As a general rule there is a 56 °C drop (100 °F) in the temperature of the process for every foot of ½ inch uninsulated piping.

3.5.3 General Piping Guidelines

- When measuring fluids that contain suspended solids, install permanent valves at regular intervals to blow-down piping.
- Blow-down all lines on new installations with compressed air or steam, and flush them with process fluids (where possible) before connecting these lines to the Transmitter Meter Body.
- Verify that the valves in the blow-down lines are closed tightly after the initial blow-down procedure and each maintenance procedure thereafter.

3.5.4 Procedure to Install Flange Adapters

The following procedure provides the steps for removing and replacing an optional flange adapter on the process head.

This procedure does not require that the Meter Body be removed from the Electronics Housing. If flange adapters are being replaced with parts from other kits (for example, process heads), follow the procedures for the kits and incorporate the following procedure.

NOTE: The threaded hole in each Flange Adapter is offset from center. To ensure proper orientation for re-assembly, note the orientation of the offset relative to each Process Head **before removing any adapter**.

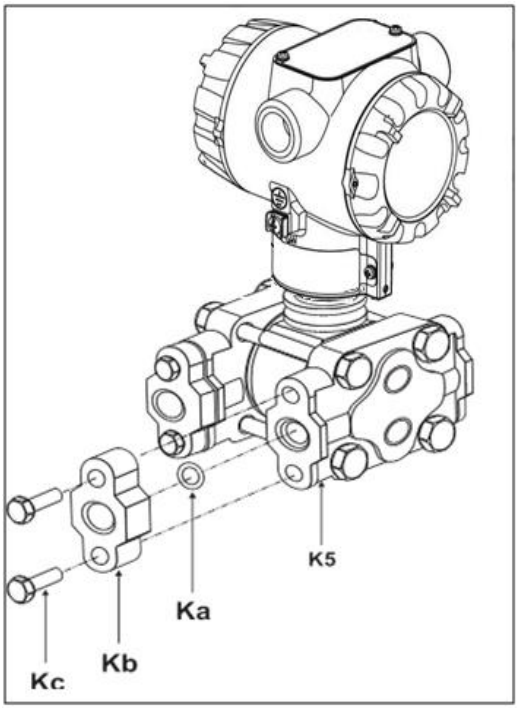


Figure 13 – Flange Adapter Removal and Replacement

Refer to the instructions included with the kit for removal and replacement procedures.

3.6 Wiring a Transmitter

3.6.1 Overview

The transmitter is designed to operate in a two-wire power/current loop with loop resistance and power supply voltage within the operating range shown in Figure 14.

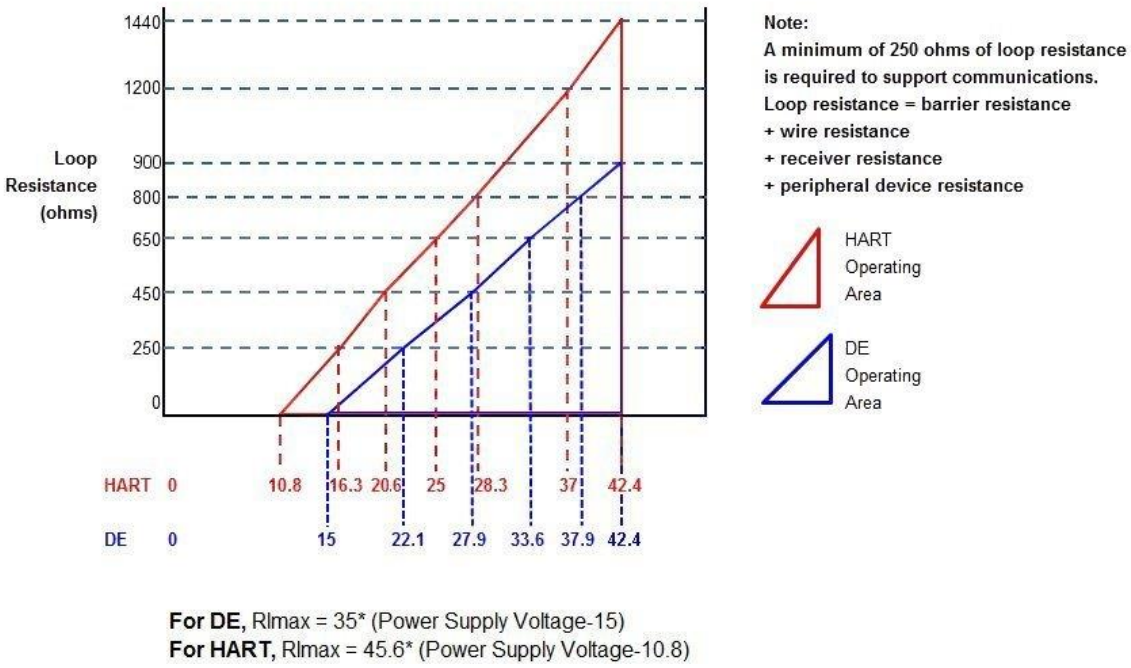


Figure 14 – Transmitter Operating Ranges

Loop wiring is connected to the Transmitter by simply attaching the positive (+) and negative (–) loop wires to the positive (+) and negative (–) terminals on the Transmitter terminal block in the Electronics Housing shown in Figure 15.

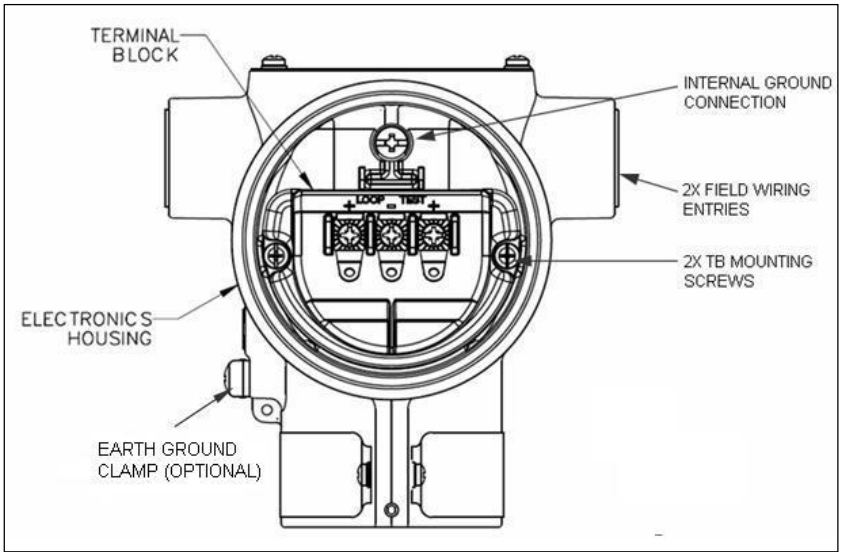


Figure 15 – Transmitter 3-Screw Terminal Board and Grounding Screw

As shown in Figure 15, each Transmitter has an internal terminal to connect it to earth ground. Optionally, a ground terminal can be added to the outside of the Electronics Housing. While it is not necessary to ground the Transmitter for proper operation, doing so tends to minimize the possible effects of noise on the output signal and affords protection against lightning and static discharge. An optional lightning terminal block can be installed in place of the non-lightning terminal block for Transmitters that will be installed in an area that is highly susceptible to lightning strikes.

Wiring must comply with local codes, regulations and ordinances. Grounding may be required to meet various approval body certification, for example CE conformity. Refer to Appendix A of this document for details.

Note: The right hand terminal is for loop test and not applicable for Fieldbus option.

The Transmitter is designed to operate in a two-wire power/current loop with loop resistance and power supply voltage within the operating range; see Figure 14. With optional lightning protection and/or a remote meter, the voltage drop for these options must be added to the basic 10.8-volt supply requirements to determine the required Transmitter voltage (V_{XMTR}) and maximum loop resistance ($R_{LOOP\ MAX}$). Additional consideration is required when selecting intrinsic safety barriers to ensure that they will supply at least minimum Transmitter voltage ($V_{XMTR\ MIN}$), including the required 250 ohms of resistance (typically within the barriers) needed for digital communications.

Transmitter loop parameters are as follows:
$R_{LOOP\ MAX}$ = maximum loop resistance (barriers plus wiring) that will allow proper Transmitter operation and is calculated as $R_{LOOP\ MAX} = (V_{SUPPLY\ MIN} - V_{XMTR\ MIN}) \div 21.8$ mA.

In this calculation:

$V_{XMTR\ MIN} = 10.8\ V + V_{LP} + V_{SM}$

$V_{SM} = 2.3$ V, remote meter

Note that V_{SM} should only be considered if a remote meter will be connected to the transmitter.

The positive and negative loop wires are connected to the positive (+) and negative (–) terminals on the terminal block in the Transmitter Electronics Housing.

Barriers can be installed per Honeywell's instructions for Transmitters to be used in intrinsically safe applications.

3.6.2 Digital System Integration Information

Transmitters that are to be digitally integrated to Honeywell's Total Plant Solution (TPS) system will be connected to the Pressure Transmitter Interface Module in the Process Manager, Advanced Process Manager or High Performance Process Manager through a Field Termination Assembly. Details about the TPS system connections are given in the *PM/APM SmartLine Transmitter Integration Manual*, PM12-410, which is part of the TDC 3000^X system bookset.

If you are digitally integrating a Transmitter in an Allen Bradley Programmable Logic Controller (PLC) process system, the same Field Terminal Assembly (FTA) and wiring procedures used with Honeywell's TPS system are also used with the Allen-Bradley 1771 and 1746 platforms.

3.6.3 Wiring Variations

The above procedures are used to connect power to a Transmitter. For loop wiring and external wiring, detailed drawings are provided for Transmitter installation in non-intrinsically safe areas and for intrinsically safe loops in hazardous area locations.
If you are using the Transmitter with Honeywell's TPS system, see *PM/APM Smartline Transmitter Integration Manual*, PM12-410, which is part of the TDC 3000^X system bookset.

3.6.4 Wiring Procedure

1. See Figure 15, above, for parts locations. Loosen the end cap lock using a 1.5 mm Allen wrench.
2. Remove the end cap cover from the terminal block end of the Electronics Housing.
3. Feed loop power leads through one end of the conduit entrances on either side of the Electronics Housing. The Transmitter accepts up to 16 AWG wire.
4. Plug the unused conduit entrance with a conduit plug appropriate for the environment.
5. Connect the positive loop power lead to the positive (+) terminal and the negative loop power lead to the negative (-) terminal. Note that the Transmitter is not polarity-sensitive.
6. Replace the end cap, and secure it in place.

3.6.5 Lightning Protection

If your Transmitter includes the optional lightning protection, connect a wire from the Earth Ground Clamp (see Figure 15) to Earth Ground to make the protection effective. Use a size 8 AWG or ($8.37mm^2$) bare or green covered wire for this connection.

3.6.6 Supply Voltage Limiting Requirements

If your Transmitter complies with the ATEX 4 directive for self-declared approval per 94/9EC, the power supply has to include a voltage-limiting device. Voltage must be limited such that it does not exceed 42 V DC. Consult the process design system documentation for specifics.

3.6.7 Process Sealing

The ST 800 SmartLine Pressure Transmitter is CSA-certified as a Dual Seal device in accordance with ANSI/ISA–12.27.01–2003, "Requirements for Process Sealing Between Electrical Systems and Flammable, or Combustible Process Fluids."

3.6.8 Explosion-Proof Conduit Seal

When installed as explosion proof in a Division 1 Hazardous Location, keep covers tight while the Transmitter is energized. Disconnect power to the Transmitter in the non-hazardous area prior to removing end caps for service.

When installed as non-incendive equipment in a Division 2 hazardous location, disconnect power to the Transmitter in the non-hazardous area, or determine that the location is non-hazardous before disconnecting or connecting the Transmitter wires.

Transmitters installed as explosion proof in Class I, Division 1, Group A Hazardous (classified) locations in accordance with ANSI/NFPA 70, the US National Electrical Code, with 1/2 inch conduit do not require an explosion-proof seal for installation. If 3/4 inch conduit is used, a LISTED explosion proof seal to be installed in the conduit, within 18 inches (457.2 mm) of the transmitter.

3.7 Startup

3.7.1 Overview

This section identifies typical start up tasks associated with several generic pressure measurement applications. It also includes the procedure for running an optional analog output check.

3.7.2 Startup Tasks

After completing the installation and configuration tasks for a Transmitter, you are ready to start up the process loop. Startup usually includes:

- Checking zero input
- Reading inputs and outputs
- Applying process pressure to the transmitter.

You can also run an optional output check to *wring out* an analog loop and check out individual Process Variable (PV) outputs in Digitally Enhanced (DE) mode before startup.

The actual steps in a startup procedure vary based on the type of Transmitter and the measurement application. In general, the procedures in this section are based on using Honeywell MC Toolkit to check the Transmitter input and output under static process conditions, and make adjustments as required initiating full operation with the running process. Note that like checks can be made using the optional three-button assembly, if your Transmitter is so equipped. Operation with the three-button assembly is discussed in the "Operation" section of this manual.

3.7.3 Output Check Procedures

The Output Check comprises the following procedures:

- The Loop Test procedure checks for continuity and the condition of components in the output current loop.
- The Trim DAC Current procedure calibrates the output of the Digital-to-Analog converter for minimum (0%) and maximum (100%) values of 4 mA and 20 mA, respectively. This procedure is used for Transmitters operating online in analog mode to ensure proper operation with associated circuit components (for example, wiring, power supply,…, control equipment). Precision test equipment (an ammeter or a voltmeter in parallel with precision resistor) is required for the Trim DAC Current procedure.
- The Apply Values procedure uses actual Process Variable (PV) input levels for calibrating the range of a Transmitter. To measure a liquid level for example, a sight-glass can be used to determine the minimum (0%) and maximum (100%) level in a vessel. The PV is carefully adjusted to stable minimum and maximum levels, and the Lower Range Limit Value (LRV) and Upper Range Limit Value (URV) are then set by commands from the MC Toolkit.



The Transmitter does not measure the given PV input or update the PV output while it operates in the Output mode.

3.7.4 Constant Current Source Mode Procedure

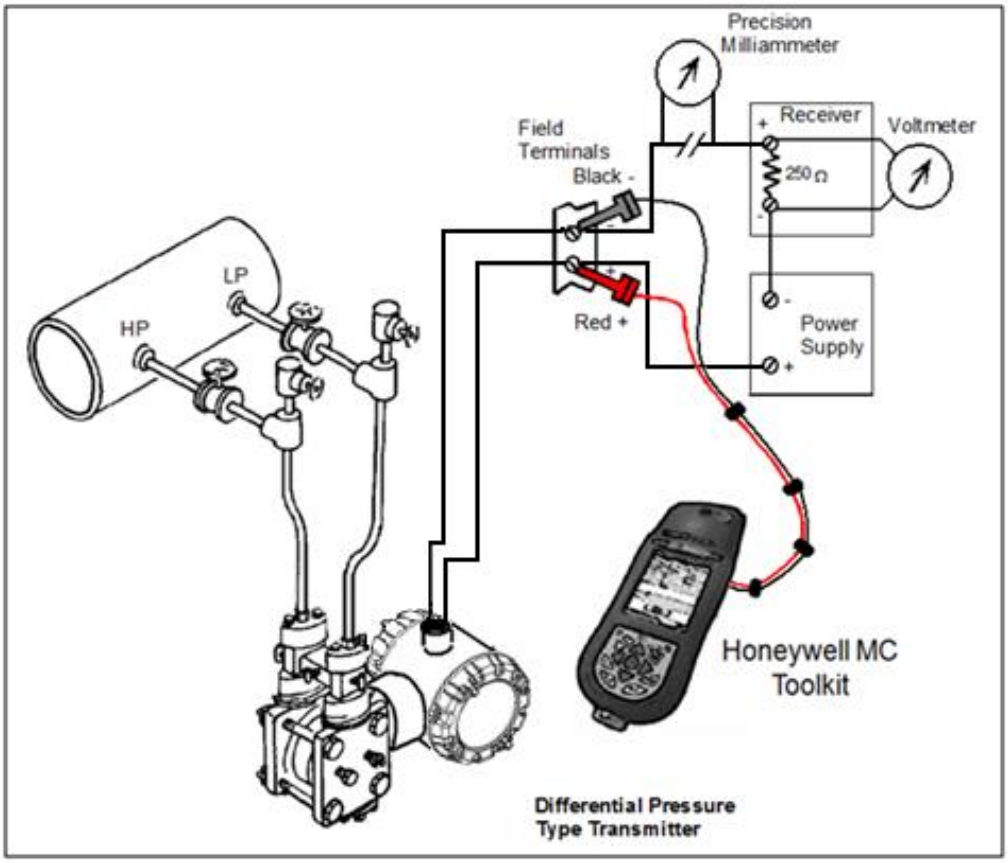


Figure 16 – Current Loop Test Connections

1. Refer to Figure 16 for test connections. Verify the integrity of electrical components in the output current loop.
2. Establish communication with the Transmitter. For these procedures, the values of components in the current loop are not critical if they support reliable communication between the Transmitter and the Toolkit.
3. On the Toolkit, display the **Output Calibration** box.
4. In the Output Calibration box, select the **Loop Test** button; the **LOOP TEST** box will be displayed.
5. Select the desired constant-level Output: 0 %, 100 %, or Other (any between 0 % - 100 %).
6. Select the Set button. A box will be displayed asking **Are you sure you want to place the transmitter in output mode?**

   With the Transmitter in Analog mode, you can observe the output on an externally-connected meter or on a local meter. In DE mode, you can observe the output on the local meter or on the Toolkit Monitor display.
7. Select the **Yes** button. Observe the output current at the percentage you selected in Step 5.
8. To view the monitor display, navigate back from the **LOOP TEST** display, and select the **MONITOR** display. A **Confirm** popup will be displayed.
9. Select **Yes** to continue. This concludes the Startup procedure.

4 Operation

4.1 Overview

This section provides the information and processes involved for both Digitally Enhanced (DE) and HART operation using the 3-button option.

4.2 Three-Button Operation

The ST 800 optional three-button interface provides a user interface and operation capability without opening the transmitter. Figure 17 shows the location of the three-button option and the labels for each button.

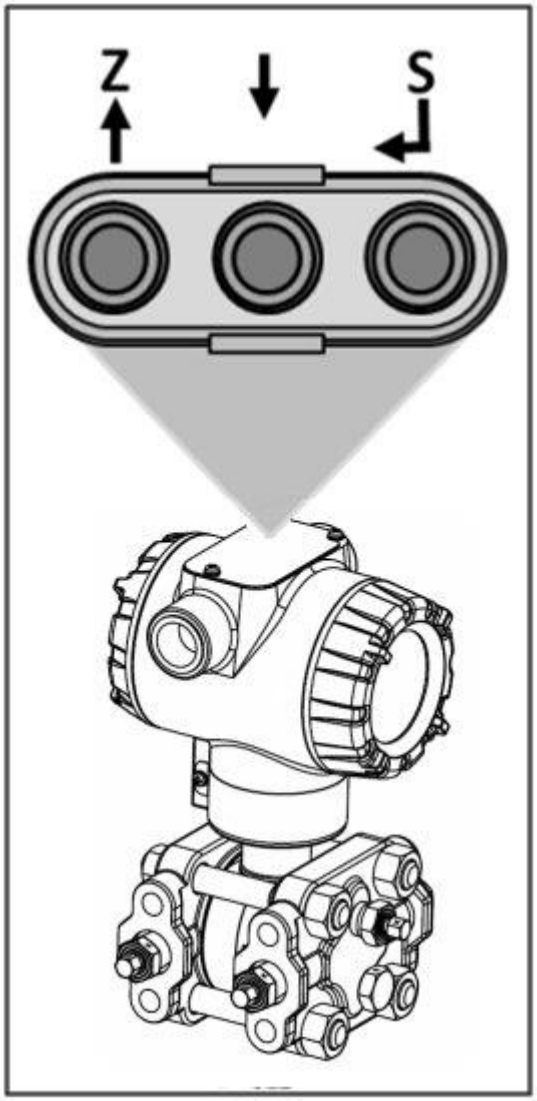


Figure 17 – Three-Button Option

Table 7 – Three-Button Option Functions

Physical Button	Basic Display	Advanced Display	Action
Left ↑	Increment Previous Menu Item	Increment Move cursor Up	Scroll to previous menu item in an active list. Scroll through alphanumeric list to desired character (ex. for entering Tag names or numeric values)
Center ↓	Decrement Next Menu Item	Decrement Move cursor Down	Scroll to next menu item in an active list. Scroll through alphanumeric list to desired character (ex. for entering Tag names or numeric values)
Right ↵	Select displayed menu item for activation or editing	Enter	Call up the Main Menu. Call up a lower-level menu. Select an item for data entry. Confirm a data entry operation Activate the service associated with a selected menu item.

4.2.1 Menu Navigation

The behavior of the buttons is the same for both the Basic and Advanced Displays. The user must press ↵ button to call up the Main Menu. To exit the Main Menu and return to the PV display screen, select <**EXIT**>.

When on a lower level menu, return to the menu above by selecting <Return>. Alternately, the (up) and (down) buttons can be pressed simultaneously to return to the menu above. When on the highest level menu, or when using the basic display menu, pressing the (up) and (down) buttons simultaneously will exit the menu and return to the PV display.

Use the ↑ and ↓ buttons to scroll through the list of menu items. Press the ↵ button to select an item for data entry or activation. When an item is selected for data entry or activation, the cursor will jump to the lower line of the LCD (Basic Display) or call up a pop-up window (Advanced Display) to allow editing of the value. No action is taken against a menu item until the ↵ button is pressed.

If a user presses the ↵ button to begin a data entry operation, they must press another button within 10 seconds or the transmitter firmware will assume that the user wants to abort the operation or has walked away from the transmitter. After 10 seconds with no action, the data entry will time out and the original value of the parameter will be preserved.

If no button presses occur within 60 seconds, menu access will time out and the transmitter will exit the menu and return to the PV display.

4.2.2 Data Entry

Data entry is performed from left to right. Select a character / digit by pressing ↑ or ↓ buttons, and then press ↵ to advance to the next character position to the right. Select the cross-hatch character ▒ to terminate the entry or if the final character is already a space character, just press ↵ again.

All numeric entries are clamped at the low or high limit if needed. You can determine the low and high limit for a parameter by selecting either the ▲ or ▼ character while the cursor is positioned over the left-most digit and press ↵ button. The Display will show the selected limit.

Table 8 – Three-Button Data Entry

Screen Symbol	Numeric data entry	Text entry
▲	Display the high limit for this parameter. This symbol only appears in the left-most position of the data entry field.	Not Available
▼	Display the low limit for this parameter. This symbol only appears in the left-most position of the data entry field.	Not Available
▒	Terminate the numeric entry	Terminate the text entry
0 thru 9, Minus, Decimal	These characters are used to enter numeric values. The minus sign only appears in the left-most digit.	These characters can be used to create custom tags and unit labels
A thru Z, 0 thru 9 special symbols	Not Available	These characters can be used to create custom tags and unit labels

4.2.3 Editing a Numeric Value

Editing a Numeric Value
Editing of a numeric value is a digit-by-digit process, starting with the left-most digit.

1. Press ↵ to begin the edit process.
2. The Basic Display will show the current value of the item on the lower line, left justified. The Advanced Display will show the current value of the item in a pop-up window in the middle of the screen
3. Press the ↑ or ↓ buttons to select the desired digit, and then press ↵ to advance to the next digit to the right.
4. After the last digit has been entered, press ↵ one more time to write the new value to the transmitter.

4.2.4 Selecting a new setting from a list of choices

Use the procedure described below to select a new setting for parameters that present a list of choices (e.g., Screen Format, Display Units, etc.).

1. Press ↵ to begin the edit process.
    a. The Basic Display will show the current setting of the item on the lower line, left justified.
    b. The Advanced Display will show the current setting of the item in a pop-up window.
2. Press the ↑ or ↓ buttons to scroll through the list of choices.
3. Press ↵ to make your selection. The new selection will be stored in the transmitter and will be displayed on the lower line, right justified.

4.2.5 The Advanced Display Menus

The Advanced Display menus are organized into three levels, as shown by Table 9. There is a <**Return**> menu item at each level that allows the user to return to the previous level.

Table 9 – Advanced Display Main Menu Structure

Level 1	Level 2	Level 3
<Exit>	n/a	n/a
Diagnostics	Critical Non-Critical PILD (Optional)*	For details go to the Diagnostics Menu table
Display Setup	LCD Contrast Common Setup Screen 1 Screen 2 … Screen 8	For details go to the Display Setup Menu table. Note that the Advanced Display supports the configuration of up to 8 different screens.
Calibration	Set Time Stamp Zero Correct LRV Correct URV Correct Reset Corrects DAC Trim Loop Test Factory Cal	For details go to the Calibration Menu table.
Transmtr Setup	Parameters Enter LRV Enter URV Set LRV Set URV Install date PILD (Optional)*	For details go to the Transmitter Setup Menu table.
Information	Display Elec Module Meterbody	For details go to the Information Menu table.

*This feature is available only if ST 800 Sensor supports PILD feature.

Table 10 – Diagnostics Menu

All Diagnostics menu items are Read Only.

<Return> Return to the Level 1 menu			
Critical	<Return>		
	Active Diags	# #	Description
	Meterbody	OK FAULT	FAULT: There is a problem with the Meterbody
	Elec. Module	OK FAULT	FAULT: There is a problem with the Electronics Module (HART, DE, or FF)
	Meterbody Comm	OK FAULT	FAULT: There is a problem with the interface between the Meterbody and the Electronics Module.
Non-Critical	<Return>		
	Active Diags	# #	Shows the number of Non-Critical Diagnostics that are currently active
	Analog Out mode	Normal FIXED OUTPUT	Normal indicates that the Loop Output reflects the current value of the PV. FIXED OUTPUT indicates that the Loop Output of the transmitter is manually set a fixed value, probably due to a DAC Trim or Loop Test operation that is currently in progress.
	Zero Correct	OK EXCESSIVE	EXCESSIVE: Input applied exceeds 5% of expected value (as defined by LRV).
	Span Correct	OK EXCESSIVE	EXCESSIVE: Input applied exceeds 5% of expected value (as defined by URV).
	Supply Voltage	OK LOW HIGH	LOW: Supply voltage is below the low specification limit HIGH: Supply voltage is above the high specification limit.
	Primary PV	OK OVERLOAD	OVERLOAD: Input pressure is greater than 200% URL (DP) or 150% URL (GP, AP)
	Meterbody Temp	OK OVER TEMP	OVERTEMP: Meterbody temperature is greater than 125 °C
	Elec Module Temp	OK OVER TEMP	OVERTEMP: Electronics temperature is greater than 85 °C
	Meterbody Comm	OK SUSPECT	SUSPECT: The interface between the Meterbody and the Electronics Module is experiencing intermittent communication failures.
	Factory Cal	OK NO FACTORY CAL	The transmitter has not been calibrated by the factory.
	DAC Temp Comp	OK NO COMPENSATION	The DAC has not been compensated for temperature effects. This is a factory operation.

Non-Critical (continued)	PILD Block OS (Optional)	OK BLOCKED	It is applicable for DP Transmitter only. *OK*: Blockage is not detected *BLOCKED*: Blockage is detected at one side of impulse line. See **Note** below this table.
	PILD Block BS (Optional)	OK BLOCKED	It is applicable for DP Transmitter only. *OK*: Blockage is not detected *BLOCKED*: Blockage is detected at Both sides of impulse line. See **Note** below this table.
	PILD Blockage (Optional)	OK BLOCKED	It is applicable for AP/GP Transmitter only. *OK*: Blockage is not detected *BLOCKED*: Blockage is detected at measurement side. See **Note** below this table.
PILD (Optional)	<Return>		
	Current Mode	Training Monitoring	Displays the current status of PILD algorithm i.e either Training mode or Monitoring Mode. See **Note** below this table
	PILD Factor	PILD factor for blockage prediction 0.0 to 1.0	Displays the current PILD factor value. See the Note below in table
	Training Result	SUCCESS FAILED	Displays the training mode result.

NOTE: This diagnostics message or PILD sub menu will be visible only if PILD feature is supported by the sensor and user enabled in the PILD option in the transmitter.

Table 11 – Display Setup Menus

<Return> Return to the Level 1 menu				
LCD Contrast	<Return>			
	Set Contrast	# #	Adjust the LCD contrast level. Range from 0 to 9. Default: 5	Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to next digit
Common Setup	<Return>			
	Set Password	####	Enter Display configuration password. Default: 0000. This value disables the password. All other values enable the password. When enabled, a prompt to enter the password is presented only on the first parameter successfully accessed to change after entering the menu.	
	Language	• English, French, German, Italian, Spanish, Russian & Turkish • English, Chinese, Japanese	Select the language for the Display. Default: English	Press ↵ to enter menu selection ↑ and ↓ to select from list. ↵ to enter
	Rotation Time	# #	Time duration, in seconds, that each configured screen is shown before moving to the next screen. Range: 3 to 30 seconds Default: 10 seconds	Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to next digit
	Units	atm bar ftH2O @ 68°F gf /cm2 inH2O @ 39°F inH2O @ 60°F inH2O @ 68°F inH2O @ 0°C kgf/cm2 kPa mbar mmH2O @ 4°C mmH2O @ 68° F mmHg @ 0 C MPa Pa psi Torr	This selection determines the units of the values shown on the following menu items: • Enter LRV • Enter URV • Set LRV • Set URV • Zero Correct (Calib. menu) • LRV Correct(Calib. menu) • URV Correct(Calib. menu) • LRL (Meterbody Info. menu) • URL (Meterbody Info. menu) For calibration, this parameter allows the user to match the value displayed on the menus to	Press ↵ to enter menu selection ↑ and ↓ to select from list ↵ to enter

			the units supported by the user's calibration equipment.			
Screens 1 thru 8	<Return>					
	Screen Format	None PV PV & Bar Graph PV & Trend	Select the Screen format from the list.			Press ↵ to enter menu selection ↑ and ↓ to select from list. ↵ to enter
	Trend Duration	##	Select the amount of historic data visible on the Trend screen. Range: 1 to 24 hours. Applies to the "PV & Trend" format only			Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to next digit
	PV Selection	DP, AP, or GP Pressure Meterbody Temp Loop Output Percent Output Static Press PILD Factor (Optional) See Note 3 below	Select the Process Variable (PV) that will be shown this screen.			Press ↵ to enter menu selection ↑ and ↓ to select from list. ↵ to enter
	PV Scaling	None	Display the PV in the default units associated with the PV Selection. Default units: • Pressure:inH2O@ 39ºF • Meterbody Temp: ºC • Loop Output: mA • Percent Output: % • Static Pressure: psi			Press ↵ to enter menu selection ↑ and ↓ to select from list. ↵ to enter Custom Units: ↑ and ↓ to select Alphanumeric ↵ to enter and shift to next char
		Convert Units (Default PV scaling selection)	Convert the displayed PV to any pressure unit listed under Display Units			
		Linear See Note 1 below	Display Units	Custom	Units up to 8 char	
		Square Root (only available for DP transmitters) See Note 2 below.	Display Units	%		
				Custom Units	up to 8 char	
				gal/min		
				gal/h		
				L/m		
				L/h		

Screens 1 thru 8 (continued)	Display Units	atm , bar, ftHO @ 68ºF gf / cm2 inH2O @ 39ºF inH2O @ 60ºF inH2O @ 68ºF inHg @ 0ºC kgf/cm2, kPa, mbar mmH2O @ 4ºC mmH2O @ 68ºF mmHg @ 0ºC MPa, Pa, psi, Torr, ºC, ºF, ºR, K	Select the Display Units for the selected PV.	Press ↵ to enter menu selection ↑ and ↓ to select from list. ↵ to enter
	Custom Units	□□□□□□□□	Enter custom text using any alphanumeric value up to 8 characters long. Custom Units is only available if PV Scaling is set to Linear or Square Root.	Custom Units: ↑ and ↓ to select Alphanumeric ↵ to enter and shift to next character
	Decimal	None X.X X.XX X.XXX	Select the decimal resolution for the PV.	Press ↵ to enter menu selection ↑ and ↓ to select from list. ↵ to enter
	Disp Low Limit	#########	Enter the lower limit shown on the Bar Graph or Trend screen	Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to next digit
	Disp High Limit	#########	Enter the upper limit shown on the Bar Graph or Trend screen.	
	Scaling Low	#########	Enter the low and high scaling limits. These limits are used to scale the displayed PV to the desired value when PV Scaling is set to either Linear or Square Root. See Notes 1 and 2 Below.	
	Scaling High	#########		
	Custom Tag	□□□□□□□□□□□□□□	Enter Custom Tag using any alphanumeric value up to 14 characters long.	Press ↵ to enter menu selection ↑ and ↓ to select Alphanumeric ↵ to enter and shift to next char.

NOTES:

Scaling only affects the value shown on the Display; it does not affect the Loop Output.

1. **Linear scaling of the displayed PV value**
   When "Linear" is selected for PV Scaling, the Display will scale the selected PV input according to the following formula:

   ((PV value – input low limit) / input span) x (Scaling High – Scaling Low) + Scaling Low

   If the PV Selection is Pressure, the input low and high limits are the LRV and URV respectively. If the PV Selection is Percent Output, the input low and high limits are 0 and 100%. If the PV Selection is Square Root, the input low and high limits are 0 and 100 %Flow.

   Note that this scaling only affects the value shown on the Display; it does not affect the Loop Output. [2]

2. **Square Root scaling of the displayed PV value**
   When "Square Root" is selected for PV Scaling, the Display computes %Flow from the Differential Pressure. This calculation is independent of the Transfer Function setting in the transmitter. This allows the user to output Differential Pressure via the 4-20 mA loop output while displaying the equivalent flow value on the Display. In addition, the Display value can be scaled to show the flow in flow units (gal/min, gal/h, etc.) by entering the correct scaling limits via the Scaling Low and Scaling High parameters.

   For example:

PV Selection:	Differential Pressure
PV Scaling:	Square Root
Scaling Low:	0.0
Scaling High:	2500.0
Display Units:	gal/h
LRV:	0.0
URV:	set as required by the process

   The Display will calculate 0-100 %Flow from the Differential Pressure and then scale this to 0 to 2500 gal/h.

   Note that the Square Root calculation is referenced to the LRV and URV settings of the transmitter and it uses the LRV and URV to calculate the %DP input into the Square Root flow algorithm. For normal flow applications, it is assumed that the LRV is set to zero and that zero pressure equals zero flow. If the LRV is less than zero, the Square Root calculation will calculate the flow as bi-directional flow.

3. **PILD Factor value Display**
   PILD Factor can be configured as screen PV selection when the PILD option is enabled. It will not display units and square root indication while displaying in large, trend or bar formats.
   The large PV format provides the current Up Limit and Down Limit values. The PILD Factor value is present only when PILD is enabled and while in Monitoring mode. Otherwise the value will be replaced by a message indicating PILD is disabled or in Training mode.

The trend format provides two dotted horizontal lines on the trend chart to indicate the Up Limit and Down Limit values.

Table 12 – Calibration Menus

<Return> Return to the Level 1 menu				
Set Time Stamp	**<Return>**			
	Hour	# #	These selections allow the user to enter a time stamp for the Zero Correct, LRV Correct, URV Correct, and Reset Corrects. This time stamp can be read via HART and FF communications.	Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to next digit ↑ and ↓ to select from list. ↵ to enter
	Minute	# #		
	Year	# # # #		
	Month	January thru December		
	Day	# #		
Zero Correct	**<Return>**			
	Do Zero Corr.	Executing this selection corrects the Zero based on the input pressure. The current live value of the primary pressure input is shown on this display so the user can easily see the effect of the Zero correction.		Press ↵ to enter menu selection Scroll to Do Zero Corr. Press ↵ to initiate
LRV Correct	**<Return>**			
	Do LRV Correct	Executing this selection corrects the LRV based on the input pressure. The current live value of the primary pressure input is shown on this display so the user can easily see the effect of the LRV correction.		Press ↵ to enter menu selection Scroll to Do LRV Correct Press ↵ to initiate
URV Correct	**<Return>**			
	Do URV Correct	Executing this selection corrects the URV based on the input pressure. The current live value of the primary pressure input is shown on this display so the user can easily see the effect of the URV correction.		Press ↵ to enter menu selection Scroll to Do URV Correct Press ↵ to initiate
Reset Corrects	**<Return>**			
	Reset Corrects	Executing this selection Resets the Zero, LRV, and URV Corrects back to Factory values		Press ↵ to enter menu selection Scroll to Reset Corrects Press ↵ to initiate

DAC Trim Note: Loop must be removed from Automatic Control	**<Return>**			
	Trim Zero	This selection will calibrate the loop zero output to 4.000 mA Connect a current meter to the transmitter to monitor the loop output. When you press Enter, the transmitter will set the loop output to 4 mA. When the prompt "Enter reading" appears, enter the value shown on the current meter (in milliamps) and press Enter again. The transmitter will adjust the DAC output to 4mA.		Press ↵ to enter menu selection Scroll to Trim Zero or Trim Span Press ↵ to initiate ↑ and ↓ to select number. ↵ to enter and shift to next digit
	Trim Span	This selection will calibrate the loop span output to 20.000 mA Connect a current meter to the transmitter to monitor the loop output. When you press Enter, the transmitter will set the loop output to 20 mA. When the prompt "Enter reading" appears, enter the value shown on the current meter (in milliamps) and press Enter again. The transmitter will adjust the DAC output to 20 mA.		
	Set DAC Normal	This selection allows the loop to be returned to its Normal mode (Automatic Control) after performing the Trim operation.		Press ↵ to enter menu selection Scroll to Set DAC Normal Press ↵ to initiate
Loop Test Note: Loop must be removed from Automatic Control	**<Return>**			
	Set DAC Output	This selection allows the user to force the DAC output to any value between 3.8 and 20.8 mA. Note: This selection will put the DAC into Fixed Output Mode.		Press ↵ to enter menu selection Scroll to Set DAC Output Press ↵ to initiate ↑ and ↓ to select number. ↵ to enter and shift to next digit
	Set DAC Normal	This selection allows the loop to be returned to its Normal mode (Automatic Control) after performing the Set DAC Output operation		Press ↵ to enter menu selection Scroll to Set DAC Normal Press ↵ to initiate
Factory Cal	**<Return>**			
	Active Cal Set	Displays the calibration used by the transmitter.		
	Select Cal Set	<Return> Cal Set A Cal Set B* Cal Set C** Best Fit	This selection allows the user to choose calibration set from drop-down menu,	Press ↵ to enter menu selection Press ↑ and ↓ to select calibration type. ↵ to initiate

NOTES:

* "Cal Set B" item in menu is available only if sensor supports Dual calibration

** “Cal Set C” item in menu will be available only if sensor supports Triple calibration.

Table 13 – Transmitter Setup Menus

<Return> Return to the Level 1 menu				
Parameters	**<Return>**			
	Tag ID	□□□□□□□□	Enter Tag ID name up to 8 characters long. □ = any Alphanumeric value	Press ↵ to enter menu selection ↑ and ↓ to select Alphanumeric ↵ to enter and shift to next character to the right.
	Damping (sec)	##. #	Selection applies digital filtering to suppress noise effects on the PV. The limits for this value are 0.0 to 32.0 seconds	
	NAMUR Selection	Disabled	Disabling sets the loop output and burnout levels to the Honeywell levels	Press ↵ to enter menu selection ↑ and ↓ to select from list ↵ to enter
		Enabled	Enabling sets the loop output and burnout levels to the NAMUR levels	
	Filter Performance	Fast SOR	Fast Speed of Response	
		Std SOR	Standard Speed of Response	
Parameters	Transfer Function	Linear	The loop output of the transmitter is a linear representation of the differential pressure.	Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to next digit
		Square Root	The loop output of the transmitter represents %Flow as defined by the DP Square Root flow equation.	
	Flow Cutoff	Single Breakpt	Allows the user to specify a single breakpoint as the low flow cutoff point. This item is only available when the Transfer Function is set to Square Root.	
		Dual Slope	Uses a dual slope formula to determine the low flow cutoff point. This item is only available when the Transfer Function is set to Square Root.	
	Breakpt(%Flow)	##. #	Enter the low flow cutoff point when Single Breakpt	

			is selected. Range: 0 to 25.0 %Flow.	

Enter LRV	**<Return>**			
	Enter LRV	###. ##	The limit for the Lower Range Value is 2X the Lower Range Limit (LRL) of the Meterbody	
Enter URV	**<Return>**			
	Enter URV	###. ##	The limit for the Upper Range Value is 2X the Upper Range Limit (URL) of the Meterbody	
Set LRV	**<Return>**			
	Set LRV	ATTENTION: Executing this service will set the Lower Range Value (LRV) equal to the input pressure		Press ↵ to enter menu selection ↵ to execute
Set URV	**<Return>**			
	Set URV	ATTENTION: Executing this service will set the Upper Range Value (URV) equal to the input pressure		Press ↵ to enter menu selection ↵ to execute
HART Setup	**<Return>**			
	Device ID	Unique for each device		Read Only
	Universal Rev	HART Revision		Read Only
	Field Device Rev	For DD/DTM compatibility		Read Only
	Final Assy Num	Asset tracking number		
	Loop mA	Disabled for Multidrop		
	Poll Address	0 (default) to 63		
	PV Units	Units of transmitted PV		
	SV Units	Units of transmitted SV		
HART Date	**<Return>**			
	Year	# # # #	Enter the current year.	
	Month	January thru December	Select the current month.	
	Day	# #	Enter the day of the month.	
	Write Date	Press ENTER to write the HART Date to the transmitter.		

Install Date	**<Return>**			
	Year	# # # #	Enter the current year. This item will only be visible if no Install Date has been written to the transmitter.	
	Month	January thru December	Select the current month. This item will only be visible if no Install Date has been written to the transmitter.	
	Day	# #	Enter the day of the month. This item will only be visible if no Install Date has been written to the transmitter.	
	Install Date	dd-mmm-yyyy	If no Install Date has been set in the transmitter, this value is a preview of the Year, Month, and Day entered above. Otherwise, this is the Install Date that was previously written to the transmitter.	
	Write Date	Press ENTER to write the Install Date to the transmitter. **<u>CAUTION</u>**: The Install Date can only be written once in the life of the transmitter. You cannot erase or overwrite the Install Date once it has been written.		
PILD (Available only if the PILD Option is enabled)	<Return>			
	PILD	Disabled	Disables PILD detection	Press ↵ to enter menu selection ↑ and ↓ to select Disabled or Enabled. ↵ to initiate. This option will be available only if sensor supports PILD feature
		Enabled	Enables PILD detection	
	Application	<Return>	**See Note below.**	Press ↵ to enter menu selection ↑ and ↓ to select Application Type. ↵ to initiate.
		DP Flow (Available only for DP Transmitter)		
		Marine Level		
		Bubbler Level		
		Other		

PILD (Available only if the PILD Option is enabled)	Sample Window	##	The sampling window of PILD in minutes, which determines the cycle of PILD runs for both training and monitoring mode. Enter the sample window Value. Range: 3 mins, 6 mins, 9 mins, 12 mins, 15 mins. **See Note below.**	Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to next digit.
	Up Limit	#.##	The up limit of PILD factor for normal status.. Enter the Up Limit Value. Range: 0.50 to 1.00. **See Note below.**	Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to next digit
	Down Limit	#.##	The Down limit of PILD factor for normal status.. Enter the Down Limit Value. Range: Both Limit to 0.50 **See Note below.**	Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to next digit
	Both Limit	#.##	The Both sides blockage limit of PILD. Enter the Both Limit Value. Range: 0.00 to Down Limit. It is applicable for only DP Transmitter. **See Note below.**	Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to next digit
	HPF f0	#.#	The High Pass Filter (HPF) Cutoff Frequency (f_0) reduces noise fluctuations in the PILD Factor measured value. Enter the HPF f0 Value. Range: 0.0 to 5.0. **See Note below.**	Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to next digit

Note:
This parameter will be “Read Only” when the user configures PILD as Enabled in this sub menu. An attempt to configure this parameter will then invoke the pop-up message”Read Only! PILD Active”. The parameters Up

Limit, Down Limit and Both Limit are available to change in Monitoring mode while PILD is enabled. An attempt to change these parameters in Training mode results in the pop-up "Read Only! Training Mode".

Table 14 – Information Menus

<Return> Return to the Level 1 menu			
Display	**<Return>**		
	Firmware Version	The firmware version of the Display Module	Read Only
Elec Module	**<Return>**		
	Firmware Version	The firmware version of the Electronics Module	Read Only
	HART/DE Version	The firmware version number of the Electronics Module as displayed via the HART and DE protocols	Read Only
	Protocol	The communications protocol of the transmitter: • HART: HART protocol • DE: Honeywell DE protocol • FF: Foundation Fieldbus	Read Only
Meterbody	**<Return>**		
	Firmware Version	The firmware version of the Meterbody	Read Only
	Model Key	Identifies the type and range of the transmitter	Read Only
	Units	The Engineering Units for the LRL and URL. Note that you can change these Units from the Transmitter Setup menu, if desired (Transmitter Setup\Parameters\Units)	Read Only
	LRL	The Lower Range Limit of the Meterbody	Read Only
	URL	The Upper Range Limit of the Meterbody	Read Only
Options	**<Return>**		
	PILD	Available/Not Available	Read Only
	Serial Number	Unique serial number of the transmitter	Read Only
	License Key	######## License key to enable PILD option	Write only (enter numeric license key

4.2.6 The Basic Display Menu

The Basic Display Menu is implemented as one long single-level menu and will "wrap around" when it reaches the start or end of the menu. Operation is as follows:

Press the ↵ button to call up the Menu.

1. Select <**Exit Menu**> and press ↵ to exit the Menu.
2. Use the ↑ and ↓ buttons to scroll through the list of menu items.

3. Press the ↵ button to select an item for data entry or activation. When an item is selected for data entry or activation, the cursor will jump to the lower line of the LCD to allow editing of the value. No action is taken against a menu item until the user presses the ↵ button.
4. If you want to abort a data entry operation, simply refrain from pushing any buttons for 10 seconds; the data entry operation will time out and the original value of the selected item will be preserved.

Table 15 – The Basic Display Menus

LCD Contrast	»»»»»»	Adjust the LCD contrast level. Range from » (1) to »»»»»»»»»» (9) Default: »»»»»»»» (7)		Press ↵ to enter menu selection ↑ and ↓ to select level. ↵ to enter
PV Display	Pressure	Pressure Units	Select Process Variable (PV) to be shown on the display from list.	Press ↵ to enter menu selection ↑ and ↓ to select from list ↵ to enter
	Percent Output	%		
	Custom Output			
	Loop Output	mA		
PV Decimal	None	Select the PV decimal resolution to be shown on selected screen from list.		
	X.X			
	X.XX			
	X.XXX			
Custom Units (Available only when Custom Output PV Display is selected)	□□□□□□□□	Enter custom text using any alphanumeric value up to 8 characters long.		Custom Units: ↑ and ↓ to select Alphanumeric ↵ to enter and shift to next character
Scaling Low (Available only when Custom Output PV Display is selected)	#########	Enter the low and high scaling limits. These limits are used to scale the loop output to the desired value.		Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to next digit
Scaling High (Available only when Custom Output PV Display is selected)	#########			
Custom Tag	□□□□□□□□□□□□□□	Enter Custom Tag using and alphanumeric value up to 14 characters long		Press ↵ to enter menu selection ↑ and ↓ to select Alphanumeric ↵ to enter and shift to next char.

Range / Cal Units	atm, bar ftH2O @ 68ºF gf/cm2 inH2O @ 39ºF inH2O @ 60ºF inH2O @ 68ºF inHg @ 0ºC kgf/cm2, kPa mbar, mmH2O @ 4ºC, mmH2O @ 68ºF, mmHg @ 0ºC, MPa, Pa, psi Torr, mH2O @ 4ºC mHg @ 0ºC	Choose engineering units for LRV, URV and Corrects values	Press ↵ to enter menu selection ↑ and ↓ to select from list ↵ to enter
Pressure Units (Available only when Pressure PV Display is selected)	atm, bar ftH2O @ 68ºF gf/cm2 inH2O @ 39ºF inH2O @ 60ºF inH2O @ 68ºF inHg @ 0ºC kgf/cm2, kPa mbar, mmH2O @ 4ºC, mmH2O @ 68ºF, mmHg @ 0ºC, MPa, Pa, psi Torr, mH2O @ 4ºC mHg @ 0ºC	Choose appropriate engineering units from list	Press ↵ to enter menu selection ↑ and ↓ to select from list ↵ to enter
Zero Correct	Do Correct	Executing this selection corrects the Zero based on the input pressure	Press ↵ to enter menu selection Press ↵ to initiate action
LRV Correct	Do Correct	Executing this selection corrects the LRV based on the input pressure	
URV Correct	Do Correct	Executing this selection corrects the LRV based on the input pressure	
Reset Corrects	Do Correct	Executing this selection Resets the Zero, LRV, and URV Corrects back to Factory values	

Active Cal Set	Shows one of the option below: Cal Set A Cal Set B Cal Set C Best Fit	Displays the current calibration used by the sensor. Cal Set B is only available with dual calibration Cal Set C is only available with triple calibration	Read Only Parameter
Select Cal Set	Cal Set A Cal Set B Cal Set C Best Fit	This selection allows the user to choose calibration type from the list. Cal Set B is only available with dual calibration Cal Set C is only available with triple calibration	Press ↵ to enter menu selection ↑ and ↓ to select from list ↵ to enter
DAC Zero Trim Note: Loop must be removed from Automatic Control	DAC Zero Trim	This selection allows the loop zero output 4mA value to be trimmed. Note: You must connect a current meter to the transmitter to monitor the loop output.	Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to the next digit to the right
DAC Span Trim Note: Loop must be removed from Automatic Control	DAC Span Trim	This selection allows the loop span output 20mA value to be trimmed. **Note:** You must connect a current meter to the transmitter to monitor the loop output.	
Loop Test Note: Loop must be removed from Automatic Control	Loop Test 12.000	This selection allows the user to force the DAC output to any value between 3.8 and 20.8 mA. Note: This selection will put the DAC into Fixed Output Mode, as indicated by the flashing output value. Navigation away from this menu item will return the loop to Normal (Automatic) Mode.	
LRV URV	#. ## #. ##	The limits are: 2X the Lower Range Limit (LRL) of the Meterbody and 2X the Upper Range Limit (URL) of the Meterbody	Press ↵ to enter menu selection ↑ and ↓ to select number. ↵ to enter and shift to the next digit to the right
Damping	#. ##	Selection applies digital filtering to suppress noise effects on the PV. The limits for this value are 0.0 to 32.0 seconds	
NAMUR	Enabled Disabled	Disabling sets the loop output and burnout levels to the Honeywell levels	Press ↵ to enter menu selection ↑ and ↓ to select from list ↵ to enter
Filter Perf	Fast SOR Standard SOR	Fast Speed of Response Standard Speed of Response	

Transfer Function (only available for DP Transmitters)	Linear	The loop output of the transmitter is a linear representation of the differential pressure	Press ↵ to enter menu selection ↑ and ↓ to select Alphanumeric ↵ to enter and shift to next character to the right.
	Square Root	The loop output of the transmitter represents %Flow as defined by the DP Square Root flow equation.	
Flow Cutoff	Single Breakpt	Allows the user to specify a single breakpoint as the low flow cutoff point. This item is only available when the Transfer Function is set to Square Root.	
	Dual Slope	Uses a dual slope formula to determine the low flow cutoff point. This item is only available when the Transfer Function is set to Square Root.	
Flow Breakpoint	##. #%	Enter the low flow cutoff point when Single Breakpt is selected. Range: 0 to 25.0 %Flow.	
Tag ID	□□□□□□□□	Enter Tag ID name up to 8 characters long. □ = any Alphanumeric value	Press ↵ to enter menu selection ↑ and ↓ to select Alphanumeric ↵ to enter and shift to next character to the right.
HART Device ID	Unique for each device		Read Only
HART PV Units	Units of transmitted PV		
PILD (optional)	Enabled Disabled	This selection allows the user to enable or disable PILD detection. This item will be available only if the PILD option is enabled.	Press ↵ to enter menu selection ↑ and ↓ to select from list ↵ to enter
Serial Number	Unique serial number for the transmitter		Read only
License key	# # # # # # # #	License key to enable PILD option	Write only
Install Date	DD MM YYYY	This selection allows the user to enter the date a transmitter is installed. The Install Date is entered in sequence of Day, Month, and Year, followed by the new date and the prompt Write Date to confirm the entry. **CAUTION**: The Install Date can only be written once in the life of the Transmitter. You cannot erase or overwrite the Install Date once it has been written.	Press ↵ to enter menu selection ↑ and ↓ to select number ↵ to enter and shift to next digit to the right. Read Only after entered

Firmware	Display Electronics Meterbody	Menu item shows the current Firmware versions of the Display, Electronics Module and the Meterbody	Read Only Parameter
Protocol	HART DE FF	Menu item shows the communications protocol	
Model Key		Identifies the type and range of the transmitter	Read Only Parameter
<Exit Menu>			

4.2.7 Selecting a new setting from a list of choices

Use the procedure described below to select a new setting for parameters that present a list of choices (e.g., PV Display, Pressure Units, etc.)

1. Press ↵ to begin the edit process. The Basic Display will show the current setting of the item on the lower line, left justified.
2. Press the ↑ or ↓ buttons to scroll through the list of choices.
3. Press ↵ to make your selection. The new selection will be stored in the transmitter and displayed on the lower line, right justified.

4.3 Three Button Operation with no Display Installed

When there is no Display installed, the buttons can be used to perform a Zero or Span adjustment of the Transmitter. Caution should be taken to insure these adjustments are only made when the correct input pressures are applied.

4.3.1 Zero Adjustment

This adjustment is the same as performing a Set LRV using the Display.

1. Connect a current meter or voltmeter as shown in Figure 16 to monitor the PV output of the Transmitter.
2. Using an accurate pressure source, apply pressure equivalent to the Transmitter LRV.
3. Press the Down (↓) and Zero (↑) buttons together to set the Zero.
4. Verify that the output is now 4 mA.

4.3.2 Span Adjustment

This adjustment is the same as performing a Set URV using the Display.

1. Connect a current meter or voltmeter as shown in Figure 16 to monitor the PV output of the Transmitter.
2. Using an accurate pressure source, apply pressure equivalent to the desired Upper Range Value of the transmitter.
3. Press the **Down (↓)** and **Span (↵**) buttons together to set the span.
4. Verify that the PV output is now 20 mA.

 You can also use the MCT 202 Toolkit to make any adjustments to an ST 800 SmartLine Pressure Transmitter. Alternately, certain adjustments are possible through an Experion Station or Universal Station, if the ST 800 is digitally integrated with either of these stations.

4.4 Changing the Default Failsafe Direction

Transmitters are shipped with a default failsafe direction of upscale. This means that the Transmitter output will set the current output to upscale failsafe (maximum output) upon detection of a critical status. You can change the direction from upscale failsafe to downscale failsafe (minimum output) by moving the top jumper located in the Electronics module.

4.4.1 DE and Analog Differences

Failsafe operation is somewhat different between DE and analog operation:

- **Analog operation** – Upscale failsafe drives the Transmitter output to 21.8 mA. Downscale failsafe drives the Transmitter output to 3.8 mA.
- **DE operation** – Upscale failsafe causes the Transmitter to generate a **+ infinity** digital signal. Downscale failsafe causes the Transmitter to generate a **– infinity** digital signal.

The Transmitter electronics module interprets either signal as *not-a-number* and initiates its own configured failsafe action for the control system.

4.4.2 Procedure to Establish Failsafe Operation

The failsafe direction display accessible via the Toolkit shows only the state of the jumper as it correlates to analog Transmitter operation. Failsafe action for the DE control system may be configured to operate in a manner different from analog, as indicated by the state of the Transmitter jumper.

The integrated circuits in the Transmitter PWA are vunerable to damage by stray static discharges when removed from the Electronics Housing. Minimize the possibility of static discharge damage when handling the PWA as follows:

Do not touch terminals, connectors, component leads, or circuits when handling the PWA.

When removing or installing the PWA, handle it by its edges or bracket section only. If you need to touch the PWA circuits, be sure you are grounded by staying in contact with a grounded surface or by wearing a grounded wrist strap.

When the PWA is removed from the Transmitter, put it in an electrically conductive bag, or wrap it in aluminum foil to protect it.

The following procedure outlines the steps for positioning the write protect and failsafe jumpers on the electronics module. See Figure 18 for the locations of the failsafe and write protect jumpers.

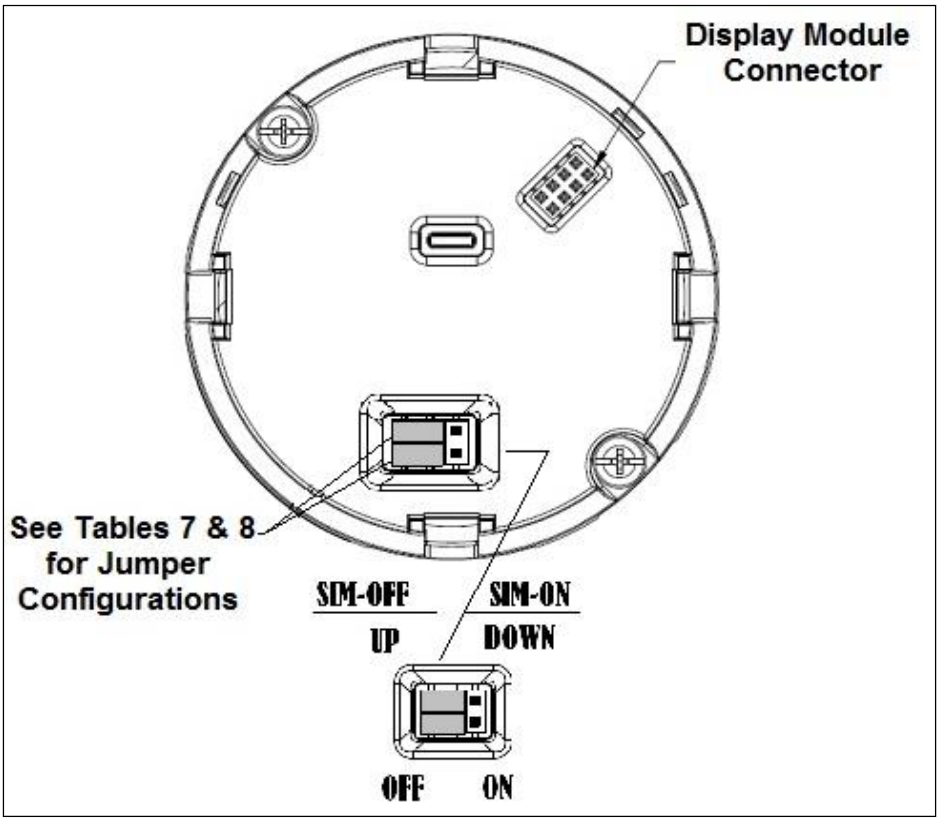


Figure 18 – Locating the Failsafe and Write Protect Jumpers

Table 16 – Hart and DE Failsafe and Write Protect Jumpers

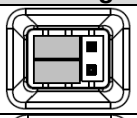
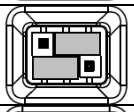
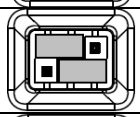
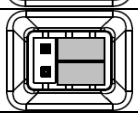
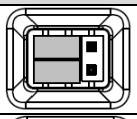
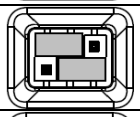
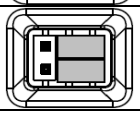
Jumper Arrangements	Description
	Failsafe = UP (High) Write Protect = OFF (Not Protected)
	Failsafe = DOWN (Low) Write Protect = OFF (Not Protected)
	Failsafe = UP (High) Write Protect = ON (Protected)
	Failsafe = Down (Low) Write Protect = On (Protected)

Table 17 – Fieldbus Simulation and Write Protect Jumpers

Image	Description
	Fieldbus Simulation Mode = OFF Write Protect = OFF (Not Protected)
	Fieldbus Simulation Mode = OFF Write Protect = ON (Protected)
	Fieldbus SIM Mode = ON Write Protect = OFF (Not Protected)

1. Turn OFF Transmitter power (Power removal is only required in accordance with area safety approvals. Power removal is only required in Class 1 Div 1 Explosionproof and Class 1 Div 2 environments).

2. Loosen the end cap lock, and unscrew the end cap from the electronics side of the Transmitter housing.

3. If equipped with a Display module, carefully depress the two tabs on the sides of the Display Module, and pull it off.

4. If necessary, unplug the interface connector from the Communication module. Do not discard the connector.

5. Set the Failsafe Jumper (top jumper) to the desired position (UP or DOWN). See Table 16 and Table 17 for jumper positioning.

6. If applicable, re-install the Display module as follows:
   - Orient the display as desired.
   - Install the Interface Connector in the Display module such that it will mate with the socket for the display in the Communication module.
   - Carefully line up the display, and snap it into place. Verify that the two tabs on the sides of the display latch.

NOTE: Installing a Display Module into a powered transmitter may cause a temporary upset to the loop output value.

Orient the Display for proper viewing through the end cap window. You can rotate the meter mounting orientation in 90 º increments.

7. Restore transmitter power if removed.

4.5 Monitoring the Basic and Advanced Displays

This section describes the information shown on the operator screens of the Advanced and Basic Displays.

4.5.1 Basic Display

Figure 19 illustrates the Basic Display format with Process Variable (PV).

- The PV value is user-configurable. This field has 7 characters. The maximum allowable numeric value is 9999999 or -999999. If fractional decimals are configured, the fractional positions will be dropped, as required. If the PV value exceeds the above limits, it is divided by 1000 and "K" is appended to the result, allowing a maximum value with multiplier of 999999K or -99999K.
- Process Variable Tag is user-configurable from a HART Host. This field has 14 characters.
- Engineering Units. This field is user-configurable. This field has 8 characters.

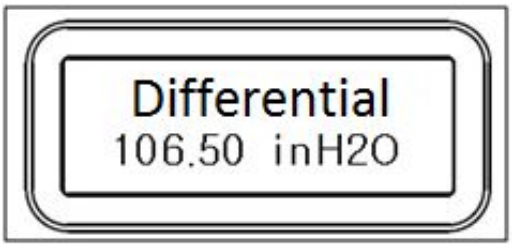


Figure 19 – Basic Display with Process Variable Format

4.5.2 Advanced Displays

As shown in Figure 20 , the Advanced Display provides three formats. Table 18 lists and describes the fields in each of the three Advanced Display formats. Essentially, all three formats provide the same information, but with the following differences:

- Bar Graph. User Configurable 126 segment Bar Graph with range settings. The Bar Graph displays the current value of the configured PV.
- PV Trend. User-configurable display period from one hour to 24 hours. The chart displays minimum, maximum, and average of the configured PV over the selected trend period.

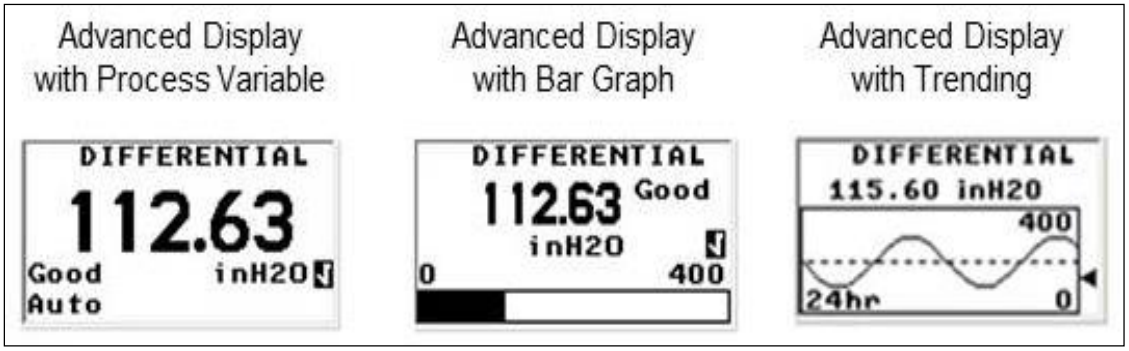


Figure 20 – Advanced Display Formats with the Process Variable

Table 18 – Advanced Displays with PV Format Display Indications

Display Indicator	What It Means
Diagnostic / Maintenance These indicators are displayed in the upper left corner of the screen when the associated conditions are present in the transmitter.	D Diagnostic condition present This indicator is displayed any time a diagnostic is present in the transmitter, either Critical or Non-Critical. If a Critical Diagnostic is present, the message "Critical Diag" will flash at the top of the screen and the appropriate Diagnostic screen will be inserted into the normal screen rotation.  To determine which Non-Critical diagnostics are active, use the local buttons to call up the Non-Critical diagnostics menu (Main Menu\Diagnostics\Non-Critical. Refer to Table 10 for details concerning the Non-Critical diagnostics. M Maintenance Mode is active This indicator is set by the Experion DCS. When this Mode is active, a screen with the text "Available for Maintenance" will be inserted into the normal screen rotation to make it easy to identify transmitters that are available for maintenance.
PV Value	User Configurable. This field has 7 characters. Maximum allowable numeric value of 9999999 or -999999. If fractional decimals are configured, the fractional positions will be dropped as required. If the PV exceeds the values above limits, the PV is divided by 1000 and "K" is appended to the result, allowing a maximum value with multiplier of 999999K or -99999K
PV Status:	Good The transmitter is operating normally Bad The transmitter has detected a fault condition. The PV Status field will flash when this condition is present and the PV Value will be displayed on a black background as shown below:  Unc Uncertain (this status is only available for FF transmitters) The PV Value is outside of normal limits.

<table>
<tr><td rowspan="2">PV Function Block Mode</td><td colspan="4">The Function Block Mode is only displayed for Foundation Fieldbus transmitters. The eight possible Modes are shown below.</td></tr>
<tr><td colspan="2">OOS Out Of Service
Auto Automatic
Man Manual
Cas Cascade</td><td colspan="2">RCas Remote Cascade
Rout Remote Output
IMan Initialization Manual
LO Local Override</td></tr>
<tr><td>Process Variable Tag</td><td colspan="4">User Configurable. This field has 14 characters</td></tr>
<tr><td rowspan="2">Engineering Units</td><td colspan="4">User Configurable. This field has 8 characters</td></tr>
<tr><td>Pressure:
atm
bar
fttH2O
gf/cm2
inH20 @ 39F
inH20 @ 60F
inH20 @ 68F
inHg @ 0C
kgf/cm2</td><td>Pressure:
kPa
mbar
mmH2O @ 4C
mmH2O @ 68F
mmHg @ 0C
mPa
Pa
psi
Torr
mH2O @ 4C
mHg @ 0C</td><td>Temp:
º C
º F
º R
K (Kelvin)</td><td>Other:
Percent (%)
milliamp (mA)
Custom Text

Flow:
gal/min
gal/h
L/min
L/hr</td></tr>
<tr><td>Square Root Output</td><td colspan="4">This indicator is displayed when the Transfer Function of the transmitter is set to “Square Root”.

Note that this indicator is not displayed on the Trend screens.</td></tr>
<tr><td>Bar Graph</td><td colspan="4">The limits of the bar graph are user-configurable for each screen.</td></tr>
<tr><td>Trend Graph</td><td colspan="4">The limits of the trend graph are user-configurable for each screen. The amount of time visible on the Trend graph is also configurable.</td></tr>
</table>

4.5.3 Button operation during monitoring

When the operator screens are active on the Advanced Display, the Increment and Decrement buttons (↑ and ↓) can be used to move to the next or previous operator screen without waiting for the rotation time to expire. Pressing the Enter button (↵) will call up the Main Menu.

5 Maintenance

5.1 Overview

This section provides information about preventive maintenance and replacing damaged parts. The topics covered in this section are:

- Preventive maintenance of the meter body barrier diaphragms and process piping to the Transmitter.
- Replacement of damaged parts such as the Transmitter Printed Wiring Assembly (PWA) and meter body

5.2 Preventive Maintenance Practices and Schedules

The ST 800 Transmitter does not require any specific maintenance at regularly scheduled intervals. However, it is recommended that you perform these typical inspection and maintenance routines on a schedule that is dictated by the characteristics of the process medium and if blow-down facilities or purge systems are being used.

- Check piping for leaks.
- Clear piping of sediment or other foreign matter.
- Clean the Transmitter process heads, including the barrier diaphragms.

5.3 Inspecting and Cleaning Barrier Diaphragms

Depending on the characteristics of the process medium, sediment or other foreign particles may collect in the process head cavity/chamber and cause faulty measurement. In addition, the barrier diaphragm(s) in the Transmitter meter body may become coated with residue from the process medium. The latter is also true for external diaphragms on flange-mount and remote seal type Transmitters.

In many cases, you can readily remove the process head(s) from the Transmitter meter body to clean the process head cavity and inspect the barrier diaphragm(s). For flange-mount and remote seal diaphragms, you may only need to run a purge line in the tank to rinse off the face of the diaphragm(s).

The following procedure comprises the general steps for inspecting and cleaning barrier diaphragms. You may have to modify these steps to meet your particular process or transmitter model requirements. Figure 21 shows an exploded view of a Differential Pressure (DP) Transmitter meter body for reference. For disassembly/reassembly purposes, Gauge Pressure (GP) and Absolute Pressure (AP) Transmitters are similar.

 It is recommended that you remove the Transmitter from service and move it to a clean area before disassembling it.

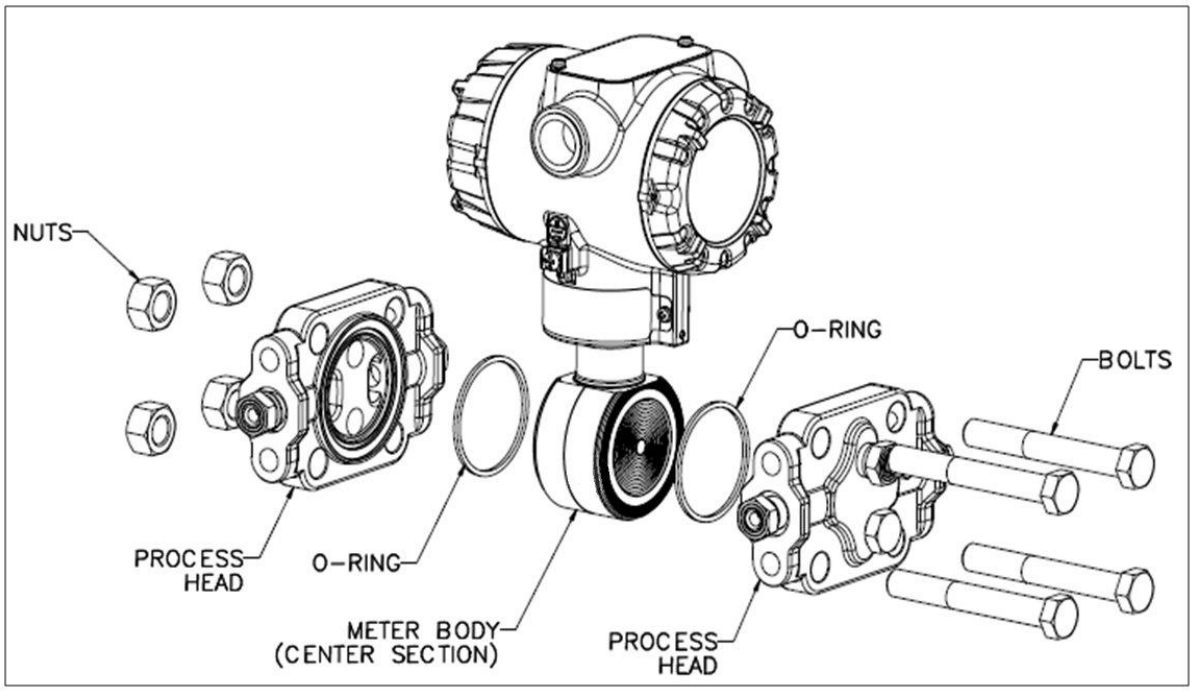


Figure 21 – DP Transmitter Head Disassembly

1. Close all valves to isolate the Transmitter from the process.
2. Open the vent in the process head to drain fluid from the Transmitter meter body, as necessary.
3. Remove the Transmitter from the process.
4. Loosen the nuts in the sequence shown in Figure 22.
5. Remove the nuts from the bolts that hold the process head(s) to the meter body.
6. Remove the process heads and bolts.
7. Remove the gasket/ O-ring, and clean the interior of the process head using a soft bristle brush and an approved solvent.
8. Inspect the barrier diaphragm for signs of deterioration, corrosion, and distortion.
9. If the diaphragm is distorted contact Honeywell for assistance.
10. Install a new gasket/O-ring in each process head.
11. Coat threads on the process head bolts with a suitable anti-seize compound, such as "Neverseize," or equivalent.
12. Using a torque wrench, gradually tighten the nuts in the sequence shown in Figure 22. Tighten head bolts in stages of 1/3-full torque, 2/3-full torque, and full torque. See Table 19 for torque requirements versus Transmitter type and model.

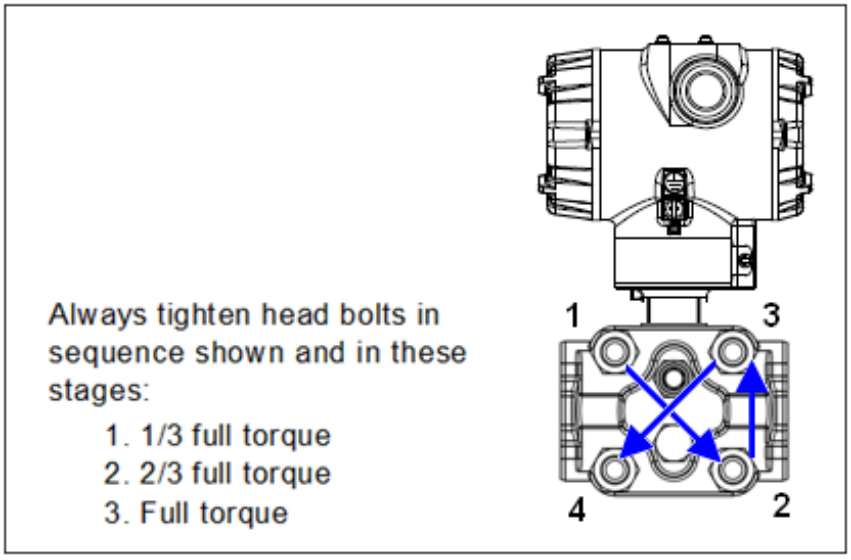


Figure 22 – Head Bolt Tightening Sequence

Table 19 – Head Bolt Torque Values

BOLTING TYPE	B7M BOLTING TABLE III B7 OPTION BOLT 51452557-004 NUT 51452559-003	PTFE COATED B7M BOLTING Y SPECIAL OPTION BOLT 51452557-007 NUT 51452559-007	MONEL K 500 BOLTING Y SPECIAL OPTION BOLT 51452557-005 NUT 51452559-005	25% CHROMIUM SUPER DUPLEX BOLTING Y SPECIAL OPTION BOLT 51452557-006 NUT 51452559-006	316 STAINLESS STEEL BOLTING TABLE III SS OPTION BOLT 51452557-003 NUT 51452557-003 BOLT 51452559-004	NACE CR BOLTING TABLE III CR OPTION BOLT 51452557-002 NUT 51452559-02	ALL GRADE 660 CLASS D BOLTING Y SPECIAL OPTION BOLT 51452557-001 NUT 51452559-008	CARBON STEEL BOLTING STANDARD OPTION BOLT 51452557-001 NUT 51452559-001	ALL GRADE 660 CLASS D BOLTING Y SPECIAL 6 KPSI OPTION BOLT 51452557-202 NUT 51452559-008
50049713XXXX, EXCEPT XXX5 ALL TRANSMITTERS EXCEPT DRAFT RANGE	48,8 N•M +/- 2,4 N•M (36.0 Lb-Ft +/- 1.8 Lb-Ft)				56,9 N•M +/- 2,8 N•M (42.0 Lb-Ft +/- 2.1 Lb-Ft)			67,8 N•M +/- 3,4 N•M (50.0 Lb-Ft +/- 2.5 Lb-Ft)	
50049713XXX5 DRAFT RANGE TRANSMITTER ONLY	20,3 N•M +/- 1,0 N•M (15.0 Lb-Ft +/- 0.8 Lb-Ft)								

5.4 Replacing the Communication Module

The Communication module includes a connector to the sensor ribbon cable and a connector to the optional Display module. This section includes the procedure to replace the Communication module.

The transmitter does not have to be removed from service to replace the Comm Module

Please take appropriate steps to avoid ESD damage when handling the Communication and Display Module assemblies

Refer to Figure 23 for parts locations.

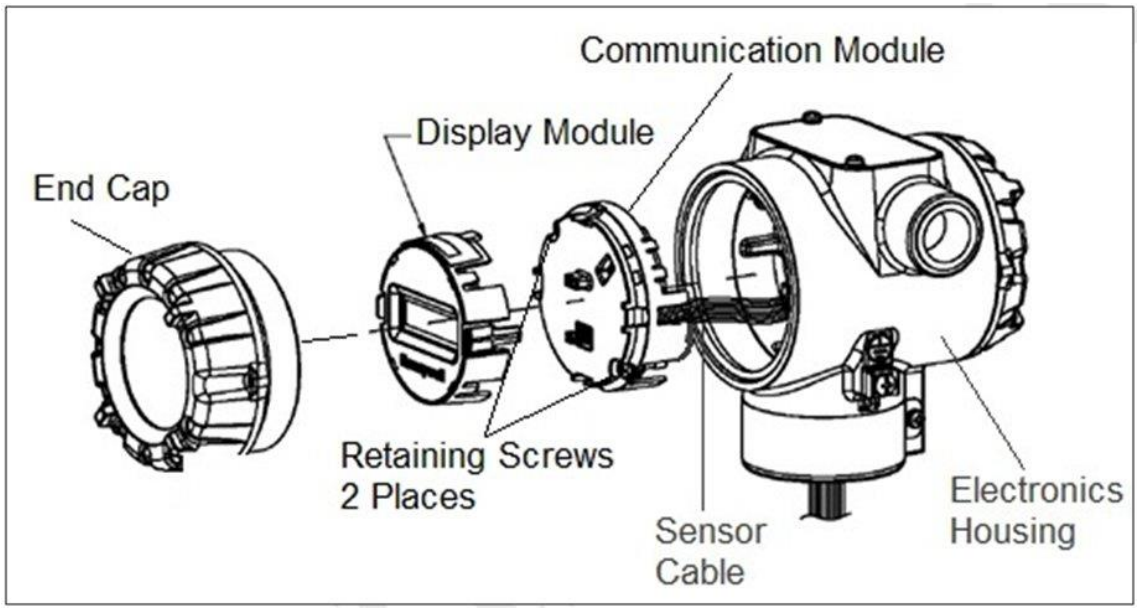


Figure 23 – PWA Replacement

1. Turn OFF Transmitter power (Power removal is only required in accordance with area safety approvals. Power removal is only required in Class 1 Div 1 Explosionproof and Class 1 Div 2 environments).
    - When removing the Communications Module with power applied, the loop will go to 0V. Likewise, installing a Communications Module into a transmitter with power applied will cause the loop output value to go to 12 ma for several seconds then the loop output value will go to the configured value based on the PV input.
    - Installing a Display Module into a powered transmitter may cause a temporary upset to the loop output value.
2. Loosen the end cap lock, and unscrew the end cap from the electronics side of the Transmitter housing.

3. If equipped with a Display module, carefully depress the two tabs on the sides of the Display Module, and pull it off.

4. If necessary, unplug the interface connector from the Communication module. **Do not discard the connector**.

5. Loosen the two retaining screws, and carefully pull the Communication module from the Electronics compartment.

6. Carefully align and connect the Sensor Ribbon Cable to the connector "J4" at the bottom of the Communication module. When installing the Communication module in the next step, be careful not to pinch the Sensor Ribbon Cable.

7. Carefully, insert the Communication module into the Electronics compartment. Ensure that the Sensor Ribbon Cable is not pinched.

8. Tighten the two Communication module retaining screws.

9. Refer to the Section 4.4 to change the FAILSAFE, READ/WRITE, and SIM-OFF/SIM-ON (Fieldbus Only) configuration settings.

10. If applicable, re-install the Display module as follows:

    a) Orient the display as desired.

    b) Install the Interface Connector in the Display module such that it will mate with the socket for the display in the Communication module.

    c) Carefully line up the display, and snap it into place. Verify that the two tabs on the sides of the display latch.

Orient the Display for proper viewing through the end cap window. You can rotate the meter mounting orientation in 90 º increments.

11. Apply Parker Super O-ring Lubricant or equivalent to the end cap O-ring before installing the end cap. Reinstall the End Cap and tighten the End Cap locking screw.

12. Installing Optional External Configuration Button Assembly.

    a) Loosen (Do Not Remove) both top nameplate screws and pivot nameplate 90°.

    b) Align the protrusion on the button assembly with the matching opening in the housing and snap the button assembly into the housing.

    c) Rotate the nameplate back to the original position, and tighten the nameplate screws.

(Steps 13 - 16 required for Field Upgrades Only)

13. Loosen the End Cap locking screw and unscrew the End Cap from the Field Wiring side of the transmitter housing.

14. Select the proper Communication/External Configuration upgrade kit label from the label strip provided and adhere to the inside of the Field Wiring compartment End Cap.

15. Apply Parker Super O-ring Lubricant or equivalent to the end cap o-ring before installing the end cap. Reinstall the End Cap and tighten the end cap locking screw.

16. Install external upgrade label (i.e. DEVICE MODIFIED…..) provided on outside of housing as shown in Figure 23.

17. Restore power if removed.

18. Check the settings of the Transmitter Setup and Display Setup parameters to make sure that the transmitter is configured correctly for your application. See the HART and DE User's Manual (ST 800 #34-ST-25-38, ST 700 #34-ST-25-47) for details on HART and DE transmitters. Refer to manual #34-ST-25-39 for additional information about Fieldbus transmitters.

19. If applicable, verify External Button Configuration operation.
    Ready to go.

5.5 Replacing the Meter Body

You can replace the complete meter body, including the process heads, or the meter body only on certain Differential Pressure (DP), Gauge Pressure (GP), and Atmospheric Pressure (AP) Transmitters by using the existing process head(s). Use the following procedure for meter body-only replacement.

1. Save or record device configuration data.
2. Turn off Transmitter power.
3. Remove the Transmitter from service, and move it to a clean area before disassembling it.
4. Refer to Figure 24. Loosen the End Cap Lock, and unscrew the End Cap from the electronics side of the Transmitter housing.

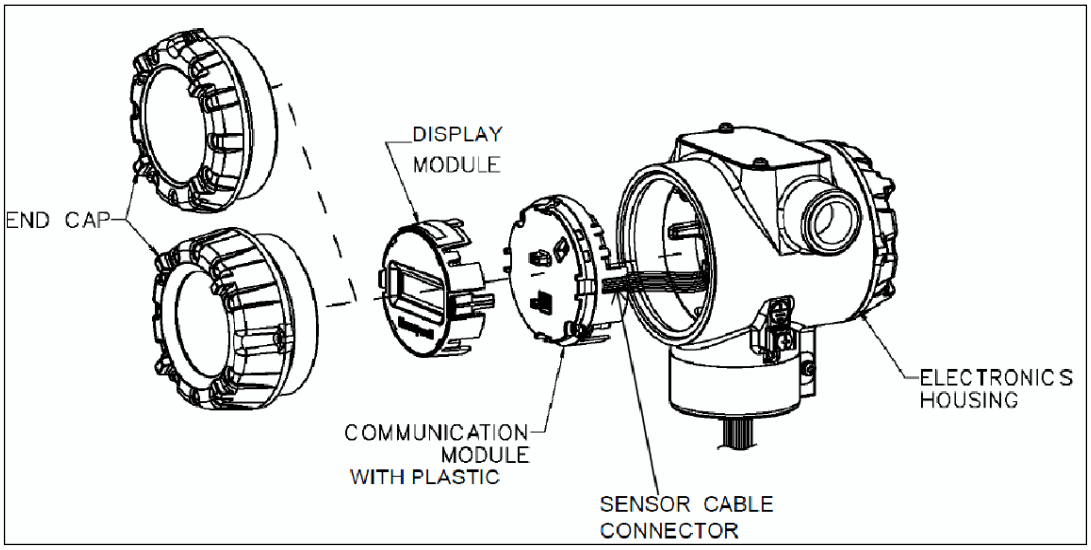


Figure 24 – Disassembly for Meter Body Replacement

Please take appropriate steps to avoid ESD damage when handling the Communication and Display Module assemblies

5. If a display is present, press the two snaps along the side, and remove it from the communication module assembly.
   Note: Do not discard or misplace the Display/Communication connector, it will be required to reassemble the Display Module
6. Loosen the two retaining screws, and remove the Communications Module assembly, and remove the Communication Module assembly from the electronics housing.
7. Disconnect the Sensor Cable from the Communications Board.
8. Refer to Figure 25 . Use a 2 mm hex wrench to completely loosen the set screw on the outside of the housing to permit rotating the meter body.

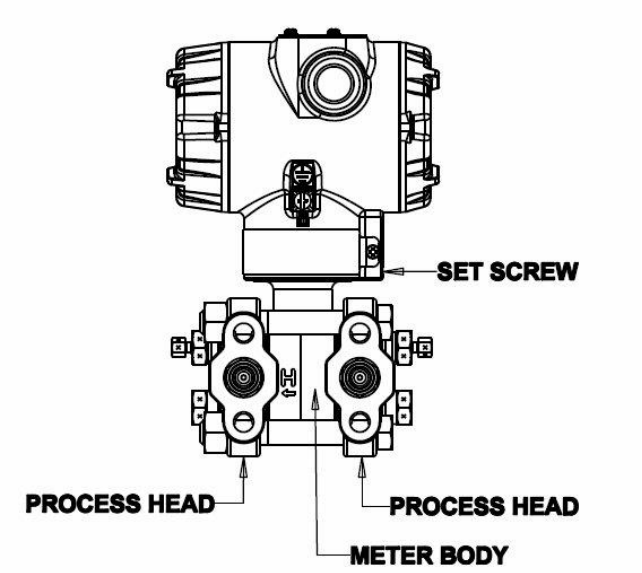


Figure 25 – Hardware Location to Remove the Meter Assembly

9. Carefully turn the complete meter body counterclockwise to unscrew it from the electronics housing.
10. Remove the nuts from bolts that hold the process head(s) to the Meter Body.
11. Remove process heads and bolts.
12. Remove the gaskets or O-rings from the process heads.
13. Clean the interior of the process head(s) with a soft bristle brush and suitable solvent.

CAUTION

To prevent damage to the diaphragm in the Meter Body, use extreme care when handling or placing the Meter Body on any surface. Carefully assemble gaskets or O-rings to the meter body. If installing O-rings, lubricate with water or leave dry.

14. Coat threads on process head bolts with anti-seize compound such as “Neverseize” or equivalent.

15. Refer to Figure 26. Apply Dow Corning #33 silicone grease to the meter body adapter O-ring and carefully assemble the O-ring to the meter body. Assemble the process head(s) and bolts to the new meter body. For now, make the bolts only finger-tight.

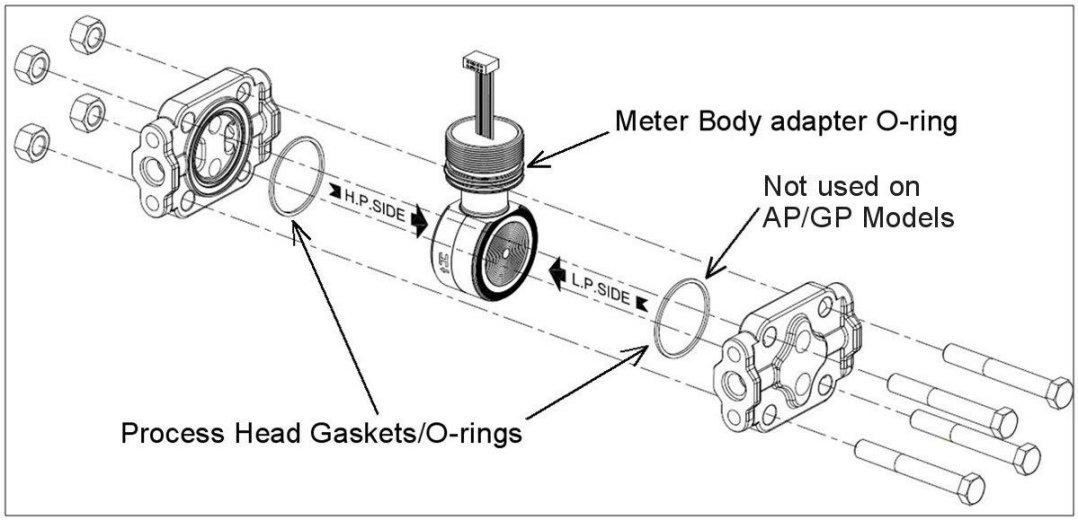


Figure 26 – Meter Body Reassembly

16. Use a torque wrench to gradually tighten nuts to torque rating in sequence shown in Figure 27. Tighten head bolts in stages of 1/3 full torque, 2/3 full torque, and then full torque.

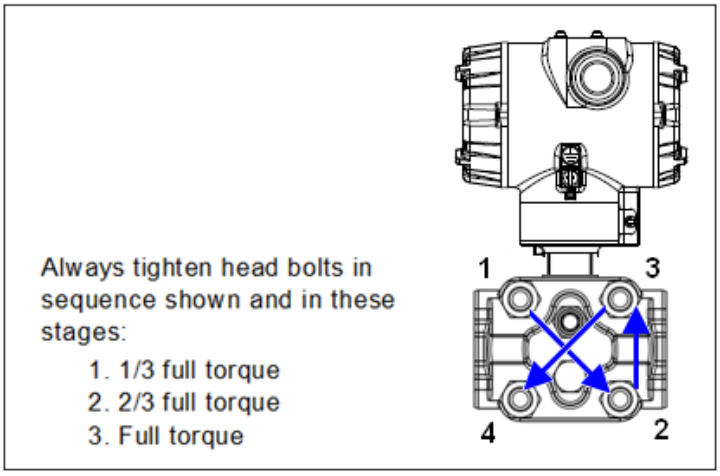


Figure 27 – Head Bolt Tightening Sequence

17. Feed the ribbon cable on the new meter body through the neck of the housing.

CAUTION

To prevent damage to the ribbon cable, use care when assembling the Meter Body to the electronics housing.

18. Screw the new meter body into the housing until the bottom of the Meter Body adapter is flush with the neck of the electronics housing.

19. Tighten the outside set screw to be sure it is fully seated in the slot in the header.
20. Loosen the set screw ½- turn.
21. Rotate the housing to the desired position (Max. 180^{o} in either direction), and tighten the set screw.
22. Carefully align and connect the Sensor Ribbon Cable to connector "J4" at the bottom of the Communication module board. When installing the Communication module in the next step, be careful not to pinch the Sensor Ribbon Cable.
23. Carefully, insert the Communication module into the Electronics compartment. Ensure that the Sensor Ribbon Cable is not pinched.
24. Tighten the two Communication module retaining screws.
25. If applicable, re-install the Display module as follows:

    a) Orient the display as desired.

    b) Install the Interface Connector in the Display module such that it will mate with the socket for the display in the Communication module.

    c) Carefully line up the display, and snap it into place. Verify that the two tabs on the sides of the display latch.

Orient the Display for proper viewing through the end cap window. You can rotate the meter mounting orientation in 90^{o} increments.

26. Connect the bracket to the Transmitter housing.
27. Recalibrate the Transmitter per Section 6 "Calibration" of this document.
28. Return the Transmitter to service, and turn ON power
29. Verify the Transmitter configuration data. Restore the saved database if necessary.
30. Lubricate the end-cap O-ring with Parker Super O-ring silicone lubricant or equivalent before replacing the end caps.

5.6 PILD Option Licensing

The PILD option can be enabled after the transmitter is shipped by purchasing and activating a license.

To obtain and activate a license for the PILD option:

- Obtain the device's Serial Number from the local display menu or from the host interface.
- Reference document PILD Upgrade Option, ST 800 Instruction (#34-ST-33-73) for firmware revision level requirements.
- Place an order for PILD Field Upgrade for ST 800, part number 50097038-501 with the Serial Number.
- Based on this information the regional distribution centre will generate and return a license key.
- The license is activated by entering the License Key parameter value from the local display menu or host interface.

- A restart of the display only will then occur.
- License activation can be confirmed by observing that the PILD option is enabled using the local display menu or host interface.

6 Calibration

6.1 Recommendations for Transmitter Calibration

The ST 800 Pressure Transmitter does not require periodic calibration to maintain accuracy. Typically, calibration of a process-connected Transmitter will degrade, rather than augment the capability of a smart Transmitter. For this reason, it is recommended that a Transmitter be removed from service before calibration. Moreover, calibration will be accomplished in a controlled, laboratory-type environment, using certified precision equipment.

6.2 Calibration Procedures

For a Transmitter operating in analog mode, you must calibrate its output signal measurement range using any compatible hand-held communicator or a local display.

One calibration option is to use the Honeywell Smart Field Communicator (SFC). Refer to the *Smart Field Communicator Operating Guide*, 34-ST-11-14 for calibration procedures.

Calibration information and procedures for a Transmitter operating in the HART/DE mode are provided in the *ST 800 Series HART/DE Option User's Manual*, document number 34-ST-25-38, Section on "Calibration."

6.2.1 Dual/Triple Cal

STA, STD, STG and STF800 models are optionally offered with multiple calibrations. In lieu of a standard factory calibration, units can be supplied with 1, 2, or 3 customer specified calibrations. These calibrations are stored in the meter body and provide users with factory calibrated performance at up to three different calibrated ranges. This increases application flexibility without requiring any costly recalibration or additional inventory.

7 Troubleshooting

7.1 Overview

Troubleshooting involves responding to error messages, primarily displayed by the MC Toolkit. Error messages that may occur on the Transmitter's local display are fairly self-explanatory and intuitive. However, this section covers the diagnostic messages that indicate critical conditions. Other than the critical conditions, additional detail is not provided. If you require assistance, contact your distributor or Honeywell Technical Support. All other messages are covered by the MC Toolkit Users' Manual.

7.2 Critical Diagnostics Screens

When a Critical Diagnostic is present in the Transmitter, the Advanced Display will show one or more of the screens pictured in Figure 28. These screens will be inserted into the normal screen rotation and displayed between the user-defined operator screens. A description of the diagnostic conditions is given Table 20, along with suggested actions for resolving the problem.

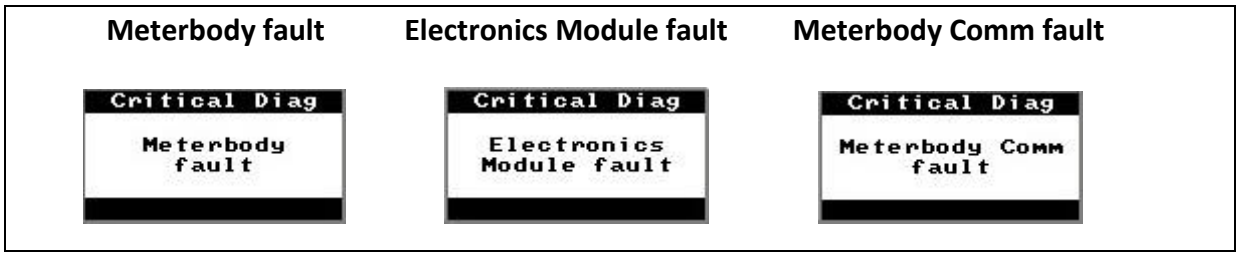


Figure 28 – Local Display Fault Diagnostic Conditions

The Basic Display will display the message CRITCAL FAULT on the top line of the LCD and the appropriate diagnostic text on the lower line.

7.2.1 Fault Conditions and Recommended Corrective Actions

Table 20 – Fault Conditions and Recommended Corrective Actions.

Condtion	Analysis	Recommended Corrective Action
Meterbody fault. A critical failure has been detected in the Meterbody	Use a HART, DE, or FF communicator to read the detailed status information from the transmitter. Refer to the appropriate communicator manual to get more information about the possible causes of the failure.	Cycle power to the Transmitter. If the problem continues to occur, replace the Meterbody.
Electronics Module Fault. A critical failure has been detected on the HART, DE, or FF Electronics Module.	Use a HART, DE, or FF communicator to read the detailed status information from the transmitter. Refer to the appropriate communicator manual for more information about the possible failure causes.	Cycle power to the transmitter. If the problem continues to occur replace the Electronics Module.

Meterbody Comm fault. Communications between the Meterbody and the Electronics Module has failed.	This could be the result of a failure on either of these modules or the cable that connects them. Use a HART, DE, or FF communicator to read the detailed status information from the transmitter. Refer to the appropriate communicator manual to get more information about the possible causes of the failure.	Check the ribbon cable that connects the Meterbody to the Electronics Module. Make sure that the cable is securely plugged into the Electronics Module. Make sure that all pins are plugged into the connector (i.e., make sure that the connector is not offset in a way that leaves some pins unconnected). Cycle power to the transmitter. If the problem continues to occur replace the Electronics Module. If this does not fix the problem, replace the Meterbody.

8 Parts List

8.1 Overview

Individually saleable parts for the various Transmitter models are listed in this section. Some parts are illustrated for identification. Parts are identified and listed in the corresponding tables as follows:

- Individually saleable parts are indicated in each figure by key number callout.
- Parts that are supplied in kits are indicated in each illustration by key number callout with the letter K prefix.

Table 21 is a summarized list of recommended spare parts.

Table 21 – Summary List of Recommended Spare Parts

Part Number	Description	Figure No.	Key No.	1-10 Units	10-100 Units	100-1000 Units
	Electronics Housing Assembly					
50049849-501 50049849-502 50049849-503 50049849-504 50049849-507 50049849-508	HART Electronics Module Without REED Sensor PWA HART Electronics Module With REED Sensor PWA DE Electronics Module Without REED Sensor PWA DE Electronics Module With REED Sensor PWA FieldBus Electronics Module Without REED Sensor PWA FIeldBus Electronics Module With REED Sensor PWA	Figure 30	5	1	1-2	2-4
51452865-201 51452865-202 51452865-203 51462865-204	**Meter Body Seal kit (includes O-rings)** Glass Filled PTFE VITON 100% PTFE GRAPHITE	Figure 33 & Figure 34	K1	1	1-2	2-4
50075472-531 50075472-532 50075472-533 50075472-534	HART/DE Terminal Block Assy Without Lightning Protection HART/DE Terminal Block Assy With Lightning Protection FieldBus Terminal Block Assy Without Lightning Protection FieldBus Terminal Block Assy With Lightning Protection	Figure 31	3	1	1	1-2
	Process head gasket kit	**Figure No.**	**Key No.**	**1-10 Units**	**10-100 Units**	**100-1000 Units**
51452868-501	Gasket only, Process Head (12 PTFE packs)	Figure 33 & Figure 34	K7	12	12-24	24-48
51452868-502	Gasket only, Process Head (6 Viton Head O-Rings)			6	6-12	12-24
51452868-507	Gasket only, Process Head Graphite Gasket (replacement only for existing graphite gasket)			6	6-12	12-24

	Meter Body	Figure No.	Key No.	1-10 Units	10-100 Units	100-1000 Units
Specify complete number from nameplate	DP Models	Figure 33	1	1	1-2	2-4
	GP/AP HEAD Models	Figure 34	1			
	LGP/LAP Models	Figure 35	1			
	Flush Mount Models	Figure 36	1			
	Flange Mount Models	Figure 37	1			
	Remote Diaphragm Seal Models	Figure 39	1			

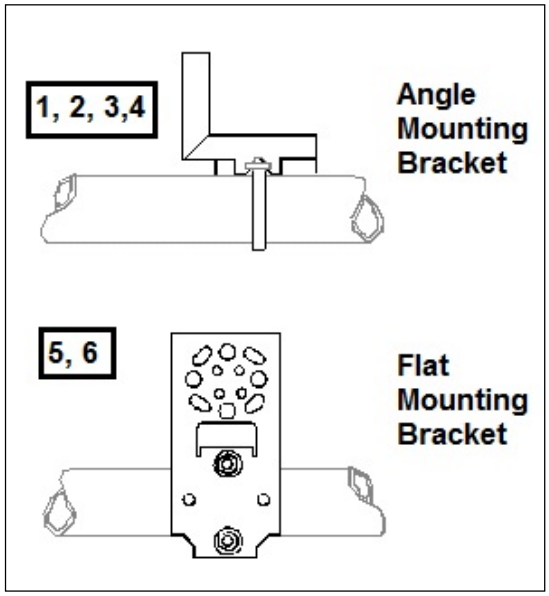


Figure 29 – Angle and Flat Bracket Parts

Table 22 – Angle and Flat Bracket Parts (Refer to Figure 29)

Key No.	Part Number	Description	Quantity Per Unit
1	30752770-103	SS 304 Angle Bracket Mounting kit for all models except In-line and Flush mount transmitters	1
2	30752770-104	SS 304 Angle Bracket Mounting kit for all In-Line and Flush mount transmitters	1
3	30752770-303	Marine Approved Angle Bracket for all models except In-line and Flush mount transmitters	1
4	30752770-304	Marine Approved Angle Bracket for all In-line and Flush mount transmitters	1
5	51196557-005	SS 304 Flat Bracket Mounting kit for all models except In-line and Flush mount transmitters	1
6	51196557-006	SS 304 Flat Bracket Mounting kit for all In-line transmitters and Flush mount transmitters	1
7	30752770-403	SS 316 Angle Bracket Mounting kit for all In-line transmitters except In-Line and Flush mount transmitters	1
8	30752770-404	SS 316 Angle Bracket Mounting kit for all In-Line and Flush mount transmitters	1
9	51196557-008	SS 316 Flat Bracket Mounting kit for all In-line transmitters except In-Line and Flush mount transmitters	1
10	51196557-009	SS 316 Flat Bracket Mounting kit for all In-Line and Flush mount transmitters	1

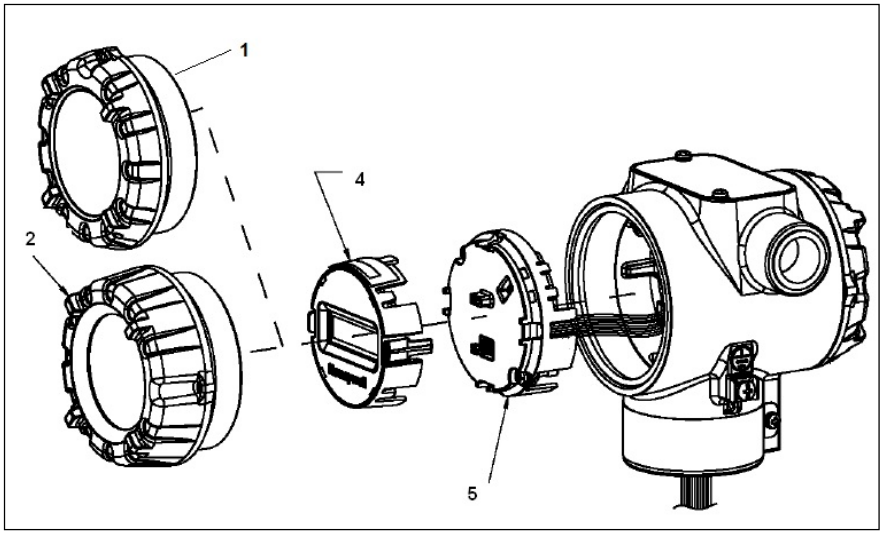


Figure 30 – Electronic Housing, Display End

Table 23 – Transmitter Major Assemblies

(Refer to Figure 31, Figure 32, Figure 33)

Key No.	Part Number	Description	Quantity Per Unit
1	50049858-501 50049858-521	End Cap (Aluminum) End Cap (Stainless Steel)	1
2	50049832-501 50049832-521	End Cap, Display (Aluminum) End Cap, Display (Stainless Steel)	1
3	50075472-531 50075472-532 50075472-533 50075472-534	Terminal Assy HART/DE without Lightning protection Terminal Assy HART/DE with Lightning protection Terminal Assy FF/PB without Lightning protection Terminal Assy FF/PB with Lightning protection	1
4	50049911-501 50049846-501	Basic Display Advanced Display	1
5	50049849-501 50049849-502 50049849-503 50049849-504 50049849-507 50049849-508	HART Electronics Module Assembly (PWA) without Reed sensor HART Electronics Module Assembly (PWA) with Reed sensor DE Electronics Module Assembly (PWA) without Reed sensor DE Electronics Module Assembly (PWA) with Reed sensor FF Electronics Module Assembly (PWA) without Reed sensor FF Electronics Module Assembly (PWA) with Reed sensor	1
6	50049915-501	External Zero, Span & Config Buttons	1
K1	30757503-005	Electronics housing seals kit (includes O-rings)	

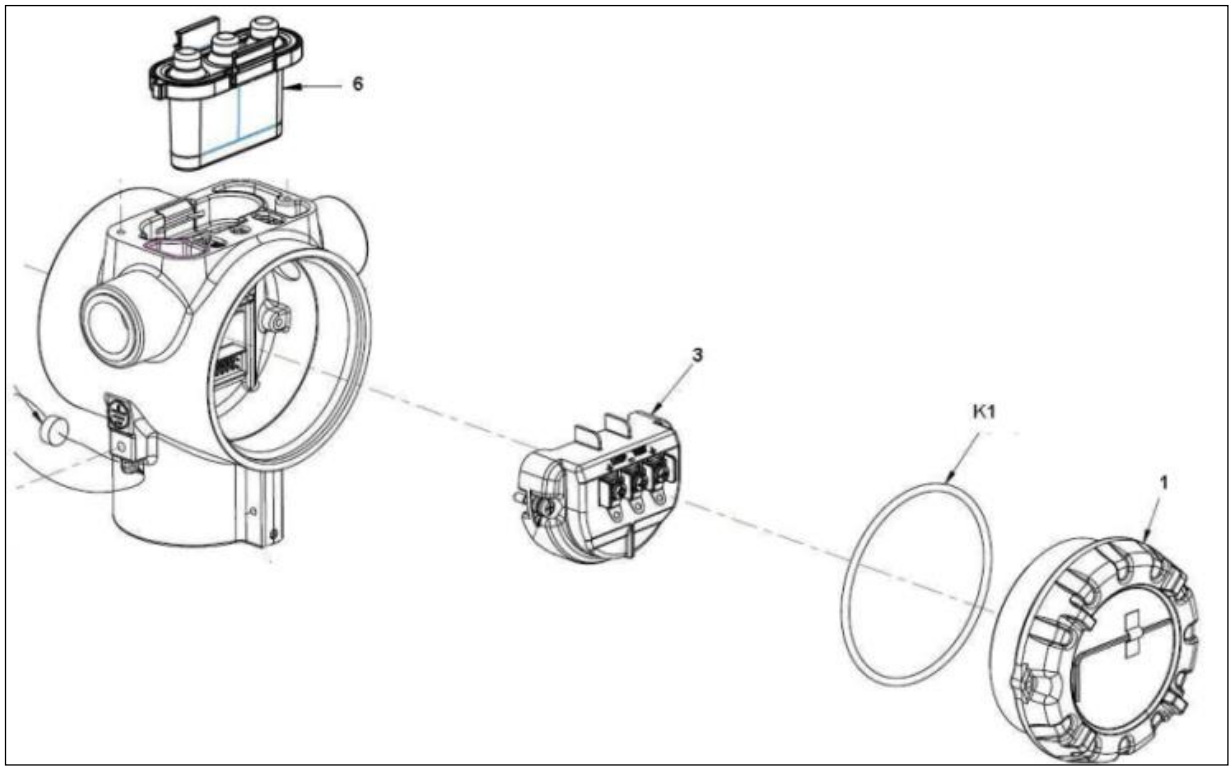


Figure 31 – Electronic Housing, Terminal Block End

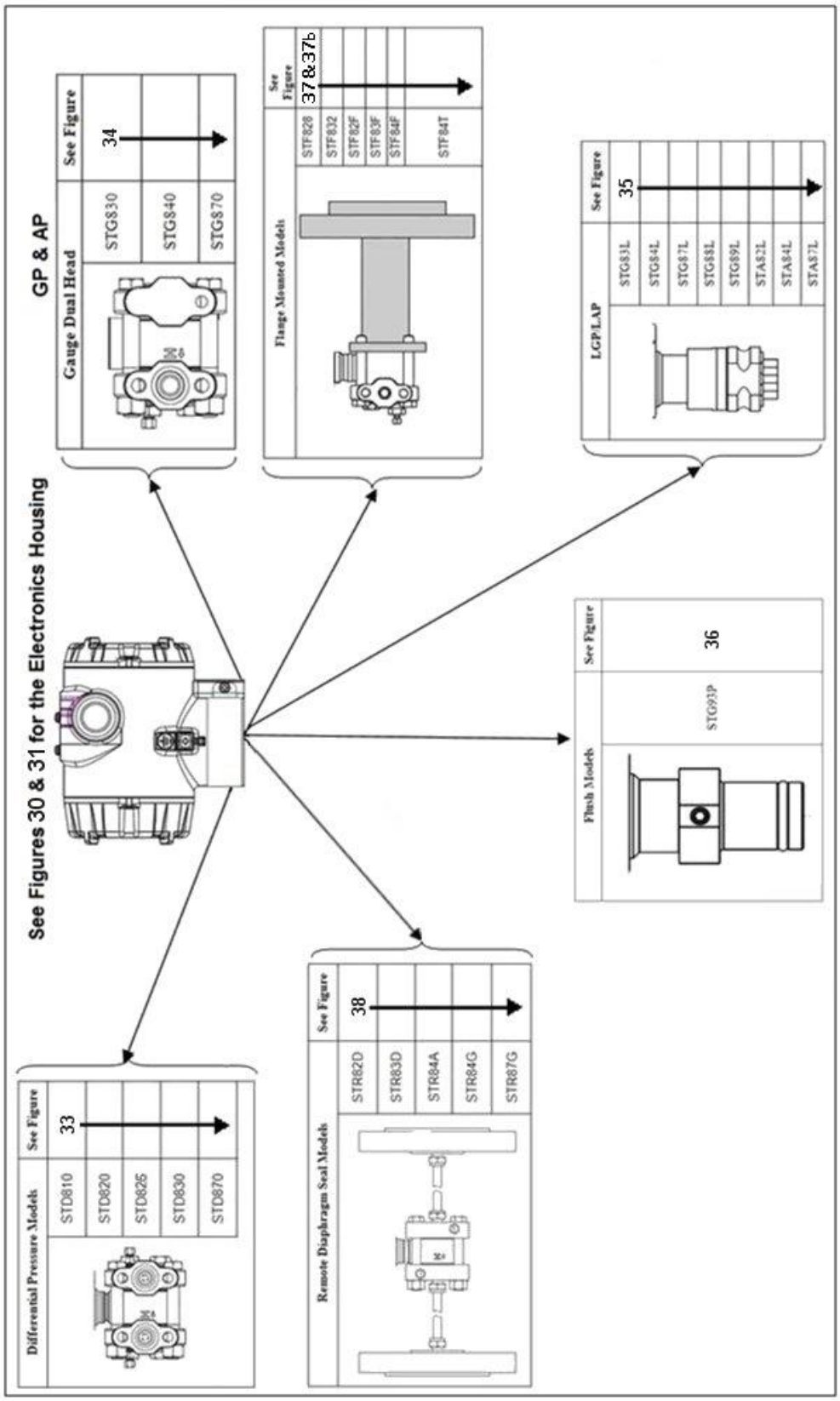


Figure 32 – Transmitter Major Assemblies

Table 24 – ST 800 Models STD810, 820, 825, 830 & 870 (Ref. Figure 33)

Key No.	Part Number	Description	Qty/Unit
		Vent and Plug Kits	
	30753785-001 30753787-001 30753786-001	Drain and Plug Kit, stainless steel Drain and Plug Kit, Monel Drain and Plug Kit, Hastelloy C	
		Each Drain and Plug Kit includes:	
K1		Pipe Plug	4
K2		Vent Plug	2
K3		Vent Bushing	2
		Meter Body Gasket Kits	
	 51452865-201 51452865-202 51452865-203 51452865-204	**Each Meter Body Gasket Kit includes:** Glass Filled PTFE VITON 100% PTFE GRAPHITE	
K6		Gasket, Process Head	6
Ka		Gasket, Flange Adapter	6
K7		O-Ring, Meter Body to Electronics Housing	3
		K7 Process Head Gasket Kits	
K6 K6 K6	51452868-501 51452868-502 51452868-507	Gasket only, Process Head (12 PTFE Gaskets/pack) Gasket only, Process Head (6 Viton Head O-Rings) Gasket only, Process Head Graphite Gasket (use only as replacement of existing graphite gasket)	12 6 6
		Flange Adapter Gasket Kits	
Ka Ka Ka	51452868-504 51452868-505 51452868-508	Gasket only, Flange Adapter, 6 PTFE Adapter Gaskets Gasket only, Flange Adapter, 6 VITON Adapter O-Rings Gasket only, Flange Adapter Graphite Gasket (use only as replacement of existing graphite gasket)	6 6 6
		½-Inch NPT Flange Adapter Kits	
	 51452867-110 51452867-210 51452867-310 51452867-410 51452867-150 51452867-350 51452867-130 51452867-330	<u>Flange Adapter Kit, with</u>: SS Flange Adapters and with carbon steel bolts SS Flange Adapters and with A286 SS (NACE) bolts SS Flange Adapters and with 316 SS (non-NACE) bolts SS Flange Adapters and with B7M alloy steel bolts Monel Flange Adapters and with carbon steel bolts Monel Flange Adapters and with 316 SS (non-NACE) bolts Hastelloy C Flange Adapters and with carbon steel bolts Hastelloy C Flange Adapters and with 316 SS (non-NACE) bolts	
		Each 1/2-inch NPT Flange Adapter Kit includes:	
Ka		Gasket, Flange Adapter	2
Kb		1/2-inch NPT Flange Adapter	2
Kc		Bolt, hex head, 7/16-20 UNF, 1.50 inches long	4

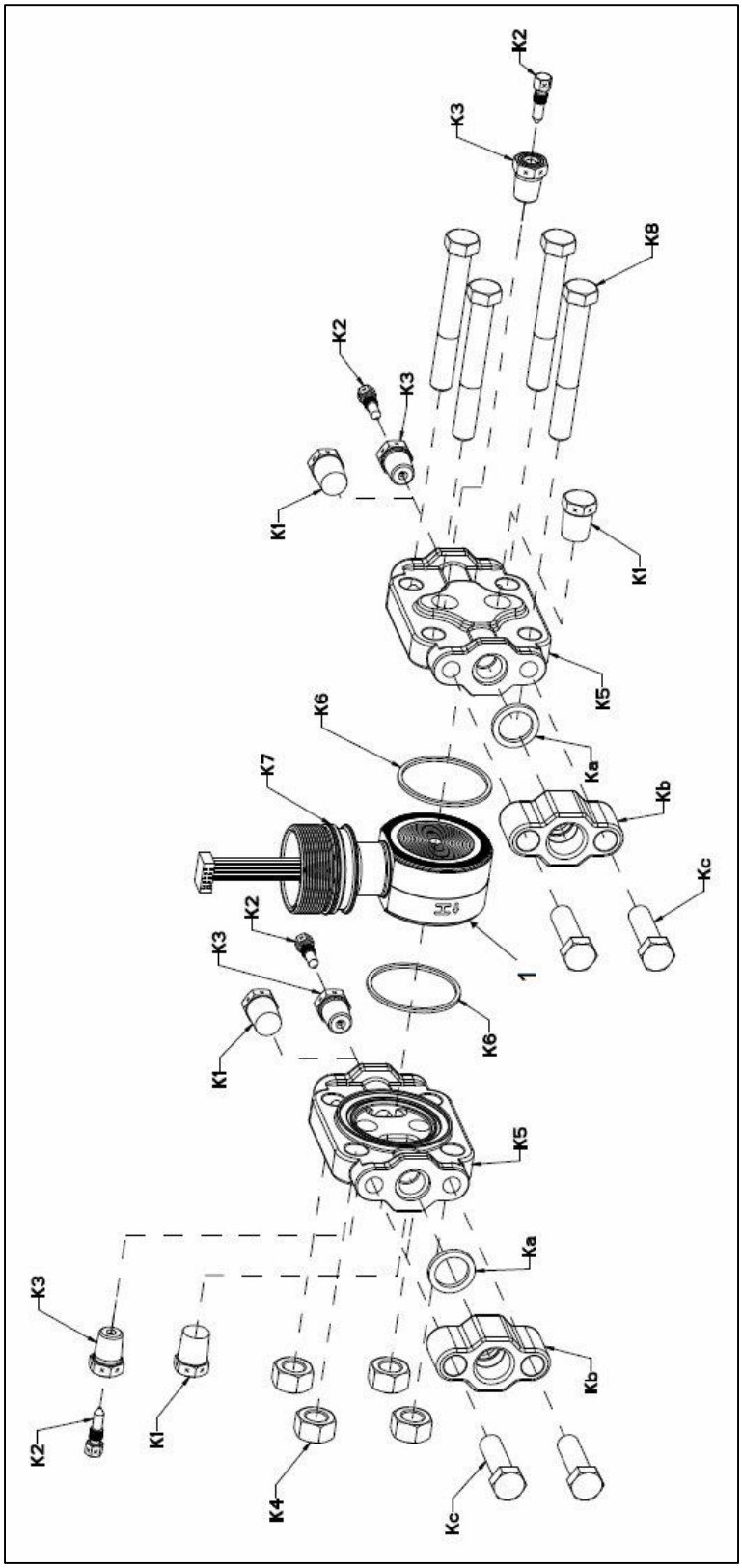


Figure 33 - ST 800 Models STD810, 820, 825, 830, & 870

Table 25 – Parts for STG830, 840, 870 and STA822, 840 Transmitter Body (Ref.)

Key No.	Part Number	Description	Qty/Unit
Process Head Assembly Kits with PTFE Gaskets			
	51452864-010 51452864-012 51452864-020 51452864-022 51452864-030 51452864-032 51452864-040 51452864-042 51452864-050 51452864-052	Carbon steel head (zinc plated) without side vent/drain Carbon steel head (zinc plated) with side vent/drain Stainless steel head without side vent/drain Stainless steel head with side vent/drain Hastelloy C head without side vent/drain Hastelloy C head with side vent/drain Monel head without side vent/drain Monel head with side vent/drain Carbon steel head (nickel plated) without side vent/drain Carbon steel head (nickel plated) with side vent/drain	
Process Head Assembly Kits with PTFE Gaskets			
	51452864-110 51452864-112 51452864-120 51452864-122 51452864-130 51452864-132 51452864-140 51452864-142 51452864-150 51452864-152	Carbon steel head (zinc plated) without side vent/drain Carbon steel head (zinc plated) with side vent/drain Stainless steel head without side vent/drain Stainless steel head with side vent/drain Hastelloy C head without side vent/drain Hastelloy C head with side vent/drain Monel head without side vent/drain Monel head with side vent/drain Carbon steel head (nickel plated) without side vent/drain Carbon steel head (nickel plated) with side vent/drain	
Each process head assembly kit includes:			
K1		Pipe Plug (See notes 1 & 2)	1
K2		Vent Plug (See note 1)	1
K3		Vent Bushing (See note 1.)	1
K5		Process Head	1
K6		Gasket (PTFE), Process Head	1
Ka		Gasket (PTFE), Flange Adapter	1
	Notes		
	Note 1: This item is made of the same material as the Process Heads, except for Kits with carbon steel Process Heads, which include stainless steel Pipe Plug, Vent Plug, and Vent Bushing. Note 2: The Kit for Process Heads without side vent/drain does not include Pipe Plugs (K1).		
Reference Head			
K9 K9	51452951-201 51452951-101	Carbon Steel Blind Reference Head 316 SS Blind Reference Head	1 1

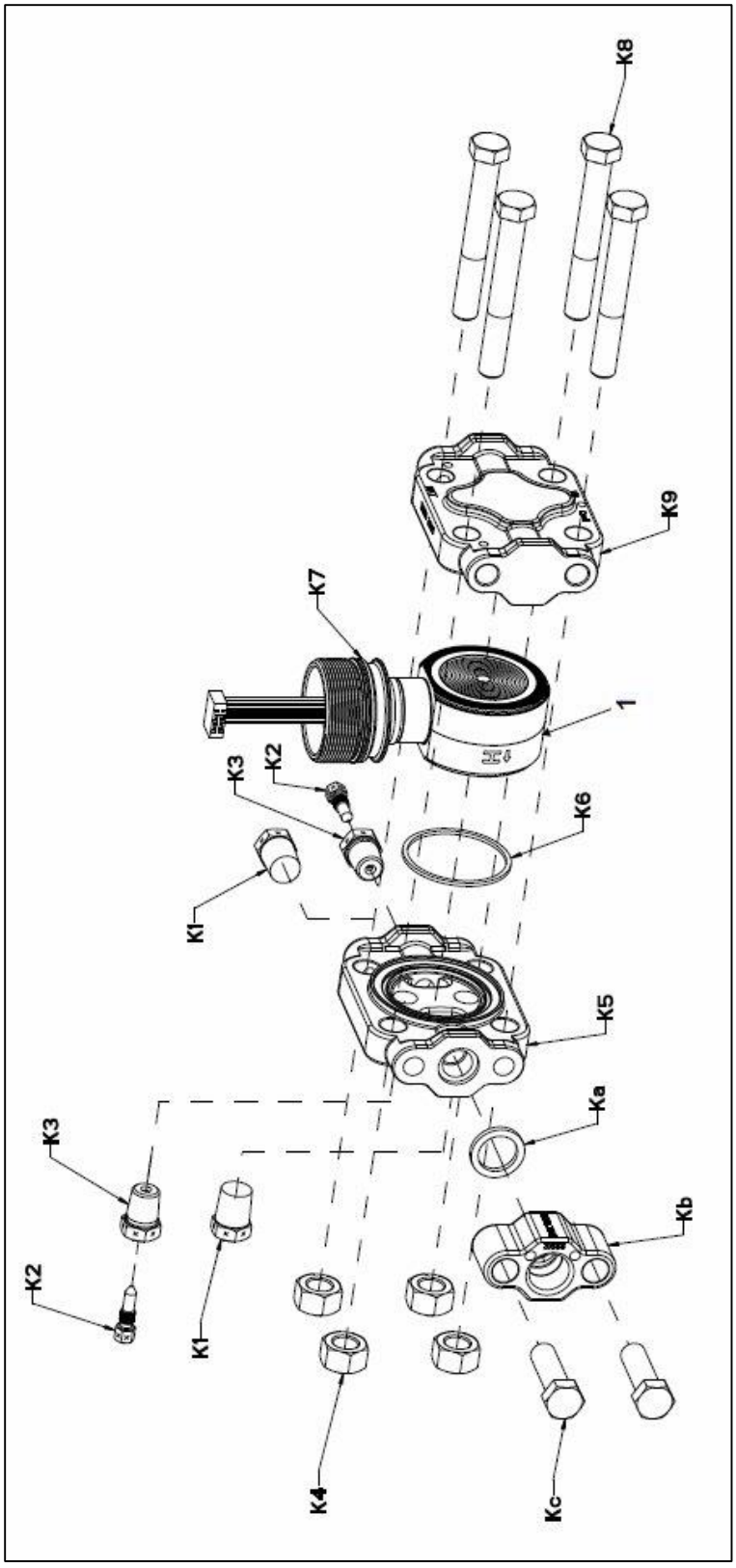


Figure 34 – STG830, 840, 870, and STA822, 840 Transmitter Body

Table 26 – Inline Gauge and Inline Atmospheric Meter Body Parts

Key No.	Part Number	Description	Qty/Unit
	Specify complete model number from nameplate	ST Series replacement meter body (LAP/LGP model)	1

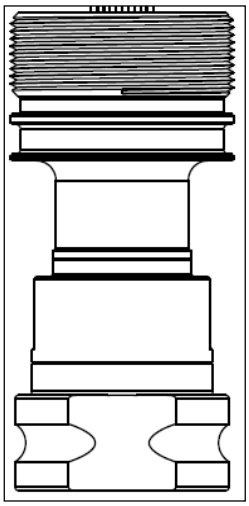


Figure 35 – Inline Gauge and Inline Atmospheric Display Bodies

Table 27 – Flush Mount Meter Body Parts

Key No.	Part Number	Description	Qty/Unit
1	Specify complete model number from nameplate	Replacement meter body (Flush Mount model)	1
	30756445-508	Gasket Kit (0-rings)	
	51204496-001	316L SS Mounting Sleeve Kit	
	51204497-001	Calibration Sleeve Kit	

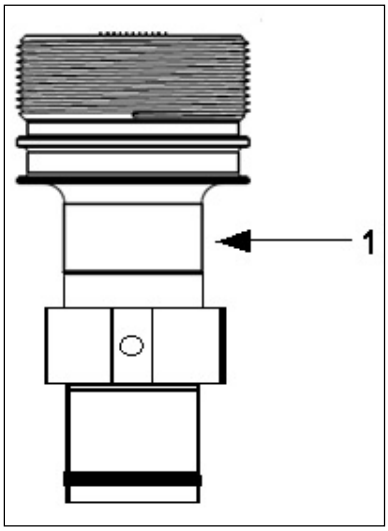


Figure 36 – Flush Mount Meter Body

Table 28 – Flange-Mounted Meter Body Parts (Refer to Figure 37 – 37b)

Key No.	Part Number	Description	Qty/Unit
1	Specify complete model number from nameplate	ST Series 800 replacement meter body	1
	30749372-005	O-ring seal	1
	30749372-001	O-ring seal	1
Optional Flange Adapter - Not Shown			
	30754419-006	Flange adapter kit (st. steel flange adapter with carbon steel bolts)	
	30754419-008	Flange adapter kit (Monel flange adapter with carbon steel bolts)	
	30754419-022	Flange adapter kit (st. steel flange adapter with 316 st. steel bolts)	
	30754419-024	Flange adapter kit (Monel with 316 st. steel bolts)	
K1		Bolt, hex head, 7/16-20 UNF, 1.375 inches lg.	2
K2		Flange adapter	1
K3		Gasket	1
K4		Filter screen	1
	30754419-007	Flange adapter kit (Hastelloy C flange adapter with carbon steel bolts)	
	30754419-023	Flange adapter kit (Hastelloy C flange adapter with 316 st. steel bolts)	
K1		Bolt, hex head, 7/16-20 UNF, 1.375 inches lg.	2
K2		Flange adapter	1
K3		Gasket	1
K5	30757503-005	Housing seal kit	1

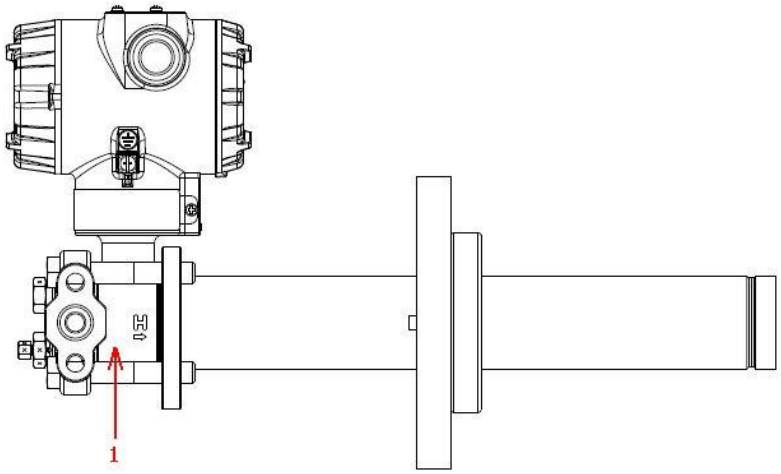


Figure 37 – Extended Flange Design

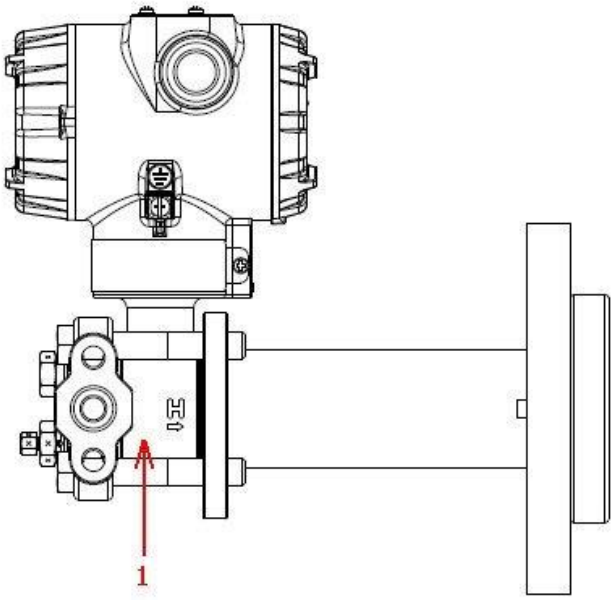


Figure 37b – Flush Flange Design

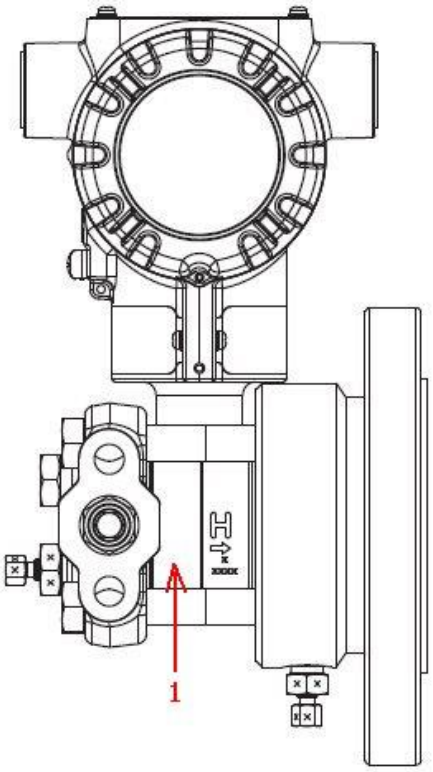


Figure 38 - Pseudo Flange design

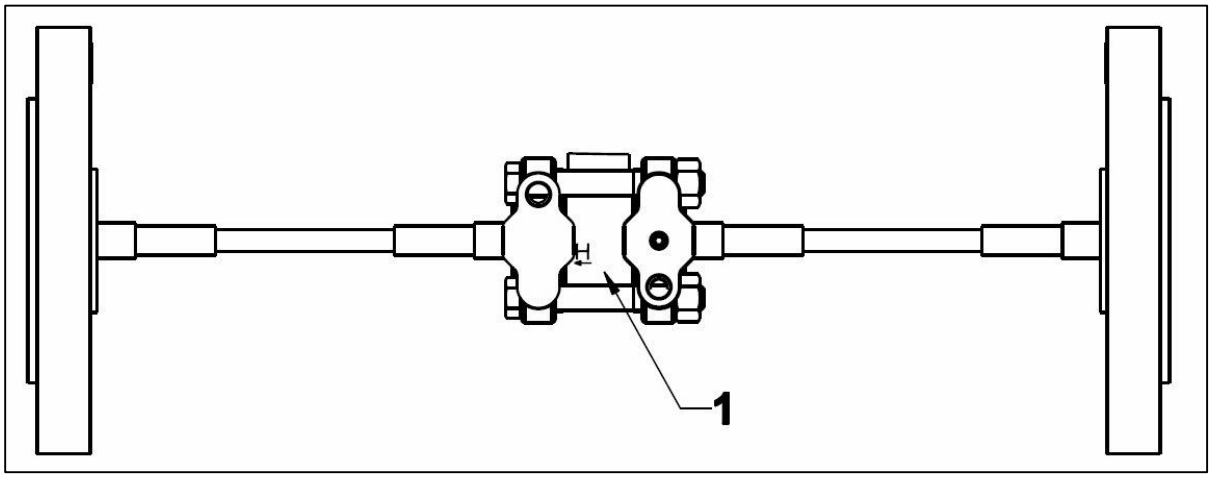


Figure 39 – Remote Seal Diaphragm

No replacement meter body (Key No.1) is available for Remote Diaphragm Seal models

Table 29 - COPLANAR ADAPTER REPLACEMENT SEALS KITS

(**Refer to Figure 40**)

Key Number	Part Number	Description	Quantity
	50062206-006	**Coplanar Adapter Glass-Filled PTFE (Teflon) Gasket Kit**	
K1		Transmitter-side glass-filled PTFE (Teflon) Gaskets	2
K2		Manifold-side glass-filled PTFE (Teflon) Gaskets	2
	50062206-007	**Coplanar Adapter Fluorocarbon (Viton) O-ring Kit**	
K1		Transmitter-side Fluorocarbon (Viton) O-rings	2
K2		Manifold-side Fluorocarbon (Viton) O-rings	2

USAGE NOTES

50062206-006 - Only use new gaskets when assembling the Coplanar Adapter Kit. Gaskets are designed for one-time use. Do not use gaskets with nicks or other surface damage.

50062206-007 - O-rings removed from service should be discarded and replaced with new o-rings. Do not use o-rings with nicks or other signs of damage.

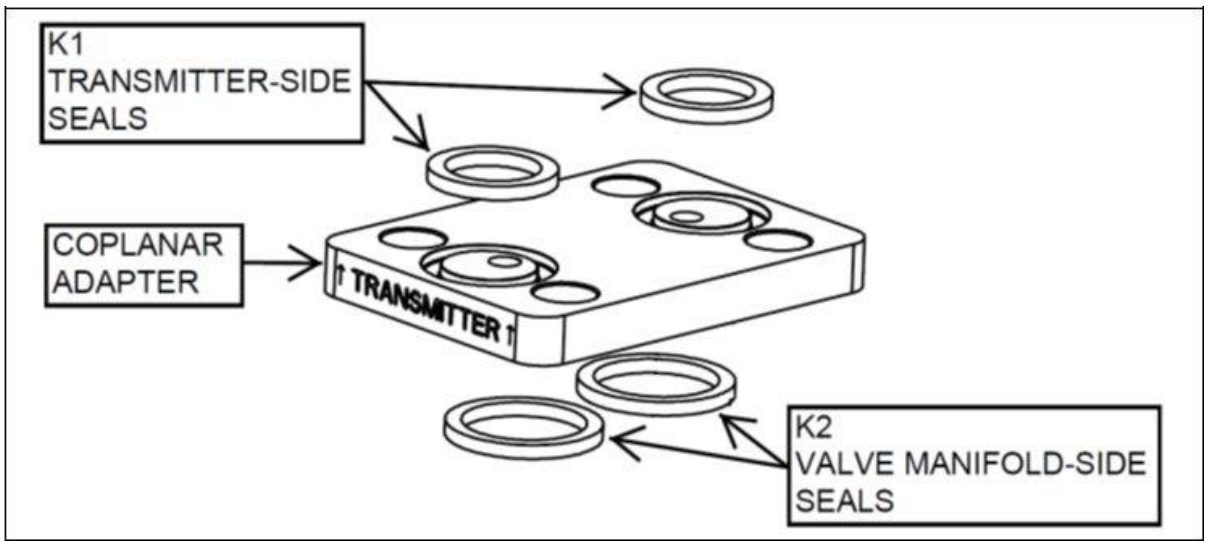


Figure 40 - COPLANAR ADAPTER REPLACEMENT SEALS KIT

Appendix A. PRODUCT CERTIFICATIONS

A1. Safety Instrumented Systems (SIS) Installations

For Safety Certified Installations, please refer to ST 800 & ST 700 Safety Manual 34-ST-25-37 for installation procedure and system requirements.

SIL 2/3 Certification	IEC 61508 SIL 2 for non-redundant use and SIL 3 for redundant use according to EXIDA, ST800 Series, HON 1002038 C001, ST 700 Series HON 1207125 C001 and TÜV Nord Sys Tec GmbH & Co. KG under the following standards: IEC61508-1: 2010; IEC 61508-2: 2010; IEC61508-3: 2010.

A2. European Directive Information (CE Mark)

CE Honeywell

50080030
Revision: N

EU DECLARATION OF CONFORMITY

We,
Honeywell International Inc.
Honeywell Field Solutions
512 Virginia Drive
Fort Washington, PA 19034 USA

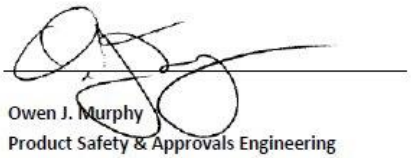
declare under our sole responsibility that the following products,

ST 800 – Smart Series Pressure Transmitter
And
ST 700- Smart Series Pressure Transmitter

to which this declaration relates, is in conformity with the provisions of the European Community Directives, including the latest amendments, as shown in the attached schedule.

Assumption of conformity is based on the application of the harmonized standards and when applicable or required, a European Community notified body certification, as shown in the attached schedule.

The authorized signatory to this declaration, on behalf of the manufacturer, and the Responsible Person is identified below.



Owen J. Murphy
Product Safety & Approvals Engineering
Issue Date: 3 June 2016

SCHEDULE
50080030
Revision: N

EMC Directive (2014/30/EU)

EN 61326-1:2013	Electrical Equipment for Measurement, Control and Laboratory Use – EMC Requirements.
IEC 61326-3-1:2008	Electrical Equipment for Measurement, Control and Laboratory Use- Part 3-1: Immunity Requirements for safety related systems and equipment intended to perform safety-related functions.

Summary of Tests Performed:

PORT	TEST	STANDARD	CRITERIA (IEC 61326-1)	CRITERIA (IEC 61326-3-1)	RESULTS
Enclosure	Radiated Emission	CISPR 11	Group1, Class A 30 – 230 MHz: 40 dB 230 – 1000 MHz: 47 dB	Group1, Class A 30 – 230 MHz: 40 dB 230 – 1000 MHz: 47 dB	PASS
	ESD Immunity	IEC61000-4-2	+/- 4KV Contact +/- 8KV Air	+/- 6KV Contact +/- 8KV Air	PASS
	EM Field- RF Radiated Susceptibility	IEC61000-4-3	10 V/m- 80 MHz to 1GHz 3 V/m - 1.4 GHz to 2.0 GHz 1 V/m- 2.0 GHz to 2.7 GHz	20 V/m- 80MHz to 1GHz 10 V/m - 1.4GHz to 2.0 GHz 3 V/m- 2.0GHz to 2.7GHz	PASS PASS PASS
	50Hz/60Hz Magnetic Field Immunity	IEC 6100-4-8	30 A/m	30 A/m	N/A 1
DC Power	EFT(B) Immunity	IEC61000-4-4	+/- 1KV	+/- 2KV	PASS
	Surge Immunity	IEC61000-4-5	+/- 1KV	+/- 2KV	PASS
	RF Conducted Susceptibility	IEC61000-4-6	3V	3 V Except the following: 10 V 3.39 to 3.410MHz 10 V 6.765 to 6.795MHz 10 V 13.553 to 13.567MHz 10 V 26.957 to 27.283MHz 10 V 40.66 to 40.70MHz	PASS
I/O Signal/ Control (Including Earth Lines)	EFT(Burst) Immunity	IEC61000-4-4	+/- 1KV	+/- 2KV	2
	Surge Immunity	IEC61000-4-5	+/- 1KV	+/- 2KV	2
	RF Conducted Susceptibility	IEC61000-4-6	3V	3 V Except the following: 10 V 3.39 to 3.410MHz	2

Honeywell

SCHEDULE
50080030
Revision: N

PORT	TEST	STANDARD	CRITERIA (IEC 61326-1)	CRITERIA (IEC 61326-3-1)	RESULTS
				10 V 6.765 to 6.795MHz 10 V 13.553 to 13.567MHz 10 V 26.957 to 27.283MHz 10 V 40.66 to 40.70MHz	
AC Power	Voltage Dip	IEC61000-4-11	0% during 1 Cycle 40% during 10-12 Cycles 70% during 25-30 Cycles		N/A[3]
	Short Interruptions	IEC61000-4-11	0% during 250-300 Cycles		N/A[3]
	EFT(Burst) Immunity	IEC61000-4-4	2KV		N/A[3]
	Surge Immunity	IEC61000-4-5	1KV/ 2KV		N/A[3]
	RF Conducted Susceptibility	IEC61000-4-6	3V		N/A[3]

1. There is no magnetic sensitive circuitry.
2. Done as part of the DC Power Testing.
3. Product is DC Powered.

SCHEDULE
50080030
Revision: N

ATEX Directive (2014/34/EU)

EC-Type Examination Certificate No: FM12ATEX0029X Protection : Flameproof and Dust
Equipment Group II Category 1/ 2 G and Group II Caegrory 2 D
Ex d IIC T5 Ga/Gb (Ta= -50°C TO 85°C)
Ex d IIC T6 Ga/Gb (Ta= -50°C TO 65°C)
Ex tb IIIC T95°C Db (Ta= -50°C TO 85°C)

Standards:
EN 60079-0: 2012 EN 60079-1: 2007 EN 60079-26: 2007
EN 60079-31: 2009 EN 60529: 1991 + A1:2000

EC-Type Examination Certificate No: Sira12ATEX2233X Protection: Intrinsically Safe
Equipment Group II Category 1 G
Ex ia IIC T4 Ga (Ta= -50°C TO 70°C)
Ex ia IIC T4 Ga (Ta= -50°C TO 70°C)
FISCO Field Device

Standards:
IEC 60079-0: 2011 IEC 60079-11: 2011 EN 60079-26: 2006

Type Examination Certificate No: Sira12ATEX4234X Protection : Non Sparking
Equipment Group II Category 3 G
Ex nA IIC T4 Gc (Ta= -50°C TO 70°C)
Ex ic IIC T4 Ga (Ta= -50°C TO 70°C)
FISCO Field Device

Standards:
IEC 60079-0: 2011 IEC 60079-11: 2011 EN 60079-15: 2010

ATEX Notified Body for EC Type Certificates
FM Approvals Ltd. [Notified Body Number: 1725]
1 Windsor Dials,
Windsor, Berkshire, SL4 1RS
England

Sira Certifcation Service [Notified Body Number: 0518]
Unit 6, Hawarden Industrial Park,
Hawarden, CH5 3US
United Kingdom

ATEX Notified Body for Quality Assurance
DEKRA Certification B.V. [Notified Body Number: 0344]
Meander 1051
6825 MJ Arnhem
The Netherlands

Honeywell

SCHEDULE
50080030
Revision: N

Pressure Equipment Directive (PED) (97/23/EC)
Pressure Equipment Directive (PED) (2014/68/EU) *(After 18 July 2016)*
ASME Boiler and Pressure Vessel Code Section VIII 'Rules for Construction of Pressure Vessels: 2000

Pressure Transmitter	**PED Module**
Absolute Pressure	
STA 822/ STA 722	Sound Engineering Practice (SEP)
STA 82L/ STA72L	
STA 840/ STA740	
STA 84L/ STA74L	
STA87L/ STA77L	Module A
Differential Pressure	
STD 810	Module A
STD820/ STD720	
STD825	
STD830/ STD730	
STD870/ STD770	
Gauge Pressure	
STG830/ STG730	Sound Engineering Practice (SEP)
STG840/ STG740	
STG83L/ STG73L	
STG84L/ STG74L	
STG870/ STG770	Module A
STG87L/ STG77L	
STG88L/ STG78L	
STG89L/ STG79L	
Flange Mounted	
STF828/ STF728	Sound Engineering Practice (SEP)
STF832/ STF732	
STF82F/ STF72F	
STF83F/ STF73F	
Remote Diaphragm	
STR82D/ STR73D	Sound Engineering Practice (SEP)
STR83D	
STR84G/ STR74G	
STR87G	
STR84A	

5 of 6

SCHEDULE
50080030
Revision: N

Measuring Instruments Directive (MID) (2014/32/EU)

NMI Evaluation Certificate: TC7948

Model	Range
STA 84L	1 to 35 Bara
STA87L	1 to 100 Bara
STG 84L	1 to 35 Barg
STG87L	1 to 100 Barg
STD 820	0 to 1Barg
STD830	0 to 7 Barg
STD870	0 to 100 Barg

WELMEC Guide 8.8 OIML R117-1: 2007(E) EN 12405-1/A1: 2006

MID Notified Body for Parts Certificates

NMi Certin B.V.
Hugo de Grootplein 1
3300 AJ Dordrecht
The Netherlands

A3. Hazardous Locations Certifications

MSG CODE	AGENCY	TYPE OF PROTECTION	COMM OPTION	Electrical Parameters	Ambient Temperature
A	FM-USA	**Explosion proof:** Class I, Division 1, Groups A, B, C, D **Dust Ignition Proof:** Class II, III, Division 1, Groups E, F, G Class I, Zone 0/1, AEx d IIC Ga/Gb Class II, Zone 21, AEx tb IIIC T 95°C Db	DE/HART /FF	Note 1	T5: -50 °C to 85°C T6: -50 °C to 65°C
		Intrinsically Safe: Class I, II, III, Division 1, Groups A, B, C, D, E, F, G Class I Zone 0 AEx ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC Ga	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non-Incendive Class I, Division 2, Groups A, B, C, D Class I Zone 2 AEx nA IIC Gc	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Enclosure: Type 4X/ IP66/ IP67	ALL	ALL	ALL
		Standards: FM 3600:2011; ANSI/ ISA 60079-0: 2009 FM 3615:2006; ANSI/ ISA 60079-1 : 2009 FM 3616 : 2011 ; ANSI/ ISA 60079-31 : 2009 FM 3610:2010; ANSI/ ISA 60079-11 : 2011 FM 3810 : 2005 ; ANSI/ ISA 60079-26 : 2008 FM 3611:2004; ANSI/ ISA 60079-15 : 2009 ; FM 3810 : 2005 ; NEMA 250 : 2003 ; ANSI/ IEC 60529 : 2004			
B	CSA-Canada	**Explosion proof:** Class I, Division 1, Groups A, B, C, D **Dust Ignition Proof:** Class II, III, Division 1, Groups E, F, G Zone 0/1, Ex d IIC Ga/Gb Ex tb IIIC T 95°C Db	DE/HART /FF	Note 1	T5: -50 °C to 85°C T6: -50 °C to 65°C
		Intrinsically Safe: Class I, II, III, Division 1, Groups A, B, C, D, E, F, G; Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC Ga	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non-Incendive Class I, Division 2, Groups A, B, C, D Ex nA IIC Gc	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Enclosure: Type 4X/ IP66/ IP67	ALL	ALL	ALL
		Standards: ANSI/ ISA 60079-0: 2009 ; CAN/ CSA-C22.2 No. 0-M91:2006; CAN/ CSAE60079-0:2002; ANSI/ UL 913 : 2010 ; ANSI/ ISA 60079-11 : 2009; CAN/ CSA-C22.2 No.157-92: 1992; CAN/CSA-E 60079-11: 2002; ANSI/ ISA 60079-26 : 2008; ANSI/ ISA 12.12.01 : 2007 ; ANSI/ ISA 60079-15 : 2009 ; C22.2 No. 213-M1987; CAN/CSA-E60079-15: 2002; ANSI/ UL 50 : 2007 ; ANSI/ IEC 60529 : 2004			

MSG CODE	AGENCY	TYPE OF PROTECTION	COMM OPTION	Electrical Parameters	Ambient Temperature
C	ATEX	**Flameproof:** FM12ATEX0029X II 1/2 G Ex d IIC Ga/Gb II 2 D Ex tb IIIC T 95°C Db	DE/HART /FF	Note 1	T5: -50 °C to 85°C T6: -50 °C to 65°C
		Standards: EN 60079-0: 2011 EN 60079-1 : 2007 EN 60079-31 : 2009 EN 60079-26 : 2007 EN 60529 : 2000 + A1			
		Intrinsically Safe: **Sira12ATEX2233X** II 1 G Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC T4	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non Sparking: Sira12ATEX4234X II 3 G Ex nA IIC Gc	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Standards: EN 60079-0: 2011 EN 60079-11 : 2011 EN 60079-26 : 2006 EN 60079-15 : 2007 IEC 60529 : 2009 with Corr 3			
		Enclosure: IP66/ IP67	ALL	ALL	ALL
D	IECEx	**Intrinsically Safe:** SIRA 12.0100 Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC Ga	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non Sparking: SIRA 12.0100 Ex nA IIC Gc	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Standards: IEC 60079-0: 2011 IEC 60079-11 : 2011 IEC 60079-26 : 2006 IEC 60079-15 : 2011 IEC 60529 : 2009 with Corr 3			
		Flameproof: Ex d IIC Ga/Gb Ex tb IIIC Db T 95°C	DE/HART /FF	Note 1	T5: -50 °C to 85°C T6: -50 °C to 65°C
		Standards: IEC 60079-0: 2011 IEC 60079-1 : 2007 IEC 60079-31 : 2008 IEC 60079-26 : 2006 IEC 60529 : 2009 with Corr 3			
		Enclosure: IP66/ IP67	ALL	ALL	ALL
E	SAEx (South Africa)	**Intrinsically Safe:** Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC Ga	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non Sparking: Ex nA IIC Gc	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Flameproof: Ex d IIC Ga/Gb Ex tb IIIC T 95°C Db	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Enclosure: IP66/ IP67	ALL	ALL	ALL

F	INMETRO	**Intrinsically Safe:** Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC Ga	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non Sparking: Ex nA IIC Gc	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Flameproof: Ex d IIC Ga/Gb Ex tb IIIC T 95°C Db	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Enclosure: IP66/ IP67	ALL	ALL	ALL
G	NEPSI (CHINA)	**Intrinsically Safe:** Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC Gc	DE/HART /FF	Note 2	T4: -50°C to 70°C
		Non Sparking: Ex nA IIC Gc	DE/HART /FF	Note 1	T4: -50°C to 85°C
		Flameproof: 1 Ex d IIC Ga/Gb Ex tb IIIC Db T 95°C Db	All	Note 1	T4: -50 °C to 85°C
		Enclosure: IP66/ IP67	ALL	ALL	ALL
-------	GOST	**Intrinsically Safe:** 0 Ex ia IIC Ga FISCO Field Device (Only for FF Option) Ex ia IIC	DE/ HART/ FF	Note 2	T4: -50 °C to 70°C
		Enclosure : IP 66/67	All	All	

Notes

1. Operating Parameters:

DE/HART	Voltage= 11 to 42 V	Current= 4-20 mA Normal (3.8 – 23 mA Faults)
Foundation Fieldbus	Voltages = 9 to 23 V	Current = 25 mA

2. Intrinsically Safe Entity Parameters

For details see Control Drawing on page 102.

3. Marking ATEX Directive

General:

The following information is provided as part of the labeling of the transmitter:

- Name and Address of the manufacturer
- Notified Body identification: DEKRA Quality B.V., Arnhem, the Netherlands
- For complete model number, see the Model Selection Guide for the particular model of pressure transmitter.
- The serial number of the transmitter is located on the Meter Body data-plate. The first two digits of the serial number identify the year (02) and the second two digits identify the week of the year (23); for example, 0223xxxxxxxx indicates that the product was manufactured in 2002, in the 23 rd week.

Apparatus Marked with Multiple Types of Protection

The user must determine the type of protection required for installation the equipment. The user shall then check the box [ ] adjacent to the type of protection used on the equipment certification nameplate. Once a type of protection has been checked on the nameplate, the equipment shall not then be reinstalled using any of the other certification types.

4. WARNINGS and Cautions:

Intrinsically Safe and Non-Incendive Equipment:
WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR USE IN HAZARDOUS LOCATIONS.
Explosion-Proof/ Flameproof:
WARNING: DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE MAY BE PRESENT
Non-Incendive Equipment:
WARNING: DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE MAYBE PRESENT
WARNING: FOR CONNECTION IN AMBIENTS ABOVE 60ºC USE WIRE RATED 105oC

5. Conditions of Use for Ex Equipment, "Hazardous Location Equipment" or "Schedule of Limitations":

Painted surface of the ST800 may store electrostatic charge and become a source of ignition in applications with a low relative humidity less than approximately30% relative humidity where the painted surface is relatively free of surface contamination such as dirt, dust or oil. Cleaning of the painted surface should only be done with a damp cloth.

Flame-proof Installations: The Transmitter can installed in the boundary wall between an area of EPL Ga/ Class I Zone 0/ Category 1 and the less hazardous area, EPL Gb/ Class I Zone 1/ Category 2. In this configuration, the process connection is installed in EPL Ga/ Class I Zone 0/ Category 1, while the transmitter housing is located in EPL Gb/ Class I Zone 1/ Category 2.

The applicable temperature class, ambient temperature range and maximum process temperature of the equipment is as follows;
T5 for -50°C < Ta < 85°C
T6 for -50°C < Ta < 65°C
Maximum process temperature = 125°C

Consult the manufacturer for dimensional information on the flameproof joints for repair.

The Transmitter can be installed in the boundary wall between an area of Category 1 and the less hazardous area, Category 2. In this configuration, the process connection is installed in Category 1 while the transmitter housing is installed in Category 2.

Intrinsically Safe: Must be installed per drawing 50049892

Division 2: This equipment is suitable for use in a Class I, Division 2, Groups A, B, C, D; T4 or Non-Hazardous Locations Only.

The enclosure is manufactured from low copper aluminum alloy. In rare cases, ignition sources due to impact and friction sparks could occur. This shall be considered during Installation, particularly if equipment is installed a Zone 0 location.
If a charge-generating mechanism is present, the exposed metallic part on the enclosure is capable of storing a level of electrostatic that could become incendive for IIC gases. Therefore, the user/ installer shall implement precautions to prevent the buildup of electrostatic charge, e.g. earthing the metallic part. This is particularly important if equipment is installed a Zone 0 location.

A4. Control Drawing

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PRE REL							
ISS	REVISION & DATE						APPD
F	11/21/13 ECO-0094776						OJM

ST 800/ ST 700 Series Pressure, ANALOG, HART/DE and FF/ PA Communications

1. Intrinsically safe installation shall be in accordance with
   a. FM (USA): ANSI/NFPA 70, NEC® Articles 504 and 505.
   b. CSA (Canada): Canadian Electrical Code (CEC), part I, section 18.
   c. ATEX: Requirements of EN 60079-14, 12.3 (See also 5.2.4).
   d. IECEx: Requirements of IEC 60079-14, 12.3 (See also 5.2.4).
2. ENTITY approved equipment shall be installed in accordance with the manufacturer's Intrinsic Safety Control Drawing.
3. The Intrinsic Safety ENTITY concept allows the interconnection of two ENTITY Approved Intrinsically safe devices with ENTITY parameters not specifically examined in combination as a system when:

   Uo, Voc, or Vt $\leq$ Ui or Vmax; Io, Isc, or It $\leq$ Ii or Imax; Ca or Co $\geq$ Ci + Ccable, La or Lo $\geq$ Li + Lcable, Po $\leq$ Pi. Where two separate barrier channels are required, one dual-channel or two single-channel barriers may be used, where in either case, both channels have been Certified for use together with combined entity parameters that meet the above equations.
4. System Entity Parameters:

   ST 800/ ST 700 Transmitter: Vmax Voc or Uo, Imax Isc or Io;
   ST 800/ ST 700 Transmitter: Ci + Ccable $\leq$ Control Apparatus Ca,
   ST 800/ ST 700 Transmitter: Li + Lcable $\leq$ Control Apparatus La.
5. When the electrical parameters of the cable are unknown, the following values may be used:

   Capacitance: 197pF/m (60 pF/ft)
   Inductance: 0.66µH/m (0.020µH/ft).
6. Control equipment that is connected to Associated Equipment must not use or generate more than 250 V.
7. Associated equipment must be FM, CSA ATEX or IECEx (depending on location) listed. Associated equipment may be installed in a Class I, Division 2 or Zone 2 Hazardous (Classified) location if so approved.
8. Non-Galvanically isolated equipment (grounded Zener Barriers) must be connected to a suitable ground electrode per:
   a. FM (USA): NFPA 70, Article 504 and 505. The resistance of the ground path must be less than 1.0 ohm.
   b. CSA (Canada): Canadian Electrical Code (CEC), part I, section 10.
   c. ATEX: Requirements of EN 60079-14, 12.2.4.
   d. IECEx: Requirements of IEC 60079-14, 12.2.4.
9. Intrinsically Safe DIVISION 1/ Zone 0 WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR USE IN HAZARDOUS LOCATIONS.
10. Division 2/ Zone 2: WARNING: DO NOT OPEN WHEN AN EXPLOSIVE GAS ATMOSPHERE IS PRESENT.
11. NO REVISION OF THIS CONTROL DRAWING IS PERMITTED WITHOUT AUTHORIZATION FROM THE AGENCIES listed.
12. For release approvals see ECO # 0094464.

	DRAWN		
	CHECKED		
	DEV ENG		
	MFG ENG		
	QA ENG		
	TOLERANCE UNLESS NOTED		
MASTER FILE TYPE: MS WORD	ANGULAR DIMENSION		

Honeywell

CONTROL DRAWING
ST 800/ ST 700 SERIES PRESSURE TRANSMITTER
DIVISIONS 1 & 2 / ZONE 0 & 2

A/A4 — 50049892

SCALE: None	USED ON	SH. 1 OF 4

HART/DE

ENTITY PARAMETERS	Associated Apparatus
Ui or Vmax ≤ 30V	Uo, Voc or Vt ≤ 30V
Ii or Imax ≤ 105 mA	Io (Isc or It) ≤ 105 mA
Pi or Pmax = 0.9W	Po ≤ 0.9 W
Ci= 3.9 nF	Ca or Co ≥ C_{cable} + $C_{ST\ 800/\ ST\ 700}$
Li= 984 µH	La or Lo ≥ L_{cable} + $L_{ST\ 800/\ ST\ 700}$

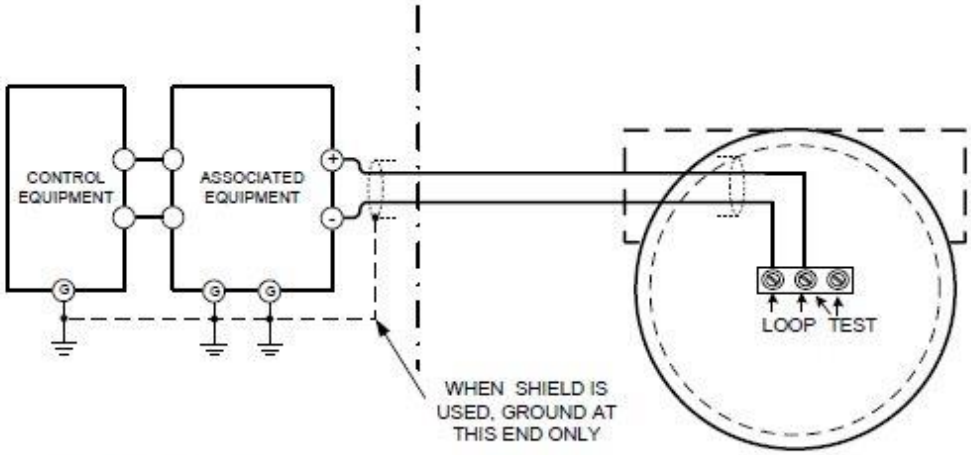
After 9/27/2013, Terminal Module Revision E or Later

NOTE: THE REVISION IS ON THE LABEL THAT IS ON THE MODULE. THERE WILL BE TWO LINES OF TEXT ON THE LABEL:
- FIRST IS THE MODULE PART #: 50049839-001 OR 50049839-002
- SECOND LINE HAS THE SUPPLIER INFORMATION, ALONG WITH THE REVISION: XXXXXXX-EXXXX, THE "X" IS PRODUCTION RELATED, THE POSITION OF THE "E" IS THE REVISION.

ENTITY PARAMETERS	Associated Apparatus
Ui or Vmax ≤ 30V	Uo, Voc or Vt ≤ 30V
Ii or Imax ≤ 225 mA	Io (Isc or It) ≤ 225 mA
Pi or Pmax = 0.9W	Po ≤ 0.9 W
Ci= 3.9 nF	Ca or Co ≥ C_{cable} + $C_{ST\ 800/\ ST\ 700}$
Li= 0 µH	La or Lo ≥ L_{cable} + $L_{ST\ 800/\ ST\ 700}$

NON-HAZARDOUS LOCATION

HAZARDOUS (CLASSIFIED) LOCATION
CLASS I, DIVISION 1, GROUPS A, B, C, D, E, F & G;
ZONE 0 IIC & ZONE 2 IIC,
CLASS I DIVISION 2, GROUPS A, B, C, D;



ASSOCIATED EQUIPMENT NOT REQUIRED FOR DIV 2 / ZONE 2 INSTALLATIONS

CONTROL EQUIPMENT PARAMETERS WHEN NO ASSOCIATED EQUIPMENT
Umax = Ui = 42V, 4-20 mA, Po ≤ 1 W

Honeywell	A/A4	50049892	
	SCALE: None	REV F DATE 21 November 2013	SH. 2 of 4

FOUNDATION FIELDBUS/ PROFIBUS

ENTITY PARAMETERS	Associated Apparatus
Ui or Vmax ≤ 30V	Uo, Voc or Vt ≤ 30V
Ii or Imax ≤ 180 mA	Io (Isc or It) ≤ 180 mA
Pi or Pmax = 1W	Po ≤ 1 W
Ci= 0 nF	Ca or Co ≥ C_{cable} + $C_{ST\ 800/\ ST\ 700}$
Li= 984 µH	La or Lo ≥ L_{cable} + $L_{ST\ 800/\ ST\ 700}$

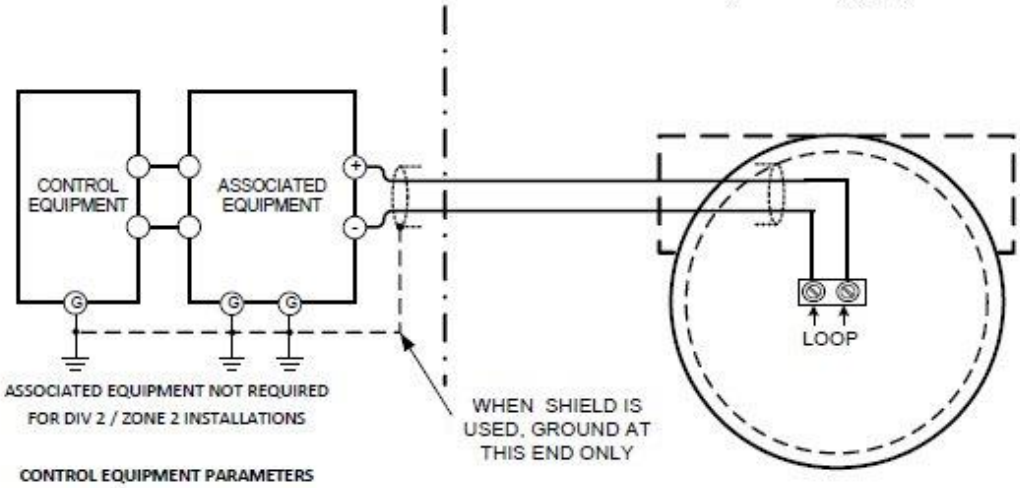
Terminal Module Revision F or Later

NOTE: THE REVISION IS ON THE LABEL THAT IS ON THE MODULE. THERE WILL BE TWO LINES OF TEXT ON THE LABEL:
- FIRST IS THE MODULE PART #: 50049839-003 OR 50049839-004
- SECOND LINE HAS THE SUPPLIER INFORMATION, ALONG WITH THE REVISION: XXXXXXX-FXXXX, THE "X" IS PRODUCTION RELATED; THE POSITION OF THE "F" IS THE REVISION.

ENTITY PARAMETERS	Associated Apparatus
Ui or Vmax ≤ 30V	Uo, Voc or Vt ≤ 30V
Ii or Imax ≤ 225 mA	Io (Isc or It) ≤ 225 mA
Pi or Pmax = 1W	Po ≤ 1 W
Ci= 0 nF	Ca or Co ≥ C_{cable} + $C_{ST\ 800/\ ST\ 700}$
Li= 0 µH	La or Lo ≥ L_{cable} + $L_{ST\ 800/\ ST\ 700}$

NON-HAZARDOUS LOCATION

HAZARDOUS (CLASSIFIED) LOCATION
CLASS I, CLASS II, DIVISION 1, GROUPS A, B, C, D, E, F & G;
ZONE 0 IIC & ZONE 2 IIC,
CLASS I DIVISION 2, GROUPS A, B, C, D;



CONTROL EQUIPMENT PARAMETERS WHEN NO ASSOCIATED EQUIPMENT
Umax=Ui= 32V, 25 mA, Po ≤ 1 W

Honeywell	A/A4	50049892	
	SCALE: None	REV F DATE 21 November 2013	SH. 3 of 4

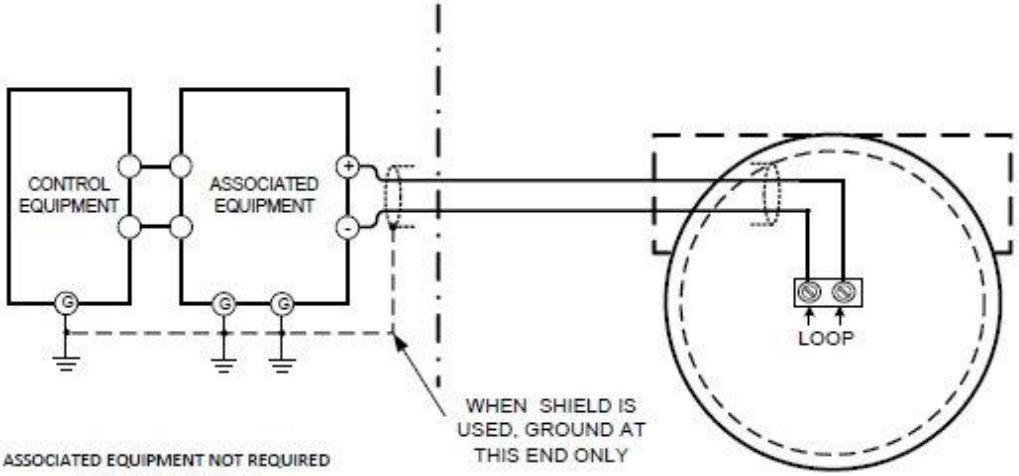
FISCO Terminal Module Revision F or Later

NOTE: THE REVISION IS ON THE LABEL THAT IS ON THE MODULE. THERE WILL BE TWO LINES OF TEXT ON THE LABEL:
- FIRST IS THE MODULE PART #: 50049839-003 OR 50049839-004
- SECOND LINE HAS THE SUPPLIER INFORMATION, ALONG WITH THE REVISION: XXXXXXX-FXXXX, THE "X" IS PRODUCTION RELATED, THE POSITION OF THE "F" IS THE REVISION.

ENTITY PARAMETERS	Associated Apparatus
Ui or Vmax ≤ 17.5	Uo, Voc or Vt ≤ 17.5V
Ii or Imax ≤ 380 mA	Io (Isc or It) ≤ 380 mA
Pi or Pmax = 5.32W	Po ≤ 5.32 W
Ci= 0 nF	Ca or Co ≥ C_{cable} + $C_{ST\ 800/\ ST\ 700}$
Li= 0 µH	La or Lo ≥ L_{cable} + $L_{ST\ 800/\ ST\ 700}$

NON-HAZARDOUS LOCATION

HAZARDOUS (CLASSIFIED) LOCATION
ZONE 0 IIC & ZONE 2 IIC,



ASSOCIATED EQUIPMENT NOT REQUIRED
ZONE 2 INSTALLATIONS

CONTROL EQUIPMENT PARAMETERS WHEN NO ASSOCIATED EQUIPMENT

Honeywell	A/A4	50049892	
	SCALE: None	REV F DATE 21 November 2013	SH. 4 of 4

A5. Marine Approvals

American Bureau of Shipping (ABS)

Certificate Number: 14-HS1265317

ABS Rules: Rules for Conditions of Classification, Part 1 - 2014 Steel Vessel Rules 1-1-4/7.7, 1-1-A3, 1-1-A4 which Covers the following: Steel Vessels 4-6-2/5.15, 4-8-3/13, 4-8-4/27.5.1, 4-9-8/13; Offshore Support Vessels 4-8-3/13, 4-8-4/29.5.1, 4-9-8/13; High Speed Craft 4-6-3/9.1.1(a), 4-7-9/15.1; Rules for Conditions of Classification, Part 1 - 2014 Offshore Units and Structures 1-1-4/9.7, 1-1-A2, 1-1-A3

Bureau Veritas (BV)

Certificate Number: 39542/A0 BV

Requirements: Bureau Veritas Rules for the Classification of Steel Ships

EC Code: 41S

Det Norske Veritas (DNV)

Certificate Number: A-13982

Application/ Location Classes:

Temperature D Humidity: B

Vibration: A EMC: B

Enclosure: C

For salt spray exposure; enclosure of 316 SST or 2-part epoxy protection with 316 SST bolts to be applied.

Korean Register of Shipping (KR)

Appl. No: DLN-T0044-14

Lloyd's Register (LR)

Certificate Number: 14/60017

Application: For use in environmental categories ENV1, ENV2, ENV3 adn ENV5 as defined by Lloyd's Register Test specification No. 1, 2013

A6. Measurement Instruments Directive (MID)

CERTIFICATE Number: TC8395

ISSUED BY: NMI CERTIN B.V**.**

MECHANICAL CLASS: M3 **ELECTROMAGNETIC ENVIRONMENT:** E2 AND E3

AMBIENT TEMPERATURE RANGE: -25 °C TO + 55 °C **HUMIDITY:** CONDENSING

PRESSURE RANGE:

Unit	Pressure Range
STD820	0 to 1000 mBar
STD830	0 to 7 Bar
STA84L	0 to 35 Bar A
STG84L	0 to 35 Bar
STD870	0 to 100 Bar
STA87L	0 to 100 Bar A
STG87L	0 to 100 Bar

Glossary

AP	Absolute Pressure
AWG	American Wire Gauge
DE	Digital Enhanced Communications Mode
DP	Differential Pressure
d1	Inside diameter of pipe
d2	Orifice plate bore diameter at flowing temperature
do	Inside diameter of orifice
EMI	Electromagnetic Interference
FTA	Field Termination Assembly
GP	Gauge Pressure
HP	High Pressure (also, High Pressure side of a Differential Pressure Transmitter)
Hz	Hertz
inH_2O	Inches of Water
LGP	In-Line Gauge Pressure
LP	Low Pressure (also, Low Pressure side of a Differential Pressure Transmitter)
LRL	Lower Range Limit
LRV	Lower Range Value
mAdc	Milliamperes Direct Current
mmHg	Millimeters of Mercury
mV	Millivolts
Nm	Newton·meters
NPT	National Pipe Thread
NVM	Non-Volatile Memory
Pa	Measured static pressure in PV4 algorithm
Pc	Absolute critical pressure of the gas
Pd	Static pressure at downstream point
Pdp	Measured differential pressure in Pascals in PV4 algorithm
Pf	Absolute pressure of flowing gas
Pr	Reduced pressure
Pu	Static pressure at upstream point
PM	Process Manger
PSI	Pounds per Square Inch
PSIA	Pounds per Square Inch Absolute
PV	Process Variable
PWA	Printed Wiring Assembly
RFI	Radio Frequency Interference
RTD	Resistance Temperature Detector
SFC	Smart Field Communicator
STIM	Pressure Transmitter Interface Module
STIMV IOP	Pressure Transmitter Interface Multivariable Input/Output Processor
T/C	Thermocouple
URL	Upper Range Limit
URV	Upper Range Value
US	Universal Station
Vac	Volts Alternating Current
Vdc	Volts Direct Current

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Sales and Service

For application assistance, current specifications, pricing, or name of the nearest Authorized Distributor, contact one of the offices below.

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Or contact your Honeywell Account Manager

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Shanghai, China 20061

www.honeywellprocess.com

34-ST-25-25 Rev.10
July 2016
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MAJOR INSTRUMENTATION MANUALS INDEX

TAB	MANUFACTURER	MANUAL	INSTRUMENT
1	ASCO	8320	FCV, LCV, PCV, SDV
2	Ashcroft	50EI	TI
3		600B	TI
4		1279	PI
5		Thermowells	TW
6	Brooks	Ar-Mite	ME
7	Chromalox	Circulation Heater	H
8	Emerson - FieldQ	Valve Actuator	SDV
9	Emerson - Fisher	67CFR	FCV, LCV, PCV, TCV, SDV
10		299H	LT
11		627	PCV
12		657	FCV, PCV
13		667	FCV, LCV, PCV
14		846	LCV
15		2052	TCV
16		D4	LCV
17		DLC3010	LT
18		DVC6200	FCV, LCV, PCV, TCV
19		ET, EAT	FCV, PCV
20		EZ	LCV, PCV
21		EZ-C, ET-C, EWT-C	FCV
22		HP, HPA, HPT	LCV
23		Micro-Form	LCV
24		V150, V200, V300	TCV
25		Whisper III	PCV
26	Emerson - Rosemount	3051	FE, FT
27	Farris	2600 Series	PSV
28		2700 Series	PSV
29		3800 Series	PSV
30		IOM	PSV
31	Grove	B5 Ball Valve	SDV
32	Honeywell	ST 700 Series	FT, LT, PDT, PT
33		ST 800 Series	TT

TAB	MANUFACTURER	MANUAL	INSTRUMENT
34	JMS Southeast	3ESBNK	TE
35	Midwest	120 Series	PDI
36	Pentair	Keystone	SDV
37		Morin	SDV, XV
38		Vanessa	SDV, XV
39		Westlock	SDV, XV
40	PGI	2, 3, & 5 Valve Manifold	FT, PDT
41	Phymetrix	Moisture Analyzer	ME
42	PLT	MG	LI
43	Quality Products	Orifice Plate	FE
44		Restriction Union	RO
45	Quest-Tec	1S, RL, TL, TM	LG
46	S.O.R.	700 Series	LSHH
47	Topworx	DXP	FCV, PCV, SDV
48	Versa	VSG	SDV
49	WKM	370D6	SDV

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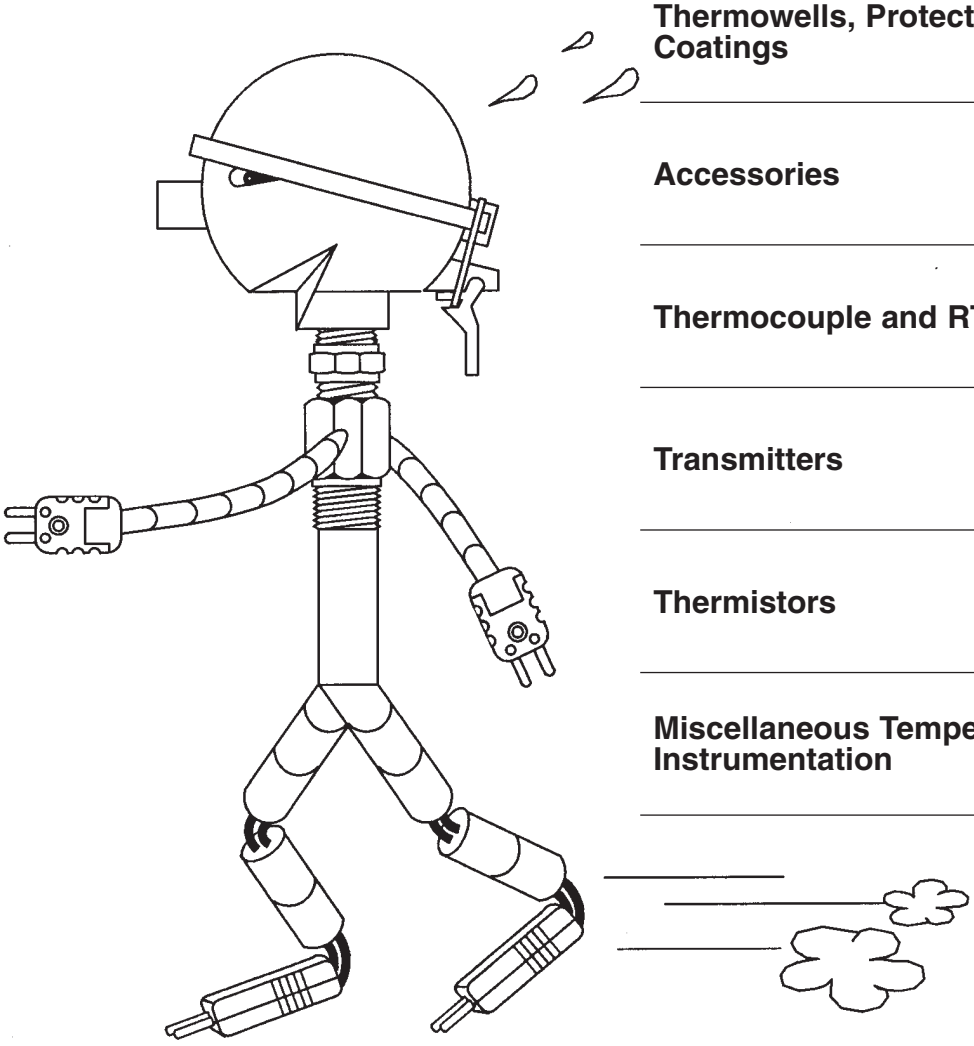
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Swifty Sensor




JMS SOUTHEAST INC.
Temperature
Measurement
STATESVILLE
PROCESS INSTRUMENTS

JMS Southeast, Inc.
Temperature Measurement

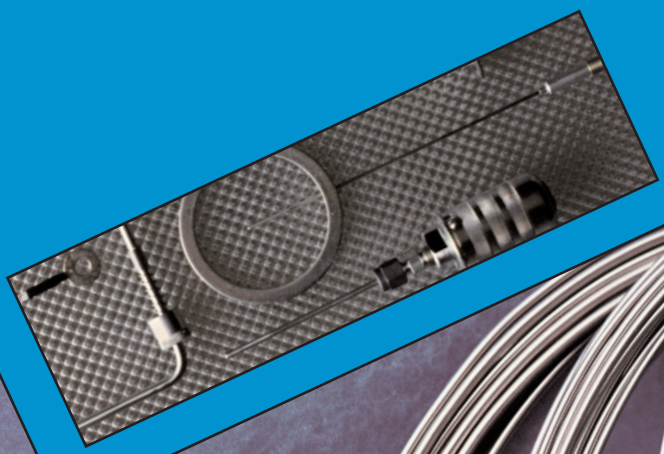


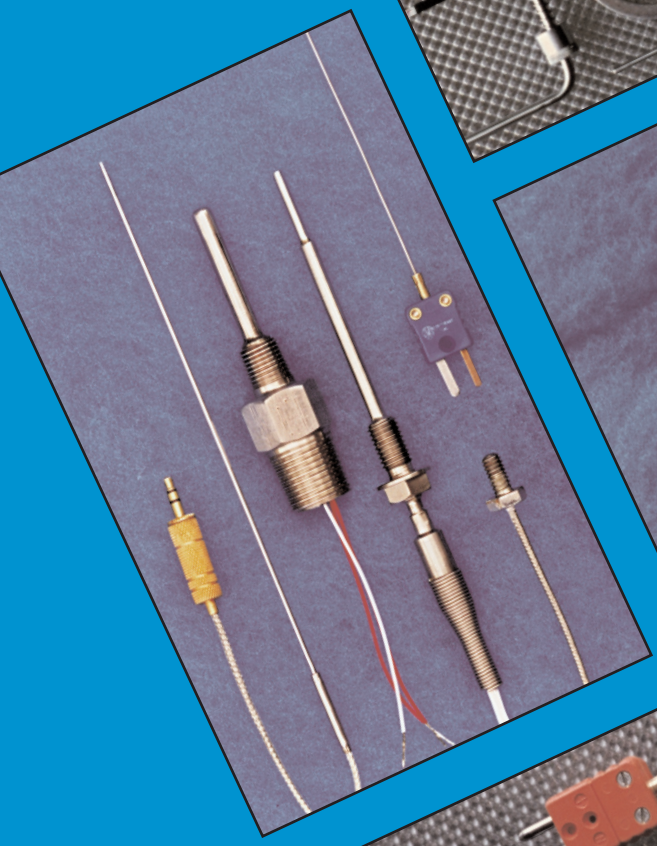
SECTION 1

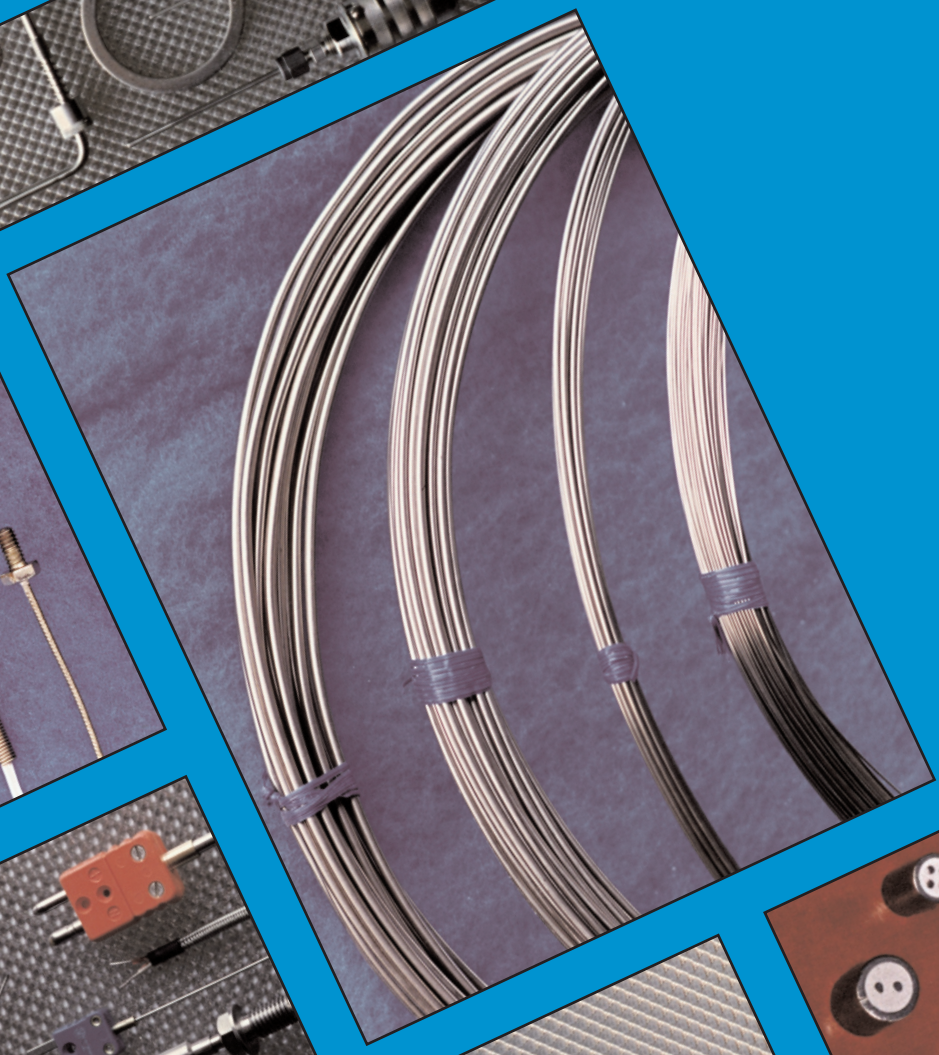
Miniature and Industrial Thermocouples

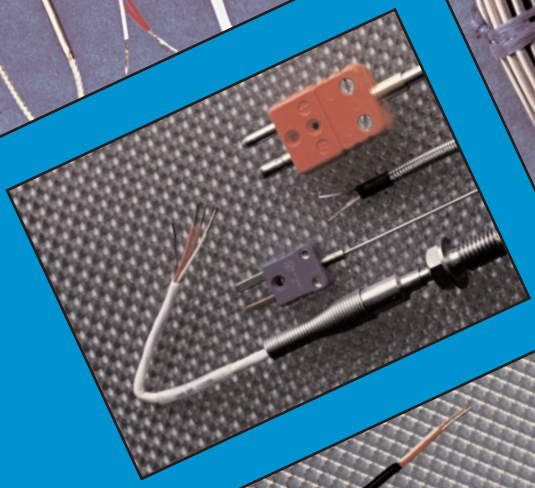


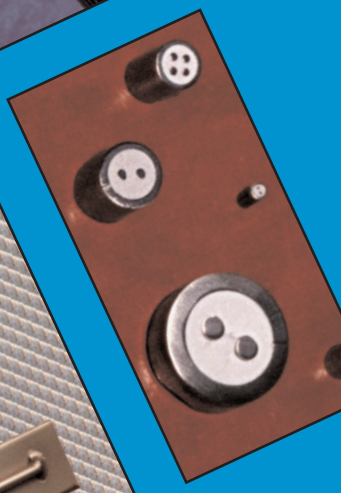


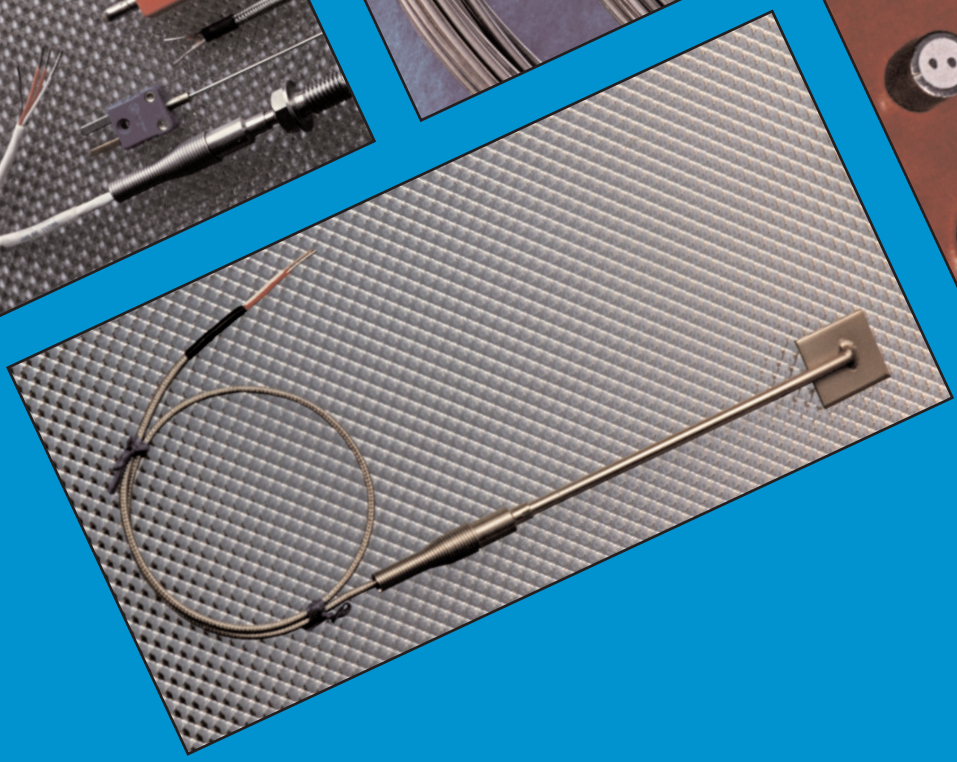












MINIATURE AND INDUSTRIAL THERMOCOUPLES

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Note: All thermocouples may be coated for abrasion resistance or resistance to chemical attack. See pages 5-35 through 5-39.

MINIATURE AND INDUSTRIAL THERMOCOUPLES

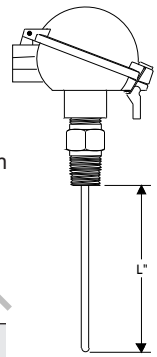
#1	SERIES [6, 7]
1	Thermocouple

#2	TYPE [8, 9, 10]
–"	J, T, K, E, N, X (Other, specify)

#3	LIMITS OF ERROR [9]	ELEMENT CONSTRUCTION
1	Standard	Single
2	Standard	Dual
3	Special	Single
4	Special	Dual
X	Other, specify	

Note: For hollow tube sensors see pages 2-1 and 2-2.

For fixed fittings and types S, C, D, B, N4, 6 and S4, 6 (symbol #8) this length normally equals the "A" dimension if a thermowell is used. (See Section 5)



#4	OUTSIDE DIAMETER [11]	CONDUCTOR SIZE (FOR BASE METALS ONLY) SINGLE (awg)	DUAL (awg)
*A	3/8"	13	16
B	1/4"	16	18
C	3/16"	19	20
D	1/8"	22	24
E	1/16"	28	30
*F	1/25"	32	34
X	Other, specify		
Z	N/A		

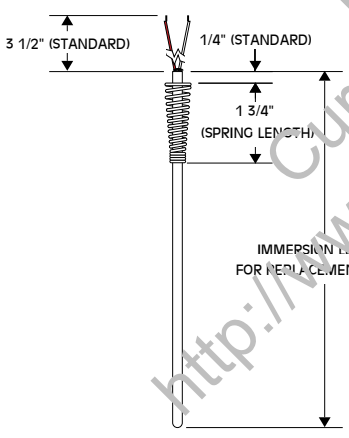
Note: IMS now offers sheath as small as .010 in diameter

#5	SHEATH MATERIAL [11]	MAX °F [2-8, 4-17]
H	304 Stainless Steel	1650
J	310 Stainless Steel	2100
V	STABALOY	2220
K	316 Stainless Steel	1650
M	Inconel 600	2100
C	Teflon coated SS	400
X	Other, specify	

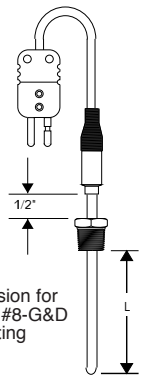
[ ]BRACKETS INDICATE PAGE NUMBERS ON WEB OR FULL CATALOG FOR ADDITIONAL TECHNICAL INFORMATION WWW.JMS-SE.COM

#6	MEASURING JUNCTION [12, 13, 15]		
G	Grounded	*P	Reduced tip, grounded
U	Ungrounded	*Y	Reduced tip, ungrounded
E	Exposed (Isolated on dual)	*R	Gas/Air, exposed
I	Isolated	*S	Gas/Air, grounded
*J	Pointed tip, grounded	*T	Gas/Air, ungrounded
*K	Pointed tip, ungrounded	*V	Enlarged tip, grounded
*L	Weld pad, grounded	*W	Enlarged tip, ungrounded
*M	Weld pad, ungrounded	*X	Other, specify
N	Weld pad, removable grounded		**Note:** When selecting these options, a decription must be provided
*O	Weld pad, removable ungrounded		

#7	LENGTH (See sketches on Pg. 1-1, 2, 3 & 4 for lengths)
--"	Length in inches Note: If sensors requires a bend from the factory use page 2-1 to order.



Immersion for Symbol #8-E Spring



Immersion for Symbol #8-G&D Fitting

#8	STANDARD INDUSTRIAL ATTACHING DEVICE [1-3, 6- 13]
W	Fixed NPT ss fitting - double threaded
S	Spring loaded NPT ss fitting -double threaded
C	Spring loaded NPT ss w/ oil ring - double threaded
D	Spring loaded ss fitting - single threaded
B	Bayonet spring loaded assembly for thermowells and heads
*E	Adjustable spring over .250", .188", .125" sheath
F	Reverse mounted steel plug fixed for attaching head
G	Fixed stainless steel to sheath (See drawing to left)
*H	Compression fitting ss w/ ss ferrule
*I	Compression fitting ss w/ teflon ferrule
*J	Compression fitting ss w/ lava ferrule
*K	Compression fitting ss w/ nylon ferrule
*L	Compression fitting brass w/ brass ferrule
N4	4" Nipple-Union-Nipple (NUN4G1)
N6	6" Nipple-Union-Nipple (NUN6G1)
S4	4" Spring-Loaded-Union-Nipple (NU4G1)
S6	6" Spring-Loaded-Union-Nipple (NU6G1)
X	Other, specify or if more than 1 is needed
Z	Not applicable (no fitting required)

For materials other than SS, (ex: brass, carbon steel, etc.) Use X + material + letter designation

(SEE PAGE 1-3) FOR MORE NIPPLE OPTIONS.

*** Length is calculated without consideration of these attaching device. (See dwg on pg. 1-2)**

1	J	1	B	H	G	12"	S	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

MINIATURE AND INDUSTRIAL THERMOCOUPLES

#9 PROCESS NPT [3]

L	1/8”
M	1/4”
P	1/2” (**Standard** w/ symbols W, S, C, and N in symbol #8)
O	3/4”
X	Other, specify
Z	N/A

#10 LEAD WIRE TYPE & LENGTH IN INCHES [SEE SECTION 7]

Z	No lead wires
1__”	Glass braid
2__”	PVC
3__”	Teflon
4__”	Hi-temp glass braid
5__”	Kapton
7__”	Bare wire
X__”	Other, specify

} Solid 20awg

8	PVC coil cord - **Standard** when using symbol #8-B and #13-R

Note: For non-stock stranded wire, add ”S” before symbol designation in this column. 24 awg or smaller may be used to accommodate some smaller diameters and flex armor extensions.

#11 ARMOR OR HEAT SHRINK [7-7] [16]

A	3/16” ID SS flex armor
B	3/16” ID SS flex armor PVC coated white
C	3/16” ID SS flex armor PVC coated black
D	1/8” ID SS flex armor
F	SS overbraid
G	Heat shrink / sleeving
H	Jacket to match primary insulation

J	Aluminum mylar shielded and jacketed to match primary insulation
X	Other, specify
Z	N/A

Note: Bell Springs are used for most wire extensions at transition. A special armor adapter is used when armor is longer than 60”.

#12 TYPE OF TRANSITION [16]

H	Heat shrink
S	Size on size
T	3/8” OD (**Standard**)
R	1/4” OD
X	Other, specify
Z	No transition

Note: For high humidity / moisture environments, ≤ 500˚F put a “2” after your selection.

* For high temperature at the transition area use an X + type of transition and maximum temperature. >500°F

#13 COLD END TERMINATION [SEE SECTION 6] PICK AS MANY AS APPLICABLE

A	Bare ends
B	Miniature plug
C	Standard plug
D	Miniature jack
E	Standard jack
F	High temperature plug (< 800˚ F)
G	High Temperature jack (< 800˚ F)
I	Explosion proof Nema 7 head (6I / 6PT)
K	Spade lugs (6SL)
L	Aluminum head w/ hinged cover (6L / 6B4)
M	Aluminum head w/ screw cover & chain (6M / 6B4)
N	Cast iron head w/ screw cover (6N / 6B4)
O	Open terminal block (6M)

Note: For any other cold end termintion, use symbol X and describe using appropriate part numbers from section 6 in place of symbol #13.

Q	Black nylon Nema 4 head (6Q / 6B4)
R	High dome head (6R)
W*	Microphone style connector (6DA) -Male
8H	Isolated Transmitter
8N	Non IsolatedTransmitter
8S	AI-1500
8I	TempIR with Hart Protocol
8E	Intrinsically Safe TempIR
8D	TempIR/ Hart/ Intrinsically Safe
X	Other, specify

*Use double symbol here for matching female connectors. i.e. B/BB (male with matching female.

#14 OPTIONS USE ONLY IF APPLICABLE [INTRODUCTION]

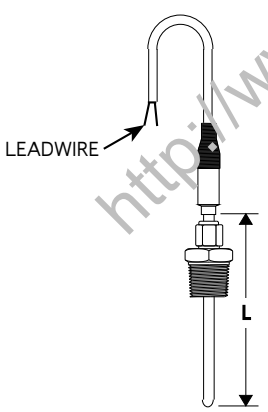
TAGGING

1	Stainless steel tag
2	Plastic tag
3	Paper tag
4	Electroetch on probe

Note: You must always specify information required on tag

CALIBRATION

5	Calibrate at specified point(s). Corrections data will be provided for each point.
6	Calibrate specified temperature range. Corrections data will be provided for all temperatures within the range. **Note:** You must specify increments & range Ex. 0 to 300°F, 0.1° increments
7	CE Marking [Page XV]
8	Guide 17025 calibration
9	BAR CODE
Z	N/A

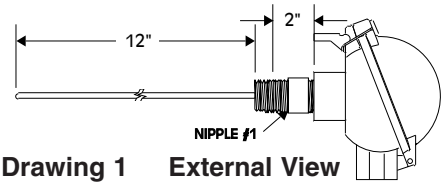


Immersion is overall length of tube for non-fixed attaching devices

L	Z	G	Z	L	1	

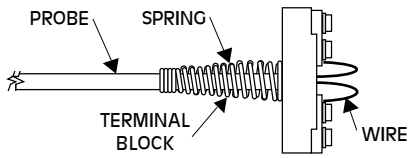
Part Numbers Obsolete
Current Part Numbers available at
http://www.ims-sensor.com/pdf/JMS_catalog_final.pdf
or call JMS direct at 1-800-633-1835
for assistance

NIPPLE-UNION-NIPPLE EXTENSION ASSEMBLIES

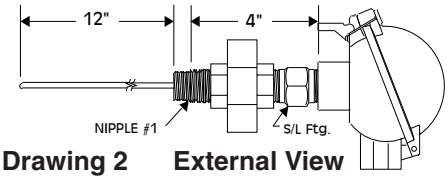


Drawing 1 External View

Drawing 1 - Nipple Only
Minimum Nipple L=1"
Ex. Part#: 1J1BHG12"EXZZZL
X = N2"G1

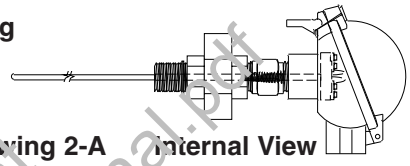


Direct Mounted Spring on Terminal Block

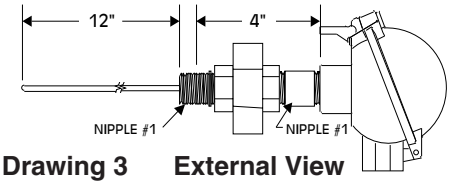


Drawing 2 External View

Drawing 2 - Nipple-Union with Machined 1/2" x 1/2" Spring Loaded Fitting
Minimum NU L=4" (includes S/L fitting)
Ex. Part#: 1J1BHG12"SXZZZL
X = NU4"G1

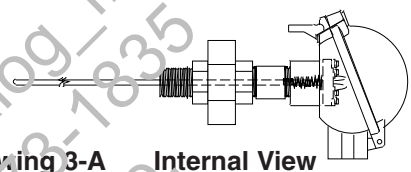


Drawing 2-A Internal View



Drawing 3 External View

Drawing 3 - Nipple-Union-Nipple with Spring Against Terminal Block
Minimum NUN L=4"
EX. Part#: 1J1BHG12"EXZZZL
X = NUN4"G1



Drawing 3-A Internal View

An extension assembly may be needed to provide extra length for your sensor in order to extend your sensor head through insulation, or away from the heat of the process. This extension can include a pipe nipple only or a nipple-union-nipple or a nipple-union with a spring-loaded fitting.

Standard nipples and unions are 1/2" NPT and are available in galvanized or stainless steel. The union joins two nipples in an extension assembly and has a standard pressure rating of 150 pounds.

When a nipple-union-nipple or nipple only assembly is used and spring loading of the thermocouple element is required, there are two different methods of spring loading the sensor. The preferred method is to use the machined 1/2" by 1/2" NPT spring-loaded stainless steel fitting as one of the nipples (see symbol #8, S page 1-1). With this design, the probe is secured within the fitting and is mounted to the head in a rigid manner (see drawing #2 above). The appropriate part number for this assembly would be selected from symbols #6 and #9 from page 1-1 and 1-2, in addition to the symbols on this page. A cheaper method is a spring, mounted over the probe and loaded against the bottom of the terminal block in the head. With this method the probe is not supported within the nipple-union-nipple. It is secured only by the wires into the terminal block. (See drawings 1 & 3 above). We do not recommend that you use this method of spring loading if your probe is mounted horizontally.

When specifying this sensor extension, the nipple-union-nipple length tolerance is ± 1/4".

Part Numbers Obsolete
Current Part Numbers available at
http://www.jmsse.com/JMS_Catalog_final.pdf
or call JMS Directly at 1-800-878-1835
for fast and friendly assistance.

#1	EXTENSION ASSEMBLY
N	Nipple Only (Dwg #1)
NU	Nipple-Union (Dwg #2)
NUN	Nipple-Union-Nipple (Dwg #3)

#2	LENGTH
--"	Specify length in inches

#3	MATERIAL
G	Galvanized Steel
H	304 Stainless Steel
C	Black Steel

#4	PRESSURE RATING	
1	#150 - A351 spec (Standard)	ASTM
2	#3000 - A182 spec	
3	#6000 - A182 spec	
X	Other, specify	

NUN	6"	G	1

BEADED THERMOCOUPLES

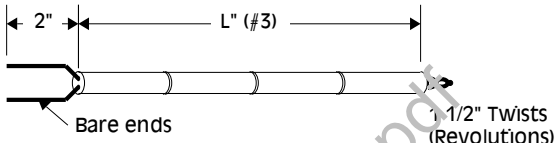
#1	SERIES
1B	Beaded Thermocouple

#2	SERIES
B	Welded bead only
T	Twisted and welded bead

Base metal 8–14 AWG is bent to fit JMS terminal block 6G with 2" leads.
(see section 6 for additional terminations)

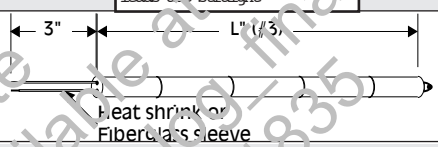
#3	INSULATOR TYPE AND LENGTH (L)
A __"	1 inch - Round
D __"	3 inch - Round
F __"	One piece construction - Round
G __"	1 inch - Oval
H __"	3 inch - Oval
X __"	Other, specify in description

Note: Oval insulators are recommended for lengths beyond 100".



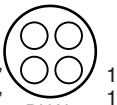
Base metal 15–30 AWG leads are straight

#4	COLD END INSULATION
1	Fiberglass sleeve (Standard)
2	Heat shrink
3	Mullite fish spine beads (includes tangs)
Z	Bare ends
X	Other, specify

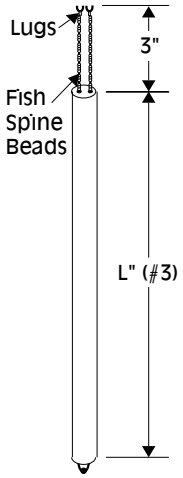


#5	INSULATOR MATERIAL
A	Alumina (Standard for noble metals)
M	Mullite (Standard for base metals)

#6 SINGLE ELEMENT	WIRE GAUGE	O.D. OF 1" OR 3" OVAL INSULATORS	O.D. OF 1" OR 3" ROUND INSULATORS	O.D. OF 1 PIECE ROUND INSULATORS
D08	8 (Standard oval)	5/16" x 7/16"	7/16"	7/16"
D14	14 (Standard oval)	3/16" x 1/4"	1/4"	1/4"
D20	20		3/16"	3/16"
D24	24	OVAL	3/16"	3/16"
D26	26	NOT	3/16"	3/16"
D30	30	AVAILABLE	1/8"	1/8"
DX	Other, specify	IN SINGLE		
DUAL ELEMENT				
D08	8		7/16"	1/2"
D14	14	OVAL	5/16"	1/4"
D20	20	NOT	3/16"	3/16"
D24	24	AVAILABLE	3/16"	3/16"
D26	26	IN DUAL	3/16"	3/16"
D30	30		1/8"	1/8"
DX	Other, specify			



Platinum T/C have spade lugs



#7	TYPE
_	J, K, E, S, R, B, N, X(Other, specify)

#8	LEAD LENGTH IN INCHES
--"	Specify length of thermocouple leads in inches. (See drawings) (2" Recommended for replacement elements)

#9		OPTIONS USE ONLY IF APPLICABLE [INTRODUCTION]		
TAGGING	1	Stainless steel tag	CALIBRATION	4 Calibrate at specified point(s). Corrections data will be pro vided for each point.
	2	Plastic tag		5 calibrate specified temperature range. corrections data will be provided for all temperatures within the range.
	3	Paper tag		**Note:** You must specify incre ments & range Ex. 0 to 300˚F, 0.1˚ increments.

Insulator Tolerances
Ø: ± 6% or .005" whichever is greater.
Length: ± .063".

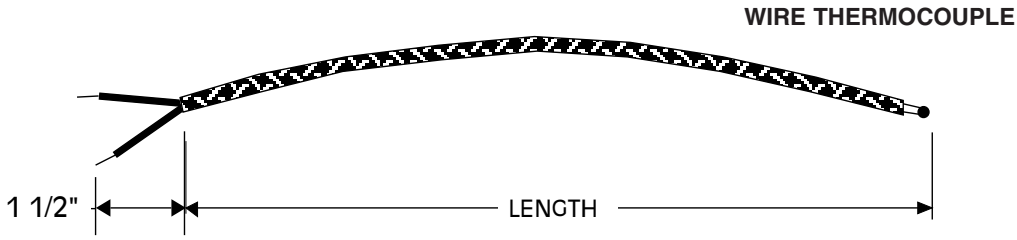
Noble metal thermocouples are normally 24 gauge wires.
To specify ceramic or metal protection tubes for above assemblies, see "Thermowells and Protection Tubes Section".

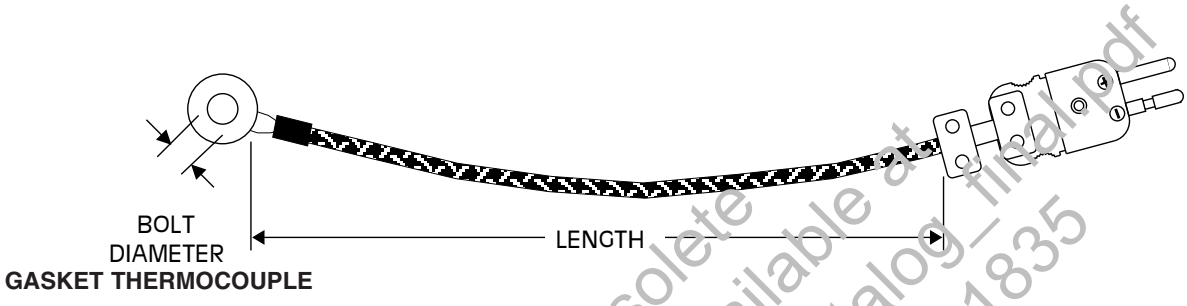
Oval Insulators will be used for any bent beaded thermocouple.

1B	B	A (18)	Z	A	24	R	3"	3	

Part Numbers Obsolete
Current Part Numbers available at
www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-973-1835
for fast and friendly assistance.
http://

WIRE, GASKET, AND LUG THERMOCOUPLES





Old Numbers Obsolete
Current Part Numbers available at
http://www.jmsse.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

#1	DESCRIPTION
1D	Wire and Gasket thermocouples

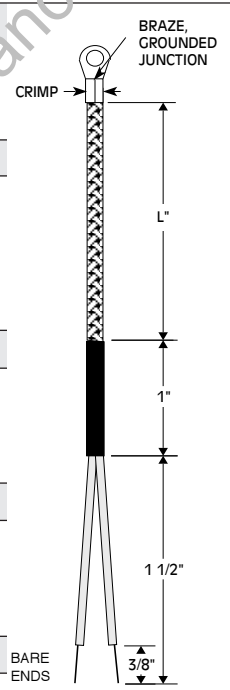
#2	TYPE OF THERMOCOUPLE
G	Wire thermocouple
H	Gasket thermocouple
L	Ring Terminal thermocouple
S	Spade Lug thermocouple

#3	TYPE
J	Iron/Constantan
T	Copper/Constantan
K	Chromel/Alumel
E	Chromel/Constantan
N	Nicrosil/Nisil
X	Other, specify

#4	GASKET MATERIAL
C	Copper (Standard)
P	Spark plug washer (1 cycle automotive)
S	Stainless steel
X	Other, specify
Z	N/A

#5	BOLT DIAMETER
A	#10
B	#12
C	1/4"
X	Other, specify
Z	N/A

#6	WIRE INSULATION
1	Glass braid
3	FEP teflon
4	Hi-temp glass braid
5	Kapton
8	Glass braid / stainless steel overbraid
X	Other, specify



RING TERMINAL THERMOCOUPLE

#7	DESCRIPTION
--"	Length in inches

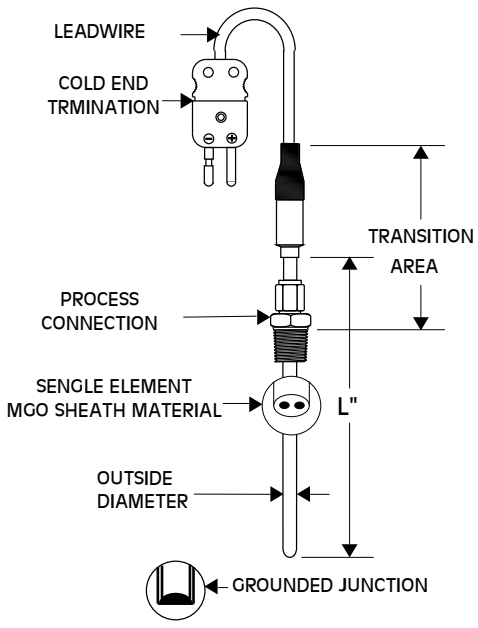
#8	COLD END TERMINATION
A	Bare ends (Heat shrink used with braided insulation)
B	Miniature plug
C	Standard plug
X	Other, specify (See page 1-2 or section 6 for options)

1D	G	J	C	A	1	36"	C	

THERMOCOUPLES

Thermocouples operate on the principle that when two dissimilar metals are joined at both ends and one of the ends is a different temperature, a measurable and repeatable EMF is produced.

The preferred design for JMS thermocouples is mineral insulated sheath. The high purity, hard packed magnesium oxide provides excellent insulation of the positive and negative wire conductors in relation to each other and to the outer metal material. Among the outstanding features of sheath are: (A) flexibility to bend or form to a radius = to 2x sheath diameter, (B) its rigidity to maintain size and shape after bending or straightening, (C) vibration nor shock has little affect on the sensor, (D) sheath withstands pressures upwards to 50,000 psi, and (E) sheath may be used in applications where temperatures may range from -400° to 3000°F depending on requirements and selection of materials.



COMPONENTS OF THERMOCOUPLES

HOT END

Outside Diameter

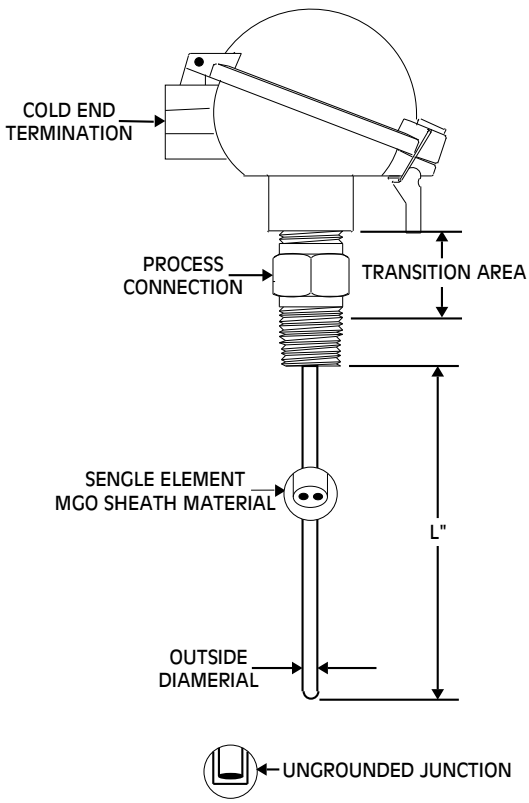
Thermocouples range in outside diameters from .010” to .500”. A general rule of thumb is the smaller the diameter, the quicker the response time. For additional information see page 1-13.

Sheath Material

JMS offers thermocouples in a wide variety of sheath materials, with 304 and 316 stainless steel being the most popular. Both temperature and environment should be taken into consideration when selecting your sheath material. See pages 1-1, 1-11 and 4-17 for temperature ratings of various materials. See page 2-8 for insulation characteristics.

Measuring Junction

The measuring junction is the sensitive portion of the thermocouple. Grounded junctions are the most frequently requested junctions. For a complete description of measuring junctions available and their advantages and disadvantages see page 1-12, 1-13.



TRANSITION AREA

This area is between the points when the sheath or tube ends and the cold end begins. The area includes the **actual transition point** (see pg. 1-16) and any process fitting or connections within these two points. Process connection **fittings** include compression fittings and 1/2” x 1/2” N.P.T. welded or spring loaded fittings. See page 1-2 for full selection of process connections. Metal parts and process connections can either be welded or brazed (silver solder), depending on the wall size of the material to which the parts are being attached.

COLD END

Leadwire Insulation

JMS offers a large selection of thermocouple leadwire. Insulations include fiberglass, PVC, teflon, kapton, high temperature fiberglass, and fiberglass with stainless steel overbraid or flexible armor. Additional information can be found in the “Thermocouple and RTD Wire” section. (Section 7)

Cold End Termination

This may be in the form of wires, plugs, or terminal heads. A partial list is given on page 1-2. See section 6.

4, one hour sessions training video. $1200.00 - Call for information.

THERMOCOUPLE GENERAL INFORMATION

Thermocouples consist of two dissimilar metals and provide a means of sensing temperature in a variety of processes. Temperature is the most widely measured process variable and its measurement is critical in many manufacturing processes. We at JMS manufacture temperature probes of exceptional quality to assure this measurement is accurate.

Thermocouples can be constructed in a variety of ways from flexible wires smaller than a human hair to rugged sheath one half inch in diameter. They can measure temperatures from -454°F to 4200°F.

Thermocouples are low-impedance devices that work by producing electro-motive forces and these EMF's are correlated to a temperature based on a curve specified for that particular thermocouple calibration. The EMF produced occurs due to temperature gradients along the wire and not at the junction. This phenomenon can be explained in three scientific theories called the Seebeck effect, the Peltier effect, and the Thompson effect.

Three laws of thermoelectric circuits that explain thermocouple behavior are **The Law of Intermediate Metals** which explains that a circuit's EMFs are algebraically additive unless the circuit is at a uniform temperature, **The Law of Homogeneous Metals** which indicates an EMF cannot be created unless another type of metal exists in the circuit and a temperature gradient exists.

The third law is the **The Law of Intermediate Temperatures**. If two dissimilar homogeneous metals produce a thermal EMF of X; it will remain at that number if a third material is introduced into the circuit, if both ends of that third material are at the same temperature.

The millivolt signal produced by the thermocouple is a very, very, very low level signal. Thus, transmitting this signal over a long distance may be difficult if any extraneous "noise" is introduced into the system. This noise may cause errors in the EMF signal. Shielded lead wire should be used in areas with excessive "noise" to help eliminate the problem.

The lead wire that extends from the thermocouple must match the calibration of the thermocouple. This lead wire continues to transmit the signal from the thermocouple to the instrument, and as long as it is one homogeneous metal, it does not produce an EMF along that length even if it does experience temperature gradients.

The output of a thermocouple depends on the magnitude of the temperature difference between the measuring junction and the reference junction. The reference junction is the cold end to which the thermocouple is connected. While the hot measuring junction is stable at a given temperature, the output of the point at which the reference junction is made must be compensated for in the instrumentation. This is accomplished through "cold junction Compensation." The temperature of the cold junction is measured and calculated into the overall EMF signal to obtain the accurate hot junction temperature, or the temperature of the process.[2]

[2]Benedict, R.P. Fundamentals of Temperature, Pressure and flow Measurement, Second Edition, Wiley, New York (1977).

THERMOCOUPLE POINTS

1. A thermocouple produces an EMF based on the composition of the two dissimilar metals only, irregardless of the dimension or length of the conductors.

2. No voltage is produced at the thermocouple junction, only in those portions of the sensor that are in a temperature gradient.

JMS has access to several papers on noise and its effect on instruments. Call us and we will mail or fax you a copy.

4, one hour sessions training video. $1200.00 - Call for information.

THERMOCOUPLE TYPE INFORMATION

JMS offers thermocouples and wire in the following types. Listed below are suggested criteria to consider in selecting the desired type for your application. Contact JMS Southeast if additional information is required.

(J)–Iron vs Constantan (Most Common)

May be used in vacuum, oxidizing, reducing, and inert atmospheres. Heavier gauge wire is recommended for long term life above 1000°F since the iron element oxidizes rapidly at these temperatures.

(T)–Copper vs Constantan (Most Common Cold)

May be used in vacuum, oxidizing, reducing, and inert atmospheres. It is resistant to corrosion in most atmospheres. High stability at sub-zero temperatures and its limits of error are guaranteed at cryogenic temperatures.

(K)–Chromel vs Alumel (Most Common Real Hot)

Recommended for continuous use in oxidizing or inert atmospheres up to 2300°F (1260°C), especially above 1000°F. Cycling above and below 1800°F (1000°C), is not recommended due to EMF alteration from hysteresis effects. Should not be used in sulfurous or alternating reducing and oxidizing atmospheres unless protected with protection tubes. Fairly reliable and accurate at high temperatures.

(E)–Chromel vs Constantan

May be used in oxidizing or inert atmospheres, but not recommended for alternating oxidizing or inert atmospheres. Not subject to corrosion under most atmospheric conditions. Has the highest EMF produced per degree than any other standard thermocouple and must be protected from sulfurous atmospheres.

(S,R)–Platinum vs Platinum Rhodium (Most Common Real, Real Hot)

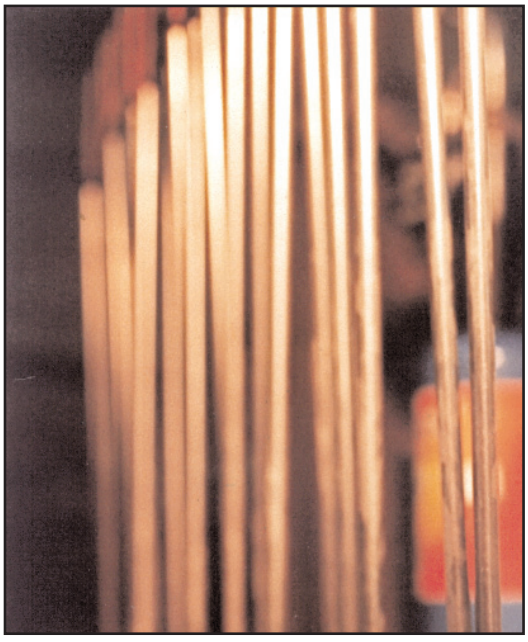
Recommended for use in oxidizing or inert atmospheres. Reducing atmospheres may cause excessive grain growth and drifts in calibration.

(N)–Nicrosil vs Nisil (New ... Better Than "K")

May be used in oxidizing, dry reducing, or inert atmospheres. Must be protected in sulfurous atmospheres. Very reliable and accurate at high temperatures. Can replace Type K thermocouples in many application.

(C)–Tungsten 5% Rhenium vs Tungsten 26% Rhenium

Recommended for use in vacuum, high purity hydrogen, or pure inert atmospheres. May be used at very high temperatures (2316°C), however, is inherently brittle.



THERMOCOUPLE TYPE INFORMATION

	ANSI T/C TYPE	NAMES	CONDUCTOR IDENTIFICATION	ASTM COLOR CODING	MAGNETIC	IEC COLOR CODING
	J	Iron Constantan	+ -	white red	yes no	white black
	T	Copper Constantan	+ -	blue red	no no	white brown
	K	Chromel Alumel	+ -	yellow red	no yes	white green
	E	Chromel Constantan	+ -	purple red	no no	white violet
Not ANSI	P	Platinel	N/A	N/A	N/A	N/A
	S	Platinum 10% Rhodium Pure platinum	+ -	black red	no no	white orange
	R	Platinum 13% Rhodium Pure platinum	+ -	black red	no no	white orange
	B	Platinum 30% Rhodium Platinum 6% Rhodium	+ -	grey red	no no	white grey
	N	Nicrosil Nisil	+ -	orange red	no slightly	white pink
Not ANSI	C	Tungsten 5% Rhenium Tungsten 26% Rhenium	+ -	white red	no no	N/A

See Section 7 for wire insulation color codes.

ANSI THERMOCOUPLE TYPE	TEMP. RANGE (°C)	TEMP. RANGE (°F)	LIMITS OF ERROR STANDARD °C	LIMITS OF ERROR STANDARD °F	LIMITS OF ERROR SPECIAL °C	LIMITS OF ERROR SPECIAL °F
J	0 to 760	32 to 1400	±2.2 or ±0.75%	See Note	±1.1 or 0.4%	See Note
T	0 to 370	32 to 700	±1 or ±0.75%		±0.5 or 0.4%	
K	0 to 1260	32 to 2300	±2.2 or ±0.75%		±1.1 or ±0.4%	
E	0 to 870	32 to 1600	±1.7 or ±0.5%		±1 or ±0.4%	
S	0 to 1480	32 to 2700	±1.5 or ±0.25%		±0.6 or ±0.1%	
R	0 to 1480	32 to 2700	±1.5 or ±0.25%		±0.6 or ±0.1%	
N	0 to 1246	32 to 2300	±2.2 or ±0.75%		±1.1 or ±0.4%	
B	870 to 1700	1600 to 3100	±0.5%		±0.25%	
T[A]	-200 to 0	-328 to 32	±1 or ±1.5%		[B]	
E[A]	-200 to 0	-328 to 32	±1.7 or ±1%		[B]	
K[A]	-200 to 0	-328 to 32	±2.2 or ±2		[B]	

[A] Thermocouple and thermocouple materials are normally supplied to meet the tolerances specified in the table for temperatures above 0°C. The same materials, however, may not fall within the tolerances given for temperatures below 0°C in the section section of the table. If materials are required to meet the tolerances stated for temperatures below 0°C the purchase order must so state. Selection of materials usually will be required.

[B] Special tolerances for temperatures below 0°C are difficult to justify due to limited available information.

Note: The °F tolerance is 1.8 times larger than the °C tolerance at the equivalent °C temperature.

THERMOCOUPLE-MILLIVOLT GRAPH

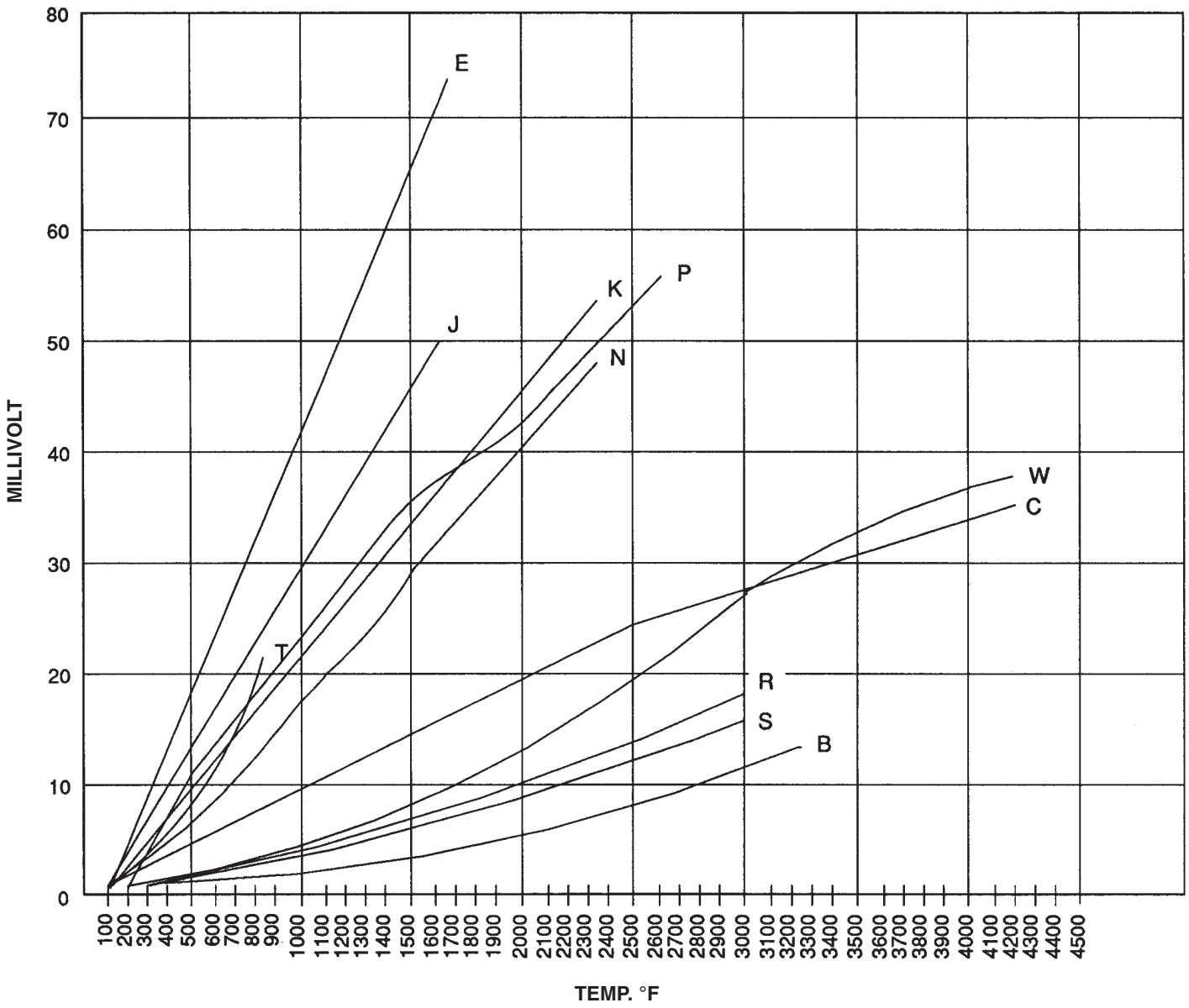
T=Copper vs. Constantan
E=Chromel vs. Constantan
J=Iron vs. Constantan
K=Chromel vs. Alumel
W=Tungsten vs. Tungsten 26% Rhenium (also known as Type G)
C=Tungsten 5% Rhenium vs. Tungsten 26% Rhenium (also known as Type W5)
R=Platinum vs. Platinum 13% Rhodium
S=Platinum vs. Platinum 10% Rhodium
B=Platinum 6% Rhodium vs. Platinum 30% Rhodium
N=Nicrosil vs. Nisil
P=Platinel

Selection of the optimum type of thermocouple and auxiliary components for a pyrometric system is necessarily based on a number of variables or factors of the application. The temperature range, EMF output, accuracy required, resistance to atmospheric conditions, pressure and shock are typical thermocouple systems for a given application.

The following technical information is intended to serve only as a guide for thermocouple selection. Any recommendation stated is based on past practices and experience, and no guarantees, implied or otherwise, are made as to optimum operation conditions.

Although some of these materials will operate at higher temperatures than shown on the chart, they represent what is generally conceded as the maximum reliable operating temperature.

4, one hour sessions training video. $1200.00 - Call for information.



ELEMENT CONSTRUCTION

JMS Southeast offers the choice of single, dual, or triple element thermocouples. A single element thermocouple is used when a single signal is required. If two inputs are required, we offer dual element sensors. Dual isolated elements are frequently used for two different monitoring systems such as a recorder and controller. Although not as commonly used as single or dual elements, JMS also manufactures triple element sensors for applications that require three inputs. It is possible to parallel outputs from a thermocouple to any number of instruments, but this is not a recommended practice. The use of dual or triple elements should also specify isolated junctions. See page 1-1.

SUGGESTED UPPER LIMIT FOR OUTSIDE DIAMETER (SINGLE ELEMENT) ˚C (˚F)

Sheath		Thermocouple Type				
In.	mm	T	J	E	K	N
1/25”	1.0	260˚ (500˚)	260˚ (500˚)	300˚ (570˚)	700˚ (1290˚)	700˚ (1290˚)
1/16”	1.6	260˚ (500˚)	440˚ (825˚)	510˚ (950˚)	920˚ (1690˚)	920˚ (1690˚)
1/8”	3.2	315˚ (600˚)	520˚ (970˚)	650˚ (1200˚)	1070˚ (1960˚)	1070˚ (1960˚)
3/16”	4.8	370˚ (700˚)	620˚ (1150˚)	730˚ (1350˚)	1150˚ (2100˚)	1150˚ (2100˚)
1/4”	6.3	370˚ (700˚)	720˚ (1330˚)	820˚ (1510˚)	1150˚ (2100˚)	1150˚ (2100˚)
3/8”	9.5	370˚ (700˚)	720˚ (1330˚)	820˚ (1510˚)	1150˚(2100˚)	1150˚ (2100˚)

TEMPERATURE INFORMATION FOR SHEATH MATERIAL

MATERIAL SYMBOL	SHEATH MATERIAL	MELTING POINT (°F)	MAX. TEMP. IN AIR (°F)	ATMOSPHERE*
H	304SS	2550	1650	ORNV
J	310SS	2550	2100	ORNV
L	316LSS	2550	1650	ORNV
O	446SS	2700	2100	ORNV
M	Inconel 600	2500	2100	ONV
P	Inconel 702	2620	1500	ONV
Q	Platinum	3216	3000	ON
R	Molybdenum	4750	1000	VNR
S	Tantalum	5440	750	V
T	Titanium	3300	600	V
V	STABALOY	2552	2220	ORNV

*KEY
O=Oxidizing R=Reducing N=Neutral V=Vacuum

NEW!

4, one hour sessions training video. $1200.00 - Call for information.

For high temperature applications 1000°F to 2300°F, new proprietary materials have been developed to perform better than the alloys used in the past.

V = STABALOY: “...can be used at ultra high temperatures for prolonged periods with little degradation to the thermocouple wires.”

MEASURING JUNCTION



GROUNDED JUNCTION

The **grounded** thermocouple junction is an integral part of the thermocouple sheath tip.

Advantages:

- fast response time in relation to ungrounded and isolated junctions.
- protects the wires from environmental chemicals and corrosives.
- prolongs the operational life of the thermocouple. Longer lifespan than the exposed junction thermocouple.
- it is recommended for high pressure applications.
- it is the least expensive construction.

Disadvantages:

- thermal expansion of sheath material may differ from element to cause mechanical stress and work hardening of metals.
- ground loops may cause interference with instruments.
- faults in insulation are more difficult to detect.



UNGROUNDED JUNCTION

The **ungrounded** thermocouple junction is electrically insulated and electrically isolated from the outer sheath material. In a dual ungrounded thermocouple, one common junction is electrically insulated from the outside sheath.

Advantages:

- the thermocouple junction is isolated from the ground.
- defects in the MgO insulation can be detected by measuring resistance from loop to sheath.
- long term drift under cycling conditions is minimized.

Disadvantages:

- response time is usually slower than grounded thermocouples.
- more expensive than grounded thermocouples.

Dual exposed junctions are common, except for 8 awg



EXPOSED JUNCTION

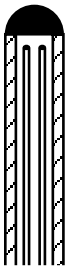
The **exposed** thermocouple junction extends beyond the protective metallic sheath.

Advantages:

- recommended for measurement of noncorrosive static gas, or air.
- very fast response time, faster than grounded junction.

Disadvantages:

- cannot be used in an environment with a high percentage of solids, high pressure, or flowing material since the junction is exposed to this environment.



ISOLATED JUNCTION

Isolated thermocouple junctions are used in a dual or triple thermocouple when the junctions are isolated from the outer sheath material as well as from each other.

Advantages:

- the elements are insulated from ground.
- performs better than ungrounded or grounded junctions in a thermal cycling environment.

Disadvantages:

- slower response time than a grounded dual thermocouple.

*For tip sensitivity information, see page 3-8.

MEASURING JUNCTION TYPICAL RESPONSE TIME

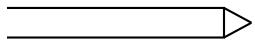
SHEATH O.D.	MEASURING JUNCTION	*RESPONSE
.040 (1/25”)	Grounded	.07
	Ungrounded / Isolated	.11
.063 (1/16”)	Grounded	.09
	Ungrounded / Isolated	.28
.125 (1/8”)	Grounded	.34
	Ungrounded / Isolated	1.6
.188 (3/16”)	Grounded	.7
	Ungrounded / Isolated	2.6
.250 (1/4”)	Grounded	1.7
	Ungrounded / Isolated	4.5
	Exposed	.09

*Response time in seconds. The above table is the average of several thermocouples tested in each category. Tests were performed during a step change from room temperature to boiling water. The above indicates time required to show 63.2% of a temperature change. No process we know of matches these conditions. Please use this data as a means of comparing sheath size and junction only. Actual response time in your process can be simulated by our laboratory. Please call us for help.

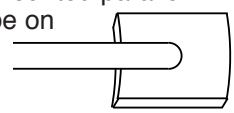
SPECIAL JUNCTIONS

To specify the following special junctions in the thermocouple part number, you may use the appropriate symbol below in place of symbol #6 on page 1-1.

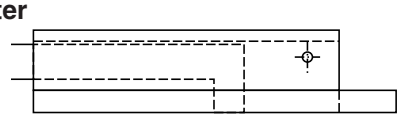
SYMBOL	SPECIAL JUNCTIONS
J	Pointed tip grounded
K	Pointed tip ungrounded See page 1-15
L	Weld pad grounded (standard pad size 1” x 1” x 1/8” thick)
M	Weld pad ungrounded (standard pad size 1” x 1” x 1/8” thick See page 1-14
N	Weld pad, removable grounded (standard pad size1” x 2 1/4” x 1/8” thick)
O	Weld pad, removable ungrounded (standard pad size 1” x 2 1/4” x 1/8” thick See page 1-14
P	Reduced tip grounded (specify overall length, reduced tip length and outside diameters in description)
Q	Reduced tip ungrounded (specify overall length, reduced tip length and outside diameters in description) See page 1-15
	See page 1-15
R	Gas/Air exposed
S	Gas/Air grounded
T	Gas/Air ungrounded
F	Ultra fast response (40 awg kapton wire) TC only.
V	Enlarged tip grounded (specify overall length, enlarged tip length and outside diameters in description)
W	Enlarged tip ungrounded (specify overall length, enlarged tip length and outside diameters in description) See page 1-15

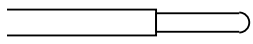


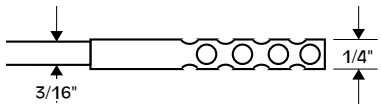
EG: 1N1DVX... X=L 2" TUBE If curved, use X in symbol #6 and specify pipe / tube diameter and wether the sensor is mounted parallel or perpendicular to the tube on which it is to be mounted.

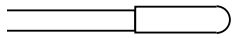


Specify Pipe / Tube Diameter









TUBE-SKIN SENSORS

Tube skin sensors are designed for measuring the temperature of tube walls in chemical power and petroleum industries. Power houses use this type of thermocouple on boiler and superheater requirements. The measurements are used to determine the fatigue of the tube material. For tube skin thermocouples, JMS Southeast uses sheath material which allows for proper insulation, expansion loops, and easy installation. The weld pad should match the tube material and may be used in upper temperature ranges to 2100°F. The standard weld pad dimensions are 1" x 1" x 1/8" thickness. The removable weld pad dimensions are 1" x 2 1/4" x 1/8" thickness. The pads can be curved to fit the radius of your pipe.

On installation, we recommend attaching weld pads to a surface for good thermal conduction. Avoid any currents or still places of flow in your process.

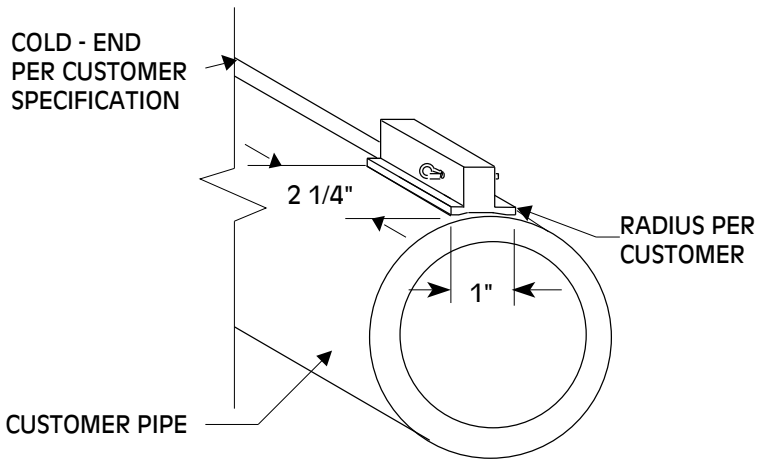
When mounting the tube skin through a furnace wall, insert the probe and mount it into the wall with a compression fitting, then slide another compression fitting onto the probe to secure the head to the cold end.

If this type of mounting is required, the extra compression fitting should be ordered as an accessory piece. The unit will be shipped with the head disassembled.

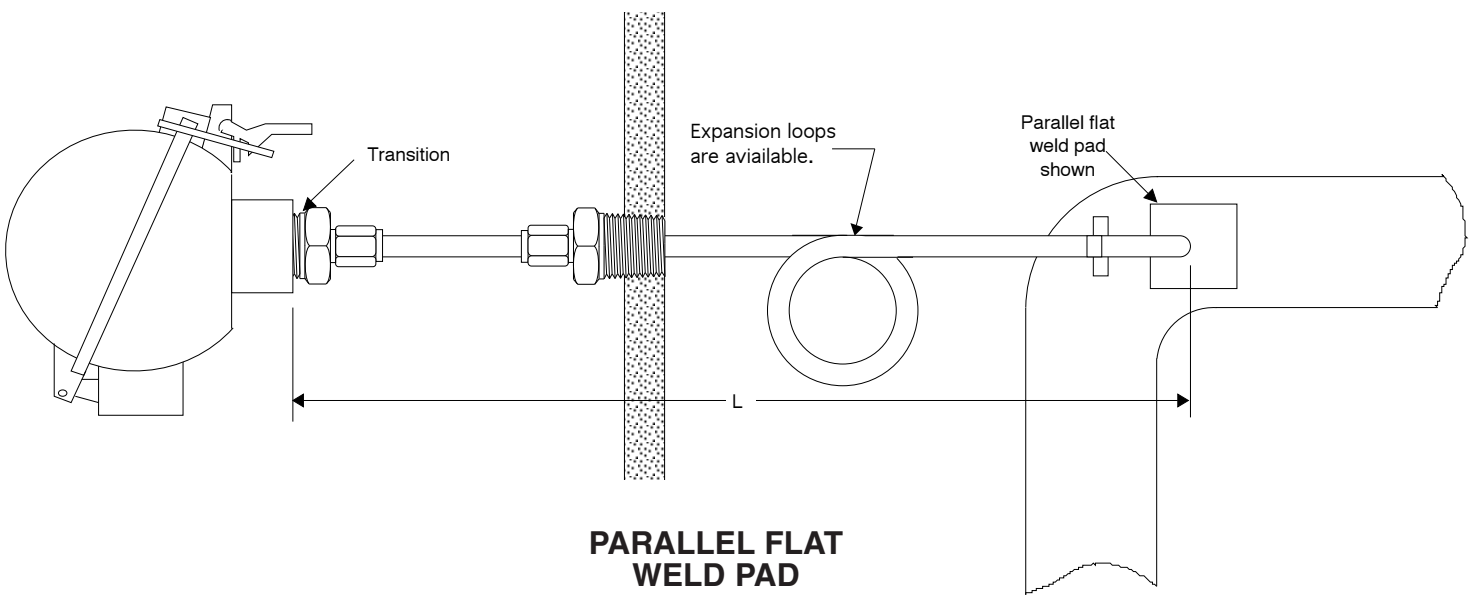
Any other mounting configuration can be specified by a drawing or in the part number description. These fitting options are listed in the ordering symbols below.

Note: Proprietary designs are available for removable tubeskin thermocouples. Call for assistance.

4, one hour sessions training video. $1200.00 - Call for information.



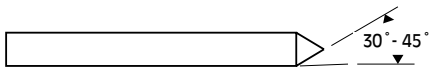
REMOVABLE WELD PAD



PARALLEL FLAT WELD PAD

SPECIAL JUNCTIONS

POINTED TIP

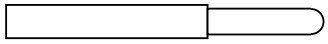


The pointed tip sensor actually acts like a “needle”, and can be inserted into an item to measure its temperature. The angle of the point is approximately 30° - 45°.
This type of probe is most commonly used in the food processing and pharmaceutical industries.

This sensor can be manufactured in Types J, K, T, E, and N thermocouple calibration. Any cold end details can be selected from those listed on page 1-2 .

The conical point on this sensor is designed to penetrate into soft and semi-frozen objects. It is made from rugged stainless steel and can be manufactured with a durable plastic handle for hand held penetration and measurement, if needed.

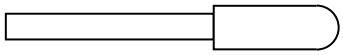
REDUCED TIP



The reduced tip sensor is used to yield a quicker response time. The smaller diameter probe at the tip provides less mass at the sensing end, thus a faster response time.

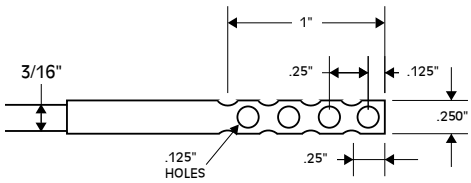
Specify desired diameter needs, large and reduced, and the lengths of both: i.e., X=Reduced tip, 1/4” x 5”, 1/8” x 1”. This sensor can be used for immersion into air or liquids. Care should be taken to assure high velocity flow and/or pressure does not exist if using a small diameter reduced tip sensor. This sensor can be manufactured in any calibrations. Cold end details can be selected from page 1-2.

ENLARGED TIP



The enlarged tip sensor is usually used for better thermal transfer in an old well. Specify desired diameter needs, reduced and large, and the lengths of both: i.e., X=Enlarged tip, 1/4” x 6”, 1/2” x 8”. The cold end details can be specified from page 1-2 of the JMS catalog. The standard material used is 316SS.

GAS / AIR TIP



The gas / air section of the probe is made to cover the exposed sensor measuring junction to protect the junction while still allowing air to flow thru the holes. JMS has a standard pattern of hole size and spacing as shown in the drawing above.

This stainless steel cover over the junction acts as a radiant energy shield to protect the measuring junction from radiant heat which may be emitted from a flame or heater in the process. The thermocouple tip is still exposed to air flow for fast measurement. This type of probe can be inserted into duct work, grills, and air vents.
For RTD’s, a type E sensor (page 3-1) is either exposed (bare) or enclosed in a 1/8” hollow tube for moisture protection. An ultra fast response type is also available.

POTTING COMPOUNDS

JMS Southeast utilizes several potting compounds in the manufacturing of our temperature sensors. Our standard is a moisture impermeable epoxy which is black in color. Its recommended upper temperature limit is 500°F.

The potting compound used in higher temperature applications is a cement which is white in color. It is not as moisture impermeable as the lower temperature epoxy compound, yet it can withstand temperatures to 1750°F. It has a lower mechanical strength than the epoxy compound, but is the recommended choice for high temperature applications. Use an X in symbol #12 to utilize a higher temperature transition. The end of the part # to include the highest temperature (°F) the transition will see + type of transition, ie. X=650T .

Through the JMS Southeast sensor ordering information, we determine the maximum temperature that the potting will be exposed to and select the appropriate potting compound.

JMS provides special hermetic sealing from moisture for those sensors used in high humidity / moisture or total immersion environments. Any moisture penetrating the transition will kill the integrity of the electrical property of the sensor. Our special hermetic sealing will prevent this in any environment. Use a “2” after your selection for symbol #12 on page 1-2.

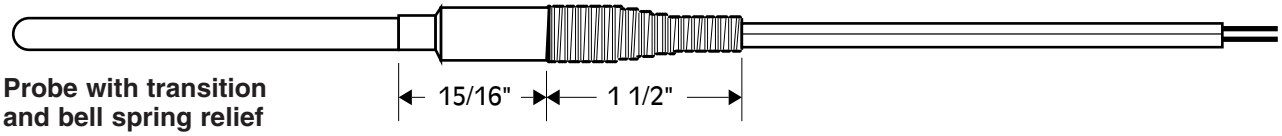
When shipping by air, there is the distinct possibility that the sensor(s) will be exposed to varying pressure, humidity and temperature conditions. This can and does cause some sensors to admit moisture into the insulation. We have experienced a few cases in which the sensor passed the ASTM tests performed here only to fail the same tests after shipping by air. Our recommendation is that you specify special shipping containers in those instances including the use of desiccants, or other moisture prevention devices. Hermetic sealing may be a necessary component as well.

THERMOCOUPLE TRANSITIONS

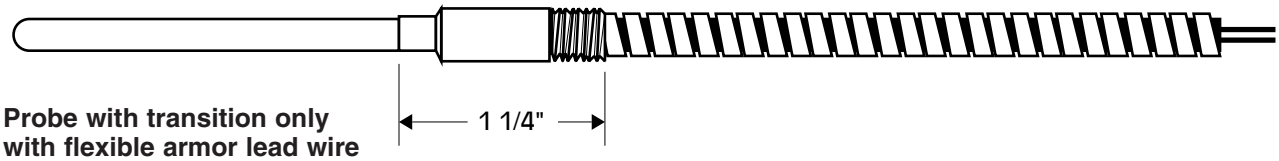
The transition contains the braze joint that connects the sheathed thermocouple conductors to the lead wire. The stainless steel joint supports and contains the potting compound used to encapsulate the connection.

The standard size of JMS transition is .375 outer diameter by 3/4” long, tapering down and extending over the thermocouple sheath material for 1/4” . The outside diameter that tapers down onto the sheath is approximately .055” larger than the thermocouple sheath diameter.

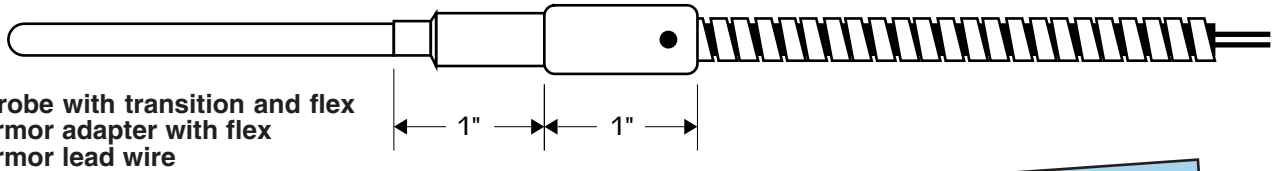
A transition may be used to provide support for lead wire. A bell spring relief may also be used which will extend the rigid length of the probe by approximately 1”. The transition and bell spring relief extends the length for a total of approximately 2 1/2”.



Probe with transition and bell spring relief



Probe with transition only with flexible armor lead wire
(Standard on low temp. transition, single elements.)



Probe with transition and flex armor adapter with flex armor lead wire

4, one hour sessions training video. $1200.00 - Call for information.

THERMOCOUPLE OPERATION AND INSTALLATION INSTRUCTIONS

Thermocouples are installed by means of compression fittings, welded 1/2" x 1/2" NPT fittings, or bayonet fittings.

Follow these instructions for installation of a thermocouple with a 1/2" x 1/2" NPT fitting:

(1) Insert thermocouple into process hole
(2) Tighten probe into place by turning probe into threaded connection.

When installing a spring-loaded sensor, the wires should be disconnected from the terminal block to prevent twisting and shorting during installation.

INSTALLATION:

Place thermocouple in area not too close to heating element or direct flame.

When measuring very high temperatures, install thermocouple vertically, if possible, to avoid protection tube element sagging.

Always use thermocouple extension wire to correlate with calibration of thermocouple and instrumentation being used.

Install thermocouple away from AC power lines, preferably more than one foot away.

Do not run thermocouple wires in the same conduit with other electrical wires.

Apply lacquer or silicon resin to screws to prevent effects of vibration and oxidation.

ELECTRICAL:

Make sure the extension wire is clean so a good electrical connection will result at the terminal block. Connect the positive extension wire to the positive thermocouple wire and the negative extension wire to the negative thermocouple wire. Wires are color coded for identification as follows, notice that the negative leg is always red.

	THERMOCOUPLE TYPE			EXTENSION WIRES		
	POS.	NEG.	OUTER JACKET	POS.	NEG*	OUTER JACKET
E	purple	red	brown	purple	red	purple
J	white	red	brown	white	red	black
K	yellow	red	brown	yellow	red	yellow
R	N/A	N/A	N/A	black	red	green
S	N/A	N/A	N/A	black	red	green
T	blue	red	brown	blue	red	blue
N	orange	red	brown	orange	red	orange

See Page 1-9 for IEC color codes for primary conductor and color codes. The outer jacket matches the primary conductor unless specified for an intrinsically safe area, in which case all outer jackets are blue.

*A tracer having the color corresponding to the positive extension may be used on the negative wire code. Occasionally, it is necessary to determine thermocouple polarity in the field. The above characteristics are helpful, along with the information on the following page.

4, one hour sessions training video.
$1200.00 - Call for information.

TYPE E-The negative wire has lower resistance in ohms per foot than the positive element for the same size wire.

TYPE J-The positive element is frequently rusty and is magnetic. It has a lower resistance in ohms per foot for the same size wire.

TYPE K-The negative element is slightly magnetic. It has a lower resistance in ohms per foot for the same size positive wire.

TYPE R or S-The negative wire is softer. The positive wire has a lower resistance in ohms per foot for the same size wire.

TYPE T-The negative wire is silver in appearance. The positive wire has a lower resistance in ohms per foot for the same size wire, and is usually copper colored.

TYPE N-The positive leg has a higher resistance in ohms per foot for the same size wire.

Note: When in doubt, twist the wire together, and connect opposite ends to a volt meter. Heat the twisted end with a cigarette lighter. If the volts go up - polarity is correct ...

OPERATION:

The temperature of the connection head should be kept as near room temperature as possible to avoid errors due to the extension wires. The maximum recommended temperature at the terminal block is 400°F.

MAINTENANCE:

The quality and frequency of calibration checks must be determined for each individual application by noting the decalibration rate of each thermocouple at individual installations. Thermocouples will deteriorate due to contamination from their environments. Calibration is usually made by comparison with a working standard. The thermocouple may be removed from its installation and checked in an electric furnace with the working standard; however, check the thermocouple in its installed position and location if possible. See page VI.

Return thermocouples that were removed for tests to the same location and immersion depth for reliable and repeatable readings.

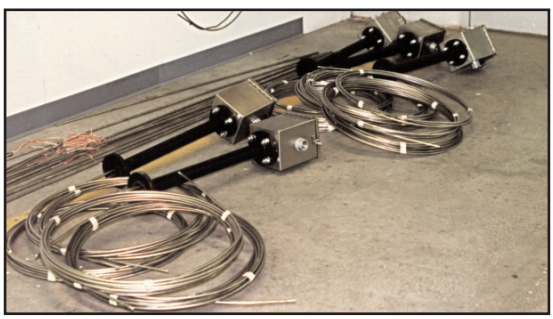
Do not use a thermocouple to measure a very low temperature if it has been used to measure a very high temperature previously.

Make sure protection tubes and thermowells are in good condition when protecting thermocouples with them.

Do not run a single thermocouple to two different instruments. This can result in instrument imbalance. A dual isolated thermocouple should be used instead.

STORAGE:

Store in a clean dry place. Avoid stacking probes in areas of excessive moisture or humidity (ie: dripping, condensation). Special packing with desiccant can be specified. (See page II)



TYPE N THERMOCOUPLE VERSUS TYPE K THERMOCOUPLE IN A BRICK MANUFACTURING FACILITY

The following paper was presented by Barbara Hudson, former General Manager of JMS Southeast, Inc., at the Brick Plant Forum Convention at Clemson University in Clemson, South Carolina.

ABSTRACT:

The brick industry historically has had the option of a Type K thermocouple, which is inaccurate yet inexpensive, versus Type R and S thermocouples which are very expensive yet accurate. This article investigates the Type N thermocouple which has been developed as a substitute for the Type K thermocouple in the 32°F to 2300°F temperature range.

TYPE K VERSUS TYPE R OR S THERMOCOUPLE

Through the years, many changes have occurred in the firing of structural clays including gas, oil, and sawdust combustion. Yet, the temperature measuring methods has remained the same as far as thermocouple configurations are concerned. Throughout history, a Type K thermocouple has been used in an area which was thought of as being "non-critical". The Type R or S thermocouples (platinum-rhodium) have been used in the past in "control" areas. The reasons for these uses include: Type K thermocouples, but are also less stable and less accurate. Type K thermocouples are easily attainable, however, and widely accepted in all industries.

The reasons for the instability in Type K thermocouples are due to some inherent properties in the chromel/alumel material. One problem that occurs with this thermocouple is an effect called short-range ordering. It occurs in a temperature range of about 500°F to 1020°F when nickel and chromium atoms in the chromel leg tend to form an ordered crystalline structure. The ordering produces a different metallurgical structure and if a temperature gradient exists, an erroneous EMF is produced.

Another shortcoming of Type K thermocouples is the hysteresis effect that occurs when a Type K thermocouple is cycled up and down in temperatures above and below 1800°F. The re-ordering of the crystalline structure changes with each cycle. After the first pass above this temperature, the Type K temperature indication will probably be accurate. However, with each additional cycle after this one, the error will increase more and more. The Type K thermocouple also experiences a cumulative drift after a period of time at temperatures above 1650°F. Finally, this thermocouple experiences a physical defect called "green rot" which is caused due to preferential oxidation of the chromel leg.

Even with these problems of instability and lack of longevity in Type K thermocouples, they are widely used and accepted in the brick industry as well as other industries. This is due to the fact that they are inexpensive and the choices have been limited in the past to a thermocouple that could replace Type K at a comparable price.

The platinum-rhodium thermocouples (Type R and S) on the other hand have been used as control thermocouples in the past. They are much more stable than the Type K thermocouples, but much more expensive also. They can be ten times the expense of a Type K thermocouple. Type R or S thermocouples do, however, after a period of time at elevated temperatures, experience a drift due to platinum migration.

In essence, for temperature measurement in a brick kiln, we have a fairly accurate option at a high cost versus an unstable and "short life" option at a reasonable cost. A compromise was needed!

TYPE N THERMOCOUPLES

Noel Burley, from Australia, began extensive research on a type N thermocouple (nisil/nicrosil). The composition of this thermocouple is the following: Nicrosil-NI-14.2%, Cr-1.4%, Si and Nisil-Ni-4.4%, Si-.1%, Mg. Noel Burley's research showed that the Type N thermocouple exhibited thermal stability above 1650°F, while Type K thermocouples showed a

gradual and cumulative drift. He also showed the Type N thermocouple showed no short-term change due to crystal restructuring that occurred with the Type K thermocouple. Also, the Type N had superior resistance to oxidation (no "green rot") and could replace the Type K throughout its entire range of 32°F-2300°F. Its cost is about the cost of a Type J thermocouple. Due to this information, we decided to experiment with the Type N thermocouple in a brick manufacturing environment.

EXPERIMENTATION:

Frank Todd and Frank Todd, Jr., at Fletcher Brick were kind enough to allow us to do some experimentation in their facility. We were restricted to a short time frame, so we needed accelerated life data on comparisons between a Type K and Type N thermocouple. In communication with Fletcher Brick, a top to bottom and side to side temperature gradient was suspected in their tunnel kiln. They desired better monitoring to attain better control, thus better brick. If they were to go to platinum/rhodium thermocouples as side port monitoring sensors, the thermocouples alone would have cost in excess of $6,000 not including the data logger needed for data collection. Due to accelerated life data needed, we used 20 gauge thermocouples realizing they would deteriorate quickly. Stage 1 of our experimentation included manufacturing 10 dual thermocouples which consisted of one 20 gauge Type K and one 20 gauge Type N thermocouple in each sensor. These were installed in side ports of the kiln and ran for 30 days. The Type R thermocouples existed in the top center of the kiln as control thermocouples. All monitoring thermocouples were connected to a 40 channel data logger which printed the temperature of all sensors every six hours. This data was converted to actual temperatures for the Type N thermocouples and was compared to the control Type R sensors for kiln changes. After all the data was compiled, the drift was plotted for four Type K thermocouples. The drift of the Type K thermocouple was difficult to predict. All four sensors drifted in non-repeatable and inconsistent patterns.

The Type N readings were graphed and they also failed within the 30 day period as was predicted since 20 gauge wire was used. The drift, however, was more predictable. This was only a preliminary stage of our experimentation. We will continue our work with the 14 gauge Type N versus Type K thermocouples.

CONCLUSION:

In conclusion, Type N thermocouples can be used in all areas of the brick; i.e. traveling thermocouples, air conditioning vents, kiln control, monitoring sensors, and drying sensors.

Research has shown Type N thermocouples have better thermal stability than Type K in the temperature range of 1200°F-1400°F, which is the pre-heat zone where carbon burn-out occurs.

Also better control can be obtained with a Type N thermocouple at the quartz inversion point of 1050°F.

Two or three different types of thermocouples used in a single plant within the Type N temperature range of 32°F-2300°F can be replaced by the Type N thermocouple. This would standardize the plant with one type of thermocouple enabling the use of one type of controller, one type of data logger, etc.

This thermocouple is also ASTM certified. It has been given a color code of orange/red. It is listed in most thermocouple manufacturers catalog. We at JMS Southeast, Inc., will continue doing research with the Type N thermocouple in structural clay firing applications.

REFERENCES:

1. Brick Association of North Carolina (Marion Cochran).
2. The Nicrosil versus Nisil Thermocouple: Properties and Thermoelectric reference Data - NBS Monograph 161.
3. Temperature Sensors Product Information Bulletin (TS-02) by R. Kampion of Leeds and Northrup.

TYPE N THERMOCOUPLE GENERAL INFORMATION

COMPOSITION: Nisil/Nicrosil

Nisil: Ni-4.4 wt%
Si-0.1 wt%
Mg

Nicrosil: Ni-14.2 wt%
Cr-1.4 wt%
Si

	Color Code	Magnetic
Nisil: (N)	Red	No
Nicrosil:(P)	Orange	No

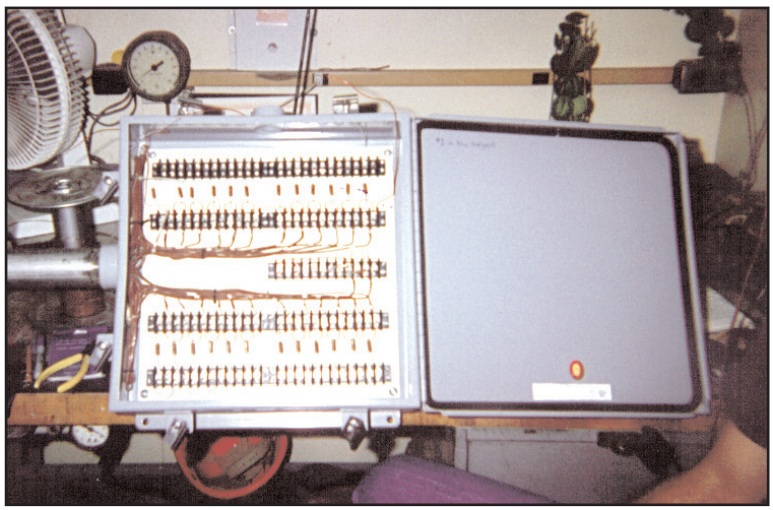
ACCURACY:

32°F to 2300°, ± 4° or .75% of temperature reading. Can replace Type “K” thermocouples throughout entire range.

Type “N” is available in beaded assemblies or sheath material. Extension wire and other temperature accessories such as meters, controllers, transmitters, etc., are also available.

ADVANTAGES:

1. Superior thermal stability at temperatures over 1650°F, while other thermocouples such as Type “K” exhibit much greater cumulative drift.
2. Superior thermal stability in that no short term change occurs due to the crystal restructuring.
3. Superior resistance to oxidation. (No green rot.)
4. Does not exhibit hysteresis effect as the Type “K” thermocouple does.



ITS-90 Table for type B thermocouple

Thermoelectric Voltage in mV

øF	0	1	2	3	4	5	6	7	8	9	10
30			0.000	0.000	0.000	0.000	-0.001	-0.001	-0.001	-0.001	-0.00
40	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.002	-0.002	-0.002	-0.002	-0.00
50	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.00
60	-0.002	-0.002	-0.002	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.00
70	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.002	-0.002	-0.002	-0.00
80	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.00
90	-0.002	-0.002	-0.002	-0.002	-0.002	-0.001	-0.001	-0.001	-0.001	-0.001	-0.00
100	-0.001	-0.001	-0.001	-0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.00
110	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.00
120	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.004	0.00
130	0.004	0.004	0.004	0.005	0.005	0.005	0.005	0.005	0.006	0.006	0.00
140	0.006	0.006	0.007	0.007	0.007	0.007	0.008	0.008	0.008	0.009	0.00
150	0.009	0.009	0.009	0.010	0.010	0.010	0.011	0.011	0.011	0.012	0.01
160	0.012	0.012	0.013	0.013	0.013	0.014	0.014	0.014	0.015	0.015	0.01
170	0.015	0.016	0.016	0.016	0.017	0.017	0.017	0.018	0.018	0.019	0.01
180	0.019	0.019	0.020	0.020	0.021	0.021	0.021	0.022	0.022	0.023	0.02
190	0.023	0.023	0.024	0.024	0.025	0.025	0.026	0.026	0.027	0.027	0.02
200	0.027	0.028	0.028	0.029	0.029	0.030	0.030	0.031	0.031	0.032	0.03
210	0.032	0.033	0.033	0.034	0.034	0.035	0.035	0.036	0.036	0.037	0.03
220	0.037	0.038	0.038	0.039	0.039	0.040	0.041	0.041	0.042	0.042	0.04
230	0.043	0.043	0.044	0.044	0.045	0.046	0.046	0.047	0.047	0.048	0.04
240	0.049	0.049	0.050	0.050	0.051	0.052	0.052	0.053	0.053	0.054	0.05
250	0.055	0.055	0.056	0.057	0.057	0.058	0.059	0.059	0.060	0.060	0.06
260	0.061	0.062	0.062	0.063	0.064	0.065	0.065	0.066	0.067	0.067	0.06
270	0.068	0.069	0.069	0.070	0.071	0.072	0.072	0.073	0.074	0.074	0.07
280	0.075	0.076	0.077	0.077	0.078	0.079	0.080	0.080	0.081	0.082	0.08
290	0.083	0.083	0.084	0.085	0.086	0.086	0.087	0.088	0.089	0.090	0.09
300	0.090	0.091	0.092	0.093	0.094	0.094	0.095	0.096	0.097	0.098	0.09
310	0.099	0.099	0.100	0.101	0.102	0.103	0.104	0.105	0.105	0.106	0.10
320	0.107	0.108	0.109	0.110	0.111	0.112	0.112	0.113	0.114	0.115	0.11
330	0.116	0.117	0.118	0.119	0.120	0.121	0.121	0.122	0.123	0.124	0.12
340	0.125	0.126	0.127	0.128	0.129	0.130	0.131	0.132	0.133	0.134	0.13
350	0.135	0.136	0.137	0.138	0.139	0.140	0.141	0.142	0.143	0.144	0.14
360	0.145	0.146	0.147	0.148	0.149	0.150	0.151	0.152	0.153	0.154	0.15
370	0.155	0.156	0.157	0.158	0.159	0.160	0.161	0.162	0.163	0.164	0.16
380	0.165	0.166	0.167	0.168	0.170	0.171	0.172	0.173	0.174	0.175	0.17
390	0.176	0.177	0.178	0.179	0.180	0.182	0.183	0.184	0.185	0.186	0.18
400	0.187	0.188	0.190	0.191	0.192	0.193	0.194	0.195	0.196	0.198	0.19
410	0.199	0.200	0.201	0.202	0.203	0.205	0.206	0.207	0.208	0.209	0.21
420	0.211	0.212	0.213	0.214	0.215	0.217	0.218	0.219	0.220	0.222	0.22
430	0.223	0.224	0.225	0.226	0.228	0.229	0.230	0.231	0.233	0.234	0.23
440	0.235	0.236	0.238	0.239	0.240	0.242	0.243	0.244	0.245	0.247	0.24
450	0.248	0.249	0.251	0.252	0.253	0.255	0.256	0.257	0.259	0.260	0.26
460	0.261	0.263	0.264	0.265	0.267	0.268	0.269	0.271	0.272	0.273	0.27
470	0.275	0.276	0.277	0.279	0.280	0.282	0.283	0.284	0.286	0.287	0.28
480	0.288	0.290	0.291	0.293	0.294	0.296	0.297	0.298	0.300	0.301	0.30
490	0.303	0.304	0.305	0.307	0.308	0.310	0.311	0.313	0.314	0.316	0.31
500	0.317	0.319	0.320	0.321	0.323	0.324	0.326	0.327	0.329	0.330	0.33
510	0.332	0.333	0.335	0.336	0.338	0.339	0.341	0.342	0.344	0.345	0.34
520	0.347	0.348	0.350	0.352	0.353	0.355	0.356	0.358	0.359	0.361	0.36
530	0.362	0.364	0.365	0.367	0.369	0.370	0.372	0.373	0.375	0.377	0.37
540	0.378	0.380	0.381	0.383	0.384	0.386	0.388	0.389	0.391	0.393	0.39
550	0.394	0.396	0.397	0.399	0.401	0.402	0.404	0.406	0.407	0.409	0.41
560	0.411	0.412	0.414	0.416	0.417	0.419	0.421	0.422	0.424	0.426	0.42
570	0.427	0.429	0.431	0.432	0.434	0.436	0.437	0.439	0.441	0.443	0.44
580	0.444	0.446	0.448	0.449	0.451	0.453	0.455	0.456	0.458	0.460	0.46
590	0.462	0.463	0.465	0.467	0.469	0.470	0.472	0.474	0.476	0.478	0.47
600	0.479	0.481	0.483	0.485	0.486	0.488	0.490	0.492	0.494	0.495	0.49
610	0.497	0.499	0.501	0.503	0.505	0.506	0.508	0.510	0.512	0.514	0.51
620	0.516	0.517	0.519	0.521	0.523	0.525	0.527	0.529	0.530	0.532	0.53
630	0.534	0.536	0.538	0.540	0.542	0.544	0.546	0.547	0.549	0.551	0.55
640	0.553	0.555	0.557	0.559	0.561	0.563	0.565	0.567	0.569	0.570	0.57
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type B thermocouple

Thermoelectric Voltage in mV

øF	0	1	2	3	4	5	6	7	8	9	10
650	0.572	0.574	0.576	0.578	0.580	0.582	0.584	0.586	0.588	0.590	0.59
660	0.592	0.594	0.596	0.598	0.600	0.602	0.604	0.606	0.608	0.610	0.61
670	0.612	0.614	0.616	0.618	0.620	0.622	0.624	0.626	0.628	0.630	0.63
680	0.632	0.634	0.636	0.638	0.640	0.642	0.644	0.646	0.648	0.650	0.65
690	0.653	0.655	0.657	0.659	0.661	0.663	0.665	0.667	0.669	0.671	0.67
700	0.673	0.675	0.678	0.680	0.682	0.684	0.686	0.688	0.690	0.692	0.69
710	0.694	0.697	0.699	0.701	0.703	0.705	0.707	0.709	0.712	0.714	0.71
720	0.716	0.718	0.720	0.722	0.725	0.727	0.729	0.731	0.733	0.735	0.73
730	0.738	0.740	0.742	0.744	0.746	0.749	0.751	0.753	0.755	0.757	0.76
740	0.760	0.762	0.764	0.766	0.769	0.771	0.773	0.775	0.778	0.780	0.78
750	0.782	0.784	0.787	0.789	0.791	0.793	0.796	0.798	0.800	0.802	0.80
760	0.805	0.807	0.809	0.812	0.814	0.816	0.818	0.821	0.823	0.825	0.82
770	0.828	0.830	0.832	0.835	0.837	0.839	0.842	0.844	0.846	0.849	0.85
780	0.851	0.853	0.856	0.858	0.860	0.863	0.865	0.867	0.870	0.872	0.87
790	0.875	0.877	0.879	0.882	0.884	0.886	0.889	0.891	0.894	0.896	0.89
800	0.898	0.901	0.903	0.906	0.908	0.910	0.913	0.915	0.918	0.920	0.92
810	0.923	0.925	0.927	0.930	0.932	0.935	0.937	0.940	0.942	0.945	0.94
820	0.947	0.950	0.952	0.955	0.957	0.959	0.962	0.964	0.967	0.969	0.97
830	0.972	0.974	0.977	0.979	0.982	0.984	0.987	0.989	0.992	0.994	0.99
840	0.997	1.000	1.002	1.005	1.007	1.010	1.012	1.015	1.017	1.020	1.02
850	1.022	1.025	1.027	1.030	1.033	1.035	1.038	1.040	1.043	1.045	1.04
860	1.048	1.051	1.053	1.056	1.058	1.061	1.064	1.066	1.069	1.071	1.07
870	1.074	1.077	1.079	1.082	1.085	1.087	1.090	1.092	1.095	1.098	1.10
880	1.100	1.103	1.106	1.108	1.111	1.114	1.116	1.119	1.122	1.124	1.12
890	1.127	1.130	1.132	1.135	1.138	1.140	1.143	1.146	1.148	1.151	1.15
900	1.154	1.157	1.159	1.162	1.165	1.167	1.170	1.173	1.176	1.178	1.18
910	1.181	1.184	1.186	1.189	1.192	1.195	1.197	1.200	1.203	1.206	1.20
920	1.208	1.211	1.214	1.217	1.220	1.222	1.225	1.228	1.231	1.233	1.23
930	1.236	1.239	1.242	1.245	1.247	1.250	1.253	1.256	1.259	1.262	1.26
940	1.264	1.267	1.270	1.273	1.276	1.278	1.281	1.284	1.287	1.290	1.29
950	1.293	1.296	1.298	1.301	1.304	1.307	1.310	1.313	1.316	1.318	1.32
960	1.321	1.324	1.327	1.330	1.333	1.336	1.339	1.342	1.344	1.347	1.35
970	1.350	1.353	1.356	1.359	1.362	1.365	1.368	1.371	1.374	1.377	1.37
980	1.379	1.382	1.385	1.388	1.391	1.394	1.397	1.400	1.403	1.406	1.40
990	1.409	1.412	1.415	1.418	1.421	1.424	1.427	1.430	1.433	1.436	1.43
1000	1.439	1.442	1.445	1.448	1.451	1.454	1.457	1.460	1.463	1.466	1.46
1010	1.469	1.472	1.475	1.478	1.481	1.484	1.487	1.490	1.493	1.496	1.49
1020	1.499	1.502	1.505	1.508	1.511	1.515	1.518	1.521	1.524	1.527	1.53
1030	1.530	1.533	1.536	1.539	1.542	1.545	1.548	1.552	1.555	1.558	1.56
1040	1.561	1.564	1.567	1.570	1.573	1.576	1.580	1.583	1.586	1.589	1.59
1050	1.592	1.595	1.598	1.601	1.605	1.608	1.611	1.614	1.617	1.620	1.62
1060	1.624	1.627	1.630	1.633	1.636	1.639	1.643	1.646	1.649	1.652	1.65
1070	1.655	1.659	1.662	1.665	1.668	1.671	1.675	1.678	1.681	1.684	1.68
1080	1.687	1.691	1.694	1.697	1.700	1.704	1.707	1.710	1.713	1.716	1.72
1090	1.720	1.723	1.726	1.729	1.733	1.736	1.739	1.743	1.746	1.749	1.75
1100	1.752	1.756	1.759	1.762	1.765	1.769	1.772	1.775	1.779	1.782	1.78
1110	1.785	1.789	1.792	1.795	1.798	1.802	1.805	1.808	1.812	1.815	1.81
1120	1.818	1.822	1.825	1.828	1.832	1.835	1.838	1.842	1.845	1.849	1.85
1130	1.852	1.855	1.859	1.862	1.865	1.869	1.872	1.875	1.879	1.882	1.88
1140	1.886	1.889	1.892	1.896	1.899	1.903	1.906	1.909	1.913	1.916	1.92
1150	1.920	1.923	1.926	1.930	1.933	1.937	1.940	1.944	1.947	1.950	1.95
1160	1.954	1.957	1.961	1.964	1.968	1.971	1.975	1.978	1.981	1.985	1.98
1170	1.988	1.992	1.995	1.999	2.002	2.006	2.009	2.013	2.016	2.020	2.02
1180	2.023	2.027	2.030	2.034	2.037	2.041	2.044	2.048	2.051	2.055	2.05
1190	2.058	2.062	2.065	2.069	2.072	2.076	2.079	2.083	2.086	2.090	2.09
1200	2.094	2.097	2.101	2.104	2.108	2.111	2.115	2.118	2.122	2.126	2.12
1210	2.129	2.133	2.136	2.140	2.143	2.147	2.151	2.154	2.158	2.161	2.16
1220	2.165	2.169	2.172	2.176	2.179	2.183	2.187	2.190	2.194	2.197	2.20
1230	2.201	2.205	2.208	2.212	2.216	2.219	2.223	2.226	2.230	2.234	2.23
1240	2.237	2.241	2.245	2.248	2.252	2.256	2.259	2.263	2.267	2.270	2.27
1250	2.274	2.278	2.281	2.285	2.289	2.292	2.296	2.300	2.303	2.307	2.31
1260	2.311	2.315	2.318	2.322	2.326	2.329	2.333	2.337	2.341	2.344	2.34
1270	2.348	2.352	2.355	2.359	2.363	2.367	2.370	2.374	2.378	2.382	2.38
1280	2.385	2.389	2.393	2.397	2.400	2.404	2.408	2.412	2.416	2.419	2.42
1290	2.423	2.427	2.431	2.434	2.438	2.442	2.446	2.450	2.453	2.457	2.46
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type B thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
1300	2.461	2.465	2.469	2.472	2.476	2.480	2.484	2.488	2.492	2.495	2.49
1310	2.499	2.503	2.507	2.511	2.515	2.518	2.522	2.526	2.530	2.534	2.53
1320	2.538	2.541	2.545	2.549	2.553	2.557	2.561	2.565	2.569	2.572	2.57
1330	2.576	2.580	2.584	2.588	2.592	2.596	2.600	2.604	2.607	2.611	2.61
1340	2.615	2.619	2.623	2.627	2.631	2.635	2.639	2.643	2.647	2.651	2.65
1350	2.654	2.658	2.662	2.666	2.670	2.674	2.678	2.682	2.686	2.690	2.69
1360	2.694	2.698	2.702	2.706	2.710	2.714	2.718	2.722	2.726	2.730	2.73
1370	2.734	2.738	2.742	2.746	2.750	2.754	2.758	2.762	2.766	2.770	2.77
1380	2.774	2.778	2.782	2.786	2.790	2.794	2.798	2.802	2.806	2.810	2.81
1390	2.814	2.818	2.822	2.826	2.830	2.834	2.838	2.842	2.846	2.850	2.85
1400	2.854	2.859	2.863	2.867	2.871	2.875	2.879	2.883	2.887	2.891	2.89
1410	2.895	2.899	2.903	2.908	2.912	2.916	2.920	2.924	2.928	2.932	2.93
1420	2.936	2.940	2.944	2.949	2.953	2.957	2.961	2.965	2.969	2.973	2.97
1430	2.978	2.982	2.986	2.990	2.994	2.998	3.002	3.007	3.011	3.015	3.01
1440	3.019	3.023	3.027	3.032	3.036	3.040	3.044	3.048	3.052	3.057	3.06
1450	3.061	3.065	3.069	3.073	3.078	3.082	3.086	3.090	3.094	3.099	3.10
1460	3.103	3.107	3.111	3.116	3.120	3.124	3.128	3.132	3.137	3.141	3.14
1470	3.145	3.149	3.154	3.158	3.162	3.166	3.171	3.175	3.179	3.183	3.18
1480	3.188	3.192	3.196	3.200	3.205	3.209	3.213	3.218	3.222	3.226	3.23
1490	3.230	3.235	3.239	3.243	3.248	3.252	3.256	3.261	3.265	3.269	3.27
1500	3.273	3.278	3.282	3.286	3.291	3.295	3.299	3.304	3.308	3.312	3.31
1510	3.317	3.321	3.325	3.330	3.334	3.338	3.343	3.347	3.352	3.356	3.36
1520	3.360	3.365	3.369	3.373	3.378	3.382	3.386	3.391	3.395	3.400	3.40
1530	3.404	3.408	3.413	3.417	3.422	3.426	3.430	3.435	3.439	3.444	3.44
1540	3.448	3.452	3.457	3.461	3.466	3.470	3.474	3.479	3.483	3.488	3.49
1550	3.492	3.497	3.501	3.506	3.510	3.514	3.519	3.523	3.528	3.532	3.53
1560	3.537	3.541	3.546	3.550	3.555	3.559	3.563	3.568	3.572	3.577	3.58
1570	3.581	3.586	3.590	3.595	3.599	3.604	3.608	3.613	3.617	3.622	3.62
1580	3.626	3.631	3.635	3.640	3.644	3.649	3.653	3.658	3.662	3.667	3.67
1590	3.672	3.676	3.681	3.685	3.690	3.694	3.699	3.703	3.708	3.712	3.71
1600	3.717	3.722	3.726	3.731	3.735	3.740	3.744	3.749	3.753	3.758	3.76
1610	3.763	3.767	3.772	3.776	3.781	3.786	3.790	3.795	3.799	3.804	3.80
1620	3.809	3.813	3.818	3.822	3.827	3.832	3.836	3.841	3.845	3.850	3.85
1630	3.855	3.859	3.864	3.869	3.873	3.878	3.882	3.887	3.892	3.896	3.90
1640	3.901	3.906	3.910	3.915	3.920	3.924	3.929	3.934	3.938	3.943	3.94
1650	3.948	3.952	3.957	3.962	3.966	3.971	3.976	3.980	3.985	3.990	3.99
1660	3.994	3.999	4.004	4.009	4.013	4.018	4.023	4.027	4.032	4.037	4.04
1670	4.041	4.046	4.051	4.056	4.060	4.065	4.070	4.075	4.079	4.084	4.08
1680	4.089	4.093	4.098	4.103	4.108	4.112	4.117	4.122	4.127	4.131	4.13
1690	4.136	4.141	4.146	4.151	4.155	4.160	4.165	4.170	4.174	4.179	4.18
1700	4.184	4.189	4.194	4.198	4.203	4.208	4.213	4.217	4.222	4.227	4.23
1710	4.232	4.237	4.242	4.246	4.251	4.256	4.261	4.266	4.270	4.275	4.28
1720	4.280	4.285	4.290	4.295	4.299	4.304	4.309	4.314	4.319	4.324	4.32
1730	4.328	4.333	4.338	4.343	4.348	4.353	4.358	4.362	4.367	4.372	4.37
1740	4.377	4.382	4.387	4.392	4.397	4.401	4.406	4.411	4.416	4.421	4.42
1750	4.426	4.431	4.436	4.441	4.445	4.450	4.455	4.460	4.465	4.470	4.47
1760	4.475	4.480	4.485	4.490	4.495	4.500	4.504	4.509	4.514	4.519	4.52
1770	4.524	4.529	4.534	4.539	4.544	4.549	4.554	4.559	4.564	4.569	4.57
1780	4.574	4.579	4.584	4.589	4.593	4.598	4.603	4.608	4.613	4.618	4.62
1790	4.623	4.628	4.633	4.638	4.643	4.648	4.653	4.658	4.663	4.668	4.67
1800	4.673	4.678	4.683	4.688	4.693	4.698	4.703	4.708	4.713	4.718	4.72
1810	4.723	4.728	4.733	4.738	4.743	4.748	4.754	4.759	4.764	4.769	4.77
1820	4.774	4.779	4.784	4.789	4.794	4.799	4.804	4.809	4.814	4.819	4.82
1830	4.824	4.829	4.834	4.839	4.844	4.850	4.855	4.860	4.865	4.870	4.87
1840	4.875	4.880	4.885	4.890	4.895	4.900	4.905	4.911	4.916	4.921	4.92
1850	4.926	4.931	4.936	4.941	4.946	4.951	4.957	4.962	4.967	4.972	4.97
1860	4.977	4.982	4.987	4.992	4.998	5.003	5.008	5.013	5.018	5.023	5.02
1870	5.028	5.034	5.039	5.044	5.049	5.054	5.059	5.065	5.070	5.075	5.08
1880	5.080	5.085	5.090	5.096	5.101	5.106	5.111	5.116	5.121	5.127	5.13
1890	5.132	5.137	5.142	5.147	5.153	5.158	5.163	5.168	5.173	5.179	5.18
1900	5.184	5.189	5.194	5.199	5.205	5.210	5.215	5.220	5.225	5.231	5.23
1910	5.236	5.241	5.246	5.252	5.257	5.262	5.267	5.273	5.278	5.283	5.28
1920	5.288	5.294	5.299	5.304	5.309	5.315	5.320	5.325	5.330	5.336	5.34
1930	5.341	5.346	5.351	5.357	5.362	5.367	5.373	5.378	5.383	5.388	5.39
1940	5.394	5.399	5.404	5.410	5.415	5.420	5.425	5.431	5.436	5.441	5.44
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type B thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
1950	5.447	5.452	5.457	5.463	5.468	5.473	5.479	5.484	5.489	5.495	5.50
1960	5.500	5.505	5.511	5.516	5.521	5.527	5.532	5.537	5.543	5.548	5.55
1970	5.553	5.559	5.564	5.569	5.575	5.580	5.585	5.591	5.596	5.601	5.60
1980	5.607	5.612	5.618	5.623	5.628	5.634	5.639	5.644	5.650	5.655	5.66
1990	5.661	5.666	5.671	5.677	5.682	5.688	5.693	5.698	5.704	5.709	5.71
2000	5.715	5.720	5.725	5.731	5.736	5.742	5.747	5.752	5.758	5.763	5.76
2010	5.769	5.774	5.780	5.785	5.790	5.796	5.801	5.807	5.812	5.818	5.82
2020	5.823	5.828	5.834	5.839	5.845	5.850	5.856	5.861	5.867	5.872	5.87
2030	5.878	5.883	5.888	5.894	5.899	5.905	5.910	5.916	5.921	5.927	5.93
2040	5.932	5.938	5.943	5.949	5.954	5.960	5.965	5.971	5.976	5.982	5.98
2050	5.987	5.993	5.998	6.004	6.009	6.015	6.020	6.026	6.031	6.037	6.04
2060	6.042	6.048	6.053	6.059	6.064	6.070	6.075	6.081	6.086	6.092	6.09
2070	6.098	6.103	6.109	6.114	6.120	6.125	6.131	6.136	6.142	6.147	6.15
2080	6.153	6.159	6.164	6.170	6.175	6.181	6.186	6.192	6.197	6.203	6.20
2090	6.209	6.214	6.220	6.225	6.231	6.237	6.242	6.248	6.253	6.259	6.26
2100	6.264	6.270	6.276	6.281	6.287	6.292	6.298	6.304	6.309	6.315	6.32
2110	6.320	6.326	6.332	6.337	6.343	6.349	6.354	6.360	6.365	6.371	6.37
2120	6.377	6.382	6.388	6.394	6.399	6.405	6.410	6.416	6.422	6.427	6.43
2130	6.433	6.439	6.444	6.450	6.456	6.461	6.467	6.473	6.478	6.484	6.49
2140	6.490	6.495	6.501	6.507	6.512	6.518	6.524	6.529	6.535	6.541	6.54
2150	6.546	6.552	6.558	6.563	6.569	6.575	6.580	6.586	6.592	6.597	6.60
2160	6.603	6.609	6.615	6.620	6.626	6.632	6.637	6.643	6.649	6.655	6.66
2170	6.660	6.666	6.672	6.677	6.683	6.689	6.695	6.700	6.706	6.712	6.71
2180	6.718	6.723	6.729	6.735	6.740	6.746	6.752	6.758	6.763	6.769	6.77
2190	6.775	6.781	6.786	6.792	6.798	6.804	6.809	6.815	6.821	6.827	6.83
2200	6.833	6.838	6.844	6.850	6.856	6.861	6.867	6.873	6.879	6.884	6.89
2210	6.890	6.896	6.902	6.908	6.913	6.919	6.925	6.931	6.937	6.942	6.94
2220	6.948	6.954	6.960	6.966	6.971	6.977	6.983	6.989	6.995	7.000	7.00
2230	7.006	7.012	7.018	7.024	7.030	7.035	7.041	7.047	7.053	7.059	7.06
2240	7.065	7.070	7.076	7.082	7.088	7.094	7.100	7.105	7.111	7.117	7.12
2250	7.123	7.129	7.135	7.141	7.146	7.152	7.158	7.164	7.170	7.176	7.18
2260	7.182	7.187	7.193	7.199	7.205	7.211	7.217	7.223	7.229	7.234	7.24
2270	7.240	7.246	7.252	7.258	7.264	7.270	7.276	7.281	7.287	7.293	7.29
2280	7.299	7.305	7.311	7.317	7.323	7.329	7.335	7.340	7.346	7.352	7.35
2290	7.358	7.364	7.370	7.376	7.382	7.388	7.394	7.400	7.406	7.412	7.41
2300	7.417	7.423	7.429	7.435	7.441	7.447	7.453	7.459	7.465	7.471	7.47
2310	7.477	7.483	7.489	7.495	7.501	7.507	7.512	7.518	7.524	7.530	7.53
2320	7.536	7.542	7.548	7.554	7.560	7.566	7.572	7.578	7.584	7.590	7.59
2330	7.596	7.602	7.608	7.614	7.620	7.626	7.632	7.638	7.644	7.650	7.65
2340	7.656	7.662	7.668	7.674	7.680	7.686	7.692	7.698	7.704	7.710	7.71
2350	7.716	7.722	7.728	7.734	7.740	7.746	7.752	7.758	7.764	7.770	7.77
2360	7.776	7.782	7.788	7.794	7.800	7.806	7.812	7.818	7.824	7.830	7.83
2370	7.836	7.842	7.848	7.854	7.860	7.866	7.872	7.878	7.884	7.891	7.89
2380	7.897	7.903	7.909	7.915	7.921	7.927	7.933	7.939	7.945	7.951	7.95
2390	7.957	7.963	7.969	7.975	7.981	7.987	7.994	8.000	8.006	8.012	8.01
2400	8.018	8.024	8.030	8.036	8.042	8.048	8.054	8.060	8.066	8.073	8.07
2410	8.079	8.085	8.091	8.097	8.103	8.109	8.115	8.121	8.127	8.134	8.14
2420	8.140	8.146	8.152	8.158	8.164	8.170	8.176	8.182	8.188	8.195	8.20
2430	8.201	8.207	8.213	8.219	8.225	8.231	8.237	8.244	8.250	8.256	8.26
2440	8.262	8.268	8.274	8.280	8.286	8.293	8.299	8.305	8.311	8.317	8.32
2450	8.323	8.329	8.336	8.342	8.348	8.354	8.360	8.366	8.372	8.379	8.38
2460	8.385	8.391	8.397	8.403	8.409	8.416	8.422	8.428	8.434	8.440	8.44
2470	8.446	8.453	8.459	8.465	8.471	8.477	8.483	8.490	8.496	8.502	8.50
2480	8.508	8.514	8.521	8.527	8.533	8.539	8.545	8.551	8.558	8.564	8.57
2490	8.570	8.576	8.582	8.589	8.595	8.601	8.607	8.613	8.620	8.626	8.63
2500	8.632	8.638	8.644	8.651	8.657	8.663	8.669	8.675	8.682	8.688	8.69
2510	8.694	8.700	8.707	8.713	8.719	8.725	8.731	8.738	8.744	8.750	8.75
2520	8.756	8.763	8.769	8.775	8.781	8.787	8.794	8.800	8.806	8.812	8.81
2530	8.819	8.825	8.831	8.837	8.844	8.850	8.856	8.862	8.869	8.875	8.88
2540	8.881	8.887	8.894	8.900	8.906	8.912	8.919	8.925	8.931	8.937	8.94
2550	8.944	8.950	8.956	8.962	8.969	8.975	8.981	8.988	8.994	9.000	9.00
2560	9.006	9.013	9.019	9.025	9.031	9.038	9.044	9.050	9.057	9.063	9.06
2570	9.069	9.075	9.082	9.088	9.094	9.101	9.107	9.113	9.119	9.126	9.13
2580	9.132	9.138	9.145	9.151	9.157	9.164	9.170	9.176	9.182	9.189	9.19
2590	9.195	9.201	9.208	9.214	9.220	9.227	9.233	9.239	9.245	9.252	9.25
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type B thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
0	0.000	0.000	0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.002	-0.002	-0.00
10	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.003	-0.003	-0.00
20	-0.003	-0.003	-0.003	-0.003	-0.003	-0.002	-0.002	-0.002	-0.002	-0.002	-0.00
30	-0.002	-0.002	-0.002	-0.002	-0.002	-0.001	-0.001	-0.001	-0.001	-0.001	0.00
40	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.002	0.00
50	0.002	0.003	0.003	0.003	0.004	0.004	0.004	0.005	0.005	0.006	0.00
60	0.006	0.007	0.007	0.008	0.008	0.009	0.009	0.010	0.010	0.011	0.01
70	0.011	0.012	0.012	0.013	0.014	0.014	0.015	0.015	0.016	0.017	0.01
80	0.017	0.018	0.019	0.020	0.020	0.021	0.022	0.022	0.023	0.024	0.02
90	0.025	0.026	0.026	0.027	0.028	0.029	0.030	0.031	0.031	0.032	0.03
100	0.033	0.034	0.035	0.036	0.037	0.038	0.039	0.040	0.041	0.042	0.04
110	0.043	0.044	0.045	0.046	0.047	0.048	0.049	0.050	0.051	0.052	0.05
120	0.053	0.055	0.056	0.057	0.058	0.059	0.060	0.062	0.063	0.064	0.06
130	0.065	0.066	0.068	0.069	0.070	0.072	0.073	0.074	0.075	0.077	0.07
140	0.078	0.079	0.081	0.082	0.084	0.085	0.086	0.088	0.089	0.091	0.09
150	0.092	0.094	0.095	0.096	0.098	0.099	0.101	0.102	0.104	0.106	0.10
160	0.107	0.109	0.110	0.112	0.113	0.115	0.117	0.118	0.120	0.122	0.12
170	0.123	0.125	0.127	0.128	0.130	0.132	0.134	0.135	0.137	0.139	0.14
180	0.141	0.142	0.144	0.146	0.148	0.150	0.151	0.153	0.155	0.157	0.15
190	0.159	0.161	0.163	0.165	0.166	0.168	0.170	0.172	0.174	0.176	0.17
200	0.178	0.180	0.182	0.184	0.186	0.188	0.190	0.192	0.195	0.197	0.19
210	0.199	0.201	0.203	0.205	0.207	0.209	0.212	0.214	0.216	0.218	0.22
220	0.220	0.222	0.225	0.227	0.229	0.231	0.234	0.236	0.238	0.241	0.24
230	0.243	0.245	0.248	0.250	0.252	0.255	0.257	0.259	0.262	0.264	0.26
240	0.267	0.269	0.271	0.274	0.276	0.279	0.281	0.284	0.286	0.289	0.29
250	0.291	0.294	0.296	0.299	0.301	0.304	0.307	0.309	0.312	0.314	0.31
260	0.317	0.320	0.322	0.325	0.328	0.330	0.333	0.336	0.338	0.341	0.34
270	0.344	0.347	0.349	0.352	0.355	0.358	0.360	0.363	0.366	0.369	0.37
280	0.372	0.375	0.377	0.380	0.383	0.386	0.389	0.392	0.395	0.398	0.40
290	0.401	0.404	0.407	0.410	0.413	0.416	0.419	0.422	0.425	0.428	0.43
300	0.431	0.434	0.437	0.440	0.443	0.446	0.449	0.452	0.455	0.458	0.46
310	0.462	0.465	0.468	0.471	0.474	0.478	0.481	0.484	0.487	0.490	0.49
320	0.494	0.497	0.500	0.503	0.507	0.510	0.513	0.517	0.520	0.523	0.52
330	0.527	0.530	0.533	0.537	0.540	0.544	0.547	0.550	0.554	0.557	0.56
340	0.561	0.564	0.568	0.571	0.575	0.578	0.582	0.585	0.589	0.592	0.59
350	0.596	0.599	0.603	0.607	0.610	0.614	0.617	0.621	0.625	0.628	0.63
360	0.632	0.636	0.639	0.643	0.647	0.650	0.654	0.658	0.662	0.665	0.66
370	0.669	0.673	0.677	0.680	0.684	0.688	0.692	0.696	0.700	0.703	0.70
380	0.707	0.711	0.715	0.719	0.723	0.727	0.731	0.735	0.738	0.742	0.74
390	0.746	0.750	0.754	0.758	0.762	0.766	0.770	0.774	0.778	0.782	0.78
400	0.787	0.791	0.795	0.799	0.803	0.807	0.811	0.815	0.819	0.824	0.82
410	0.828	0.832	0.836	0.840	0.844	0.849	0.853	0.857	0.861	0.866	0.87
420	0.870	0.874	0.878	0.883	0.887	0.891	0.896	0.900	0.904	0.909	0.91
430	0.913	0.917	0.922	0.926	0.930	0.935	0.939	0.944	0.948	0.953	0.95
440	0.957	0.961	0.966	0.970	0.975	0.979	0.984	0.988	0.993	0.997	1.00
450	1.002	1.007	1.011	1.016	1.020	1.025	1.030	1.034	1.039	1.043	1.04
460	1.048	1.053	1.057	1.062	1.067	1.071	1.076	1.081	1.086	1.090	1.09
3070	12.290	12.296	12.303	12.309	12.316	12.322	12.329	12.335	12.342	12.348	12.35
3080	12.355	12.361	12.368	12.374	12.381	12.387	12.394	12.400	12.407	12.413	12.42
3090	12.420	12.426	12.433	12.439	12.446	12.452	12.458	12.465	12.471	12.478	12.48
3100	12.484	12.491	12.497	12.504	12.510	12.517	12.523	12.530	12.536	12.543	12.54
3110	12.549	12.556	12.562	12.569	12.575	12.582	12.588	12.595	12.601	12.607	12.61
3120	12.614	12.620	12.627	12.633	12.640	12.646	12.653	12.659	12.666	12.672	12.67
3130	12.679	12.685	12.692	12.698	12.704	12.711	12.717	12.724	12.730	12.737	12.74
3140	12.743	12.750	12.756	12.763	12.769	12.776	12.782	12.789	12.795	12.801	12.80
3150	12.808	12.814	12.821	12.827	12.834	12.840	12.847	12.853	12.860	12.866	12.87
3160	12.872	12.879	12.885	12.892	12.898	12.905	12.911	12.918	12.924	12.931	12.93
3170	12.937	12.943	12.950	12.956	12.963	12.969	12.976	12.982	12.989	12.995	13.00
3180	13.001	13.008	13.014	13.021	13.027	13.034	13.040	13.047	13.053	13.059	13.06
3190	13.066	13.072	13.079	13.085	13.092	13.098	13.104	13.111	13.117	13.124	13.13
3200	13.130	13.137	13.143	13.149	13.156	13.162	13.169	13.175	13.182	13.188	13.19
3210	13.194	13.201	13.207	13.214	13.220	13.227	13.233	13.239	13.246	13.252	13.25
3220	13.259	13.265	13.271	13.278	13.284	13.291	13.297	13.304	13.310	13.316	13.32
3230	13.323	13.329	13.336	13.342	13.348	13.355	13.361	13.368	13.374	13.380	13.38
3240	13.387	13.393	13.400	13.406	13.412	13.419	13.425	13.432	13.438	13.444	13.45

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type B thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
3250	13.451	13.457	13.464	13.470	13.476	13.483	13.489	13.496	13.502	13.508	13.51
3260	13.515	13.521	13.527	13.534	13.540	13.547	13.553	13.559	13.566	13.572	13.57
3270	13.579	13.585	13.591	13.598	13.604	13.610	13.617	13.623	13.630	13.636	13.64
3280	13.642	13.649	13.655	13.661	13.668	13.674	13.680	13.687	13.693	13.700	13.70
3290	13.706	13.712	13.719	13.725	13.731	13.738	13.744	13.750	13.757	13.763	13.76

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type B thermocouple

Thermoelectric Voltage in mV

øC	0	1	2	3	4	5	6	7	8	9	10
0	0.000	0.000	0.000	-0.001	-0.001	-0.001	-0.001	-0.001	-0.002	-0.002	-0.00
10	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002	-0.003	-0.003	-0.00
20	-0.003	-0.003	-0.003	-0.003	-0.003	-0.002	-0.002	-0.002	-0.002	-0.002	-0.00
30	-0.002	-0.002	-0.002	-0.002	-0.002	-0.001	-0.001	-0.001	-0.001	-0.001	0.00
40	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.002	0.00
50	0.002	0.003	0.003	0.003	0.004	0.004	0.004	0.005	0.005	0.006	0.00
60	0.006	0.007	0.007	0.008	0.008	0.009	0.009	0.010	0.010	0.011	0.01
70	0.011	0.012	0.012	0.013	0.014	0.014	0.015	0.015	0.016	0.017	0.01
80	0.017	0.018	0.019	0.020	0.020	0.021	0.022	0.022	0.023	0.024	0.02
90	0.025	0.026	0.026	0.027	0.028	0.029	0.030	0.031	0.031	0.032	0.03
100	0.033	0.034	0.035	0.036	0.037	0.038	0.039	0.040	0.041	0.042	0.04
110	0.043	0.044	0.045	0.046	0.047	0.048	0.049	0.050	0.051	0.052	0.05
120	0.053	0.055	0.056	0.057	0.058	0.059	0.060	0.062	0.063	0.064	0.06
130	0.065	0.066	0.068	0.069	0.070	0.072	0.073	0.074	0.075	0.077	0.07
140	0.078	0.079	0.081	0.082	0.084	0.085	0.086	0.088	0.089	0.091	0.09
150	0.092	0.094	0.095	0.096	0.098	0.099	0.101	0.102	0.104	0.106	0.10
160	0.107	0.109	0.110	0.112	0.113	0.115	0.117	0.118	0.120	0.122	0.12
170	0.123	0.125	0.127	0.128	0.130	0.132	0.134	0.135	0.137	0.139	0.14
180	0.141	0.142	0.144	0.146	0.148	0.150	0.151	0.153	0.155	0.157	0.15
190	0.159	0.161	0.163	0.165	0.166	0.168	0.170	0.172	0.174	0.176	0.17
200	0.178	0.180	0.182	0.184	0.186	0.188	0.190	0.192	0.195	0.197	0.19
210	0.199	0.201	0.203	0.205	0.207	0.209	0.212	0.214	0.216	0.218	0.22
220	0.220	0.222	0.225	0.227	0.229	0.231	0.234	0.236	0.238	0.241	0.24
230	0.243	0.245	0.248	0.250	0.252	0.255	0.257	0.259	0.262	0.264	0.26
240	0.267	0.269	0.271	0.274	0.276	0.279	0.281	0.284	0.286	0.289	0.29
250	0.291	0.294	0.296	0.299	0.301	0.304	0.307	0.309	0.312	0.314	0.31
260	0.317	0.320	0.322	0.325	0.328	0.330	0.333	0.336	0.338	0.341	0.34
270	0.344	0.347	0.349	0.352	0.355	0.358	0.360	0.363	0.366	0.369	0.37
280	0.372	0.375	0.377	0.380	0.383	0.386	0.389	0.392	0.395	0.398	0.40
290	0.401	0.404	0.407	0.410	0.413	0.416	0.419	0.422	0.425	0.428	0.43
300	0.431	0.434	0.437	0.440	0.443	0.446	0.449	0.452	0.455	0.458	0.46
310	0.462	0.465	0.468	0.471	0.474	0.478	0.481	0.484	0.487	0.490	0.49
320	0.494	0.497	0.500	0.503	0.507	0.510	0.513	0.517	0.520	0.523	0.52
330	0.527	0.530	0.533	0.537	0.540	0.544	0.547	0.550	0.554	0.557	0.56
340	0.561	0.564	0.568	0.571	0.575	0.578	0.582	0.585	0.589	0.592	0.59
350	0.596	0.599	0.603	0.607	0.610	0.614	0.617	0.621	0.625	0.628	0.63
360	0.632	0.636	0.639	0.643	0.647	0.650	0.654	0.658	0.662	0.665	0.66
370	0.669	0.673	0.677	0.680	0.684	0.688	0.692	0.696	0.700	0.703	0.70
380	0.707	0.711	0.715	0.719	0.723	0.727	0.731	0.735	0.738	0.742	0.74
390	0.746	0.750	0.754	0.758	0.762	0.766	0.770	0.774	0.778	0.782	0.78
400	0.787	0.791	0.795	0.799	0.803	0.807	0.811	0.815	0.819	0.824	0.82
410	0.828	0.832	0.836	0.840	0.844	0.849	0.853	0.857	0.861	0.866	0.87
420	0.870	0.874	0.878	0.883	0.887	0.891	0.896	0.900	0.904	0.909	0.91
430	0.913	0.917	0.922	0.926	0.930	0.935	0.939	0.944	0.948	0.953	0.95
440	0.957	0.961	0.966	0.970	0.975	0.979	0.984	0.988	0.993	0.997	1.00
450	1.002	1.007	1.011	1.016	1.020	1.025	1.030	1.034	1.039	1.043	1.04
460	1.048	1.053	1.057	1.062	1.067	1.071	1.076	1.081	1.086	1.090	1.09
470	1.095	1.100	1.105	1.109	1.114	1.119	1.124	1.129	1.133	1.138	1.14
480	1.143	1.148	1.153	1.158	1.163	1.167	1.172	1.177	1.182	1.187	1.19
490	1.192	1.197	1.202	1.207	1.212	1.217	1.222	1.227	1.232	1.237	1.24
500	1.242	1.247	1.252	1.257	1.262	1.267	1.272	1.277	1.282	1.288	1.29
510	1.293	1.298	1.303	1.308	1.313	1.318	1.324	1.329	1.334	1.339	1.34
520	1.344	1.350	1.355	1.360	1.365	1.371	1.376	1.381	1.387	1.392	1.39
530	1.397	1.402	1.408	1.413	1.418	1.424	1.429	1.435	1.440	1.445	1.45
540	1.451	1.456	1.462	1.467	1.472	1.478	1.483	1.489	1.494	1.500	1.50
550	1.505	1.511	1.516	1.522	1.527	1.533	1.539	1.544	1.550	1.555	1.56
560	1.561	1.566	1.572	1.578	1.583	1.589	1.595	1.600	1.606	1.612	1.61
570	1.617	1.623	1.629	1.634	1.640	1.646	1.652	1.657	1.663	1.669	1.67
580	1.675	1.680	1.686	1.692	1.698	1.704	1.709	1.715	1.721	1.727	1.73
590	1.733	1.739	1.745	1.750	1.756	1.762	1.768	1.774	1.780	1.786	1.79
600	1.792	1.798	1.804	1.810	1.816	1.822	1.828	1.834	1.840	1.846	1.85
610	1.852	1.858	1.864	1.870	1.876	1.882	1.888	1.894	1.901	1.907	1.91
620	1.913	1.919	1.925	1.931	1.937	1.944	1.950	1.956	1.962	1.968	1.97
630	1.975	1.981	1.987	1.993	1.999	2.006	2.012	2.018	2.025	2.031	2.03
640	2.037	2.043	2.050	2.056	2.062	2.069	2.075	2.082	2.088	2.094	2.10
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type B thermocouple

Thermoelectric Voltage in mV

øC	0	1	2	3	4	5	6	7	8	9	10
650	2.101	2.107	2.113	2.120	2.126	2.133	2.139	2.146	2.152	2.158	2.16
660	2.165	2.171	2.178	2.184	2.191	2.197	2.204	2.210	2.217	2.224	2.23
670	2.230	2.237	2.243	2.250	2.256	2.263	2.270	2.276	2.283	2.289	2.29
680	2.296	2.303	2.309	2.316	2.323	2.329	2.336	2.343	2.350	2.356	2.36
690	2.363	2.370	2.376	2.383	2.390	2.397	2.403	2.410	2.417	2.424	2.43
700	2.431	2.437	2.444	2.451	2.458	2.465	2.472	2.479	2.485	2.492	2.49
710	2.499	2.506	2.513	2.520	2.527	2.534	2.541	2.548	2.555	2.562	2.56
720	2.569	2.576	2.583	2.590	2.597	2.604	2.611	2.618	2.625	2.632	2.63
730	2.639	2.646	2.653	2.660	2.667	2.674	2.681	2.688	2.696	2.703	2.71
740	2.710	2.717	2.724	2.731	2.738	2.746	2.753	2.760	2.767	2.775	2.78
750	2.782	2.789	2.796	2.803	2.811	2.818	2.825	2.833	2.840	2.847	2.85
760	2.854	2.862	2.869	2.876	2.884	2.891	2.898	2.906	2.913	2.921	2.92
770	2.928	2.935	2.943	2.950	2.958	2.965	2.973	2.980	2.987	2.995	3.00
780	3.002	3.010	3.017	3.025	3.032	3.040	3.047	3.055	3.062	3.070	3.07
790	3.078	3.085	3.093	3.100	3.108	3.116	3.123	3.131	3.138	3.146	3.15
800	3.154	3.161	3.169	3.177	3.184	3.192	3.200	3.207	3.215	3.223	3.23
810	3.230	3.238	3.246	3.254	3.261	3.269	3.277	3.285	3.292	3.300	3.30
820	3.308	3.316	3.324	3.331	3.339	3.347	3.355	3.363	3.371	3.379	3.38
830	3.386	3.394	3.402	3.410	3.418	3.426	3.434	3.442	3.450	3.458	3.46
840	3.466	3.474	3.482	3.490	3.498	3.506	3.514	3.522	3.530	3.538	3.54
850	3.546	3.554	3.562	3.570	3.578	3.586	3.594	3.602	3.610	3.618	3.62
860	3.626	3.634	3.643	3.651	3.659	3.667	3.675	3.683	3.692	3.700	3.70
870	3.708	3.716	3.724	3.732	3.741	3.749	3.757	3.765	3.774	3.782	3.79
880	3.790	3.798	3.807	3.815	3.823	3.832	3.840	3.848	3.857	3.865	3.87
890	3.873	3.882	3.890	3.898	3.907	3.915	3.923	3.932	3.940	3.949	3.95
900	3.957	3.965	3.974	3.982	3.991	3.999	4.008	4.016	4.024	4.033	4.04
910	4.041	4.050	4.058	4.067	4.075	4.084	4.093	4.101	4.110	4.118	4.12
920	4.127	4.135	4.144	4.152	4.161	4.170	4.178	4.187	4.195	4.204	4.21
930	4.213	4.221	4.230	4.239	4.247	4.256	4.265	4.273	4.282	4.291	4.29
940	4.299	4.308	4.317	4.326	4.334	4.343	4.352	4.360	4.369	4.378	4.38
950	4.387	4.396	4.404	4.413	4.422	4.431	4.440	4.448	4.457	4.466	4.47
960	4.475	4.484	4.493	4.501	4.510	4.519	4.528	4.537	4.546	4.555	4.56
970	4.564	4.573	4.582	4.591	4.599	4.608	4.617	4.626	4.635	4.644	4.65
980	4.653	4.662	4.671	4.680	4.689	4.698	4.707	4.716	4.725	4.734	4.74
990	4.743	4.753	4.762	4.771	4.780	4.789	4.798	4.807	4.816	4.825	4.83
1000	4.834	4.843	4.853	4.862	4.871	4.880	4.889	4.898	4.908	4.917	4.92
1010	4.926	4.935	4.944	4.954	4.963	4.972	4.981	4.990	5.000	5.009	5.01
1020	5.018	5.027	5.037	5.046	5.055	5.065	5.074	5.083	5.092	5.102	5.11
1030	5.111	5.120	5.130	5.139	5.148	5.158	5.167	5.176	5.186	5.195	5.20
1040	5.205	5.214	5.223	5.233	5.242	5.252	5.261	5.270	5.280	5.289	5.29
1050	5.299	5.308	5.318	5.327	5.337	5.346	5.356	5.365	5.375	5.384	5.39
1060	5.394	5.403	5.413	5.422	5.432	5.441	5.451	5.460	5.470	5.480	5.48
1070	5.489	5.499	5.508	5.518	5.528	5.537	5.547	5.556	5.566	5.576	5.58
1080	5.585	5.595	5.605	5.614	5.624	5.634	5.643	5.653	5.663	5.672	5.68
1090	5.682	5.692	5.702	5.711	5.721	5.731	5.740	5.750	5.760	5.770	5.78
1100	5.780	5.789	5.799	5.809	5.819	5.828	5.838	5.848	5.858	5.868	5.87
1110	5.878	5.887	5.897	5.907	5.917	5.927	5.937	5.947	5.956	5.966	5.97
1120	5.976	5.986	5.996	6.006	6.016	6.026	6.036	6.046	6.055	6.065	6.07
1130	6.075	6.085	6.095	6.105	6.115	6.125	6.135	6.145	6.155	6.165	6.17
1140	6.175	6.185	6.195	6.205	6.215	6.225	6.235	6.245	6.256	6.266	6.27
1150	6.276	6.286	6.296	6.306	6.316	6.326	6.336	6.346	6.356	6.367	6.37
1160	6.377	6.387	6.397	6.407	6.417	6.427	6.438	6.448	6.458	6.468	6.47
1170	6.478	6.488	6.499	6.509	6.519	6.529	6.539	6.550	6.560	6.570	6.58
1180	6.580	6.591	6.601	6.611	6.621	6.632	6.642	6.652	6.663	6.673	6.68
1190	6.683	6.693	6.704	6.714	6.724	6.735	6.745	6.755	6.766	6.776	6.78
1200	6.786	6.797	6.807	6.818	6.828	6.838	6.849	6.859	6.869	6.880	6.89
1210	6.890	6.901	6.911	6.922	6.932	6.942	6.953	6.963	6.974	6.984	6.99
1220	6.995	7.005	7.016	7.026	7.037	7.047	7.058	7.068	7.079	7.089	7.10
1230	7.100	7.110	7.121	7.131	7.142	7.152	7.163	7.173	7.184	7.194	7.20
1240	7.205	7.216	7.226	7.237	7.247	7.258	7.269	7.279	7.290	7.300	7.31
1250	7.311	7.322	7.332	7.343	7.353	7.364	7.375	7.385	7.396	7.407	7.41
1260	7.417	7.428	7.439	7.449	7.460	7.471	7.482	7.492	7.503	7.514	7.52
1270	7.524	7.535	7.546	7.557	7.567	7.578	7.589	7.600	7.610	7.621	7.63
1280	7.632	7.643	7.653	7.664	7.675	7.686	7.697	7.707	7.718	7.729	7.74
1290	7.740	7.751	7.761	7.772	7.783	7.794	7.805	7.816	7.827	7.837	7.84
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type B thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
1300	7.848	7.859	7.870	7.881	7.892	7.903	7.914	7.924	7.935	7.946	7.95
1310	7.957	7.968	7.979	7.990	8.001	8.012	8.023	8.034	8.045	8.056	8.06
1320	8.066	8.077	8.088	8.099	8.110	8.121	8.132	8.143	8.154	8.165	8.17
1330	8.176	8.187	8.198	8.209	8.220	8.231	8.242	8.253	8.264	8.275	8.28
1340	8.286	8.298	8.309	8.320	8.331	8.342	8.353	8.364	8.375	8.386	8.39
1350	8.397	8.408	8.419	8.430	8.441	8.453	8.464	8.475	8.486	8.497	8.50
1360	8.508	8.519	8.530	8.542	8.553	8.564	8.575	8.586	8.597	8.608	8.62
1370	8.620	8.631	8.642	8.653	8.664	8.675	8.687	8.698	8.709	8.720	8.73
1380	8.731	8.743	8.754	8.765	8.776	8.787	8.799	8.810	8.821	8.832	8.84
1390	8.844	8.855	8.866	8.877	8.889	8.900	8.911	8.922	8.934	8.945	8.95
1400	8.956	8.967	8.979	8.990	9.001	9.013	9.024	9.035	9.047	9.058	9.06
1410	9.069	9.080	9.092	9.103	9.114	9.126	9.137	9.148	9.160	9.171	9.18
1420	9.182	9.194	9.205	9.216	9.228	9.239	9.251	9.262	9.273	9.285	9.29
1430	9.296	9.307	9.319	9.330	9.342	9.353	9.364	9.376	9.387	9.398	9.41
1440	9.410	9.421	9.433	9.444	9.456	9.467	9.478	9.490	9.501	9.513	9.52
1450	9.524	9.536	9.547	9.558	9.570	9.581	9.593	9.604	9.616	9.627	9.63
1460	9.639	9.650	9.662	9.673	9.684	9.696	9.707	9.719	9.730	9.742	9.75
1470	9.753	9.765	9.776	9.788	9.799	9.811	9.822	9.834	9.845	9.857	9.86
1480	9.868	9.880	9.891	9.903	9.914	9.926	9.937	9.949	9.961	9.972	9.98
1490	9.984	9.995	10.007	10.018	10.030	10.041	10.053	10.064	10.076	10.088	10.09
1500	10.099	10.111	10.122	10.134	10.145	10.157	10.168	10.180	10.192	10.203	10.21
1510	10.215	10.226	10.238	10.249	10.261	10.273	10.284	10.296	10.307	10.319	10.33
1520	10.331	10.342	10.354	10.365	10.377	10.389	10.400	10.412	10.423	10.435	10.44
1530	10.447	10.458	10.470	10.482	10.493	10.505	10.516	10.528	10.540	10.551	10.56
1540	10.563	10.575	10.586	10.598	10.609	10.621	10.633	10.644	10.656	10.668	10.67
1550	10.679	10.691	10.703	10.714	10.726	10.738	10.749	10.761	10.773	10.784	10.79
1560	10.796	10.808	10.819	10.831	10.843	10.854	10.866	10.877	10.889	10.901	10.91
1570	10.913	10.924	10.936	10.948	10.959	10.971	10.983	10.994	11.006	11.018	11.02
1580	11.029	11.041	11.053	11.064	11.076	11.088	11.099	11.111	11.123	11.134	11.14
1590	11.146	11.158	11.169	11.181	11.193	11.205	11.216	11.228	11.240	11.251	11.26
1600	11.263	11.275	11.286	11.298	11.310	11.321	11.333	11.345	11.357	11.368	11.38
1610	11.380	11.392	11.403	11.415	11.427	11.438	11.450	11.462	11.474	11.485	11.49
1620	11.497	11.509	11.520	11.532	11.544	11.555	11.567	11.579	11.591	11.602	11.61
1630	11.614	11.626	11.637	11.649	11.661	11.673	11.684	11.696	11.708	11.719	11.73
1640	11.731	11.743	11.754	11.766	11.778	11.790	11.801	11.813	11.825	11.836	11.84
1650	11.848	11.860	11.871	11.883	11.895	11.907	11.918	11.930	11.942	11.953	11.96
1660	11.965	11.977	11.988	12.000	12.012	12.024	12.035	12.047	12.059	12.070	12.08
1670	12.082	12.094	12.105	12.117	12.129	12.141	12.152	12.164	12.176	12.187	12.19
1680	12.199	12.211	12.222	12.234	12.246	12.257	12.269	12.281	12.292	12.304	12.31
1690	12.316	12.327	12.339	12.351	12.363	12.374	12.386	12.398	12.409	12.421	12.43
1700	12.433	12.444	12.456	12.468	12.479	12.491	12.503	12.514	12.526	12.538	12.54
1710	12.549	12.561	12.572	12.584	12.596	12.607	12.619	12.631	12.642	12.654	12.66
1720	12.666	12.677	12.689	12.701	12.712	12.724	12.736	12.747	12.759	12.770	12.78
1730	12.782	12.794	12.805	12.817	12.829	12.840	12.852	12.863	12.875	12.887	12.89
1740	12.898	12.910	12.921	12.933	12.945	12.956	12.968	12.980	12.991	13.003	13.01
1750	13.014	13.026	13.037	13.049	13.061	13.072	13.084	13.095	13.107	13.119	13.13
1760	13.130	13.142	13.153	13.165	13.176	13.188	13.200	13.211	13.223	13.234	13.24
1770	13.246	13.257	13.269	13.280	13.292	13.304	13.315	13.327	13.338	13.350	13.36
1780	13.361	13.373	13.384	13.396	13.407	13.419	13.430	13.442	13.453	13.465	13.47
1790	13.476	13.488	13.499	13.511	13.522	13.534	13.545	13.557	13.568	13.580	13.59
1800	13.591	13.603	13.614	13.626	13.637	13.649	13.660	13.672	13.683	13.694	13.70
1810	13.706	13.717	13.729	13.740	13.752	13.763	13.775	13.786	13.797	13.809	13.82
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type E thermocouple

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
					Thermoelectric Voltage in mV						
-440	-9.830	-9.829	-9.827	-9.825	-9.823	-9.821	-9.819	-9.817	-9.814	-9.812	-9.80
-430	-9.809	-9.806	-9.803	-9.800	-9.797	-9.793	-9.790	-9.786	-9.782	-9.779	-9.77
-420	-9.775	-9.771	-9.766	-9.762	-9.758	-9.753	-9.749	-9.744	-9.739	-9.734	-9.72
-410	-9.729	-9.724	-9.718	-9.713	-9.707	-9.702	-9.696	-9.690	-9.684	-9.678	-9.67
-400	-9.672	-9.666	-9.659	-9.653	-9.646	-9.639	-9.632	-9.625	-9.618	-9.611	-9.60
-390	-9.604	-9.597	-9.589	-9.581	-9.574	-9.566	-9.558	-9.550	-9.542	-9.534	-9.52
-380	-9.525	-9.517	-9.508	-9.500	-9.491	-9.482	-9.473	-9.464	-9.455	-9.446	-9.43
-370	-9.436	-9.427	-9.417	-9.408	-9.398	-9.388	-9.378	-9.368	-9.358	-9.348	-9.33
-360	-9.338	-9.327	-9.317	-9.306	-9.295	-9.285	-9.274	-9.263	-9.252	-9.241	-9.22
-350	-9.229	-9.218	-9.207	-9.195	-9.184	-9.172	-9.160	-9.148	-9.136	-9.124	-9.11
-340	-9.112	-9.100	-9.088	-9.075	-9.063	-9.050	-9.038	-9.025	-9.012	-8.999	-8.98
-330	-8.986	-8.973	-8.960	-8.947	-8.934	-8.920	-8.907	-8.893	-8.880	-8.866	-8.85
-320	-8.852	-8.839	-8.825	-8.811	-8.797	-8.782	-8.768	-8.754	-8.739	-8.725	-8.71
-310	-8.710	-8.696	-8.681	-8.666	-8.652	-8.637	-8.622	-8.607	-8.591	-8.576	-8.56
-300	-8.561	-8.546	-8.530	-8.515	-8.499	-8.483	-8.468	-8.452	-8.436	-8.420	-8.40
-290	-8.404	-8.388	-8.372	-8.356	-8.339	-8.323	-8.307	-8.290	-8.273	-8.257	-8.24
-280	-8.240	-8.223	-8.206	-8.189	-8.173	-8.155	-8.138	-8.121	-8.104	-8.087	-8.06
-270	-8.069	-8.052	-8.034	-8.017	-7.999	-7.981	-7.963	-7.945	-7.928	-7.910	-7.89
-260	-7.891	-7.873	-7.855	-7.837	-7.819	-7.800	-7.782	-7.763	-7.745	-7.726	-7.70
-250	-7.707	-7.688	-7.670	-7.651	-7.632	-7.613	-7.593	-7.574	-7.555	-7.536	-7.51
-240	-7.516	-7.497	-7.478	-7.458	-7.438	-7.419	-7.399	-7.379	-7.359	-7.339	-7.31
-230	-7.319	-7.299	-7.279	-7.259	-7.239	-7.219	-7.198	-7.178	-7.157	-7.137	-7.11
-220	-7.116	-7.096	-7.075	-7.054	-7.033	-7.013	-6.992	-6.971	-6.950	-6.928	-6.90
-210	-6.907	-6.886	-6.865	-6.843	-6.822	-6.801	-6.779	-6.757	-6.736	-6.714	-6.69
-200	-6.692	-6.671	-6.649	-6.627	-6.605	-6.583	-6.561	-6.539	-6.516	-6.494	-6.47
-190	-6.472	-6.449	-6.427	-6.405	-6.382	-6.359	-6.337	-6.314	-6.291	-6.269	-6.24
-180	-6.246	-6.223	-6.200	-6.177	-6.154	-6.130	-6.107	-6.084	-6.061	-6.037	-6.01
-170	-6.014	-5.991	-5.967	-5.943	-5.920	-5.896	-5.872	-5.849	-5.825	-5.801	-5.77
-160	-5.777	-5.753	-5.729	-5.705	-5.681	-5.656	-5.632	-5.608	-5.584	-5.559	-5.53
-150	-5.535	-5.510	-5.486	-5.461	-5.436	-5.412	-5.387	-5.362	-5.337	-5.312	-5.28
-140	-5.287	-5.262	-5.237	-5.212	-5.187	-5.162	-5.136	-5.111	-5.086	-5.060	-5.03
-130	-5.035	-5.009	-4.984	-4.958	-4.932	-4.907	-4.881	-4.855	-4.829	-4.803	-4.77
-120	-4.777	-4.751	-4.725	-4.699	-4.673	-4.647	-4.621	-4.594	-4.568	-4.542	-4.51
-110	-4.515	-4.489	-4.462	-4.436	-4.409	-4.382	-4.355	-4.329	-4.302	-4.275	-4.24
-100	-4.248	-4.221	-4.194	-4.167	-4.140	-4.113	-4.086	-4.058	-4.031	-4.004	-3.97
-90	-3.976	-3.949	-3.922	-3.894	-3.867	-3.839	-3.811	-3.784	-3.756	-3.728	-3.70
-80	-3.700	-3.672	-3.645	-3.617	-3.589	-3.561	-3.532	-3.504	-3.476	-3.448	-3.42
-70	-3.420	-3.391	-3.363	-3.335	-3.306	-3.278	-3.249	-3.221	-3.192	-3.163	-3.13
-60	-3.135	-3.106	-3.077	-3.048	-3.020	-2.991	-2.962	-2.933	-2.904	-2.875	-2.84
-50	-2.846	-2.816	-2.787	-2.758	-2.729	-2.699	-2.670	-2.641	-2.611	-2.582	-2.55
-40	-2.552	-2.523	-2.493	-2.463	-2.434	-2.404	-2.374	-2.344	-2.315	-2.285	-2.25
-30	-2.255	-2.225	-2.195	-2.165	-2.135	-2.105	-2.074	-2.044	-2.014	-1.984	-1.95
-20	-1.953	-1.923	-1.893	-1.862	-1.832	-1.801	-1.771	-1.740	-1.709	-1.679	-1.64
-10	-1.648	-1.617	-1.587	-1.556	-1.525	-1.494	-1.463	-1.432	-1.401	-1.370	-1.33
0	-1.339	-1.308	-1.277	-1.245	-1.214	-1.183	-1.152	-1.120	-1.089	-1.057	-1.02

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

ITS-90 Table for type E thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
0	-1.026	-0.994	-0.963	-0.931	-0.900	-0.868	-0.836	-0.805	-0.773	-0.741	-0.70
10	-0.709	-0.677	-0.645	-0.614	-0.582	-0.550	-0.517	-0.485	-0.453	-0.421	-0.38
20	-0.389	-0.357	-0.324	-0.292	-0.260	-0.227	-0.195	-0.163	-0.130	-0.098	-0.06
30	-0.065	-0.033	0.000	0.033	0.065	0.098	0.131	0.163	0.196	0.229	0.26
40	0.262	0.294	0.327	0.360	0.393	0.426	0.459	0.492	0.525	0.558	0.59
50	0.591	0.624	0.657	0.691	0.724	0.757	0.790	0.824	0.857	0.890	0.92
60	0.924	0.957	0.990	1.024	1.057	1.091	1.124	1.158	1.192	1.225	1.25
70	1.259	1.292	1.326	1.360	1.394	1.427	1.461	1.495	1.529	1.563	1.59
80	1.597	1.631	1.665	1.699	1.733	1.767	1.801	1.835	1.869	1.904	1.93
90	1.938	1.972	2.006	2.041	2.075	2.109	2.144	2.178	2.212	2.247	2.28
100	2.281	2.316	2.351	2.385	2.420	2.454	2.489	2.524	2.558	2.593	2.62
110	2.628	2.663	2.698	2.733	2.767	2.802	2.837	2.872	2.907	2.942	2.97
120	2.977	3.012	3.048	3.083	3.118	3.153	3.188	3.224	3.259	3.294	3.33
130	3.330	3.365	3.400	3.436	3.471	3.507	3.542	3.578	3.613	3.649	3.68
140	3.685	3.720	3.756	3.792	3.827	3.863	3.899	3.935	3.970	4.006	4.04
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type E thermocouple

Thermoelectric Voltage in mV

øF	0	1	2	3	4	5	6	7	8	9	10
150	4.042	4.078	4.114	4.150	4.186	4.222	4.258	4.294	4.330	4.366	4.40
160	4.403	4.439	4.475	4.511	4.547	4.584	4.620	4.656	4.693	4.729	4.76
170	4.766	4.802	4.839	4.875	4.912	4.948	4.985	5.021	5.058	5.095	5.13
180	5.131	5.168	5.205	5.242	5.278	5.315	5.352	5.389	5.426	5.463	5.50
190	5.500	5.537	5.574	5.611	5.648	5.685	5.722	5.759	5.796	5.833	5.87
200	5.871	5.908	5.945	5.982	6.020	6.057	6.094	6.132	6.169	6.207	6.24
210	6.244	6.281	6.319	6.356	6.394	6.432	6.469	6.507	6.544	6.582	6.62
220	6.620	6.658	6.695	6.733	6.771	6.809	6.847	6.884	6.922	6.960	6.99
230	6.998	7.036	7.074	7.112	7.150	7.188	7.226	7.264	7.302	7.341	7.37
240	7.379	7.417	7.455	7.493	7.532	7.570	7.608	7.647	7.685	7.723	7.76
250	7.762	7.800	7.839	7.877	7.916	7.954	7.993	8.031	8.070	8.108	8.14
260	8.147	8.186	8.224	8.263	8.302	8.340	8.379	8.418	8.457	8.496	8.53
270	8.535	8.573	8.612	8.651	8.690	8.729	8.768	8.807	8.846	8.885	8.92
280	8.924	8.963	9.002	9.041	9.081	9.120	9.159	9.198	9.237	9.277	9.31
290	9.316	9.355	9.395	9.434	9.473	9.513	9.552	9.591	9.631	9.670	9.71
300	9.710	9.749	9.789	9.828	9.868	9.907	9.947	9.987	10.026	10.066	10.10
310	10.106	10.145	10.185	10.225	10.265	10.304	10.344	10.384	10.424	10.464	10.50
320	10.503	10.543	10.583	10.623	10.663	10.703	10.743	10.783	10.823	10.863	10.90
330	10.903	10.943	10.983	11.024	11.064	11.104	11.144	11.184	11.224	11.265	11.30
340	11.305	11.345	11.385	11.426	11.466	11.506	11.547	11.587	11.627	11.668	11.70
350	11.708	11.749	11.789	11.830	11.870	11.911	11.951	11.992	12.032	12.073	12.11
360	12.113	12.154	12.195	12.235	12.276	12.317	12.357	12.398	12.439	12.480	12.52
370	12.520	12.561	12.602	12.643	12.684	12.724	12.765	12.806	12.847	12.888	12.92
380	12.929	12.970	13.011	13.052	13.093	13.134	13.175	13.216	13.257	13.298	13.33
390	13.339	13.380	13.421	13.462	13.504	13.545	13.586	13.627	13.668	13.710	13.75
400	13.751	13.792	13.833	13.875	13.916	13.957	13.999	14.040	14.081	14.123	14.16
410	14.164	14.205	14.247	14.288	14.330	14.371	14.413	14.454	14.496	14.537	14.57
420	14.579	14.620	14.662	14.704	14.745	14.787	14.828	14.870	14.912	14.953	14.99
430	14.995	15.037	15.078	15.120	15.162	15.204	15.245	15.287	15.329	15.371	15.41
440	15.413	15.454	15.496	15.538	15.580	15.622	15.664	15.706	15.748	15.790	15.83
450	15.831	15.873	15.915	15.957	15.999	16.041	16.083	16.125	16.168	16.210	16.25
460	16.252	16.294	16.336	16.378	16.420	16.462	16.504	16.547	16.589	16.631	16.67
470	16.673	16.715	16.758	16.800	16.842	16.884	16.927	16.969	17.011	17.054	17.09
480	17.096	17.138	17.181	17.223	17.265	17.308	17.350	17.392	17.435	17.477	17.52
490	17.520	17.562	17.605	17.647	17.690	17.732	17.775	17.817	17.860	17.902	17.94
500	17.945	17.987	18.030	18.073	18.115	18.158	18.200	18.243	18.286	18.328	18.37
510	18.371	18.414	18.456	18.499	18.542	18.585	18.627	18.670	18.713	18.756	18.79
520	18.798	18.841	18.884	18.927	18.969	19.012	19.055	19.098	19.141	19.184	19.22
530	19.227	19.269	19.312	19.355	19.398	19.441	19.484	19.527	19.570	19.613	19.65
540	19.656	19.699	19.742	19.785	19.828	19.871	19.914	19.957	20.000	20.043	20.08
550	20.086	20.129	20.172	20.216	20.259	20.302	20.345	20.388	20.431	20.474	20.51
560	20.517	20.561	20.604	20.647	20.690	20.733	20.777	20.820	20.863	20.906	20.95
570	20.950	20.993	21.036	21.080	21.123	21.166	21.209	21.253	21.296	21.339	21.38
580	21.383	21.426	21.470	21.513	21.556	21.600	21.643	21.686	21.730	21.773	21.81
590	21.817	21.860	21.904	21.947	21.991	22.034	22.078	22.121	22.165	22.208	22.25
600	22.252	22.295	22.339	22.382	22.426	22.469	22.513	22.556	22.600	22.644	22.68
610	22.687	22.731	22.774	22.818	22.862	22.905	22.949	22.993	23.036	23.080	23.12
620	23.124	23.167	23.211	23.255	23.298	23.342	23.386	23.429	23.473	23.517	23.56
630	23.561	23.604	23.648	23.692	23.736	23.780	23.823	23.867	23.911	23.955	23.99
640	23.999	24.042	24.086	24.130	24.174	24.218	24.262	24.305	24.349	24.393	24.43
650	24.437	24.481	24.525	24.569	24.613	24.657	24.701	24.745	24.789	24.832	24.87
660	24.876	24.920	24.964	25.008	25.052	25.096	25.140	25.184	25.228	25.272	25.31
670	25.316	25.360	25.404	25.448	25.493	25.537	25.581	25.625	25.669	25.713	25.75
680	25.757	25.801	25.845	25.889	25.933	25.977	26.022	26.066	26.110	26.154	26.19
690	26.198	26.242	26.286	26.331	26.375	26.419	26.463	26.507	26.552	26.596	26.64
700	26.640	26.684	26.728	26.773	26.817	26.861	26.905	26.950	26.994	27.038	27.08
710	27.082	27.127	27.171	27.215	27.259	27.304	27.348	27.392	27.437	27.481	27.52
720	27.525	27.570	27.614	27.658	27.703	27.747	27.791	27.836	27.880	27.924	27.96
730	27.969	28.013	28.057	28.102	28.146	28.191	28.235	28.279	28.324	28.368	28.41
740	28.413	28.457	28.501	28.546	28.590	28.635	28.679	28.724	28.768	28.813	28.85
750	28.857	28.901	28.946	28.990	29.035	29.079	29.124	29.168	29.213	29.257	29.30
760	29.302	29.346	29.391	29.435	29.480	29.525	29.569	29.614	29.658	29.703	29.74
770	29.747	29.792	29.836	29.881	29.925	29.970	30.015	30.059	30.104	30.148	30.19
780	30.193	30.238	30.282	30.327	30.371	30.416	30.461	30.505	30.550	30.595	30.63
790	30.639	30.684	30.728	30.773	30.818	30.862	30.907	30.952	30.996	31.041	31.08
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type E thermocouple

Thermoelectric Voltage in mV

øF	0	1	2	3	4	5	6	7	8	9	10
800	31.086	31.130	31.175	31.220	31.264	31.309	31.354	31.398	31.443	31.488	31.53
810	31.533	31.577	31.622	31.667	31.711	31.756	31.801	31.846	31.890	31.935	31.98
820	31.980	32.025	32.069	32.114	32.159	32.204	32.248	32.293	32.338	32.383	32.42
830	32.427	32.472	32.517	32.562	32.606	32.651	32.696	32.741	32.786	32.830	32.87
840	32.875	32.920	32.965	33.010	33.054	33.099	33.144	33.189	33.234	33.278	33.32
850	33.323	33.368	33.413	33.458	33.503	33.547	33.592	33.637	33.682	33.727	33.77
860	33.772	33.816	33.861	33.906	33.951	33.996	34.041	34.086	34.130	34.175	34.22
870	34.220	34.265	34.310	34.355	34.400	34.445	34.489	34.534	34.579	34.624	34.66
880	34.669	34.714	34.759	34.804	34.849	34.893	34.938	34.983	35.028	35.073	35.11
890	35.118	35.163	35.208	35.253	35.298	35.343	35.387	35.432	35.477	35.522	35.56
900	35.567	35.612	35.657	35.702	35.747	35.792	35.837	35.882	35.927	35.972	36.01
910	36.016	36.061	36.106	36.151	36.196	36.241	36.286	36.331	36.376	36.421	36.46
920	36.466	36.511	36.556	36.601	36.646	36.691	36.736	36.781	36.826	36.870	36.91
930	36.915	36.960	37.005	37.050	37.095	37.140	37.185	37.230	37.275	37.320	37.36
940	37.365	37.410	37.455	37.500	37.545	37.590	37.635	37.680	37.725	37.770	37.81
950	37.815	37.860	37.905	37.950	37.995	38.040	38.085	38.130	38.175	38.220	38.26
960	38.265	38.309	38.354	38.399	38.444	38.489	38.534	38.579	38.624	38.669	38.71
970	38.714	38.759	38.804	38.849	38.894	38.939	38.984	39.029	39.074	39.119	39.16
980	39.164	39.209	39.254	39.299	39.344	39.389	39.434	39.479	39.524	39.569	39.61
990	39.614	39.659	39.704	39.749	39.794	39.839	39.884	39.929	39.974	40.019	40.06
1000	40.064	40.109	40.154	40.199	40.243	40.288	40.333	40.378	40.423	40.468	40.51
1010	40.513	40.558	40.603	40.648	40.693	40.738	40.783	40.828	40.873	40.918	40.96
1020	40.963	41.008	41.053	41.098	41.143	41.188	41.233	41.278	41.323	41.368	41.41
1030	41.412	41.457	41.502	41.547	41.592	41.637	41.682	41.727	41.772	41.817	41.86
1040	41.862	41.907	41.952	41.997	42.042	42.087	42.132	42.176	42.221	42.266	42.31
1050	42.311	42.356	42.401	42.446	42.491	42.536	42.581	42.626	42.671	42.715	42.76
1060	42.760	42.805	42.850	42.895	42.940	42.985	43.030	43.075	43.120	43.165	43.20
1070	43.209	43.254	43.299	43.344	43.389	43.434	43.479	43.524	43.569	43.613	43.65
1080	43.658	43.703	43.748	43.793	43.838	43.883	43.928	43.972	44.017	44.062	44.10
1090	44.107	44.152	44.197	44.242	44.286	44.331	44.376	44.421	44.466	44.511	44.55
1100	44.555	44.600	44.645	44.690	44.735	44.780	44.824	44.869	44.914	44.959	45.00
1110	45.004	45.049	45.093	45.138	45.183	45.228	45.273	45.317	45.362	45.407	45.45
1120	45.452	45.497	45.541	45.586	45.631	45.676	45.720	45.765	45.810	45.855	45.90
1130	45.900	45.944	45.989	46.034	46.079	46.123	46.168	46.213	46.258	46.302	46.34
1140	46.347	46.392	46.437	46.481	46.526	46.571	46.616	46.660	46.705	46.750	46.79
1150	46.794	46.839	46.884	46.929	46.973	47.018	47.063	47.107	47.152	47.197	47.24
1160	47.241	47.286	47.331	47.375	47.420	47.465	47.509	47.554	47.599	47.643	47.68
1170	47.688	47.733	47.777	47.822	47.867	47.911	47.956	48.001	48.045	48.090	48.13
1180	48.135	48.179	48.224	48.268	48.313	48.358	48.402	48.447	48.492	48.536	48.58
1190	48.581	48.625	48.670	48.715	48.759	48.804	48.848	48.893	48.937	48.982	49.02
1200	49.027	49.071	49.116	49.160	49.205	49.249	49.294	49.338	49.383	49.428	49.47
1210	49.472	49.517	49.561	49.606	49.650	49.695	49.739	49.784	49.828	49.873	49.91
1220	49.917	49.962	50.006	50.051	50.095	50.140	50.184	50.229	50.273	50.318	50.36
1230	50.362	50.407	50.451	50.495	50.540	50.584	50.629	50.673	50.718	50.762	50.80
1240	50.807	50.851	50.895	50.940	50.984	51.029	51.073	51.118	51.162	51.206	51.25
1250	51.251	51.295	51.340	51.384	51.428	51.473	51.517	51.561	51.606	51.650	51.69
1260	51.695	51.739	51.783	51.828	51.872	51.916	51.961	52.005	52.049	52.094	52.13
1270	52.138	52.182	52.227	52.271	52.315	52.360	52.404	52.448	52.493	52.537	52.58
1280	52.581	52.625	52.670	52.714	52.758	52.803	52.847	52.891	52.935	52.980	53.02
1290	53.024	53.068	53.112	53.157	53.201	53.245	53.289	53.334	53.378	53.422	53.46
1300	53.466	53.510	53.555	53.599	53.643	53.687	53.732	53.776	53.820	53.864	53.90
1310	53.908	53.952	53.997	54.041	54.085	54.129	54.173	54.218	54.262	54.306	54.35
1320	54.350	54.394	54.438	54.482	54.527	54.571	54.615	54.659	54.703	54.747	54.79
1330	54.791	54.835	54.879	54.924	54.968	55.012	55.056	55.100	55.144	55.188	55.23
1340	55.232	55.276	55.320	55.364	55.408	55.453	55.497	55.541	55.585	55.629	55.67
1350	55.673	55.717	55.761	55.805	55.849	55.893	55.937	55.981	56.025	56.069	56.11
1360	56.113	56.157	56.201	56.245	56.289	56.333	56.377	56.421	56.465	56.509	56.55
1370	56.553	56.597	56.641	56.685	56.729	56.773	56.816	56.860	56.904	56.948	56.99
1380	56.992	57.036	57.080	57.124	57.168	57.212	57.256	57.300	57.344	57.387	57.43
1390	57.431	57.475	57.519	57.563	57.607	57.651	57.695	57.738	57.782	57.826	57.87
1400	57.870	57.914	57.958	58.002	58.045	58.089	58.133	58.177	58.221	58.265	58.30
1410	58.308	58.352	58.396	58.440	58.484	58.527	58.571	58.615	58.659	58.702	58.74
1420	58.746	58.790	58.834	58.878	58.921	58.965	59.009	59.053	59.096	59.140	59.18
1430	59.184	59.228	59.271	59.315	59.359	59.402	59.446	59.490	59.534	59.577	59.62
1440	59.621	59.665	59.708	59.752	59.796	59.839	59.883	59.927	59.970	60.014	60.05
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type E thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
1450	60.058	60.101	60.145	60.189	60.232	60.276	60.320	60.363	60.407	60.451	60.49
1460	60.494	60.538	60.581	60.625	60.669	60.712	60.756	60.799	60.843	60.887	60.93
1470	60.930	60.974	61.017	61.061	61.105	61.148	61.192	61.235	61.279	61.322	61.36
1480	61.366	61.409	61.453	61.496	61.540	61.583	61.627	61.671	61.714	61.758	61.80
1490	61.801	61.845	61.888	61.932	61.975	62.018	62.062	62.105	62.149	62.192	62.23
1500	62.236	62.279	62.323	62.366	62.410	62.453	62.496	62.540	62.583	62.627	62.67
1510	62.670	62.714	62.757	62.800	62.844	62.887	62.931	62.974	63.017	63.061	63.10
1520	63.104	63.148	63.191	63.234	63.278	63.321	63.364	63.408	63.451	63.494	63.53
1530	63.538	63.581	63.624	63.668	63.711	63.754	63.798	63.841	63.884	63.927	63.97
1540	63.971	64.014	64.057	64.101	64.144	64.187	64.230	64.274	64.317	64.360	64.40
1550	64.403	64.447	64.490	64.533	64.576	64.619	64.663	64.706	64.749	64.792	64.83
1560	64.835	64.879	64.922	64.965	65.008	65.051	65.094	65.138	65.181	65.224	65.26
1570	65.267	65.310	65.353	65.396	65.440	65.483	65.526	65.569	65.612	65.655	65.69
1580	65.698	65.741	65.784	65.827	65.871	65.914	65.957	66.000	66.043	66.086	66.12
1590	66.129	66.172	66.215	66.258	66.301	66.344	66.387	66.430	66.473	66.516	66.55
1600	66.559	66.602	66.645	66.688	66.731	66.774	66.817	66.860	66.903	66.946	66.98
1610	66.989	67.031	67.074	67.117	67.160	67.203	67.246	67.289	67.332	67.375	67.41
1620	67.418	67.460	67.503	67.546	67.589	67.632	67.675	67.718	67.760	67.803	67.84
1630	67.846	67.889	67.932	67.974	68.017	68.060	68.103	68.146	68.188	68.231	68.27
1640	68.274	68.317	68.359	68.402	68.445	68.488	68.530	68.573	68.616	68.659	68.70
1650	68.701	68.744	68.787	68.829	68.872	68.915	68.957	69.000	69.043	69.085	69.12
1660	69.128	69.171	69.213	69.256	69.298	69.341	69.384	69.426	69.469	69.511	69.55
1670	69.554	69.597	69.639	69.682	69.724	69.767	69.809	69.852	69.894	69.937	69.97
1680	69.979	70.022	70.064	70.107	70.149	70.192	70.234	70.277	70.319	70.362	70.40
1690	70.404	70.447	70.489	70.531	70.574	70.616	70.659	70.701	70.744	70.786	70.82
1700	70.828	70.871	70.913	70.955	70.998	71.040	71.082	71.125	71.167	71.209	71.25
1710	71.252	71.294	71.336	71.379	71.421	71.463	71.506	71.548	71.590	71.632	71.67
1720	71.675	71.717	71.759	71.801	71.844	71.886	71.928	71.970	72.012	72.055	72.09
1730	72.097	72.139	72.181	72.223	72.266	72.308	72.350	72.392	72.434	72.476	72.51
1740	72.518	72.561	72.603	72.645	72.687	72.729	72.771	72.813	72.855	72.897	72.93
1750	72.939	72.981	73.023	73.066	73.108	73.150	73.192	73.234	73.276	73.318	73.36
1760	73.360	73.402	73.444	73.486	73.528	73.570	73.612	73.654	73.696	73.738	73.78
1770	73.780	73.821	73.863	73.905	73.947	73.989	74.031	74.073	74.115	74.157	74.19
1780	74.199	74.241	74.283	74.324	74.366	74.408	74.450	74.492	74.534	74.576	74.61
1790	74.618	74.659	74.701	74.743	74.785	74.827	74.869	74.910	74.952	74.994	75.03
1800	75.036	75.078	75.120	75.161	75.203	75.245	75.287	75.329	75.370	75.412	75.45
1810	75.454	75.496	75.538	75.579	75.621	75.663	75.705	75.746	75.788	75.830	75.87
1820	75.872	75.913	75.955	75.997	76.039	76.081	76.122	76.164	76.206	76.248	76.28
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type E thermocouple

øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
					Thermoelectric Voltage in mV						
-260	-9.835	-9.833	-9.831	-9.828	-9.825	-9.821	-9.817	-9.813	-9.808	-9.802	-9.79
-250	-9.797	-9.790	-9.784	-9.777	-9.770	-9.762	-9.754	-9.746	-9.737	-9.728	-9.71
-240	-9.718	-9.709	-9.698	-9.688	-9.677	-9.666	-9.654	-9.642	-9.630	-9.617	-9.60
-230	-9.604	-9.591	-9.577	-9.563	-9.548	-9.534	-9.519	-9.503	-9.487	-9.471	-9.45
-220	-9.455	-9.438	-9.421	-9.404	-9.386	-9.368	-9.350	-9.331	-9.313	-9.293	-9.27
-210	-9.274	-9.254	-9.234	-9.214	-9.193	-9.172	-9.151	-9.129	-9.107	-9.085	-9.06
-200	-9.063	-9.040	-9.017	-8.994	-8.971	-8.947	-8.923	-8.899	-8.874	-8.850	-8.82
-190	-8.825	-8.799	-8.774	-8.748	-8.722	-8.696	-8.669	-8.643	-8.616	-8.588	-8.56
-180	-8.561	-8.533	-8.505	-8.477	-8.449	-8.420	-8.391	-8.362	-8.333	-8.303	-8.27
-170	-8.273	-8.243	-8.213	-8.183	-8.152	-8.121	-8.090	-8.059	-8.027	-7.995	-7.96
-160	-7.963	-7.931	-7.899	-7.866	-7.833	-7.800	-7.767	-7.733	-7.700	-7.666	-7.63
-150	-7.632	-7.597	-7.563	-7.528	-7.493	-7.458	-7.423	-7.387	-7.351	-7.315	-7.27
-140	-7.279	-7.243	-7.206	-7.170	-7.133	-7.096	-7.058	-7.021	-6.983	-6.945	-6.90
-130	-6.907	-6.869	-6.831	-6.792	-6.753	-6.714	-6.675	-6.636	-6.596	-6.556	-6.51
-120	-6.516	-6.476	-6.436	-6.396	-6.355	-6.314	-6.273	-6.232	-6.191	-6.149	-6.10
-110	-6.107	-6.065	-6.023	-5.981	-5.939	-5.896	-5.853	-5.810	-5.767	-5.724	-5.68
-100	-5.681	-5.637	-5.593	-5.549	-5.505	-5.461	-5.417	-5.372	-5.327	-5.282	-5.23
-90	-5.237	-5.192	-5.147	-5.101	-5.055	-5.009	-4.963	-4.917	-4.871	-4.824	-4.77
-80	-4.777	-4.731	-4.684	-4.636	-4.589	-4.542	-4.494	-4.446	-4.398	-4.350	-4.30
-70	-4.302	-4.254	-4.205	-4.156	-4.107	-4.058	-4.009	-3.960	-3.911	-3.861	-3.81
-60	-3.811	-3.761	-3.711	-3.661	-3.611	-3.561	-3.510	-3.459	-3.408	-3.357	-3.30
-50	-3.306	-3.255	-3.204	-3.152	-3.100	-3.048	-2.996	-2.944	-2.892	-2.840	-2.78
-40	-2.787	-2.735	-2.682	-2.629	-2.576	-2.523	-2.469	-2.416	-2.362	-2.309	-2.25
-30	-2.255	-2.201	-2.147	-2.093	-2.038	-1.984	-1.929	-1.874	-1.820	-1.765	-1.70
-20	-1.709	-1.654	-1.599	-1.543	-1.488	-1.432	-1.376	-1.320	-1.264	-1.208	-1.15
-10	-1.152	-1.095	-1.039	-0.982	-0.925	-0.868	-0.811	-0.754	-0.697	-0.639	-0.58
0	-0.582	-0.524	-0.466	-0.408	-0.350	-0.292	-0.234	-0.176	-0.117	-0.059	0.00

ITS-90 Table for type E thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
0	0.000	0.059	0.118	0.176	0.235	0.294	0.354	0.413	0.472	0.532	0.59
10	0.591	0.651	0.711	0.770	0.830	0.890	0.950	1.010	1.071	1.131	1.19
20	1.192	1.252	1.313	1.373	1.434	1.495	1.556	1.617	1.678	1.740	1.80
30	1.801	1.862	1.924	1.986	2.047	2.109	2.171	2.233	2.295	2.357	2.42
40	2.420	2.482	2.545	2.607	2.670	2.733	2.795	2.858	2.921	2.984	3.04
50	3.048	3.111	3.174	3.238	3.301	3.365	3.429	3.492	3.556	3.620	3.68
60	3.685	3.749	3.813	3.877	3.942	4.006	4.071	4.136	4.200	4.265	4.33
70	4.330	4.395	4.460	4.526	4.591	4.656	4.722	4.788	4.853	4.919	4.98
80	4.985	5.051	5.117	5.183	5.249	5.315	5.382	5.448	5.514	5.581	5.64
90	5.648	5.714	5.781	5.848	5.915	5.982	6.049	6.117	6.184	6.251	6.31
100	6.319	6.386	6.454	6.522	6.590	6.658	6.725	6.794	6.862	6.930	6.99
110	6.998	7.066	7.135	7.203	7.272	7.341	7.409	7.478	7.547	7.616	7.68
120	7.685	7.754	7.823	7.892	7.962	8.031	8.101	8.170	8.240	8.309	8.37
130	8.379	8.449	8.519	8.589	8.659	8.729	8.799	8.869	8.940	9.010	9.08
140	9.081	9.151	9.222	9.292	9.363	9.434	9.505	9.576	9.647	9.718	9.78
150	9.789	9.860	9.931	10.003	10.074	10.145	10.217	10.288	10.360	10.432	10.50
160	10.503	10.575	10.647	10.719	10.791	10.863	10.935	11.007	11.080	11.152	11.22
170	11.224	11.297	11.369	11.442	11.514	11.587	11.660	11.733	11.805	11.878	11.95
180	11.951	12.024	12.097	12.170	12.243	12.317	12.390	12.463	12.537	12.610	12.68
190	12.684	12.757	12.831	12.904	12.978	13.052	13.126	13.199	13.273	13.347	13.42
200	13.421	13.495	13.569	13.644	13.718	13.792	13.866	13.941	14.015	14.090	14.16
210	14.164	14.239	14.313	14.388	14.463	14.537	14.612	14.687	14.762	14.837	14.91
220	14.912	14.987	15.062	15.137	15.212	15.287	15.362	15.438	15.513	15.588	15.66
230	15.664	15.739	15.815	15.890	15.966	16.041	16.117	16.193	16.269	16.344	16.42
240	16.420	16.496	16.572	16.648	16.724	16.800	16.876	16.952	17.028	17.104	17.18
250	17.181	17.257	17.333	17.409	17.486	17.562	17.639	17.715	17.792	17.868	17.94
260	17.945	18.021	18.098	18.175	18.252	18.328	18.405	18.482	18.559	18.636	18.71
270	18.713	18.790	18.867	18.944	19.021	19.098	19.175	19.252	19.330	19.407	19.48
280	19.484	19.561	19.639	19.716	19.794	19.871	19.948	20.026	20.103	20.181	20.25
290	20.259	20.336	20.414	20.492	20.569	20.647	20.725	20.803	20.880	20.958	21.03
300	21.036	21.114	21.192	21.270	21.348	21.426	21.504	21.582	21.660	21.739	21.81
310	21.817	21.895	21.973	22.051	22.130	22.208	22.286	22.365	22.443	22.522	22.60
320	22.600	22.678	22.757	22.835	22.914	22.993	23.071	23.150	23.228	23.307	23.38
330	23.386	23.464	23.543	23.622	23.701	23.780	23.858	23.937	24.016	24.095	24.17
340	24.174	24.253	24.332	24.411	24.490	24.569	24.648	24.727	24.806	24.885	24.96
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type E thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
350	24.964	25.044	25.123	25.202	25.281	25.360	25.440	25.519	25.598	25.678	25.75
360	25.757	25.836	25.916	25.995	26.075	26.154	26.233	26.313	26.392	26.472	26.55
370	26.552	26.631	26.711	26.790	26.870	26.950	27.029	27.109	27.189	27.268	27.34
380	27.348	27.428	27.507	27.587	27.667	27.747	27.827	27.907	27.986	28.066	28.14
390	28.146	28.226	28.306	28.386	28.466	28.546	28.626	28.706	28.786	28.866	28.94
400	28.946	29.026	29.106	29.186	29.266	29.346	29.427	29.507	29.587	29.667	29.74
410	29.747	29.827	29.908	29.988	30.068	30.148	30.229	30.309	30.389	30.470	30.55
420	30.550	30.630	30.711	30.791	30.871	30.952	31.032	31.112	31.193	31.273	31.35
430	31.354	31.434	31.515	31.595	31.676	31.756	31.837	31.917	31.998	32.078	32.15
440	32.159	32.239	32.320	32.400	32.481	32.562	32.642	32.723	32.803	32.884	32.96
450	32.965	33.045	33.126	33.207	33.287	33.368	33.449	33.529	33.610	33.691	33.77
460	33.772	33.852	33.933	34.014	34.095	34.175	34.256	34.337	34.418	34.498	34.57
470	34.579	34.660	34.741	34.822	34.902	34.983	35.064	35.145	35.226	35.307	35.38
480	35.387	35.468	35.549	35.630	35.711	35.792	35.873	35.954	36.034	36.115	36.19
490	36.196	36.277	36.358	36.439	36.520	36.601	36.682	36.763	36.843	36.924	37.00
500	37.005	37.086	37.167	37.248	37.329	37.410	37.491	37.572	37.653	37.734	37.81
510	37.815	37.896	37.977	38.058	38.139	38.220	38.300	38.381	38.462	38.543	38.62
520	38.624	38.705	38.786	38.867	38.948	39.029	39.110	39.191	39.272	39.353	39.43
530	39.434	39.515	39.596	39.677	39.758	39.839	39.920	40.001	40.082	40.163	40.24
540	40.243	40.324	40.405	40.486	40.567	40.648	40.729	40.810	40.891	40.972	41.05
550	41.053	41.134	41.215	41.296	41.377	41.457	41.538	41.619	41.700	41.781	41.86
560	41.862	41.943	42.024	42.105	42.185	42.266	42.347	42.428	42.509	42.590	42.67
570	42.671	42.751	42.832	42.913	42.994	43.075	43.156	43.236	43.317	43.398	43.47
580	43.479	43.560	43.640	43.721	43.802	43.883	43.963	44.044	44.125	44.206	44.28
590	44.286	44.367	44.448	44.529	44.609	44.690	44.771	44.851	44.932	45.013	45.09
600	45.093	45.174	45.255	45.335	45.416	45.497	45.577	45.658	45.738	45.819	45.90
610	45.900	45.980	46.061	46.141	46.222	46.302	46.383	46.463	46.544	46.624	46.70
620	46.705	46.785	46.866	46.946	47.027	47.107	47.188	47.268	47.349	47.429	47.50
630	47.509	47.590	47.670	47.751	47.831	47.911	47.992	48.072	48.152	48.233	48.31
640	48.313	48.393	48.474	48.554	48.634	48.715	48.795	48.875	48.955	49.035	49.11
650	49.116	49.196	49.276	49.356	49.436	49.517	49.597	49.677	49.757	49.837	49.91
660	49.917	49.997	50.077	50.157	50.238	50.318	50.398	50.478	50.558	50.638	50.71
670	50.718	50.798	50.878	50.958	51.038	51.118	51.197	51.277	51.357	51.437	51.51
680	51.517	51.597	51.677	51.757	51.837	51.916	51.996	52.076	52.156	52.236	52.31
690	52.315	52.395	52.475	52.555	52.634	52.714	52.794	52.873	52.953	53.033	53.11
700	53.112	53.192	53.272	53.351	53.431	53.510	53.590	53.670	53.749	53.829	53.90
710	53.908	53.988	54.067	54.147	54.226	54.306	54.385	54.465	54.544	54.624	54.70
720	54.703	54.782	54.862	54.941	55.021	55.100	55.179	55.259	55.338	55.417	55.49
730	55.497	55.576	55.655	55.734	55.814	55.893	55.972	56.051	56.131	56.210	56.28
740	56.289	56.368	56.447	56.526	56.606	56.685	56.764	56.843	56.922	57.001	57.08
750	57.080	57.159	57.238	57.317	57.396	57.475	57.554	57.633	57.712	57.791	57.87
760	57.870	57.949	58.028	58.107	58.186	58.265	58.343	58.422	58.501	58.580	58.65
770	58.659	58.738	58.816	58.895	58.974	59.053	59.131	59.210	59.289	59.367	59.44
780	59.446	59.525	59.604	59.682	59.761	59.839	59.918	59.997	60.075	60.154	60.23
790	60.232	60.311	60.390	60.468	60.547	60.625	60.704	60.782	60.860	60.939	61.01
800	61.017	61.096	61.174	61.253	61.331	61.409	61.488	61.566	61.644	61.723	61.80
810	61.801	61.879	61.958	62.036	62.114	62.192	62.271	62.349	62.427	62.505	62.58
820	62.583	62.662	62.740	62.818	62.896	62.974	63.052	63.130	63.208	63.286	63.36
830	63.364	63.442	63.520	63.598	63.676	63.754	63.832	63.910	63.988	64.066	64.14
840	64.144	64.222	64.300	64.377	64.455	64.533	64.611	64.689	64.766	64.844	64.92
850	64.922	65.000	65.077	65.155	65.233	65.310	65.388	65.465	65.543	65.621	65.69
860	65.698	65.776	65.853	65.931	66.008	66.086	66.163	66.241	66.318	66.396	66.47
870	66.473	66.550	66.628	66.705	66.782	66.860	66.937	67.014	67.092	67.169	67.24
880	67.246	67.323	67.400	67.478	67.555	67.632	67.709	67.786	67.863	67.940	68.01
890	68.017	68.094	68.171	68.248	68.325	68.402	68.479	68.556	68.633	68.710	68.78
900	68.787	68.863	68.940	69.017	69.094	69.171	69.247	69.324	69.401	69.477	69.55
910	69.554	69.631	69.707	69.784	69.860	69.937	70.013	70.090	70.166	70.243	70.31
920	70.319	70.396	70.472	70.548	70.625	70.701	70.777	70.854	70.930	71.006	71.08
930	71.082	71.159	71.235	71.311	71.387	71.463	71.539	71.615	71.692	71.768	71.84
940	71.844	71.920	71.996	72.072	72.147	72.223	72.299	72.375	72.451	72.527	72.60
950	72.603	72.678	72.754	72.830	72.906	72.981	73.057	73.133	73.208	73.284	73.36
960	73.360	73.435	73.511	73.586	73.662	73.738	73.813	73.889	73.964	74.040	74.11
970	74.115	74.190	74.266	74.341	74.417	74.492	74.567	74.643	74.718	74.793	74.86
980	74.869	74.944	75.019	75.095	75.170	75.245	75.320	75.395	75.471	75.546	75.62
990	75.621	75.696	75.771	75.847	75.922	75.997	76.072	76.147	76.223	76.298	76.37
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type J thermocouple

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
					Thermoelectric Voltage in mV						
-340					-8.095	-8.085	-8.074	-8.063	-8.052	-8.041	-8.03
-330	-8.030	-8.019	-8.008	-7.996	-7.985	-7.973	-7.962	-7.950	-7.938	-7.927	-7.91
-320	-7.915	-7.903	-7.890	-7.878	-7.866	-7.854	-7.841	-7.829	-7.816	-7.804	-7.79
-310	-7.791	-7.778	-7.765	-7.752	-7.739	-7.726	-7.713	-7.699	-7.686	-7.672	-7.65
-300	-7.659	-7.645	-7.632	-7.618	-7.604	-7.590	-7.576	-7.562	-7.548	-7.534	-7.51
-290	-7.519	-7.505	-7.491	-7.476	-7.462	-7.447	-7.432	-7.417	-7.403	-7.388	-7.37
-280	-7.373	-7.357	-7.342	-7.327	-7.312	-7.296	-7.281	-7.265	-7.250	-7.234	-7.21
-270	-7.219	-7.203	-7.187	-7.171	-7.155	-7.139	-7.123	-7.107	-7.090	-7.074	-7.05
-260	-7.058	-7.041	-7.025	-7.008	-6.991	-6.975	-6.958	-6.941	-6.924	-6.907	-6.89
-250	-6.890	-6.873	-6.856	-6.839	-6.821	-6.804	-6.787	-6.769	-6.752	-6.734	-6.71
-240	-6.716	-6.699	-6.681	-6.663	-6.645	-6.627	-6.609	-6.591	-6.573	-6.555	-6.53
-230	-6.536	-6.518	-6.500	-6.481	-6.463	-6.444	-6.426	-6.407	-6.388	-6.370	-6.35
-220	-6.351	-6.332	-6.313	-6.294	-6.275	-6.256	-6.236	-6.217	-6.198	-6.179	-6.15
-210	-6.159	-6.140	-6.120	-6.101	-6.081	-6.061	-6.042	-6.022	-6.002	-5.982	-5.96
-200	-5.962	-5.942	-5.922	-5.902	-5.882	-5.862	-5.842	-5.821	-5.801	-5.781	-5.76
-190	-5.760	-5.740	-5.719	-5.699	-5.678	-5.657	-5.637	-5.616	-5.595	-5.574	-5.55
-180	-5.553	-5.532	-5.511	-5.490	-5.469	-5.448	-5.426	-5.405	-5.384	-5.363	-5.34
-170	-5.341	-5.320	-5.298	-5.277	-5.255	-5.233	-5.212	-5.190	-5.168	-5.146	-5.12
-160	-5.125	-5.103	-5.081	-5.059	-5.037	-5.015	-4.992	-4.970	-4.948	-4.926	-4.90
-150	-4.903	-4.881	-4.859	-4.836	-4.814	-4.791	-4.769	-4.746	-4.724	-4.701	-4.67
-140	-4.678	-4.655	-4.633	-4.610	-4.587	-4.564	-4.541	-4.518	-4.495	-4.472	-4.44
-130	-4.449	-4.425	-4.402	-4.379	-4.356	-4.332	-4.309	-4.286	-4.262	-4.239	-4.21
-120	-4.215	-4.192	-4.168	-4.144	-4.121	-4.097	-4.073	-4.050	-4.026	-4.002	-3.97
-110	-3.978	-3.954	-3.930	-3.906	-3.882	-3.858	-3.834	-3.810	-3.786	-3.761	-3.73
-100	-3.737	-3.713	-3.688	-3.664	-3.640	-3.615	-3.591	-3.566	-3.542	-3.517	-3.49
-90	-3.493	-3.468	-3.443	-3.419	-3.394	-3.369	-3.344	-3.320	-3.295	-3.270	-3.24
-80	-3.245	-3.220	-3.195	-3.170	-3.145	-3.120	-3.095	-3.070	-3.044	-3.019	-2.99
-70	-2.994	-2.969	-2.943	-2.918	-2.893	-2.867	-2.842	-2.817	-2.791	-2.766	-2.74
-60	-2.740	-2.714	-2.689	-2.663	-2.638	-2.612	-2.586	-2.560	-2.535	-2.509	-2.48
-50	-2.483	-2.457	-2.431	-2.405	-2.379	-2.353	-2.327	-2.301	-2.275	-2.249	-2.22
-40	-2.223	-2.197	-2.171	-2.145	-2.118	-2.092	-2.066	-2.040	-2.013	-1.987	-1.96
-30	-1.961	-1.934	-1.908	-1.881	-1.855	-1.828	-1.802	-1.775	-1.749	-1.722	-1.69
-20	-1.695	-1.669	-1.642	-1.615	-1.589	-1.562	-1.535	-1.508	-1.482	-1.455	-1.42
-10	-1.428	-1.401	-1.374	-1.347	-1.320	-1.293	-1.266	-1.239	-1.212	-1.185	-1.15
0	-1.158	-1.131	-1.104	-1.076	-1.049	-1.022	-0.995	-0.967	-0.940	-0.913	-0.88

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

ITS-90 Table for type J thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
0	-0.886	-0.858	-0.831	-0.803	-0.776	-0.749	-0.721	-0.694	-0.666	-0.639	-0.61
10	-0.611	-0.583	-0.556	-0.528	-0.501	-0.473	-0.445	-0.418	-0.390	-0.362	-0.33
20	-0.334	-0.307	-0.279	-0.251	-0.223	-0.195	-0.168	-0.140	-0.112	-0.084	-0.05
30	-0.056	-0.028	0.000	0.028	0.056	0.084	0.112	0.140	0.168	0.196	0.22
40	0.225	0.253	0.281	0.309	0.337	0.365	0.394	0.422	0.450	0.478	0.50
50	0.507	0.535	0.563	0.592	0.620	0.649	0.677	0.705	0.734	0.762	0.79
60	0.791	0.819	0.848	0.876	0.905	0.933	0.962	0.991	1.019	1.048	1.07
70	1.076	1.105	1.134	1.162	1.191	1.220	1.249	1.277	1.306	1.335	1.36
80	1.364	1.392	1.421	1.450	1.479	1.508	1.537	1.566	1.594	1.623	1.65
90	1.652	1.681	1.710	1.739	1.768	1.797	1.826	1.855	1.884	1.913	1.94
100	1.942	1.972	2.001	2.030	2.059	2.088	2.117	2.146	2.175	2.205	2.23
110	2.234	2.263	2.292	2.322	2.351	2.380	2.409	2.439	2.468	2.497	2.52
120	2.527	2.556	2.585	2.615	2.644	2.673	2.703	2.732	2.762	2.791	2.82
130	2.821	2.850	2.880	2.909	2.938	2.968	2.997	3.027	3.057	3.086	3.11
140	3.116	3.145	3.175	3.204	3.234	3.264	3.293	3.323	3.353	3.382	3.41
150	3.412	3.442	3.471	3.501	3.531	3.560	3.590	3.620	3.650	3.679	3.70
160	3.709	3.739	3.769	3.798	3.828	3.858	3.888	3.918	3.948	3.977	4.00
170	4.007	4.037	4.067	4.097	4.127	4.157	4.187	4.217	4.246	4.276	4.30
180	4.306	4.336	4.366	4.396	4.426	4.456	4.486	4.516	4.546	4.576	4.60
190	4.606	4.636	4.666	4.696	4.726	4.757	4.787	4.817	4.847	4.877	4.90
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type J thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
200	4.907	4.937	4.967	4.997	5.028	5.058	5.088	5.118	5.148	5.178	5.20
210	5.209	5.239	5.269	5.299	5.329	5.360	5.390	5.420	5.450	5.480	5.51
220	5.511	5.541	5.571	5.602	5.632	5.662	5.692	5.723	5.753	5.783	5.81
230	5.814	5.844	5.874	5.905	5.935	5.965	5.996	6.026	6.056	6.087	6.11
240	6.117	6.147	6.178	6.208	6.239	6.269	6.299	6.330	6.360	6.391	6.42
250	6.421	6.452	6.482	6.512	6.543	6.573	6.604	6.634	6.665	6.695	6.72
260	6.726	6.756	6.787	6.817	6.848	6.878	6.909	6.939	6.970	7.000	7.03
270	7.031	7.061	7.092	7.122	7.153	7.184	7.214	7.245	7.275	7.306	7.33
280	7.336	7.367	7.398	7.428	7.459	7.489	7.520	7.550	7.581	7.612	7.64
290	7.642	7.673	7.704	7.734	7.765	7.795	7.826	7.857	7.887	7.918	7.94
300	7.949	7.979	8.010	8.041	8.071	8.102	8.133	8.163	8.194	8.225	8.25
310	8.255	8.286	8.317	8.347	8.378	8.409	8.439	8.470	8.501	8.532	8.56
320	8.562	8.593	8.624	8.654	8.685	8.716	8.747	8.777	8.808	8.839	8.86
330	8.869	8.900	8.931	8.962	8.992	9.023	9.054	9.085	9.115	9.146	9.17
340	9.177	9.208	9.238	9.269	9.300	9.331	9.362	9.392	9.423	9.454	9.48
350	9.485	9.515	9.546	9.577	9.608	9.639	9.669	9.700	9.731	9.762	9.79
360	9.793	9.823	9.854	9.885	9.916	9.947	9.977	10.008	10.039	10.070	10.10
370	10.101	10.131	10.162	10.193	10.224	10.255	10.285	10.316	10.347	10.378	10.40
380	10.409	10.440	10.470	10.501	10.532	10.563	10.594	10.625	10.655	10.686	10.71
390	10.717	10.748	10.779	10.810	10.840	10.871	10.902	10.933	10.964	10.995	11.02
400	11.025	11.056	11.087	11.118	11.149	11.180	11.211	11.241	11.272	11.303	11.33
410	11.334	11.365	11.396	11.426	11.457	11.488	11.519	11.550	11.581	11.612	11.64
420	11.642	11.673	11.704	11.735	11.766	11.797	11.828	11.858	11.889	11.920	11.95
430	11.951	11.982	12.013	12.044	12.074	12.105	12.136	12.167	12.198	12.229	12.26
440	12.260	12.290	12.321	12.352	12.383	12.414	12.445	12.476	12.506	12.537	12.56
450	12.568	12.599	12.630	12.661	12.691	12.722	12.753	12.784	12.815	12.846	12.87
460	12.877	12.907	12.938	12.969	13.000	13.031	13.062	13.093	13.123	13.154	13.18
470	13.185	13.216	13.247	13.278	13.308	13.339	13.370	13.401	13.432	13.463	13.49
480	13.494	13.524	13.555	13.586	13.617	13.648	13.679	13.709	13.740	13.771	13.80
490	13.802	13.833	13.864	13.894	13.925	13.956	13.987	14.018	14.049	14.079	14.11
500	14.110	14.141	14.172	14.203	14.233	14.264	14.295	14.326	14.357	14.388	14.41
510	14.418	14.449	14.480	14.511	14.542	14.573	14.603	14.634	14.665	14.696	14.72
520	14.727	14.757	14.788	14.819	14.850	14.881	14.911	14.942	14.973	15.004	15.03
530	15.035	15.065	15.096	15.127	15.158	15.189	15.219	15.250	15.281	15.312	15.34
540	15.343	15.373	15.404	15.435	15.466	15.496	15.527	15.558	15.589	15.620	15.65
550	15.650	15.681	15.712	15.743	15.773	15.804	15.835	15.866	15.897	15.927	15.95
560	15.958	15.989	16.020	16.050	16.081	16.112	16.143	16.173	16.204	16.235	16.26
570	16.266	16.296	16.327	16.358	16.389	16.419	16.450	16.481	16.512	16.542	16.57
580	16.573	16.604	16.635	16.665	16.696	16.727	16.758	16.788	16.819	16.850	16.88
590	16.881	16.911	16.942	16.973	17.003	17.034	17.065	17.096	17.126	17.157	17.18
600	17.188	17.219	17.249	17.280	17.311	17.341	17.372	17.403	17.434	17.464	17.49
610	17.495	17.526	17.556	17.587	17.618	17.649	17.679	17.710	17.741	17.771	17.80
620	17.802	17.833	17.863	17.894	17.925	17.955	17.986	18.017	18.048	18.078	18.10
630	18.109	18.140	18.170	18.201	18.232	18.262	18.293	18.324	18.354	18.385	18.41
640	18.416	18.446	18.477	18.508	18.538	18.569	18.600	18.630	18.661	18.692	18.72
650	18.722	18.753	18.784	18.814	18.845	18.876	18.906	18.937	18.968	18.998	19.02
660	19.029	19.060	19.090	19.121	19.152	19.182	19.213	19.244	19.274	19.305	19.33
670	19.336	19.366	19.397	19.428	19.458	19.489	19.520	19.550	19.581	19.612	19.64
680	19.642	19.673	19.704	19.734	19.765	19.795	19.826	19.857	19.887	19.918	19.94
690	19.949	19.979	20.010	20.041	20.071	20.102	20.132	20.163	20.194	20.224	20.25
700	20.255	20.286	20.316	20.347	20.378	20.408	20.439	20.469	20.500	20.531	20.56
710	20.561	20.592	20.623	20.653	20.684	20.715	20.745	20.776	20.806	20.837	20.86
720	20.868	20.898	20.929	20.960	20.990	21.021	21.052	21.082	21.113	21.143	21.17
730	21.174	21.205	21.235	21.266	21.297	21.327	21.358	21.389	21.419	21.450	21.48
740	21.480	21.511	21.542	21.572	21.603	21.634	21.664	21.695	21.726	21.756	21.78
750	21.787	21.817	21.848	21.879	21.909	21.940	21.971	22.001	22.032	22.063	22.09
760	22.093	22.124	22.154	22.185	22.216	22.246	22.277	22.308	22.338	22.369	22.40
770	22.400	22.430	22.461	22.492	22.522	22.553	22.584	22.614	22.645	22.676	22.70
780	22.706	22.737	22.768	22.798	22.829	22.860	22.890	22.921	22.952	22.982	23.01
790	23.013	23.044	23.074	23.105	23.136	23.166	23.197	23.228	23.258	23.289	23.32

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type J thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
800	23.320	23.350	23.381	23.412	23.442	23.473	23.504	23.535	23.565	23.596	23.62
810	23.627	23.657	23.688	23.719	23.749	23.780	23.811	23.842	23.872	23.903	23.93
820	23.934	23.964	23.995	24.026	24.057	24.087	24.118	24.149	24.180	24.210	24.24
830	24.241	24.272	24.303	24.333	24.364	24.395	24.426	24.456	24.487	24.518	24.54
840	24.549	24.579	24.610	24.641	24.672	24.702	24.733	24.764	24.795	24.826	24.85
850	24.856	24.887	24.918	24.949	24.979	25.010	25.041	25.072	25.103	25.134	25.16
860	25.164	25.195	25.226	25.257	25.288	25.318	25.349	25.380	25.411	25.442	25.47
870	25.473	25.504	25.534	25.565	25.596	25.627	25.658	25.689	25.720	25.750	25.78
880	25.781	25.812	25.843	25.874	25.905	25.936	25.967	25.998	26.028	26.059	26.09
890	26.090	26.121	26.152	26.183	26.214	26.245	26.276	26.307	26.338	26.369	26.40
900	26.400	26.431	26.462	26.493	26.524	26.555	26.586	26.617	26.648	26.679	26.71
910	26.710	26.741	26.772	26.803	26.834	26.865	26.896	26.927	26.958	26.989	27.02
920	27.020	27.051	27.082	27.113	27.144	27.175	27.206	27.237	27.268	27.299	27.33
930	27.330	27.362	27.393	27.424	27.455	27.486	27.517	27.548	27.579	27.610	27.64
940	27.642	27.673	27.704	27.735	27.766	27.797	27.829	27.860	27.891	27.922	27.95
950	27.953	27.985	28.016	28.047	28.078	28.109	28.141	28.172	28.203	28.234	28.26
960	28.266	28.297	28.328	28.359	28.391	28.422	28.453	28.485	28.516	28.547	28.57
970	28.579	28.610	28.641	28.672	28.704	28.735	28.767	28.798	28.829	28.861	28.89
980	28.892	28.923	28.955	28.986	29.018	29.049	29.080	29.112	29.143	29.175	29.20
990	29.206	29.238	29.269	29.301	29.332	29.363	29.395	29.426	29.458	29.489	29.52
1000	29.521	29.552	29.584	29.616	29.647	29.679	29.710	29.742	29.773	29.805	29.83
1010	29.836	29.868	29.900	29.931	29.963	29.995	30.026	30.058	30.089	30.121	30.15
1020	30.153	30.184	30.216	30.248	30.279	30.311	30.343	30.375	30.406	30.438	30.47
1030	30.470	30.502	30.533	30.565	30.597	30.629	30.660	30.692	30.724	30.756	30.78
1040	30.788	30.819	30.851	30.883	30.915	30.947	30.979	31.011	31.043	31.074	31.10
1050	31.106	31.138	31.170	31.202	31.234	31.266	31.298	31.330	31.362	31.394	31.42
1060	31.426	31.458	31.490	31.522	31.554	31.586	31.618	31.650	31.682	31.714	31.74
1070	31.746	31.778	31.811	31.843	31.875	31.907	31.939	31.971	32.003	32.035	32.06
1080	32.068	32.100	32.132	32.164	32.196	32.229	32.261	32.293	32.325	32.358	32.39
1090	32.390	32.422	32.455	32.487	32.519	32.551	32.584	32.616	32.648	32.681	32.71
1100	32.713	32.746	32.778	32.810	32.843	32.875	32.908	32.940	32.973	33.005	33.03
1110	33.037	33.070	33.102	33.135	33.167	33.200	33.232	33.265	33.298	33.330	33.36
1120	33.363	33.395	33.428	33.460	33.493	33.526	33.558	33.591	33.624	33.656	33.68
1130	33.689	33.722	33.754	33.787	33.820	33.853	33.885	33.918	33.951	33.984	34.01
1140	34.016	34.049	34.082	34.115	34.148	34.180	34.213	34.246	34.279	34.312	34.34
1150	34.345	34.378	34.411	34.444	34.476	34.509	34.542	34.575	34.608	34.641	34.67
1160	34.674	34.707	34.740	34.773	34.806	34.840	34.873	34.906	34.939	34.972	35.00
1170	35.005	35.038	35.071	35.104	35.138	35.171	35.204	35.237	35.270	35.304	35.33
1180	35.337	35.370	35.403	35.437	35.470	35.503	35.536	35.570	35.603	35.636	35.67
1190	35.670	35.703	35.736	35.770	35.803	35.837	35.870	35.903	35.937	35.970	36.00
1200	36.004	36.037	36.071	36.104	36.138	36.171	36.205	36.238	36.272	36.305	36.33
1210	36.339	36.373	36.406	36.440	36.473	36.507	36.541	36.574	36.608	36.642	36.67
1220	36.675	36.709	36.743	36.777	36.810	36.844	36.878	36.912	36.945	36.979	37.01
1230	37.013	37.047	37.081	37.114	37.148	37.182	37.216	37.250	37.284	37.318	37.35
1240	37.352	37.386	37.420	37.454	37.488	37.522	37.556	37.590	37.624	37.658	37.69
1250	37.692	37.726	37.760	37.794	37.828	37.862	37.896	37.930	37.964	37.999	38.03
1260	38.033	38.067	38.101	38.135	38.169	38.204	38.238	38.272	38.306	38.341	38.37
1270	38.375	38.409	38.444	38.478	38.512	38.546	38.581	38.615	38.650	38.684	38.71
1280	38.718	38.753	38.787	38.822	38.856	38.890	38.925	38.959	38.994	39.028	39.06
1290	39.063	39.097	39.132	39.166	39.201	39.235	39.270	39.305	39.339	39.374	39.40
1300	39.408	39.443	39.478	39.512	39.547	39.582	39.616	39.651	39.686	39.720	39.75
1310	39.755	39.790	39.825	39.859	39.894	39.929	39.964	39.998	40.033	40.068	40.10
1320	40.103	40.138	40.173	40.207	40.242	40.277	40.312	40.347	40.382	40.417	40.45
1330	40.452	40.487	40.522	40.556	40.591	40.626	40.661	40.696	40.731	40.766	40.80
1340	40.801	40.836	40.872	40.907	40.942	40.977	41.012	41.047	41.082	41.117	41.15
1350	41.152	41.187	41.222	41.258	41.293	41.328	41.363	41.398	41.433	41.469	41.50
1360	41.504	41.539	41.574	41.610	41.645	41.680	41.715	41.751	41.786	41.821	41.85
1370	41.856	41.892	41.927	41.962	41.998	42.033	42.068	42.104	42.139	42.174	42.21
1380	42.210	42.245	42.281	42.316	42.351	42.387	42.422	42.458	42.493	42.528	42.56
1390	42.564	42.599	42.635	42.670	42.706	42.741	42.777	42.812	42.848	42.883	42.91

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type J thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
1400	42.919	42.954	42.990	43.025	43.061	43.096	43.132	43.167	43.203	43.239	43.27
1410	43.274	43.310	43.346	43.381	43.417	43.452	43.488	43.524	43.559	43.595	43.63
1420	43.631	43.667	43.702	43.738	43.774	43.809	43.845	43.881	43.917	43.953	43.98
1430	43.988	44.024	44.060	44.096	44.131	44.167	44.203	44.239	44.275	44.310	44.34
1440	44.346	44.382	44.418	44.454	44.490	44.525	44.561	44.597	44.633	44.669	44.70
1450	44.705	44.741	44.777	44.812	44.848	44.884	44.920	44.956	44.992	45.028	45.06
1460	45.064	45.099	45.135	45.171	45.207	45.243	45.279	45.315	45.351	45.387	45.42
1470	45.423	45.458	45.494	45.530	45.566	45.602	45.638	45.674	45.710	45.746	45.78
1480	45.782	45.818	45.853	45.889	45.925	45.961	45.997	46.033	46.069	46.105	46.14
1490	46.141	46.177	46.212	46.248	46.284	46.320	46.356	46.392	46.428	46.464	46.50
1500	46.500	46.535	46.571	46.607	46.643	46.679	46.715	46.751	46.786	46.822	46.85
1510	46.858	46.894	46.930	46.966	47.001	47.037	47.073	47.109	47.145	47.181	47.21
1520	47.216	47.252	47.288	47.324	47.359	47.395	47.431	47.467	47.503	47.538	47.57
1530	47.574	47.610	47.646	47.681	47.717	47.753	47.788	47.824	47.860	47.896	47.93
1540	47.931	47.967	48.003	48.038	48.074	48.110	48.145	48.181	48.217	48.252	48.28
1550	48.288	48.324	48.359	48.395	48.430	48.466	48.502	48.537	48.573	48.608	48.64
1560	48.644	48.679	48.715	48.750	48.786	48.822	48.857	48.893	48.928	48.964	48.99
1570	48.999	49.034	49.070	49.105	49.141	49.176	49.212	49.247	49.283	49.318	49.35
1580	49.353	49.389	49.424	49.460	49.495	49.530	49.566	49.601	49.636	49.672	49.70
1590	49.707	49.742	49.778	49.813	49.848	49.883	49.919	49.954	49.989	50.024	50.06
1600	50.060	50.095	50.130	50.165	50.200	50.235	50.271	50.306	50.341	50.376	50.41
1610	50.411	50.446	50.481	50.517	50.552	50.587	50.622	50.657	50.692	50.727	50.76
1620	50.762	50.797	50.832	50.867	50.902	50.937	50.972	51.007	51.042	51.077	51.11
1630	51.112	51.147	51.181	51.216	51.251	51.286	51.321	51.356	51.391	51.425	51.46
1640	51.460	51.495	51.530	51.565	51.599	51.634	51.669	51.704	51.738	51.773	51.80
1650	51.808	51.843	51.877	51.912	51.947	51.981	52.016	52.051	52.085	52.120	52.15
1660	52.154	52.189	52.224	52.258	52.293	52.327	52.362	52.396	52.431	52.465	52.50
1670	52.500	52.534	52.569	52.603	52.638	52.672	52.707	52.741	52.776	52.810	52.84
1680	52.844	52.879	52.913	52.947	52.982	53.016	53.050	53.085	53.119	53.153	53.18
1690	53.188	53.222	53.256	53.290	53.325	53.359	53.393	53.427	53.462	53.496	53.53
1700	53.530	53.564	53.598	53.632	53.667	53.701	53.735	53.769	53.803	53.837	53.87
1710	53.871	53.905	53.939	53.973	54.007	54.041	54.075	54.109	54.143	54.177	54.21
1720	54.211	54.245	54.279	54.313	54.347	54.381	54.415	54.449	54.483	54.516	54.55
1730	54.550	54.584	54.618	54.652	54.686	54.719	54.753	54.787	54.821	54.855	54.88
1740	54.888	54.922	54.956	54.990	55.023	55.057	55.091	55.124	55.158	55.192	55.22
1750	55.225	55.259	55.293	55.326	55.360	55.393	55.427	55.461	55.494	55.528	55.56
1760	55.561	55.595	55.628	55.662	55.695	55.729	55.762	55.796	55.829	55.863	55.89
1770	55.896	55.930	55.963	55.997	56.030	56.063	56.097	56.130	56.164	56.197	56.23
1780	56.230	56.264	56.297	56.330	56.364	56.397	56.430	56.464	56.497	56.530	56.56
1790	56.564	56.597	56.630	56.663	56.697	56.730	56.763	56.796	56.829	56.863	56.89
1800	56.896	56.929	56.962	56.995	57.028	57.062	57.095	57.128	57.161	57.194	57.22
1810	57.227	57.260	57.293	57.326	57.360	57.393	57.426	57.459	57.492	57.525	57.55
1820	57.558	57.591	57.624	57.657	57.690	57.723	57.756	57.789	57.822	57.855	57.88
1830	57.888	57.920	57.953	57.986	58.019	58.052	58.085	58.118	58.151	58.184	58.21
1840	58.217	58.249	58.282	58.315	58.348	58.381	58.414	58.446	58.479	58.512	58.54
1850	58.545	58.578	58.610	58.643	58.676	58.709	58.741	58.774	58.807	58.840	58.87
1860	58.872	58.905	58.938	58.971	59.003	59.036	59.069	59.101	59.134	59.167	59.19
1870	59.199	59.232	59.265	59.297	59.330	59.363	59.395	59.428	59.460	59.493	59.52
1880	59.526	59.558	59.591	59.623	59.656	59.689	59.721	59.754	59.786	59.819	59.85
1890	59.851	59.884	59.916	59.949	59.982	60.014	60.047	60.079	60.112	60.144	60.17
1900	60.177	60.209	60.242	60.274	60.307	60.339	60.371	60.404	60.436	60.469	60.50
1910	60.501	60.534	60.566	60.599	60.631	60.663	60.696	60.728	60.761	60.793	60.82
1920	60.826	60.858	60.890	60.923	60.955	60.987	61.020	61.052	61.085	61.117	61.14
1930	61.149	61.182	61.214	61.246	61.279	61.311	61.343	61.376	61.408	61.440	61.47
1940	61.473	61.505	61.537	61.570	61.602	61.634	61.667	61.699	61.731	61.763	61.79
1950	61.796	61.828	61.860	61.893	61.925	61.957	61.989	62.022	62.054	62.086	62.11
1960	62.118	62.151	62.183	62.215	62.247	62.280	62.312	62.344	62.376	62.409	62.44
1970	62.441	62.473	62.505	62.537	62.570	62.602	62.634	62.666	62.699	62.731	62.76
1980	62.763	62.795	62.827	62.860	62.892	62.924	62.956	62.988	63.020	63.053	63.08
1990	63.085	63.117	63.149	63.181	63.214	63.246	63.278	63.310	63.342	63.374	63.40

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type J thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
2000	63.406	63.439	63.471	63.503	63.535	63.567	63.599	63.632	63.664	63.696	63.72
2010	63.728	63.760	63.792	63.824	63.856	63.889	63.921	63.953	63.985	64.017	64.04
2020	64.049	64.081	64.113	64.146	64.178	64.210	64.242	64.274	64.306	64.338	64.37
2030	64.370	64.402	64.435	64.467	64.499	64.531	64.563	64.595	64.627	64.659	64.69
2040	64.691	64.723	64.756	64.788	64.820	64.852	64.884	64.916	64.948	64.980	65.01
2050	65.012	65.044	65.076	65.109	65.141	65.173	65.205	65.237	65.269	65.301	65.33
2060	65.333	65.365	65.397	65.429	65.461	65.493	65.525	65.557	65.590	65.622	65.65
2070	65.654	65.686	65.718	65.750	65.782	65.814	65.846	65.878	65.910	65.942	65.97
2080	65.974	66.006	66.038	66.070	66.102	66.134	66.166	66.199	66.231	66.263	66.29
2090	66.295	66.327	66.359	66.391	66.423	66.455	66.487	66.519	66.551	66.583	66.61
2100	66.615	66.647	66.679	66.711	66.743	66.775	66.807	66.839	66.871	66.903	66.93
2110	66.935	66.967	66.999	67.031	67.063	67.095	67.127	67.159	67.191	67.223	67.25
2120	67.255	67.287	67.319	67.351	67.383	67.415	67.447	67.479	67.511	67.543	67.57
2130	67.575	67.607	67.639	67.671	67.703	67.735	67.767	67.799	67.831	67.863	67.89
2140	67.895	67.927	67.959	67.991	68.023	68.055	68.087	68.119	68.150	68.182	68.21
2150	68.214	68.246	68.278	68.310	68.342	68.374	68.406	68.438	68.470	68.502	68.53
2160	68.534	68.566	68.597	68.629	68.661	68.693	68.725	68.757	68.789	68.821	68.85
2170	68.853	68.884	68.916	68.948	68.980	69.012	69.044	69.076	69.108	69.139	69.17
2180	69.171	69.203	69.235	69.267	69.299	69.330	69.362	69.394	69.426	69.458	69.49
2190	69.490	69.521	69.553								

| øF | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

ITS-90 Table for type J thermocouple

øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
Thermoelectric Voltage in mV											
-200	-8.095	-8.076	-8.057	-8.037	-8.017	-7.996	-7.976	-7.955	-7.934	-7.912	-7.89
-190	-7.890	-7.868	-7.846	-7.824	-7.801	-7.778	-7.755	-7.731	-7.707	-7.683	-7.65
-180	-7.659	-7.634	-7.610	-7.585	-7.559	-7.534	-7.508	-7.482	-7.456	-7.429	-7.40
-170	-7.403	-7.376	-7.348	-7.321	-7.293	-7.265	-7.237	-7.209	-7.181	-7.152	-7.12
-160	-7.123	-7.094	-7.064	-7.035	-7.005	-6.975	-6.944	-6.914	-6.883	-6.853	-6.82
-150	-6.821	-6.790	-6.759	-6.727	-6.695	-6.663	-6.631	-6.598	-6.566	-6.533	-6.50
-140	-6.500	-6.467	-6.433	-6.400	-6.366	-6.332	-6.298	-6.263	-6.229	-6.194	-6.15
-130	-6.159	-6.124	-6.089	-6.054	-6.018	-5.982	-5.946	-5.910	-5.874	-5.838	-5.80
-120	-5.801	-5.764	-5.727	-5.690	-5.653	-5.616	-5.578	-5.541	-5.503	-5.465	-5.42
-110	-5.426	-5.388	-5.350	-5.311	-5.272	-5.233	-5.194	-5.155	-5.116	-5.076	-5.03
-100	-5.037	-4.997	-4.957	-4.917	-4.877	-4.836	-4.796	-4.755	-4.714	-4.674	-4.63
-90	-4.633	-4.591	-4.550	-4.509	-4.467	-4.425	-4.384	-4.342	-4.300	-4.257	-4.21
-80	-4.215	-4.173	-4.130	-4.088	-4.045	-4.002	-3.959	-3.916	-3.872	-3.829	-3.78
-70	-3.786	-3.742	-3.698	-3.654	-3.610	-3.566	-3.522	-3.478	-3.434	-3.389	-3.34
-60	-3.344	-3.300	-3.255	-3.210	-3.165	-3.120	-3.075	-3.029	-2.984	-2.938	-2.89
-50	-2.893	-2.847	-2.801	-2.755	-2.709	-2.663	-2.617	-2.571	-2.524	-2.478	-2.43
-40	-2.431	-2.385	-2.338	-2.291	-2.244	-2.197	-2.150	-2.103	-2.055	-2.008	-1.96
-30	-1.961	-1.913	-1.865	-1.818	-1.770	-1.722	-1.674	-1.626	-1.578	-1.530	-1.48
-20	-1.482	-1.433	-1.385	-1.336	-1.288	-1.239	-1.190	-1.142	-1.093	-1.044	-0.99
-10	-0.995	-0.946	-0.896	-0.847	-0.798	-0.749	-0.699	-0.650	-0.600	-0.550	-0.50
0	-0.501	-0.451	-0.401	-0.351	-0.301	-0.251	-0.201	-0.151	-0.101	-0.050	0.00

ITS-90 Table for type J thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
Thermoelectric Voltage in mV											
0	0.000	0.050	0.101	0.151	0.202	0.253	0.303	0.354	0.405	0.456	0.50
10	0.507	0.558	0.609	0.660	0.711	0.762	0.814	0.865	0.916	0.968	1.01
20	1.019	1.071	1.122	1.174	1.226	1.277	1.329	1.381	1.433	1.485	1.53
30	1.537	1.589	1.641	1.693	1.745	1.797	1.849	1.902	1.954	2.006	2.05
40	2.059	2.111	2.164	2.216	2.269	2.322	2.374	2.427	2.480	2.532	2.58
50	2.585	2.638	2.691	2.744	2.797	2.850	2.903	2.956	3.009	3.062	3.11
60	3.116	3.169	3.222	3.275	3.329	3.382	3.436	3.489	3.543	3.596	3.65
70	3.650	3.703	3.757	3.810	3.864	3.918	3.971	4.025	4.079	4.133	4.18
80	4.187	4.240	4.294	4.348	4.402	4.456	4.510	4.564	4.618	4.672	4.72
90	4.726	4.781	4.835	4.889	4.943	4.997	5.052	5.106	5.160	5.215	5.26
100	5.269	5.323	5.378	5.432	5.487	5.541	5.595	5.650	5.705	5.759	5.81
110	5.814	5.868	5.923	5.977	6.032	6.087	6.141	6.196	6.251	6.306	6.36
120	6.360	6.415	6.470	6.525	6.579	6.634	6.689	6.744	6.799	6.854	6.90
130	6.909	6.964	7.019	7.074	7.129	7.184	7.239	7.294	7.349	7.404	7.45
140	7.459	7.514	7.569	7.624	7.679	7.734	7.789	7.844	7.900	7.955	8.01
150	8.010	8.065	8.120	8.175	8.231	8.286	8.341	8.396	8.452	8.507	8.56
160	8.562	8.618	8.673	8.728	8.783	8.839	8.894	8.949	9.005	9.060	9.11
170	9.115	9.171	9.226	9.282	9.337	9.392	9.448	9.503	9.559	9.614	9.66
180	9.669	9.725	9.780	9.836	9.891	9.947	10.002	10.057	10.113	10.168	10.22
190	10.224	10.279	10.335	10.390	10.446	10.501	10.557	10.612	10.668	10.723	10.77
200	10.779	10.834	10.890	10.945	11.001	11.056	11.112	11.167	11.223	11.278	11.33
210	11.334	11.389	11.445	11.501	11.556	11.612	11.667	11.723	11.778	11.834	11.88
220	11.889	11.945	12.000	12.056	12.111	12.167	12.222	12.278	12.334	12.389	12.44
230	12.445	12.500	12.556	12.611	12.667	12.722	12.778	12.833	12.889	12.944	13.00
240	13.000	13.056	13.111	13.167	13.222	13.278	13.333	13.389	13.444	13.500	13.55
250	13.555	13.611	13.666	13.722	13.777	13.833	13.888	13.944	13.999	14.055	14.11
260	14.110	14.166	14.221	14.277	14.332	14.388	14.443	14.499	14.554	14.609	14.66
270	14.665	14.720	14.776	14.831	14.887	14.942	14.998	15.053	15.109	15.164	15.21
280	15.219	15.275	15.330	15.386	15.441	15.496	15.552	15.607	15.663	15.718	15.77
290	15.773	15.829	15.884	15.940	15.995	16.050	16.106	16.161	16.216	16.272	16.32
300	16.327	16.383	16.438	16.493	16.549	16.604	16.659	16.715	16.770	16.825	16.88
310	16.881	16.936	16.991	17.046	17.102	17.157	17.212	17.268	17.323	17.378	17.43
320	17.434	17.489	17.544	17.599	17.655	17.710	17.765	17.820	17.876	17.931	17.98
330	17.986	18.041	18.097	18.152	18.207	18.262	18.318	18.373	18.428	18.483	18.53
340	18.538	18.594	18.649	18.704	18.759	18.814	18.870	18.925	18.980	19.035	19.09

øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type J thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
Thermoelectric Voltage in mV											
350	19.090	19.146	19.201	19.256	19.311	19.366	19.422	19.477	19.532	19.587	19.64
360	19.642	19.697	19.753	19.808	19.863	19.918	19.973	20.028	20.083	20.139	20.19
370	20.194	20.249	20.304	20.359	20.414	20.469	20.525	20.580	20.635	20.690	20.74
380	20.745	20.800	20.855	20.911	20.966	21.021	21.076	21.131	21.186	21.241	21.29
390	21.297	21.352	21.407	21.462	21.517	21.572	21.627	21.683	21.738	21.793	21.84
400	21.848	21.903	21.958	22.014	22.069	22.124	22.179	22.234	22.289	22.345	22.40
410	22.400	22.455	22.510	22.565	22.620	22.676	22.731	22.786	22.841	22.896	22.95
420	22.952	23.007	23.062	23.117	23.172	23.228	23.283	23.338	23.393	23.449	23.50
430	23.504	23.559	23.614	23.670	23.725	23.780	23.835	23.891	23.946	24.001	24.05
440	24.057	24.112	24.167	24.223	24.278	24.333	24.389	24.444	24.499	24.555	24.61
450	24.610	24.665	24.721	24.776	24.832	24.887	24.943	24.998	25.053	25.109	25.16
460	25.164	25.220	25.275	25.331	25.386	25.442	25.497	25.553	25.608	25.664	25.72
470	25.720	25.775	25.831	25.886	25.942	25.998	26.053	26.109	26.165	26.220	26.27
480	26.276	26.332	26.387	26.443	26.499	26.555	26.610	26.666	26.722	26.778	26.83
490	26.834	26.889	26.945	27.001	27.057	27.113	27.169	27.225	27.281	27.337	27.39
500	27.393	27.449	27.505	27.561	27.617	27.673	27.729	27.785	27.841	27.897	27.95
510	27.953	28.010	28.066	28.122	28.178	28.234	28.291	28.347	28.403	28.460	28.51
520	28.516	28.572	28.629	28.685	28.741	28.798	28.854	28.911	28.967	29.024	29.08
530	29.080	29.137	29.194	29.250	29.307	29.363	29.420	29.477	29.534	29.590	29.64
540	29.647	29.704	29.761	29.818	29.874	29.931	29.988	30.045	30.102	30.159	30.21
550	30.216	30.273	30.330	30.387	30.444	30.502	30.559	30.616	30.673	30.730	30.78
560	30.788	30.845	30.902	30.960	31.017	31.074	31.132	31.189	31.247	31.304	31.36
570	31.362	31.419	31.477	31.535	31.592	31.650	31.708	31.766	31.823	31.881	31.93
580	31.939	31.997	32.055	32.113	32.171	32.229	32.287	32.345	32.403	32.461	32.51
590	32.519	32.577	32.636	32.694	32.752	32.810	32.869	32.927	32.985	33.044	33.10
600	33.102	33.161	33.219	33.278	33.337	33.395	33.454	33.513	33.571	33.630	33.68
610	33.689	33.748	33.807	33.866	33.925	33.984	34.043	34.102	34.161	34.220	34.27
620	34.279	34.338	34.397	34.457	34.516	34.575	34.635	34.694	34.754	34.813	34.87
630	34.873	34.932	34.992	35.051	35.111	35.171	35.230	35.290	35.350	35.410	35.47
640	35.470	35.530	35.590	35.650	35.710	35.770	35.830	35.890	35.950	36.010	36.07
650	36.071	36.131	36.191	36.252	36.312	36.373	36.433	36.494	36.554	36.615	36.67
660	36.675	36.736	36.797	36.858	36.918	36.979	37.040	37.101	37.162	37.223	37.28
670	37.284	37.345	37.406	37.467	37.528	37.590	37.651	37.712	37.773	37.835	37.89
680	37.896	37.958	38.019	38.081	38.142	38.204	38.265	38.327	38.389	38.450	38.51
690	38.512	38.574	38.636	38.698	38.760	38.822	38.884	38.946	39.008	39.070	39.13
700	39.132	39.194	39.256	39.318	39.381	39.443	39.505	39.568	39.630	39.693	39.75
710	39.755	39.818	39.880	39.943	40.005	40.068	40.131	40.193	40.256	40.319	40.38
720	40.382	40.445	40.508	40.570	40.633	40.696	40.759	40.822	40.886	40.949	41.01
730	41.012	41.075	41.138	41.201	41.265	41.328	41.391	41.455	41.518	41.581	41.64
740	41.645	41.708	41.772	41.835	41.899	41.962	42.026	42.090	42.153	42.217	42.28
750	42.281	42.344	42.408	42.472	42.536	42.599	42.663	42.727	42.791	42.855	42.91
760	42.919	42.983	43.047	43.111	43.175	43.239	43.303	43.367	43.431	43.495	43.55
770	43.559	43.624	43.688	43.752	43.817	43.881	43.945	44.010	44.074	44.139	44.20
780	44.203	44.267	44.332	44.396	44.461	44.525	44.590	44.655	44.719	44.784	44.84
790	44.848	44.913	44.977	45.042	45.107	45.171	45.236	45.301	45.365	45.430	45.49
800	45.494	45.559	45.624	45.688	45.753	45.818	45.882	45.947	46.011	46.076	46.14
810	46.141	46.205	46.270	46.334	46.399	46.464	46.528	46.593	46.657	46.722	46.78
820	46.786	46.851	46.915	46.980	47.044	47.109	47.173	47.238	47.302	47.367	47.43
830	47.431	47.495	47.560	47.624	47.688	47.753	47.817	47.881	47.946	48.010	48.07
840	48.074	48.138	48.202	48.267	48.331	48.395	48.459	48.523	48.587	48.651	48.71
850	48.715	48.779	48.843	48.907	48.971	49.034	49.098	49.162	49.226	49.290	49.35
860	49.353	49.417	49.481	49.544	49.608	49.672	49.735	49.799	49.862	49.926	49.98
870	49.989	50.052	50.116	50.179	50.243	50.306	50.369	50.432	50.495	50.559	50.62
880	50.622	50.685	50.748	50.811	50.874	50.937	51.000	51.063	51.126	51.188	51.25
890	51.251	51.314	51.377	51.439	51.502	51.565	51.627	51.690	51.752	51.815	51.87
900	51.877	51.940	52.002	52.064	52.127	52.189	52.251	52.314	52.376	52.438	52.50
910	52.500	52.562	52.624	52.686	52.748	52.810	52.872	52.934	52.996	53.057	53.11
920	53.119	53.181	53.243	53.304	53.366	53.427	53.489	53.550	53.612	53.673	53.73
930	53.735	53.796	53.857	53.919	53.980	54.041	54.102	54.164	54.225	54.286	54.34
940	54.347	54.408	54.469	54.530	54.591	54.652	54.713	54.773	54.834	54.895	54.95
950	54.956	55.016	55.077	55.138	55.198	55.259	55.319	55.380	55.440	55.501	55.56
960	55.561	55.622	55.682	55.742	55.803	55.863	55.923	55.983	56.043	56.104	56.16
970	56.164	56.224	56.284	56.344	56.404	56.464	56.524	56.584	56.643	56.703	56.76
980	56.763	56.823	56.883	56.942	57.002	57.062	57.121	57.181	57.240	57.300	57.36
990	57.360	57.419	57.479	57.538	57.597	57.657	57.716	57.776	57.835	57.894	57.95

øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type J thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
1000	57.953	58.013	58.072	58.131	58.190	58.249	58.309	58.368	58.427	58.486	58.54
1010	58.545	58.604	58.663	58.722	58.781	58.840	58.899	58.957	59.016	59.075	59.13
1020	59.134	59.193	59.252	59.310	59.369	59.428	59.487	59.545	59.604	59.663	59.72
1030	59.721	59.780	59.838	59.897	59.956	60.014	60.073	60.131	60.190	60.248	60.30
1040	60.307	60.365	60.423	60.482	60.540	60.599	60.657	60.715	60.774	60.832	60.89
1050	60.890	60.949	61.007	61.065	61.123	61.182	61.240	61.298	61.356	61.415	61.47
1060	61.473	61.531	61.589	61.647	61.705	61.763	61.822	61.880	61.938	61.996	62.05
1070	62.054	62.112	62.170	62.228	62.286	62.344	62.402	62.460	62.518	62.576	62.63
1080	62.634	62.692	62.750	62.808	62.866	62.924	62.982	63.040	63.098	63.156	63.21
1090	63.214	63.271	63.329	63.387	63.445	63.503	63.561	63.619	63.677	63.734	63.79
1100	63.792	63.850	63.908	63.966	64.024	64.081	64.139	64.197	64.255	64.313	64.37
1110	64.370	64.428	64.486	64.544	64.602	64.659	64.717	64.775	64.833	64.890	64.94
1120	64.948	65.006	65.064	65.121	65.179	65.237	65.295	65.352	65.410	65.468	65.52
1130	65.525	65.583	65.641	65.699	65.756	65.814	65.872	65.929	65.987	66.045	66.10
1140	66.102	66.160	66.218	66.275	66.333	66.391	66.448	66.506	66.564	66.621	66.67
1150	66.679	66.737	66.794	66.852	66.910	66.967	67.025	67.082	67.140	67.198	67.25
1160	67.255	67.313	67.370	67.428	67.486	67.543	67.601	67.658	67.716	67.773	67.83
1170	67.831	67.888	67.946	68.003	68.061	68.119	68.176	68.234	68.291	68.348	68.40
1180	68.406	68.463	68.521	68.578	68.636	68.693	68.751	68.808	68.865	68.923	68.98
1190	68.980	69.037	69.095	69.152	69.209	69.267	69.324	69.381	69.439	69.496	69.55

øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type K thermocouple

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
					Thermoelectric Voltage in mV						
-440	-6.456	-6.455	-6.454	-6.454	-6.453	-6.452	-6.451	-6.450	-6.449	-6.448	-6.44
-430	-6.446	-6.445	-6.444	-6.443	-6.441	-6.440	-6.438	-6.436	-6.435	-6.433	-6.43
-420	-6.431	-6.429	-6.427	-6.425	-6.423	-6.421	-6.419	-6.416	-6.414	-6.411	-6.40
-410	-6.409	-6.406	-6.404	-6.401	-6.398	-6.395	-6.392	-6.389	-6.386	-6.383	-6.38
-400	-6.380	-6.377	-6.373	-6.370	-6.366	-6.363	-6.359	-6.355	-6.352	-6.348	-6.34
-390	-6.344	-6.340	-6.336	-6.332	-6.328	-6.323	-6.319	-6.315	-6.310	-6.306	-6.30
-380	-6.301	-6.296	-6.292	-6.287	-6.282	-6.277	-6.272	-6.267	-6.262	-6.257	-6.25
-370	-6.251	-6.246	-6.241	-6.235	-6.230	-6.224	-6.218	-6.213	-6.207	-6.201	-6.19
-360	-6.195	-6.189	-6.183	-6.177	-6.171	-6.165	-6.158	-6.152	-6.146	-6.139	-6.13
-350	-6.133	-6.126	-6.119	-6.113	-6.106	-6.099	-6.092	-6.085	-6.078	-6.071	-6.06
-340	-6.064	-6.057	-6.049	-6.042	-6.035	-6.027	-6.020	-6.012	-6.004	-5.997	-5.98
-330	-5.989	-5.981	-5.973	-5.965	-5.957	-5.949	-5.941	-5.933	-5.925	-5.917	-5.90
-320	-5.908	-5.900	-5.891	-5.883	-5.874	-5.866	-5.857	-5.848	-5.840	-5.831	-5.82
-310	-5.822	-5.813	-5.804	-5.795	-5.786	-5.776	-5.767	-5.758	-5.749	-5.739	-5.73
-300	-5.730	-5.720	-5.711	-5.701	-5.691	-5.682	-5.672	-5.662	-5.652	-5.642	-5.63
-290	-5.632	-5.622	-5.612	-5.602	-5.592	-5.581	-5.571	-5.561	-5.550	-5.540	-5.52
-280	-5.529	-5.519	-5.508	-5.497	-5.487	-5.476	-5.465	-5.454	-5.443	-5.432	-5.42
-270	-5.421	-5.410	-5.399	-5.388	-5.377	-5.365	-5.354	-5.343	-5.331	-5.320	-5.30
-260	-5.308	-5.296	-5.285	-5.273	-5.261	-5.250	-5.238	-5.226	-5.214	-5.202	-5.19
-250	-5.190	-5.178	-5.166	-5.153	-5.141	-5.129	-5.117	-5.104	-5.092	-5.079	-5.06
-240	-5.067	-5.054	-5.042	-5.029	-5.016	-5.003	-4.991	-4.978	-4.965	-4.952	-4.93
-230	-4.939	-4.926	-4.913	-4.900	-4.886	-4.873	-4.860	-4.847	-4.833	-4.820	-4.80
-220	-4.806	-4.793	-4.779	-4.766	-4.752	-4.738	-4.724	-4.711	-4.697	-4.683	-4.66
-210	-4.669	-4.655	-4.641	-4.627	-4.613	-4.599	-4.584	-4.570	-4.556	-4.542	-4.52
-200	-4.527	-4.513	-4.498	-4.484	-4.469	-4.455	-4.440	-4.425	-4.411	-4.396	-4.38
-190	-4.381	-4.366	-4.351	-4.336	-4.321	-4.306	-4.291	-4.276	-4.261	-4.246	-4.23
-180	-4.231	-4.215	-4.200	-4.185	-4.169	-4.154	-4.138	-4.123	-4.107	-4.091	-4.07
-170	-4.076	-4.060	-4.044	-4.029	-4.013	-3.997	-3.981	-3.965	-3.949	-3.933	-3.91
-160	-3.917	-3.901	-3.885	-3.869	-3.852	-3.836	-3.820	-3.803	-3.787	-3.771	-3.75
-150	-3.754	-3.738	-3.721	-3.705	-3.688	-3.671	-3.655	-3.638	-3.621	-3.604	-3.58
-140	-3.587	-3.571	-3.554	-3.537	-3.520	-3.503	-3.486	-3.468	-3.451	-3.434	-3.41
-130	-3.417	-3.400	-3.382	-3.365	-3.348	-3.330	-3.313	-3.295	-3.278	-3.260	-3.24
-120	-3.243	-3.225	-3.207	-3.190	-3.172	-3.154	-3.136	-3.119	-3.101	-3.083	-3.06
-110	-3.065	-3.047	-3.029	-3.011	-2.993	-2.975	-2.957	-2.938	-2.920	-2.902	-2.88
-100	-2.884	-2.865	-2.847	-2.829	-2.810	-2.792	-2.773	-2.755	-2.736	-2.718	-2.69
-90	-2.699	-2.680	-2.662	-2.643	-2.624	-2.605	-2.587	-2.568	-2.549	-2.530	-2.51
-80	-2.511	-2.492	-2.473	-2.454	-2.435	-2.416	-2.397	-2.378	-2.359	-2.339	-2.32
-70	-2.320	-2.301	-2.282	-2.262	-2.243	-2.223	-2.204	-2.185	-2.165	-2.146	-2.12
-60	-2.126	-2.106	-2.087	-2.067	-2.048	-2.028	-2.008	-1.988	-1.969	-1.949	-1.92
-50	-1.929	-1.909	-1.889	-1.869	-1.850	-1.830	-1.810	-1.790	-1.770	-1.749	-1.72
-40	-1.729	-1.709	-1.689	-1.669	-1.649	-1.628	-1.608	-1.588	-1.568	-1.547	-1.52
-30	-1.527	-1.507	-1.486	-1.466	-1.445	-1.425	-1.404	-1.384	-1.363	-1.343	-1.32
-20	-1.322	-1.301	-1.281	-1.260	-1.239	-1.218	-1.198	-1.177	-1.156	-1.135	-1.11
-10	-1.114	-1.094	-1.073	-1.052	-1.031	-1.010	-0.989	-0.968	-0.947	-0.926	-0.90
0	-0.905	-0.883	-0.862	-0.841	-0.820	-0.799	-0.778	-0.756	-0.735	-0.714	-0.69

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

ITS-90 Table for type K thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
0	-0.692	-0.671	-0.650	-0.628	-0.607	-0.586	-0.564	-0.543	-0.521	-0.500	-0.47
10	-0.478	-0.457	-0.435	-0.413	-0.392	-0.370	-0.349	-0.327	-0.305	-0.284	-0.26
20	-0.262	-0.240	-0.218	-0.197	-0.175	-0.153	-0.131	-0.109	-0.088	-0.066	-0.04
30	-0.044	-0.022	0.000	0.022	0.044	0.066	0.088	0.110	0.132	0.154	0.17
40	0.176	0.198	0.220	0.242	0.264	0.286	0.308	0.330	0.353	0.375	0.39
50	0.397	0.419	0.441	0.463	0.486	0.508	0.530	0.552	0.575	0.597	0.61
60	0.619	0.642	0.664	0.686	0.709	0.731	0.753	0.776	0.798	0.821	0.84
70	0.843	0.865	0.888	0.910	0.933	0.955	0.978	1.000	1.023	1.045	1.06
80	1.068	1.090	1.113	1.136	1.158	1.181	1.203	1.226	1.249	1.271	1.29
90	1.294	1.316	1.339	1.362	1.384	1.407	1.430	1.453	1.475	1.498	1.52
100	1.521	1.543	1.566	1.589	1.612	1.635	1.657	1.680	1.703	1.726	1.74
110	1.749	1.771	1.794	1.817	1.840	1.863	1.886	1.909	1.931	1.954	1.97
120	1.977	2.000	2.023	2.046	2.069	2.092	2.115	2.138	2.161	2.184	2.20
130	2.207	2.230	2.253	2.276	2.298	2.321	2.344	2.367	2.390	2.413	2.43
140	2.436	2.459	2.483	2.506	2.529	2.552	2.575	2.598	2.621	2.644	2.66

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type K thermocouple

Thermoelectric Voltage in mV

øF	0	1	2	3	4	5	6	7	8	9	10
150	2.667	2.690	2.713	2.736	2.759	2.782	2.805	2.828	2.851	2.874	2.89
160	2.897	2.920	2.944	2.967	2.990	3.013	3.036	3.059	3.082	3.105	3.12
170	3.128	3.151	3.174	3.197	3.220	3.244	3.267	3.290	3.313	3.336	3.35
180	3.359	3.382	3.405	3.428	3.451	3.474	3.497	3.520	3.544	3.567	3.59
190	3.590	3.613	3.636	3.659	3.682	3.705	3.728	3.751	3.774	3.797	3.82
200	3.820	3.843	3.866	3.889	3.912	3.935	3.958	3.981	4.004	4.027	4.05
210	4.050	4.073	4.096	4.119	4.142	4.165	4.188	4.211	4.234	4.257	4.28
220	4.280	4.303	4.326	4.349	4.372	4.395	4.417	4.440	4.463	4.486	4.50
230	4.509	4.532	4.555	4.578	4.601	4.623	4.646	4.669	4.692	4.715	4.73
240	4.738	4.760	4.783	4.806	4.829	4.852	4.874	4.897	4.920	4.943	4.96
250	4.965	4.988	5.011	5.034	5.056	5.079	5.102	5.124	5.147	5.170	5.19
260	5.192	5.215	5.238	5.260	5.283	5.306	5.328	5.351	5.374	5.396	5.41
270	5.419	5.441	5.464	5.487	5.509	5.532	5.554	5.577	5.599	5.622	5.64
280	5.644	5.667	5.690	5.712	5.735	5.757	5.779	5.802	5.824	5.847	5.86
290	5.869	5.892	5.914	5.937	5.959	5.982	6.004	6.026	6.049	6.071	6.09
300	6.094	6.116	6.138	6.161	6.183	6.205	6.228	6.250	6.272	6.295	6.31
310	6.317	6.339	6.362	6.384	6.406	6.429	6.451	6.473	6.496	6.518	6.54
320	6.540	6.562	6.585	6.607	6.629	6.652	6.674	6.696	6.718	6.741	6.76
330	6.763	6.785	6.807	6.829	6.852	6.874	6.896	6.918	6.941	6.963	6.98
340	6.985	7.007	7.029	7.052	7.074	7.096	7.118	7.140	7.163	7.185	7.20
350	7.207	7.229	7.251	7.273	7.296	7.318	7.340	7.362	7.384	7.407	7.42
360	7.429	7.451	7.473	7.495	7.517	7.540	7.562	7.584	7.606	7.628	7.65
370	7.650	7.673	7.695	7.717	7.739	7.761	7.783	7.806	7.828	7.850	7.87
380	7.872	7.894	7.917	7.939	7.961	7.983	8.005	8.027	8.050	8.072	8.09
390	8.094	8.116	8.138	8.161	8.183	8.205	8.227	8.250	8.272	8.294	8.31
400	8.316	8.338	8.361	8.383	8.405	8.427	8.450	8.472	8.494	8.516	8.53
410	8.539	8.561	8.583	8.605	8.628	8.650	8.672	8.694	8.717	8.739	8.76
420	8.761	8.784	8.806	8.828	8.851	8.873	8.895	8.918	8.940	8.962	8.98
430	8.985	9.007	9.029	9.052	9.074	9.096	9.119	9.141	9.163	9.186	9.20
440	9.208	9.231	9.253	9.275	9.298	9.320	9.343	9.365	9.388	9.410	9.43
450	9.432	9.455	9.477	9.500	9.522	9.545	9.567	9.590	9.612	9.635	9.65
460	9.657	9.680	9.702	9.725	9.747	9.770	9.792	9.815	9.837	9.860	9.88
470	9.882	9.905	9.927	9.950	9.973	9.995	10.018	10.040	10.063	10.086	10.10
480	10.108	10.131	10.153	10.176	10.199	10.221	10.244	10.267	10.289	10.312	10.33
490	10.334	10.357	10.380	10.402	10.425	10.448	10.471	10.493	10.516	10.539	10.56
500	10.561	10.584	10.607	10.629	10.652	10.675	10.698	10.720	10.743	10.766	10.78
510	10.789	10.811	10.834	10.857	10.880	10.903	10.925	10.948	10.971	10.994	11.01
520	11.017	11.039	11.062	11.085	11.108	11.131	11.154	11.176	11.199	11.222	11.24
530	11.245	11.268	11.291	11.313	11.336	11.359	11.382	11.405	11.428	11.451	11.47
540	11.474	11.497	11.519	11.542	11.565	11.588	11.611	11.634	11.657	11.680	11.70
550	11.703	11.726	11.749	11.772	11.795	11.818	11.841	11.864	11.887	11.910	11.93
560	11.933	11.956	11.978	12.001	12.024	12.047	12.070	12.093	12.116	12.140	12.16
570	12.163	12.186	12.209	12.232	12.255	12.278	12.301	12.324	12.347	12.370	12.39
580	12.393	12.416	12.439	12.462	12.485	12.508	12.531	12.554	12.577	12.600	12.62
590	12.624	12.647	12.670	12.693	12.716	12.739	12.762	12.785	12.808	12.831	12.85
600	12.855	12.878	12.901	12.924	12.947	12.970	12.993	13.016	13.040	13.063	13.08
610	13.086	13.109	13.132	13.155	13.179	13.202	13.225	13.248	13.271	13.294	13.31
620	13.318	13.341	13.364	13.387	13.410	13.433	13.457	13.480	13.503	13.526	13.54
630	13.549	13.573	13.596	13.619	13.642	13.665	13.689	13.712	13.735	13.758	13.78
640	13.782	13.805	13.828	13.851	13.874	13.898	13.921	13.944	13.967	13.991	14.01
650	14.014	14.037	14.060	14.084	14.107	14.130	14.154	14.177	14.200	14.223	14.24
660	14.247	14.270	14.293	14.316	14.340	14.363	14.386	14.410	14.433	14.456	14.47
670	14.479	14.503	14.526	14.549	14.573	14.596	14.619	14.643	14.666	14.689	14.71
680	14.713	14.736	14.759	14.783	14.806	14.829	14.853	14.876	14.899	14.923	14.94
690	14.946	14.969	14.993	15.016	15.039	15.063	15.086	15.109	15.133	15.156	15.17
700	15.179	15.203	15.226	15.250	15.273	15.296	15.320	15.343	15.366	15.390	15.41
710	15.413	15.437	15.460	15.483	15.507	15.530	15.554	15.577	15.600	15.624	15.64
720	15.647	15.671	15.694	15.717	15.741	15.764	15.788	15.811	15.834	15.858	15.88
730	15.881	15.905	15.928	15.952	15.975	15.998	16.022	16.045	16.069	16.092	16.11
740	16.116	16.139	16.163	16.186	16.209	16.233	16.256	16.280	16.303	16.327	16.35
750	16.350	16.374	16.397	16.421	16.444	16.468	16.491	16.514	16.538	16.561	16.58
760	16.585	16.608	16.632	16.655	16.679	16.702	16.726	16.749	16.773	16.796	16.82
770	16.820	16.843	16.867	16.890	16.914	16.937	16.961	16.984	17.008	17.031	17.05
780	17.055	17.078	17.102	17.125	17.149	17.173	17.196	17.220	17.243	17.267	17.29
790	17.290	17.314	17.337	17.361	17.384	17.408	17.431	17.455	17.478	17.502	17.52
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type K thermocouple

Thermoelectric Voltage in mV

øF	0	1	2	3	4	5	6	7	8	9	10
800	17.526	17.549	17.573	17.596	17.620	17.643	17.667	17.690	17.714	17.738	17.76
810	17.761	17.785	17.808	17.832	17.855	17.879	17.902	17.926	17.950	17.973	17.99
820	17.997	18.020	18.044	18.068	18.091	18.115	18.138	18.162	18.185	18.209	18.23
830	18.233	18.256	18.280	18.303	18.327	18.351	18.374	18.398	18.421	18.445	18.46
840	18.469	18.492	18.516	18.539	18.563	18.587	18.610	18.634	18.657	18.681	18.70
850	18.705	18.728	18.752	18.776	18.799	18.823	18.846	18.870	18.894	18.917	18.94
860	18.941	18.965	18.988	19.012	19.035	19.059	19.083	19.106	19.130	19.154	19.17
870	19.177	19.201	19.224	19.248	19.272	19.295	19.319	19.343	19.366	19.390	19.41
880	19.414	19.437	19.461	19.485	19.508	19.532	19.556	19.579	19.603	19.626	19.65
890	19.650	19.674	19.697	19.721	19.745	19.768	19.792	19.816	19.839	19.863	19.88
900	19.887	19.910	19.934	19.958	19.981	20.005	20.029	20.052	20.076	20.100	20.12
910	20.123	20.147	20.171	20.194	20.218	20.242	20.265	20.289	20.313	20.336	20.36
920	20.360	20.384	20.407	20.431	20.455	20.479	20.502	20.526	20.550	20.573	20.59
930	20.597	20.621	20.644	20.668	20.692	20.715	20.739	20.763	20.786	20.810	20.83
940	20.834	20.857	20.881	20.905	20.929	20.952	20.976	21.000	21.023	21.047	21.07
950	21.071	21.094	21.118	21.142	21.165	21.189	21.213	21.236	21.260	21.284	21.30
960	21.308	21.331	21.355	21.379	21.402	21.426	21.450	21.473	21.497	21.521	21.54
970	21.544	21.568	21.592	21.616	21.639	21.663	21.687	21.710	21.734	21.758	21.78
980	21.781	21.805	21.829	21.852	21.876	21.900	21.924	21.947	21.971	21.995	22.01
990	22.018	22.042	22.066	22.089	22.113	22.137	22.160	22.184	22.208	22.232	22.25
1000	22.255	22.279	22.303	22.326	22.350	22.374	22.397	22.421	22.445	22.468	22.49
1010	22.492	22.516	22.540	22.563	22.587	22.611	22.634	22.658	22.682	22.705	22.72
1020	22.729	22.753	22.776	22.800	22.824	22.847	22.871	22.895	22.919	22.942	22.96
1030	22.966	22.990	23.013	23.037	23.061	23.084	23.108	23.132	23.155	23.179	23.20
1040	23.203	23.226	23.250	23.274	23.297	23.321	23.345	23.368	23.392	23.416	23.43
1050	23.439	23.463	23.487	23.510	23.534	23.558	23.581	23.605	23.629	23.652	23.67
1060	23.676	23.700	23.723	23.747	23.771	23.794	23.818	23.842	23.865	23.889	23.91
1070	23.913	23.936	23.960	23.984	24.007	24.031	24.055	24.078	24.102	24.126	24.14
1080	24.149	24.173	24.197	24.220	24.244	24.267	24.291	24.315	24.338	24.362	24.38
1090	24.386	24.409	24.433	24.457	24.480	24.504	24.527	24.551	24.575	24.598	24.62
1100	24.622	24.646	24.669	24.693	24.717	24.740	24.764	24.787	24.811	24.835	24.85
1110	24.858	24.882	24.905	24.929	24.953	24.976	25.000	25.024	25.047	25.071	25.09
1120	25.094	25.118	25.142	25.165	25.189	25.212	25.236	25.260	25.283	25.307	25.33
1130	25.330	25.354	25.377	25.401	25.425	25.448	25.472	25.495	25.519	25.543	25.56
1140	25.566	25.590	25.613	25.637	25.660	25.684	25.708	25.731	25.755	25.778	25.80
1150	25.802	25.825	25.849	25.873	25.896	25.920	25.943	25.967	25.990	26.014	26.03
1160	26.037	26.061	26.084	26.108	26.132	26.155	26.179	26.202	26.226	26.249	26.27
1170	26.273	26.296	26.320	26.343	26.367	26.390	26.414	26.437	26.461	26.484	26.50
1180	26.508	26.532	26.555	26.579	26.602	26.626	26.649	26.673	26.696	26.720	26.74
1190	26.743	26.767	26.790	26.814	26.837	26.861	26.884	26.907	26.931	26.954	26.97
1200	26.978	27.001	27.025	27.048	27.072	27.095	27.119	27.142	27.166	27.189	27.21
1210	27.213	27.236	27.259	27.283	27.306	27.330	27.353	27.377	27.400	27.424	27.44
1220	27.447	27.471	27.494	27.517	27.541	27.564	27.588	27.611	27.635	27.658	27.68
1230	27.681	27.705	27.728	27.752	27.775	27.798	27.822	27.845	27.869	27.892	27.91
1240	27.915	27.939	27.962	27.986	28.009	28.032	28.056	28.079	28.103	28.126	28.14
1250	28.149	28.173	28.196	28.219	28.243	28.266	28.289	28.313	28.336	28.360	28.38
1260	28.383	28.406	28.430	28.453	28.476	28.500	28.523	28.546	28.570	28.593	28.61
1270	28.616	28.640	28.663	28.686	28.710	28.733	28.756	28.780	28.803	28.826	28.84
1280	28.849	28.873	28.896	28.919	28.943	28.966	28.989	29.013	29.036	29.059	29.08
1290	29.082	29.106	29.129	29.152	29.176	29.199	29.222	29.245	29.269	29.292	29.31
1300	29.315	29.338	29.362	29.385	29.408	29.431	29.455	29.478	29.501	29.524	29.54
1310	29.548	29.571	29.594	29.617	29.640	29.664	29.687	29.710	29.733	29.757	29.78
1320	29.780	29.803	29.826	29.849	29.873	29.896	29.919	29.942	29.965	29.989	30.01
1330	30.012	30.035	30.058	30.081	30.104	30.128	30.151	30.174	30.197	30.220	30.24
1340	30.243	30.267	30.290	30.313	30.336	30.359	30.382	30.405	30.429	30.452	30.47
1350	30.475	30.498	30.521	30.544	30.567	30.590	30.613	30.637	30.660	30.683	30.70
1360	30.706	30.729	30.752	30.775	30.798	30.821	30.844	30.868	30.891	30.914	30.93
1370	30.937	30.960	30.983	31.006	31.029	31.052	31.075	31.098	31.121	31.144	31.16
1380	31.167	31.190	31.213	31.236	31.260	31.283	31.306	31.329	31.352	31.375	31.39
1390	31.398	31.421	31.444	31.467	31.490	31.513	31.536	31.559	31.582	31.605	31.62
1400	31.628	31.651	31.674	31.697	31.720	31.743	31.766	31.789	31.812	31.834	31.85
1410	31.857	31.880	31.903	31.926	31.949	31.972	31.995	32.018	32.041	32.064	32.08
1420	32.087	32.110	32.133	32.156	32.179	32.202	32.224	32.247	32.270	32.293	32.31
1430	32.316	32.339	32.362	32.385	32.408	32.431	32.453	32.476	32.499	32.522	32.54
1440	32.545	32.568	32.591	32.614	32.636	32.659	32.682	32.705	32.728	32.751	32.77
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type K thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
				Thermoelectric Voltage in mV							
1450	32.774	32.796	32.819	32.842	32.865	32.888	32.911	32.933	32.956	32.979	33.00
1460	33.002	33.025	33.047	33.070	33.093	33.116	33.139	33.161	33.184	33.207	33.23
1470	33.230	33.253	33.275	33.298	33.321	33.344	33.366	33.389	33.412	33.435	33.45
1480	33.458	33.480	33.503	33.526	33.548	33.571	33.594	33.617	33.639	33.662	33.68
1490	33.685	33.708	33.730	33.753	33.776	33.798	33.821	33.844	33.867	33.889	33.91
1500	33.912	33.935	33.957	33.980	34.003	34.025	34.048	34.071	34.093	34.116	34.13
1510	34.139	34.161	34.184	34.207	34.229	34.252	34.275	34.297	34.320	34.343	34.36
1520	34.365	34.388	34.410	34.433	34.456	34.478	34.501	34.524	34.546	34.569	34.59
1530	34.591	34.614	34.637	34.659	34.682	34.704	34.727	34.750	34.772	34.795	34.81
1540	34.817	34.840	34.862	34.885	34.908	34.930	34.953	34.975	34.998	35.020	35.04
1550	35.043	35.065	35.088	35.110	35.133	35.156	35.178	35.201	35.223	35.246	35.26
1560	35.268	35.291	35.313	35.336	35.358	35.381	35.403	35.426	35.448	35.471	35.49
1570	35.493	35.516	35.538	35.560	35.583	35.605	35.628	35.650	35.673	35.695	35.71
1580	35.718	35.740	35.763	35.785	35.807	35.830	35.852	35.875	35.897	35.920	35.94
1590	35.942	35.964	35.987	36.009	36.032	36.054	36.076	36.099	36.121	36.144	36.16
1600	36.166	36.188	36.211	36.233	36.256	36.278	36.300	36.323	36.345	36.367	36.39
1610	36.390	36.412	36.434	36.457	36.479	36.501	36.524	36.546	36.568	36.591	36.61
1620	36.613	36.635	36.658	36.680	36.702	36.725	36.747	36.769	36.792	36.814	36.83
1630	36.836	36.859	36.881	36.903	36.925	36.948	36.970	36.992	37.014	37.037	37.05
1640	37.059	37.081	37.104	37.126	37.148	37.170	37.193	37.215	37.237	37.259	37.28
1650	37.281	37.304	37.326	37.348	37.370	37.393	37.415	37.437	37.459	37.481	37.50
1660	37.504	37.526	37.548	37.570	37.592	37.615	37.637	37.659	37.681	37.703	37.72
1670	37.725	37.748	37.770	37.792	37.814	37.836	37.858	37.881	37.903	37.925	37.94
1680	37.947	37.969	37.991	38.013	38.036	38.058	38.080	38.102	38.124	38.146	38.16
1690	38.168	38.190	38.212	38.235	38.257	38.279	38.301	38.323	38.345	38.367	38.38
1700	38.389	38.411	38.433	38.455	38.477	38.499	38.522	38.544	38.566	38.588	38.61
1710	38.610	38.632	38.654	38.676	38.698	38.720	38.742	38.764	38.786	38.808	38.83
1720	38.830	38.852	38.874	38.896	38.918	38.940	38.962	38.984	39.006	39.028	39.05
1730	39.050	39.072	39.094	39.116	39.138	39.160	39.182	39.204	39.226	39.248	39.27
1740	39.270	39.292	39.314	39.335	39.357	39.379	39.401	39.423	39.445	39.467	39.48
1750	39.489	39.511	39.533	39.555	39.577	39.599	39.620	39.642	39.664	39.686	39.70
1760	39.708	39.730	39.752	39.774	39.796	39.817	39.839	39.861	39.883	39.905	39.92
1770	39.927	39.949	39.970	39.992	40.014	40.036	40.058	40.080	40.101	40.123	40.14
1780	40.145	40.167	40.189	40.211	40.232	40.254	40.276	40.298	40.320	40.341	40.36
1790	40.363	40.385	40.407	40.429	40.450	40.472	40.494	40.516	40.537	40.559	40.58
1800	40.581	40.603	40.624	40.646	40.668	40.690	40.711	40.733	40.755	40.777	40.79
1810	40.798	40.820	40.842	40.864	40.885	40.907	40.929	40.950	40.972	40.994	41.01
1820	41.015	41.037	41.059	41.081	41.102	41.124	41.146	41.167	41.189	41.211	41.23
1830	41.232	41.254	41.276	41.297	41.319	41.341	41.362	41.384	41.405	41.427	41.44
1840	41.449	41.470	41.492	41.514	41.535	41.557	41.578	41.600	41.622	41.643	41.66
1850	41.665	41.686	41.708	41.730	41.751	41.773	41.794	41.816	41.838	41.859	41.88
1860	41.881	41.902	41.924	41.945	41.967	41.988	42.010	42.032	42.053	42.075	42.09
1870	42.096	42.118	42.139	42.161	42.182	42.204	42.225	42.247	42.268	42.290	42.31
1880	42.311	42.333	42.354	42.376	42.397	42.419	42.440	42.462	42.483	42.505	42.52
1890	42.526	42.548	42.569	42.591	42.612	42.633	42.655	42.676	42.698	42.719	42.74
1900	42.741	42.762	42.783	42.805	42.826	42.848	42.869	42.891	42.912	42.933	42.95
1910	42.955	42.976	42.998	43.019	43.040	43.062	43.083	43.104	43.126	43.147	43.16
1920	43.169	43.190	43.211	43.233	43.254	43.275	43.297	43.318	43.339	43.361	43.38
1930	43.382	43.403	43.425	43.446	43.467	43.489	43.510	43.531	43.552	43.574	43.59
1940	43.595	43.616	43.638	43.659	43.680	43.701	43.723	43.744	43.765	43.787	43.80
1950	43.808	43.829	43.850	43.872	43.893	43.914	43.935	43.957	43.978	43.999	44.02
1960	44.020	44.041	44.063	44.084	44.105	44.126	44.147	44.169	44.190	44.211	44.23
1970	44.232	44.253	44.275	44.296	44.317	44.338	44.359	44.380	44.402	44.423	44.44
1980	44.444	44.465	44.486	44.507	44.528	44.550	44.571	44.592	44.613	44.634	44.65
1990	44.655	44.676	44.697	44.719	44.740	44.761	44.782	44.803	44.824	44.845	44.86
2000	44.866	44.887	44.908	44.929	44.950	44.971	44.992	45.014	45.035	45.056	45.07
2010	45.077	45.098	45.119	45.140	45.161	45.182	45.203	45.224	45.245	45.266	45.28
2020	45.287	45.308	45.329	45.350	45.371	45.392	45.413	45.434	45.455	45.476	45.49
2030	45.497	45.518	45.539	45.560	45.580	45.601	45.622	45.643	45.664	45.685	45.70
2040	45.706	45.727	45.748	45.769	45.790	45.811	45.832	45.852	45.873	45.894	45.91
2050	45.915	45.936	45.957	45.978	45.999	46.019	46.040	46.061	46.082	46.103	46.12
2060	46.124	46.145	46.165	46.186	46.207	46.228	46.249	46.269	46.290	46.311	46.33
2070	46.332	46.353	46.373	46.394	46.415	46.436	46.457	46.477	46.498	46.519	46.54
2080	46.540	46.560	46.581	46.602	46.623	46.643	46.664	46.685	46.706	46.726	46.74
2090	46.747	46.768	46.789	46.809	46.830	46.851	46.871	46.892	46.913	46.933	46.95
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type K thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
				Thermoelectric Voltage in mV							
2100	46.954	46.975	46.995	47.016	47.037	47.057	47.078	47.099	47.119	47.140	47.16
2110	47.161	47.181	47.202	47.223	47.243	47.264	47.284	47.305	47.326	47.346	47.36
2120	47.367	47.387	47.408	47.429	47.449	47.470	47.490	47.511	47.531	47.552	47.57
2130	47.573	47.593	47.614	47.634	47.655	47.675	47.696	47.716	47.737	47.757	47.77
2140	47.778	47.798	47.819	47.839	47.860	47.880	47.901	47.921	47.942	47.962	47.98
2150	47.983	48.003	48.024	48.044	48.065	48.085	48.105	48.126	48.146	48.167	48.18
2160	48.187	48.208	48.228	48.248	48.269	48.289	48.310	48.330	48.350	48.371	48.39
2170	48.391	48.411	48.432	48.452	48.473	48.493	48.513	48.534	48.554	48.574	48.59
2180	48.595	48.615	48.635	48.656	48.676	48.696	48.717	48.737	48.757	48.777	48.79
2190	48.798	48.818	48.838	48.859	48.879	48.899	48.919	48.940	48.960	48.980	49.00
2200	49.000	49.021	49.041	49.061	49.081	49.101	49.122	49.142	49.162	49.182	49.20
2210	49.202	49.223	49.243	49.263	49.283	49.303	49.323	49.344	49.364	49.384	49.40
2220	49.404	49.424	49.444	49.465	49.485	49.505	49.525	49.545	49.565	49.585	49.60
2230	49.605	49.625	49.645	49.666	49.686	49.706	49.726	49.746	49.766	49.786	49.80
2240	49.806	49.826	49.846	49.866	49.886	49.906	49.926	49.946	49.966	49.986	50.00
2250	50.006	50.026	50.046	50.066	50.086	50.106	50.126	50.146	50.166	50.186	50.20
2260	50.206	50.226	50.246	50.266	50.286	50.306	50.326	50.346	50.366	50.385	50.40
2270	50.405	50.425	50.445	50.465	50.485	50.505	50.525	50.545	50.564	50.584	50.60
2280	50.604	50.624	50.644	50.664	50.684	50.703	50.723	50.743	50.763	50.783	50.80
2290	50.802	50.822	50.842	50.862	50.882	50.901	50.921	50.941	50.961	50.981	51.00
2300	51.000	51.020	51.040	51.060	51.079	51.099	51.119	51.139	51.158	51.178	51.19
2310	51.198	51.217	51.237	51.257	51.276	51.296	51.316	51.336	51.355	51.375	51.39
2320	51.395	51.414	51.434	51.453	51.473	51.493	51.512	51.532	51.552	51.571	51.59
2330	51.591	51.611	51.630	51.650	51.669	51.689	51.708	51.728	51.748	51.767	51.78
2340	51.787	51.806	51.826	51.845	51.865	51.885	51.904	51.924	51.943	51.963	51.98
2350	51.982	52.002	52.021	52.041	52.060	52.080	52.099	52.119	52.138	52.158	52.17
2360	52.177	52.197	52.216	52.235	52.255	52.274	52.294	52.313	52.333	52.352	52.37
2370	52.371	52.391	52.410	52.430	52.449	52.468	52.488	52.507	52.527	52.546	52.56
2380	52.565	52.585	52.604	52.623	52.643	52.662	52.681	52.701	52.720	52.739	52.75
2390	52.759	52.778	52.797	52.817	52.836	52.855	52.875	52.894	52.913	52.932	52.95
2400	52.952	52.971	52.990	53.010	53.029	53.048	53.067	53.087	53.106	53.125	53.14
2410	53.144	53.163	53.183	53.202	53.221	53.240	53.260	53.279	53.298	53.317	53.33
2420	53.336	53.355	53.375	53.394	53.413	53.432	53.451	53.470	53.490	53.509	53.52
2430	53.528	53.547	53.566	53.585	53.604	53.623	53.643	53.662	53.681	53.700	53.71
2440	53.719	53.738	53.757	53.776	53.795	53.814	53.833	53.852	53.871	53.890	53.91
2450	53.910	53.929	53.948	53.967	53.986	54.005	54.024	54.043	54.062	54.081	54.10
2460	54.100	54.119	54.138	54.157	54.176	54.195	54.214	54.233	54.252	54.271	54.28
2470	54.289	54.308	54.327	54.346	54.365	54.384	54.403	54.422	54.441	54.460	54.47
2480	54.479	54.498	54.517	54.536	54.554	54.573	54.592	54.611	54.630	54.649	54.66
2490	54.668	54.687	54.705	54.724	54.743	54.762	54.781	54.800	54.819	54.837	54.85
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type K thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
				Thermoelectric Voltage in mV							
350	14.293	14.335	14.377	14.419	14.461	14.503	14.545	14.587	14.629	14.671	14.71
360	14.713	14.755	14.797	14.839	14.881	14.923	14.965	15.007	15.049	15.091	15.13
370	15.133	15.175	15.217	15.259	15.301	15.343	15.385	15.427	15.469	15.511	15.55
380	15.554	15.596	15.638	15.680	15.722	15.764	15.806	15.849	15.891	15.933	15.97
390	15.975	16.017	16.059	16.102	16.144	16.186	16.228	16.270	16.313	16.355	16.39
400	16.397	16.439	16.482	16.524	16.566	16.608	16.651	16.693	16.735	16.778	16.82
410	16.820	16.862	16.904	16.947	16.989	17.031	17.074	17.116	17.158	17.201	17.24
420	17.243	17.285	17.328	17.370	17.413	17.455	17.497	17.540	17.582	17.624	17.66
430	17.667	17.709	17.752	17.794	17.837	17.879	17.921	17.964	18.006	18.049	18.09
440	18.091	18.134	18.176	18.218	18.261	18.303	18.346	18.388	18.431	18.473	18.51
450	18.516	18.558	18.601	18.643	18.686	18.728	18.771	18.813	18.856	18.898	18.94
460	18.941	18.983	19.026	19.068	19.111	19.154	19.196	19.239	19.281	19.324	19.36
470	19.366	19.409	19.451	19.494	19.537	19.579	19.622	19.664	19.707	19.750	19.79
480	19.792	19.835	19.877	19.920	19.962	20.005	20.048	20.090	20.133	20.175	20.21
490	20.218	20.261	20.303	20.346	20.389	20.431	20.474	20.516	20.559	20.602	20.64
500	20.644	20.687	20.730	20.772	20.815	20.857	20.900	20.943	20.985	21.028	21.07
510	21.071	21.113	21.156	21.199	21.241	21.284	21.326	21.369	21.412	21.454	21.49
520	21.497	21.540	21.582	21.625	21.668	21.710	21.753	21.796	21.838	21.881	21.92
530	21.924	21.966	22.009	22.052	22.094	22.137	22.179	22.222	22.265	22.307	22.35
540	22.350	22.393	22.435	22.478	22.521	22.563	22.606	22.649	22.691	22.734	22.77
550	22.776	22.819	22.862	22.904	22.947	22.990	23.032	23.075	23.117	23.160	23.20
560	23.203	23.245	23.288	23.331	23.373	23.416	23.458	23.501	23.544	23.586	23.62
570	23.629	23.671	23.714	23.757	23.799	23.842	23.884	23.927	23.970	24.012	24.05
580	24.055	24.097	24.140	24.182	24.225	24.267	24.310	24.353	24.395	24.438	24.48
590	24.480	24.523	24.565	24.608	24.650	24.693	24.735	24.778	24.820	24.863	24.90
600	24.905	24.948	24.990	25.033	25.075	25.118	25.160	25.203	25.245	25.288	25.33
610	25.330	25.373	25.415	25.458	25.500	25.543	25.585	25.627	25.670	25.712	25.75
620	25.755	25.797	25.840	25.882	25.924	25.967	26.009	26.052	26.094	26.136	26.17
630	26.179	26.221	26.263	26.306	26.348	26.390	26.433	26.475	26.517	26.560	26.60
640	26.602	26.644	26.687	26.729	26.771	26.814	26.856	26.898	26.940	26.983	27.02
650	27.025	27.067	27.109	27.152	27.194	27.236	27.278	27.320	27.363	27.405	27.44
660	27.447	27.489	27.531	27.574	27.616	27.658	27.700	27.742	27.784	27.826	27.86
670	27.869	27.911	27.953	27.995	28.037	28.079	28.121	28.163	28.205	28.247	28.28
680	28.289	28.332	28.374	28.416	28.458	28.500	28.542	28.584	28.626	28.668	28.71
690	28.710	28.752	28.794	28.835	28.877	28.919	28.961	29.003	29.045	29.087	29.12
700	29.129	29.171	29.213	29.255	29.297	29.338	29.380	29.422	29.464	29.506	29.54
710	29.548	29.589	29.631	29.673	29.715	29.757	29.798	29.840	29.882	29.924	29.96
720	29.965	30.007	30.049	30.090	30.132	30.174	30.216	30.257	30.299	30.341	30.38
730	30.382	30.424	30.466	30.507	30.549	30.590	30.632	30.674	30.715	30.757	30.79
740	30.798	30.840	30.881	30.923	30.964	31.006	31.047	31.089	31.130	31.172	31.21
750	31.213	31.255	31.296	31.338	31.379	31.421	31.462	31.504	31.545	31.586	31.62
760	31.628	31.669	31.710	31.752	31.793	31.834	31.876	31.917	31.958	32.000	32.04
770	32.041	32.082	32.124	32.165	32.206	32.247	32.289	32.330	32.371	32.412	32.45
780	32.453	32.495	32.536	32.577	32.618	32.659	32.700	32.742	32.783	32.824	32.86
790	32.865	32.906	32.947	32.988	33.029	33.070	33.111	33.152	33.193	33.234	33.27
800	33.275	33.316	33.357	33.398	33.439	33.480	33.521	33.562	33.603	33.644	33.68
810	33.685	33.726	33.767	33.808	33.848	33.889	33.930	33.971	34.012	34.053	34.09
820	34.093	34.134	34.175	34.216	34.257	34.297	34.338	34.379	34.420	34.460	34.50
830	34.501	34.542	34.582	34.623	34.664	34.704	34.745	34.786	34.826	34.867	34.90
840	34.908	34.948	34.989	35.029	35.070	35.110	35.151	35.192	35.232	35.273	35.31
850	35.313	35.354	35.394	35.435	35.475	35.516	35.556	35.596	35.637	35.677	35.71
860	35.718	35.758	35.798	35.839	35.879	35.920	35.960	36.000	36.041	36.081	36.12
870	36.121	36.162	36.202	36.242	36.282	36.323	36.363	36.403	36.443	36.484	36.52
880	36.524	36.564	36.604	36.644	36.685	36.725	36.765	36.805	36.845	36.885	36.92
890	36.925	36.965	37.006	37.046	37.086	37.126	37.166	37.206	37.246	37.286	37.32
900	37.326	37.366	37.406	37.446	37.486	37.526	37.566	37.606	37.646	37.686	37.72
910	37.725	37.765	37.805	37.845	37.885	37.925	37.965	38.005	38.044	38.084	38.12
920	38.124	38.164	38.204	38.243	38.283	38.323	38.363	38.402	38.442	38.482	38.52
930	38.522	38.561	38.601	38.641	38.680	38.720	38.760	38.799	38.839	38.878	38.91
940	38.918	38.958	38.997	39.037	39.076	39.116	39.155	39.195	39.235	39.274	39.31
950	39.314	39.353	39.393	39.432	39.471	39.511	39.550	39.590	39.629	39.669	39.70
960	39.708	39.747	39.787	39.826	39.866	39.905	39.944	39.984	40.023	40.062	40.10
970	40.101	40.141	40.180	40.219	40.259	40.298	40.337	40.376	40.415	40.455	40.49
980	40.494	40.533	40.572	40.611	40.651	40.690	40.729	40.768	40.807	40.846	40.88
990	40.885	40.924	40.963	41.002	41.042	41.081	41.120	41.159	41.198	41.237	41.27
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type K thermocouple

øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
				Thermoelectric Voltage in mV							
-260	-6.458	-6.457	-6.456	-6.455	-6.453	-6.452	-6.450	-6.448	-6.446	-6.444	-6.44
-250	-6.441	-6.438	-6.435	-6.432	-6.429	-6.425	-6.421	-6.417	-6.413	-6.408	-6.40
-240	-6.404	-6.399	-6.393	-6.388	-6.382	-6.377	-6.370	-6.364	-6.358	-6.351	-6.34
-230	-6.344	-6.337	-6.329	-6.322	-6.314	-6.306	-6.297	-6.289	-6.280	-6.271	-6.26
-220	-6.262	-6.252	-6.243	-6.233	-6.223	-6.213	-6.202	-6.192	-6.181	-6.170	-6.15
-210	-6.158	-6.147	-6.135	-6.123	-6.111	-6.099	-6.087	-6.074	-6.061	-6.048	-6.03
-200	-6.035	-6.021	-6.007	-5.994	-5.980	-5.965	-5.951	-5.936	-5.922	-5.907	-5.89
-190	-5.891	-5.876	-5.861	-5.845	-5.829	-5.813	-5.797	-5.780	-5.763	-5.747	-5.73
-180	-5.730	-5.713	-5.695	-5.678	-5.660	-5.642	-5.624	-5.606	-5.588	-5.569	-5.55
-170	-5.550	-5.531	-5.512	-5.493	-5.474	-5.454	-5.435	-5.415	-5.395	-5.374	-5.35
-160	-5.354	-5.333	-5.313	-5.292	-5.271	-5.250	-5.228	-5.207	-5.185	-5.163	-5.14
-150	-5.141	-5.119	-5.097	-5.074	-5.052	-5.029	-5.006	-4.983	-4.960	-4.936	-4.91
-140	-4.913	-4.889	-4.865	-4.841	-4.817	-4.793	-4.768	-4.744	-4.719	-4.694	-4.66
-130	-4.669	-4.644	-4.618	-4.593	-4.567	-4.542	-4.516	-4.490	-4.463	-4.437	-4.41
-120	-4.411	-4.384	-4.357	-4.330	-4.303	-4.276	-4.249	-4.221	-4.194	-4.166	-4.13
-110	-4.138	-4.110	-4.082	-4.054	-4.025	-3.997	-3.968	-3.939	-3.911	-3.882	-3.85
-100	-3.852	-3.823	-3.794	-3.764	-3.734	-3.705	-3.675	-3.645	-3.614	-3.584	-3.55
-90	-3.554	-3.523	-3.492	-3.462	-3.431	-3.400	-3.368	-3.337	-3.306	-3.274	-3.24
-80	-3.243	-3.211	-3.179	-3.147	-3.115	-3.083	-3.050	-3.018	-2.986	-2.953	-2.92
-70	-2.920	-2.887	-2.854	-2.821	-2.788	-2.755	-2.721	-2.688	-2.654	-2.620	-2.58
-60	-2.587	-2.553	-2.519	-2.485	-2.450	-2.416	-2.382	-2.347	-2.312	-2.278	-2.24
-50	-2.243	-2.208	-2.173	-2.138	-2.103	-2.067	-2.032	-1.996	-1.961	-1.925	-1.88
-40	-1.889	-1.854	-1.818	-1.782	-1.745	-1.709	-1.673	-1.637	-1.600	-1.564	-1.52
-30	-1.527	-1.490	-1.453	-1.417	-1.380	-1.343	-1.305	-1.268	-1.231	-1.194	-1.15
-20	-1.156	-1.119	-1.081	-1.043	-1.006	-0.968	-0.930	-0.892	-0.854	-0.816	-0.77
-10	-0.778	-0.739	-0.701	-0.663	-0.624	-0.586	-0.547	-0.508	-0.470	-0.431	-0.39
0	-0.392	-0.353	-0.314	-0.275	-0.236	-0.197	-0.157	-0.118	-0.079	-0.039	0.00

ITS-90 Table for type K thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
				Thermoelectric Voltage in mV							
0	0.000	0.039	0.079	0.119	0.158	0.198	0.238	0.277	0.317	0.357	0.39
10	0.397	0.437	0.477	0.517	0.557	0.597	0.637	0.677	0.718	0.758	0.79
20	0.798	0.838	0.879	0.919	0.960	1.000	1.041	1.081	1.122	1.163	1.20
30	1.203	1.244	1.285	1.326	1.366	1.407	1.448	1.489	1.530	1.571	1.61
40	1.612	1.653	1.694	1.735	1.776	1.817	1.858	1.899	1.941	1.982	2.02
50	2.023	2.064	2.106	2.147	2.188	2.230	2.271	2.312	2.354	2.395	2.43
60	2.436	2.478	2.519	2.561	2.602	2.644	2.685	2.727	2.768	2.810	2.85
70	2.851	2.893	2.934	2.976	3.017	3.059	3.100	3.142	3.184	3.225	3.26
80	3.267	3.308	3.350	3.391	3.433	3.474	3.516	3.557	3.599	3.640	3.68
90	3.682	3.723	3.765	3.806	3.848	3.889	3.931	3.972	4.013	4.055	4.09
100	4.096	4.138	4.179	4.220	4.262	4.303	4.344	4.385	4.427	4.468	4.50
110	4.509	4.550	4.591	4.633	4.674	4.715	4.756	4.797	4.838	4.879	4.92
120	4.920	4.961	5.002	5.043	5.084	5.124	5.165	5.206	5.247	5.288	5.32
130	5.328	5.369	5.410	5.450	5.491	5.532	5.572	5.613	5.653	5.694	5.73
140	5.735	5.775	5.815	5.856	5.896	5.937	5.977	6.017	6.058	6.098	6.13
150	6.138	6.179	6.219	6.259	6.299	6.339	6.380	6.420	6.460	6.500	6.54
160	6.540	6.580	6.620	6.660	6.701	6.741	6.781	6.821	6.861	6.901	6.94
170	6.941	6.981	7.021	7.060	7.100	7.140	7.180	7.220	7.260	7.300	7.34
180	7.340	7.380	7.420	7.460	7.500	7.540	7.579	7.619	7.659	7.699	7.73
190	7.739	7.779	7.819	7.859	7.899	7.939	7.979	8.019	8.059	8.099	8.13
200	8.138	8.178	8.218	8.258	8.298	8.338	8.378	8.418	8.458	8.499	8.53
210	8.539	8.579	8.619	8.659	8.699	8.739	8.779	8.819	8.860	8.900	8.94
220	8.940	8.980	9.020	9.061	9.101	9.141	9.181	9.222	9.262	9.302	9.34
230	9.343	9.383	9.423	9.464	9.504	9.545	9.585	9.626	9.666	9.707	9.74
240	9.747	9.788	9.828	9.869	9.909	9.950	9.991	10.031	10.072	10.113	10.15
250	10.153	10.194	10.235	10.276	10.316	10.357	10.398	10.439	10.480	10.520	10.56
260	10.561	10.602	10.643	10.684	10.725	10.766	10.807	10.848	10.889	10.930	10.97
270	10.971	11.012	11.053	11.094	11.135	11.176	11.217	11.259	11.300	11.341	11.38
280	11.382	11.423	11.465	11.506	11.547	11.588	11.630	11.671	11.712	11.753	11.79
290	11.795	11.836	11.877	11.919	11.960	12.001	12.043	12.084	12.126	12.167	12.20
300	12.209	12.250	12.291	12.333	12.374	12.416	12.457	12.499	12.540	12.582	12.62
310	12.624	12.665	12.707	12.748	12.790	12.831	12.873	12.915	12.956	12.998	13.04
320	13.040	13.081	13.123	13.165	13.206	13.248	13.290	13.331	13.373	13.415	13.45
330	13.457	13.498	13.540	13.582	13.624	13.665	13.707	13.749	13.791	13.833	13.87
340	13.874	13.916	13.958	14.000	14.042	14.084	14.126	14.167	14.209	14.251	14.29
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type K thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
1000	41.276	41.315	41.354	41.393	41.431	41.470	41.509	41.548	41.587	41.626	41.66
1010	41.665	41.704	41.743	41.781	41.820	41.859	41.898	41.937	41.976	42.014	42.05
1020	42.053	42.092	42.131	42.169	42.208	42.247	42.286	42.324	42.363	42.402	42.44
1030	42.440	42.479	42.518	42.556	42.595	42.633	42.672	42.711	42.749	42.788	42.82
1040	42.826	42.865	42.903	42.942	42.980	43.019	43.057	43.096	43.134	43.173	43.21
1050	43.211	43.250	43.288	43.327	43.365	43.403	43.442	43.480	43.518	43.557	43.59
1060	43.595	43.633	43.672	43.710	43.748	43.787	43.825	43.863	43.901	43.940	43.97
1070	43.978	44.016	44.054	44.092	44.130	44.169	44.207	44.245	44.283	44.321	44.35
1080	44.359	44.397	44.435	44.473	44.512	44.550	44.588	44.626	44.664	44.702	44.74
1090	44.740	44.778	44.816	44.853	44.891	44.929	44.967	45.005	45.043	45.081	45.11
1100	45.119	45.157	45.194	45.232	45.270	45.308	45.346	45.383	45.421	45.459	45.49
1110	45.497	45.534	45.572	45.610	45.647	45.685	45.723	45.760	45.798	45.836	45.87
1120	45.873	45.911	45.948	45.986	46.024	46.061	46.099	46.136	46.174	46.211	46.24
1130	46.249	46.286	46.324	46.361	46.398	46.436	46.473	46.511	46.548	46.585	46.62
1140	46.623	46.660	46.697	46.735	46.772	46.809	46.847	46.884	46.921	46.958	46.99
1150	46.995	47.033	47.070	47.107	47.144	47.181	47.218	47.256	47.293	47.330	47.36
1160	47.367	47.404	47.441	47.478	47.515	47.552	47.589	47.626	47.663	47.700	47.73
1170	47.737	47.774	47.811	47.848	47.884	47.921	47.958	47.995	48.032	48.069	48.10
1180	48.105	48.142	48.179	48.216	48.252	48.289	48.326	48.363	48.399	48.436	48.47
1190	48.473	48.509	48.546	48.582	48.619	48.656	48.692	48.729	48.765	48.802	48.83
1200	48.838	48.875	48.911	48.948	48.984	49.021	49.057	49.093	49.130	49.166	49.20
1210	49.202	49.239	49.275	49.311	49.348	49.384	49.420	49.456	49.493	49.529	49.56
1220	49.565	49.601	49.637	49.674	49.710	49.746	49.782	49.818	49.854	49.890	49.92
1230	49.926	49.962	49.998	50.034	50.070	50.106	50.142	50.178	50.214	50.250	50.28
1240	50.286	50.322	50.358	50.393	50.429	50.465	50.501	50.537	50.572	50.608	50.64
1250	50.644	50.680	50.715	50.751	50.787	50.822	50.858	50.894	50.929	50.965	51.00
1260	51.000	51.036	51.071	51.107	51.142	51.178	51.213	51.249	51.284	51.320	51.35
1270	51.355	51.391	51.426	51.461	51.497	51.532	51.567	51.603	51.638	51.673	51.70
1280	51.708	51.744	51.779	51.814	51.849	51.885	51.920	51.955	51.990	52.025	52.06
1290	52.060	52.095	52.130	52.165	52.200	52.235	52.270	52.305	52.340	52.375	52.41
1300	52.410	52.445	52.480	52.515	52.550	52.585	52.620	52.654	52.689	52.724	52.75
1310	52.759	52.794	52.828	52.863	52.898	52.932	52.967	53.002	53.037	53.071	53.10
1320	53.106	53.140	53.175	53.210	53.244	53.279	53.313	53.348	53.382	53.417	53.45
1330	53.451	53.486	53.520	53.555	53.589	53.623	53.658	53.692	53.727	53.761	53.79
1340	53.795	53.830	53.864	53.898	53.932	53.967	54.001	54.035	54.069	54.104	54.13
1350	54.138	54.172	54.206	54.240	54.274	54.308	54.343	54.377	54.411	54.445	54.47
1360	54.479	54.513	54.547	54.581	54.615	54.649	54.683	54.717	54.751	54.785	54.81

øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type N thermocouple

øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
					Thermoelectric Voltage in mV						
-260	-4.345	-4.345	-4.344	-4.344	-4.343	-4.342	-4.341	-4.340	-4.339	-4.337	-4.33
-250	-4.336	-4.334	-4.332	-4.330	-4.328	-4.326	-4.324	-4.321	-4.319	-4.316	-4.31
-240	-4.313	-4.310	-4.307	-4.304	-4.300	-4.297	-4.293	-4.289	-4.285	-4.281	-4.27
-230	-4.277	-4.273	-4.268	-4.263	-4.258	-4.254	-4.248	-4.243	-4.238	-4.232	-4.22
-220	-4.226	-4.221	-4.215	-4.209	-4.202	-4.196	-4.189	-4.183	-4.176	-4.169	-4.16
-210	-4.162	-4.154	-4.147	-4.140	-4.132	-4.124	-4.116	-4.108	-4.100	-4.091	-4.08
-200	-4.083	-4.074	-4.066	-4.057	-4.048	-4.038	-4.029	-4.020	-4.010	-4.000	-3.99
-190	-3.990	-3.980	-3.970	-3.960	-3.950	-3.939	-3.928	-3.918	-3.907	-3.896	-3.88
-180	-3.884	-3.873	-3.862	-3.850	-3.838	-3.827	-3.815	-3.803	-3.790	-3.778	-3.76
-170	-3.766	-3.753	-3.740	-3.728	-3.715	-3.702	-3.688	-3.675	-3.662	-3.648	-3.63
-160	-3.634	-3.621	-3.607	-3.593	-3.578	-3.564	-3.550	-3.535	-3.521	-3.506	-3.49
-150	-3.491	-3.476	-3.461	-3.446	-3.431	-3.415	-3.400	-3.384	-3.368	-3.352	-3.33
-140	-3.336	-3.320	-3.304	-3.288	-3.271	-3.255	-3.238	-3.221	-3.205	-3.188	-3.17
-130	-3.171	-3.153	-3.136	-3.119	-3.101	-3.084	-3.066	-3.048	-3.030	-3.012	-2.99
-120	-2.994	-2.976	-2.958	-2.939	-2.921	-2.902	-2.883	-2.865	-2.846	-2.827	-2.80
-110	-2.808	-2.789	-2.769	-2.750	-2.730	-2.711	-2.691	-2.672	-2.652	-2.632	-2.61
-100	-2.612	-2.592	-2.571	-2.551	-2.531	-2.510	-2.490	-2.469	-2.448	-2.428	-2.40
-90	-2.407	-2.386	-2.365	-2.344	-2.322	-2.301	-2.280	-2.258	-2.237	-2.215	-2.19
-80	-2.193	-2.172	-2.150	-2.128	-2.106	-2.084	-2.062	-2.039	-2.017	-1.995	-1.97
-70	-1.972	-1.950	-1.927	-1.905	-1.882	-1.859	-1.836	-1.813	-1.790	-1.767	-1.74
-60	-1.744	-1.721	-1.698	-1.674	-1.651	-1.627	-1.604	-1.580	-1.557	-1.533	-1.50
-50	-1.509	-1.485	-1.462	-1.438	-1.414	-1.390	-1.366	-1.341	-1.317	-1.293	-1.26

øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type N thermocouple

øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
					Thermoelectric Voltage in mV						
-40	-1.269	-1.244	-1.220	-1.195	-1.171	-1.146	-1.122	-1.097	-1.072	-1.048	-1.02
-30	-1.023	-0.998	-0.973	-0.948	-0.923	-0.898	-0.873	-0.848	-0.823	-0.798	-0.77
-20	-0.772	-0.747	-0.722	-0.696	-0.671	-0.646	-0.620	-0.595	-0.569	-0.544	-0.51
-10	-0.518	-0.492	-0.467	-0.441	-0.415	-0.390	-0.364	-0.338	-0.312	-0.286	-0.26
0	-0.260	-0.234	-0.209	-0.183	-0.157	-0.131	-0.104	-0.078	-0.052	-0.026	0.00

øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

ITS-90 Table for type N thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
0	0.000	0.026	0.052	0.078	0.104	0.130	0.156	0.182	0.208	0.235	0.26
10	0.261	0.287	0.313	0.340	0.366	0.393	0.419	0.446	0.472	0.499	0.52
20	0.525	0.552	0.578	0.605	0.632	0.659	0.685	0.712	0.739	0.766	0.79
30	0.793	0.820	0.847	0.874	0.901	0.928	0.955	0.983	1.010	1.037	1.06
40	1.065	1.092	1.119	1.147	1.174	1.202	1.229	1.257	1.284	1.312	1.34
50	1.340	1.368	1.395	1.423	1.451	1.479	1.507	1.535	1.563	1.591	1.61
60	1.619	1.647	1.675	1.703	1.732	1.760	1.788	1.817	1.845	1.873	1.90
70	1.902	1.930	1.959	1.988	2.016	2.045	2.074	2.102	2.131	2.160	2.18
80	2.189	2.218	2.247	2.276	2.305	2.334	2.363	2.392	2.421	2.450	2.48
90	2.480	2.509	2.538	2.568	2.597	2.626	2.656	2.685	2.715	2.744	2.77
100	2.774	2.804	2.833	2.863	2.893	2.923	2.953	2.983	3.012	3.042	3.07
110	3.072	3.102	3.133	3.163	3.193	3.223	3.253	3.283	3.314	3.344	3.37
120	3.374	3.405	3.435	3.466	3.496	3.527	3.557	3.588	3.619	3.649	3.68
130	3.680	3.711	3.742	3.772	3.803	3.834	3.865	3.896	3.927	3.958	3.98
140	3.989	4.020	4.051	4.083	4.114	4.145	4.176	4.208	4.239	4.270	4.30
150	4.302	4.333	4.365	4.396	4.428	4.459	4.491	4.523	4.554	4.586	4.61
160	4.618	4.650	4.681	4.713	4.745	4.777	4.809	4.841	4.873	4.905	4.93
170	4.937	4.969	5.001	5.033	5.066	5.098	5.130	5.162	5.195	5.227	5.25
180	5.259	5.292	5.324	5.357	5.389	5.422	5.454	5.487	5.520	5.552	5.58
190	5.585	5.618	5.650	5.683	5.716	5.749	5.782	5.815	5.847	5.880	5.91
200	5.913	5.946	5.979	6.013	6.046	6.079	6.112	6.145	6.178	6.211	6.24
210	6.245	6.278	6.311	6.345	6.378	6.411	6.445	6.478	6.512	6.545	6.57
220	6.579	6.612	6.646	6.680	6.713	6.747	6.781	6.814	6.848	6.882	6.91
230	6.916	6.949	6.983	7.017	7.051	7.085	7.119	7.153	7.187	7.221	7.25
240	7.255	7.289	7.323	7.357	7.392	7.426	7.460	7.494	7.528	7.563	7.59
250	7.597	7.631	7.666	7.700	7.734	7.769	7.803	7.838	7.872	7.907	7.94
260	7.941	7.976	8.010	8.045	8.080	8.114	8.149	8.184	8.218	8.253	8.28
270	8.288	8.323	8.358	8.392	8.427	8.462	8.497	8.532	8.567	8.602	8.63
280	8.637	8.672	8.707	8.742	8.777	8.812	8.847	8.882	8.918	8.953	8.98
290	8.988	9.023	9.058	9.094	9.129	9.164	9.200	9.235	9.270	9.306	9.34
300	9.341	9.377	9.412	9.448	9.483	9.519	9.554	9.590	9.625	9.661	9.69
310	9.696	9.732	9.768	9.803	9.839	9.875	9.910	9.946	9.982	10.018	10.05
320	10.054	10.089	10.125	10.161	10.197	10.233	10.269	10.305	10.341	10.377	10.41
330	10.413	10.449	10.485	10.521	10.557	10.593	10.629	10.665	10.701	10.737	10.77
340	10.774	10.810	10.846	10.882	10.918	10.955	10.991	11.027	11.064	11.100	11.13
350	11.136	11.173	11.209	11.245	11.282	11.318	11.355	11.391	11.428	11.464	11.50
360	11.501	11.537	11.574	11.610	11.647	11.683	11.720	11.757	11.793	11.830	11.86
370	11.867	11.903	11.940	11.977	12.013	12.050	12.087	12.124	12.160	12.197	12.23
380	12.234	12.271	12.308	12.345	12.382	12.418	12.455	12.492	12.529	12.566	12.60
390	12.603	12.640	12.677	12.714	12.751	12.788	12.825	12.862	12.899	12.937	12.97
400	12.974	13.011	13.048	13.085	13.122	13.159	13.197	13.234	13.271	13.308	13.34
410	13.346	13.383	13.420	13.457	13.495	13.532	13.569	13.607	13.644	13.682	13.71
420	13.719	13.756	13.794	13.831	13.869	13.906	13.944	13.981	14.019	14.056	14.09
430	14.094	14.131	14.169	14.206	14.244	14.281	14.319	14.356	14.394	14.432	14.46
440	14.469	14.507	14.545	14.582	14.620	14.658	14.695	14.733	14.771	14.809	14.84
450	14.846	14.884	14.922	14.960	14.998	15.035	15.073	15.111	15.149	15.187	15.22
460	15.225	15.262	15.300	15.338	15.376	15.414	15.452	15.490	15.528	15.566	15.60
470	15.604	15.642	15.680	15.718	15.756	15.794	15.832	15.870	15.908	15.946	15.98
480	15.984	16.022	16.060	16.099	16.137	16.175	16.213	16.251	16.289	16.327	16.36
490	16.366	16.404	16.442	16.480	16.518	16.557	16.595	16.633	16.671	16.710	16.74
500	16.748	16.786	16.824	16.863	16.901	16.939	16.978	17.016	17.054	17.093	17.13
510	17.131	17.169	17.208	17.246	17.285	17.323	17.361	17.400	17.438	17.477	17.51
520	17.515	17.554	17.592	17.630	17.669	17.707	17.746	17.784	17.823	17.861	17.90
530	17.900	17.938	17.977	18.016	18.054	18.093	18.131	18.170	18.208	18.247	18.28
540	18.286	18.324	18.363	18.401	18.440	18.479	18.517	18.556	18.595	18.633	18.67

øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type N thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
550	18.672	18.711	18.749	18.788	18.827	18.865	18.904	18.943	18.982	19.020	19.05
560	19.059	19.098	19.136	19.175	19.214	19.253	19.292	19.330	19.369	19.408	19.44
570	19.447	19.485	19.524	19.563	19.602	19.641	19.680	19.718	19.757	19.796	19.83
580	19.835	19.874	19.913	19.952	19.990	20.029	20.068	20.107	20.146	20.185	20.22
590	20.224	20.263	20.302	20.341	20.379	20.418	20.457	20.496	20.535	20.574	20.61
600	20.613	20.652	20.691	20.730	20.769	20.808	20.847	20.886	20.925	20.964	21.00
610	21.003	21.042	21.081	21.120	21.159	21.198	21.237	21.276	21.315	21.354	21.39
620	21.393	21.432	21.471	21.510	21.549	21.588	21.628	21.667	21.706	21.745	21.78
630	21.784	21.823	21.862	21.901	21.940	21.979	22.018	22.058	22.097	22.136	22.17
640	22.175	22.214	22.253	22.292	22.331	22.370	22.410	22.449	22.488	22.527	22.56
650	22.566	22.605	22.644	22.684	22.723	22.762	22.801	22.840	22.879	22.919	22.95
660	22.958	22.997	23.036	23.075	23.115	23.154	23.193	23.232	23.271	23.311	23.35
670	23.350	23.389	23.428	23.467	23.507	23.546	23.585	23.624	23.663	23.703	23.74
680	23.742	23.781	23.820	23.860	23.899	23.938	23.977	24.016	24.056	24.095	24.13
690	24.134	24.173	24.213	24.252	24.291	24.330	24.370	24.409	24.448	24.487	24.52
700	24.527	24.566	24.605	24.644	24.684	24.723	24.762	24.801	24.841	24.880	24.91
710	24.919	24.959	24.998	25.037	25.076	25.116	25.155	25.194	25.233	25.273	25.31
720	25.312	25.351	25.391	25.430	25.469	25.508	25.548	25.587	25.626	25.666	25.70
730	25.705	25.744	25.783	25.823	25.862	25.901	25.941	25.980	26.019	26.058	26.09
740	26.098	26.137	26.176	26.216	26.255	26.294	26.333	26.373	26.412	26.451	26.49
750	26.491	26.530	26.569	26.608	26.648	26.687	26.726	26.766	26.805	26.844	26.88
760	26.883	26.923	26.962	27.001	27.041	27.080	27.119	27.158	27.198	27.237	27.27
770	27.276	27.316	27.355	27.394	27.433	27.473	27.512	27.551	27.591	27.630	27.66
780	27.669	27.708	27.748	27.787	27.826	27.866	27.905	27.944	27.983	28.023	28.06
790	28.062	28.101	28.140	28.180	28.219	28.258	28.297	28.337	28.376	28.415	28.45
800	28.455	28.494	28.533	28.572	28.612	28.651	28.690	28.729	28.769	28.808	28.84
810	28.847	28.886	28.926	28.965	29.004	29.043	29.083	29.122	29.161	29.200	29.23
820	29.239	29.279	29.318	29.357	29.396	29.436	29.475	29.514	29.553	29.592	29.63
830	29.632	29.671	29.710	29.749	29.789	29.828	29.867	29.906	29.945	29.985	30.02
840	30.024	30.063	30.102	30.141	30.181	30.220	30.259	30.298	30.337	30.376	30.41
850	30.416	30.455	30.494	30.533	30.572	30.611	30.651	30.690	30.729	30.768	30.80
860	30.807	30.846	30.886	30.925	30.964	31.003	31.042	31.081	31.120	31.160	31.19
870	31.199	31.238	31.277	31.316	31.355	31.394	31.433	31.473	31.512	31.551	31.59
880	31.590	31.629	31.668	31.707	31.746	31.785	31.824	31.863	31.903	31.942	31.98
890	31.981	32.020	32.059	32.098	32.137	32.176	32.215	32.254	32.293	32.332	32.37
900	32.371	32.410	32.449	32.488	32.527	32.566	32.605	32.644	32.683	32.722	32.76
910	32.761	32.800	32.839	32.878	32.917	32.956	32.995	33.034	33.073	33.112	33.15
920	33.151	33.190	33.229	33.268	33.307	33.346	33.385	33.424	33.463	33.502	33.54
930	33.541	33.580	33.619	33.658	33.697	33.736	33.774	33.813	33.852	33.891	33.93
940	33.930	33.969	34.008	34.047	34.086	34.124	34.163	34.202	34.241	34.280	34.31
950	34.319	34.358	34.396	34.435	34.474	34.513	34.552	34.591	34.629	34.668	34.70
960	34.707	34.746	34.785	34.823	34.862	34.901	34.940	34.979	35.017	35.056	35.09
970	35.095	35.134	35.172	35.211	35.250	35.289	35.327	35.366	35.405	35.444	35.48
980	35.482	35.521	35.560	35.598	35.637	35.676	35.714	35.753	35.792	35.831	35.86
990	35.869	35.908	35.946	35.985	36.024	36.062	36.101	36.140	36.178	36.217	36.25
1000	36.256	36.294	36.333	36.371	36.410	36.449	36.487	36.526	36.564	36.603	36.64
1010	36.641	36.680	36.718	36.757	36.796	36.834	36.873	36.911	36.950	36.988	37.02
1020	37.027	37.065	37.104	37.142	37.181	37.219	37.258	37.296	37.334	37.373	37.41
1030	37.411	37.450	37.488	37.527	37.565	37.603	37.642	37.680	37.719	37.757	37.79
1040	37.795	37.834	37.872	37.911	37.949	37.987	38.026	38.064	38.102	38.141	38.17
1050	38.179	38.217	38.256	38.294	38.332	38.370	38.409	38.447	38.485	38.524	38.56
1060	38.562	38.600	38.638	38.677	38.715	38.753	38.791	38.829	38.868	38.906	38.94
1070	38.944	38.982	39.020	39.059	39.097	39.135	39.173	39.211	39.249	39.287	39.32
1080	39.326	39.364	39.402	39.440	39.478	39.516	39.554	39.592	39.630	39.668	39.70
1090	39.706	39.744	39.783	39.821	39.859	39.897	39.935	39.973	40.011	40.049	40.08
1100	40.087	40.125	40.163	40.201	40.238	40.276	40.314	40.352	40.390	40.428	40.46
1110	40.466	40.504	40.542	40.580	40.618	40.655	40.693	40.731	40.769	40.807	40.84
1120	40.845	40.883	40.920	40.958	40.996	41.034	41.072	41.109	41.147	41.185	41.22
1130	41.223	41.260	41.298	41.336	41.374	41.411	41.449	41.487	41.525	41.562	41.60
1140	41.600	41.638	41.675	41.713	41.751	41.788	41.826	41.864	41.901	41.939	41.97
1150	41.976	42.014	42.052	42.089	42.127	42.164	42.202	42.239	42.277	42.314	42.35
1160	42.352	42.390	42.427	42.465	42.502	42.540	42.577	42.614	42.652	42.689	42.72
1170	42.727	42.764	42.802	42.839	42.877	42.914	42.951	42.989	43.026	43.064	43.10
1180	43.101	43.138	43.176	43.213	43.250	43.288	43.325	43.362	43.399	43.437	43.47
1190	43.474	43.511	43.549	43.586	43.623	43.660	43.698	43.735	43.772	43.809	43.84
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type N thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
1100	40.087	40.125	40.163	40.201	40.238	40.276	40.314	40.352	40.390	40.428	40.46
1110	40.466	40.504	40.542	40.580	40.618	40.655	40.693	40.731	40.769	40.807	40.84
1120	40.845	40.883	40.920	40.958	40.996	41.034	41.072	41.109	41.147	41.185	41.22
1130	41.223	41.260	41.298	41.336	41.374	41.411	41.449	41.487	41.525	41.562	41.60
1140	41.600	41.638	41.675	41.713	41.751	41.788	41.826	41.864	41.901	41.939	41.97
1150	41.976	42.014	42.052	42.089	42.127	42.164	42.202	42.239	42.277	42.314	42.35
1160	42.352	42.390	42.427	42.465	42.502	42.540	42.577	42.614	42.652	42.689	42.72
1170	42.727	42.764	42.802	42.839	42.877	42.914	42.951	42.989	43.026	43.064	43.10
1180	43.101	43.138	43.176	43.213	43.250	43.288	43.325	43.362	43.399	43.437	43.47
1190	43.474	43.511	43.549	43.586	43.623	43.660	43.698	43.735	43.772	43.809	43.84
1200	43.846	43.884	43.921	43.958	43.995	44.032	44.069	44.106	44.144	44.181	44.21
1210	44.218	44.255	44.292	44.329	44.366	44.403	44.440	44.477	44.514	44.551	44.58
1220	44.588	44.625	44.662	44.699	44.736	44.773	44.810	44.847	44.884	44.921	44.95
1230	44.958	44.995	45.032	45.069	45.105	45.142	45.179	45.216	45.253	45.290	45.32
1240	45.326	45.363	45.400	45.437	45.474	45.510	45.547	45.584	45.621	45.657	45.69
1250	45.694	45.731	45.767	45.804	45.841	45.877	45.914	45.951	45.987	46.024	46.06
1260	46.060	46.097	46.133	46.170	46.207	46.243	46.280	46.316	46.353	46.389	46.42
1270	46.425	46.462	46.498	46.535	46.571	46.608	46.644	46.680	46.717	46.753	46.78
1280	46.789	46.826	46.862	46.898	46.935	46.971	47.007	47.043	47.079	47.116	47.15
1290	47.152	47.188	47.224	47.260	47.296	47.333	47.369	47.405	47.441	47.477	47.51
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type N thermocouple

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
					Thermoelectric Voltage in mV						
-440	-4.344	-4.344	-4.343	-4.343	-4.342	-4.342	-4.341	-4.341	-4.340	-4.340	-4.33
-430	-4.339	-4.338	-4.337	-4.337	-4.336	-4.335	-4.334	-4.333	-4.332	-4.331	-4.33
-420	-4.330	-4.329	-4.327	-4.326	-4.325	-4.324	-4.322	-4.321	-4.319	-4.318	-4.31
-410	-4.316	-4.315	-4.313	-4.312	-4.310	-4.308	-4.306	-4.305	-4.303	-4.301	-4.29
-400	-4.299	-4.297	-4.295	-4.293	-4.291	-4.288	-4.286	-4.284	-4.282	-4.279	-4.27
-390	-4.277	-4.275	-4.272	-4.270	-4.267	-4.264	-4.262	-4.259	-4.256	-4.254	-4.25
-380	-4.251	-4.248	-4.245	-4.242	-4.239	-4.236	-4.233	-4.230	-4.226	-4.223	-4.22
-370	-4.220	-4.217	-4.213	-4.210	-4.206	-4.203	-4.199	-4.196	-4.192	-4.189	-4.18
-360	-4.185	-4.181	-4.177	-4.174	-4.170	-4.166	-4.162	-4.158	-4.154	-4.150	-4.14
-350	-4.145	-4.141	-4.137	-4.133	-4.128	-4.124	-4.120	-4.115	-4.111	-4.106	-4.10
-340	-4.102	-4.097	-4.092	-4.088	-4.083	-4.078	-4.073	-4.068	-4.064	-4.059	-4.05
-330	-4.054	-4.049	-4.043	-4.038	-4.033	-4.028	-4.023	-4.017	-4.012	-4.007	-4.00
-320	-4.001	-3.996	-3.990	-3.985	-3.979	-3.974	-3.968	-3.962	-3.957	-3.951	-3.94
-310	-3.945	-3.939	-3.933	-3.927	-3.921	-3.915	-3.909	-3.903	-3.897	-3.891	-3.88
-300	-3.884	-3.878	-3.872	-3.866	-3.859	-3.853	-3.846	-3.840	-3.833	-3.827	-3.82
-290	-3.820	-3.813	-3.807	-3.800	-3.793	-3.786	-3.779	-3.773	-3.766	-3.759	-3.75
-280	-3.752	-3.745	-3.738	-3.730	-3.723	-3.716	-3.709	-3.702	-3.694	-3.687	-3.67
-270	-3.679	-3.672	-3.665	-3.657	-3.650	-3.642	-3.634	-3.627	-3.619	-3.611	-3.60
-260	-3.604	-3.596	-3.588	-3.580	-3.572	-3.564	-3.556	-3.548	-3.540	-3.532	-3.52
-250	-3.524	-3.516	-3.508	-3.499	-3.491	-3.483	-3.474	-3.466	-3.458	-3.449	-3.44
-240	-3.441	-3.432	-3.424	-3.415	-3.407	-3.398	-3.389	-3.380	-3.372	-3.363	-3.35
-230	-3.354	-3.345	-3.336	-3.327	-3.318	-3.309	-3.300	-3.291	-3.282	-3.273	-3.26
-220	-3.264	-3.255	-3.246	-3.236	-3.227	-3.218	-3.208	-3.199	-3.189	-3.180	-3.17
-210	-3.171	-3.161	-3.151	-3.142	-3.132	-3.123	-3.113	-3.103	-3.093	-3.084	-3.07
-200	-3.074	-3.064	-3.054	-3.044	-3.034	-3.024	-3.014	-3.004	-2.994	-2.984	-2.97
-190	-2.974	-2.964	-2.954	-2.943	-2.933	-2.923	-2.912	-2.902	-2.892	-2.881	-2.87
-180	-2.871	-2.860	-2.850	-2.839	-2.829	-2.818	-2.808	-2.797	-2.786	-2.776	-2.76
-170	-2.765	-2.754	-2.743	-2.733	-2.722	-2.711	-2.700	-2.689	-2.678	-2.667	-2.65
-160	-2.656	-2.645	-2.634	-2.623	-2.612	-2.601	-2.589	-2.578	-2.567	-2.556	-2.54
-150	-2.544	-2.533	-2.522	-2.510	-2.499	-2.488	-2.476	-2.465	-2.453	-2.442	-2.43
-140	-2.430	-2.418	-2.407	-2.395	-2.384	-2.372	-2.360	-2.348	-2.337	-2.325	-2.31
-130	-2.313	-2.301	-2.289	-2.277	-2.265	-2.254	-2.242	-2.230	-2.218	-2.206	-2.19
-120	-2.193	-2.181	-2.169	-2.157	-2.145	-2.133	-2.121	-2.108	-2.096	-2.084	-2.07
-110	-2.072	-2.059	-2.047	-2.035	-2.022	-2.010	-1.997	-1.985	-1.972	-1.960	-1.94
-100	-1.947	-1.935	-1.922	-1.910	-1.897	-1.884	-1.872	-1.859	-1.846	-1.834	-1.82
-90	-1.821	-1.808	-1.795	-1.783	-1.770	-1.757	-1.744	-1.731	-1.718	-1.705	-1.69
-80	-1.692	-1.679	-1.666	-1.653	-1.640	-1.627	-1.614	-1.601	-1.588	-1.575	-1.56
-70	-1.562	-1.549	-1.536	-1.522	-1.509	-1.496	-1.483	-1.470	-1.456	-1.443	-1.43
-60	-1.430	-1.416	-1.403	-1.390	-1.376	-1.363	-1.349	-1.336	-1.323	-1.309	-1.29
-50	-1.296	-1.282	-1.269	-1.255	-1.242	-1.228	-1.214	-1.201	-1.187	-1.174	-1.16
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type N thermocouple

Thermoelectric Voltage in mV

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
-40	-1.160	-1.146	-1.133	-1.119	-1.105	-1.092	-1.078	-1.064	-1.050	-1.037	-1.02
-30	-1.023	-1.009	-0.995	-0.981	-0.967	-0.954	-0.940	-0.926	-0.912	-0.898	-0.88
-20	-0.884	-0.870	-0.856	-0.842	-0.828	-0.814	-0.800	-0.786	-0.772	-0.758	-0.74
-10	-0.744	-0.730	-0.716	-0.702	-0.688	-0.674	-0.660	-0.646	-0.632	-0.617	-0.60
0	-0.603	-0.589	-0.575	-0.561	-0.546	-0.532	-0.518	-0.504	-0.490	-0.475	-0.46

ITS-90 Table for type N thermocouple

Thermoelectric Voltage in mV

øF	0	1	2	3	4	5	6	7	8	9	10
0	-0.461	-0.447	-0.433	-0.418	-0.404	-0.390	-0.375	-0.361	-0.347	-0.332	-0.31
10	-0.318	-0.304	-0.289	-0.275	-0.260	-0.246	-0.232	-0.217	-0.203	-0.188	-0.17
20	-0.174	-0.159	-0.145	-0.131	-0.116	-0.102	-0.087	-0.073	-0.058	-0.044	-0.02
30	-0.029	-0.015	0.000	0.014	0.029	0.043	0.058	0.072	0.087	0.101	0.11
40	0.116	0.130	0.145	0.159	0.174	0.188	0.203	0.217	0.232	0.246	0.26
50	0.261	0.275	0.290	0.305	0.319	0.334	0.349	0.363	0.378	0.393	0.40
60	0.407	0.422	0.437	0.451	0.466	0.481	0.496	0.510	0.525	0.540	0.55
70	0.555	0.570	0.584	0.599	0.614	0.629	0.644	0.659	0.674	0.688	0.70
80	0.703	0.718	0.733	0.748	0.763	0.778	0.793	0.808	0.823	0.838	0.85
90	0.853	0.868	0.883	0.898	0.913	0.928	0.943	0.958	0.974	0.989	1.00
100	1.004	1.019	1.034	1.049	1.065	1.080	1.095	1.110	1.125	1.141	1.15
110	1.156	1.171	1.186	1.202	1.217	1.232	1.248	1.263	1.278	1.294	1.30
120	1.309	1.324	1.340	1.355	1.371	1.386	1.402	1.417	1.432	1.448	1.46
130	1.463	1.479	1.494	1.510	1.525	1.541	1.557	1.572	1.588	1.603	1.61
140	1.619	1.635	1.650	1.666	1.682	1.697	1.713	1.729	1.744	1.760	1.77
150	1.776	1.791	1.807	1.823	1.839	1.855	1.870	1.886	1.902	1.918	1.93
160	1.934	1.950	1.965	1.981	1.997	2.013	2.029	2.045	2.061	2.077	2.09
170	2.093	2.109	2.125	2.141	2.157	2.173	2.189	2.205	2.221	2.237	2.25
180	2.253	2.269	2.285	2.301	2.318	2.334	2.350	2.366	2.382	2.398	2.41
190	2.415	2.431	2.447	2.463	2.480	2.496	2.512	2.528	2.545	2.561	2.57
200	2.577	2.594	2.610	2.626	2.643	2.659	2.676	2.692	2.708	2.725	2.74
210	2.741	2.758	2.774	2.791	2.807	2.824	2.840	2.857	2.873	2.890	2.90
220	2.906	2.923	2.939	2.956	2.973	2.989	3.006	3.022	3.039	3.056	3.07
230	3.072	3.089	3.106	3.123	3.139	3.156	3.173	3.189	3.206	3.223	3.24
240	3.240	3.257	3.273	3.290	3.307	3.324	3.341	3.358	3.374	3.391	3.40
250	3.408	3.425	3.442	3.459	3.476	3.493	3.510	3.527	3.544	3.561	3.57
260	3.578	3.595	3.612	3.629	3.646	3.663	3.680	3.697	3.714	3.731	3.74
270	3.748	3.766	3.783	3.800	3.817	3.834	3.851	3.869	3.886	3.903	3.92
280	3.920	3.937	3.955	3.972	3.989	4.007	4.024	4.041	4.058	4.076	4.09
290	4.093	4.110	4.128	4.145	4.162	4.180	4.197	4.215	4.232	4.250	4.26
300	4.267	4.284	4.302	4.319	4.337	4.354	4.372	4.389	4.407	4.424	4.44
310	4.442	4.459	4.477	4.495	4.512	4.530	4.547	4.565	4.583	4.600	4.61
320	4.618	4.635	4.653	4.671	4.688	4.706	4.724	4.742	4.759	4.777	4.79
330	4.795	4.813	4.830	4.848	4.866	4.884	4.901	4.919	4.937	4.955	4.97
340	4.973	4.991	5.008	5.026	5.044	5.062	5.080	5.098	5.116	5.134	5.15
350	5.152	5.170	5.188	5.206	5.224	5.241	5.259	5.277	5.295	5.314	5.33
360	5.332	5.350	5.368	5.386	5.404	5.422	5.440	5.458	5.476	5.494	5.51
370	5.512	5.531	5.549	5.567	5.585	5.603	5.621	5.639	5.658	5.676	5.69
380	5.694	5.712	5.731	5.749	5.767	5.785	5.804	5.822	5.840	5.858	5.87
390	5.877	5.895	5.913	5.932	5.950	5.968	5.987	6.005	6.024	6.042	6.06
400	6.060	6.079	6.097	6.116	6.134	6.152	6.171	6.189	6.208	6.226	6.24
410	6.245	6.263	6.282	6.300	6.319	6.337	6.356	6.374	6.393	6.411	6.43
420	6.430	6.449	6.467	6.486	6.504	6.523	6.542	6.560	6.579	6.597	6.61
430	6.616	6.635	6.653	6.672	6.691	6.710	6.728	6.747	6.766	6.784	6.80
440	6.803	6.822	6.841	6.859	6.878	6.897	6.916	6.934	6.953	6.972	6.99
450	6.991	7.010	7.029	7.047	7.066	7.085	7.104	7.123	7.142	7.161	7.17
460	7.179	7.198	7.217	7.236	7.255	7.274	7.293	7.312	7.331	7.350	7.36
470	7.369	7.388	7.407	7.426	7.445	7.464	7.483	7.502	7.521	7.540	7.55
480	7.559	7.578	7.597	7.616	7.635	7.654	7.673	7.692	7.711	7.731	7.75
490	7.750	7.769	7.788	7.807	7.826	7.845	7.865	7.884	7.903	7.922	7.94
500	7.941	7.960	7.980	7.999	8.018	8.037	8.057	8.076	8.095	8.114	8.13
510	8.134	8.153	8.172	8.191	8.211	8.230	8.249	8.269	8.288	8.307	8.32
520	8.327	8.346	8.365	8.385	8.404	8.423	8.443	8.462	8.482	8.501	8.52
530	8.520	8.540	8.559	8.579	8.598	8.617	8.637	8.656	8.676	8.695	8.71
540	8.715	8.734	8.754	8.773	8.793	8.812	8.832	8.851	8.871	8.890	8.91
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type N thermocouple

Thermoelectric Voltage in mV

øF	0	1	2	3	4	5	6	7	8	9	10
550	8.910	8.929	8.949	8.968	8.988	9.008	9.027	9.047	9.066	9.086	9.10
560	9.105	9.125	9.145	9.164	9.184	9.204	9.223	9.243	9.262	9.282	9.30
570	9.302	9.321	9.341	9.361	9.381	9.400	9.420	9.440	9.459	9.479	9.49
580	9.499	9.519	9.538	9.558	9.578	9.598	9.617	9.637	9.657	9.677	9.69
590	9.696	9.716	9.736	9.756	9.776	9.795	9.815	9.835	9.855	9.875	9.89
600	9.895	9.914	9.934	9.954	9.974	9.994	10.014	10.034	10.054	10.073	10.09
610	10.093	10.113	10.133	10.153	10.173	10.193	10.213	10.233	10.253	10.273	10.29
620	10.293	10.313	10.333	10.353	10.373	10.393	10.413	10.433	10.453	10.473	10.49
630	10.493	10.513	10.533	10.553	10.573	10.593	10.613	10.633	10.653	10.673	10.69
640	10.693	10.713	10.733	10.753	10.774	10.794	10.814	10.834	10.854	10.874	10.89
650	10.894	10.914	10.934	10.955	10.975	10.995	11.015	11.035	11.055	11.076	11.09
660	11.096	11.116	11.136	11.156	11.177	11.197	11.217	11.237	11.257	11.278	11.29
670	11.298	11.318	11.338	11.359	11.379	11.399	11.419	11.440	11.460	11.480	11.50
680	11.501	11.521	11.541	11.561	11.582	11.602	11.622	11.643	11.663	11.683	11.70
690	11.704	11.724	11.744	11.765	11.785	11.805	11.826	11.846	11.867	11.887	11.90
700	11.907	11.928	11.948	11.968	11.989	12.009	12.030	12.050	12.071	12.091	12.11
710	12.111	12.132	12.152	12.173	12.193	12.214	12.234	12.255	12.275	12.295	12.31
720	12.316	12.336	12.357	12.377	12.398	12.418	12.439	12.459	12.480	12.500	12.52
730	12.521	12.542	12.562	12.583	12.603	12.624	12.644	12.665	12.685	12.706	12.72
740	12.726	12.747	12.768	12.788	12.809	12.829	12.850	12.871	12.891	12.912	12.93
750	12.932	12.953	12.974	12.994	13.015	13.036	13.056	13.077	13.098	13.118	13.13
760	13.139	13.159	13.180	13.201	13.221	13.242	13.263	13.284	13.304	13.325	13.34
770	13.346	13.366	13.387	13.408	13.428	13.449	13.470	13.491	13.511	13.532	13.55
780	13.553	13.574	13.594	13.615	13.636	13.657	13.677	13.698	13.719	13.740	13.76
790	13.760	13.781	13.802	13.823	13.844	13.864	13.885	13.906	13.927	13.948	13.96
800	13.969	13.989	14.010	14.031	14.052	14.073	14.094	14.114	14.135	14.156	14.17
810	14.177	14.198	14.219	14.240	14.260	14.281	14.302	14.323	14.344	14.365	14.38
820	14.386	14.407	14.428	14.448	14.469	14.490	14.511	14.532	14.553	14.574	14.59
830	14.595	14.616	14.637	14.658	14.679	14.700	14.721	14.742	14.763	14.784	14.80
840	14.804	14.825	14.846	14.867	14.888	14.909	14.930	14.951	14.972	14.993	15.01
850	15.014	15.035	15.056	15.077	15.098	15.119	15.140	15.162	15.183	15.204	15.22
860	15.225	15.246	15.267	15.288	15.309	15.330	15.351	15.372	15.393	15.414	15.43
870	15.435	15.456	15.477	15.498	15.520	15.541	15.562	15.583	15.604	15.625	15.64
880	15.646	15.667	15.688	15.709	15.731	15.752	15.773	15.794	15.815	15.836	15.85
890	15.857	15.878	15.900	15.921	15.942	15.963	15.984	16.005	16.027	16.048	16.06
900	16.069	16.090	16.111	16.132	16.154	16.175	16.196	16.217	16.238	16.260	16.28
910	16.281	16.302	16.323	16.344	16.366	16.387	16.408	16.429	16.450	16.472	16.49
920	16.493	16.514	16.535	16.557	16.578	16.599	16.620	16.642	16.663	16.684	16.70
930	16.705	16.727	16.748	16.769	16.790	16.812	16.833	16.854	16.875	16.897	16.91
940	16.918	16.939	16.961	16.982	17.003	17.025	17.046	17.067	17.088	17.110	17.13
950	17.131	17.152	17.174	17.195	17.216	17.238	17.259	17.280	17.302	17.323	17.34
960	17.344	17.366	17.387	17.408	17.430	17.451	17.472	17.494	17.515	17.536	17.55
970	17.558	17.579	17.601	17.622	17.643	17.665	17.686	17.707	17.729	17.750	17.77
980	17.772	17.793	17.814	17.836	17.857	17.879	17.900	17.921	17.943	17.964	17.98
990	17.986	18.007	18.028	18.050	18.071	18.093	18.114	18.136	18.157	18.178	18.20
1000	18.200	18.221	18.243	18.264	18.286	18.307	18.328	18.350	18.371	18.393	18.41
1010	18.414	18.436	18.457	18.479	18.500	18.522	18.543	18.565	18.586	18.608	18.62
1020	18.629	18.650	18.672	18.693	18.715	18.736	18.758	18.779	18.801	18.822	18.84
1030	18.844	18.865	18.887	18.908	18.930	18.951	18.973	18.994	19.016	19.037	19.05
1040	19.059	19.081	19.102	19.124	19.145	19.167	19.188	19.210	19.231	19.253	19.27
1050	19.274	19.296	19.317	19.339	19.360	19.382	19.404	19.425	19.447	19.468	19.49
1060	19.490	19.511	19.533	19.554	19.576	19.598	19.619	19.641	19.662	19.684	19.70
1070	19.705	19.727	19.749	19.770	19.792	19.813	19.835	19.857	19.878	19.900	19.92
1080	19.921	19.943	19.964	19.986	20.008	20.029	20.051	20.072	20.094	20.116	20.13
1090	20.137	20.159	20.181	20.202	20.224	20.245	20.267	20.289	20.310	20.332	20.35
1100	20.353	20.375	20.397	20.418	20.440	20.462	20.483	20.505	20.527	20.548	20.57
1110	20.570	20.591	20.613	20.635	20.656	20.678	20.700	20.721	20.743	20.765	20.78
1120	20.786	20.808	20.830	20.851	20.873	20.895	20.916	20.938	20.960	20.981	21.00
1130	21.003	21.025	21.046	21.068	21.090	21.111	21.133	21.155	21.176	21.198	21.22
1140	21.220	21.241	21.263	21.285	21.306	21.328	21.350	21.371	21.393	21.415	21.43
1150	21.437	21.458	21.480	21.502	21.523	21.545	21.567	21.588	21.610	21.632	21.65
1160	21.654	21.675	21.697	21.719	21.740	21.762	21.784	21.806	21.827	21.849	21.87
1170	21.871	21.892	21.914	21.936	21.958	21.979	22.001	22.023	22.044	22.066	22.08
1180	22.088	22.110	22.131	22.153	22.175	22.197	22.218	22.240	22.262	22.284	22.30
1190	22.305	22.327	22.349	22.370	22.392	22.414	22.436	22.457	22.479	22.501	22.52
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type N thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
1100	20.353	20.375	20.397	20.418	20.440	20.462	20.483	20.505	20.527	20.548	20.57
1110	20.570	20.591	20.613	20.635	20.656	20.678	20.700	20.721	20.743	20.765	20.78
1120	20.786	20.808	20.830	20.851	20.873	20.895	20.916	20.938	20.960	20.981	21.00
1130	21.003	21.025	21.046	21.068	21.090	21.111	21.133	21.155	21.176	21.198	21.22
1140	21.220	21.241	21.263	21.285	21.306	21.328	21.350	21.371	21.393	21.415	21.43
1150	21.437	21.458	21.480	21.502	21.523	21.545	21.567	21.588	21.610	21.632	21.65
1160	21.654	21.675	21.697	21.719	21.740	21.762	21.784	21.806	21.827	21.849	21.87
1170	21.871	21.892	21.914	21.936	21.958	21.979	22.001	22.023	22.044	22.066	22.08
1180	22.088	22.110	22.131	22.153	22.175	22.197	22.218	22.240	22.262	22.284	22.30
1190	22.305	22.327	22.349	22.370	22.392	22.414	22.436	22.457	22.479	22.501	22.52
1200	22.523	22.544	22.566	22.588	22.610	22.631	22.653	22.675	22.697	22.718	22.74
1210	22.740	22.762	22.784	22.805	22.827	22.849	22.871	22.893	22.914	22.936	22.95
1220	22.958	22.980	23.001	23.023	23.045	23.067	23.088	23.110	23.132	23.154	23.17
1230	23.176	23.197	23.219	23.241	23.263	23.284	23.306	23.328	23.350	23.372	23.39
1240	23.393	23.415	23.437	23.459	23.480	23.502	23.524	23.546	23.568	23.589	23.61
1250	23.611	23.633	23.655	23.676	23.698	23.720	23.742	23.764	23.785	23.807	23.82
1260	23.829	23.851	23.873	23.894	23.916	23.938	23.960	23.982	24.003	24.025	24.04
1270	24.047	24.069	24.091	24.112	24.134	24.156	24.178	24.200	24.221	24.243	24.26
1280	24.265	24.287	24.309	24.330	24.352	24.374	24.396	24.418	24.439	24.461	24.48
1290	24.483	24.505	24.527	24.548	24.570	24.592	24.614	24.636	24.658	24.679	24.70
1300	24.701	24.723	24.745	24.767	24.788	24.810	24.832	24.854	24.876	24.897	24.91
1310	24.919	24.941	24.963	24.985	25.007	25.028	25.050	25.072	25.094	25.116	25.13
1320	25.137	25.159	25.181	25.203	25.225	25.247	25.268	25.290	25.312	25.334	25.35
1330	25.356	25.377	25.399	25.421	25.443	25.465	25.487	25.508	25.530	25.552	25.57
1340	25.574	25.596	25.618	25.639	25.661	25.683	25.705	25.727	25.748	25.770	25.79
1350	25.792	25.814	25.836	25.858	25.879	25.901	25.923	25.945	25.967	25.989	26.01
1360	26.010	26.032	26.054	26.076	26.098	26.119	26.141	26.163	26.185	26.207	26.22
1370	26.229	26.250	26.272	26.294	26.316	26.338	26.360	26.381	26.403	26.425	26.44
1380	26.447	26.469	26.491	26.512	26.534	26.556	26.578	26.600	26.622	26.643	26.66
1390	26.665	26.687	26.709	26.731	26.752	26.774	26.796	26.818	26.840	26.862	26.88
1400	26.883	26.905	26.927	26.949	26.971	26.993	27.014	27.036	27.058	27.080	27.10
1410	27.102	27.124	27.145	27.167	27.189	27.211	27.233	27.254	27.276	27.298	27.32
1420	27.320	27.342	27.364	27.385	27.407	27.429	27.451	27.473	27.495	27.516	27.53
1430	27.538	27.560	27.582	27.604	27.625	27.647	27.669	27.691	27.713	27.735	27.75
1440	27.756	27.778	27.800	27.822	27.844	27.866	27.887	27.909	27.931	27.953	27.97
1450	27.975	27.996	28.018	28.040	28.062	28.084	28.105	28.127	28.149	28.171	28.19
1460	28.193	28.215	28.236	28.258	28.280	28.302	28.324	28.345	28.367	28.389	28.41
1470	28.411	28.433	28.455	28.476	28.498	28.520	28.542	28.564	28.585	28.607	28.62
1480	28.629	28.651	28.673	28.694	28.716	28.738	28.760	28.782	28.803	28.825	28.84
1490	28.847	28.869	28.891	28.912	28.934	28.956	28.978	29.000	29.021	29.043	29.06
1500	29.065	29.087	29.109	29.130	29.152	29.174	29.196	29.218	29.239	29.261	29.28
1510	29.283	29.305	29.327	29.348	29.370	29.392	29.414	29.436	29.457	29.479	29.50
1520	29.501	29.523	29.545	29.566	29.588	29.610	29.632	29.653	29.675	29.697	29.71
1530	29.719	29.741	29.762	29.784	29.806	29.828	29.850	29.871	29.893	29.915	29.93
1540	29.937	29.958	29.980	30.002	30.024	30.046	30.067	30.089	30.111	30.133	30.15
1550	30.154	30.176	30.198	30.220	30.242	30.263	30.285	30.307	30.329	30.350	30.37
1560	30.372	30.394	30.416	30.437	30.459	30.481	30.503	30.524	30.546	30.568	30.59
1570	30.590	30.611	30.633	30.655	30.677	30.699	30.720	30.742	30.764	30.786	30.80
1580	30.807	30.829	30.851	30.873	30.894	30.916	30.938	30.960	30.981	31.003	31.02
1590	31.025	31.047	31.068	31.090	31.112	31.133	31.155	31.177	31.199	31.220	31.24
1600	31.242	31.264	31.286	31.307	31.329	31.351	31.373	31.394	31.416	31.438	31.45
1610	31.459	31.481	31.503	31.525	31.546	31.568	31.590	31.612	31.633	31.655	31.67
1620	31.677	31.698	31.720	31.742	31.764	31.785	31.807	31.829	31.850	31.872	31.89
1630	31.894	31.916	31.937	31.959	31.981	32.002	32.024	32.046	32.068	32.089	32.11
1640	32.111	32.133	32.154	32.176	32.198	32.219	32.241	32.263	32.284	32.306	32.32
1650	32.328	32.350	32.371	32.393	32.415	32.436	32.458	32.480	32.501	32.523	32.54
1660	32.545	32.566	32.588	32.610	32.631	32.653	32.675	32.696	32.718	32.740	32.76
1670	32.761	32.783	32.805	32.826	32.848	32.870	32.891	32.913	32.935	32.956	32.97
1680	32.978	33.000	33.021	33.043	33.065	33.086	33.108	33.130	33.151	33.173	33.19
1690	33.195	33.216	33.238	33.260	33.281	33.303	33.325	33.346	33.368	33.389	33.41
1700	33.411	33.433	33.454	33.476	33.498	33.519	33.541	33.563	33.584	33.606	33.62
1710	33.627	33.649	33.671	33.692	33.714	33.736	33.757	33.779	33.800	33.822	33.84
1720	33.844	33.865	33.887	33.908	33.930	33.952	33.973	33.995	34.016	34.038	34.06
1730	34.060	34.081	34.103	34.124	34.146	34.168	34.189	34.211	34.232	34.254	34.27
1740	34.276	34.297	34.319	34.340	34.362	34.384	34.405	34.427	34.448	34.470	34.49
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type N thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
1700	33.411	33.433	33.454	33.476	33.498	33.519	33.541	33.563	33.584	33.606	33.62
1710	33.627	33.649	33.671	33.692	33.714	33.736	33.757	33.779	33.800	33.822	33.84
1720	33.844	33.865	33.887	33.908	33.930	33.952	33.973	33.995	34.016	34.038	34.06
1730	34.060	34.081	34.103	34.124	34.146	34.168	34.189	34.211	34.232	34.254	34.27
1740	34.276	34.297	34.319	34.340	34.362	34.384	34.405	34.427	34.448	34.470	34.49
1750	34.491	34.513	34.535	34.556	34.578	34.599	34.621	34.642	34.664	34.686	34.70
1760	34.707	34.729	34.750	34.772	34.793	34.815	34.836	34.858	34.879	34.901	34.92
1770	34.923	34.944	34.966	34.987	35.009	35.030	35.052	35.073	35.095	35.116	35.13
1780	35.138	35.160	35.181	35.203	35.224	35.246	35.267	35.289	35.310	35.332	35.35
1790	35.353	35.375	35.396	35.418	35.439	35.461	35.482	35.504	35.525	35.547	35.56
1800	35.568	35.590	35.611	35.633	35.654	35.676	35.697	35.719	35.740	35.762	35.78
1810	35.783	35.805	35.826	35.848	35.869	35.891	35.912	35.934	35.955	35.977	35.99
1820	35.998	36.019	36.041	36.062	36.084	36.105	36.127	36.148	36.170	36.191	36.21
1830	36.213	36.234	36.256	36.277	36.298	36.320	36.341	36.363	36.384	36.406	36.42
1840	36.427	36.449	36.470	36.491	36.513	36.534	36.556	36.577	36.599	36.620	36.64
1850	36.641	36.663	36.684	36.706	36.727	36.748	36.770	36.791	36.813	36.834	36.85
1860	36.855	36.877	36.898	36.920	36.941	36.962	36.984	37.005	37.027	37.048	37.06
1870	37.069	37.091	37.112	37.134	37.155	37.176	37.198	37.219	37.240	37.262	37.28
1880	37.283	37.305	37.326	37.347	37.369	37.390	37.411	37.433	37.454	37.475	37.49
1890	37.497	37.518	37.539	37.561	37.582	37.603	37.625	37.646	37.667	37.689	37.71
1900	37.710	37.731	37.753	37.774	37.795	37.817	37.838	37.859	37.881	37.902	37.92
1910	37.923	37.945	37.966	37.987	38.009	38.030	38.051	38.073	38.094	38.115	38.13
1920	38.136	38.158	38.179	38.200	38.222	38.243	38.264	38.285	38.307	38.328	38.34
1930	38.349	38.370	38.392	38.413	38.434	38.456	38.477	38.498	38.519	38.541	38.56
1940	38.562	38.583	38.604	38.626	38.647	38.668	38.689	38.711	38.732	38.753	38.77
1950	38.774	38.795	38.817	38.838	38.859	38.880	38.902	38.923	38.944	38.965	38.98
1960	38.986	39.008	39.029	39.050	39.071	39.093	39.114	39.135	39.156	39.177	39.19
1970	39.198	39.220	39.241	39.262	39.283	39.304	39.326	39.347	39.368	39.389	39.41
1980	39.410	39.431	39.453	39.474	39.495	39.516	39.537	39.558	39.580	39.601	39.62
1990	39.622	39.643	39.664	39.685	39.706	39.728	39.749	39.770	39.791	39.812	39.83
2000	39.833	39.854	39.875	39.897	39.918	39.939	39.960	39.981	40.002	40.023	40.04
2010	40.044	40.066	40.087	40.108	40.129	40.150	40.171	40.192	40.213	40.234	40.25
2020	40.255	40.276	40.297	40.319	40.340	40.361	40.382	40.403	40.424	40.445	40.46
2030	40.466	40.487	40.508	40.529	40.550	40.571	40.592	40.613	40.634	40.655	40.67
2040	40.677	40.698	40.719	40.740	40.761	40.782	40.803	40.824	40.845	40.866	40.88
2050	40.887	40.908	40.929	40.950	40.971	40.992	41.013	41.034	41.055	41.076	41.09
2060	41.097	41.118	41.139	41.160	41.181	41.202	41.223	41.244	41.265	41.286	41.30
2070	41.307	41.328	41.349	41.370	41.390	41.411	41.432	41.453	41.474	41.495	41.51
2080	41.516	41.537	41.558	41.579	41.600	41.621	41.642	41.663	41.684	41.705	41.72
2090	41.725	41.746	41.767	41.788	41.809	41.830	41.851	41.872	41.893	41.914	41.93
2100	41.935	41.955	41.976	41.997	42.018	42.039	42.060	42.081	42.102	42.123	42.14
2110	42.143	42.164	42.185	42.206	42.227	42.248	42.269	42.289	42.310	42.331	42.35
2120	42.352	42.373	42.394	42.415	42.435	42.456	42.477	42.498	42.519	42.540	42.56
2130	42.560	42.581	42.602	42.623	42.644	42.664	42.685	42.706	42.727	42.748	42.76
2140	42.768	42.789	42.810	42.831	42.852	42.872	42.893	42.914	42.935	42.956	42.97
2150	42.976	42.997	43.018	43.039	43.059	43.080	43.101	43.122	43.142	43.163	43.18
2160	43.184	43.205	43.225	43.246	43.267	43.288	43.308	43.329	43.350	43.370	43.39
2170	43.391	43.412	43.433	43.453	43.474	43.495	43.515	43.536	43.557	43.578	43.59
2180	43.598	43.619	43.640	43.660	43.681	43.702	43.722	43.743	43.764	43.784	43.80
2190	43.805	43.826	43.846	43.867	43.888	43.908	43.929	43.950	43.970	43.991	44.01
2200	44.012	44.032	44.053	44.073	44.094	44.115	44.135	44.156	44.177	44.197	44.21
2210	44.218	44.238	44.259	44.280	44.300	44.321	44.341	44.362	44.383	44.403	44.42
2220	44.424	44.444	44.465	44.485	44.506	44.527	44.547	44.568	44.588	44.609	44.62
2230	44.629	44.650	44.671	44.691	44.712	44.732	44.753	44.773	44.794	44.814	44.83
2240	44.835	44.855	44.876	44.896	44.917	44.937	44.958	44.978	44.999	45.019	45.04
2250	45.040	45.060	45.081	45.101	45.122	45.142	45.163	45.183	45.204	45.224	45.24
2260	45.245	45.265	45.286	45.306	45.326	45.347	45.367	45.388	45.408	45.429	45.44
2270	45.449	45.469	45.490	45.510	45.531	45.551	45.572	45.592	45.612	45.633	45.65
2280	45.653	45.674	45.694	45.714	45.735	45.755	45.775	45.796	45.816	45.837	45.85
2290	45.857	45.877	45.898	45.918	45.938	45.959	45.979	45.999	46.020	46.040	46.06
2300	46.060	46.081	46.101	46.121	46.142	46.162	46.182	46.202	46.223	46.243	46.26
2310	46.263	46.284	46.304	46.324	46.344	46.365	46.385	46.405	46.425	46.446	46.46
2320	46.466	46.486	46.506	46.527	46.547	46.567	46.587	46.608	46.628	46.648	46.66
2330	46.668	46.688	46.709	46.729	46.749	46.769	46.789	46.810	46.830	46.850	46.87
2340	46.870	46.890	46.910	46.931	46.951	46.971	46.991	47.011	47.031	47.051	47.07
2350	47.071	47.092	47.112	47.132	47.152	47.172	47.192	47.212	47.232	47.252	47.27
2360	47.272	47.292	47.312	47.333	47.353	47.373	47.393	47.413	47.433	47.453	47.47
2370	47.473	47.493	47.513								
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type R thermocouple

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
					Thermoelectric Voltage in mV						
-40	-0.210	-0.208	-0.205	-0.203	-0.201	-0.199	-0.197	-0.194	-0.192	-0.190	-0.18
-30	-0.188	-0.185	-0.183	-0.181	-0.179	-0.176	-0.174	-0.172	-0.169	-0.167	-0.16
-20	-0.165	-0.162	-0.160	-0.158	-0.155	-0.153	-0.150	-0.148	-0.145	-0.143	-0.14
-10	-0.141	-0.138	-0.136	-0.133	-0.131	-0.128	-0.126	-0.123	-0.121	-0.118	-0.11
0	-0.116	-0.113	-0.110	-0.108	-0.105	-0.103	-0.100	-0.097	-0.095	-0.092	-0.09

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

ITS-90 Table for type R thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
0	-0.090	-0.087	-0.084	-0.082	-0.079	-0.076	-0.073	-0.071	-0.068	-0.065	-0.06
10	-0.063	-0.060	-0.057	-0.054	-0.051	-0.049	-0.046	-0.043	-0.040	-0.037	-0.03
20	-0.035	-0.032	-0.029	-0.026	-0.023	-0.020	-0.017	-0.015	-0.012	-0.009	-0.00
30	-0.006	-0.003	0.000	0.003	0.006	0.009	0.012	0.015	0.018	0.021	0.02
40	0.024	0.027	0.030	0.033	0.036	0.039	0.042	0.045	0.048	0.051	0.05
50	0.054	0.057	0.060	0.064	0.067	0.070	0.073	0.076	0.079	0.082	0.08
60	0.086	0.089	0.092	0.095	0.098	0.102	0.105	0.108	0.111	0.114	0.11
70	0.118	0.121	0.124	0.127	0.131	0.134	0.137	0.141	0.144	0.147	0.15
80	0.151	0.154	0.157	0.161	0.164	0.167	0.171	0.174	0.177	0.181	0.18
90	0.184	0.188	0.191	0.194	0.198	0.201	0.205	0.208	0.212	0.215	0.21
100	0.218	0.222	0.225	0.229	0.232	0.236	0.239	0.243	0.246	0.250	0.25
110	0.254	0.257	0.261	0.264	0.268	0.271	0.275	0.278	0.282	0.286	0.28
120	0.289	0.293	0.296	0.300	0.304	0.307	0.311	0.315	0.318	0.322	0.32
130	0.326	0.329	0.333	0.337	0.340	0.344	0.348	0.352	0.355	0.359	0.36
140	0.363	0.366	0.370	0.374	0.378	0.382	0.385	0.389	0.393	0.397	0.40
150	0.400	0.404	0.408	0.412	0.416	0.420	0.423	0.427	0.431	0.435	0.43
160	0.439	0.443	0.447	0.450	0.454	0.458	0.462	0.466	0.470	0.474	0.47
170	0.478	0.482	0.486	0.489	0.493	0.497	0.501	0.505	0.509	0.513	0.51
180	0.517	0.521	0.525	0.529	0.533	0.537	0.541	0.545	0.549	0.553	0.55
190	0.557	0.561	0.565	0.569	0.573	0.578	0.582	0.586	0.590	0.594	0.59
200	0.598	0.602	0.606	0.610	0.614	0.618	0.623	0.627	0.631	0.635	0.63
210	0.639	0.643	0.647	0.652	0.656	0.660	0.664	0.668	0.672	0.677	0.68
220	0.681	0.685	0.689	0.693	0.698	0.702	0.706	0.710	0.715	0.719	0.72
230	0.723	0.727	0.732	0.736	0.740	0.744	0.749	0.753	0.757	0.761	0.76
240	0.766	0.770	0.774	0.779	0.783	0.787	0.792	0.796	0.800	0.805	0.80
250	0.809	0.813	0.818	0.822	0.826	0.831	0.835	0.839	0.844	0.848	0.85
260	0.853	0.857	0.861	0.866	0.870	0.875	0.879	0.883	0.888	0.892	0.89
270	0.897	0.901	0.906	0.910	0.915	0.919	0.923	0.928	0.932	0.937	0.94
280	0.941	0.946	0.950	0.955	0.959	0.964	0.968	0.973	0.977	0.982	0.98
290	0.986	0.991	0.995	1.000	1.005	1.009	1.014	1.018	1.023	1.027	1.03
300	1.032	1.036	1.041	1.046	1.050	1.055	1.059	1.064	1.069	1.073	1.07
310	1.078	1.082	1.087	1.092	1.096	1.101	1.105	1.110	1.115	1.119	1.12
320	1.124	1.129	1.133	1.138	1.143	1.147	1.152	1.157	1.161	1.166	1.17
330	1.171	1.175	1.180	1.185	1.190	1.194	1.199	1.204	1.208	1.213	1.21
340	1.218	1.223	1.227	1.232	1.237	1.242	1.246	1.251	1.256	1.261	1.26
350	1.265	1.270	1.275	1.280	1.284	1.289	1.294	1.299	1.304	1.308	1.31
360	1.313	1.318	1.323	1.328	1.332	1.337	1.342	1.347	1.352	1.356	1.36
370	1.361	1.366	1.371	1.376	1.381	1.386	1.390	1.395	1.400	1.405	1.41
380	1.410	1.415	1.420	1.425	1.429	1.434	1.439	1.444	1.449	1.454	1.45
390	1.459	1.464	1.469	1.473	1.478	1.483	1.488	1.493	1.498	1.503	1.50
400	1.508	1.513	1.518	1.523	1.528	1.533	1.538	1.543	1.548	1.553	1.55
410	1.558	1.563	1.568	1.572	1.577	1.582	1.587	1.592	1.597	1.602	1.60
420	1.607	1.612	1.617	1.622	1.627	1.632	1.638	1.643	1.648	1.653	1.65
430	1.658	1.663	1.668	1.673	1.678	1.683	1.688	1.693	1.698	1.703	1.70
440	1.708	1.713	1.718	1.723	1.728	1.733	1.739	1.744	1.749	1.754	1.75
450	1.759	1.764	1.769	1.774	1.779	1.784	1.790	1.795	1.800	1.805	1.81
460	1.810	1.815	1.820	1.825	1.831	1.836	1.841	1.846	1.851	1.856	1.86
470	1.861	1.867	1.872	1.877	1.882	1.887	1.892	1.898	1.903	1.908	1.91
480	1.913	1.918	1.923	1.929	1.934	1.939	1.944	1.949	1.955	1.960	1.96
490	1.965	1.970	1.975	1.981	1.986	1.991	1.996	2.002	2.007	2.012	2.01
500	2.017	2.022	2.028	2.033	2.038	2.043	2.049	2.054	2.059	2.064	2.07
510	2.070	2.075	2.080	2.085	2.091	2.096	2.101	2.107	2.112	2.117	2.12
520	2.122	2.128	2.133	2.138	2.144	2.149	2.154	2.159	2.165	2.170	2.17
530	2.175	2.181	2.186	2.191	2.197	2.202	2.207	2.213	2.218	2.223	2.22
540	2.229	2.234	2.239	2.245	2.250	2.255	2.261	2.266	2.271	2.277	2.28

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type R thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
550	2.282	2.287	2.293	2.298	2.304	2.309	2.314	2.320	2.325	2.330	2.33
560	2.336	2.341	2.347	2.352	2.357	2.363	2.368	2.374	2.379	2.384	2.39
570	2.390	2.395	2.401	2.406	2.411	2.417	2.422	2.428	2.433	2.438	2.44
580	2.444	2.449	2.455	2.460	2.466	2.471	2.477	2.482	2.487	2.493	2.49
590	2.498	2.504	2.509	2.515	2.520	2.526	2.531	2.537	2.542	2.547	2.55
600	2.553	2.558	2.564	2.569	2.575	2.580	2.586	2.591	2.597	2.602	2.60
610	2.608	2.613	2.619	2.624	2.630	2.635	2.641	2.646	2.652	2.657	2.66
620	2.663	2.668	2.674	2.679	2.685	2.690	2.696	2.701	2.707	2.713	2.71
630	2.718	2.724	2.729	2.735	2.740	2.746	2.751	2.757	2.762	2.768	2.77
640	2.773	2.779	2.785	2.790	2.796	2.801	2.807	2.812	2.818	2.824	2.82
650	2.829	2.835	2.840	2.846	2.851	2.857	2.863	2.868	2.874	2.879	2.88
660	2.885	2.891	2.896	2.902	2.907	2.913	2.919	2.924	2.930	2.935	2.94
670	2.941	2.947	2.952	2.958	2.964	2.969	2.975	2.980	2.986	2.992	2.99
680	2.997	3.003	3.009	3.014	3.020	3.026	3.031	3.037	3.042	3.048	3.05
690	3.054	3.059	3.065	3.071	3.076	3.082	3.088	3.093	3.099	3.105	3.11
700	3.110	3.116	3.122	3.127	3.133	3.139	3.144	3.150	3.156	3.161	3.16
710	3.167	3.173	3.179	3.184	3.190	3.196	3.201	3.207	3.213	3.218	3.22
720	3.224	3.230	3.236	3.241	3.247	3.253	3.258	3.264	3.270	3.276	3.28
730	3.281	3.287	3.293	3.298	3.304	3.310	3.316	3.321	3.327	3.333	3.33
740	3.339	3.344	3.350	3.356	3.362	3.367	3.373	3.379	3.385	3.390	3.39
750	3.396	3.402	3.408	3.413	3.419	3.425	3.431	3.437	3.442	3.448	3.45
760	3.454	3.460	3.465	3.471	3.477	3.483	3.489	3.494	3.500	3.506	3.51
770	3.512	3.517	3.523	3.529	3.535	3.541	3.546	3.552	3.558	3.564	3.57
780	3.570	3.576	3.581	3.587	3.593	3.599	3.605	3.610	3.616	3.622	3.62
790	3.628	3.634	3.640	3.645	3.651	3.657	3.663	3.669	3.675	3.680	3.68
800	3.686	3.692	3.698	3.704	3.710	3.716	3.721	3.727	3.733	3.739	3.74
810	3.745	3.751	3.757	3.762	3.768	3.774	3.780	3.786	3.792	3.798	3.80
820	3.803	3.809	3.815	3.821	3.827	3.833	3.839	3.845	3.851	3.856	3.86
830	3.862	3.868	3.874	3.880	3.886	3.892	3.898	3.904	3.909	3.915	3.92
840	3.921	3.927	3.933	3.939	3.945	3.951	3.957	3.963	3.969	3.975	3.98
850	3.980	3.986	3.992	3.998	4.004	4.010	4.016	4.022	4.028	4.034	4.04
860	4.040	4.046	4.052	4.058	4.064	4.069	4.075	4.081	4.087	4.093	4.09
870	4.099	4.105	4.111	4.117	4.123	4.129	4.135	4.141	4.147	4.153	4.15
880	4.159	4.165	4.171	4.177	4.183	4.189	4.195	4.201	4.207	4.213	4.21
890	4.219	4.225	4.231	4.237	4.243	4.249	4.255	4.261	4.267	4.273	4.27
900	4.279	4.285	4.291	4.297	4.303	4.309	4.315	4.321	4.327	4.333	4.33
910	4.339	4.345	4.351	4.357	4.363	4.369	4.375	4.381	4.387	4.393	4.39
920	4.399	4.405	4.411	4.417	4.423	4.429	4.435	4.441	4.447	4.453	4.45
930	4.459	4.465	4.471	4.477	4.483	4.489	4.495	4.502	4.508	4.514	4.52
940	4.520	4.526	4.532	4.538	4.544	4.550	4.556	4.562	4.568	4.574	4.58
950	4.580	4.586	4.593	4.599	4.605	4.611	4.617	4.623	4.629	4.635	4.64
960	4.641	4.647	4.653	4.659	4.666	4.672	4.678	4.684	4.690	4.696	4.70
970	4.702	4.708	4.714	4.720	4.727	4.733	4.739	4.745	4.751	4.757	4.76
980	4.763	4.769	4.775	4.782	4.788	4.794	4.800	4.806	4.812	4.818	4.82
990	4.824	4.831	4.837	4.843	4.849	4.855	4.861	4.867	4.874	4.880	4.88
1000	4.886	4.892	4.898	4.904	4.910	4.917	4.923	4.929	4.935	4.941	4.94
1010	4.947	4.954	4.960	4.966	4.972	4.978	4.984	4.991	4.997	5.003	5.00
1020	5.009	5.015	5.021	5.028	5.034	5.040	5.046	5.052	5.059	5.065	5.07
1030	5.071	5.077	5.083	5.090	5.096	5.102	5.108	5.114	5.121	5.127	5.13
1040	5.133	5.139	5.145	5.152	5.158	5.164	5.170	5.176	5.183	5.189	5.19
1050	5.195	5.201	5.207	5.214	5.220	5.226	5.232	5.239	5.245	5.251	5.25
1060	5.257	5.264	5.270	5.276	5.282	5.289	5.295	5.301	5.307	5.313	5.32
1070	5.320	5.326	5.332	5.338	5.345	5.351	5.357	5.364	5.370	5.376	5.38
1080	5.382	5.389	5.395	5.401	5.407	5.414	5.420	5.426	5.432	5.439	5.44
1090	5.445	5.451	5.458	5.464	5.470	5.476	5.483	5.489	5.495	5.502	5.50
1100	5.508	5.514	5.520	5.527	5.533	5.539	5.546	5.552	5.558	5.565	5.57
1110	5.571	5.577	5.583	5.590	5.596	5.602	5.609	5.615	5.621	5.628	5.63
1120	5.634	5.640	5.647	5.653	5.659	5.666	5.672	5.678	5.685	5.691	5.69
1130	5.697	5.704	5.710	5.716	5.723	5.729	5.735	5.742	5.748	5.754	5.76
1140	5.761	5.767	5.773	5.780	5.786	5.792	5.799	5.805	5.812	5.818	5.82
1150	5.824	5.831	5.837	5.843	5.850	5.856	5.862	5.869	5.875	5.882	5.88
1160	5.888	5.894	5.901	5.907	5.913	5.920	5.926	5.933	5.939	5.945	5.95
1170	5.952	5.958	5.965	5.971	5.977	5.984	5.990	5.997	6.003	6.009	6.01
1180	6.016	6.022	6.029	6.035	6.041	6.048	6.054	6.061	6.067	6.074	6.08
1190	6.080	6.086	6.093	6.099	6.106	6.112	6.119	6.125	6.131	6.138	6.14

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type R thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
1200	6.144	6.151	6.157	6.164	6.170	6.176	6.183	6.189	6.196	6.202	6.20
1210	6.209	6.215	6.222	6.228	6.235	6.241	6.247	6.254	6.260	6.267	6.27
1220	6.273	6.280	6.286	6.293	6.299	6.306	6.312	6.319	6.325	6.332	6.33
1230	6.338	6.345	6.351	6.358	6.364	6.370	6.377	6.383	6.390	6.396	6.40
1240	6.403	6.409	6.416	6.422	6.429	6.435	6.442	6.448	6.455	6.461	6.46
1250	6.468	6.474	6.481	6.488	6.494	6.501	6.507	6.514	6.520	6.527	6.53
1260	6.533	6.540	6.546	6.553	6.559	6.566	6.572	6.579	6.585	6.592	6.59
1270	6.598	6.605	6.612	6.618	6.625	6.631	6.638	6.644	6.651	6.657	6.66
1280	6.664	6.671	6.677	6.684	6.690	6.697	6.703	6.710	6.716	6.723	6.73
1290	6.730	6.736	6.743	6.749	6.756	6.762	6.769	6.776	6.782	6.789	6.79
1300	6.795	6.802	6.809	6.815	6.822	6.828	6.835	6.841	6.848	6.855	6.86
1310	6.861	6.868	6.874	6.881	6.888	6.894	6.901	6.907	6.914	6.921	6.92
1320	6.927	6.934	6.941	6.947	6.954	6.960	6.967	6.974	6.980	6.987	6.99
1330	6.994	7.000	7.007	7.013	7.020	7.027	7.033	7.040	7.047	7.053	7.06
1340	7.060	7.067	7.073	7.080	7.086	7.093	7.100	7.106	7.113	7.120	7.12
1350	7.126	7.133	7.140	7.146	7.153	7.160	7.166	7.173	7.180	7.186	7.19
1360	7.193	7.200	7.206	7.213	7.220	7.226	7.233	7.240	7.247	7.253	7.26
1370	7.260	7.267	7.273	7.280	7.287	7.293	7.300	7.307	7.313	7.320	7.32
1380	7.327	7.334	7.340	7.347	7.354	7.360	7.367	7.374	7.381	7.387	7.39
1390	7.394	7.401	7.407	7.414	7.421	7.428	7.434	7.441	7.448	7.454	7.46
1400	7.461	7.468	7.475	7.481	7.488	7.495	7.502	7.508	7.515	7.522	7.52
1410	7.529	7.535	7.542	7.549	7.556	7.562	7.569	7.576	7.583	7.589	7.59
1420	7.596	7.603	7.610	7.616	7.623	7.630	7.637	7.644	7.650	7.657	7.66
1430	7.664	7.671	7.677	7.684	7.691	7.698	7.705	7.711	7.718	7.725	7.73
1440	7.732	7.739	7.745	7.752	7.759	7.766	7.772	7.779	7.786	7.793	7.80
1450	7.800	7.807	7.813	7.820	7.827	7.834	7.841	7.847	7.854	7.861	7.86
1460	7.868	7.875	7.882	7.888	7.895	7.902	7.909	7.916	7.922	7.929	7.93
1470	7.936	7.943	7.950	7.957	7.964	7.970	7.977	7.984	7.991	7.998	8.00
1480	8.005	8.011	8.018	8.025	8.032	8.039	8.046	8.053	8.059	8.066	8.07
1490	8.073	8.080	8.087	8.094	8.101	8.108	8.114	8.121	8.128	8.135	8.14
1500	8.142	8.149	8.156	8.163	8.169	8.176	8.183	8.190	8.197	8.204	8.21
1510	8.211	8.218	8.225	8.232	8.238	8.245	8.252	8.259	8.266	8.273	8.28
1520	8.280	8.287	8.294	8.301	8.308	8.314	8.321	8.328	8.335	8.342	8.34
1530	8.349	8.356	8.363	8.370	8.377	8.384	8.391	8.398	8.405	8.411	8.41
1540	8.418	8.425	8.432	8.439	8.446	8.453	8.460	8.467	8.474	8.481	8.48
1550	8.488	8.495	8.502	8.509	8.516	8.523	8.530	8.537	8.544	8.551	8.55
1560	8.557	8.564	8.571	8.578	8.585	8.592	8.599	8.606	8.613	8.620	8.62
1570	8.627	8.634	8.641	8.648	8.655	8.662	8.669	8.676	8.683	8.690	8.69
1580	8.697	8.704	8.711	8.718	8.725	8.732	8.739	8.746	8.753	8.760	8.76
1590	8.767	8.774	8.781	8.788	8.795	8.802	8.809	8.816	8.823	8.830	8.83
1600	8.837	8.844	8.852	8.859	8.866	8.873	8.880	8.887	8.894	8.901	8.90
1610	8.908	8.915	8.922	8.929	8.936	8.943	8.950	8.957	8.964	8.971	8.97
1620	8.978	8.985	8.992	8.999	9.007	9.014	9.021	9.028	9.035	9.042	9.04
1630	9.049	9.056	9.063	9.070	9.077	9.084	9.091	9.098	9.106	9.113	9.12
1640	9.120	9.127	9.134	9.141	9.148	9.155	9.162	9.169	9.176	9.184	9.19
1650	9.191	9.198	9.205	9.212	9.219	9.226	9.233	9.240	9.248	9.255	9.26
1660	9.262	9.269	9.276	9.283	9.290	9.297	9.304	9.312	9.319	9.326	9.33
1670	9.333	9.340	9.347	9.354	9.361	9.369	9.376	9.383	9.390	9.397	9.40
1680	9.404	9.411	9.419	9.426	9.433	9.440	9.447	9.454	9.461	9.469	9.47
1690	9.476	9.483	9.490	9.497	9.504	9.512	9.519	9.526	9.533	9.540	9.54
1700	9.547	9.555	9.562	9.569	9.576	9.583	9.590	9.598	9.605	9.612	9.61
1710	9.619	9.626	9.634	9.641	9.648	9.655	9.662	9.670	9.677	9.684	9.69
1720	9.691	9.698	9.706	9.713	9.720	9.727	9.734	9.742	9.749	9.756	9.76
1730	9.763	9.770	9.778	9.785	9.792	9.799	9.806	9.814	9.821	9.828	9.83
1740	9.835	9.843	9.850	9.857	9.864	9.872	9.879	9.886	9.893	9.900	9.90
1750	9.908	9.915	9.922	9.929	9.937	9.944	9.951	9.958	9.966	9.973	9.98
1760	9.980	9.987	9.995	10.002	10.009	10.016	10.024	10.031	10.038	10.046	10.05
1770	10.053	10.060	10.067	10.075	10.082	10.089	10.096	10.104	10.111	10.118	10.12
1780	10.126	10.133	10.140	10.147	10.155	10.162	10.169	10.177	10.184	10.191	10.19
1790	10.198	10.206	10.213	10.220	10.228	10.235	10.242	10.250	10.257	10.264	10.27
1800	10.271	10.279	10.286	10.293	10.301	10.308	10.315	10.323	10.330	10.337	10.34
1810	10.345	10.352	10.359	10.367	10.374	10.381	10.389	10.396	10.403	10.411	10.41
1820	10.418	10.425	10.433	10.440	10.447	10.455	10.462	10.469	10.477	10.484	10.49
1830	10.491	10.499	10.506	10.513	10.521	10.528	10.535	10.543	10.550	10.557	10.56
1840	10.565	10.572	10.580	10.587	10.594	10.602	10.609	10.616	10.624	10.631	10.63
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type R thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
1850	10.638	10.646	10.653	10.661	10.668	10.675	10.683	10.690	10.698	10.705	10.71
1860	10.712	10.720	10.727	10.734	10.742	10.749	10.757	10.764	10.771	10.779	10.78
1870	10.786	10.794	10.801	10.808	10.816	10.823	10.831	10.838	10.845	10.853	10.86
1880	10.860	10.868	10.875	10.883	10.890	10.897	10.905	10.912	10.920	10.927	10.93
1890	10.934	10.942	10.949	10.957	10.964	10.972	10.979	10.986	10.994	11.001	11.00
1900	11.009	11.016	11.024	11.031	11.039	11.046	11.053	11.061	11.068	11.076	11.08
1910	11.083	11.091	11.098	11.106	11.113	11.121	11.128	11.135	11.143	11.150	11.15
1920	11.158	11.165	11.173	11.180	11.188	11.195	11.203	11.210	11.218	11.225	11.23
1930	11.233	11.240	11.247	11.255	11.262	11.270	11.277	11.285	11.292	11.300	11.30
1940	11.307	11.315	11.322	11.330	11.337	11.345	11.352	11.360	11.367	11.375	11.38
1950	11.382	11.390	11.397	11.405	11.412	11.420	11.427	11.435	11.442	11.450	11.45
1960	11.457	11.465	11.472	11.480	11.487	11.495	11.502	11.510	11.518	11.525	11.53
1970	11.533	11.540	11.548	11.555	11.563	11.570	11.578	11.585	11.593	11.600	11.60
1980	11.608	11.615	11.623	11.631	11.638	11.646	11.653	11.661	11.668	11.676	11.68
1990	11.683	11.691	11.698	11.706	11.714	11.721	11.729	11.736	11.744	11.751	11.75
2000	11.759	11.766	11.774	11.782	11.789	11.797	11.804	11.812	11.819	11.827	11.83
2010	11.834	11.842	11.850	11.857	11.865	11.872	11.880	11.888	11.895	11.903	11.91
2020	11.910	11.918	11.925	11.933	11.941	11.948	11.956	11.963	11.971	11.979	11.98
2030	11.986	11.994	12.001	12.009	12.016	12.024	12.032	12.039	12.047	12.054	12.06
2040	12.062	12.070	12.077	12.085	12.092	12.100	12.108	12.115	12.123	12.131	12.13
2050	12.138	12.146	12.153	12.161	12.169	12.176	12.184	12.191	12.199	12.207	12.21
2060	12.214	12.222	12.230	12.237	12.245	12.252	12.260	12.268	12.275	12.283	12.29
2070	12.291	12.298	12.306	12.313	12.321	12.329	12.336	12.344	12.352	12.359	12.36
2080	12.367	12.375	12.382	12.390	12.397	12.405	12.413	12.420	12.428	12.436	12.44
2090	12.443	12.451	12.459	12.466	12.474	12.482	12.489	12.497	12.505	12.512	12.52
2100	12.520	12.528	12.535	12.543	12.551	12.558	12.566	12.574	12.581	12.589	12.59
2110	12.597	12.604	12.612	12.620	12.627	12.635	12.643	12.650	12.658	12.666	12.67
2120	12.673	12.681	12.689	12.696	12.704	12.712	12.719	12.727	12.735	12.742	12.75
2130	12.750	12.758	12.765	12.773	12.781	12.788	12.796	12.804	12.812	12.819	12.82
2140	12.827	12.835	12.842	12.850	12.858	12.865	12.873	12.881	12.889	12.896	12.90
2150	12.904	12.912	12.919	12.927	12.935	12.942	12.950	12.958	12.966	12.973	12.98
2160	12.981	12.989	12.996	13.004	13.012	13.019	13.027	13.035	13.043	13.050	13.05
2170	13.058	13.066	13.073	13.081	13.089	13.097	13.104	13.112	13.120	13.128	13.13
2180	13.135	13.143	13.151	13.158	13.166	13.174	13.182	13.189	13.197	13.205	13.21
2190	13.213	13.220	13.228	13.236	13.243	13.251	13.259	13.267	13.274	13.282	13.29
2200	13.290	13.298	13.305	13.313	13.321	13.329	13.336	13.344	13.352	13.359	13.36
2210	13.367	13.375	13.383	13.390	13.398	13.406	13.414	13.421	13.429	13.437	13.44
2220	13.445	13.452	13.460	13.468	13.476	13.483	13.491	13.499	13.507	13.514	13.52
2230	13.522	13.530	13.538	13.545	13.553	13.561	13.569	13.577	13.584	13.592	13.60
2240	13.600	13.608	13.615	13.623	13.631	13.639	13.646	13.654	13.662	13.670	13.67
2250	13.677	13.685	13.693	13.701	13.709	13.716	13.724	13.732	13.740	13.747	13.75
2260	13.755	13.763	13.771	13.778	13.786	13.794	13.802	13.810	13.817	13.825	13.83
2270	13.833	13.841	13.848	13.856	13.864	13.872	13.880	13.887	13.895	13.903	13.91
2280	13.911	13.919	13.926	13.934	13.942	13.950	13.957	13.965	13.973	13.981	13.98
2290	13.989	13.996	14.004	14.012	14.020	14.028	14.035	14.043	14.051	14.059	14.06
2300	14.066	14.074	14.082	14.090	14.098	14.105	14.113	14.121	14.129	14.137	14.14
2310	14.144	14.152	14.160	14.168	14.176	14.183	14.191	14.199	14.207	14.215	14.22
2320	14.222	14.230	14.238	14.246	14.254	14.261	14.269	14.277	14.285	14.293	14.30
2330	14.300	14.308	14.316	14.324	14.332	14.340	14.347	14.355	14.363	14.371	14.37
2340	14.379	14.386	14.394	14.402	14.410	14.418	14.425	14.433	14.441	14.449	14.45
2350	14.457	14.465	14.472	14.480	14.488	14.496	14.504	14.511	14.519	14.527	14.53
2360	14.535	14.543	14.551	14.558	14.566	14.574	14.582	14.590	14.597	14.605	14.61
2370	14.613	14.621	14.629	14.637	14.644	14.652	14.660	14.668	14.676	14.683	14.69
2380	14.691	14.699	14.707	14.715	14.723	14.730	14.738	14.746	14.754	14.762	14.77
2390	14.770	14.777	14.785	14.793	14.801	14.809	14.817	14.824	14.832	14.840	14.84
2400	14.848	14.856	14.864	14.871	14.879	14.887	14.895	14.903	14.911	14.918	14.92
2410	14.926	14.934	14.942	14.950	14.958	14.965	14.973	14.981	14.989	14.997	15.00
2420	15.005	15.012	15.020	15.028	15.036	15.044	15.052	15.059	15.067	15.075	15.08
2430	15.083	15.091	15.099	15.106	15.114	15.122	15.130	15.138	15.146	15.153	15.16
2440	15.161	15.169	15.177	15.185	15.193	15.200	15.208	15.216	15.224	15.232	15.24
2450	15.240	15.248	15.255	15.263	15.271	15.279	15.287	15.295	15.302	15.310	15.31
2460	15.318	15.326	15.334	15.342	15.349	15.357	15.365	15.373	15.381	15.389	15.39
2470	15.397	15.404	15.412	15.420	15.428	15.436	15.444	15.451	15.459	15.467	15.47
2480	15.475	15.483	15.491	15.499	15.506	15.514	15.522	15.530	15.538	15.546	15.55
2490	15.553	15.561	15.569	15.577	15.585	15.593	15.601	15.608	15.616	15.624	15.63
øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type R thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
2500	15.632	15.640	15.648	15.655	15.663	15.671	15.679	15.687	15.695	15.703	15.71
2510	15.710	15.718	15.726	15.734	15.742	15.750	15.758	15.765	15.773	15.781	15.78
2520	15.789	15.797	15.805	15.812	15.820	15.828	15.836	15.844	15.852	15.860	15.86
2530	15.867	15.875	15.883	15.891	15.899	15.907	15.915	15.922	15.930	15.938	15.94
2540	15.946	15.954	15.962	15.969	15.977	15.985	15.993	16.001	16.009	16.017	16.02
2550	16.024	16.032	16.040	16.048	16.056	16.064	16.071	16.079	16.087	16.095	16.10
2560	16.103	16.111	16.119	16.126	16.134	16.142	16.150	16.158	16.166	16.174	16.18
2570	16.181	16.189	16.197	16.205	16.213	16.221	16.228	16.236	16.244	16.252	16.26
2580	16.260	16.268	16.276	16.283	16.291	16.299	16.307	16.315	16.323	16.330	16.33
2590	16.338	16.346	16.354	16.362	16.370	16.378	16.385	16.393	16.401	16.409	16.41
2600	16.417	16.425	16.432	16.440	16.448	16.456	16.464	16.472	16.480	16.487	16.49
2610	16.495	16.503	16.511	16.519	16.527	16.534	16.542	16.550	16.558	16.566	16.57
2620	16.574	16.582	16.589	16.597	16.605	16.613	16.621	16.629	16.636	16.644	16.65
2630	16.652	16.660	16.668	16.676	16.683	16.691	16.699	16.707	16.715	16.723	16.73
2640	16.731	16.738	16.746	16.754	16.762	16.770	16.778	16.785	16.793	16.801	16.80
2650	16.809	16.817	16.825	16.832	16.840	16.848	16.856	16.864	16.872	16.879	16.88
2660	16.887	16.895	16.903	16.911	16.919	16.926	16.934	16.942	16.950	16.958	16.96
2670	16.966	16.973	16.981	16.989	16.997	17.005	17.013	17.020	17.028	17.036	17.04
2680	17.044	17.052	17.060	17.067	17.075	17.083	17.091	17.099	17.107	17.114	17.12
2690	17.122	17.130	17.138	17.146	17.154	17.161	17.169	17.177	17.185	17.193	17.20
2700	17.200	17.208	17.216	17.224	17.232	17.240	17.247	17.255	17.263	17.271	17.27
2710	17.279	17.286	17.294	17.302	17.310	17.318	17.326	17.333	17.341	17.349	17.35
2720	17.357	17.365	17.373	17.380	17.388	17.396	17.404	17.412	17.419	17.427	17.43
2730	17.435	17.443	17.451	17.458	17.466	17.474	17.482	17.490	17.498	17.505	17.51
2740	17.513	17.521	17.529	17.537	17.544	17.552	17.560	17.568	17.576	17.583	17.59
2750	17.591	17.599	17.607	17.615	17.622	17.630	17.638	17.646	17.654	17.661	17.66
2760	17.669	17.677	17.685	17.693	17.700	17.708	17.716	17.724	17.732	17.739	17.74
2770	17.747	17.755	17.763	17.771	17.778	17.786	17.794	17.802	17.810	17.817	17.82
2780	17.825	17.833	17.841	17.849	17.856	17.864	17.872	17.880	17.888	17.895	17.90
2790	17.903	17.911	17.919	17.926	17.934	17.942	17.950	17.958	17.965	17.973	17.98
2800	17.981	17.989	17.997	18.004	18.012	18.020	18.028	18.035	18.043	18.051	18.05
2810	18.059	18.067	18.074	18.082	18.090	18.098	18.105	18.113	18.121	18.129	18.13
2820	18.137	18.144	18.152	18.160	18.168	18.175	18.183	18.191	18.199	18.206	18.21
2830	18.214	18.222	18.230	18.238	18.245	18.253	18.261	18.269	18.276	18.284	18.29
2840	18.292	18.300	18.307	18.315	18.323	18.331	18.338	18.346	18.354	18.362	18.36
2850	18.369	18.377	18.385	18.393	18.400	18.408	18.416	18.424	18.431	18.439	18.44
2860	18.447	18.455	18.462	18.470	18.478	18.486	18.493	18.501	18.509	18.517	18.52
2870	18.524	18.532	18.540	18.548	18.555	18.563	18.571	18.579	18.586	18.594	18.60
2880	18.602	18.610	18.617	18.625	18.633	18.640	18.648	18.656	18.664	18.671	18.67
2890	18.679	18.687	18.695	18.702	18.710	18.718	18.725	18.733	18.741	18.749	18.75
2900	18.756	18.764	18.772	18.779	18.787	18.795	18.803	18.810	18.818	18.826	18.83
2910	18.834	18.841	18.849	18.857	18.864	18.872	18.880	18.887	18.895	18.903	18.91
2920	18.911	18.918	18.926	18.934	18.941	18.949	18.957	18.965	18.972	18.980	18.98
2930	18.988	18.995	19.003	19.011	19.018	19.026	19.034	19.042	19.049	19.057	19.06
2940	19.065	19.072	19.080	19.088	19.095	19.103	19.111	19.118	19.126	19.134	19.14
2950	19.141	19.149	19.157	19.165	19.172	19.180	19.188	19.195	19.203	19.211	19.21
2960	19.218	19.226	19.234	19.241	19.249	19.257	19.264	19.272	19.280	19.287	19.29
2970	19.295	19.303	19.310	19.318	19.326	19.333	19.341	19.349	19.356	19.364	19.37
2980	19.372	19.379	19.387	19.395	19.402	19.410	19.418	19.425	19.433	19.440	19.44
2990	19.448	19.456	19.463	19.471	19.479	19.486	19.494	19.502	19.509	19.517	19.52
3000	19.525	19.532	19.540	19.547	19.555	19.563	19.570	19.578	19.586	19.593	19.60
3010	19.601	19.609	19.616	19.624	19.631	19.639	19.647	19.654	19.662	19.670	19.67
3020	19.677	19.685	19.692	19.700	19.708	19.715	19.723	19.730	19.738	19.746	19.75
3030	19.753	19.761	19.769	19.776	19.784	19.791	19.799	19.807	19.814	19.822	19.82
3040	19.829	19.837	19.845	19.852	19.860	19.867	19.875	19.882	19.890	19.898	19.90
3050	19.905	19.913	19.920	19.928	19.936	19.943	19.951	19.958	19.966	19.973	19.98
3060	19.981	19.989	19.996	20.004	20.011	20.019	20.026	20.034	20.041	20.049	20.05
3070	20.056	20.064	20.072	20.079	20.087	20.094	20.102	20.109	20.117	20.124	20.13
3080	20.132	20.139	20.147	20.154	20.162	20.169	20.177	20.184	20.192	20.199	20.20
3090	20.207	20.214	20.222	20.229	20.237	20.244	20.252	20.259	20.266	20.274	20.28
3100	20.281	20.289	20.296	20.304	20.311	20.319	20.326	20.333	20.341	20.348	20.35
3110	20.356	20.363	20.371	20.378	20.385	20.393	20.400	20.407	20.415	20.422	20.43
3120	20.430	20.437	20.444	20.452	20.459	20.466	20.474	20.481	20.488	20.496	20.50
3130	20.503	20.510	20.518	20.525	20.532	20.540	20.547	20.554	20.562	20.569	20.57
3140	20.576	20.583	20.591	20.598	20.605	20.612	20.620	20.627	20.634	20.641	20.64

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type R thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
3150	20.649	20.656	20.663	20.670	20.678	20.685	20.692	20.699	20.706	20.714	20.72
3160	20.721	20.728	20.735	20.742	20.749	20.756	20.764	20.771	20.778	20.785	20.79
3170	20.792	20.799	20.806	20.813	20.821	20.828	20.835	20.842	20.849	20.856	20.86
3180	20.863	20.870	20.877	20.884	20.891	20.898	20.905	20.912	20.919	20.926	20.93
3190	20.933	20.940	20.947	20.954	20.961	20.968	20.975	20.982	20.989	20.996	21.00
3200	21.003	21.010	21.016	21.023	21.030	21.037	21.044	21.051	21.058	21.065	21.07
3210	21.071	21.078	21.085	21.092	21.099						

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type R thermocouple

øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
					Thermoelectric Voltage in mV						
-40	-0.226	-0.223	-0.219	-0.215	-0.211	-0.208	-0.204	-0.200	-0.196	-0.192	-0.18
-30	-0.188	-0.184	-0.180	-0.175	-0.171	-0.167	-0.163	-0.158	-0.154	-0.150	-0.14
-20	-0.145	-0.141	-0.137	-0.132	-0.128	-0.123	-0.119	-0.114	-0.109	-0.105	-0.10
-10	-0.100	-0.095	-0.091	-0.086	-0.081	-0.076	-0.071	-0.066	-0.061	-0.056	-0.05
0	-0.051	-0.046	-0.041	-0.036	-0.031	-0.026	-0.021	-0.016	-0.011	-0.005	0.00

øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

ITS-90 Table for type R thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
0	0.000	0.005	0.011	0.016	0.021	0.027	0.032	0.038	0.043	0.049	0.05
10	0.054	0.060	0.065	0.071	0.077	0.082	0.088	0.094	0.100	0.105	0.11
20	0.111	0.117	0.123	0.129	0.135	0.141	0.147	0.153	0.159	0.165	0.17
30	0.171	0.177	0.183	0.189	0.195	0.201	0.207	0.214	0.220	0.226	0.23
40	0.232	0.239	0.245	0.251	0.258	0.264	0.271	0.277	0.284	0.290	0.29
50	0.296	0.303	0.310	0.316	0.323	0.329	0.336	0.343	0.349	0.356	0.36
60	0.363	0.369	0.376	0.383	0.390	0.397	0.403	0.410	0.417	0.424	0.43
70	0.431	0.438	0.445	0.452	0.459	0.466	0.473	0.480	0.487	0.494	0.50
80	0.501	0.508	0.516	0.523	0.530	0.537	0.544	0.552	0.559	0.566	0.57
90	0.573	0.581	0.588	0.595	0.603	0.610	0.618	0.625	0.632	0.640	0.64
100	0.647	0.655	0.662	0.670	0.677	0.685	0.693	0.700	0.708	0.715	0.72
110	0.723	0.731	0.738	0.746	0.754	0.761	0.769	0.777	0.785	0.792	0.80
120	0.800	0.808	0.816	0.824	0.832	0.839	0.847	0.855	0.863	0.871	0.87
130	0.879	0.887	0.895	0.903	0.911	0.919	0.927	0.935	0.943	0.951	0.95
140	0.959	0.967	0.976	0.984	0.992	1.000	1.008	1.016	1.025	1.033	1.04
150	1.041	1.049	1.058	1.066	1.074	1.082	1.091	1.099	1.107	1.116	1.12
160	1.124	1.132	1.141	1.149	1.158	1.166	1.175	1.183	1.191	1.200	1.20
170	1.208	1.217	1.225	1.234	1.242	1.251	1.260	1.268	1.277	1.285	1.29
180	1.294	1.303	1.311	1.320	1.329	1.337	1.346	1.355	1.363	1.372	1.38
190	1.381	1.389	1.398	1.407	1.416	1.425	1.433	1.442	1.451	1.460	1.46
200	1.469	1.477	1.486	1.495	1.504	1.513	1.522	1.531	1.540	1.549	1.55
210	1.558	1.567	1.575	1.584	1.593	1.602	1.611	1.620	1.629	1.639	1.64
220	1.648	1.657	1.666	1.675	1.684	1.693	1.702	1.711	1.720	1.729	1.73
230	1.739	1.748	1.757	1.766	1.775	1.784	1.794	1.803	1.812	1.821	1.83
240	1.831	1.840	1.849	1.858	1.868	1.877	1.886	1.895	1.905	1.914	1.92
250	1.923	1.933	1.942	1.951	1.961	1.970	1.980	1.989	1.998	2.008	2.01
260	2.017	2.027	2.036	2.046	2.055	2.064	2.074	2.083	2.093	2.102	2.11
270	2.112	2.121	2.131	2.140	2.150	2.159	2.169	2.179	2.188	2.198	2.20
280	2.207	2.217	2.226	2.236	2.246	2.255	2.265	2.275	2.284	2.294	2.30
290	2.304	2.313	2.323	2.333	2.342	2.352	2.362	2.371	2.381	2.391	2.40
300	2.401	2.410	2.420	2.430	2.440	2.449	2.459	2.469	2.479	2.488	2.49
310	2.498	2.508	2.518	2.528	2.538	2.547	2.557	2.567	2.577	2.587	2.59
320	2.597	2.607	2.617	2.626	2.636	2.646	2.656	2.666	2.676	2.686	2.69
330	2.696	2.706	2.716	2.726	2.736	2.746	2.756	2.766	2.776	2.786	2.79
340	2.796	2.806	2.816	2.826	2.836	2.846	2.856	2.866	2.876	2.886	2.89
350	2.896	2.906	2.916	2.926	2.937	2.947	2.957	2.967	2.977	2.987	2.99
360	2.997	3.007	3.018	3.028	3.038	3.048	3.058	3.068	3.079	3.089	3.09
370	3.099	3.109	3.119	3.130	3.140	3.150	3.160	3.171	3.181	3.191	3.20
380	3.201	3.212	3.222	3.232	3.242	3.253	3.263	3.273	3.284	3.294	3.30
390	3.304	3.315	3.325	3.335	3.346	3.356	3.366	3.377	3.387	3.397	3.40

øC	0	1	2	3	4	5	6	7	8	9	10

øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
ITS-90 Table for type R thermocouple											
øC	0	1	2	3	4	5	6	7	8	9	10
Thermoelectric Voltage in mV											
400	3.408	3.418	3.428	3.439	3.449	3.460	3.470	3.480	3.491	3.501	3.51
410	3.512	3.522	3.533	3.543	3.553	3.564	3.574	3.585	3.595	3.606	3.61
420	3.616	3.627	3.637	3.648	3.658	3.669	3.679	3.690	3.700	3.711	3.72
430	3.721	3.732	3.742	3.753	3.764	3.774	3.785	3.795	3.806	3.816	3.82
440	3.827	3.838	3.848	3.859	3.869	3.880	3.891	3.901	3.912	3.922	3.93
450	3.933	3.944	3.954	3.965	3.976	3.986	3.997	4.008	4.018	4.029	4.04
460	4.040	4.050	4.061	4.072	4.083	4.093	4.104	4.115	4.125	4.136	4.14
470	4.147	4.158	4.168	4.179	4.190	4.201	4.211	4.222	4.233	4.244	4.25
480	4.255	4.265	4.276	4.287	4.298	4.309	4.319	4.330	4.341	4.352	4.36
490	4.363	4.373	4.384	4.395	4.406	4.417	4.428	4.439	4.449	4.460	4.47
500	4.471	4.482	4.493	4.504	4.515	4.526	4.537	4.548	4.558	4.569	4.58
510	4.580	4.591	4.602	4.613	4.624	4.635	4.646	4.657	4.668	4.679	4.69
520	4.690	4.701	4.712	4.723	4.734	4.745	4.756	4.767	4.778	4.789	4.80
530	4.800	4.811	4.822	4.833	4.844	4.855	4.866	4.877	4.888	4.899	4.91
540	4.910	4.922	4.933	4.944	4.955	4.966	4.977	4.988	4.999	5.010	5.02
550	5.021	5.033	5.044	5.055	5.066	5.077	5.088	5.099	5.111	5.122	5.13
560	5.133	5.144	5.155	5.166	5.178	5.189	5.200	5.211	5.222	5.234	5.24
570	5.245	5.256	5.267	5.279	5.290	5.301	5.312	5.323	5.335	5.346	5.35
580	5.357	5.369	5.380	5.391	5.402	5.414	5.425	5.436	5.448	5.459	5.47
590	5.470	5.481	5.493	5.504	5.515	5.527	5.538	5.549	5.561	5.572	5.58
600	5.583	5.595	5.606	5.618	5.629	5.640	5.652	5.663	5.674	5.686	5.69
610	5.697	5.709	5.720	5.731	5.743	5.754	5.766	5.777	5.789	5.800	5.81
620	5.812	5.823	5.834	5.846	5.857	5.869	5.880	5.892	5.903	5.915	5.92
630	5.926	5.938	5.949	5.961	5.972	5.984	5.995	6.007	6.018	6.030	6.04
640	6.041	6.053	6.065	6.076	6.088	6.099	6.111	6.122	6.134	6.146	6.15
650	6.157	6.169	6.180	6.192	6.204	6.215	6.227	6.238	6.250	6.262	6.27
660	6.273	6.285	6.297	6.308	6.320	6.332	6.343	6.355	6.367	6.378	6.39
670	6.390	6.402	6.413	6.425	6.437	6.448	6.460	6.472	6.484	6.495	6.50
680	6.507	6.519	6.531	6.542	6.554	6.566	6.578	6.589	6.601	6.613	6.62
690	6.625	6.636	6.648	6.660	6.672	6.684	6.695	6.707	6.719	6.731	6.74
700	6.743	6.755	6.766	6.778	6.790	6.802	6.814	6.826	6.838	6.849	6.86
710	6.861	6.873	6.885	6.897	6.909	6.921	6.933	6.945	6.956	6.968	6.98
720	6.980	6.992	7.004	7.016	7.028	7.040	7.052	7.064	7.076	7.088	7.10
730	7.100	7.112	7.124	7.136	7.148	7.160	7.172	7.184	7.196	7.208	7.22
740	7.220	7.232	7.244	7.256	7.268	7.280	7.292	7.304	7.316	7.328	7.34
750	7.340	7.352	7.364	7.376	7.389	7.401	7.413	7.425	7.437	7.449	7.46
760	7.461	7.473	7.485	7.498	7.510	7.522	7.534	7.546	7.558	7.570	7.58
770	7.583	7.595	7.607	7.619	7.631	7.644	7.656	7.668	7.680	7.692	7.70
780	7.705	7.717	7.729	7.741	7.753	7.766	7.778	7.790	7.802	7.815	7.82
790	7.827	7.839	7.851	7.864	7.876	7.888	7.901	7.913	7.925	7.938	7.95
800	7.950	7.962	7.974	7.987	7.999	8.011	8.024	8.036	8.048	8.061	8.07
810	8.073	8.086	8.098	8.110	8.123	8.135	8.147	8.160	8.172	8.185	8.19
820	8.197	8.209	8.222	8.234	8.247	8.259	8.272	8.284	8.296	8.309	8.32
830	8.321	8.334	8.346	8.359	8.371	8.384	8.396	8.409	8.421	8.434	8.44
840	8.446	8.459	8.471	8.484	8.496	8.509	8.521	8.534	8.546	8.559	8.57
850	8.571	8.584	8.597	8.609	8.622	8.634	8.647	8.659	8.672	8.685	8.69
860	8.697	8.710	8.722	8.735	8.748	8.760	8.773	8.785	8.798	8.811	8.82
870	8.823	8.836	8.849	8.861	8.874	8.887	8.899	8.912	8.925	8.937	8.95
880	8.950	8.963	8.975	8.988	9.001	9.014	9.026	9.039	9.052	9.065	9.07
890	9.077	9.090	9.103	9.115	9.128	9.141	9.154	9.167	9.179	9.192	9.20
900	9.205	9.218	9.230	9.243	9.256	9.269	9.282	9.294	9.307	9.320	9.33
910	9.333	9.346	9.359	9.371	9.384	9.397	9.410	9.423	9.436	9.449	9.46
920	9.461	9.474	9.487	9.500	9.513	9.526	9.539	9.552	9.565	9.578	9.59
930	9.590	9.603	9.616	9.629	9.642	9.655	9.668	9.681	9.694	9.707	9.72
940	9.720	9.733	9.746	9.759	9.772	9.785	9.798	9.811	9.824	9.837	9.85
950	9.850	9.863	9.876	9.889	9.902	9.915	9.928	9.941	9.954	9.967	9.98
960	9.980	9.993	10.006	10.019	10.032	10.046	10.059	10.072	10.085	10.098	10.11
970	10.111	10.124	10.137	10.150	10.163	10.177	10.190	10.203	10.216	10.229	10.24
980	10.242	10.255	10.268	10.282	10.295	10.308	10.321	10.334	10.347	10.361	10.37
990	10.374	10.387	10.400	10.413	10.427	10.440	10.453	10.466	10.480	10.493	10.50
øC	0	1	2	3	4	5	6	7	8	9	10

øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
ITS-90 Table for type R thermocouple											
øC	0	1	2	3	4	5	6	7	8	9	10
Thermoelectric Voltage in mV											
1000	10.506	10.519	10.532	10.546	10.559	10.572	10.585	10.599	10.612	10.625	10.63
1010	10.638	10.652	10.665	10.678	10.692	10.705	10.718	10.731	10.745	10.758	10.77
1020	10.771	10.785	10.798	10.811	10.825	10.838	10.851	10.865	10.878	10.891	10.90
1030	10.905	10.918	10.932	10.945	10.958	10.972	10.985	10.998	11.012	11.025	11.03
1040	11.039	11.052	11.065	11.079	11.092	11.106	11.119	11.132	11.146	11.159	11.17
1050	11.173	11.186	11.200	11.213	11.227	11.240	11.253	11.267	11.280	11.294	11.30
1060	11.307	11.321	11.334	11.348	11.361	11.375	11.388	11.402	11.415	11.429	11.44
1070	11.442	11.456	11.469	11.483	11.496	11.510	11.524	11.537	11.551	11.564	11.57
1080	11.578	11.591	11.605	11.618	11.632	11.646	11.659	11.673	11.686	11.700	11.71
1090	11.714	11.727	11.741	11.754	11.768	11.782	11.795	11.809	11.822	11.836	11.85
1100	11.850	11.863	11.877	11.891	11.904	11.918	11.931	11.945	11.959	11.972	11.98
1110	11.986	12.000	12.013	12.027	12.041	12.054	12.068	12.082	12.096	12.109	12.12
1120	12.123	12.137	12.150	12.164	12.178	12.191	12.205	12.219	12.233	12.246	12.26
1130	12.260	12.274	12.288	12.301	12.315	12.329	12.342	12.356	12.370	12.384	12.39
1140	12.397	12.411	12.425	12.439	12.453	12.466	12.480	12.494	12.508	12.521	12.53
1150	12.535	12.549	12.563	12.577	12.590	12.604	12.618	12.632	12.646	12.659	12.67
1160	12.673	12.687	12.701	12.715	12.729	12.742	12.756	12.770	12.784	12.798	12.81
1170	12.812	12.825	12.839	12.853	12.867	12.881	12.895	12.909	12.922	12.936	12.95
1180	12.950	12.964	12.978	12.992	13.006	13.019	13.033	13.047	13.061	13.075	13.08
1190	13.089	13.103	13.117	13.131	13.145	13.158	13.172	13.186	13.200	13.214	13.22
1200	13.228	13.242	13.256	13.270	13.284	13.298	13.311	13.325	13.339	13.353	13.36
1210	13.367	13.381	13.395	13.409	13.423	13.437	13.451	13.465	13.479	13.493	13.50
1220	13.507	13.521	13.535	13.549	13.563	13.577	13.590	13.604	13.618	13.632	13.64
1230	13.646	13.660	13.674	13.688	13.702	13.716	13.730	13.744	13.758	13.772	13.78
1240	13.786	13.800	13.814	13.828	13.842	13.856	13.870	13.884	13.898	13.912	13.92
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type S thermocouple											
øF	0	1	2	3	4	5	6	7	8	9	10
Thermoelectric Voltage in mV											
550	2.212	2.217	2.222	2.227	2.232	2.237	2.242	2.247	2.252	2.257	2.26
560	2.262	2.267	2.272	2.277	2.283	2.288	2.293	2.298	2.303	2.308	2.31
570	2.313	2.318	2.323	2.328	2.333	2.338	2.343	2.348	2.354	2.359	2.36
580	2.364	2.369	2.374	2.379	2.384	2.389	2.394	2.399	2.404	2.410	2.41
590	2.415	2.420	2.425	2.430	2.435	2.440	2.445	2.450	2.455	2.461	2.46
600	2.466	2.471	2.476	2.481	2.486	2.491	2.496	2.502	2.507	2.512	2.51
610	2.517	2.522	2.527	2.532	2.537	2.543	2.548	2.553	2.558	2.563	2.56
620	2.568	2.574	2.579	2.584	2.589	2.594	2.599	2.604	2.610	2.615	2.62
630	2.620	2.625	2.630	2.635	2.641	2.646	2.651	2.656	2.661	2.666	2.67
640	2.672	2.677	2.682	2.687	2.692	2.697	2.703	2.708	2.713	2.718	2.72
650	2.723	2.729	2.734	2.739	2.744	2.749	2.755	2.760	2.765	2.770	2.77
660	2.775	2.781	2.786	2.791	2.796	2.801	2.807	2.812	2.817	2.822	2.82
670	2.827	2.833	2.838	2.843	2.848	2.854	2.859	2.864	2.869	2.874	2.88
680	2.880	2.885	2.890	2.895	2.901	2.906	2.911	2.916	2.922	2.927	2.93
690	2.932	2.937	2.943	2.948	2.953	2.958	2.964	2.969	2.974	2.979	2.98
700	2.985	2.990	2.995	3.000	3.006	3.011	3.016	3.021	3.027	3.032	3.03
710	3.037	3.042	3.048	3.053	3.058	3.063	3.069	3.074	3.079	3.085	3.09
720	3.090	3.095	3.100	3.106	3.111	3.116	3.122	3.127	3.132	3.137	3.14
730	3.143	3.148	3.153	3.159	3.164	3.169	3.174	3.180	3.185	3.190	3.19
740	3.196	3.201	3.206	3.212	3.217	3.222	3.227	3.233	3.238	3.243	3.24
750	3.249	3.254	3.259	3.265	3.270	3.275	3.281	3.286	3.291	3.297	3.30
760	3.302	3.307	3.313	3.318	3.323	3.329	3.334	3.339	3.345	3.350	3.35
770	3.355	3.361	3.366	3.371	3.377	3.382	3.387	3.393	3.398	3.403	3.40
780	3.409	3.414	3.419	3.425	3.430	3.435	3.441	3.446	3.451	3.457	3.46
790	3.462	3.468	3.473	3.478	3.484	3.489	3.494	3.500	3.505	3.510	3.51
800	3.516	3.521	3.527	3.532	3.537	3.543	3.548	3.553	3.559	3.564	3.57
810	3.570	3.575	3.580	3.586	3.591	3.596	3.602	3.607	3.613	3.618	3.62
820	3.623	3.629	3.634	3.640	3.645	3.650	3.656	3.661	3.667	3.672	3.67
830	3.677	3.683	3.688	3.694	3.699	3.704	3.710	3.715	3.721	3.726	3.73
840	3.731	3.737	3.742	3.748	3.753	3.758	3.764	3.769	3.775	3.780	3.78
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type S thermocouple

Thermoelectric Voltage in mV

øF	0	1	2	3	4	5	6	7	8	9	10
850	3.786	3.791	3.796	3.802	3.807	3.813	3.818	3.823	3.829	3.834	3.84
860	3.840	3.845	3.851	3.856	3.862	3.867	3.872	3.878	3.883	3.889	3.89
870	3.894	3.900	3.905	3.910	3.916	3.921	3.927	3.932	3.938	3.943	3.94
880	3.949	3.954	3.959	3.965	3.970	3.976	3.981	3.987	3.992	3.998	4.00
890	4.003	4.009	4.014	4.020	4.025	4.030	4.036	4.041	4.047	4.052	4.05
900	4.058	4.063	4.069	4.074	4.080	4.085	4.091	4.096	4.102	4.107	4.11
910	4.113	4.118	4.123	4.129	4.134	4.140	4.145	4.151	4.156	4.162	4.16
920	4.167	4.173	4.178	4.184	4.189	4.195	4.200	4.206	4.211	4.217	4.22
930	4.222	4.228	4.233	4.239	4.244	4.250	4.255	4.261	4.266	4.272	4.27
940	4.277	4.283	4.288	4.294	4.299	4.305	4.310	4.316	4.321	4.327	4.33
950	4.332	4.338	4.343	4.349	4.355	4.360	4.366	4.371	4.377	4.382	4.38
960	4.388	4.393	4.399	4.404	4.410	4.415	4.421	4.426	4.432	4.437	4.44
970	4.443	4.449	4.454	4.460	4.465	4.471	4.476	4.482	4.487	4.493	4.49
980	4.498	4.504	4.510	4.515	4.521	4.526	4.532	4.537	4.543	4.548	4.55
990	4.554	4.559	4.565	4.571	4.576	4.582	4.587	4.593	4.598	4.604	4.61
1000	4.610	4.615	4.621	4.626	4.632	4.637	4.643	4.648	4.654	4.660	4.66
1010	4.665	4.671	4.676	4.682	4.688	4.693	4.699	4.704	4.710	4.715	4.72
1720	20.488	20.502	20.515	20.528	20.541	20.554	20.567	20.581	20.594	20.607	20.62
1730	20.620	20.633	20.646	20.659	20.672	20.685	20.698	20.711	20.724	20.736	20.74
1740	20.749	20.762	20.775	20.788	20.801	20.813	20.826	20.839	20.852	20.864	20.87
1750	20.877	20.890	20.902	20.915	20.928	20.940	20.953	20.965	20.978	20.990	21.00
1760	21.003	21.015	21.027	21.040	21.052	21.065	21.077	21.089	21.101		

øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type S thermocouple

Thermoelectric Voltage in mV

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
-50			-0.236	-0.233	-0.231	-0.229	-0.227	-0.224	-0.222	-0.220	-0.21
-40	-0.218	-0.215	-0.213	-0.211	-0.208	-0.206	-0.204	-0.201	-0.199	-0.197	-0.19
-30	-0.194	-0.192	-0.190	-0.187	-0.185	-0.182	-0.180	-0.178	-0.175	-0.173	-0.17
-20	-0.170	-0.168	-0.165	-0.163	-0.160	-0.158	-0.155	-0.153	-0.150	-0.148	-0.14
-10	-0.145	-0.142	-0.140	-0.137	-0.135	-0.132	-0.129	-0.127	-0.124	-0.122	-0.11
0	-0.119	-0.116	-0.114	-0.111	-0.108	-0.106	-0.103	-0.100	-0.097	-0.095	-0.09

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

ITS-90 Table for type S thermocouple

Thermoelectric Voltage in mV

øF	0	1	2	3	4	5	6	7	8	9	10
0	-0.092	-0.089	-0.086	-0.084	-0.081	-0.078	-0.075	-0.073	-0.070	-0.067	-0.06
10	-0.064	-0.061	-0.058	-0.056	-0.053	-0.050	-0.047	-0.044	-0.041	-0.038	-0.03
20	-0.035	-0.033	-0.030	-0.027	-0.024	-0.021	-0.018	-0.015	-0.012	-0.009	-0.00
30	-0.006	-0.003	0.000	0.003	0.006	0.009	0.012	0.015	0.018	0.021	0.02
40	0.024	0.027	0.030	0.033	0.037	0.040	0.043	0.046	0.049	0.052	0.05
50	0.055	0.058	0.062	0.065	0.068	0.071	0.074	0.077	0.081	0.084	0.08
60	0.087	0.090	0.093	0.097	0.100	0.103	0.106	0.110	0.113	0.116	0.11
70	0.119	0.123	0.126	0.129	0.133	0.136	0.139	0.143	0.146	0.149	0.15
80	0.153	0.156	0.159	0.163	0.166	0.169	0.173	0.176	0.180	0.183	0.18
90	0.186	0.190	0.193	0.197	0.200	0.204	0.207	0.210	0.214	0.217	0.22
100	0.221	0.224	0.228	0.231	0.235	0.238	0.242	0.245	0.249	0.252	0.25
110	0.256	0.260	0.263	0.267	0.270	0.274	0.277	0.281	0.285	0.288	0.29
120	0.292	0.295	0.299	0.303	0.306	0.310	0.313	0.317	0.321	0.324	0.32
130	0.328	0.332	0.335	0.339	0.343	0.346	0.350	0.354	0.357	0.361	0.36
140	0.365	0.369	0.372	0.376	0.380	0.384	0.387	0.391	0.395	0.399	0.40
150	0.402	0.406	0.410	0.414	0.417	0.421	0.425	0.429	0.433	0.436	0.44
160	0.440	0.444	0.448	0.452	0.456	0.459	0.463	0.467	0.471	0.475	0.47
170	0.479	0.483	0.487	0.490	0.494	0.498	0.502	0.506	0.510	0.514	0.51
180	0.518	0.522	0.526	0.530	0.534	0.538	0.541	0.545	0.549	0.553	0.55
190	0.557	0.561	0.565	0.569	0.573	0.577	0.581	0.585	0.589	0.593	0.59
200	0.597	0.601	0.605	0.609	0.613	0.617	0.622	0.626	0.630	0.634	0.63
210	0.638	0.642	0.646	0.650	0.654	0.658	0.662	0.666	0.670	0.675	0.67
220	0.679	0.683	0.687	0.691	0.695	0.699	0.703	0.708	0.712	0.716	0.72
230	0.720	0.724	0.728	0.732	0.737	0.741	0.745	0.749	0.753	0.758	0.76
240	0.762	0.766	0.770	0.774	0.779	0.783	0.787	0.791	0.795	0.800	0.80

øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type S thermocouple

Thermoelectric Voltage in mV

øF	0	1	2	3	4	5	6	7	8	9	10
150	0.402	0.406	0.410	0.414	0.417	0.421	0.425	0.429	0.433	0.436	0.44
160	0.440	0.444	0.448	0.452	0.456	0.459	0.463	0.467	0.471	0.475	0.47
170	0.479	0.483	0.487	0.490	0.494	0.498	0.502	0.506	0.510	0.514	0.51
180	0.518	0.522	0.526	0.530	0.534	0.538	0.541	0.545	0.549	0.553	0.55
190	0.557	0.561	0.565	0.569	0.573	0.577	0.581	0.585	0.589	0.593	0.59
200	0.597	0.601	0.605	0.609	0.613	0.617	0.622	0.626	0.630	0.634	0.63
210	0.638	0.642	0.646	0.650	0.654	0.658	0.662	0.666	0.670	0.675	0.67
220	0.679	0.683	0.687	0.691	0.695	0.699	0.703	0.708	0.712	0.716	0.72
230	0.720	0.724	0.728	0.732	0.737	0.741	0.745	0.749	0.753	0.758	0.76
240	0.762	0.766	0.770	0.774	0.779	0.783	0.787	0.791	0.795	0.800	0.80
250	0.804	0.808	0.812	0.817	0.821	0.825	0.829	0.834	0.838	0.842	0.84
260	0.847	0.851	0.855	0.859	0.864	0.868	0.872	0.877	0.881	0.885	0.88
270	0.889	0.894	0.898	0.902	0.907	0.911	0.915	0.920	0.924	0.928	0.93
280	0.933	0.937	0.942	0.946	0.950	0.955	0.959	0.963	0.968	0.972	0.97
290	0.977	0.981	0.985	0.990	0.994	0.998	1.003	1.007	1.012	1.016	1.02
300	1.021	1.025	1.029	1.034	1.038	1.043	1.047	1.052	1.056	1.061	1.06
310	1.065	1.069	1.074	1.078	1.083	1.087	1.092	1.096	1.101	1.105	1.11
320	1.110	1.114	1.119	1.123	1.128	1.132	1.137	1.141	1.146	1.150	1.15
330	1.155	1.159	1.164	1.168	1.173	1.177	1.182	1.186	1.191	1.196	1.20
340	1.200	1.205	1.209	1.214	1.218	1.223	1.227	1.232	1.237	1.241	1.24
350	1.246	1.250	1.255	1.260	1.264	1.269	1.273	1.278	1.283	1.287	1.29
360	1.292	1.296	1.301	1.306	1.310	1.315	1.319	1.324	1.329	1.333	1.33
370	1.338	1.343	1.347	1.352	1.357	1.361	1.366	1.371	1.375	1.380	1.38
380	1.385	1.389	1.394	1.399	1.403	1.408	1.413	1.417	1.422	1.427	1.43
390	1.431	1.436	1.441	1.445	1.450	1.455	1.460	1.464	1.469	1.474	1.47
400	1.478	1.483	1.488	1.493	1.497	1.502	1.507	1.512	1.516	1.521	1.52
410	1.526	1.531	1.535	1.540	1.545	1.550	1.554	1.559	1.564	1.569	1.57
420	1.573	1.578	1.583	1.588	1.592	1.597	1.602	1.607	1.612	1.616	1.62
430	1.621	1.626	1.631	1.636	1.640	1.645	1.650	1.655	1.660	1.664	1.66
440	1.669	1.674	1.679	1.684	1.689	1.693	1.698	1.703	1.708	1.713	1.71
450	1.718	1.722	1.727	1.732	1.737	1.742	1.747	1.752	1.756	1.761	1.76
460	1.766	1.771	1.776	1.781	1.786	1.790	1.795	1.800	1.805	1.810	1.81
470	1.815	1.820	1.825	1.829	1.834	1.839	1.844	1.849	1.854	1.859	1.86
480	1.864	1.869	1.874	1.878	1.883	1.888	1.893	1.898	1.903	1.908	1.91
490	1.913	1.918	1.923	1.928	1.933	1.938	1.942	1.947	1.952	1.957	1.96
500	1.962	1.967	1.972	1.977	1.982	1.987	1.992	1.997	2.002	2.007	2.01
510	2.012	2.017	2.022	2.027	2.032	2.037	2.042	2.047	2.052	2.057	2.06
520	2.062	2.067	2.072	2.076	2.081	2.086	2.091	2.096	2.101	2.106	2.11
530	2.111	2.116	2.121	2.126	2.131	2.136	2.141	2.147	2.152	2.157	2.16
540	2.162	2.167	2.172	2.177	2.182	2.187	2.192	2.197	2.202	2.207	2.21
550	2.212	2.217	2.222	2.227	2.232	2.237	2.242	2.247	2.252	2.257	2.26
560	2.262	2.267	2.272	2.277	2.283	2.288	2.293	2.298	2.303	2.308	2.31
570	2.313	2.318	2.323	2.328	2.333	2.338	2.343	2.348	2.354	2.359	2.36
580	2.364	2.369	2.374	2.379	2.384	2.389	2.394	2.399	2.404	2.410	2.41
590	2.415	2.420	2.425	2.430	2.435	2.440	2.445	2.450	2.455	2.461	2.46
600	2.466	2.471	2.476	2.481	2.486	2.491	2.496	2.502	2.507	2.512	2.51
610	2.517	2.522	2.527	2.532	2.537	2.543	2.548	2.553	2.558	2.563	2.56
620	2.568	2.574	2.579	2.584	2.589	2.594	2.599	2.604	2.610	2.615	2.62
630	2.620	2.625	2.630	2.635	2.641	2.646	2.651	2.656	2.661	2.666	2.67
640	2.672	2.677	2.682	2.687	2.692	2.697	2.703	2.708	2.713	2.718	2.72
650	2.723	2.729	2.734	2.739	2.744	2.749	2.755	2.760	2.765	2.770	2.77
660	2.775	2.781	2.786	2.791	2.796	2.801	2.807	2.812	2.817	2.822	2.82
670	2.827	2.833	2.838	2.843	2.848	2.854	2.859	2.864	2.869	2.874	2.88
680	2.880	2.885	2.890	2.895	2.901	2.906	2.911	2.916	2.922	2.927	2.93
690	2.932	2.937	2.943	2.948	2.953	2.958	2.964	2.969	2.974	2.979	2.98
700	2.985	2.990	2.995	3.000	3.006	3.011	3.016	3.021	3.027	3.032	3.03
710	3.037	3.042	3.048	3.053	3.058	3.063	3.069	3.074	3.079	3.085	3.09
720	3.090	3.095	3.100	3.106	3.111	3.116	3.122	3.127	3.132	3.137	3.14
730	3.143	3.148	3.153	3.159	3.164	3.169	3.174	3.180	3.185	3.190	3.19
740	3.196	3.201	3.206	3.212	3.217	3.222	3.227	3.233	3.238	3.243	3.24
750	3.249	3.254	3.259	3.265	3.270	3.275	3.281	3.286	3.291	3.297	3.30
760	3.302	3.307	3.313	3.318	3.323	3.329	3.334	3.339	3.345	3.350	3.35
770	3.355	3.361	3.366	3.371	3.377	3.382	3.387	3.393	3.398	3.403	3.40
780	3.409	3.414	3.419	3.425	3.430	3.435	3.441	3.446	3.451	3.457	3.46
790	3.462	3.468	3.473	3.478	3.484	3.489	3.494	3.500	3.505	3.510	3.51

øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type S thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
						Thermoelectric Voltage in mV					
800	3.516	3.521	3.527	3.532	3.537	3.543	3.548	3.553	3.559	3.564	3.57
810	3.570	3.575	3.580	3.586	3.591	3.596	3.602	3.607	3.613	3.618	3.62
820	3.623	3.629	3.634	3.640	3.645	3.650	3.656	3.661	3.667	3.672	3.67
830	3.677	3.683	3.688	3.694	3.699	3.704	3.710	3.715	3.721	3.726	3.73
840	3.731	3.737	3.742	3.748	3.753	3.758	3.764	3.769	3.775	3.780	3.78
850	3.786	3.791	3.796	3.802	3.807	3.813	3.818	3.823	3.829	3.834	3.84
860	3.840	3.845	3.851	3.856	3.862	3.867	3.872	3.878	3.883	3.889	3.89
870	3.894	3.900	3.905	3.910	3.916	3.921	3.927	3.932	3.938	3.943	3.94
880	3.949	3.954	3.959	3.965	3.970	3.976	3.981	3.987	3.992	3.998	4.00
890	4.003	4.009	4.014	4.020	4.025	4.030	4.036	4.041	4.047	4.052	4.05
900	4.058	4.063	4.069	4.074	4.080	4.085	4.091	4.096	4.102	4.107	4.11
910	4.113	4.118	4.123	4.129	4.134	4.140	4.145	4.151	4.156	4.162	4.16
920	4.167	4.173	4.178	4.184	4.189	4.195	4.200	4.206	4.211	4.217	4.22
930	4.222	4.228	4.233	4.239	4.244	4.250	4.255	4.261	4.266	4.272	4.27
940	4.277	4.283	4.288	4.294	4.299	4.305	4.310	4.316	4.321	4.327	4.33
950	4.332	4.338	4.343	4.349	4.355	4.360	4.366	4.371	4.377	4.382	4.38
960	4.388	4.393	4.399	4.404	4.410	4.415	4.421	4.426	4.432	4.437	4.44
970	4.443	4.449	4.454	4.460	4.465	4.471	4.476	4.482	4.487	4.493	4.49
980	4.498	4.504	4.510	4.515	4.521	4.526	4.532	4.537	4.543	4.548	4.55
990	4.554	4.559	4.565	4.571	4.576	4.582	4.587	4.593	4.598	4.604	4.61
1000	4.610	4.615	4.621	4.626	4.632	4.637	4.643	4.648	4.654	4.660	4.66
1010	4.665	4.671	4.676	4.682	4.688	4.693	4.699	4.704	4.710	4.715	4.72
1020	4.721	4.727	4.732	4.738	4.743	4.749	4.755	4.760	4.766	4.771	4.77
1030	4.777	4.782	4.788	4.794	4.799	4.805	4.810	4.816	4.822	4.827	4.83
1040	4.833	4.838	4.844	4.850	4.855	4.861	4.866	4.872	4.878	4.883	4.88
1050	4.889	4.895	4.900	4.906	4.911	4.917	4.923	4.928	4.934	4.939	4.94
1060	4.945	4.951	4.956	4.962	4.968	4.973	4.979	4.984	4.990	4.996	5.00
1070	5.001	5.007	5.013	5.018	5.024	5.030	5.035	5.041	5.046	5.052	5.05
1080	5.058	5.063	5.069	5.075	5.080	5.086	5.092	5.097	5.103	5.109	5.11
1090	5.114	5.120	5.125	5.131	5.137	5.142	5.148	5.154	5.159	5.165	5.17
1100	5.171	5.176	5.182	5.188	5.193	5.199	5.205	5.210	5.216	5.222	5.22
1110	5.227	5.233	5.239	5.244	5.250	5.256	5.261	5.267	5.273	5.278	5.28
1120	5.284	5.290	5.295	5.301	5.307	5.312	5.318	5.324	5.330	5.335	5.34
1130	5.341	5.347	5.352	5.358	5.364	5.369	5.375	5.381	5.386	5.392	5.39
1140	5.398	5.404	5.409	5.415	5.421	5.426	5.432	5.438	5.443	5.449	5.45
1150	5.455	5.461	5.466	5.472	5.478	5.483	5.489	5.495	5.501	5.506	5.51
1160	5.512	5.518	5.523	5.529	5.535	5.541	5.546	5.552	5.558	5.563	5.56
1170	5.569	5.575	5.581	5.586	5.592	5.598	5.604	5.609	5.615	5.621	5.62
1180	5.627	5.632	5.638	5.644	5.649	5.655	5.661	5.667	5.672	5.678	5.68
1190	5.684	5.690	5.695	5.701	5.707	5.713	5.718	5.724	5.730	5.736	5.74
1200	5.741	5.747	5.753	5.759	5.764	5.770	5.776	5.782	5.788	5.793	5.79
1210	5.799	5.805	5.811	5.816	5.822	5.828	5.834	5.839	5.845	5.851	5.85
1220	5.857	5.863	5.868	5.874	5.880	5.886	5.891	5.897	5.903	5.909	5.91
1230	5.915	5.920	5.926	5.932	5.938	5.944	5.949	5.955	5.961	5.967	5.97
1240	5.972	5.978	5.984	5.990	5.996	6.001	6.007	6.013	6.019	6.025	6.03
1250	6.030	6.036	6.042	6.048	6.054	6.060	6.065	6.071	6.077	6.083	6.08
1260	6.089	6.094	6.100	6.106	6.112	6.118	6.124	6.129	6.135	6.141	6.14
1270	6.147	6.153	6.158	6.164	6.170	6.176	6.182	6.188	6.193	6.199	6.20
1280	6.205	6.211	6.217	6.223	6.228	6.234	6.240	6.246	6.252	6.258	6.26
1290	6.264	6.269	6.275	6.281	6.287	6.293	6.299	6.305	6.310	6.316	6.32
1300	6.322	6.328	6.334	6.340	6.346	6.351	6.357	6.363	6.369	6.375	6.38
1310	6.381	6.387	6.392	6.398	6.404	6.410	6.416	6.422	6.428	6.434	6.43
1320	6.439	6.445	6.451	6.457	6.463	6.469	6.475	6.481	6.486	6.492	6.49
1330	6.498	6.504	6.510	6.516	6.522	6.528	6.534	6.539	6.545	6.551	6.55
1340	6.557	6.563	6.569	6.575	6.581	6.587	6.593	6.598	6.604	6.610	6.61
1350	6.616	6.622	6.628	6.634	6.640	6.646	6.652	6.658	6.664	6.669	6.67
1360	6.675	6.681	6.687	6.693	6.699	6.705	6.711	6.717	6.723	6.729	6.73
1370	6.735	6.741	6.746	6.752	6.758	6.764	6.770	6.776	6.782	6.788	6.79
1380	6.794	6.800	6.806	6.812	6.818	6.824	6.830	6.836	6.842	6.847	6.85
1390	6.853	6.859	6.865	6.871	6.877	6.883	6.889	6.895	6.901	6.907	6.91
1400	6.913	6.919	6.925	6.931	6.937	6.943	6.949	6.955	6.961	6.967	6.97
1410	6.973	6.979	6.985	6.991	6.997	7.003	7.008	7.014	7.020	7.026	7.03
1420	7.032	7.038	7.044	7.050	7.056	7.062	7.068	7.074	7.080	7.086	7.09
1430	7.092	7.098	7.104	7.110	7.116	7.122	7.128	7.134	7.140	7.146	7.15
1440	7.152	7.158	7.164	7.170	7.176	7.182	7.188	7.194	7.200	7.206	7.21
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type S thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
						Thermoelectric Voltage in mV					
1450	7.212	7.218	7.224	7.230	7.236	7.242	7.249	7.255	7.261	7.267	7.27
1460	7.273	7.279	7.285	7.291	7.297	7.303	7.309	7.315	7.321	7.327	7.33
1470	7.333	7.339	7.345	7.351	7.357	7.363	7.369	7.375	7.381	7.387	7.39
1480	7.393	7.399	7.405	7.411	7.418	7.424	7.430	7.436	7.442	7.448	7.45
1490	7.454	7.460	7.466	7.472	7.478	7.484	7.490	7.496	7.502	7.508	7.51
1500	7.514	7.521	7.527	7.533	7.539	7.545	7.551	7.557	7.563	7.569	7.57
1510	7.575	7.581	7.587	7.593	7.600	7.606	7.612	7.618	7.624	7.630	7.63
1520	7.636	7.642	7.648	7.654	7.660	7.667	7.673	7.679	7.685	7.691	7.69
1530	7.697	7.703	7.709	7.715	7.721	7.728	7.734	7.740	7.746	7.752	7.75
1540	7.758	7.764	7.770	7.776	7.783	7.789	7.795	7.801	7.807	7.813	7.81
1550	7.819	7.825	7.832	7.838	7.844	7.850	7.856	7.862	7.868	7.874	7.88
1560	7.881	7.887	7.893	7.899	7.905	7.911	7.917	7.923	7.930	7.936	7.94
1570	7.942	7.948	7.954	7.960	7.966	7.973	7.979	7.985	7.991	7.997	8.00
1580	8.003	8.010	8.016	8.022	8.028	8.034	8.040	8.047	8.053	8.059	8.06
1590	8.065	8.071	8.077	8.083	8.090	8.096	8.102	8.108	8.114	8.121	8.12
1600	8.127	8.133	8.139	8.145	8.151	8.158	8.164	8.170	8.176	8.182	8.18
1610	8.189	8.195	8.201	8.207	8.213	8.219	8.226	8.232	8.238	8.244	8.25
1620	8.250	8.257	8.263	8.269	8.275	8.281	8.288	8.294	8.300	8.306	8.31
1630	8.312	8.319	8.325	8.331	8.337	8.343	8.350	8.356	8.362	8.368	8.37
1640	8.375	8.381	8.387	8.393	8.399	8.406	8.412	8.418	8.424	8.431	8.43
1650	8.437	8.443	8.449	8.455	8.462	8.468	8.474	8.480	8.487	8.493	8.49
1660	8.499	8.505	8.512	8.518	8.524	8.530	8.537	8.543	8.549	8.555	8.56
1670	8.562	8.568	8.574	8.580	8.587	8.593	8.599	8.605	8.612	8.618	8.62
1680	8.624	8.630	8.637	8.643	8.649	8.655	8.662	8.668	8.674	8.680	8.68
1690	8.687	8.693	8.699	8.706	8.712	8.718	8.724	8.731	8.737	8.743	8.74
1700	8.749	8.756	8.762	8.768	8.775	8.781	8.787	8.793	8.800	8.806	8.81
1710	8.812	8.819	8.825	8.831	8.837	8.844	8.850	8.856	8.863	8.869	8.87
1720	8.875	8.882	8.888	8.894	8.900	8.907	8.913	8.919	8.926	8.932	8.93
1730	8.938	8.945	8.951	8.957	8.964	8.970	8.976	8.983	8.989	8.995	9.00
1740	9.001	9.008	9.014	9.020	9.027	9.033	9.039	9.046	9.052	9.058	9.06
1750	9.065	9.071	9.077	9.084	9.090	9.096	9.103	9.109	9.115	9.122	9.12
1760	9.128	9.134	9.141	9.147	9.153	9.160	9.166	9.172	9.179	9.185	9.19
1770	9.192	9.198	9.204	9.211	9.217	9.223	9.230	9.236	9.242	9.249	9.25
1780	9.255	9.261	9.268	9.274	9.281	9.287	9.293	9.300	9.306	9.312	9.31
1790	9.319	9.325	9.331	9.338	9.344	9.351	9.357	9.363	9.370	9.376	9.38
1800	9.382	9.389	9.395	9.402	9.408	9.414	9.421	9.427	9.434	9.440	9.44
1810	9.446	9.453	9.459	9.465	9.472	9.478	9.485	9.491	9.497	9.504	9.51
1820	9.510	9.517	9.523	9.529	9.536	9.542	9.549	9.555	9.561	9.568	9.57
1830	9.574	9.581	9.587	9.594	9.600	9.606	9.613	9.619	9.626	9.632	9.63
1840	9.638	9.645	9.651	9.658	9.664	9.671	9.677	9.683	9.690	9.696	9.70
1850	9.703	9.709	9.716	9.722	9.728	9.735	9.741	9.748	9.754	9.761	9.76
1860	9.767	9.773	9.780	9.786	9.793	9.799	9.806	9.812	9.819	9.825	9.83
1870	9.831	9.838	9.844	9.851	9.857	9.864	9.870	9.877	9.883	9.889	9.89
1880	9.896	9.902	9.909	9.915	9.922	9.928	9.935	9.941	9.948	9.954	9.96
1890	9.961	9.967	9.973	9.980	9.986	9.993	9.999	10.006	10.012	10.019	10.02
1900	10.025	10.032	10.038	10.045	10.051	10.058	10.064	10.071	10.077	10.084	10.09
1910	10.090	10.097	10.103	10.110	10.116	10.123	10.129	10.136	10.142	10.149	10.15
1920	10.155	10.162	10.168	10.175	10.181	10.188	10.194	10.201	10.207	10.214	10.22
1930	10.220	10.227	10.233	10.240	10.246	10.253	10.259	10.266	10.272	10.279	10.28
1940	10.285	10.292	10.298	10.305	10.311	10.318	10.324	10.331	10.337	10.344	10.35
1950	10.350	10.357	10.363	10.370	10.376	10.383	10.390	10.396	10.403	10.409	10.41
1960	10.416	10.422	10.429	10.435	10.442	10.448	10.455	10.461	10.468	10.475	10.48
1970	10.481	10.488	10.494	10.501	10.507	10.514	10.520	10.527	10.533	10.540	10.54
1980	10.547	10.553	10.560	10.566	10.573	10.579	10.586	10.592	10.599	10.606	10.61
1990	10.612	10.619	10.625	10.632	10.638	10.645	10.651	10.658	10.665	10.671	10.67
2000	10.678	10.684	10.691	10.697	10.704	10.711	10.717	10.724	10.730	10.737	10.74
2010	10.743	10.750	10.757	10.763	10.770	10.776	10.783	10.789	10.796	10.803	10.80
2020	10.809	10.816	10.822	10.829	10.836	10.842	10.849	10.855	10.862	10.868	10.87
2030	10.875	10.882	10.888	10.895	10.901	10.908	10.915	10.921	10.928	10.934	10.94
2040	10.941	10.948	10.954	10.961	10.967	10.974	10.981	10.987	10.994	11.000	11.00
2050	11.007	11.014	11.020	11.027	11.033	11.040	11.047	11.053	11.060	11.066	11.07
2060	11.073	11.080	11.086	11.093	11.099	11.106	11.113	11.119	11.126	11.132	11.13
2070	11.139	11.146	11.152	11.159	11.166	11.172	11.179	11.185	11.192	11.199	11.20
2080	11.205	11.212	11.219	11.225	11.232	11.238	11.245	11.252	11.258	11.265	11.27
2090	11.272	11.278	11.285	11.291	11.298	11.305	11.311	11.318	11.325	11.331	11.33
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type S thermocouple

Thermoelectric Voltage in mV

øF	0	1	2	3	4	5	6	7	8	9	10
2100	11.338	11.345	11.351	11.358	11.364	11.371	11.378	11.384	11.391	11.398	11.40
2110	11.404	11.411	11.418	11.424	11.431	11.437	11.444	11.451	11.457	11.464	11.47
2120	11.471	11.477	11.484	11.491	11.497	11.504	11.511	11.517	11.524	11.531	11.53
2130	11.537	11.544	11.550	11.557	11.564	11.570	11.577	11.584	11.590	11.597	11.60
2140	11.604	11.610	11.617	11.624	11.630	11.637	11.644	11.650	11.657	11.664	11.67
2150	11.670	11.677	11.684	11.690	11.697	11.704	11.710	11.717	11.724	11.730	11.73
2160	11.737	11.744	11.750	11.757	11.764	11.770	11.777	11.784	11.790	11.797	11.80
2170	11.804	11.810	11.817	11.824	11.830	11.837	11.844	11.850	11.857	11.864	11.87
2180	11.870	11.877	11.884	11.890	11.897	11.904	11.910	11.917	11.924	11.931	11.93
2190	11.937	11.944	11.951	11.957	11.964	11.971	11.977	11.984	11.991	11.997	12.00
2200	12.004	12.011	12.017	12.024	12.031	12.037	12.044	12.051	12.058	12.064	12.07
2210	12.071	12.078	12.084	12.091	12.098	12.104	12.111	12.118	12.124	12.131	12.13
2220	12.138	12.145	12.151	12.158	12.165	12.171	12.178	12.185	12.191	12.198	12.20
2230	12.205	12.211	12.218	12.225	12.232	12.238	12.245	12.252	12.258	12.265	12.27
2240	12.272	12.278	12.285	12.292	12.299	12.305	12.312	12.319	12.325	12.332	12.33
2250	12.339	12.346	12.352	12.359	12.366	12.372	12.379	12.386	12.392	12.399	12.40
2260	12.406	12.413	12.419	12.426	12.433	12.439	12.446	12.453	12.460	12.466	12.47
2270	12.473	12.480	12.486	12.493	12.500	12.507	12.513	12.520	12.527	12.533	12.54
2280	12.540	12.547	12.554	12.560	12.567	12.574	12.580	12.587	12.594	12.601	12.60
2290	12.607	12.614	12.621	12.627	12.634	12.641	12.648	12.654	12.661	12.668	12.67
2300	12.675	12.681	12.688	12.695	12.701	12.708	12.715	12.722	12.728	12.735	12.74
2310	12.742	12.748	12.755	12.762	12.769	12.775	12.782	12.789	12.796	12.802	12.80
2320	12.809	12.816	12.822	12.829	12.836	12.843	12.849	12.856	12.863	12.870	12.87
2330	12.876	12.883	12.890	12.896	12.903	12.910	12.917	12.923	12.930	12.937	12.94
2340	12.944	12.950	12.957	12.964	12.971	12.977	12.984	12.991	12.997	13.004	13.01
2350	13.011	13.018	13.024	13.031	13.038	13.045	13.051	13.058	13.065	13.072	13.07
2360	13.078	13.085	13.092	13.098	13.105	13.112	13.119	13.125	13.132	13.139	13.14
2370	13.146	13.152	13.159	13.166	13.173	13.179	13.186	13.193	13.199	13.206	13.21
2380	13.213	13.220	13.226	13.233	13.240	13.247	13.253	13.260	13.267	13.274	13.28
2390	13.280	13.287	13.294	13.301	13.307	13.314	13.321	13.328	13.334	13.341	13.34
2400	13.348	13.354	13.361	13.368	13.375	13.381	13.388	13.395	13.402	13.408	13.41
2410	13.415	13.422	13.429	13.435	13.442	13.449	13.456	13.462	13.469	13.476	13.48
2420	13.483	13.489	13.496	13.503	13.510	13.516	13.523	13.530	13.537	13.543	13.55
2430	13.550	13.557	13.563	13.570	13.577	13.584	13.590	13.597	13.604	13.611	13.61
2440	13.617	13.624	13.631	13.638	13.644	13.651	13.658	13.665	13.671	13.678	13.68
2450	13.685	13.692	13.698	13.705	13.712	13.719	13.725	13.732	13.739	13.746	13.75
2460	13.752	13.759	13.766	13.773	13.779	13.786	13.793	13.800	13.806	13.813	13.82
2470	13.820	13.826	13.833	13.840	13.847	13.853	13.860	13.867	13.874	13.880	13.88
2480	13.887	13.894	13.901	13.907	13.914	13.921	13.928	13.934	13.941	13.948	13.95
2490	13.955	13.961	13.968	13.975	13.982	13.988	13.995	14.002	14.009	14.015	14.02
2500	14.022	14.029	14.036	14.042	14.049	14.056	14.063	14.069	14.076	14.083	14.08
2510	14.089	14.096	14.103	14.110	14.116	14.123	14.130	14.137	14.143	14.150	14.15
2520	14.157	14.164	14.170	14.177	14.184	14.191	14.197	14.204	14.211	14.218	14.22
2530	14.224	14.231	14.238	14.245	14.251	14.258	14.265	14.272	14.278	14.285	14.29
2540	14.292	14.298	14.305	14.312	14.319	14.325	14.332	14.339	14.346	14.352	14.35
2550	14.359	14.366	14.373	14.379	14.386	14.393	14.400	14.406	14.413	14.420	14.42
2560	14.426	14.433	14.440	14.447	14.453	14.460	14.467	14.474	14.480	14.487	14.49
2570	14.494	14.501	14.507	14.514	14.521	14.528	14.534	14.541	14.548	14.554	14.56
2580	14.561	14.568	14.575	14.581	14.588	14.595	14.602	14.608	14.615	14.622	14.62
2590	14.629	14.635	14.642	14.649	14.655	14.662	14.669	14.676	14.682	14.689	14.69
2600	14.696	14.703	14.709	14.716	14.723	14.729	14.736	14.743	14.750	14.756	14.76
2610	14.763	14.770	14.777	14.783	14.790	14.797	14.803	14.810	14.817	14.824	14.83
2620	14.830	14.837	14.844	14.851	14.857	14.864	14.871	14.877	14.884	14.891	14.89
2630	14.898	14.904	14.911	14.918	14.925	14.931	14.938	14.945	14.951	14.958	14.96
2640	14.965	14.972	14.978	14.985	14.992	14.998	15.005	15.012	15.019	15.025	15.03
2650	15.032	15.039	15.045	15.052	15.059	15.066	15.072	15.079	15.086	15.092	15.09
2660	15.099	15.106	15.113	15.119	15.126	15.133	15.139	15.146	15.153	15.160	15.16
2670	15.166	15.173	15.180	15.186	15.193	15.200	15.207	15.213	15.220	15.227	15.23
2680	15.233	15.240	15.247	15.254	15.260	15.267	15.274	15.280	15.287	15.294	15.30
2690	15.300	15.307	15.314	15.321	15.327	15.334	15.341	15.347	15.354	15.361	15.36
2700	15.367	15.374	15.381	15.388	15.394	15.401	15.408	15.414	15.421	15.428	15.43
2710	15.434	15.441	15.448	15.455	15.461	15.468	15.475	15.481	15.488	15.495	15.50
2720	15.501	15.508	15.515	15.521	15.528	15.535	15.542	15.548	15.555	15.562	15.56
2730	15.568	15.575	15.582	15.588	15.595	15.602	15.608	15.615	15.622	15.628	15.63
2740	15.635	15.642	15.649	15.655	15.662	15.669	15.675	15.682	15.689	15.695	15.70

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type S thermocouple

Thermoelectric Voltage in mV

øF	0	1	2	3	4	5	6	7	8	9	10
2750	15.702	15.709	15.715	15.722	15.729	15.735	15.742	15.749	15.755	15.762	15.76
2760	15.769	15.775	15.782	15.789	15.795	15.802	15.809	15.815	15.822	15.829	15.83
2770	15.835	15.842	15.849	15.855	15.862	15.869	15.875	15.882	15.889	15.895	15.90
2780	15.902	15.909	15.915	15.922	15.929	15.935	15.942	15.949	15.955	15.962	15.96
2790	15.969	15.975	15.982	15.989	15.995	16.002	16.009	16.015	16.022	16.029	16.03
2800	16.035	16.042	16.049	16.055	16.062	16.069	16.075	16.082	16.089	16.095	16.10
2810	16.102	16.108	16.115	16.122	16.128	16.135	16.142	16.148	16.155	16.162	16.16
2820	16.168	16.175	16.182	16.188	16.195	16.202	16.208	16.215	16.221	16.228	16.23
2830	16.235	16.241	16.248	16.255	16.261	16.268	16.275	16.281	16.288	16.294	16.30
2840	16.301	16.308	16.314	16.321	16.328	16.334	16.341	16.347	16.354	16.361	16.36
2850	16.367	16.374	16.381	16.387	16.394	16.400	16.407	16.414	16.420	16.427	16.43
2860	16.434	16.440	16.447	16.453	16.460	16.467	16.473	16.480	16.486	16.493	16.50
2870	16.500	16.506	16.513	16.520	16.526	16.533	16.539	16.546	16.553	16.559	16.56
2880	16.566	16.572	16.579	16.586	16.592	16.599	16.605	16.612	16.619	16.625	16.63
2890	16.632	16.638	16.645	16.652	16.658	16.665	16.671	16.678	16.685	16.691	16.69
2900	16.698	16.704	16.711	16.718	16.724	16.731	16.737	16.744	16.751	16.757	16.76
2910	16.764	16.770	16.777	16.783	16.790	16.797	16.803	16.810	16.816	16.823	16.82
2920	16.829	16.836	16.843	16.849	16.856	16.862	16.869	16.876	16.882	16.889	16.89
2930	16.895	16.902	16.908	16.915	16.922	16.928	16.935	16.941	16.948	16.954	16.96
2940	16.961	16.967	16.974	16.981	16.987	16.994	17.000	17.007	17.013	17.020	17.02
2950	17.026	17.033	17.040	17.046	17.053	17.059	17.066	17.072	17.079	17.085	17.09
2960	17.092	17.099	17.105	17.112	17.118	17.125	17.131	17.138	17.144	17.151	17.15
2970	17.157	17.164	17.171	17.177	17.184	17.190	17.197	17.203	17.210	17.216	17.22
2980	17.223	17.229	17.236	17.242	17.249	17.255	17.262	17.268	17.275	17.282	17.28
2990	17.288	17.295	17.301	17.308	17.314	17.321	17.327	17.334	17.340	17.347	17.35
3000	17.353	17.360	17.366	17.373	17.379	17.386	17.392	17.399	17.405	17.412	17.41
3010	17.418	17.425	17.431	17.438	17.444	17.451	17.457	17.464	17.470	17.477	17.48
3020	17.483	17.490	17.496	17.503	17.509	17.516	17.522	17.529	17.535	17.542	17.54
3030	17.548	17.555	17.561	17.568	17.574	17.581	17.587	17.594	17.600	17.607	17.61
3040	17.613	17.620	17.626	17.633	17.639	17.645	17.652	17.658	17.665	17.671	17.67
3050	17.678	17.684	17.691	17.697	17.704	17.710	17.717	17.723	17.729	17.736	17.74
3060	17.742	17.749	17.755	17.762	17.768	17.775	17.781	17.787	17.794	17.800	17.80
3070	17.807	17.813	17.819	17.826	17.832	17.839	17.845	17.852	17.858	17.864	17.87
3080	17.871	17.877	17.884	17.890	17.896	17.903	17.909	17.915	17.922	17.928	17.93
3090	17.935	17.941	17.947	17.954	17.960	17.966	17.973	17.979	17.985	17.992	17.99
3100	17.998	18.004	18.011	18.017	18.023	18.030	18.036	18.042	18.049	18.055	18.06
3110	18.061	18.068	18.074	18.080	18.086	18.093	18.099	18.105	18.112	18.118	18.12
3120	18.124	18.130	18.137	18.143	18.149	18.155	18.162	18.168	18.174	18.180	18.18
3130	18.187	18.193	18.199	18.205	18.211	18.218	18.224	18.230	18.236	18.242	18.24
3140	18.248	18.255	18.261	18.267	18.273	18.279	18.285	18.292	18.298	18.304	18.31
3150	18.310	18.316	18.322	18.328	18.334	18.341	18.347	18.353	18.359	18.365	18.37
3160	18.371	18.377	18.383	18.389	18.395	18.401	18.407	18.413	18.419	18.425	18.43
3170	18.431	18.437	18.443	18.449	18.455	18.461	18.467	18.473	18.479	18.485	18.49
3180	18.491	18.497	18.503	18.509	18.515	18.521	18.527	18.533	18.539	18.545	18.55
3190	18.551	18.557	18.562	18.568	18.574	18.580	18.586	18.592	18.598	18.603	18.60
3200	18.609	18.615	18.621	18.627	18.633	18.638	18.644	18.650	18.656	18.661	18.66
3210	18.667	18.673	18.679	18.684	18.690						

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type S thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
600	5.239	5.249	5.259	5.269	5.280	5.290	5.300	5.310	5.320	5.331	5.34
610	5.341	5.351	5.361	5.372	5.382	5.392	5.402	5.413	5.423	5.433	5.44
620	5.443	5.454	5.464	5.474	5.485	5.495	5.505	5.515	5.526	5.536	5.54
630	5.546	5.557	5.567	5.577	5.588	5.598	5.608	5.618	5.629	5.639	5.64
640	5.649	5.660	5.670	5.680	5.691	5.701	5.712	5.722	5.732	5.743	5.75
650	5.753	5.763	5.774	5.784	5.794	5.805	5.815	5.826	5.836	5.846	5.85
660	5.857	5.867	5.878	5.888	5.898	5.909	5.919	5.930	5.940	5.950	5.96
670	5.961	5.971	5.982	5.992	6.003	6.013	6.024	6.034	6.044	6.055	6.06
680	6.065	6.076	6.086	6.097	6.107	6.118	6.128	6.139	6.149	6.160	6.17
690	6.170	6.181	6.191	6.202	6.212	6.223	6.233	6.244	6.254	6.265	6.27
700	6.275	6.286	6.296	6.307	6.317	6.328	6.338	6.349	6.360	6.370	6.38
710	6.381	6.391	6.402	6.412	6.423	6.434	6.444	6.455	6.465	6.476	6.48
720	6.486	6.497	6.508	6.518	6.529	6.539	6.550	6.561	6.571	6.582	6.59
730	6.593	6.603	6.614	6.624	6.635	6.646	6.656	6.667	6.678	6.688	6.69
740	6.699	6.710	6.720	6.731	6.742	6.752	6.763	6.774	6.784	6.795	6.80
750	6.806	6.817	6.827	6.838	6.849	6.859	6.870	6.881	6.892	6.902	6.91
760	6.913	6.924	6.934	6.945	6.956	6.967	6.977	6.988	6.999	7.010	7.02
770	7.020	7.031	7.042	7.053	7.064	7.074	7.085	7.096	7.107	7.117	7.12
780	7.128	7.139	7.150	7.161	7.172	7.182	7.193	7.204	7.215	7.226	7.23
790	7.236	7.247	7.258	7.269	7.280	7.291	7.302	7.312	7.323	7.334	7.34
800	7.345	7.356	7.367	7.378	7.388	7.399	7.410	7.421	7.432	7.443	7.45
810	7.454	7.465	7.476	7.487	7.497	7.508	7.519	7.530	7.541	7.552	7.56
820	7.563	7.574	7.585	7.596	7.607	7.618	7.629	7.640	7.651	7.662	7.67
830	7.673	7.684	7.695	7.706	7.717	7.728	7.739	7.750	7.761	7.772	7.78
840	7.783	7.794	7.805	7.816	7.827	7.838	7.849	7.860	7.871	7.882	7.89
850	7.893	7.904	7.915	7.926	7.937	7.948	7.959	7.970	7.981	7.992	8.00
860	8.003	8.014	8.026	8.037	8.048	8.059	8.070	8.081	8.092	8.103	8.11
870	8.114	8.125	8.137	8.148	8.159	8.170	8.181	8.192	8.203	8.214	8.22
880	8.226	8.237	8.248	8.259	8.270	8.281	8.293	8.304	8.315	8.326	8.33
890	8.337	8.348	8.360	8.371	8.382	8.393	8.404	8.416	8.427	8.438	8.44
900	8.449	8.460	8.472	8.483	8.494	8.505	8.517	8.528	8.539	8.550	8.56
910	8.562	8.573	8.584	8.595	8.607	8.618	8.629	8.640	8.652	8.663	8.67
920	8.674	8.685	8.697	8.708	8.719	8.731	8.742	8.753	8.765	8.776	8.78
930	8.787	8.798	8.810	8.821	8.832	8.844	8.855	8.866	8.878	8.889	8.90
940	8.900	8.912	8.923	8.935	8.946	8.957	8.969	8.980	8.991	9.003	9.01
950	9.014	9.025	9.037	9.048	9.060	9.071	9.082	9.094	9.105	9.117	9.12
960	9.128	9.139	9.151	9.162	9.174	9.185	9.197	9.208	9.219	9.231	9.24
970	9.242	9.254	9.265	9.277	9.288	9.300	9.311	9.323	9.334	9.345	9.35
980	9.357	9.368	9.380	9.391	9.403	9.414	9.426	9.437	9.449	9.460	9.47
990	9.472	9.483	9.495	9.506	9.518	9.529	9.541	9.552	9.564	9.576	9.58
1000	9.587	9.599	9.610	9.622	9.633	9.645	9.656	9.668	9.680	9.691	9.70
1010	9.703	9.714	9.726	9.737	9.749	9.761	9.772	9.784	9.795	9.807	9.81
1020	9.819	9.830	9.842	9.853	9.865	9.877	9.888	9.900	9.911	9.923	9.93
1030	9.935	9.946	9.958	9.970	9.981	9.993	10.005	10.016	10.028	10.040	10.05
1040	10.051	10.063	10.075	10.086	10.098	10.110	10.121	10.133	10.145	10.156	10.16
1050	10.168	10.180	10.191	10.203	10.215	10.227	10.238	10.250	10.262	10.273	10.28
1060	10.285	10.297	10.309	10.320	10.332	10.344	10.356	10.367	10.379	10.391	10.40
1070	10.403	10.414	10.426	10.438	10.450	10.461	10.473	10.485	10.497	10.509	10.52
1080	10.520	10.532	10.544	10.556	10.567	10.579	10.591	10.603	10.615	10.626	10.63
1090	10.638	10.650	10.662	10.674	10.686	10.697	10.709	10.721	10.733	10.745	10.75
1100	10.757	10.768	10.780	10.792	10.804	10.816	10.828	10.839	10.851	10.863	10.87
1110	10.875	10.887	10.899	10.911	10.922	10.934	10.946	10.958	10.970	10.982	10.99
1120	10.994	11.006	11.017	11.029	11.041	11.053	11.065	11.077	11.089	11.101	11.11
1130	11.113	11.125	11.136	11.148	11.160	11.172	11.184	11.196	11.208	11.220	11.23
1140	11.232	11.244	11.256	11.268	11.280	11.291	11.303	11.315	11.327	11.339	11.35
1150	11.351	11.363	11.375	11.387	11.399	11.411	11.423	11.435	11.447	11.459	11.47
1160	11.471	11.483	11.495	11.507	11.519	11.531	11.542	11.554	11.566	11.578	11.59
1170	11.590	11.602	11.614	11.626	11.638	11.650	11.662	11.674	11.686	11.698	11.71
1180	11.710	11.722	11.734	11.746	11.758	11.770	11.782	11.794	11.806	11.818	11.83
1190	11.830	11.842	11.854	11.866	11.878	11.890	11.902	11.914	11.926	11.939	11.95
1200	11.951	11.963	11.975	11.987	11.999	12.011	12.023	12.035	12.047	12.059	12.07
1210	12.071	12.083	12.095	12.107	12.119	12.131	12.143	12.155	12.167	12.179	12.19
1220	12.191	12.203	12.216	12.228	12.240	12.252	12.264	12.276	12.288	12.300	12.31
1230	12.312	12.324	12.336	12.348	12.360	12.372	12.384	12.397	12.409	12.421	12.43
1240	12.433	12.445	12.457	12.469	12.481	12.493	12.505	12.517	12.529	12.542	12.55
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type S thermocouple

øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
					Thermoelectric Voltage in mV						
-40	-0.236	-0.232	-0.228	-0.224	-0.219	-0.215	-0.211	-0.207	-0.203	-0.199	-0.19
-30	-0.194	-0.190	-0.186	-0.181	-0.177	-0.173	-0.168	-0.164	-0.159	-0.155	-0.15
-20	-0.150	-0.146	-0.141	-0.136	-0.132	-0.127	-0.122	-0.117	-0.113	-0.108	-0.10
-10	-0.103	-0.098	-0.093	-0.088	-0.083	-0.078	-0.073	-0.068	-0.063	-0.058	-0.05
0	-0.053	-0.048	-0.042	-0.037	-0.032	-0.027	-0.021	-0.016	-0.011	-0.005	0.00
øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

ITS-90 Table for type S thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
0	0.000	0.005	0.011	0.016	0.022	0.027	0.033	0.038	0.044	0.050	0.05
10	0.055	0.061	0.067	0.072	0.078	0.084	0.090	0.095	0.101	0.107	0.11
20	0.113	0.119	0.125	0.131	0.137	0.143	0.149	0.155	0.161	0.167	0.17
30	0.173	0.179	0.185	0.191	0.197	0.204	0.210	0.216	0.222	0.229	0.23
40	0.235	0.241	0.248	0.254	0.260	0.267	0.273	0.280	0.286	0.292	0.29
50	0.299	0.305	0.312	0.319	0.325	0.332	0.338	0.345	0.352	0.358	0.36
60	0.365	0.372	0.378	0.385	0.392	0.399	0.405	0.412	0.419	0.426	0.43
70	0.433	0.440	0.446	0.453	0.460	0.467	0.474	0.481	0.488	0.495	0.50
80	0.502	0.509	0.516	0.523	0.530	0.538	0.545	0.552	0.559	0.566	0.57
90	0.573	0.580	0.588	0.595	0.602	0.609	0.617	0.624	0.631	0.639	0.64
100	0.646	0.653	0.661	0.668	0.675	0.683	0.690	0.698	0.705	0.713	0.72
110	0.720	0.727	0.735	0.743	0.750	0.758	0.765	0.773	0.780	0.788	0.79
120	0.795	0.803	0.811	0.818	0.826	0.834	0.841	0.849	0.857	0.865	0.87
130	0.872	0.880	0.888	0.896	0.903	0.911	0.919	0.927	0.935	0.942	0.95
140	0.950	0.958	0.966	0.974	0.982	0.990	0.998	1.006	1.013	1.021	1.02
150	1.029	1.037	1.045	1.053	1.061	1.069	1.077	1.085	1.094	1.102	1.11
160	1.110	1.118	1.126	1.134	1.142	1.150	1.158	1.167	1.175	1.183	1.19
170	1.191	1.199	1.207	1.216	1.224	1.232	1.240	1.249	1.257	1.265	1.27
180	1.273	1.282	1.290	1.298	1.307	1.315	1.323	1.332	1.340	1.348	1.35
190	1.357	1.365	1.373	1.382	1.390	1.399	1.407	1.415	1.424	1.432	1.44
200	1.441	1.449	1.458	1.466	1.475	1.483	1.492	1.500	1.509	1.517	1.52
210	1.526	1.534	1.543	1.551	1.560	1.569	1.577	1.586	1.594	1.603	1.61
220	1.612	1.620	1.629	1.638	1.646	1.655	1.663	1.672	1.681	1.690	1.69
230	1.698	1.707	1.716	1.724	1.733	1.742	1.751	1.759	1.768	1.777	1.78
240	1.786	1.794	1.803	1.812	1.821	1.829	1.838	1.847	1.856	1.865	1.87
250	1.874	1.882	1.891	1.900	1.909	1.918	1.927	1.936	1.944	1.953	1.96
260	1.962	1.971	1.980	1.989	1.998	2.007	2.016	2.025	2.034	2.043	2.05
270	2.052	2.061	2.070	2.078	2.087	2.096	2.105	2.114	2.123	2.132	2.14
280	2.141	2.151	2.160	2.169	2.178	2.187	2.196	2.205	2.214	2.223	2.23
290	2.232	2.241	2.250	2.259	2.268	2.277	2.287	2.296	2.305	2.314	2.32
300	2.323	2.332	2.341	2.350	2.360	2.369	2.378	2.387	2.396	2.405	2.41
310	2.415	2.424	2.433	2.442	2.451	2.461	2.470	2.479	2.488	2.497	2.50
320	2.507	2.516	2.525	2.534	2.544	2.553	2.562	2.571	2.581	2.590	2.59
330	2.599	2.609	2.618	2.627	2.636	2.646	2.655	2.664	2.674	2.683	2.69
340	2.692	2.702	2.711	2.720	2.730	2.739	2.748	2.758	2.767	2.776	2.78
350	2.786	2.795	2.805	2.814	2.823	2.833	2.842	2.851	2.861	2.870	2.88
360	2.880	2.889	2.899	2.908	2.917	2.927	2.936	2.946	2.955	2.965	2.97
370	2.974	2.983	2.993	3.002	3.012	3.021	3.031	3.040	3.050	3.059	3.06
380	3.069	3.078	3.088	3.097	3.107	3.116	3.126	3.135	3.145	3.154	3.16
390	3.164	3.173	3.183	3.192	3.202	3.212	3.221	3.231	3.240	3.250	3.25
400	3.259	3.269	3.279	3.288	3.298	3.307	3.317	3.326	3.336	3.346	3.35
410	3.355	3.365	3.374	3.384	3.394	3.403	3.413	3.423	3.432	3.442	3.45
420	3.451	3.461	3.471	3.480	3.490	3.500	3.509	3.519	3.529	3.538	3.54
430	3.548	3.558	3.567	3.577	3.587	3.596	3.606	3.616	3.626	3.635	3.64
440	3.645	3.655	3.664	3.674	3.684	3.694	3.703	3.713	3.723	3.732	3.74
450	3.742	3.752	3.762	3.771	3.781	3.791	3.801	3.810	3.820	3.830	3.84
460	3.840	3.850	3.859	3.869	3.879	3.889	3.898	3.908	3.918	3.928	3.93
470	3.938	3.947	3.957	3.967	3.977	3.987	3.997	4.006	4.016	4.026	4.03
480	4.036	4.046	4.056	4.065	4.075	4.085	4.095	4.105	4.115	4.125	4.13
490	4.134	4.144	4.154	4.164	4.174	4.184	4.194	4.204	4.213	4.223	4.23
500	4.233	4.243	4.253	4.263	4.273	4.283	4.293	4.303	4.313	4.323	4.33
510	4.332	4.342	4.352	4.362	4.372	4.382	4.392	4.402	4.412	4.422	4.43
520	4.432	4.442	4.452	4.462	4.472	4.482	4.492	4.502	4.512	4.522	4.53
530	4.532	4.542	4.552	4.562	4.572	4.582	4.592	4.602	4.612	4.622	4.63
540	4.632	4.642	4.652	4.662	4.672	4.682	4.692	4.702	4.712	4.722	4.73
550	4.732	4.742	4.752	4.762	4.772	4.782	4.793	4.803	4.813	4.823	4.83
560	4.833	4.843	4.853	4.863	4.873	4.883	4.893	4.904	4.914	4.924	4.93
570	4.934	4.944	4.954	4.964	4.974	4.984	4.995	5.005	5.015	5.025	5.03
580	5.035	5.045	5.055	5.066	5.076	5.086	5.096	5.106	5.116	5.127	5.13
590	5.137	5.147	5.157	5.167	5.178	5.188	5.198	5.208	5.218	5.228	5.23
øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type S thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
1250	12.554	12.566	12.578	12.590	12.602	12.614	12.626	12.638	12.650	12.662	12.67
1260	12.675	12.687	12.699	12.711	12.723	12.735	12.747	12.759	12.771	12.783	12.79
1270	12.796	12.808	12.820	12.832	12.844	12.856	12.868	12.880	12.892	12.905	12.91
1280	12.917	12.929	12.941	12.953	12.965	12.977	12.989	13.001	13.014	13.026	13.03
1290	13.038	13.050	13.062	13.074	13.086	13.098	13.111	13.123	13.135	13.147	13.15
1300	13.159	13.171	13.183	13.195	13.208	13.220	13.232	13.244	13.256	13.268	13.28
1310	13.280	13.292	13.305	13.317	13.329	13.341	13.353	13.365	13.377	13.390	13.40
1320	13.402	13.414	13.426	13.438	13.450	13.462	13.474	13.487	13.499	13.511	13.52
1330	13.523	13.535	13.547	13.559	13.572	13.584	13.596	13.608	13.620	13.632	13.64
1340	13.644	13.657	13.669	13.681	13.693	13.705	13.717	13.729	13.742	13.754	13.76
1350	13.766	13.778	13.790	13.802	13.814	13.826	13.839	13.851	13.863	13.875	13.88
1360	13.887	13.899	13.911	13.924	13.936	13.948	13.960	13.972	13.984	13.996	14.00
1370	14.009	14.021	14.033	14.045	14.057	14.069	14.081	14.094	14.106	14.118	14.13
1380	14.130	14.142	14.154	14.166	14.178	14.191	14.203	14.215	14.227	14.239	14.25
1390	14.251	14.263	14.276	14.288	14.300	14.312	14.324	14.336	14.348	14.360	14.37
1400	14.373	14.385	14.397	14.409	14.421	14.433	14.445	14.457	14.470	14.482	14.49
1410	14.494	14.506	14.518	14.530	14.542	14.554	14.567	14.579	14.591	14.603	14.61
1420	14.615	14.627	14.639	14.651	14.664	14.676	14.688	14.700	14.712	14.724	14.73
1430	14.736	14.748	14.760	14.773	14.785	14.797	14.809	14.821	14.833	14.845	14.85
1440	14.857	14.869	14.881	14.894	14.906	14.918	14.930	14.942	14.954	14.966	14.97
1450	14.978	14.990	15.002	15.015	15.027	15.039	15.051	15.063	15.075	15.087	15.09
1460	15.099	15.111	15.123	15.135	15.148	15.160	15.172	15.184	15.196	15.208	15.22
1470	15.220	15.232	15.244	15.256	15.268	15.280	15.292	15.304	15.317	15.329	15.34
1480	15.341	15.353	15.365	15.377	15.389	15.401	15.413	15.425	15.437	15.449	15.46
1490	15.461	15.473	15.485	15.497	15.509	15.521	15.534	15.546	15.558	15.570	15.58
1500	15.582	15.594	15.606	15.618	15.630	15.642	15.654	15.666	15.678	15.690	15.70
1510	15.702	15.714	15.726	15.738	15.750	15.762	15.774	15.786	15.798	15.810	15.82
1520	15.822	15.834	15.846	15.858	15.870	15.882	15.894	15.906	15.918	15.930	15.94
1530	15.942	15.954	15.966	15.978	15.990	16.002	16.014	16.026	16.038	16.050	16.06
1540	16.062	16.074	16.086	16.098	16.110	16.122	16.134	16.146	16.158	16.170	16.18
1550	16.182	16.194	16.205	16.217	16.229	16.241	16.253	16.265	16.277	16.289	16.30
1560	16.301	16.313	16.325	16.337	16.349	16.361	16.373	16.385	16.396	16.408	16.42
1570	16.420	16.432	16.444	16.456	16.468	16.480	16.492	16.504	16.516	16.527	16.53
1580	16.539	16.551	16.563	16.575	16.587	16.599	16.611	16.623	16.634	16.646	16.65
1590	16.658	16.670	16.682	16.694	16.706	16.718	16.729	16.741	16.753	16.765	16.77
1600	16.777	16.789	16.801	16.812	16.824	16.836	16.848	16.860	16.872	16.883	16.89
1610	16.895	16.907	16.919	16.931	16.943	16.954	16.966	16.978	16.990	17.002	17.01
1620	17.013	17.025	17.037	17.049	17.061	17.072	17.084	17.096	17.108	17.120	17.13
1630	17.131	17.143	17.155	17.167	17.178	17.190	17.202	17.214	17.225	17.237	17.24
1640	17.249	17.261	17.272	17.284	17.296	17.308	17.319	17.331	17.343	17.355	17.36
1650	17.366	17.378	17.390	17.401	17.413	17.425	17.437	17.448	17.460	17.472	17.48
1660	17.483	17.495	17.507	17.518	17.530	17.542	17.553	17.565	17.577	17.588	17.60
1670	17.600	17.612	17.623	17.635	17.647	17.658	17.670	17.682	17.693	17.705	17.71
1680	17.717	17.728	17.740	17.751	17.763	17.775	17.786	17.798	17.809	17.821	17.83
1690	17.832	17.844	17.855	17.867	17.878	17.890	17.901	17.913	17.924	17.936	17.94
1700	17.947	17.959	17.970	17.982	17.993	18.004	18.016	18.027	18.039	18.050	18.06
1710	18.061	18.073	18.084	18.095	18.107	18.118	18.129	18.140	18.152	18.163	18.17
1720	18.174	18.185	18.196	18.208	18.219	18.230	18.241	18.252	18.263	18.274	18.28
1730	18.285	18.297	18.308	18.319	18.330	18.341	18.352	18.362	18.373	18.384	18.39
1740	18.395	18.406	18.417	18.428	18.439	18.449	18.460	18.471	18.482	18.493	18.50
1750	18.503	18.514	18.525	18.535	18.546	18.557	18.567	18.578	18.588	18.599	18.60
1760	18.609	18.620	18.630	18.641	18.651	18.661	18.672	18.682	18.693		

øC	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type T thermocouple

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
					Thermoelectric Voltage in mV						
-450							-6.258	-6.257	-6.256	-6.255	-6.25
-440	-6.254	-6.253	-6.252	-6.251	-6.250	-6.248	-6.247	-6.245	-6.243	-6.242	-6.24
-430	-6.240	-6.238	-6.236	-6.234	-6.232	-6.230	-6.227	-6.225	-6.222	-6.220	-6.21
-420	-6.217	-6.215	-6.212	-6.209	-6.206	-6.203	-6.200	-6.197	-6.194	-6.191	-6.18
-410	-6.187	-6.184	-6.180	-6.177	-6.173	-6.170	-6.166	-6.162	-6.158	-6.154	-6.15
-400	-6.150	-6.146	-6.141	-6.137	-6.133	-6.128	-6.124	-6.119	-6.115	-6.110	-6.10
-390	-6.105	-6.100	-6.095	-6.090	-6.085	-6.080	-6.075	-6.069	-6.064	-6.059	-6.05
-380	-6.053	-6.047	-6.042	-6.036	-6.030	-6.025	-6.019	-6.013	-6.007	-6.001	-5.99
-370	-5.994	-5.988	-5.982	-5.976	-5.969	-5.963	-5.956	-5.950	-5.943	-5.937	-5.93
-360	-5.930	-5.923	-5.916	-5.909	-5.902	-5.896	-5.888	-5.881	-5.874	-5.867	-5.86
-350	-5.860	-5.853	-5.845	-5.838	-5.830	-5.823	-5.815	-5.808	-5.800	-5.792	-5.78
-340	-5.785	-5.777	-5.769	-5.761	-5.753	-5.745	-5.737	-5.729	-5.721	-5.713	-5.70
-330	-5.705	-5.697	-5.688	-5.680	-5.672	-5.663	-5.655	-5.646	-5.638	-5.629	-5.62
-320	-5.620	-5.612	-5.603	-5.594	-5.585	-5.577	-5.568	-5.559	-5.550	-5.541	-5.53
-310	-5.532	-5.523	-5.513	-5.504	-5.495	-5.486	-5.476	-5.467	-5.458	-5.448	-5.43
-300	-5.439	-5.429	-5.420	-5.410	-5.400	-5.391	-5.381	-5.371	-5.361	-5.351	-5.34
-290	-5.341	-5.332	-5.322	-5.312	-5.301	-5.291	-5.281	-5.271	-5.261	-5.250	-5.24
-280	-5.240	-5.230	-5.219	-5.209	-5.198	-5.188	-5.177	-5.167	-5.156	-5.145	-5.13
-270	-5.135	-5.124	-5.113	-5.102	-5.091	-5.081	-5.070	-5.059	-5.048	-5.036	-5.02
-260	-5.025	-5.014	-5.003	-4.992	-4.980	-4.969	-4.958	-4.946	-4.935	-4.923	-4.91
-250	-4.912	-4.900	-4.889	-4.877	-4.865	-4.854	-4.842	-4.830	-4.818	-4.806	-4.79
-240	-4.794	-4.783	-4.771	-4.759	-4.746	-4.734	-4.722	-4.710	-4.698	-4.685	-4.67
-230	-4.673	-4.661	-4.648	-4.636	-4.624	-4.611	-4.599	-4.586	-4.573	-4.561	-4.54
-220	-4.548	-4.535	-4.523	-4.510	-4.497	-4.484	-4.471	-4.458	-4.445	-4.432	-4.41
-210	-4.419	-4.406	-4.393	-4.380	-4.366	-4.353	-4.340	-4.326	-4.313	-4.300	-4.28
-200	-4.286	-4.273	-4.259	-4.246	-4.232	-4.218	-4.205	-4.191	-4.177	-4.163	-4.14
-190	-4.149	-4.136	-4.122	-4.108	-4.094	-4.080	-4.066	-4.052	-4.037	-4.023	-4.00
-180	-4.009	-3.995	-3.980	-3.966	-3.952	-3.937	-3.923	-3.908	-3.894	-3.879	-3.86
-170	-3.865	-3.850	-3.836	-3.821	-3.806	-3.791	-3.777	-3.762	-3.747	-3.732	-3.71
-160	-3.717	-3.702	-3.687	-3.672	-3.657	-3.642	-3.626	-3.611	-3.596	-3.581	-3.56
-150	-3.565	-3.550	-3.535	-3.519	-3.504	-3.488	-3.473	-3.457	-3.441	-3.426	-3.41
-140	-3.410	-3.394	-3.379	-3.363	-3.347	-3.331	-3.315	-3.299	-3.283	-3.267	-3.25
-130	-3.251	-3.235	-3.219	-3.203	-3.187	-3.171	-3.154	-3.138	-3.122	-3.105	-3.08
-120	-3.089	-3.072	-3.056	-3.040	-3.023	-3.006	-2.990	-2.973	-2.956	-2.940	-2.92
-110	-2.923	-2.906	-2.889	-2.873	-2.856	-2.839	-2.822	-2.805	-2.788	-2.771	-2.75
-100	-2.754	-2.737	-2.719	-2.702	-2.685	-2.668	-2.651	-2.633	-2.616	-2.598	-2.58
-90	-2.581	-2.564	-2.546	-2.529	-2.511	-2.493	-2.476	-2.458	-2.440	-2.423	-2.40
-80	-2.405	-2.387	-2.369	-2.351	-2.334	-2.316	-2.298	-2.280	-2.262	-2.244	-2.22
-70	-2.225	-2.207	-2.189	-2.171	-2.153	-2.134	-2.116	-2.098	-2.079	-2.061	-2.04
-60	-2.043	-2.024	-2.006	-1.987	-1.969	-1.950	-1.931	-1.913	-1.894	-1.875	-1.85
-50	-1.857	-1.838	-1.819	-1.800	-1.781	-1.762	-1.743	-1.724	-1.705	-1.686	-1.66
-40	-1.667	-1.648	-1.629	-1.610	-1.591	-1.572	-1.552	-1.533	-1.514	-1.494	-1.47
-30	-1.475	-1.456	-1.436	-1.417	-1.397	-1.378	-1.358	-1.338	-1.319	-1.299	-1.27
-20	-1.279	-1.260	-1.240	-1.220	-1.200	-1.181	-1.161	-1.141	-1.121	-1.101	-1.08
-10	-1.081	-1.061	-1.041	-1.021	-1.001	-0.980	-0.960	-0.940	-0.920	-0.900	-0.87
0	-0.879	-0.859	-0.839	-0.818	-0.798	-0.777	-0.757	-0.736	-0.716	-0.695	-0.67

øF	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

ITS-90 Table for type T thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
0	-0.675	-0.654	-0.633	-0.613	-0.592	-0.571	-0.550	-0.530	-0.509	-0.488	-0.46
10	-0.467	-0.446	-0.425	-0.404	-0.383	-0.362	-0.341	-0.320	-0.299	-0.278	-0.25
20	-0.256	-0.235	-0.214	-0.193	-0.171	-0.150	-0.129	-0.107	-0.086	-0.064	-0.04
30	-0.043	-0.022	0.000	0.022	0.043	0.065	0.086	0.108	0.130	0.151	0.17
40	0.173	0.195	0.216	0.238	0.260	0.282	0.303	0.325	0.347	0.369	0.39
50	0.391	0.413	0.435	0.457	0.479	0.501	0.523	0.545	0.567	0.589	0.61
60	0.611	0.634	0.656	0.678	0.700	0.723	0.745	0.767	0.790	0.812	0.83
70	0.834	0.857	0.879	0.902	0.924	0.947	0.969	0.992	1.015	1.037	1.06
80	1.060	1.083	1.105	1.128	1.151	1.174	1.196	1.219	1.242	1.265	1.28
90	1.288	1.311	1.334	1.357	1.380	1.403	1.426	1.449	1.472	1.496	1.51
100	1.519	1.542	1.565	1.588	1.612	1.635	1.658	1.682	1.705	1.729	1.75
110	1.752	1.776	1.799	1.823	1.846	1.870	1.893	1.917	1.941	1.964	1.98
120	1.988	2.012	2.036	2.060	2.083	2.107	2.131	2.155	2.179	2.203	2.22
130	2.227	2.251	2.275	2.299	2.323	2.347	2.371	2.395	2.420	2.444	2.46
140	2.468	2.492	2.517	2.541	2.565	2.590	2.614	2.639	2.663	2.687	2.71

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type T thermocouple

øF	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
150	2.712	2.737	2.761	2.786	2.810	2.835	2.860	2.884	2.909	2.934	2.95
160	2.958	2.983	3.008	3.033	3.058	3.082	3.107	3.132	3.157	3.182	3.20
170	3.207	3.232	3.257	3.282	3.307	3.333	3.358	3.383	3.408	3.433	3.45
180	3.459	3.484	3.509	3.534	3.560	3.585	3.610	3.636	3.661	3.687	3.71
190	3.712	3.738	3.763	3.789	3.814	3.840	3.866	3.891	3.917	3.943	3.96
200	3.968	3.994	4.020	4.046	4.071	4.097	4.123	4.149	4.175	4.201	4.22
210	4.227	4.253	4.279	4.305	4.331	4.357	4.383	4.409	4.435	4.461	4.48
220	4.487	4.513	4.540	4.566	4.592	4.618	4.645	4.671	4.697	4.724	4.75
230	4.750	4.776	4.803	4.829	4.856	4.882	4.909	4.935	4.962	4.988	5.01
240	5.015	5.042	5.068	5.095	5.122	5.148	5.175	5.202	5.228	5.255	5.28
250	5.282	5.309	5.336	5.363	5.389	5.416	5.443	5.470	5.497	5.524	5.55
260	5.551	5.578	5.605	5.632	5.660	5.687	5.714	5.741	5.768	5.795	5.82
270	5.823	5.850	5.877	5.904	5.932	5.959	5.986	6.014	6.041	6.068	6.09
280	6.096	6.123	6.151	6.178	6.206	6.233	6.261	6.288	6.316	6.343	6.37
290	6.371	6.399	6.426	6.454	6.482	6.510	6.537	6.565	6.593	6.621	6.64
300	6.648	6.676	6.704	6.732	6.760	6.788	6.816	6.844	6.872	6.900	6.92
310	6.928	6.956	6.984	7.012	7.040	7.068	7.096	7.124	7.152	7.181	7.20
320	7.209	7.237	7.265	7.294	7.322	7.350	7.378	7.407	7.435	7.463	7.49
330	7.492	7.520	7.549	7.577	7.606	7.634	7.663	7.691	7.720	7.748	7.77
340	7.777	7.805	7.834	7.863	7.891	7.920	7.949	7.977	8.006	8.035	8.06
350	8.064	8.092	8.121	8.150	8.179	8.208	8.237	8.266	8.294	8.323	8.35
360	8.352	8.381	8.410	8.439	8.468	8.497	8.526	8.555	8.585	8.614	8.64
370	8.643	8.672	8.701	8.730	8.759	8.789	8.818	8.847	8.876	8.906	8.93
380	8.935	8.964	8.994	9.023	9.052	9.082	9.111	9.141	9.170	9.200	9.22
390	9.229	9.259	9.288	9.318	9.347	9.377	9.406	9.436	9.466	9.495	9.52
400	9.525	9.555	9.584	9.614	9.644	9.673	9.703	9.733	9.763	9.793	9.82
410	9.822	9.852	9.882	9.912	9.942	9.972	10.002	10.032	10.062	10.092	10.12
420	10.122	10.152	10.182	10.212	10.242	10.272	10.302	10.332	10.362	10.392	10.42
430	10.423	10.453	10.483	10.513	10.543	10.574	10.604	10.634	10.664	10.695	10.72
440	10.725	10.755	10.786	10.816	10.847	10.877	10.907	10.938	10.968	10.999	11.02
450	11.029	11.060	11.090	11.121	11.151	11.182	11.213	11.243	11.274	11.304	11.33
460	11.335	11.366	11.396	11.427	11.458	11.489	11.519	11.550	11.581	11.612	11.64
470	11.643	11.673	11.704	11.735	11.766	11.797	11.828	11.859	11.890	11.920	11.95
480	11.951	11.982	12.013	12.044	12.075	12.106	12.138	12.169	12.200	12.231	12.26
490	12.262	12.293	12.324	12.355	12.386	12.418	12.449	12.480	12.511	12.543	12.57
500	12.574	12.605	12.636	12.668	12.699	12.730	12.762	12.793	12.824	12.856	12.88
510	12.887	12.919	12.950	12.982	13.013	13.045	13.076	13.108	13.139	13.171	13.20
520	13.202	13.234	13.265	13.297	13.328	13.360	13.392	13.423	13.455	13.487	13.51
530	13.518	13.550	13.582	13.614	13.645	13.677	13.709	13.741	13.772	13.804	13.83
540	13.836	13.868	13.900	13.932	13.964	13.995	14.027	14.059	14.091	14.123	14.15
550	14.155	14.187	14.219	14.251	14.283	14.315	14.347	14.379	14.411	14.444	14.47
560	14.476	14.508	14.540	14.572	14.604	14.636	14.669	14.701	14.733	14.765	14.79
570	14.797	14.830	14.862	14.894	14.926	14.959	14.991	15.023	15.056	15.088	15.12
580	15.121	15.153	15.185	15.218	15.250	15.283	15.315	15.347	15.380	15.412	15.44
590	15.445	15.477	15.510	15.543	15.575	15.608	15.640	15.673	15.705	15.738	15.77
600	15.771	15.803	15.836	15.869	15.901	15.934	15.967	15.999	16.032	16.065	16.09
610	16.098	16.130	16.163	16.196	16.229	16.262	16.295	16.327	16.360	16.393	16.42
620	16.426	16.459	16.492	16.525	16.558	16.591	16.624	16.657	16.690	16.723	16.75
630	16.756	16.789	16.822	16.855	16.888	16.921	16.954	16.987	17.020	17.053	17.08
640	17.086	17.120	17.153	17.186	17.219	17.252	17.286	17.319	17.352	17.385	17.41
650	17.418	17.452	17.485	17.518	17.552	17.585	17.618	17.652	17.685	17.718	17.75
660	17.752	17.785	17.819	17.852	17.886	17.919	17.952	17.986	18.019	18.053	18.08
670	18.086	18.120	18.153	18.187	18.221	18.254	18.288	18.321	18.355	18.389	18.42
680	18.422	18.456	18.490	18.523	18.557	18.591	18.624	18.658	18.692	18.725	18.75
690	18.759	18.793	18.827	18.861	18.894	18.928	18.962	18.996	19.030	19.064	19.09
700	19.097	19.131	19.165	19.199	19.233	19.267	19.301	19.335	19.369	19.403	19.43
710	19.437	19.471	19.505	19.539	19.573	19.607	19.641	19.675	19.709	19.743	19.77
720	19.777	19.811	19.845	19.879	19.913	19.947	19.982	20.016	20.050	20.084	20.11
730	20.118	20.152	20.187	20.221	20.255	20.289	20.323	20.358	20.392	20.426	20.46
740	20.460	20.495	20.529	20.563	20.597	20.632	20.666	20.700	20.735	20.769	20.80
750	20.803	20.838	20.872								

øF	0	1	2	3	4	5	6	7	8	9	10

ITS-90 Table for type T thermocouple

øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
					Thermoelectric Voltage in mV						
-260	-6.258	-6.256	-6.255	-6.253	-6.251	-6.248	-6.245	-6.242	-6.239	-6.236	-6.23
-250	-6.232	-6.228	-6.223	-6.219	-6.214	-6.209	-6.204	-6.198	-6.193	-6.187	-6.18
-240	-6.180	-6.174	-6.167	-6.160	-6.153	-6.146	-6.138	-6.130	-6.122	-6.114	-6.10
-230	-6.105	-6.096	-6.087	-6.078	-6.068	-6.059	-6.049	-6.038	-6.028	-6.017	-6.00
-220	-6.007	-5.996	-5.985	-5.973	-5.962	-5.950	-5.938	-5.926	-5.914	-5.901	-5.88
-210	-5.888	-5.876	-5.863	-5.850	-5.836	-5.823	-5.809	-5.795	-5.782	-5.767	-5.75
-200	-5.753	-5.739	-5.724	-5.710	-5.695	-5.680	-5.665	-5.650	-5.634	-5.619	-5.60
-190	-5.603	-5.587	-5.571	-5.555	-5.539	-5.523	-5.506	-5.489	-5.473	-5.456	-5.43
-180	-5.439	-5.421	-5.404	-5.387	-5.369	-5.351	-5.334	-5.316	-5.297	-5.279	-5.26
-170	-5.261	-5.242	-5.224	-5.205	-5.186	-5.167	-5.148	-5.128	-5.109	-5.089	-5.07
-160	-5.070	-5.050	-5.030	-5.010	-4.989	-4.969	-4.949	-4.928	-4.907	-4.886	-4.86
-150	-4.865	-4.844	-4.823	-4.802	-4.780	-4.759	-4.737	-4.715	-4.693	-4.671	-4.64
-140	-4.648	-4.626	-4.604	-4.581	-4.558	-4.535	-4.512	-4.489	-4.466	-4.443	-4.41
-130	-4.419	-4.395	-4.372	-4.348	-4.324	-4.300	-4.275	-4.251	-4.226	-4.202	-4.17
-120	-4.177	-4.152	-4.127	-4.102	-4.077	-4.052	-4.026	-4.000	-3.975	-3.949	-3.92
-110	-3.923	-3.897	-3.871	-3.844	-3.818	-3.791	-3.765	-3.738	-3.711	-3.684	-3.65
-100	-3.657	-3.629	-3.602	-3.574	-3.547	-3.519	-3.491	-3.463	-3.435	-3.407	-3.37
-90	-3.379	-3.350	-3.322	-3.293	-3.264	-3.235	-3.206	-3.177	-3.148	-3.118	-3.08
-80	-3.089	-3.059	-3.030	-3.000	-2.970	-2.940	-2.910	-2.879	-2.849	-2.818	-2.78
-70	-2.788	-2.757	-2.726	-2.695	-2.664	-2.633	-2.602	-2.571	-2.539	-2.507	-2.47
-60	-2.476	-2.444	-2.412	-2.380	-2.348	-2.316	-2.283	-2.251	-2.218	-2.186	-2.15
-50	-2.153	-2.120	-2.087	-2.054	-2.021	-1.987	-1.954	-1.920	-1.887	-1.853	-1.81
-40	-1.819	-1.785	-1.751	-1.717	-1.683	-1.648	-1.614	-1.579	-1.545	-1.510	-1.47
-30	-1.475	-1.440	-1.405	-1.370	-1.335	-1.299	-1.264	-1.228	-1.192	-1.157	-1.12
-20	-1.121	-1.085	-1.049	-1.013	-0.976	-0.940	-0.904	-0.867	-0.830	-0.794	-0.75
-10	-0.757	-0.720	-0.683	-0.646	-0.608	-0.571	-0.534	-0.496	-0.459	-0.421	-0.38
0	-0.383	-0.345	-0.307	-0.269	-0.231	-0.193	-0.154	-0.116	-0.077	-0.039	0.00

øC	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0

ITS-90 Table for type T thermocouple

øC	0	1	2	3	4	5	6	7	8	9	10
					Thermoelectric Voltage in mV						
0	0.000	0.039	0.078	0.117	0.156	0.195	0.234	0.273	0.312	0.352	0.39
10	0.391	0.431	0.470	0.510	0.549	0.589	0.629	0.669	0.709	0.749	0.79
20	0.790	0.830	0.870	0.911	0.951	0.992	1.033	1.074	1.114	1.155	1.19
30	1.196	1.238	1.279	1.320	1.362	1.403	1.445	1.486	1.528	1.570	1.61
40	1.612	1.654	1.696	1.738	1.780	1.823	1.865	1.908	1.950	1.993	2.03
50	2.036	2.079	2.122	2.165	2.208	2.251	2.294	2.338	2.381	2.425	2.46
60	2.468	2.512	2.556	2.600	2.643	2.687	2.732	2.776	2.820	2.864	2.90
70	2.909	2.953	2.998	3.043	3.087	3.132	3.177	3.222	3.267	3.312	3.35
80	3.358	3.403	3.448	3.494	3.539	3.585	3.631	3.677	3.722	3.768	3.81
90	3.814	3.860	3.907	3.953	3.999	4.046	4.092	4.138	4.185	4.232	4.27
100	4.279	4.325	4.372	4.419	4.466	4.513	4.561	4.608	4.655	4.702	4.75
110	4.750	4.798	4.845	4.893	4.941	4.988	5.036	5.084	5.132	5.180	5.22
120	5.228	5.277	5.325	5.373	5.422	5.470	5.519	5.567	5.616	5.665	5.71
130	5.714	5.763	5.812	5.861	5.910	5.959	6.008	6.057	6.107	6.156	6.20
140	6.206	6.255	6.305	6.355	6.404	6.454	6.504	6.554	6.604	6.654	6.70
150	6.704	6.754	6.805	6.855	6.905	6.956	7.006	7.057	7.107	7.158	7.20
160	7.209	7.260	7.310	7.361	7.412	7.463	7.515	7.566	7.617	7.668	7.72
170	7.720	7.771	7.823	7.874	7.926	7.977	8.029	8.081	8.133	8.185	8.23
180	8.237	8.289	8.341	8.393	8.445	8.497	8.550	8.602	8.654	8.707	8.75
190	8.759	8.812	8.865	8.917	8.970	9.023	9.076	9.129	9.182	9.235	9.28
200	9.288	9.341	9.395	9.448	9.501	9.555	9.608	9.662	9.715	9.769	9.82
210	9.822	9.876	9.930	9.984	10.038	10.092	10.146	10.200	10.254	10.308	10.36
220	10.362	10.417	10.471	10.525	10.580	10.634	10.689	10.743	10.798	10.853	10.90
230	10.907	10.962	11.017	11.072	11.127	11.182	11.237	11.292	11.347	11.403	11.45
240	11.458	11.513	11.569	11.624	11.680	11.735	11.791	11.846	11.902	11.958	12.01
250	12.013	12.069	12.125	12.181	12.237	12.293	12.349	12.405	12.461	12.518	12.57
260	12.574	12.630	12.687	12.743	12.799	12.856	12.912	12.969	13.026	13.082	13.13
270	13.139	13.196	13.253	13.310	13.366	13.423	13.480	13.537	13.595	13.652	13.70
280	13.709	13.766	13.823	13.881	13.938	13.995	14.053	14.110	14.168	14.226	14.28
290	14.283	14.341	14.399	14.456	14.514	14.572	14.630	14.688	14.746	14.804	14.86
300	14.862	14.920	14.978	15.036	15.095	15.153	15.211	15.270	15.328	15.386	15.44
310	15.445	15.503	15.562	15.621	15.679	15.738	15.797	15.856	15.914	15.973	16.03
320	16.032	16.091	16.150	16.209	16.268	16.327	16.387	16.446	16.505	16.564	16.62
330	16.624	16.683	16.742	16.802	16.861	16.921	16.980	17.040	17.100	17.159	17.21

øC	0	1	2	3	4	5	6	7	8	9	10

Gold versus Platinum Thermocouples—Thermoelectric voltage as a function of temperature (°C), reference junctions at 0°C

°C	0	1	2	3	4	5	6	7	8	9	10	°C
	Thermoelectric Voltage in Microvolts											
0	0.0	6.1	12.1	18.3	24.6	30.7	36.8	43.2	49.6	55.9	62.3	0
10	62.5	68.7	75.2	81.7	88.3	94.8	101.4	108.1	114.8	121.5	128.3	10
20	128.3	135.1	141.9	148.8	155.7	162.7	169.7	176.7	183.7	190.8	197.9	20
30	197.9	205.1	212.3	219.5	226.8	234.1	241.4	248.8	256.2	263.6	271.1	30
40	271.1	278.6	286.1	293.7	301.3	308.9	316.6	324.3	332.1	339.8	347.6	40
50	347.6	355.5	363.5	371.3	379.2	387.1	395.1	403.2	411.3	419.3	427.5	50
60	427.5	435.8	443.9	452.1	460.3	468.6	476.9	485.3	493.8	502.1	510.5	60
70	510.5	519.0	527.5	536.0	544.6	553.2	561.8	570.5	579.2	587.9	596.6	70
80	596.6	605.4	614.2	623.1	632.0	640.9	649.8	658.7	667.7	676.8	685.9	80
90	685.9	694.9	704.0	713.1	722.3	731.5	740.7	750.0	759.2	768.5	777.9	90
100	777.9	787.3	796.7	806.1	815.5	825.0	834.5	844.1	853.6	863.2	872.8	100
110	872.8	882.5	892.2	901.8	911.6	921.4	931.2	941.0	950.8	960.7	970.5	110
120	970.5	980.5	990.5	1000.4	1010.4	1020.5	1030.5	1040.6	1050.7	1060.8	1071.0	120
130	1071.0	1081.2	1091.4	1101.7	1112.0	1122.3	1132.6	1142.9	1153.3	1163.7	1174.1	130
140	1174.1	1184.6	1195.1	1205.6	1216.1	1226.7	1237.2	1247.8	1258.5	1269.1	1279.8	140
150	1279.8	1290.5	1301.3	1312.0	1322.8	1333.6	1344.4	1355.3	1366.2	1377.1	1388.0	150
160	1388.0	1398.9	1410.0	1421.0	1432.0	1443.1	1454.1	1465.3	1476.4	1487.5	1498.7	160
170	1498.7	1509.9	1521.1	1532.4	1543.7	1555.0	1566.3	1577.6	1589.0	1600.4	1611.8	170
180	1611.8	1623.3	1634.7	1646.3	1657.7	1669.3	1680.8	1692.4	1704.0	1715.6	1727.3	180
190	1727.3	1739.0	1750.7	1762.4	1774.1	1785.8	1797.7	1809.5	1821.3	1833.2	1845.1	190
200	1845.1	1857.0	1868.9	1880.9	1892.8	1904.8	1916.8	1928.8	1941.0	1953.0	1965.1	200
210	1965.1	1977.3	1989.4	2001.6	2013.8	2026.0	2038.3	2050.5	2062.8	2075.1	2087.4	210
220	2087.4	2099.8	2112.2	2124.6	2137.0	2149.4	2161.9	2174.4	2186.9	2199.4	2211.9	220
230	2211.9	2224.5	2237.1	2249.7	2262.3	2275.0	2287.7	2300.4	2313.1	2325.8	2338.6	230
240	2338.6	2351.4	2364.2	2377.0	2389.8	2402.7	2415.6	2428.5	2441.4	2454.4	2467.3	240
250	2467.3	2480.3	2493.3	2506.4	2519.4	2532.5	2545.6	2558.7	2571.9	2585.0	2598.2	250
260	2598.2	2611.4	2624.6	2637.8	2651.1	2664.4	2677.7	2691.0	2704.3	2717.7	2731.1	260
270	2731.1	2744.6	2758.0	2771.5	2784.9	2798.5	2811.9	2825.5	2839.0	2852.6	2866.2	270
280	2866.2	2879.8	2893.5	2907.2	2920.9	2934.6	2948.3	2962.1	2975.8	2989.6	3003.4	280
290	3003.4	3017.2	3031.0	3044.8	3058.8	3072.7	3086.6	3100.6	3114.5	3128.5	3142.5	290
300	3142.5	3156.5	3170.6	3184.6	3198.7	3212.9	3227.0	3241.1	3255.3	3269.4	3283.6	300
310	3283.6	3297.8	3312.0	3326.3	3340.5	3354.8	3369.0	3383.3	3397.6	3411.9	3426.3	310
320	3426.3	3440.7	3455.1	3469.5	3483.9	3498.4	3512.8	3527.3	3541.8	3556.3	3570.8	320
330	3570.8	3585.4	3599.9	3614.5	3629.1	3643.8	3658.4	3673.1	3687.8	3702.5	3717.2	330
340	3717.2	3731.9	3746.6	3761.4	3776.2	3790.9	3805.8	3820.6	3835.4	3850.3	3865.2	340
350	3865.2	3880.0	3894.9	3909.8	3924.8	3939.7	3954.7	3969.7	3984.7	3999.7	4014.8	350
360	4014.8	4029.8	4044.9	4060.0	4075.1	4090.2	4105.4	4120.5	4135.7	4150.9	4166.1	360
370	4166.1	4181.3	4196.6	4211.8	4227.1	4242.4	4257.7	4273.0	4288.3	4303.7	4319.0	370
380	4319.0	4334.4	4349.8	4365.2	4380.6	4396.0	4411.5	4426.9	4442.4	4457.9	4473.4	380
390	4473.4	4489.0	4504.5	4520.1	4535.7	4551.3	4566.9	4582.5	4598.1	4613.8	4629.4	390
400	4629.4	4645.1	4660.8	4676.5	4692.2	4707.9	4723.7	4739.4	4755.2	4771.0	4786.8	400
410	4786.8	4802.6	4818.4	4834.3	4850.1	4866.0	4881.9	4897.8	4913.7	4929.6	4945.5	410
420	4945.5	4961.5	4977.4	4993.4	5009.4	5025.4	5041.4	5057.4	5073.4	5089.5	5105.5	420
430	5105.5	5121.6	5137.7	5153.8	5169.9	5186.0	5202.1	5218.3	5234.4	5250.6	5266.8	430
440	5266.8	5283.0	5299.2	5315.4	5331.7	5347.9	5364.2	5380.5	5396.8	5413.1	5429.4	440
450	5429.4	5445.8	5462.1	5478.5	5494.9	5511.3	5527.7	5544.1	5560.5	5577.0	5593.4	450
460	5593.4	5609.9	5626.4	5642.9	5659.4	5675.9	5692.5	5709.0	5725.6	5742.2	5758.8	460
470	5758.8	5775.4	5792.0	5808.7	5825.3	5842.0	5858.7	5875.4	5892.1	5908.8	5925.5	470
480	5925.5	5942.3	5959.0	5975.8	5992.6	6009.4	6026.2	6043.0	6059.8	6076.7	6093.5	480
490	6093.5	6110.4	6127.3	6144.2	6161.1	6178.0	6195.0	6211.9	6228.9	6245.9	6262.9	490
500	6262.9	6279.9	6296.9	6314.0	6331.0	6348.1	6365.2	6382.3	6399.4	6416.5	6433.6	500
510	6433.6	6450.8	6467.9	6485.1	6502.3	6519.5	6536.7	6553.9	6571.2	6588.4	6605.7	510
520	6605.7	6623.0	6640.3	6657.6	6674.9	6692.3	6709.6	6727.0	6744.4	6761.8	6779.2	520
530	6779.2	6796.6	6814.1	6831.5	6849.0	6866.5	6884.0	6901.5	6919.0	6936.6	6954.1	530
540	6954.1	6971.7	6989.3	7006.9	7024.5	7042.1	7059.7	7077.4	7095.0	7112.7	7130.4	540
550	7130.4	7148.1	7165.8	7183.5	7201.2	7219.0	7236.7	7254.5	7272.3	7290.1	7307.9	550
560	7307.9	7325.7	7343.5	7361.4	7379.2	7397.1	7415.0	7432.9	7450.8	7468.7	7486.7	560
570	7486.7	7504.6	7522.6	7540.6	7558.6	7576.6	7594.6	7612.6	7630.7	7648.7	7666.8	570
580	7666.8	7684.9	7703.0	7721.1	7739.2	7757.3	7775.5	7793.6	7811.8	7830.0	7848.2	580
590	7848.2	7866.4	7884.6	7902.8	7921.1	7939.3	7957.6	7975.9	7994.2	8012.5	8030.8	590
600	8030.8	8049.2	8067.5	8085.9	8104.3	8122.7	8141.1	8159.5	8178.0	8196.4	8214.9	600
610	8214.9	8233.4	8251.9	8270.4	8289.0	8307.5	8326.1	8344.7	8363.3	8381.9	8400.5	610
620	8400.5	8419.1	8437.8	8456.4	8475.1	8493.8	8512.5	8531.2	8549.9	8568.7	8587.4	620
630	8587.4	8606.2	8625.0	8643.8	8662.6	8681.4	8700.2	8719.0	8737.9	8756.8	8775.6	630
640	8775.6	8794.5	8813.4	8832.4	8851.3	8870.2	8889.2	8908.2	8927.2	8946.2	8965.2	640
650	8965.2	8984.2	9003.3	9022.3	9041.4	9060.5	9079.6	9098.7	9117.8	9136.9	9156.1	650
660	9156.1	9175.2	9194.4	9213.6	9232.8	9252.0	9271.2	9290.4	9309.7	9328.9	9348.2	660
670	9348.2	9367.5	9386.8	9406.1	9425.4	9444.8	9464.1	9483.5	9502.9	9522.3	9541.7	670
680	9541.7	9561.1	9580.5	9600.0	9619.4	9638.9	9658.4	9677.9	9697.4	9717.0	9736.5	680
690	9736.5	9756.1	9775.7	9795.3	9814.9	9834.5	9854.1	9873.8	9893.4	9913.1	9932.8	690
700	9932.8	9952.5	9972.2	9991.9	10011.6	10031.4	10051.1	10070.9	10090.7	10110.5	10130.3	700
710	10130.3	10150.1	10169.9	10189.7	10209.6	10229.4	10249.3	10269.2	10289.1	10309.0	10328.9	710
720	10328.9	10348.8	10368.8	10388.7	10408.7	10428.6	10448.6	10468.6	10488.6	10508.7	10528.7	720
730	10528.7	10548.7	10568.8	10588.8	10608.9	10629.0	10649.1	10669.2	10689.3	10709.4	10729.6	730
740	10729.6	10749.7	10769.9	10790.0	10810.2	10830.4	10850.6	10870.8	10891.0	10911.3	10931.5	740
750	10931.5	10951.8	10972.0	10992.3	11012.6	11032.9	11053.2	11073.5	11093.8	11114.1	11134.4	750
760	11134.4	11154.8	11175.1	11195.5	11215.8	11236.2	11256.6	11277.0	11297.4	11317.8	11338.2	760
770	11338.2	11358.6	11379.1	11399.5	11420.0	11440.4	11460.9	11481.4	11501.9	11522.4	11542.9	770
780	11542.9	11563.4	11584.0	11604.5	11625.1	11645.6	11666.2	11686.8	11707.4	11728.0	11748.6	780
790	11748.6	11769.2	11789.8	11810.4	11831.1	11851.7	11872.4	11893.0	11913.7	11934.4	11955.1	790
800	11955.1	11975.8	11996.5	12017.2	12037.9	12058.6	12079.3	12100.1	12120.8	12141.6	12162.3	800
810	12162.3	12183.1	12203.9	12224.7	12245.5	12266.3	12287.1	12307.9	12328.7	12349.5	12370.4	810
820	12370.4	12391.2	12412.1	12432.9	12453.8	12474.7	12495.6	12516.4	12537.3	12558.2	12579.1	820
830	12579.1	12600.0	12620.9	12641.8	12662.8	12683.7	12704.6	12725.6	12746.5	12767.5	12788.4	830
840	12788.4	12809.4	12830.4	12851.3	12872.3	12893.3	12914.3	12935.3	12956.3	12977.3	12998.3	840
850	12998.3	13019.3	13040.3	13061.4	13082.4	13103.4	13124.5	13145.5	13166.6	13187.6	13208.7	850
860	13208.7	13229.8	13250.8	13271.9	13293.0	13314.1	13335.2	13356.3	13377.4	13398.5	13419.6	860
870	13419.6	13440.7	13461.8	13483.0	13504.1	13525.2	13546.4	13567.5	13588.7	13609.8	13631.0	870
880	13631.0	13652.1	13673.3	13694.5	13715.7	13736.8	13758.0	13779.2	13800.4	13821.6	13842.8	880
890	13842.8	13864.0	13885.2	13906.4	13927.6	13948.8	13970.0	13991.2	14012.4	14033.6	14054.8	890
900	14054.8	14076.0	14097.2	14118.4	14139.6	14160.8	14182.0	14203.2	14224.4	14245.6	14266.8	900
910	14266.8	14288.0	14309.2	14330.4	14351.6	14372.8	14394.0	14415.2	14436.4	14457.6	14478.8	910
920	14478.8	14500.0	14521.2	14542.4	14563.6	14584.8	14606.0	14627.2	14648.4	14669.6	14690.8	920
930	14690.8	14712.0	14733.2	14754.4	14775.6	14796.8	14818.0	14839.2	14860.4	14881.6	14902.8	930
940	14902.8	14924.0	14945.2	14966.4	14987.6	15008.8	15030.0	15051.2	15072.4	15093.6	15114.8	940
950	15114.8	15136.0	15157.2	15178.4	15199.6	15220.8	15242.0	15263.2	15284.4	15305.6	15326.8	950
960	15326.8	15348.0	15369.2	15390.4	15411.6	15432.8	15454.0	15475.2	15496.4	15517.6	15538.8	960
970	15538.8	15560.0	15581.2	15602.4	15623.6	15644.8	15666.0	15687.2	15708.4	15729.6	15750.8	970
980	15750.8	15772.0	15793.2	15814.4	15835.6	15856.8	15878.0	15899.2	15920.4	15941.6	15962.8	980
990	15962.8	15984.0	16005.2	16026.4	16047.6	16068.8	16090.0	16111.2	16132.4	16153.6	16174.8	990
1000	16174.8	16196.0	16217.2	16238.4	16259.6	16280.8	16302.0	16323.2	16344.4	16365.6	16386.8	1000
°C	0	1	2	3	4	5	6	7	8	9	10	°C

TYPE - C THERMOCOUPLE, ITS-90 TABLE

Thermoelectric Voltage in Millivolts

°C	0	1	2	3	4	5	6	7	8	9	10	°C
0	0.000	0.013	0.026	0.040	0.053	0.067	0.080	0.094	0.107	0.121	0.135	0
10	0.135	0.148	0.162	0.176	0.189	0.203	0.217	0.231	0.244	0.258	0.272	10
20	0.272	0.286	0.300	0.314	0.328	0.342	0.356	0.370	0.384	0.398	0.412	20
30	0.412	0.426	0.440	0.454	0.469	0.483	0.497	0.511	0.525	0.540	0.554	0
40	0.554	0.568	0.583	0.597	0.612	0.626	0.640	0.655	0.669	0.684	0.698	40
50	0.698	0.713	0.727	0.742	0.757	0.771	0.786	0.801	0.815	0.830	0.845	50
60	0.845	0.860	0.874	0.889	0.904	0.919	0.934	0.948	0.963	0.978	0.993	60
70	0.993	1.008	1.023	1.038	1.053	1.068	1.083	1.098	1.114	1.129	1.144	70
80	1.144	1.159	1.174	1.189	1.205	1.220	1.235	1.250	1.266	1.281	1.296	80
90	1.296	1.312	1.327	1.342	1.358	1.373	1.389	1.404	1.420	1.435	1.451	90
100	1.451	1.466	1.482	1.497	1.513	1.529	1.544	1.560	1.576	1.591	1.607	100
110	1.607	1.623	1.639	1.654	1.670	1.686	1.702	1.718	1.733	1.749	1.765	110
120	1.765	1.781	1.797	1.813	1.829	1.845	1.861	1.877	1.893	1.909	1.925	120
130	1.925	1.941	1.957	1.973	1.989	2.006	2.022	2.038	2.054	2.070	2.087	130
140	2.087	2.103	2.119	2.135	2.152	2.168	2.184	2.201	2.217	2.233	2.250	140
150	2.250	2.266	2.283	2.299	2.316	2.332	2.349	2.365	2.382	2.398	2.415	150
160	2.415	2.431	2.448	2.464	2.481	2.498	2.514	2.531	2.548	2.564	2.581	160
170	2.581	2.598	2.614	2.631	2.648	2.665	2.682	2.698	2.715	2.732	2.749	170
180	2.749	2.766	2.783	2.800	2.816	2.833	2.850	2.867	2.884	2.901	2.918	180
190	2.918	2.935	2.952	2.969	2.986	3.003	3.020	3.038	3.055	3.072	3.089	190
200	3.089	3.106	3.123	3.140	3.158	3.175	3.192	3.209	3.227	3.244	3.26	200
210	3.261	3.278	3.296	3.313	3.330	3.348	3.365	3.382	3.400	3.417	3.434	210
220	3.434	3.452	3.469	3.487	3.504	3.522	3.539	3.557	3.574	3.592	3.609	220
230	3.609	3.627	3.644	3.662	3.679	3.697	3.714	3.732	3.750	3.767	3.785	230
240	3.785	3.803	3.820	3.838	3.856	3.873	3.891	3.909	3.927	3.944	3.962	240
250	3.962	3.980	3.998	4.015	4.033	4.051	4.069	4.087	4.104	4.122	4.140	250
260	4.140	4.158	4.176	4.194	4.212	4.230	4.248	4.266	4.284	4.301	4.319	260
270	4.319	4.337	4.355	4.373	4.391	4.410	4.428	4.446	4.464	4.482	4.500	270
280	4.500	4.518	4.536	4.554	4.572	4.590	4.608	4.627	4.645	4.663	4.681	280
290	4.681	4.699	4.717	4.736	4.754	4.772	4.790	4.809	4.827	4.845	4.863	290
300	4.863	4.882	4.900	4.918	4.937	4.955	4.973	4.992	5.010	5.028	5.047	300
310	5.047	5.065	5.083	5.102	5.120	5.139	5.157	5.175	5.194	5.212	5.231	310
320	5.231	5.249	5.268	5.286	5.305	5.323	5.342	5.360	5.379	5.397	5.416	320
330	5.416	5.434	5.453	5.471	5.490	5.508	5.527	5.546	5.564	5.583	5.601	330
340	5.601	5.620	5.639	5.657	5.676	5.695	5.713	5.732	5.751	5.769	5.788	340
350	5.788	5.807	5.825	5.844	5.863	5.882	5.900	5.919	5.938	5.956	5.975	350
360	5.975	5.994	6.013	6.032	6.050	6.069	6.088	6.107	6.126	6.144	6.163	360
370	6.163	6.182	6.201	6.220	6.239	6.257	6.276	6.295	6.314	6.333	6.352	370
380	6.352	6.371	6.390	6.409	6.427	6.446	6.465	6.484	6.503	6.522	6.541	380
390	6.541	6.560	6.579	6.598	6.617	6:636	6.655	6.674	6.693	6.712	6.731	390
400	6.731	6.750	6. 69	6.788	6.807	6.826	6.845	6.864	6.883	6.902	6.921	400
410	6.921	6.940	6.959	6.979	6.998	7.017	7.036	7.055	7.074	7.093	7.112	410
420	7.112	7.131	7.151	7.170	7.189	7.208	7.227	7.246	7.265	7.285	7.304	420
430	7.304	7.323	7.342	7.361	7.380	7.400	7.419	7.438	7.457	7.476	7.496	430
440	7.496	7.515	7.534	7.553	7.572	7.592	7.611	7.630	7.649	7.669	7.688	440
450	7.688	7.707	7.726	7.746	7.765	7.784	7.804	7.823	7.842	7.861	7.881	450
460	7.881	7.900	7.919	7.939	7.958	7.977	7.996	8.016	8.035	8.054	8.074	460
470	8.074	8.093	8.112	8.132	8.151	8.170	8.190	8.209	8.229	8.248	8.267	470
480	8.267	8.287	8.306	8.325	8.345	8.364	8.383	8.403	8.422	8.422	8.461	480
490	8.461	8.480	8.500	8.519	8.539	8.558	8.577	8.597	8.616	8.636	8.655	490
500	8.655	8.674	8.694	8.713	8.733	8.752	8.772	8.791	8.810	8.830	8.849	500
510	8.849	8.869	8.888	8.908	8.927	8.947	8.966	8.986	9.005	9.024	9.044	510
520	9.044	9.063	9.083	9.102	9.122	9.141	9.161	9.180	9.200	9.219	9.239	520
530	9.239	9.258	9.278	9.297	9.317	9.336	9.356	9.375	9.395	9.414	9.434	530
540	9.434	9.453	9.473	9.492	9.512	9.531	9.551	9.570	9.590	9.609	9.629	540
550	9.629	9.648	9.668	9.687	9.707	9.726	9.746	9.765	9.785	9.804	9.824	550
560	9.824	9.843	9.863	9.883	9.902	9.922	9.941	9.961	9.980	10.000	10.019	560
570	10.019	10.039	10.058	10.078	10.097	10.117	10.137	10.156	10.176	10.195	10.215	570
580	10.215	10.234	10.254	10.273	10.293	10.312	10.332	10.352	10.371	10.391	10.410	580
590	10.410	10.430	10.449	10.469	10.488	10.508	10.528	10.547	10.567	10.586	10.606	590
600	10.606	10-625	10.645	10.664	10.684	10.703	10.723	10.743	10.762	10.782	10.801	600
610	10.801	10.821	10.840	10.860	10.879	10.899	10.919	10.938	10.958	10.977	10.997	610
620	10.997	11.016	11.036	11.055	11.075	11.095	11.114	11.134	11.153	11.173	11.192	620
630	11.192	11.212	11.231	11.251	11.270	11.290	11.310	11.329	11.349	11.368	11.388	630
640	11.388	11.407	11.427	11.446	11.466	11.485	11.505	11.525	11.544	11.564	11.583	640
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**°C**

°C	0	1	2	3	4	5	6	7	8	9	10	°C
650	11.583	11.603	11.622	11.642	11.661	11.681	11.700	11.720	11.739	11.759	11.778	650
660	11.778	11.798	11.817	11.837	11.857	11.876	11.896	11.915	11.935	11.954	11.974	660
670	11.974	11.993	12.013	12.032	12.052	12.071	12.091	12.110	12.130	12.149	12.169	670
680	12.169	12.188	12.208	12.227	12.247	12.266	12.286	12.305	12.325	12.344	12.364	680
690	12.364	12.383	12.403	12.422	12.442	12.461	12.481	12.500	12-519	12.539	12.558	690
700	12.558	12.578	12.597	12.617	12.636	12.656	12.675	12.695	12.714	12.734	12.753	700
710	12.753	12.772	12.792	12.811	12.831	12.850	12.870	12.889	12.909	12.928	12.947	710
720	12.947	12.967	12.986	13.006	13.025	13.045	13.064	13.083	13.103	13.122	13.142	720
730	13.142	13.161	13.180	13.200	13.219	13.239	13.258	13.277	13.297	13.316	13.336	730
740	13.336	13.355	13.374	13.394	13.413	13.432	13.452	13.471	13.491	13.510	13.529	740
750	13.529	13.549	13.568	13.587	13.607	13.626	13.645	13.665	13.684	13.703	13.723	750
760	13.723	13.742	13.761	13.781	13.800	13.819	13.839	13.858	13.877	13.897	13.916	760
770	13.916	13.935	13.955	13.974	13.993	14.012	14.032	14.051	14 .070	14.090	14.109	770
780	14.109	14.128	14.147	14.167	14.186	14.205	14.224	14.244	14.263	14.282	14.302	780
790	14.302	14.321	14.340	14.359	14.378	14.398	14.417	14.436	14.455	14.475	14.494	790
800	14.494	14.513	14.532	14-551	14.571	14.590	14.609	14.628	14.647	14.667	14.686	800
810	14.686	14.705	14.724	14.743	14.762	14.782	14.801	14.820	14.839	14.858	14.877	810
820	14.877	14.897	14.916	14.935	14.954	14.973	14.992	15.011	15.030	15.050	15.069	820
830	15.069	15.088	15.107	15.126	15.145	15.164	15.183	15.202	15.221	15.241	15.260	830
840	15.260	15.279	15.298	15.317	15.336	15.355	15.374	15.393	15.412	15.431	15.450	840
850	15.450	15.469	15.488	15.507	15.526	15.545	15.564	15.583	15.602	15.621	15.640	850
860	15.640	15.659	15.678	15.697	15.716	15.735	15.754	15.773	15.792	15.811	15.830	860
870	15.830	15.849	15.868	15.887	15.906	15.925	15.944	15.963	15.982	16.001	16.020	870
880	16.020	16.038	16.057	16.076	16.095	16.114	16.133	16.152	16.171	19.190	16.208	880
890	16.208	16.227	16.246	16.265	16.284	16.303	16.322	16.340	16.359	16.378	16.397	890
900	16.397	16.416	16.435	16.453	16.472	16.491	16.510	16.529	16.547	16.566	16.585	900
910	16.585	16.604	16.623	16.641	16.660	16.679	16.698	16.716	16.735	16.754	16.773	910
920	16.773	16.791	16.810	16.829	16.848	16.866	16.885	16.904	16.923	16.941	16.960	920
930	16.960	16.979	16.997	17.016	17.035	17.053	17.072	17.091	17.109	17.128	17.147	930
940	17.147	17.165	17.184	17.203	17.221	17.240	17.258	17.277	17.296	17.314	17.333	940
950	17.333	17.352	17.370	17.389	17.407	17.426	17.444	17.463	17.482	17.500	17.519	950
960	17.519	17.537	17.556	17.574	17.593	17.611	17.630	17.648	17.667	17.686	17.704	960
970	17.704	17.723	17.741	17.760	17.778	17.796	17.815	17.833	17.852	17.870	17.889	970
980	17.889	17.907	17.926	17.944	17.963	17.981	17.999	18.018	18.036	18.055	18.073	980
990	18.073	18.092	18.110	18.128	18.147	18.165	18.184	18.202	18.220	18.239	18.257	990
1000	18.257	18.275	18.294	18.312	18.330	18.349	18.367	18.385	18.404	18.422	18.440	1000
1010	18.440	18.459	18.477	18.495	18.513	18.532	18.550	18.568	18.587	18.605	18.623	1010
1020	18.623	18.641	18.660	18.678	18.696	18.714	18.732	18.751	18.769	18.787	18.805	1020
1030	18.805	18.824	18.842	18.860	18.878	18.896	18.914	18.933	18.951	18.969	18.987	1030
1040	18.987	19.005	19.023	19.041	19.060	19.078	19.096	19.114	19.132	19.150	19.168	1040
1050	19.168	19.186	19.204	19.223	19.241	19.259	19.277	19.295	19.313	19.331	19.349	1050
1060	19.349	19.367	19.385	19.403	19.421	19.439	19.457	19.475	19.493	19.511	19.529	1060
1070	19.529	19.547	19.565	19.583	19.601	19.619	19.637	19.655	19.673	19.691	19.709	1070
1080	19.709	19.727	19.744	19.762	19.780	19.798	19.816	19.834	19.852	19.870	19.888	1080
1090	19.888	19.905	19.923	19.941	19.959	19.977	19.995	20.013	20.030	20.048	20.066	1090
1100	20.066	20.084	20.102	20.120	20.137	20.155	20.173	20.191	20.208	20.226	20.066	1100
1110	20.244	20.262	20.279	20.297	20.315	20.333	20.350	20.368	20.386	20.404	20.421	1110
1120	20.421	20.439	20.457	20.474	20.492	20.510	20.527	20.545	20.563	20.580	20.598	1120
1130	20.598	20.616	20.633	20.651	20.669	20.686	20.704	20.721	20.739	20.757	20.774	1130
1140	20.774	20.792	20.809	20.827	20.845	20.862	20.880	20.897	20.915	20.932	20.950	1140
1150	20.950	20.967	20.985	21.002	21.020	21.037	21.055	21.072	21.090	21.107	21.125	1150
1160	21.125	21.142	21.160	21.177	21.195	21.212	21.230	21.247	21.265	21.282	21.299	1160
1170	21.299	21.317	21.334	21.352	21.369	21.386	21.404	21.421	21.439	21.456	21.473	1170
1180	21.473	21.491	21.508	21.525	21.543	21.560	21.577	21.595	21.612	21.629	21.647	1180
1190	21.647	21.664	21.681	21.698	21.716	21.733	21.750	21.768	21.785	21.802	21.819	1190
1200	21.819	21.837	21.854	21.871	21.888	21.905	21.923	21.940	21.957	21.974	21.991	1200
1210	21.991	22.009	22.026	22.043	22.060	22.077	22.094	22.112	22.129	22.146	22.163	1210
1220	22.163	22.180	22.197	22.214	22.231	22.249	22.266	22.283	22.300	22.317	22.334	1220
1230	22.334	22.35	22.368	22.385	22.402	22.419	22.436	22.453	22.470	22.487	22.504	1230
1240	22.504	22.521	22.538	22.555	22.572	22.589	22.606	22.623	22.640	22.657	22.674	1240
1250	22.674	22.691	22.708	22.725	22.742	22.759	22.776	22.792	22.809	22.826	22.843	1250
1260	22.843	22.860	22.877	22.894	22.911	22.928	22.944	22.961	22.978	22.995	23.012	1260
1270	23.012	23.029	23.045	23.062	23.079	23.096	23.113	23.129	23.146	23.163	23.180	1270
1280	23.180	23.196	23.213	23.230	23.247	23.263	23.280	23.297	23.314	23.330	23.347	1280
1290	23.347	23.364	23.380	23.397	23.414	23.431	23.447	23.464	23.481	23.497	23.514	1290
°C	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**°C**

Reference Source: OMEGA® Engineering

TYPE - C THERMOCOUPLE, ITS-90 TABLE

Thermoelectric Voltage in Millivolts

°C	0	1	2	3	4	5	6	7	8	9	10	°C
1300	23.514	23.530	23.547	23.564	23.580	23.597	23.614	23.630	23.647	23.663	23.680	1300
1310	23.680	23.697	23.713	23.730	23.746	23.763	23.779	23.796	23.812	23.829	23.846	1310
1320	23.846	23.862	23.879	23.895	23.912	23.928	23.945	23.961	23.978	23.994	24.010	1320
1330	24.010	24.027	24.043	24.060	24.076	24.093	24.109	24.126	24.142	24.158	24.175	1330
1340	24.175	24.191	24.208	24.224	24.240	24.257	24.273	24.290	24.306	24.322	24.339	1340
1350	24.339	24.355	24.371	24.388	24.404	24.420	24.437	24.453	24.46	24.485	24.502	1350
1360	24.502	24.518	24.534	24.551	24.567	24.583	24.599	24.616	24.632	24.648	24.664	1360
1370	24.664	24.680	24.697	24.713	24.729	24.745	24.762	24.778	24.794	24.810	24.826	1370
1380	24.826	24.842	24.859	24.875	24.891	24.907	24.923	24.939	24.955	24.971	24.988	1380
1390	24.988	25.004	25.020	25.036	25.052	25.068	25.084	25.100	25.116	24.132	25.148	1390
1400	25.148	25.164	25.180	25.196	25.212	25.228	25.244	25.260	25.276	25.292	25.308	1400
1410	25.308	25.324	25.340	25.356	25.372	25.388	25.404	25.420	25.436	25.452	25.468	1410
1420	25.468	25.484	25.500	25.516	25.532	25.547	25.563	25.579	25.595	25.611	25.627	1420
1430	25.627	25.643	25.658	25.674	25.690	25.706	25.722	25.738	25.753	25.769	25.785	1430
1440	25.785	25.801	25.817	25.832	25.848	25.864	25.880	25.896	25.911	25.927	25.943	1440
1450	25.943	25.959	25.974	25.990	26.006	26.021	26.037	26.053	26.069	26.084	26.100	1450
1460	26.100	26.116	26.131	26.147	26.163	26.178	26.194	26.209	26.225	26.241	26.256	1460
1470	26.256	26.272	26.288	26.303	26.319	26.334	26.350	26.366	26.381	26.397	26.412	1470
1480	26.412	26.428	26.443	26.459	26.474	26.490	26.505	26.521	26.537	26.552	26.568	1480
1490	26.568	26.583	26.599	26.614	26.629	26.645	26.660	26.676	26.691	26.707	26.722	1490
1500	26.722	26.738	26.753	26.768	26.784	26.799	26.815	26.830	26.845	26.861	26.876	1500
1510	26.876	26.892	26.907	26.922	26.938	26.953	26.968	26.984	26.999	27.014	27.030	1510
1520	27.030	27.045	27.060	27.076	27.091	27.106	27.121	27.137	27.152	27.167	27.183	1520
1530	27.183	27.198	27.213	27.228	27.244	27.259	27.274	27.289	27.304	27.320	27.335	1530
1540	27.335	27.350	27.365	27.380	27.396	27.411	27.426	27.441	27.456	27.471	27.486	1540
1550	27.486	27.502	27.517	27.532	27.547	27.562	27.577	27.592	27.607	27.622	27.637	1550
1560	27.637	27.653	27.668	27.683	27.698	27.713	27.728	27.743	27.758	27.773	27.788	1560
1570	27.788	27.803	27.818	27.833	27.848	27.863	27.878	27.893	27.908	27.923	27.938	1570
1580	27.938	27.953	27.968	27.983	27.997	28.012	28.027	28.042	28.057	28.072	28.087	1580
1590	28.087	28.102	28.117	28.132	28.146	28.161	28.176	28.191	28.206	28.221	28.236	1590
1600	28.236	28.250	28.265	28.280	28.295	28.310	28.324	28.339	28.354	28.369	28.531	1600
1610	28.531	28.398	28.413	28.428	28.443	28.457	28.472	28.487	28.502	28.516	28.531	1610
1620	28.531	28.546	28.560	28.575	28.590	28.604	28.619	28.634	28.648	28.663	28.678	1620
1630	28.678	28.692	28.707	28.722	28.736	28.751	28.765	28.780	28.795	28.809	28.824	1630
1640	28.824	28.838	28.853	28.868	28.882	28.897	28.911	28.926	28.940	28.955	28.969	1640
1650	28.969	28.984	28.998	29.013	29.027	29.042	29.056	29.071	29.085	29.100	29.114	1650
1660	29.114	29.129	29.143	29.158	29.172	29.187	29.201	29.215	29.230	29.244	29.259	1660
1670	29.259	29.273	29.287	29.302	29.316	29.331	29.345	29.359	29.374	29.388	29.402	1670
1680	29.402	29.417	29.431	29.445	29.460	29.474	29.488	29.503	29.517	29.531	29.546	1680
1690	29.546	29.560	29.574	29.588	29.603	29.617	29.631	29.645	29.660	29.674	29.688	1690
1700	29.688	29.702	29.716	29.731	29.745	29.759	29.773	29.787	29.802	29.816	29.830	1700
1710	29.830	29.844	29.858	29.872	29.886	29.901	29.915	29.929	29.943	29.957	29.971	1710
1720	29.971	29.985	29.999	30.013	30.027	30.041	30.056	30.070	30.084	30.098	30.112	1720
1730	30.112	30.126	30.140	30.154	30.168	30.182	30.196	30.210	30.224	30.238	30.252	1730
1740	30.252	30.266	30.280	30.294	30.308	30.321	30.335	30.349	30.363	30.377	30.391	1740
1750	30.391	30.405	30.419	30.433	30.447	30.460	30.474	30.488	30.502	30.516	30.530	1750
1760	30.530	30.544	30.557	30.571	30.585	30.599	30.613	30.627	20.640	30.654	30.668	1760
1770	30.668	30.682	30.695	30.709	30.723	30.737	30.750	30.764	30.778	30.792	30.805	1770
1780	30.805	30.819	30.833	30.846	30.860	30.874	30.887	30.901	30.915	20.928	30.942	1780
1790	30.942	30.956	30.969	30.983	30.997	31.010	31.024	31.038	31.051	31.065	31.078	1790
1800	31.078	31.092	31.105	31.119	31.133	31.146	31.160	31.173	31.187	31.200	31.214	1800
1810	31.214	31.227	31.241	31.254	31.268	31.281	31.295	31.308	31.322	31.335	31.349	1810
1820	31.349	31.362	31.376	31.389	31.403	31.416	31.429	31.443	31.456	31.470	31.483	1820
1830	31.483	31.496	31.510	31.523	31.536	31.550	31.563	31.577	31.590	31.603	31.617	1830
1840	31.617	31.630	31.643	31.656	31.670	31.683	31.696	31.710	31.723	31.736	31.749	1840
1850	31.749	31.763	31.776	31.789	31.802	31.816	31.829	31.842	31.855	31.869	31.882	1850
1860	31.882	31.895	31.908	31.921	31.934	31.948	31.961	31.974	31.987	32.000	32.013	1860
1870	32.013	32.026	32.040	32.053	32.066	32.079	32.092	32.105	32.118	32.131	32.144	1870
1880	32.144	32.157	32.170	31.183	32.196	32.209	32.222	32.235	32.248	32.261	32.274	1880
1890	32.274	32.287	32.300	31.313	32.326	32.339	32.352	32.365	32.378	32.391	32.404	1890
1900	32.404	32.417	32.430	32.443	32.456	32.468	32.481	32.494	32.507	32.520	32.533	1900
1910	32.533	32.546	32.558	32.571	32.584	32.597	32.610	32.623	32.635	32.648	32.661	1910
1920	32.661	32.674	32.686	32.699	32.712	32.725	32.737	32.750	32.763	32.776	32.788	1920
1930	32.788	32.801	32.814	32.826	32.839	32.852	32.864	32.877	32.890	32.902	32.915	1930
1940	32.915	32.928	32.940	32.953	32.966	32.978	32.991	33.003	33.016	33.028	33.041	1940
°C	0	1	2	3	4	5	6	7	8	9	10	°C

°C	0	1	2	3	4	5	6	7	8	9	10	°C
1950	33.041	33.054	33.066	33.079	33.091	33.104	33.116	33.129	33.141	33.154	33.166	1950
1960	33.166	33.179	33.191	33.204	33.216	33.229	33.241	33.254	33.266	33.278	33.291	1960
1970	33.291	33.303	33.316	33.328	33.341	33.353	33.365	33.378	33.390	33.402	33.415	1970
1980	33.415	33.427	33.439	33.452	33.464	33.476	33.489	33.501	33.513	33.525	33.538	1980
1990	33.538	33.550	33.562	33.575	33.587	33.599	33.611	33.623	33.636	33.648	33.660	1990
2000	33.660	33.672	33.684	33.697	33.709	33.721	33.733	33.745	33.757	33.769	33.782	2000
2010	33.782	33.794	33.806	33.818	33.830	33.842	33.854	33.866	33.878	33.890	33.902	2010
2020	33.902	33.914	33.926	33.938	33.950	33.962	33.974	33.986	33.998	34.010	34.022	2020
2030	34.022	34.034	34.046	34.058	34.070	34.082	34.094	34.106	34.118	34.130	34.142	2030
2040	34.142	34.153	34.165	34.177	34.189	34.201	34.213	34.225	34.236	34.248	34.260	2040
2050	34.260	34.272	34.284	34.295	34.307	34.319	34.331	34.342	34.354	34.366	34.378	2050
2060	34.378	34.389	34.401	34.413	34.424	34.436	34.448	34.459	34.471	34.483	34.494	2060
2070	34.494	34.506	34.518	34.529	34.541	34.552	34.564	34.576	34.587	34.599	34.610	2070
2080	34.610	34.622	34.633	34.645	34.656	34.668	34.679	34.691	34.702	34.714	34.725	2080
2090	34.725	34.737	34.748	34.760	34.771	34.782	34.794	34.805	34.817	34.828	34.839	2090
2100	34.839	34.851	34.862	34.874	34.885	34.896	34.908	34.919	34.930	34.942	34.953	2100
2110	34.953	34.964	34.975	34.987	34.998	35.009	35.020	35.032	35.043	35.054	35.065	2110
2120	35.065	35.077	35.088	35.099	35.110	35.121	35.132	34.144	35.155	35.166	35.177	2120
2130	35.177	35.188	35.199	35.210	35.221	35.232	35.243	35.254	35.265	35.277	35.288	2130
2140	35.288	35.299	35.310	35.321	35.332	35.343	35.353	35.364	35.375	35.386	35.397	2140
2150	35.397	35.408	35.419	35.430	35.441	35.452	35.463	35.474	35.484	35.495	35.506	2150
2160	35.506	35.517	35.528	35.539	35.549	35.560	35.571	35.582	35.592	35.603	35.614	2160
2170	35.614	35.625	35.635	35.646	35.657	35.668	35.678	35.689	35.700	35.710	35.721	2170
2180	35.721	35.731	35.742	35.753	35.763	35.774	35.784	35.795	35.806	35.816	35.827	2180
2190	35.827	35.837	35.848	35.858	35.869	35.879	35.890	35.900	35.911	35.921	35.932	2190
2200	35.932	35.942	35.953	35.963	35.973	35.984	35.994	36.004	36.015	36.025	36.036	2200
2210	36.036	36.046	36-056	36.067	36.077	36.087	36.097	36.108	36.118	36.128	36.138	2210
2220	36.138	36.149	36.159	36.169	36.179	36.189	36.200	36.210	36.220	36.230	36.240	2220
2230	36.240	36.250	36.260	36.271	36.281	36.291	36.301	36.311	36.321	36.331	36.341	2230
2240	36.341	36.351	36.361	36.371	36.381	36.391	36.401	36.411	36.421	36.431	36.441	2240
2250	36.441	36.451	36.460	36.470	36.480	36.490	36-500	36.510	36.520	36.529	36.539	2250
2260	36.539	36.549	36.559	36.569	36.578	36.588	36.598	36.608	36.617	36.627	36.637	2260
2270	36.637	36.646	36.656	36.666	36.675	36.685	36.695	36.704	36.714	36.723	36.733	2270
2280	36.733	36.743	36.752	36.762	36.771	36.781	36.790	36.800	36.809	36.819	36.828	2280
2290	36.828	36.838	36.847	36.857	36.866	36.875	36.885	36.894	36.903	36.913	36.922	2290
2300	36.922	36.932	36.941	36.950	36.959	36.969	36.978	36.987	36.997	37.006	37.015	2300
2310	37.015	37.024	37.033	37.043	37.052	37.061	37.070	37.079	37.088	37.097	37.107	2310
°C	0	1	2	3	4	5	6	7	8	9	10	°C

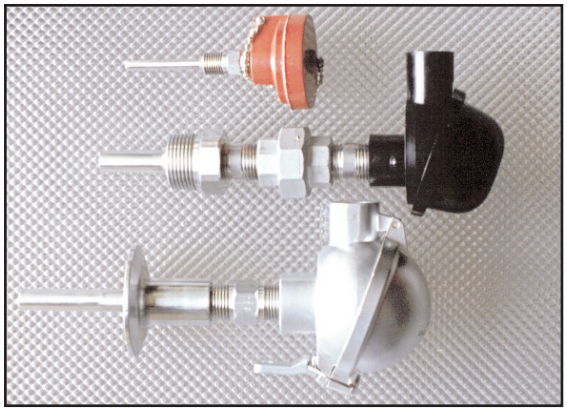
Reference Source: OMEGA® Engineering

DECIMAL EQUIVALENT CHART

INCH FRACTION	DECIMAL EQUIV.	INCH FRACTION	DECIMAL EQUIV.	INCH FRACTION	DECIMAL EQUIV.
1/64	.0156	23/64	.3594	45/64	.7031
1/32	.0312	3/8	.375	23/32	.7187
3/64	.0469	24/64	.3906	47/64	.7344
1/16	.0625	13/32	.4062	3/4	.75
5/64	.0781	27/64	.4219	49/64	.7656
3/32	.0937	7/16	.4375	25/32	.7812
7/64	.1094	39/64	.4531	51/64	.7969
1/8	.125	15/32	.4687	13/16	.8125
9/64	.1406	31/64	.4844	53/64	.8281
5/32	.1562	1/2	.5	27/32	.8437
11/64	.1719	33/64	.5156	55/64	.8594
3/16	.1875	17/32	.5312	7/8	.875
13/64	.2031	35/64	.5469	57/64	.8906
7/32	.2187	9/16	.5625	29/32	.9062
15/64	.2344	37/64	.5781	59/64	.9219
1/4	.25	19/32	.5937	15/16	.9357
17/64	.2656	39/64	.6094	61/64	.9531
9/32	.2812	5/8	.625	31/32	.9687
19/64	.2969	41/64	.6406	63/64	.9544
5/16	.3125	21/32	.6562	1	1.00
21/64	.3281	43/64	.6719		
11/32	.3437	11/16	.6875		

THERMOCOUPLE TEMPERATURE LIMITS

	Material	Couple Condition	AWG					
			8	14	16	20	24	30
S R	Platinum and Platinum-Rhodium	Bare Protected	- -	- -	- -	- 2800 F	- 2700 F	- 2400 F
T	Copper and Constantan	Bare Protected	- -	600°F 700°F	500°F 600°F	400°F 500°F	400°F 400°F	400°F 400°F
J	Iron and Constantan	Bare Protected	1200°F 1400°F	900°F 1100°F	900°F 1100°F	800°F 900°F	650°F 700°F	600°F 700°F
K	Chromel and Alumel	Bare Protected	2000°F 2300°F	1700°F 2000°F	1700°F 2000°F	1600°F 1800°F	1400°F 1600°F	1300°F 1500°F
E	Chromel and Constantan	Bare Protected	1400°F 1600°F	1100°F 1200°F	1100°F 1200°F	900°F 1000°F	700°F 800°F	700°F 800°F



MATERIAL SELECTION INFORMATION

The following information is a guide line for selecting thermocouple, RTD and thermowell materials based on the process fluid. Factors such as catalytic reaction, contamination and electrolysis are taken into consideration. However, in many cases there are even more variables which must be examined.

These suggestions are to be used only as guide lines and are based on the most economical material selection. JMS Southeast will not take any responsibility if these recommendations are not satisfactory for specific applications. Consult JMS Southeast for special applications and our engineering department will assist you in your selection.

SUBSTANCE	CONDITIONS	RECOMMENDED METAL
Acetate Solvents	Crude or Pure	Monel or Nickel
Acetic Acid	10% - 70°F	304 Stainless Steel
" "	50% - 70°F	304 Stainless Steel
" "	50% - 212°F	316 Stainless Steel
" "	99% - 70°F	430 Stainless Steel
" "	99% - 212°F	430 Stainless Steel
Acetic Anhydride		Monel
Acetone	212°F	304 Stainless Steel
Acetylene		304, Monel, Nickel
Alcohol Ethyl	70°F	304 Stainless Steel
" "	212°F	304 Stainless Steel
Alcohol Methyl	70°F	304 Stainless Steel
" "	212°F	304 Stainless Steel
Aluminum	Molten	Cast Iron
Aluminum Acetate	Saturated	304 Stainless Steel
Aluminum Sulphate	10% - 70°F	304 Stainless Steel
" "	Saturated 70°F	304 Stainless Steel
" "	10% - 212°F	316 Stainless Steel
" "	Saturated 212°F	316 Stainless Steel
Ammonia	All concentrations 70°F	304 Stainless Steel
Ammonium Chloride	All concentrations 212°F	316 Stainless Steel
Ammonium Nitrate	All concentrations 70°F	304 Stainless Steel
" "	All concentrations 212°F	304 Stainless Steel
Ammonium Sulphate	5% - 70°F	304 Stainless Steel
" "	10% - 212°F	316 Stainless Steel
" "	Saturated 212°F	316 Stainless Steel
Aniline	All concentrations 70°F	304 Stainless Steel
Amylacetate		Monel
Asphalt		Steel (C1018) Phosphor Bronze, Monel, Nickel
Barium Carbonate	70°F	304 Stainless Steel
Barium Chloride	5% - 70°F	Monel
" "	Saturated 70°F	Monel
" "	Aqueous - Hot	316 Stainless Steel
Barium Hydroxide		Steel (C1018)
Barium Sulphite		Nichrome
Benzaldehyde		Steel (C1018)
Benzene	70°F	304 Stainless Steel
Benzine		Steel (C1018) Monel, Inconel
Benzol	Hot	304 Stainless Steel
Boracic Acid	5% Hot or Cold	304 Stainless Steel
Bromine	70°F	Tantalum
Butadiene		Brass, 304
Butane	70°F	304 Stainless Steel
Butylacetate		Monel
Butyl Alcohol		Copper
Butylenes		Steel (C1018), Phosphor Bronze
Butyric Acid	5% - 70°F	304 Stainless Steel
" "	5% - 150°F	304 Stainless Steel
Calcium Bisulfite	70°F	316 Stainless Steel
Calcium Chlorate	Dilute 70°F	304 Stainless Steel
" "	Dilute 150°F	304 Stainless Steel
Calcium Hydroxide	10% - 212°F	304 Stainless Steel
" "	20% - 212°F	304 Stainless Steel
" "	50% - 212°F	317 Stainless Steel
Carbolic Acid	All 212°F	316 Stainless Steel
Carbon Dioxide	Dry	Steel (C1018), Monel
Carbon Dioxide	Wet	Aluminum,Monel,Nickel
Carbon Tetrachloride	10% - 70°F	Monel
Chlorex Caustic		316SS, 317SS
Chlorine Gas	Dry 70°F	317 Stainless Steel
" "	Moist 70°F	Hastelloy C
" "	Moist 212°F	Hastelloy C
Chromic Acid	5% - 70°F	304 Stainless Steel
" "	10% - 212°F	316 Stainless Steel
" "	50% - 212°F	316 Stainless Steel
Citric Acid	15% - 70°F	304 Stainless Steel
" "	15% - 212°F	316 Stainless Steel
" "	Concentrated 212°F	317 Stainless Steel
Coal Tar	Hot	304 Stainless Steel
Coke Oven Gas		Aluminum
Copper Nitrate		304, 316
Copper Sulphate		304, 316
Core Oils		316 Stainless Steel
Cottonseed Oil		Steel (C1018), Monel, Nickel
Creosols		304 Stainless Steel
Creosote Crude		Steel (C1018), Monel Nickel
Cyanogen Gas		304 Stainless Steel
Dowtherm		Steel (C1018)
Epsom Salt	Hot and Cold	304 Stainless Steel
Ether	70°F	304 Stainless Steel
Ethyl Acetate		Monel
Ethyl Chloride	70°F	304 Stainless Steel
Ethylene Glycol		Steel (C1018)
Ethyl Sulphate	70°F	Monel
Ferric Chloride	1% - 70°F	316 Stainless Steel
" "	5% - 70°F	Tantalum
" "	5% - Boiling	Tantalum
Ferric Sulphate	5% - 70°F	304 Stainless Steel
Ferrous Sulphate	Dilute 70°F	304 Stainless Steel
Formaldehyde		304 Stainless Steel
Freon		Steel (C1018)
Formic Acid	5% - 70°F	316 Stainless Steel
" "	5% - 150°F	316 Stainless Steel
Gallic Acid	5% - 70°F	Monel
" "	5% - 150°F	Monel
Gasoline	70°F	304 Stainless Steel
Glucose	70°F	304 Stainless Steel
Glycerine	70°F	304 Stainless Steel
Glycerol		304 Stainless Steel
Heat Treating		446 Stainless Steel
Hydrobromic Acid	48% - 212°F	Hastelloy B
Hydrochloric Acid	1% - 70°F	Hastelloy C
" "	1% - 212°F	Hastelloy B
" "	5% - 70°F	Hastelloy C
" "	5% - 212°F	Hastelloy B
" "	25% - 70°F	Hastelloy B
" "	25% - 212°F	Hastelloy B
Hydrocyanic Acid		316 Stainless Steel
Hydrofluoric Acid		Hastelloy C
Hydrogen Peroxide	70°F	316 Stainless Steel
" "	212°F	316 Stainless Steel
Hydrogen Sulphide	Wet and dry	316 Stainless Steel
Iodine	70°F	Tantalum
Kerosene	70°F	304 Stainless Steel
Lactic Acid	5% - 70°F	304 Stainless Steel
" "	5% - 150°F	316 Stainless Steel
" "	10% - 212°F	Tantalum
Lacquer	70°F	316 Stainless Steel
Latex		Steel (C1018)
Lime Sulphur		Steel (C1018), 304, Monel
Linseed Oil	70°F	304 Stainless Steel
Magnesium Chloride	5% - 70°F	Monel
" "	5% - 212°F	Nickel
Magnesium Sulphate	Cold and Hot	Monel
Malic Acid	Cold and Hot	316 Stainless Steel
Mercury		Steel (C1018), 304, Monel
Methane	70°F	Steel (1020)
Milk		304, Nickel
Mixed Acids (Sulphuric and Nitric — all temp. and %)		Carpenter #20
Molasses		Steel (C1018), 304, Monel, Nickel
Muriatic Acid	70°F	Tantalum
Naphtha	70°F	304 Stainless Steel
Natural Gas	70°F	304 Stainless Steel
Neon	70°F	304 Stainless Steel
Nickel Chloride	70°F	304 Stainless Steel
Nickel Sulphate	Hot and Cold	304 Stainless Steel
Nitric Acid	5% - 70°F	304 Stainless Steel
" "	20% - 70°F	304 Stainless Steel
" "	50% - 70°F	304 Stainless Steel
" "	50% - 212°F	304 Stainless Steel
" "	65% - 212°F	316 Stainless Steel
" "	Concentrated - 70°F	304 Stainless Steel
" "	Concentrated - 212°F	Tantalum
Nitrobenzene	70°F	304 Stainless Steel
Nitrous Acid		304 Stainless Steel
Oleic Acid	70°F	316 Stainless Steel
Oleum	70°F	316 Stainless Steel
Oxalic Acid	5% - Hot and Cold	304 Stainless Steel
" "	10% - 212°F	Monel
Oxygen	70°F	Steel (C1018)
Oxygen	Liquid	304 Stainless Steel
Palmitic Acid		316 Stainless Steel
Petroleum Ether		304 Stainless Steel
Phenol		304 Stainless Steel
Pentane		304 Stainless Steel
Phosphoric Acid	1% - 70°F	304 Stainless Steel
" "	5% - 70°F	304 Stainless Steel
" "	10% - 70°F	316 Stainless Steel
" "	10% - 212°F	Hastelloy C
" "	30% - 70°F	Hastelloy B
" "	30% - 212°F	Hastelloy B
" "	85% - 70°F	Hastelloy B
" "	85% - 212°F	Hastelloy B
Picric Acid	70°F	304 Stainless Steel
Potassium Bromide	70°F	316 Stainless Steel
Potassium Carbonate	1% - 70°F	304 Stainless Steel
Potassium Chlorate	70°F	304 Stainless Steel
Potassium Chloride	5% - 70°F	304 Stainless Steel
" "	5% - 212°F	304 Stainless Steel
Potassium Hydroxide	5% - 70°F	304 Stainless Steel
" "	25% - 212°F	304 Stainless Steel
" "	50% - 212°F	316 Stainless Steel
Potassium Nitrate	5% - 70°F	304 Stainless Steel
" "	5% - 212°F	304 Stainless Steel
Potassium Permanganate	5% - 70°F	304 Stainless Steel
Potassium Sulphate	5% - 70°F	304 Stainless Steel
" "	5% - 212°F	304 Stainless Steel
Potassium Sulphide	70°F	304 Stainless Steel
Propane		304 Stainless Steel
Pyrogallic Acid		304 Stainless Steel
Quinine Bisulphate	Dry	316 Stainless Steel
Quinine Sulphate	Dry	304 Stainless Steel
Resin		304 Stainless Steel
Rosin	Molten	304 Stainless Steel
Sea Water		Monel
Salammoniac		Monel
Salicylic Acid		Nickel
Shellac		304 Stainless Steel
Soap	70°F	304 Stainless Steel
Sodium Bicarbonate	All concentrations 70°F	304 Stainless Steel
" "	5% - 150°F	304 Stainless Steel
Sodium Bisulphate		Monel
Sodium Carbonate	5% - 70°F	304 Stainless Steel
" "	5% - 150°F	304 Stainless Steel
Sodium Chloride	5% - 70°F	316 Stainless Steel
Sodium Chloride	5% - 150°F	316 Stainless Steel
" "	Saturated - 70°F	316 Stainless Steel
" "	Saturated - 212°F	316 Stainless Steel
Sodium Fluoride	5% - 70°F	Monel
Sodium Hydroxide		304 Stainless Steel
Sodium Hypochlorite	5% still	316 Stainless Steel
Sodium Nitrate	Fused	317 Stainless Steel
Sodium Peroxide		304 Stainless Steel
Sodium Phosphate		Steel (C1018)
Sodium Silicate		Steel (C1018)
Sodium Sulphate	70°F	304 Stainless Steel
Sodium Sulphide	70°F	316 Stainless Steel
Sodium Sulphite	150°F	304 Stainless Steel
Steam		304 Stainless Steel
Stearic Acid		304 Stainless Steel
Sulphur Dioxide	Moist Gas - 70°F	316 Stainless Steel
" "	Gas - 575°F	304 Stainless Steel
Sulphur	Dry - Molten	304 Stainless Steel
"	Wet	316 Stainless Steel
Sulphuric Acid	5% - 70°F	Carp. 20, Hastelloy B
" "	5% - 212°F	Carp. 20, Hastelloy B
" "	10% - 70°F	Carp. 20, Hastelloy B
" "	10% - 212°F	Carp. 20, Hastelloy B
" "	50% - 70°F	Carp. 20, Hastelloy B
" "	50% - 212°F	Carp. 20, Hastelloy B
" "	90% - 70°F	Carp. 20, Hastelloy B
" "	90% - 212°F	Hastelloy D
Tannic Acid	70°F	304 Stainless Steel
Tar		Steel (C1018), 304, Monel, Nickel
Tartaric Acid	70°F	304 Stainless Steel
" "	150°F	316 Stainless Steel
Tin	Molten	Cast Iron
Tolvene		Aluminum, Phosphor Bronze, Monel
Trichloroethylene		Steel (C1018)
Turpentine		304 Stainless Steel
Varnish		304 Stainless Steel
Vegetable Oils		Steel (C1018), 304, Monel
Vinegar		304 Stainless Steel
Water	Fresh	Copper, Steel (C1018), Monel
Water	Salt	Aluminum Brass, Monel
Whiskey, Wine		304, Nickel
Xylene		Copper
Zinc	Molten	Cast Iron
Zinc Chloride		Monel
Zinc Sulphate	5% - 70°F	304 Stainless Steel
" "	Saturated - 70°F	304 Stainless Steel
" "	25% - 212°F	304 Stainless Steel

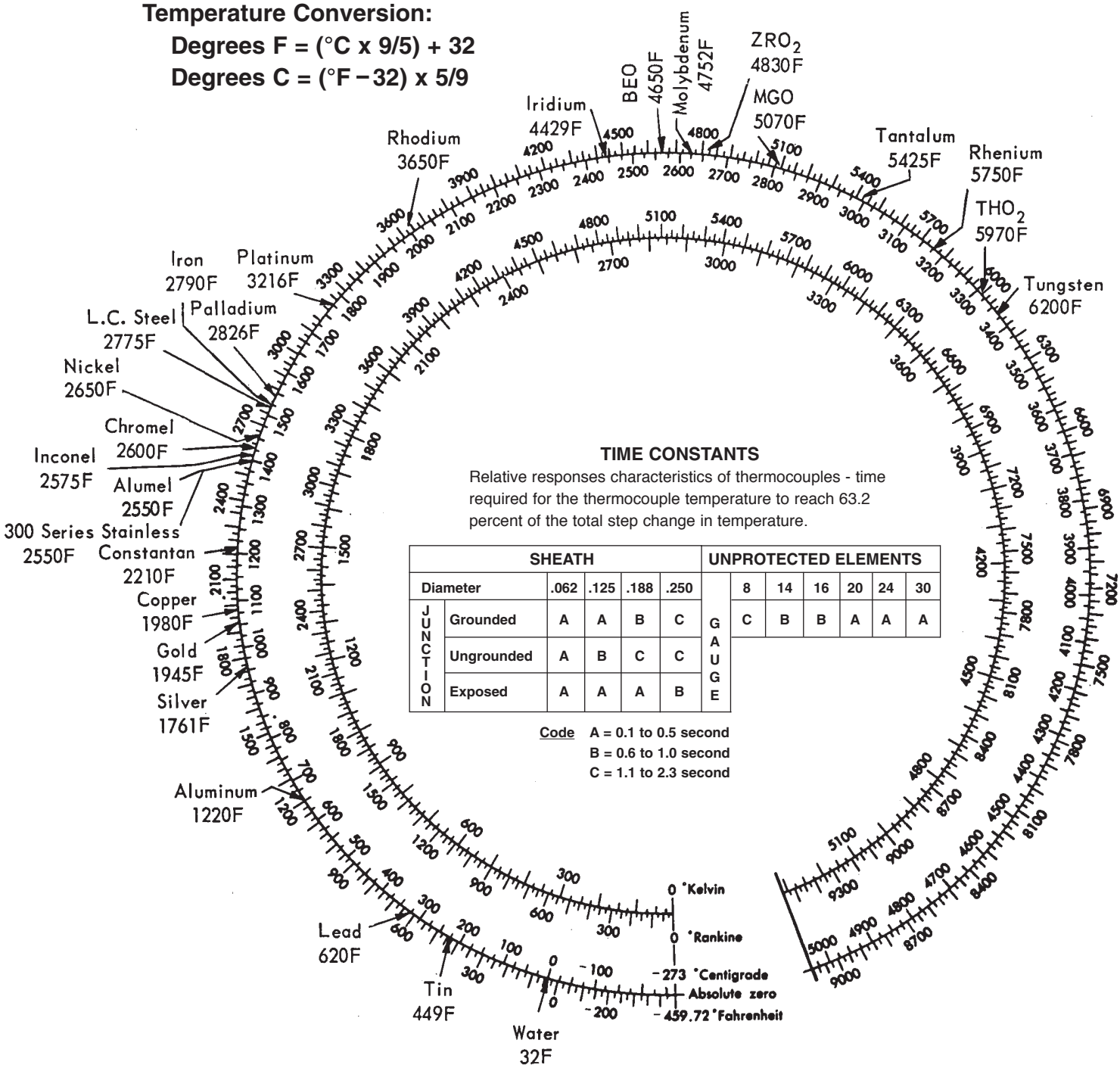
TEMPERATURE CONVERSION CHART (°F and °C)

SHOWING MELTING POINTS OF COMMONLY USED ELEMENTS

Temperature Conversion:

Degrees F = (°C x 9/5) + 32

Degrees C = (°F − 32) x 5/9



TIME CONSTANTS

Relative responses characteristics of thermocouples - time required for the thermocouple temperature to reach 63.2 percent of the total step change in temperature.

SHEATH						UNPROTECTED ELEMENTS					
Diameter		.062	.125	.188	.250	GAUGE 8	14	16	20	24	30
JUNCTION	Grounded	A	A	B	C	C	B	B	A	A	A
	Ungrounded	A	B	C	C						
	Exposed	A	A	A	B						

Code A = 0.1 to 0.5 second
B = 0.6 to 1.0 second
C = 1.1 to 2.3 second

Useful Range of Thermocouples– 458°F to + 4800°F

NOMINAL PHYSICAL PROPERTIES OF ELEMENT

	Thermoelement Material									
	Positive (+) Conductors						Negative (-) Conductors			
Property	**J**	**T**	**K,E**	**N+**	**R**	**S**	**J,T,E**	**K**	**R,S**	**N-**
Melting Point (°C)	1535	1083	1430	1410	1870	1850	1210	1400	1773	1400
Electrical Resistivity Ohms/CMF @ 20°C	60.14	10.37	425	.560			294	177	63.80	.220
Thermal Conductivity Watts/cm/°C @ 100°C	.662	3.88	.192	.031			.212	.297	.695	.055
Specific Heat Cal./GM/°C @ 20°C	.1065	.0921	.107	0.11			.094	.125	.0324	0.12
Density-lb/ln^3	.2840	.3233	.3154				.322	.3107	.7750	
Tensile Strength Annealed-PSI	50,000	35,000	95,000	110,00			60,000	85,000		95,000
Magnetic Strength @ 20°C	Strong	None	None	None	None	None	None	Weak	None	None
Specific Gravity	7.86	8.92	8.73	.852			8.9	8.60	21.45	.870

TABLE 1. Characteristics Compositions of Thermoelement Alloys.

	CHEMICAL composition (weight %)									
Alloy	Cr	Si	Mg	Mn	Al	Fe	Co	C	Cu	Ni
nicrosil	14.2	1.4	-	-	-	0.1	-	.03	-	bal.
nisil	-	4.4	0.1	-	-	0.1	-	-	-	bal.
type (or EP)	9.3	0.5	-	0.5	-	0.5	0.5	-	-	bal.
type KN	-	1.1	-	2.8	1.9	0.5	0.5	-	0.5	bal.
type JP	-	-	-	.25	-	bal.	-	-	.12	-
type JN	-	-	-	.75	-	0.3	0.3	-	bal.	44.5
type TP	-	-	-	-	-	-	-	-	99.95	-
type TN (or EN)	-	-	-	0.1	-	0.1	-	-	bal.	45

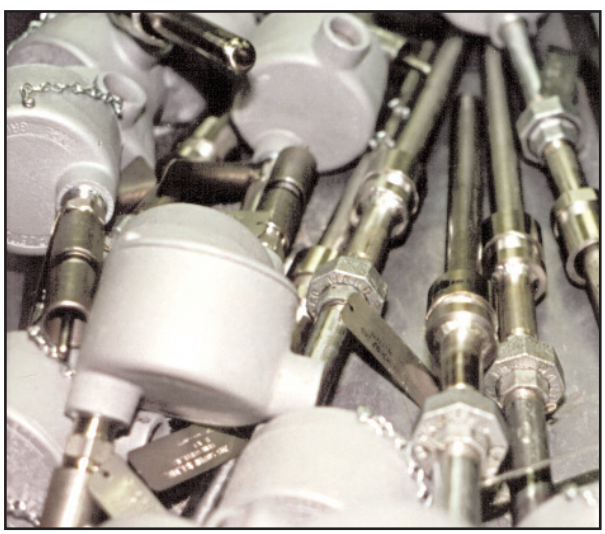


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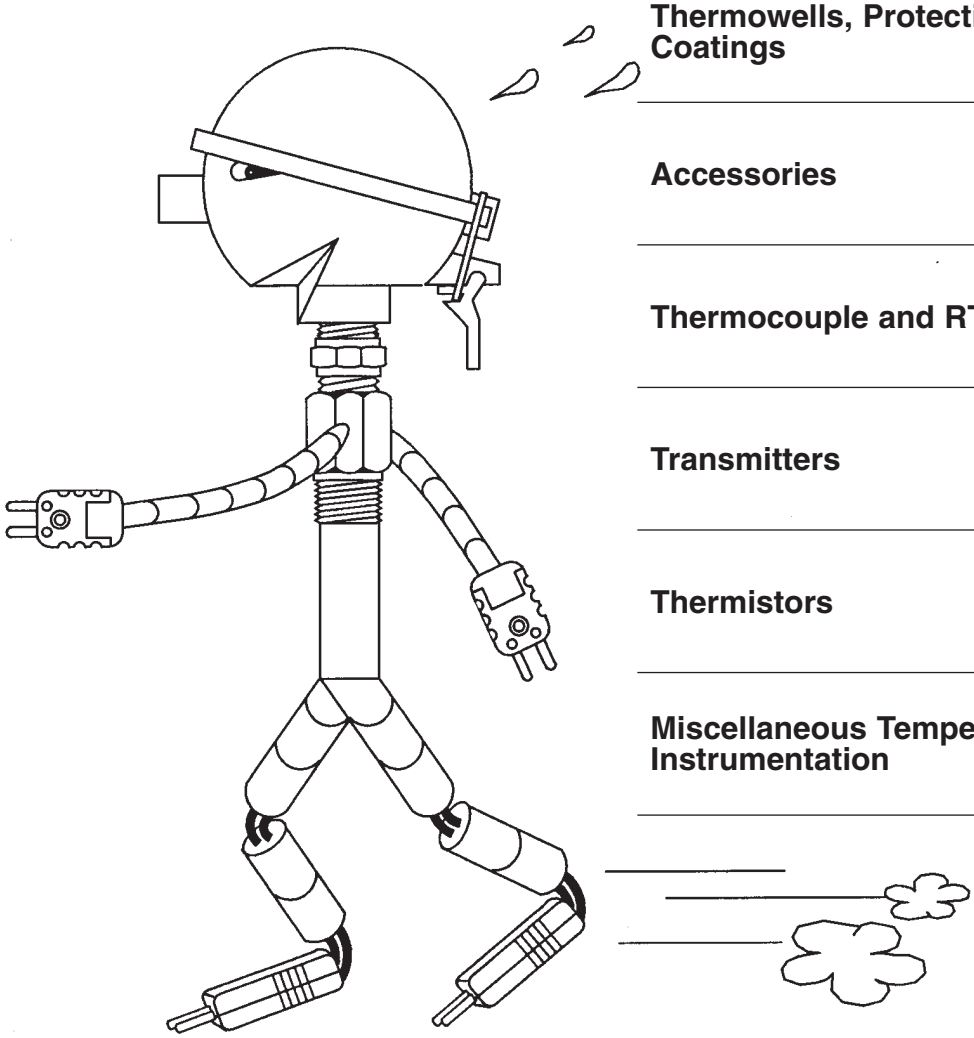
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Notes

1-800-873-1835

JMS Southeast, Inc.
Temperature Measurement

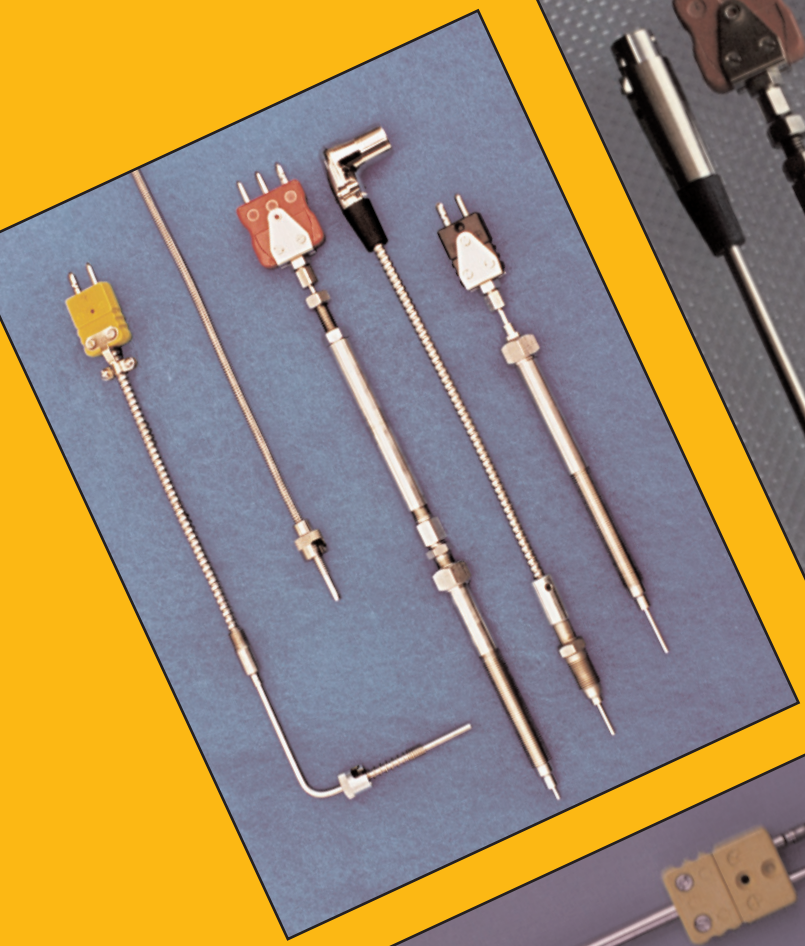




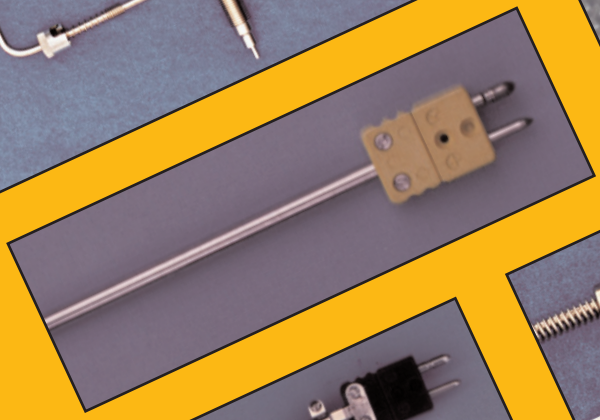
Plastics Sensors

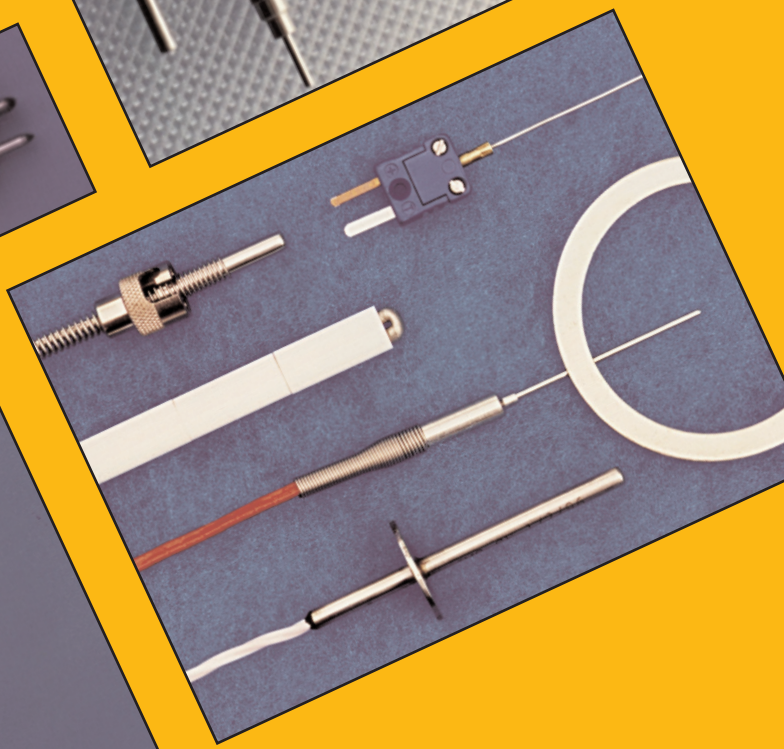














PLASTICS SENSORS

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NOTE: JMS Southeast, Inc. is a stocking distributor for electric heaters and controllers. Please call for any requirements.

PLASTICS SENSORS

BAYONET TEMPERATURE SENSORS

Bayonet style attachments are the most common in Plastics Processing. JMS has adapted this useful and safe design to other industrial sensors to utilize the best features of both.

Our standard design and most commonly used is the Adjustable Bayonet attachment device which incorporates a chrome plated brass cap with a 303 stainless steel spring. The spring fits like chinese handcuffs around the appropriately sized sensor and remains in position until such a time as the user adjusts it. This enables the same sensor to be used for many different applications in the same facility. It also makes for lower inventory levels which your accountant will love.

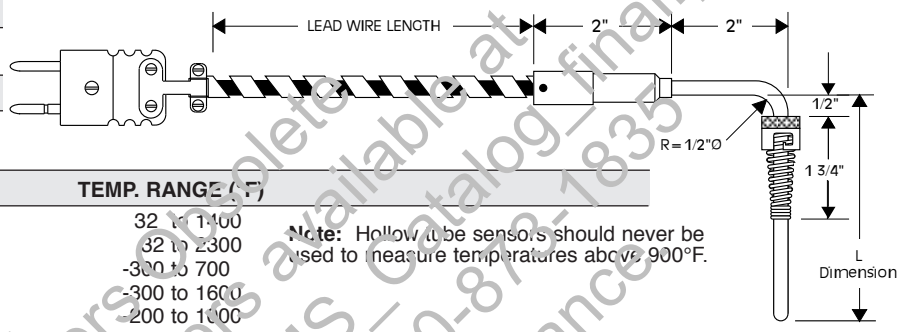
The other attachment devices we make for your sensors are standard in the industry. For those "Old Dogs" who refuse to try something innovative we still offer the fixed bayonet design. The length of this sensor cannot be changed and will only go in the hole it was specifically built to fit.

#1	SERIES
2	Plastics Sensors

#2	DESIGN [8]
M	MgO insulated (**SWAGED**)
H	Hollow tube

#3	TYPE	TEMP. RANGE (°F)
J	Iron/Constantan	32 to 1400
K	Chromel/Alumel	32 to 2300
T	Copper/Constantan	-300 to 700
E	Chromel/Constantan	-300 to 1600
3	100Ω Platinum RTD (.00385 alpha, 3 wire)	-200 to 1000
X	Other, specify	

Note: Hollow tube sensors should never be used to measure temperatures above 900°F.



ADJUSTABLE BAYONET

#4	OUTSIDE DIAMETER
C	3/16" (.188")
D	1/8" (.125")
B	1/4" (.250") (**SWAGED** only)
X	Other, specify

Note: 304 SS standard sheath material.

#5	LIMITS OF ERROR	ELEMENT CONSTRUCTION
1	Standard	Single
2	Standard	Dual
3	Special	Single
4	Special	Dual
X	Other, specify	

Special limits RTD's are JMS Class A tolerance (page 3-8)

#6	CONSTRUCTION
S	Straight
4	45° bend
9	90° bend
X	Specify bend

Note: 1/2" radius bends are standard. Other radius may be specified but they may deform the diameter of the tube at the bend.

[ ]BRACKETS INDICATE PAGE NUMBERS ON WEB OR FULL CATALOG FOR ADDITIONAL TECHNICAL INFORMATION WWW.JMS-SE.COM

SWAGED ONLY

#7	MAXIMUM TEMPERATURE AT WHICH TIP WILL BE EXPOSED	
A	<100°C (212°F)	=2 PVC*
B	<200°C (392°F)	=3 Teflon*
C	<285°C (550°F)	=5 Kapton*
D	<482°C (900°F)	=1 Fiberglass*
E	<705°C (1300°F)	=4 HT Fiberglass*
F	>705°C (1300°F)	=7 Bare ends (heat shrink)*

*If no transition (Z) is in symbol 13, we recommend these corresponding selections for primary wire insulation on hollow tube sensors.

#8	MEASURING JUNCTION [9]
G	Grounded
U	Ungrounded (RTD's are always ungrounded)
I	Isolated
E	Exposed
X	Other, specify

Note: See appropriate drawing on page 2-1 & 2-2 before you specify the immersion length.

#9	IMMERSION LENGTH (L)
--"	Length in inches

2	M	J	D	1	S	B	G	3"	

Part Numbers Complete at http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
Current Part Numbers available at http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-876-1835 for fast and friendly assistance

PLASTICS SENSORS

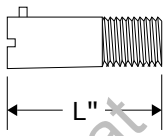
#10	ATTACHING DEVICES
J	Adjustable bayonet (**Standard**)
F	Fixed bayonet
P	Brass compression fitting 1/8" NPT
N	Non-Immersion nozzle
M	Nozzle melt
Z	N/A

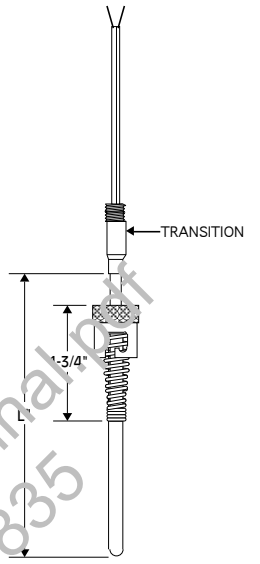
Use "0" in symbol #9 for standard length. (See drawings on this page.)

X	Other, specify

Note: Non-fixed fittings do not affect the immersion length.

#11		ADAPTER TYPE		
1/8" NPT	3/8" x 24	NICKEL PLATED STEEL SLOT HEAD MOUNTING ADAPTER (FOR BAYONET ONLY)		
Z	Z	No adapter required	K	1/4" NPT X 1 1/4" long for 1/4" bayonet
A	E	7/8" overall length		
B	F	1 1/2" overall length		
C	G	2 1/2" overall length		
D	J	3 1/2" overall length		
X	X	Other, specify		





ADJUSTABLE BAYONET
(Top of cap is usually positioned 1/2" from transition at factory)

#12	LEAD WIRE TYPE & LENGTH IN INCHES	T/C	RTD
Z	No lead wires	20 awg	24 awg
1 __"	Glass braid	20 awg	24 awg
3 __"	FEP teflon	20 awg	24 awg
6 __"	Glass braid / flex armor overall	20 awg	24 awg
7 __"	Teflon / flex armor overall	20 awg	24 awg
8 __"	Glass braid / stainless steel overbraid	20 awg	24 awg
X __"	Other, specify		

Note: 24 awg wire or smaller may be used if necessary.

#13	TYPE OF TRANSITION [1-16]
H	Heat shrink
S	Size on size
T	3/8" OD (**Standard**)
R	1/4" OD
X	Other, specify
Z	No transition
C	Cuttable design (No crimp at end of tube / nylon insert)

Note: For high humidity / moisture environments ≤500˚ F put a "2" after your selection.

For high temperature at the transition area use an X + type of transition and maximum temperature.

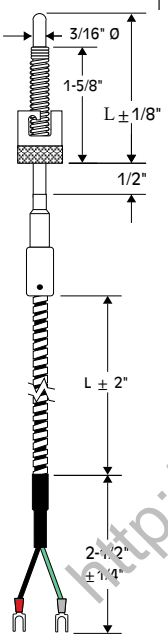
Note: When "Z" no transition is specified for a hollow tube sensor, the extension lead is crimped to the tube.

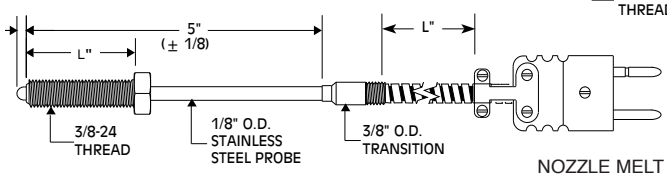
#14	COLD END TERMINATION (SECT 6, CHOOSE AS MANY AS APPLICABLE
A	Bare ends
B	Miniature plug (6A1B2)
C	Standard plug (6A1C2)
D	Miniature jack
E	Standard jack
F	High temperature plug (< 800˚ F)
G	High temperature jack (< 800˚ F)
I	Explosion proof Nema 7 head (6I / 6PT)
K	Spade lugs (6SL)
L	Aluminum head w/ hinged cover (6L / 6B4)
M	Aluminum head w/ screw cover & chain (6M / 6B4)
N	Cast iron head w/ screw cover & chain (6N / 6B4)
O	Open ceramic terminal block (6N)
Q	Black nylon Nema 4 head (6Q / 6B4)
R	High dome head (6R)
V	Hermetic connector (6DC) - Male
W	Microphone style connector (6DA) - Male
X	Other, specify

Note: For any other cold end terminations, use symbol X and descide using appropriate part numbers from section 6 in place of symbol #14.

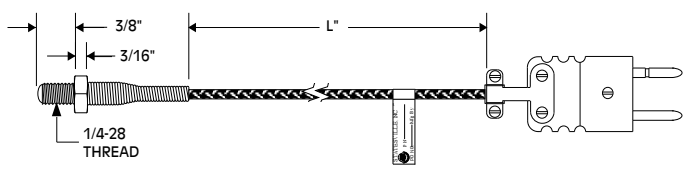
#15	TAGGING AND CALIBRATION OPTIONS (USE ONLY IF APPLICABLE)
-----	See page 1-2 #14 for ordering selections.

FIXED BAYONET





NOZZLE MELT



NON-IMMERSION NOZZLE

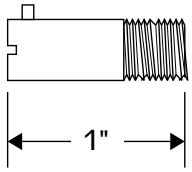
J	A	6 (36")	T	C		

Part Numbers Obsolete
Current Part Numbers available at
http://www.jinsse.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
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BAYONET ACCESSORIES

NICKEL PLATED STEEL SLOT HEAD ADAPTERS

SYMBOL			LENGTH
1/8" NPT	3/8"-24	1/4"NPT	
2A	2E		7/8" overall length
2A1	----	6BA	1 1/4" overall length
2B	2F		1 1/2"overall length
2C	2G		2 1/2" overall length
2D	2J		3 1/2" overall length



NOTE: To order adapters of different lengths, use 2A + X for 1/8" NPT and 2E + X for 3/8"-24 threads. You must specify length.

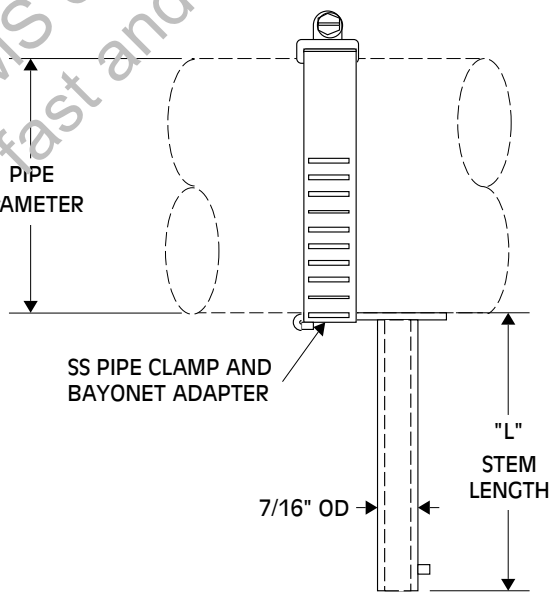
STAINLESS STEEL PIPE CLAMP ADAPTERS

#1	SERIES
2C	Pipe clamp bayonet adapter

#2	"L" LENGTH OF STEM IN INCHES
R	1 3/4"
S	3 3/4"
T	8 3/4"
X	Other, specify

#3	BAND CLAMP DIAMETER (INCHES) MIN.	MAX.	STANDARD PIPE SIZE (INCHES)
1	7/16	25/32	1/4 to 3/8
2	1 1/16	1 1/4	1/2 to 3/4
3	1 1/6	2	1 to 1 1/2
4	2 1/16	3	2 to 2 1/2
5	3 15/16	4 1/4	3 to 3 1/2
6	3 9/16	4 1/2	4
7	5 1/8	6	5
8	6 1/8	7	6

Note: "L" = Length of stem. Should be equal to the maximum insulation thickness + 3/4". The bayonet sensor length should be "L" + 3/4".



2C	S	3	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-973-1835
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PLASTIC MELT SENSORS

Plastic melt thermocouples and RTD's can fit directly into the melt stream of extruder heads. They can be used to control melt temperature gradients within the melt stream, to monitor incoming melt temperatures, or to achieve control of nozzle and nozzle manifold temperatures. All plastic melt bolts are Stainless Steel. The bolt tips are back filled with a ceramic insulator. The probe is .125" O.D.

#1	SERIES
2P	Plastic Melt Sensor

#2	STYLE [2-6]
4	*Bolt with 1 1/2" bendable metal extension and plug
5	Bolt with direct mount plug
6	**Bolt with 24" of kapton insulated wire with flexible armor and plug
X	Other, specify

*Tubular extension between bolt and plug can be formed by hand at application site to any desired angle. If a longer metal extension from hex to plug connection is required, use X and specify length desired.
Example: 2PXJ13BGP X=4-6"

**If a length other than 24" of flex armor is required, use X and specify length desired.
Example: 2PXJ13BCP X=6-36"

#3	SENSOR TYPE [1-1, 3-3]
J	Iron/Constantan, standard limits of error
A	100Ω Platinum RTD .00385 alpha (3 wire) ±.12 % accuracy - Thin film is **Standard**.
X	Other, specify

#4	LIMITS OF ERROR	ELEMENT CONSTRUCTION
1	Standard	Single
2	Standard	Dual
3	Special	Single
4	Special	Dual
X	Other, specify	

#5	BOLT LENGTH (B) [6]
3	3"
6	6"
X	Other, specify

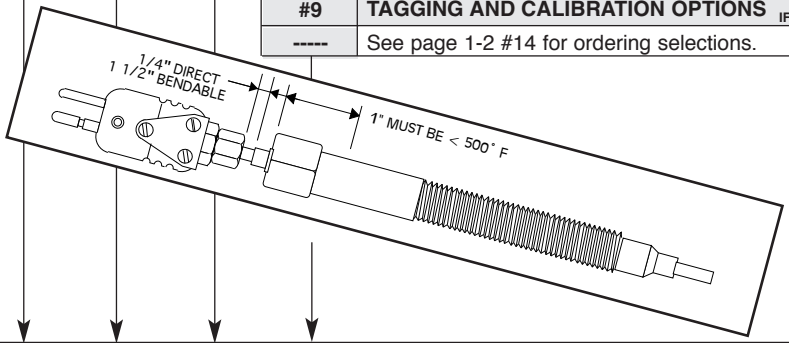
#6	IMMERSION (I) [6]
A	Flush
B	1/2" Immersion
C	1" Immersion
X	Other, specify

#7	MEASURING JUNCTION [9]
G	Grounded
U	Ungrounded (RTD's are always ungrounded)
E	Exposed
I	Isolated
X	Other, specify

For special wetted parts facing, use X + description.
i.e. X=Grounded + Hastalloy facing

#8	MAXIMUM SERVICE TEMPERATURE
P	Below 500°F
Q	500°F - 900°F

#9	TAGGING AND CALIBRATION OPTIONS (USE ONLY IF APPLICABLE)
-----	See page 1-2 #14 for ordering selections.



2P	5	J	1	6	B	G	P		

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

ADJUSTABLE PLASTIC MELT SENSORS

Adjustable plastic melt sensors can be used to measure temperature gradients in melt streams. This design gives you the ability to have an adjustable immersion depth during full operation at maximum flow rates and pressure.

The length of the measuring junction is controlled by adjusting the setting of the knurled adjusting screw.

The probe should be adjusted to flush prior to melt cool down to eliminate probe breakage on start up.

This design also eliminates melt stream barriers and turbulence that could affect product quality.

It is used to profile dimensional stream temperature variations.

SPECIFICATIONS:

304 SS sheath, .125" O.D. Maximum temperature rating is 900°F. Pressure rating is 15,000 PSI.

TO INSTALL PROBE:

1) Use wrench only on hex closest to hot end.
2) Use fingers to adjust depth and lock nut.
3) **Do not use wrench on any part of assembly when machine is hot or under pressure.**

#1	SERIES
27	Adjustable plastic melt sensor

#2	SENSOR TYPE [3-3]
J	Iron/Constantan
3	100Ω Platinum, .00385 alpha, RTD (3 wire)
X	Other, specify

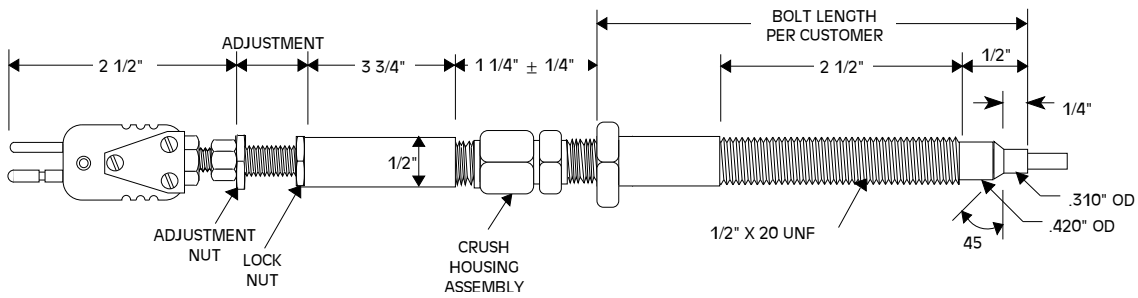
#3	BOLT LENGTH
3	3" Bolt
5	5" Bolt
7	7" Bolt
X	Other, specify

#4	IMMERSION JUNCTION [9]
A	1/8" - 1"
B	1/8" - 2 1/2"
X	Other, specify

#5	MEASURING JUNCTION
G	Grounded (Standard)
U	Ungrounded (RTD'S are always ungrounded)
E	Exposed (Recommended for profiling)
I	Isolated
X	Other, specify

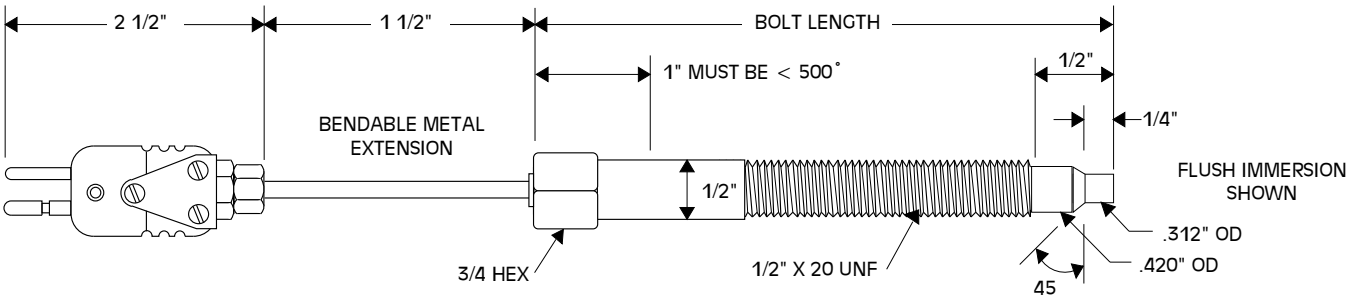
#6	MAXIMUM SERVICE TEMPERATURE
P	Below 500°F
Q	500°F - 900°F

#7	TAGGING AND CALIBRATION OPTIONS (USE ONLY IF APPLICABLE)
—	See page 1-2 #14 for ordering selections.

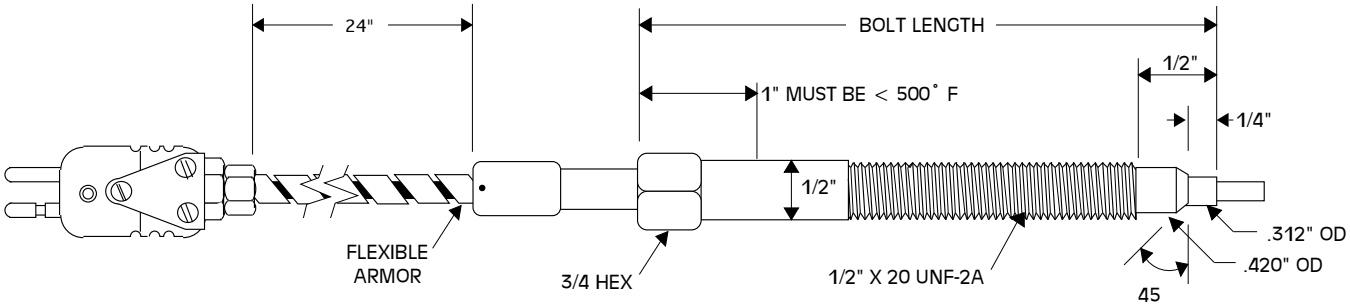


27	J	5	B	G	P		

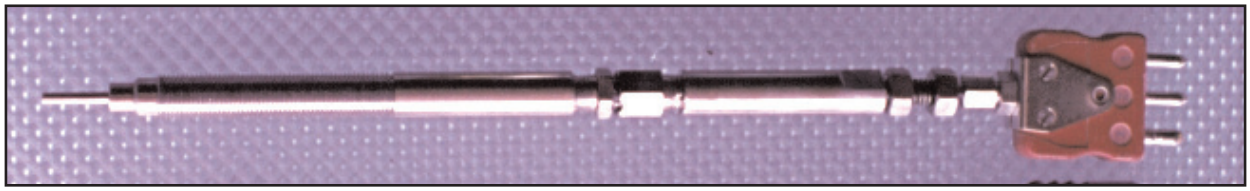
Part Numbers Obsolete
Current Part Numbers available at
http://www.jmsse.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.



BOLT WITH 1 1/2” BENDABLE METAL EXTENSION AND FLUSH IMMERSION



BOLT WITH 24” FLEXIBLE ARMOR AND 1/2” IMMERSION



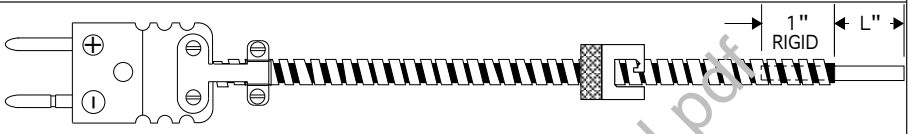
ADJUSTABLE PLASTIC MELT SENSOR

FLEX-ARMOR ADJUSTABLE DEPTH SENSOR

The flexible armor adjustable depth sensor allows adjustable immersion and spring loading in the field by simply moving the bayonet cap up and down the flexible armor. The construction is a hollow-tube design using 20 gauge or smaller fiberglass insulated wire inserted into the 1/8" or 3/16" tubing or flex armor. The flex armor is also rigid for the first 1" past the tip or hot end. Thermocouples have a flush immersion. The picture below shows a variation of this thermocouple. Good for dry temperatures between 55˚F up to 900°F.

#1	SERIES
2K	Flexible armor adjustable depth sensor

#2	SENSOR TYPE
J	Iron/Constantan (Standard)
K	Chromel/Alumel
T	Copper/Constantan
E	Chromel/Constantan
3	100Ω Platinum RTD (.00385 alpha, ±.12 %Ω @ 0°C, 3 wire)
X	Other, specify



#3	DIAMETER OF FLEX	
1	.125 ID	.210" OD.
2	.188 ID (Standard)	.270" OD.

#4	TUBE LENGTH
__" Z	Length in inches Flush - no tube (Standard)

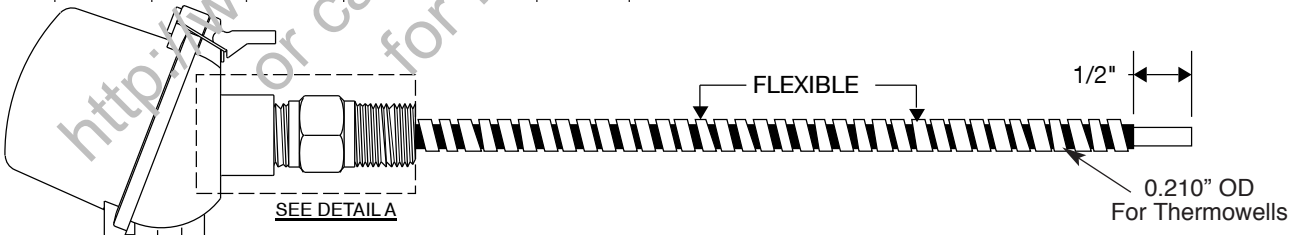
#5	JUNCTION
G	Grounded (Standard)
U	Ungrounded - (RTDs are always ungrounded)

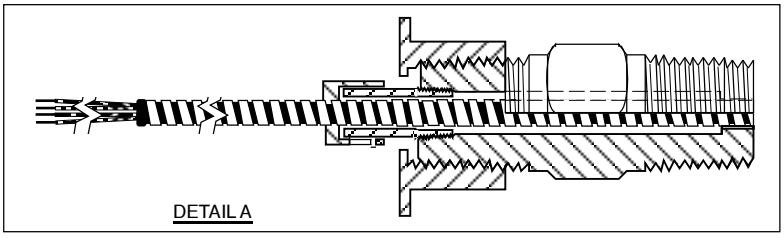
#6	LEAD WIRE LENGTH
48"	Length in inches
60"	(Stainless Steel armor)
X	Other, specify

#7	COLD END TERMINATION	
A	Bare ends (Standard)	
C	Standard plug	
E	Standard jack	
I	Explosion proof head, 3/4" x 3/4" connection with fitting	Use symbol #1 in item #3
R	High dome, general purpose head with hinged cover, 1/2" x 1/2" connection with fitting	
K	Spade lugs (compensated)	
T	Junction box connector	
X	Other, specify	

Note: If bayonet adapter is needed for mounting, see pg. 2-3.

#8	TAGGING AND CALIBRATION OPTIONS (USE ONLY IF APPLICABLE)
-----	See page 1-2 #14 for ordering selections.





2K	J	2	Z	G	60"	T		

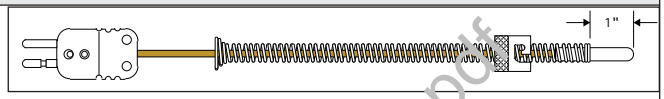
Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS direct at 1-800-873-1835
for fast and friendly assistance.

SPRING ADJUSTABLE DEPTH SENSOR

The JMS Southeast spring adjustable sensor allows adjustable immersion in the field by moving the bayonet cap up and down the 12" spring. The construction is a hollow-tube design. Single element wire is 20 awg solid and dual element may be smaller to accommodate the tubing diameter. The wires are fiberglass insulated with stainless steel overbraid inserted into a .188" Ø tubing. (Available in .188" Ø only) The tube length immersion is 1". This design is good for dry temperatures between 55° F up to 900° F.

#1	SERIES
2Q	Spring adjustable depth bayonet sensor

#2	SENSOR TYPE
J	Iron/Constantan (**Standard**)
K	Chromel/Alumel
T	Copper/Constantan
E	Chromel/Constantan
3	100Ω Platinum RTD (.00385 alpha, ±.12 %Ω @ 0°C, 3 wire)
X	Other, specify



#3	LEAD WIRE LENGTH
48"	Length in inches
60"	(Measured from front of spring to back of cable clamp.)
X	Other, specify

#4	JUNCTION
G	Grounded (**Standard**)
U	Ungrounded - (RTDs are always ungrounded)

#5	COLD END TERMINATION [6 7]
A	Bare ends (**Standard**)
C	Standard plug
E	Standard jack
K	Spade lugs (compensated)
T	Junction box connector
X	Other, specify

Note: If bayonet adapter is required, see pg. 2-3.

#6	TAGGING AND CALIBRATION OPTIONS (USE ONLY IF APPLICABLE)
- - -	See page 1-2 #14 for ordering selections.

2Q	J	60"	G	C		

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

MgO VS HOLLOW TUBE

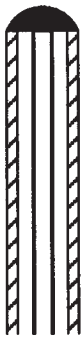
Bayonet thermocouples can be constructed with magnesium oxide sheath material of .125" or .188" O.D. Hollow tube units are made with lead wires inserted in tubing of .125" or .188" outer diameter. The magnesium oxide insulation is a dry, uncontaminated compacted ceramic powder. The MgO gives the thermocouple high insulation resistance and dielectric strength. Also, it allows excellent insulation of the positive and negative wire conductors in relation to each other and to the outer sheath. Among the outstanding features of sheath material are: (A) flexibility to bend or form to twice the radius of the sheath diameter, (B) its rigidity to maintain size and shape after bending or straightening, (C) vibration or shock has no effect on the material, (D) sheath material withstands pressures upward to 50,000 psi, and (E) sheath material may be used in applications where temperatures may range from -400° to 3000°f depending on requirements and selection of materials.

INSULATOR	PURITY %	MELTING POINT °C	MELTING POINT °F	USABLE TEMP. °C	USABLE TEMP. °F
MAGNESIA (MGO)	96.4% (std) 99.4% (must specify) 99.8% (must specify)	2790	5050	1650	3000

New insulation materials are being developed. Use an X and describe to specify.

The hollow-tube design is used for disposable thermocouples that can be replaced easily. Their life is about half of that of a magnesium oxide insulated thermocouple. The advantage of a hollow-tube design is the cost. It is the least expensive design, for the short run.

MEASURING JUNCTION

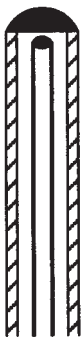


GROUNDED JUNCTION

The **grounded** thermocouple junction is an integral part of the thermocouple sheath tip.

Advantages:
- fast response time in relation to ungrounded and isolated junctions.
- protects the wires from environmental chemicals and corrosives.
- prolongs the operational life of the thermocouple. Longer lifespan than the exposed junction thermocouple.
- it is recommended for high pressure applications.
- it is the least expensive construction.

Disadvantages:
- thermal expansion of sheath material may differ from element to cause mechanical stress and work hardening of metals.
- ground loops may cause interference with instruments.
- faults in insulation are more difficult to detect.

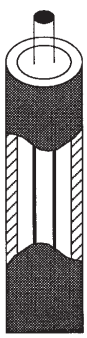


UNGROUNDED JUNCTION

The **ungrounded** thermocouple junction is electrically insulated and electrically isolated from the outer sheath material. In a dual ungrounded thermocouple, one common junction is electrically insulated from the outside sheath.

Advantages:
- the thermocouple junction is isolated from the ground.
- defects in the MgO insulation can be detected by measuring resistance from loop to sheath.
- long term drift under cycling conditions is minimized.

Disadvantages:
- response time is usually slower than grounded thermocouples.
- more expensive than grounded thermocouples.



EXPOSED JUNCTION

The **exposed** thermocouple junction extends beyond the protective metallic sheath.

Advantages:
- recommended for measurement of noncorrosive static gas, or air.
- very fast response time, faster than grounded junction.

Disadvantages:
- cannot be used in an environment with a high percentage of solids, high pressure, or flowing material since the junction is exposed to this environment.



ISOLATED JUNCTION

Isolated thermocouple junctions are used in a dual or triple thermocouple when the junctions are isolated from the outer sheath material as well as from each other.

Advantages:
- the two elements are insulated from ground.
- performs better than ungrounded or grounded junctions in a thermal cycling environment.

Disadvantages:
- slower response time than a grounded dual thermocouple.

* For tip sensitivity information, see pg. 3-8.

Please Note:

JMS Southeast has helped develop several new & innovative designs for measuring temperature in numerous sorts of plastic melt situations, from automatic profiling of nozzle melts to surface temperatures. Ask us & we'll refer you to the real experts in plastics extrusion & molding!

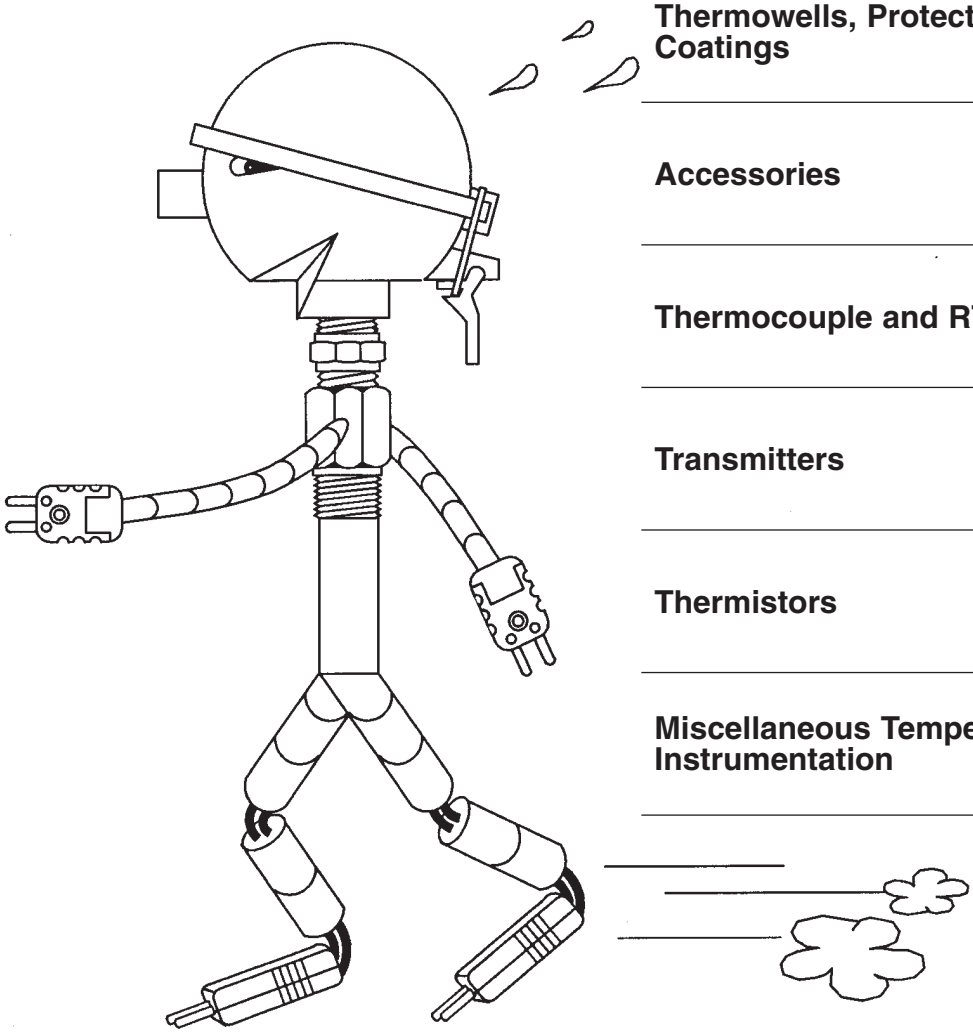
Notes

1-800-873-1835

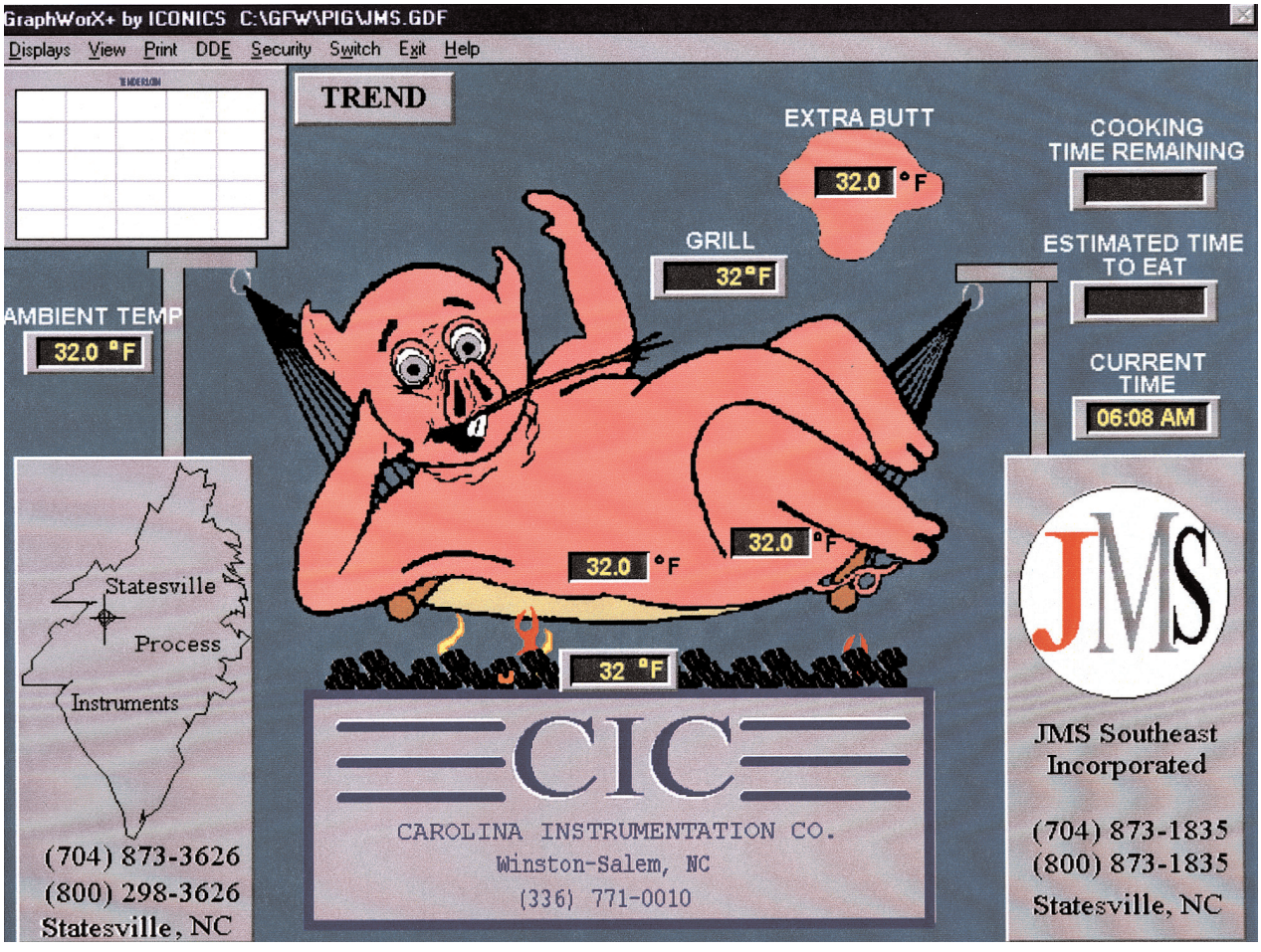
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Swifty Sensor




JMS Southeast, Inc.
Temperature Measurement
ISO 9001 Registered
UL
REGISTERED FIRM


GraphWorX+ by ICONICS C:\GFW\PIG\JMS.GDF
Displays View Print DDE Security Switch Exit Help
TREND
EXTRA BUTT
32.0 °F
COOKING TIME REMAINING
GRILL
32 °F
ESTIMATED TIME TO EAT
AMBIENT TEMP
32.0 °F
CURRENT TIME
06:08 AM
32.0 °F
32.0 °F
32 °F
Statesville
Process
Instruments
(704) 873-3626
(800) 298-3626
Statesville, NC
CIC
CAROLINA INSTRUMENTATION CO.
Winston-Salem, NC
(336) 771-0010
JMS
JMS Southeast Incorporated
(704) 873-1835
(800) 873-1835
Statesville, NC

JMS Southeast, Inc.
Temperature Measurement



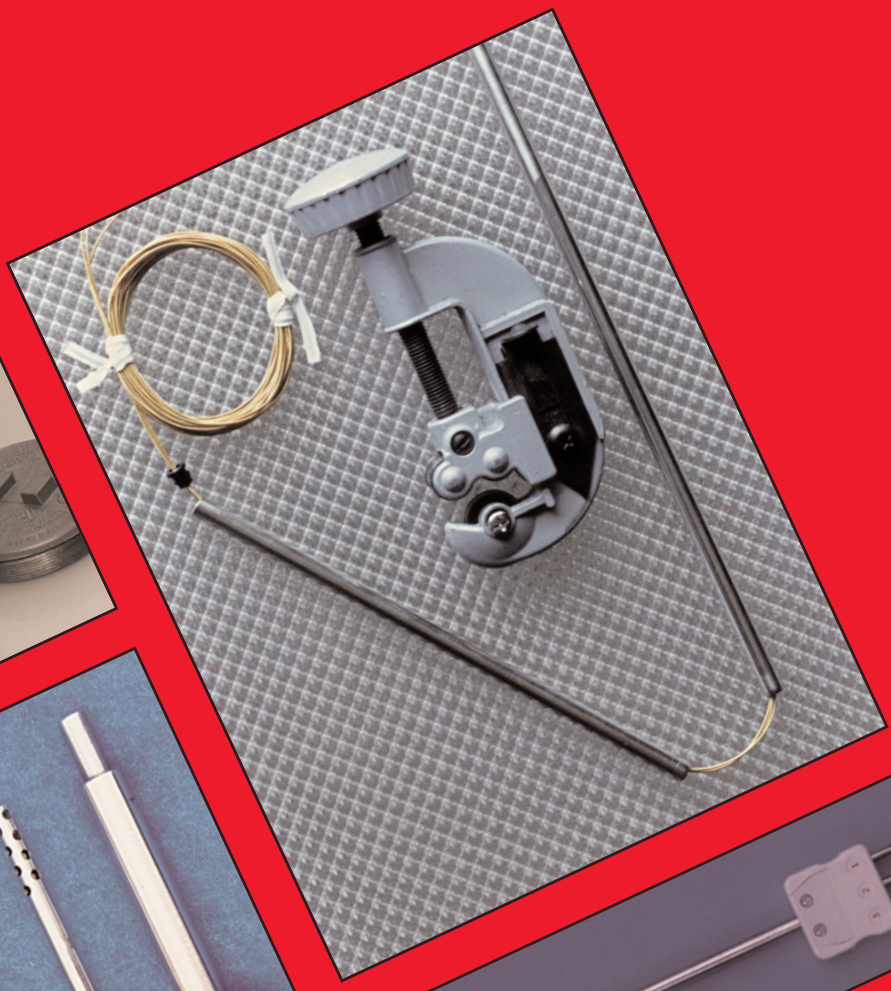
SECTION 3

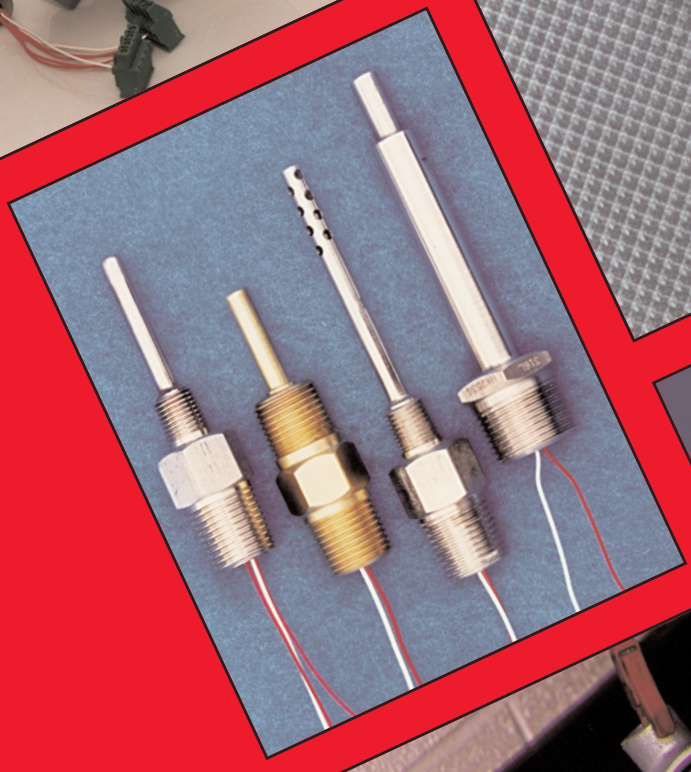
Resistance Temperature Devices

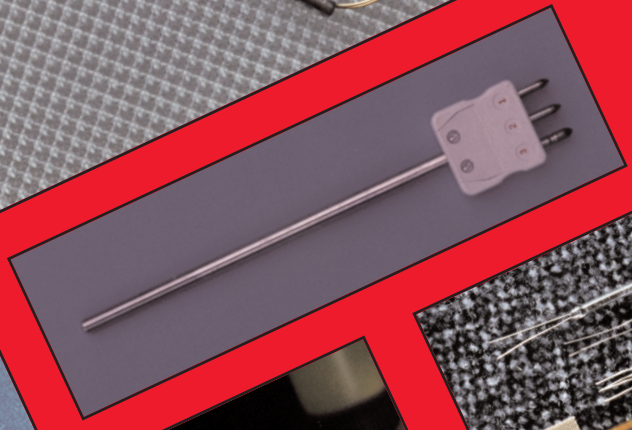




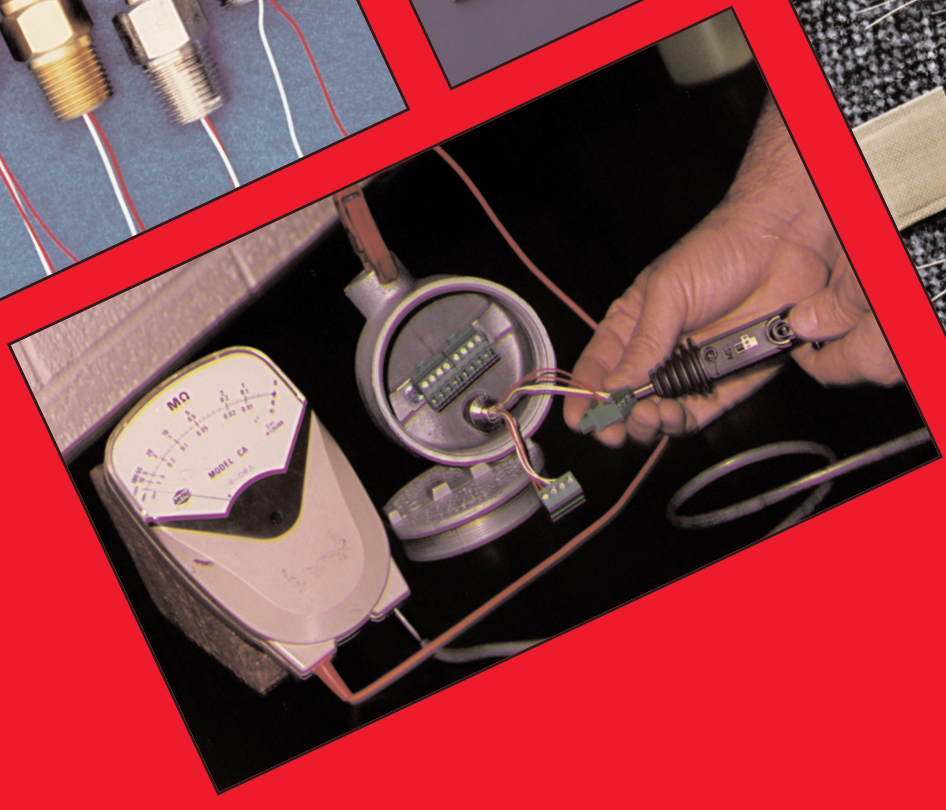











MΩ
MODEL CA

RESISTANCE TEMPERATURE DETECTORS

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Note: JMS Southeast, Inc. uses the new volt, ohm international standard approved by the National Institute of Standards and Technology (NIST) - formerly the National Bureau of Standards - to be effective 1/90.

RESISTANCE TEMPERATURE DEVICES (RTD'S)

#1	SERIES
3	RTD

#2 ELEMENT TYPE [4, 9, 10, 11, 15, 18, 22] Platinum 0.00385 alpha (Ω/Ω/°C)

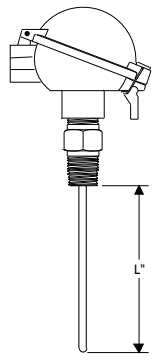
	Resistor Accuracy at 0°C	Thermometer Class [Table 3, page 3-18]	Resistor Class [Table 1 & 2, page 3-18]
B	± 0.25° C (Competitor's Std)	B	≥ F 0.15
E	± 0.1° C (**JMS Standard**)	A	≥ F 0.1
P	± 0.06° C *	AA	≥ 1/2 W 0.1
S	± 0.01° C (Best Accuracy *)	1/4 AA	≥ 1/10 W 0.1
X	Other, specify [3-22]		

* For best results, use a 4 wire RTD for high accuracy (types P & S).

#3 ELEMENT CONSTRUCTION [4] [3-11]

S	Single	Standard construction
D	Dual	Standard construction
J	Single	Swaged construction
K	Dual	Swaged construction
X	Other, specify	

Note: Use swaged for high temperature, bendability, high vibration and/or longer than 6 ft.



#4 TUBE DIAMETER - *MUST CHOOSE 1 FROM EACH COLUMN* [5-20, 1-13]

A	3/8" (.375")	N	Normal, closed tip (**Standard**)
B	1/4" (.250")	*K	Pointed tip, ungrounded
C	3/16" (.188")	*M	Weld pad, ungrounded
D	1/8" (.125")	*Q	Weld pad, removable ungrounded
X	Other, specify	*R	Gas/Air, exposed
Z	N/A	*W	Enlarged tip, ungrounded
		*Y	Reduced tip, ungrounded
		Q	Cuttable (*See full catalog)

***Note:** When selecting these options, a description must be provided.

#5 TUBE MATERIAL [11, 12]

K	316 Stainless Steel
L	316 LSS
M	I-600 (Use if symbol #7 >500°F)
C	Teflon Coated SS
X	Other, specify

For fixed fittings and types S, C,B, D & N (symbol #8) this length normally equals the "A" dimension if a thermowell is used. (See Section 5)

#6 LENGTH (Z) (See sketches on Pg. 3-1, 2, & 3 for L")

" Immersion length in inches

#7 MAX. TEMPERATURE AT WHICH TIP WILL BE EXPOSED [4, 8, 9,11, 12]

A	0°C (32°F)	=5 Kapton*
B	<200°C (392°F)	=3 Teflon*
C	<285°C (550°F)	=5 Kapton*
D	<350°C (662°F)	=1 Fiberglass*
E	<661°C (1222°F)	=4 HT Fiberglass*

*If no transition (Z) is in symbol 13, we recommend these corresponding selections for primary wire insulation in symbol 10.

#8 STANDARD INDUSTRIAL ATTACHING DEVICE [SECTION 6]

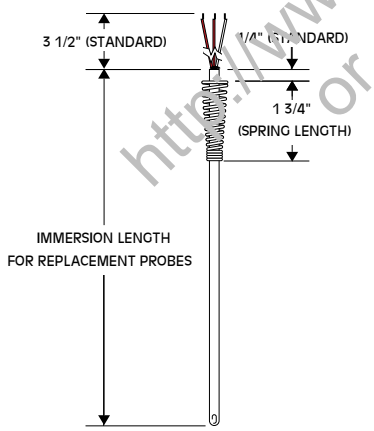
W	Fixed NPT ss fitting - double threaded
S	Spring-loaded NPT SS fitting - double threaded
C	Spring-loaded NPT SS fitting w/ oil ring - double threaded
D	Spring-loaded ss fitting - single threaded
B	Bayonet spring loaded assembly for thermowells & heads
*E	Adjustable spring over .250", .188", .125" sheath
F	Reverse mounted steel plug fixed for attaching head
G	Fixed stainless steel to sheath
*H	Compression fitting ss w/ ss ferrule
*I	Compression fitting ss w/ teflon ferrule
*J	Compression fitting ss w/ lava ferrule
*K	Compression fitting ss w/ nylon ferrule
*L	Compression fitting brass w/ brass ferrule
N4	4" Nipple-Union-Nipple (NUN4G1)
N6	6" Nipple-Union-Nipple (NUN6G1)
S4	4" Spring-Loaded-Union-Nipple (NU4G1)
S6	6" Spring-Loaded-Union-Nipple (NU6G1)
X	Other, specify or if more than 1 is needed
Z	N/A (No fitting needed)

For materials other than SS, (ex: brass, carbon steel, etc.) Use X + material + letter designation

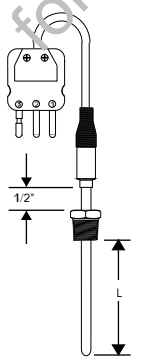
(See page 1-3) FOR MORE NIPPLE OPTIONS.

*** Length is calculated without consideration of these attaching device. (See dwg on pg. 3-2)**

[ ]BRACKETS INDICATE PAGE NUMBERS ON WEB OR FULL CATALOG FOR ADDITIONAL TECHNICAL INFORMATION WWW.JMS-SE.COM



Immersion for Symbol #8-E



Immersion for Symbol #8-G & D

3	E	S	B	K	12"	B	W	

Part Numbers Obsolete
Current Part Numbers Available at
http://www.jms-se.com/pdf/JMS_catalog_final.pdf
or call JMS directly at 1-800-345-4835
for fast and friendly assistance.

RESISTANCE TEMPERATURE DEVICES (RTD'S)

#9 PROCESS NPT [1-3]

L	1/8"
M	1/4"
P	1/2" (**Standard** w/ symbols W, S, & C above)
O	3/4"
X	Other, specify
Z	N/A

#10 LEAD WIRE TYPE & LENGTH IN INCHES [SEE SECTION 7]

1__"	Fiberglass braid	6__	Bare wire (Standard for swaged leads under 12")
2__"	PVC	X__"	Other, specify
3__"	Teflon (**Standard**)	Z	N/A
4__"	Hi-temp glass braid		
5__"	Kapton		

NOTE:
All wire will be 24 awg in tubes > 1/8" OD.
Smaller tubes will have a max. of 28 awg.
If no transition or armor is specified, wire may be fragile.
JMS standard wire tube for RTD's is Stranded Plated Copper.

#11 ARMOR OR HEAT SHRINK / JACKET [7-7]

A	3/16" ID SS flex armor (**Standard**)	G	Heat shrink / sleeving
B	3/16" ID SS flex armor PVC coated white	H	Jacket to match primary insulation
C	3/16" ID SS flex armor PVC coated black	J	Aluminum mylar shielded and jacketed to match primary insulation
D	1/8" ID SS flex armor	Z	N/A
F	SS overbraid	X	Other, specify

#12 WIRE CONFIGURATION [17, 18]

T	2 Wire
Y	3 Wire
W	4 Wire

Note: Use a double symbol for 2 separate lead wires if dual elements. i.e. TT.

#13 TYPE OF TRANSITION [14]

H	Heat shrink
S	Size on size
T	3/8" OD
R	1/4" OD
X	Other, specify
Z	No transition

Note: For extra high humidity / moisture environments, ≤ 500˚ F put a "2" after your selection.

For high temperature at the transition area use an X + type of transition and maximum temperature. >500˚ F

#14 COLD END TERMINATION [SEE SECTION 6] Pick as many as applicable

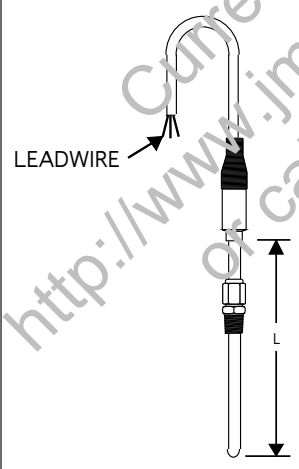
A	Bare ends
*B	Miniature plug
*C	Standard plug
**D	Miniature jack
**E	Standard jack
F	High temperature plug (< 800˚ F)
G	High temperature jack (< 800˚ F)
I	Explosion proof Nema 7 head (6I / 6PT)
K	Spade lugs (SSL)
L	Aluminum head w/ hinged cover (6L / 6B4)
M	Aluminum head w/ screw cover & chain (6M / 6B4)
N	Cast iron head w/ screw cover (6N / 6B4)
O	Open terminal block (6M)
Q	Black nylon Nema 4 head (6Q / 6B4)
R	High dome head (6R)
V*	Hermetic connector (6DC) - Male
W*	Microphone style connector (6DA) - Male

8H	Isolated Transmitter
8N	Non Isolated Transmitter
8S	AI-1500
8I	TempIR with Hart Protocol
8E	Intrinsically Safe TempIR
8D	TempIR/Hart/Intrinsically Safe
X	Other, specify

*Use double sysmbol here for matching female connector. i.e. b/bb (male with matching female)

**We do not advise using these connectors for RTD's

Note: For any other cold end termination, use appropriate part numbers from section 6 in place of symbol #14.



Immersion is overall length of tube for non-fixed attaching devices

#15 OPTIONS USE ONLY IF APPLICABLE [INTRODUCTION]

TAGGING

1	Stainless steel tag
2	Plastic tag
3	Paper tag
4	Electroetch on probe **Note:** You must always specify information required on tag

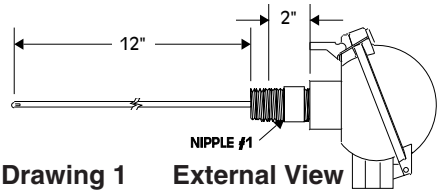
CALIBRATION

5	Calibrate at specified point(s). Corrections data will be provided for each point.
6	Calibrate specified temperature range. Corrections data will be provided for all temperatures within the range. **Note:** You must specify increments & range. Ex. 0 to 300°F, 0.1° increments
7	CE Marking [PAGE XV]
8	Bar Code
Z	N/A

P	3-36"	A	Y	T	A		

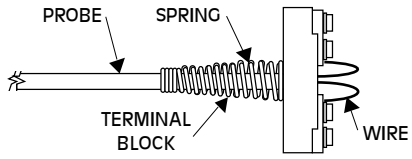
Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-876-1835
for fast and friendly assistance.

NIPPLE-UNION-NIPPLE EXTENSION ASSEMBLIES

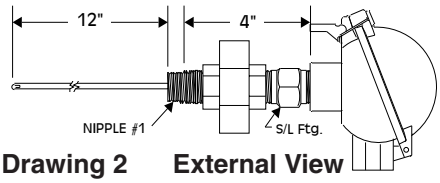


Drawing 1 External View

Drawing 1 - Nipple Only
Minimum Nipple L=1"
Ex. Part#: 3ESBK12"CEXZZYZL
X = N2"G1

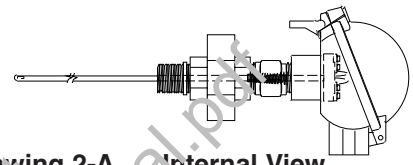


Direct Mounted Spring on Terminal Block

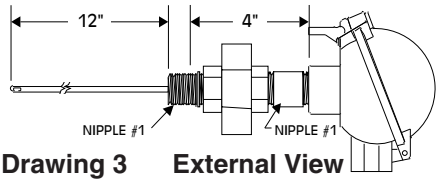


Drawing 2 External View

Drawing 2 - Nipple-Union with Machined 1/2" x 1/2" Spring Loaded Fitting
Minimum NU L=4" (includes S/L fitting)
Ex. Part#: 3ESBK12"CSXZZYZL
X = NU6"G1

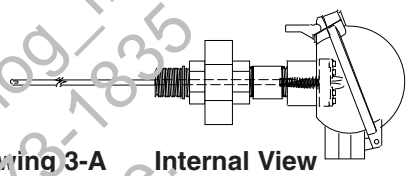


Drawing 2-A Internal View



Drawing 3 External View

Drawing 3 - Nipple-Union-Nipple with Spring Against Terminal Block
Minimum NUN L=4"
EX. Part#: 3ESBK12"CEXZZYZL
X = NUN6"G1



Drawing 3-A Internal View

An extension assembly may be needed to provide extra length for your RTD in order to extend your RTD head through insulation, or away from the heat of the process. This extension can include a pipe nipple only or a nipple-union-nipple or a nipple-union with a spring-loaded fitting from symbol #8 page 3-1.

Standard nipples and unions are 1/2" NPT and are available in galvanized or stainless steel. The union joins two nipples in an extension assembly and has a standard pressure rating of 150 pounds.

When a nipple-union-nipple or nipple only assembly is used and spring loading of the thermocouple element is required, there are two different methods of spring loading the sensor. The preferred method is to use the machined 1/2" by 1/2" NPT spring-loaded stainless steel fitting as one of the nipples (see symbol #8, S page 3-1). With this design, the probe is secured within the fitting and is mounted to the head in a rigid manner (see drawing #2 above). The appropriate part number for this assembly would be selected from symbols #8 (S) and #9 (X) from page 3-1 and 3-2, in addition to the symbols on this page. A cheaper method is a spring mounted over the probe and loaded against the bottom of the terminal block in the head. With this method the probe is not supported within the nipple-union-nipple. It is secured only by the wires into the terminal block. (See drawings 1 & 3 above). We do not recommend that you use this method of spring loading if your probe is mounted horizontally.

When a nipple-union-nipple is specified, the nipple and union closest to the head or cold end termination (drawing 2 & 3 above) is kept at an approximate length of 3 1/2". The length of the NUN is varied by the nipple length beyond the union on the probe end of the assembly.

For example, if a NUN 6" G is required, nipple #2 length would equal approximately 2 1/2".

When specifying this sensor extension, the nipple-union-nipple length tolerance is ± 1/2".

#1	EXTENSION ASSEMBLY
N	Nipple Only (Dwg #1)
NU	Nipple-Union (Dwg #2)
NUN	Nipple-Union-Nipple (Dwg #3)

#2	LENGTH
--"	Specify length in inches

#3	MATERIAL
G	Galvanized Steel
H	304 Stainless Steel
C	Black Steel

#4	PRESSURE RATING	
1	#150 - A351 spec (Standard)	ASTM
2	#3000 - A182 spec	
3	#6000 - A182 spec	
X	Other, specify	

NUN	6"	G	1

Part Numbers Obsolete
http://www.ims-se.com/pdf/IMS_Catalog_final.pdf
or call IMS directly at 1-800-878-1835
for fast and friendly assistance.

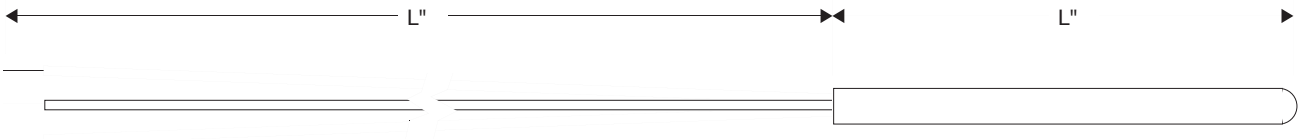
CUT TO LENGTH / UNIVERSAL RTD

JMS Southeast manufactures a cuttable resistance temperature detector that can be cut to 4” in length from a standard length of 24”. The design provides flexibility to the end user that enables him/her to order one RTD length for all applications. The standard universal RTD is the 100 ohm, .00385 ohm/ohm/C DIN, single element. The tubing is 316 stainless with an outside diameter of 1/4”. This unit is potted with high temperature cement and assembled with 48” of fiberglass lead-wire with no cold end termination. If a different fitting or longer leadwire is required, change these characters in the part number accordingly on pages 3-1 and 3-2. If the probe will be used at temperatures above 550°F change symbol “7” accordingly.

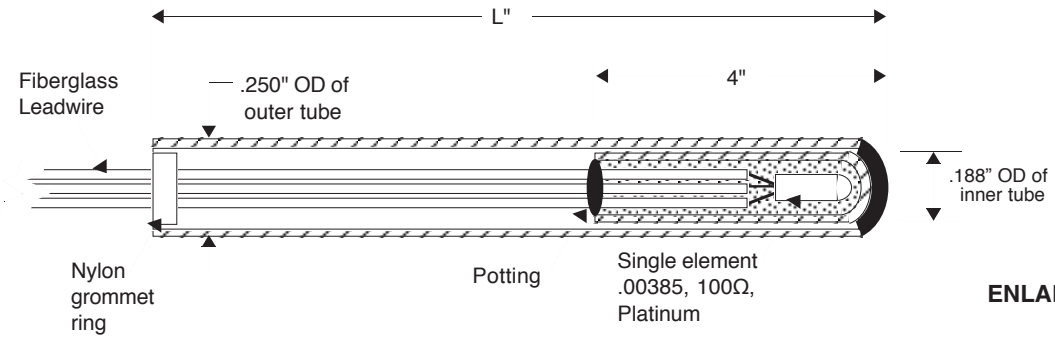
Feel free to call JMS for additional information. A typical JMS part number for this standard unit is as follows:

3ESQK24”DZZ1-48”ZYZA
[For Cuttable Thermocouples go to page 2-1 and 2-2]

Special note: Cuttable sensors may not provide the best accuracy over periods of time. They are not recommended for critical applications.



NOT TO SCALE



ENLARGED VIEW

HIGH TEMPERATURE RTD’S

JMS now offers an industrial RTD, capable of withstanding temperatures and vibration previously requiring a thermocouple. Manufactured using a special high temperature cable, the probe can be bent to a radius of twice its diameter.

Inconel 600 is primarily used for high temperature applications; while 316 stainless steel is available for situations where high vibration is the main concern. Solid leads of 24 awg. for the .188” diameter probes and 22 awg. for the .250” diameter probes match the temperature and vibration resistant qualities of this special design.

Following is a table outlining the available initial calibration specifications for this probe design. Ordering of these elements may be made on page 3-1.

Tube Material	Tube Diameters	Element Construction	Resistor Class
316 SS, Inconel 600	.188”	Single 3-wire, Single 4-wire Dual 3-wire	≥1/2 W 0.1
316 SS, Inconel 600	.250”	Single 3-wire, Dual 3-wire Single 4-wire	

AVERAGING RTD'S

Continuous averaging resistance temperature detectors are most frequently used in air washing and air handling systems where turbulent and stratified air flow may effect the temperature measurement in a tip sensitive probe. The average temperature of the air in the duct can be measured with this type of sensor.

Any application which requires an averaging of temperature across an area would be suited for this sensor type.

The operating temperature range for a continuous averaging RTD is from -100 to 400°F. The lower temperature and temperatures up to 500°F are handled with a multipoint design (4, 8, or 16 points).

Please contact JMS Southeast with any questions or application problems you may have.

#1	SERIES
3A	Averaging RTD

#2	Element Type 0.00385, IEC 751; 1983, 100Ω @ 0°C			
E	(-50˚ TO 275˚ F)	P16	Platinum 16 point, <900°F	**Note:** Call the JMS Engineering Department for information about averaging thermocouples, swamp boxes and special proprietary multipoint designs.
P4	Platinum 4 point, <900°F	X	Other, specify	
P8	Platinum 8 point, <900°F			

#3	TUBE DIAMETER		
B	1/4" (.250")	C	3/16" (.188")

#4	SENSING LENGTH
__"	In inches

#5	TUBE MATERIAL		
K	316 Stainless Steel	F	Copper

#6	TOTAL PROBE LENGTH
__"	Length in inches

#7	STANDARD INDUSTRIAL FITTINGS
W	Fixed NPT ss fitting - double threaded. Sheath diameters less than 3/16", fittings are brazed to sheath.
B	Bayonet spring loaded assembly for thermowells & heads
E	Reverse mounted steel plug fixed to sheath for attaching head
G	Fixed stainless steel to sheath
H	Compression fitting ss w/ ss ferrule } For all compression fittings except "6",immersion is overall length of the tube.
I	Compression fitting ss w/ teflon ferrule
J	Compression fitting ss w/ lava ferrule
K	Compression fitting ss w/ nylon ferrule
X	Other, specify
Z	N/A (No fitting needed)

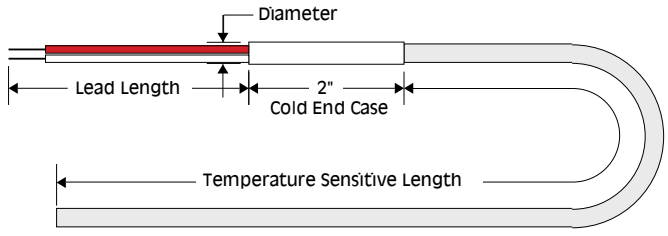
Note: To specify extensions such as nipples, unions, couplings, use X and see pg 3-3 for complete part #.

#8	PROCESS NPT		
L	1/8"	X	Other, specify
M	1/4"	Z	N/A
P	1/2"		

#9	LEAD WIRE TYPE & LENGTH IN INCHES [SEE SECTION 7]
1__"	Glass braid
3__"	Teflon
6__"	Glass braid / flex armor overall
7__"	Teflon / flexible armor overall
8__"	Glass braid / SS overbraid (3 wire only)
9__"	Three conductor teflon with overall jacket of teflon tape
10__"	Three conductor teflon / SS overbraid with overall jacket of teflon tape
X	Other, specify
Z	No leadwire

#10	WIRE CONFIGURATION		
T	2 Wire	W	4 Wire
Y	3 Wire	V	4 Wire (Compensating loop)

#11	MAX TEMP. OF TRANSITION	
P	< 500° F	**Note:** Q potting may not comply with ASTM megohm check.
Q	> 500° F	



3A	E	B	12"	K	18"	I	M	3-36"	Y	P	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS direct at 1-800-873-1835
for fast and friendly assistance.

AVERAGING RTD'S

#12	COLD END TERMINATION [SEE SECTION 6] Pick as many as applicable
A	Bare ends
**B	Miniature plug
**C	Standard plug
D	Miniature jack
E	Standard jack
F	High temperature plug (< 800˚ F)
G	High temperature jack (< 800˚ F)
I	Explosion proof Nema 7 head (6I / 6PT)
K	Spade lugs (6SL)
L	Aluminum head w/ hinged cover (6L / 6B4)
M	Aluminum head w/ screw cover & chain (6M / 6B4)
N	Cast iron head w/ screw cover (6N / 6B4)
O	Open terminal block (6M)
Q	Black nylon Nema 4 head (6Q / 6B4)
R	High dome head (6R)
V*	Hermetic connector (6DC) - Male
W*	Microphone style connector (6DA) - Male
X	Other, specify

* Use double symbol here for matching female connector. i.e. B/BB (male with matching female).

**We do not advise using these connectors for RTD's

Note: For any other cold end termination, use appropriate part numbers from section 6 in place of symbol #12.

#13	TAGGING AND CALIBRATION OPTIONS (USE ONLY IF APPLICABLE)
1	Stainless steel tag
2	Plastic tag
3	Paper tag
4	Electroetch on probe **Note:** You must always specify information required on tag
5	Calibrate at specified point(s). Corrections data will be provided for each point.
6	Calibrate specified temperature range. Corrections data will be provided for all temperatures within the range. **Note:** You must specify increments & range. Ex. 0 to 300°F, 0.1° increments
7	CE Marking [PAGE XV]

C	1

LOW COST AVERAGING RTD'S

Sense temperature of air streams in ducts and plenums. Sensors include a junction box with gasket to prevent leakage and vibration noise.

These thermometers have a continuous element to sense true average temperature along their entire length. They provide accurate composite reading in locations where air may be stratified into hot and cold layers.

Rigid averaging sensors have a brass case. Bendable models have aluminum sheaths (copper on special order) formable to a radius of 4". Bendable sensors can criss-cross duct to average temperatures in two dimensions.

Specifications:
Temperature range: -45.5 to 135˚ C (-50 to 275˚ F)
Gasket: 100˚ C (212˚ F)
Leadwire: 22awg, teflon insulated, 8" long
Sheath diameter: .188" OD.

#1	SERIES
3L	Platinum, 100 @ 0 C, a= .00385

#2	SENSOR TYPE
56	Rigid Sensor
57	Bendable Sensor

#3	WIRE CONFIGURATION
T	2 Wire
Y	3 Wire

#4	INSERTION LENGTH
_____"	Length in inches (**Standard** Lengths for Rigid type (inches): 12", 18", 24", 48", 60", 72" **Standard** Lengths for Bendable type (feet): 6 Ft, 12 Ft, 24 Ft)

#5	OPTIONS
A	Weatherproof connection box (2.12" W X 4.0" H X1.75" D)
B	Sensor only, no box
C	Stainless steel tag
X	Other

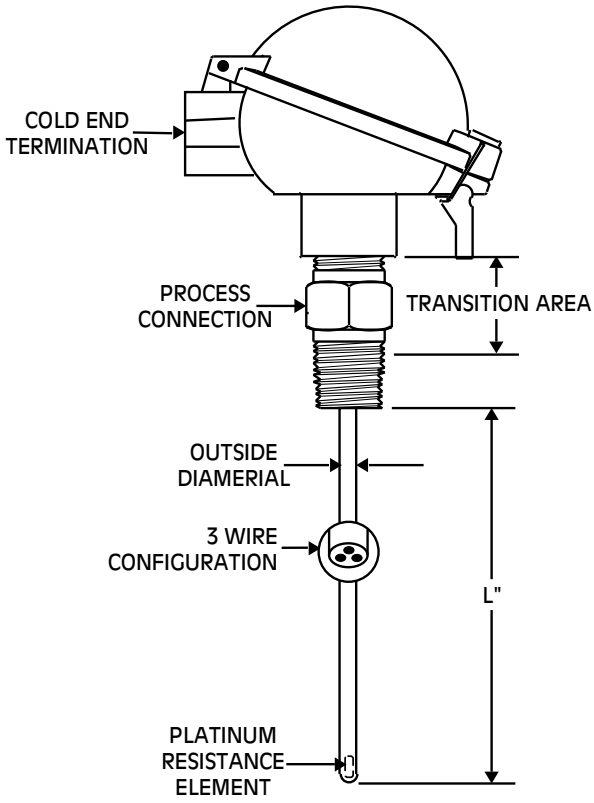
3L	56	T	60"	A

Part Numbers Obsolete at
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

RTD'S - RESISTANCE TEMPERATURE DETECTORS

RTD's work on the principle that there is a positive correlation between the electrical resistance of a metal conductor and changes in temperature. The standard temperature range is from -200°F to 900°F. High temperature assemblies are available which can operate at up to 1475°F.

The advantages of using RTD's include accuracy, repeatability, and stability. Another advantage is that cold junction compensation is unnecessary. Copper wire is used for all connections. The signal level of an RTD is over ten times higher than that of a thermocouple which eliminates the need for high gain amplifiers. The signal is also less susceptible to noise than thermocouples. The accuracy of a 4 wire RTD is independent of the distance between the sensor and the readout instrument.



COMPONENTS OF RTD's

The Platinum Resistance Element

This is the actual temperature sensing portion of the RTD. Elements range in length from 1/8" to 3" (See Pg 3-8). There are many options. The standard resistance is 100 ohms at 0°C and the standard temperature coefficient is an alpha of 0.00385. A complete list of options is listed on page 3-22.

Outside diameter / Inside diameter

The most standard outside diameter is 1/4". However, outside diameters range from .063" to .500". A selection of tube diameters can be found on page 1.

Tubing Material

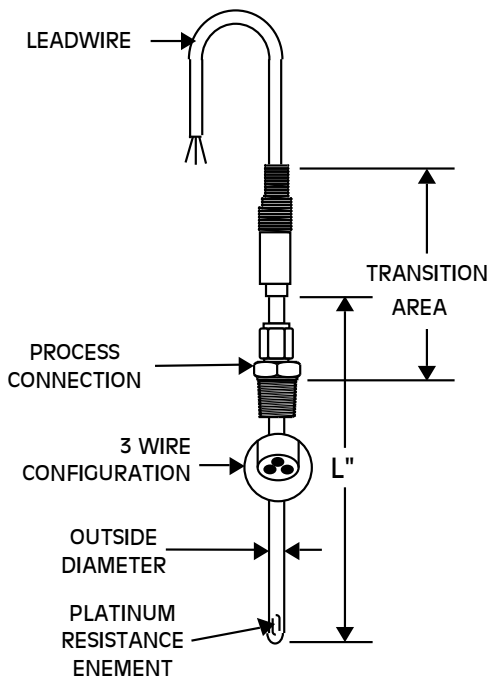
316 Stainless steel is commonly used for all assemblies up to 500°F. Above 500°F it is advisable to use Inconel 600. A list of some materials available is on page 1.

Process Connection

Process connection fittings include compression fittings and 1/2" N.P.T. x 1/2" N.P.T. welded or spring-loaded fittings. Various connection options are listed on page 1.

Wire Configuration and Insulation

RTD's are available in two, three, and four wire configurations. Three wire configuration is the most common. See page 3-17 for further information on selecting wire configuration for your application. Teflon and fiberglass are the standard wire insulation materials. Teflon is moisture resistant and has a maximum temperature rating of 400°F. Fiberglass is used for high temperature applications because it has a maximum temperature rating of 1000°F. ALO_2 powder is used to fill voids. Hard ceramic insulators may be used for high temperatures.

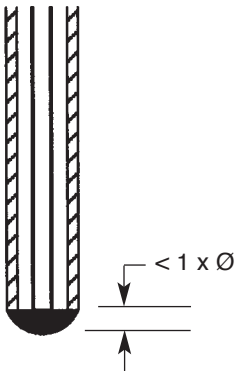


Cold End Termination

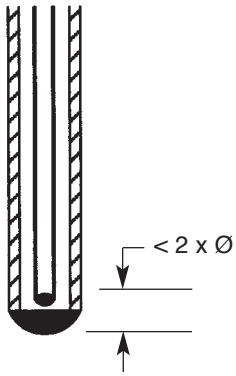
This may be in the form of bare wires, plugs, or terminal heads. The accessory section contains a wide variety of these options. Standard cold end terminations are listed on page 3-2.

TIP SENSITIVITY

Tip sensitivity in the finished probe is usually not considered a serious factor in sensor specifications. However, JMS SE believes tip sensitivity is extremely critical if the customer is to receive the same results time after time. For instance, if the sensor was originally designed to minimize penetration into the process, a thin film sensor might have been used. If that sensor is later replaced with a standard 15mm long element, response time will change drastically, affecting the PID of a control situation and certainly the total temperature reading of the process would be upset.



GROUNDED T/C

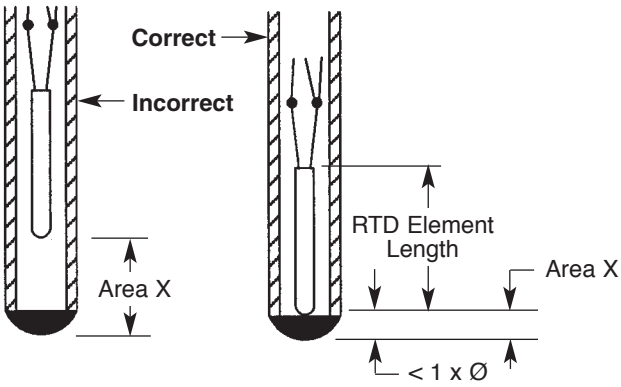


UNGROUNDED T/C

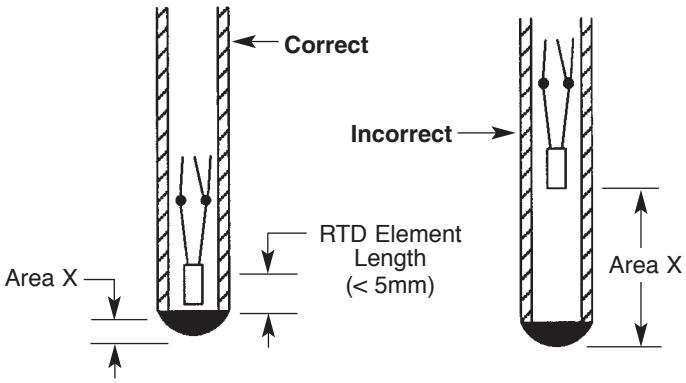
AREA X (How far is the tip of the sensing element from the tip of the tube?)

In any sensor or probe the location of the element inside the tube is critical. Even if the sensor element was 2" away from the tip, that condition would go undetected using the ASTM tests. (18 x Ø for wire thermocouples) JMS tests for the element placement on our sensors in order to assure consistency of your measurements.

Area X = <1 x Ø.



RTD ELEMENT



TYPE T RTD ELEMENT

RTD element length: E, P, S standard = 8mm - 15mm
"T" thin film = 2mm - 5mm
Others = 8mm - 50mm

Special designs can be used to obtain certain tip sensitivity. Ask your sales representative at JMS.

RTD STANDARDS

Maximum Operating Range = -200°C to 850°C (-392°F to 1562°F)
Note: RTD's are not commonly used above 900°F. However, JMS offers a special high temperature RTD which will withstand temperatures up to 1560°F.

Interchangeability = ±.01°C to .25°C at 0°C

Stability = Less than .05°C shift per year.

Electric Supply = AC or DC ≤ 500 Hz.

Nominal Operating Current ≤ 1 milliampere.

Maximum Safe Current = 20 Milliamperes.

Insulation Resistance = 100 mega ohms minimum at 50 VDC.

Probe Encapsulation = High purity alumina oxide.

Time constant for RTD element without tubing = 1 second maximum for the sensor to reach 63.2% of a step change in temperature in water at 3 feet per second.

RTD probes will usually not have a transition if the lead wires are less than 12" in length.



Accuracy
The standard accuracy of JMS Southeast's RTD is .1% of resistance at 0°C . Accuracies of .03% and .01% of resistance at 0°C are also available.

Stability
JMS Southeast bulbs are aged as part of the manufacturing process, thus ensuring high levels of stability. Generally the resistance at 0°C will hold less than a .05°C shift per year.

Vibration
JMS detectors can withstand a vibration level of 30g over the frequency range 10 Hz to 1 KHz.

Pressure
JMS RTD's are insensitive to large changes of pressure.

Response Time
Response time of JMS Southeast metal encapsulated probes is dependent on the outside diameter of the probe and the immersion media, usually matches that of the same size ungrounded thermocouple. (See page 1-13)

Self Heating
When tested in accordance with requirements of BS 1904: 1964 Section 3.16 the indicated temperature rise in the temperature detector with a power of 10.0mW dissipated in it, will not exceed +.3°C.

RESISTANCE TEMPERATURE DETECTORS

General Information

A resistance temperature detector or platinum resistance thermometer works on the principle that the electrical resistance of a metal changes in a significant and repeatable way when temperature changes. This resistance is inversely proportional to cross sectional area and proportional to length.

Platinum is the most widely used metal for resistance temperature detection due to the following characteristics:

1) chemical inertness
2) a temperature coefficient of resistance that is large enough to give readily measurable resistance changes with temperature
3) an almost strain free fabrication metal (in that resistance doesn't drastically change with strain)
4) an almost linear relation between resistance and temperature

Each resistance versus temperature relation for an RTD is qualified by a term known as "alpha". "Alpha" is the slope of the resistance between 0°C and 100°C. This is also referred to as the temperature coefficient of resistance, with the most common being 0.00385Ω/Ω/°C.

Other types of RTD's manufactured include copper, nickel and nickel alloys.

The amount of resistance of an individual RTD bulb (100Ω, 200Ω, etc.) is determined by the amount of metal between the terminal points and by the configuration of the element.

When ordering an RTD, the alpha and resistance value at 0°C (i.e.: Ro) must be specified to match the measuring instrumentation used with the RTD.

The RTD standard must also be specified. There are several RTD standards set by various organizations. These specifications are not identical and read out instrumentation must be adjusted for the specific standard of the RTD used with that equipment. Differences in the alpha values of these standards can cause errors in measurement of an RTD if one standard is connected to the instrumentation of another standard.

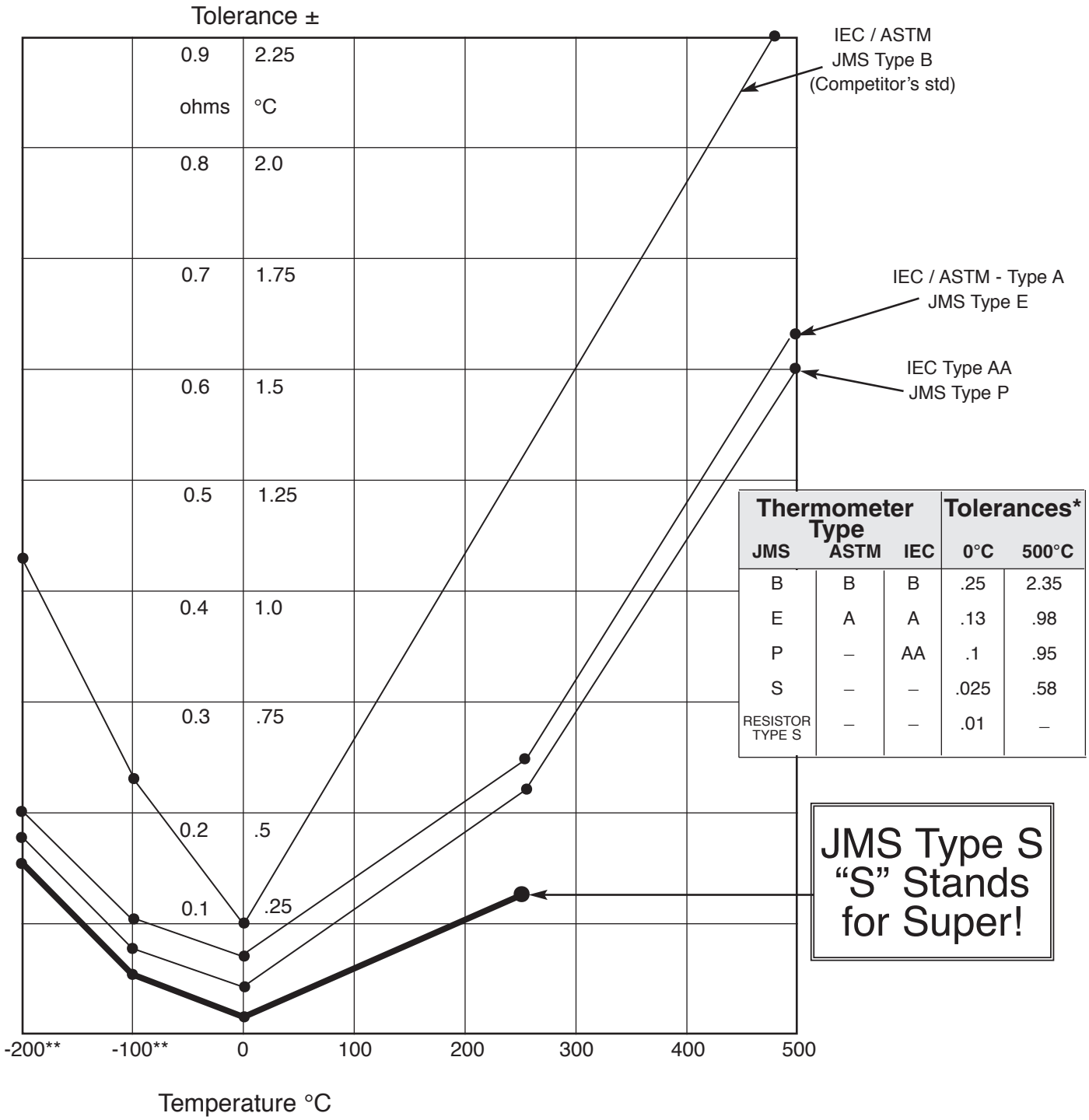
The following chart indicates some common RTD standards.

ORGANIZATION	STANDARD	ALPHA	NOMINAL RESISTANCE(ohms) AT 0°C
American Scientific Apparatus Makers Association (SAMA)	RC21-4-1966	0.003923	98.129
British Standards Association	B.S. 1904-1964	0.003850	100
FachnormenausschuB Elektrotchnek im Deutschen NormenausschuB	DIN 43760	0.003850	100
International Electrotechnical Commission (Supersedes BS & DIN)	IEC 751: 1983	0.003850	100
US Department of Defense	MIL-T-24388	0.00392	100

RESISTANCE TEMPERATURE DETECTORS

JMS TYPE "S" ("S" Stands for SUPER!)

-Meets DIN 43760, I.E.C. 751 .00385 ohms/ohms/°C, to
1/10 design tolerance at initial resistor calibration
Not available in dual element swaged
-Tip sensitivity = 1 Ø + 1/2" (See page 3-8)
-Probe can be manufactured as a 3/32", 1/8", 1/4" or larger tube



Thermometer Type			Tolerances*	
JMS	ASTM	IEC	0°C	500°C
B	B	B	.25	2.35
E	A	A	.13	.98
P	–	AA	.1	.95
S	–	–	.025	.58
RESISTOR TYPE S	–	–	.01	–

* Initial Calibration Accuracy
** Negative tolerances extrapolated from ASTM E1137

TUBE MATERIAL

JMS Southeast, Inc., recommends stainless steel tubing as the encapsulation for RTD's in most industrial applications.

If a corrosive environment exists, 316 low carbon stainless steel is recommended due to its resistance to corrosiveness. A more detailed explanation of this phenomenon follows.

For high temperature RTD's above 500°F, we recommend I600 encapsulation due to the absence of iron in I600. Platinum RTD bulbs sometimes experience "poisoning" at high temperatures due to iron migration. The iron attacks the grain boundaries of the platinum and the alpha of the bulb is erroneously lowered, thus yielding lower temperature readings than actual.

Please contact JMS for questions concerning environmental condition questions or exotic material needs for probe encapsulation.

CORROSION IN 316 STAINLESS STEEL VERSUS 316 LOW CARBON STAINLESS STEEL

Barbara Feldhacker Hudson
JMS Southeast, Inc.
Statesville, NC

BACKGROUND:

When 316 stainless steel is welded it is exposed to temperatures in the range of 1000°F to 1600°F and carbon readily diffuses toward the grain boundaries in this temperature range. This excess carbon in these areas adjacent to the grain boundaries combines with the chromium in the steel to form chromium carbides. This action depletes the effective chromium content near and at the grain boundaries, leaving this area of the metal susceptible to corrosive attack. When welding occurs and this phenomenon occurs, the chromium from within these grains cannot replenish this shortage rapidly enough to overcome this susceptibility. This is called "sensitization."

Stainless steel loses its resistance to corrosion when the chromium content drops below 10.5-11%. Intergranular corrosion occurs when the chromium content along the grain boundaries drops below this amount. The less chromium present the more rapid the attack that could ensue.

Corrosion also occurs more readily in austenitic stainless steels that contain more than .03% carbon due to the fact that complex chromium carbides precipitate along grain boundaries when the chromium ties up with this carbon. After the metal is cooled from the 1000°F-1600°F temperature range, any areas that experienced that temperature and are depleted of chromium are very susceptible to corrosion. In the manufacture of resistance temperature detectors, approximately the last 3 inches of the probe and the weld area experience these temperatures. Therefore, they are prime candidates for corrosion.

CORROSION PREVENTION:

There are a number of ways to combat the susceptibility of corrosion in 316 stainless steel. We have investigated a number of options. Water quenching of the entire susceptible area would avoid this corrosive property due to the fact that this cooling would dissolve the chromium carbides and the chromium content would be again uniform throughout the metal. Water quenching cools the metals rapidly enough to prevent the combination of chromium with carbon. We, at JMS, felt this option was not as feasible due to the problem of quenching every probe in manufacturing. This could not be done to an RTD assembly due to the fact that it would cause thermal shock to the probe and a sudden strain to the RTD bulb. RTD's are susceptible to strain and thermal shock and this could be detrimental to the sensor.

A second method of avoiding the corrosion phenomenon in 316 stainless steel is to add carbide forming elements to the stainless steels. If the carbon in the metal is tied up with other elements, it can not tie up with chromium and the free chromium present could not form chromium carbides and migrate to the grain boundaries. Some elements added to stainless steels for this purpose are titanium, columbium and tantalum. These elements have greater affinity for carbon than chromium so they stabilize the steel against chromium depletion. An example of this is Monel. This is a

more expensive option than what JMS Southeast decided upon.

A third method to avoid this possibility of corrosion of 316 stainless steel is to keep the steel in the "sensitizing" temperature range (1000°F-1600°F) for a long enough time for thermal stabilization to take place. The chromium carbides do form at the grain boundaries; however, after additional time, the chromium can diffuse into the area of impoverished grain boundaries.

The option was not feasible however, due to the fact that this thermal stabilization usually takes four hours. This is difficult to impossible to accomplish during welding.The method that JMS Southeast decided upon to combat corrosion in 316 stainless steel is to keep the carbon content so low in the metal that there is not adequate carbon present to form detrimental amounts of chromium carbide. If there is not enough carbon to tie up with the chromium then the chromium does not become depleted and corrosion is much less likely to occur. This type of protection is accomplished by using 316 low carbon stainless steel (316L) which has a maximum carbon content of .03%.

In an environment containing chlorides, the 316 stainless steel probe is at an even greater risk due to the fact that chlorides promote the formation of active/passive electrolytic cells. This can be explained by the fact that all stainless steels are passive under most conditions; however, if the probe is exposed to the "sensitization" temperature range and this molecular transformation occurs it forms anodic area (opposite the passive area). The oxygen around these two areas serves as a depolarizer and corrosion proceeds at an accelerated rate at the point the two areas meet.

Chlorides also have a higher valence state. Any chloride in an appreciable concentration is a source of trouble in promoting corrosion. Therefore, the use of 316 low carbon stainless steel becomes even more necessary in a chloride atmosphere if the metal is to endure a satisfactory lifetime. This occurs in an area that has been welded and is adjacent to the non-effected area.

Another problem of chlorides is that deposits may occur in crevices on the probe. In a crevice, oxygen supply is limited and cannot repair the passive oxide film. A crevice stays damp longer than a fully exposed surface. Salts are likely to accumulate in crevices particularly if the area around the crevice is alternately wet and dry. If the oxygen concentration decreases below a level necessary to maintain passivity in the anodic area, there is a double electrolytic effect. The difference in oxygen concentration alone will tend to promote attack on the anodic area and the potential between the passive and active area is already quite high, so corrosion becomes even more aggressive. Chlorides, being electrolytes will not contribute to passivity and will become very acidic thus accelerating the corrosive attack even more.

It is to difficult to predict the corrosion rate of 316 stainless steel or 316 low carbon stainless steel due to the environmental variables; however, our experience has shown an increase of up to twice the life in a low carbon stainless steel probe versus a standard stainless steel probe. The problem with pitting corrosion and crevice corrosion in an RTD probe is that through these openings in the metal sheath, the RTD bulb can become contaminated and fail. If quantified specimen tests are needed, the ASTM lists some approved corrosion testing procedures.

In the ASTM A262-64 Standard two widely used intergranular corrosion susceptibility tests are described. They include the Huey test, which test subject samples to five 48 hours boils in 65% nitric acid solutions. A weight loss after each boil is noted and translated to a corrosion rate in inches per month. This test, however, indicates overall corrosion not grain boundary corrosion.

A second test is the oxalic acid etch test which involves etching a polished specimen then examining the appearance under a microscope. Comparisons are then made to some ASTM photographs.

Two other tests listed in A262 are the boiling sulfuric acid-ferric sulfate solution test and the nitric acid-hydrofluoric acid test at room temperature. These are not as widely used, however.

In conclusion, corrosion of 316 stainless steel in a chloride environment is a definite problem. To minimize this problem, low carbon stainless steel metal should be used in this environment as the encapsulation for RTD probes. If this is not done, the RTD longevity will be substantially reduced. JMS Southeast recommends the use of 316 low carbon stainless steel to all our customers who are using RTD's for temperature measurement in a process that contains chlorides.

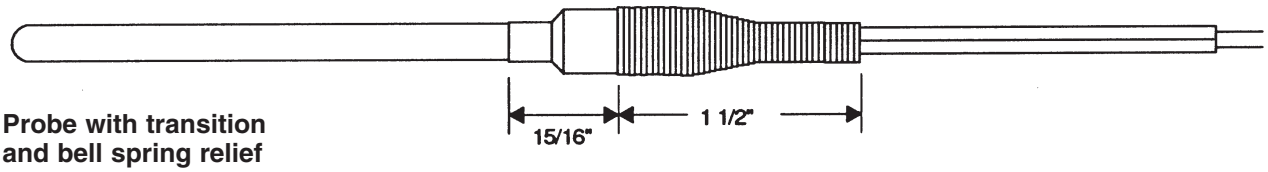
REFERENCES:

1. Zak, C.A., "Intergranular Corrosion of Austenitic Stainless Steels" Metallurgy of Tubing/Volume 8
2. American Society for Metals, "Metals Handbook" Volume 8, No. 1, 1961

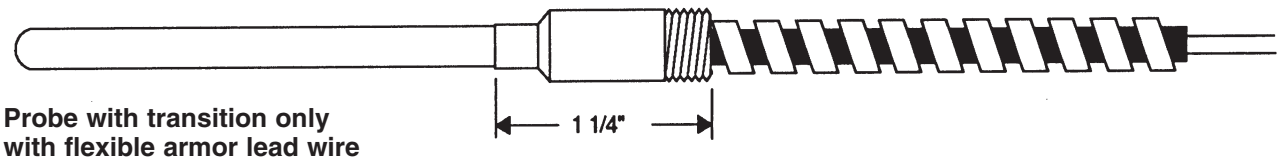
RTD TRANSITIONS

The transition on an RTD assembly supports the lead wires attached to the RTD probe and contains the protective potting compound used to encapsulate the probe. The transition is stainless steel and has a .375" outside diameter for 3/4", and tapers down over the probe for an additional 1/4". This 1/4" outer diameter is approximately .055" larger than the probe outer diameter.

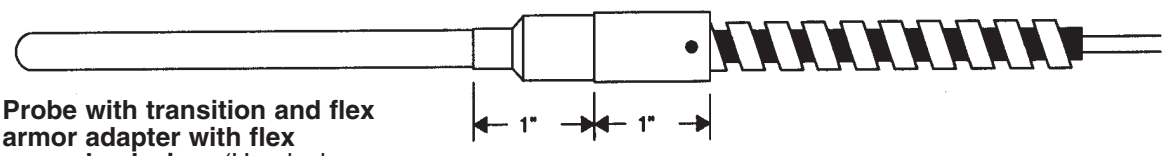
The bell spring adds approximately 1" to the rigid length of the probe.



Probe with transition and bell spring relief



Probe with transition only with flexible armor lead wire
(Standard on low temp. (transition) single elements)



Probe with transition and flex armor adapter with flex armor lead wire. (Used when armor is 60" or greater.)

JMS provides special hermetic sealing from moisture for those sensors used in high humidity / moisture or total immersion environments. Use a "2" after your selection in symbol #13 page 3-2. Any moisture penetrating the transition will kill the integrity of the electrical property of the sensor. Our special hermetic sealing will prevent this as well as possible in any environment. See page1-16 for more information.

TOLERANCES

Tolerances of RTD's are specified as a function of temperature.

They can be expressed in ohms, temperature, or percentages.

JMS now features RTD Thermometers using platinum resistors with a tolerance as low as 0.01% of resistance @ 0°C.

Better accuracies are possible by performing calibrations on a sensor at several different temperatures and listing exact resistance readings of that RTD at those temperatures. This is a more expensive method, but can be cost effective when accuracy is critical in a process. (See pages VIII, IX, X)

Readout instrumentation of RTD's converts resistance to temperature. Typical accuracies of this equipment are 0.1%. Lead wire and connection error for 2 and 3 wire RTD's can be significant.

After an RTD is manufactured there are some conditions that can alter the accuracy and reliability of an RTD. Moisture within the RTD can decrease the resistance value of the RTD and cause errors. Bad seals on the RTD are usually the cause. High temperatures can cause the insulation material's electrical resistance to decrease significantly. Also, at high temperatures, if any iron exists within the probe, iron migration can cause a poisoning of the platinum, thus measurement errors.

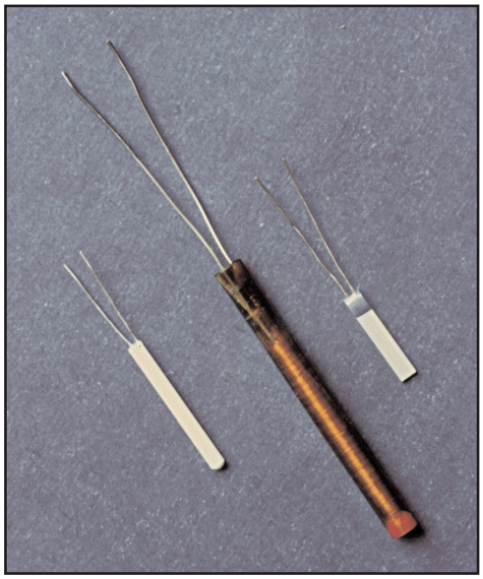
Physical or mechanical changes can cause shifts in the calibration of RTD's.

Rapid cooling can cause defects in the platinum structure and thus measurement errors. The defects can usually be eliminated by reannealing at 450°C.

Vibration in the process can also cause a drift in RTD's by causing a shift in the windings.

Stretching or strain on a metal can change it's resistance independent of temperature.

Due to the fact that RTD's are wound on a mandrel and supported in some way, the expansion coefficient of the supporting medium should match that of platinum, or else the actual contact of the winding with the medium used should be minimized. Thin film, thick film, totally supported, partially supported and bird cage constructions all have specific applications. JMS Southeast, Inc. manufactures high quality RTD's using thin film and semi-supported bulbs.



4, one hour sessions training video. $1200.00 - Call for information.

THERMOCOUPLES VS RTD'S

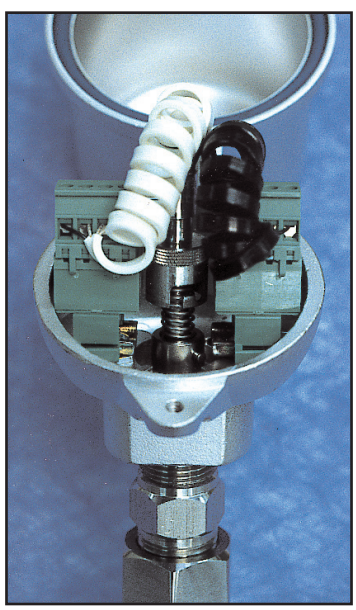
The following chart indicates some inherent advantages and disadvantages of RTD's or thermocouples.

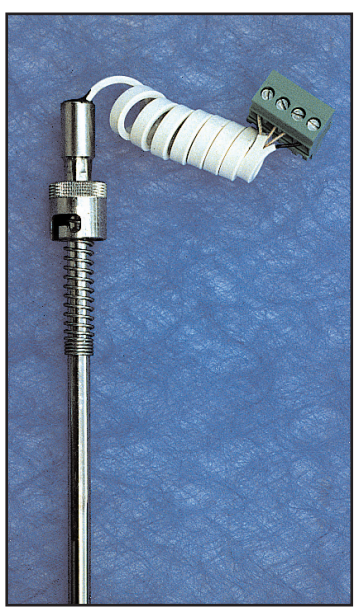
	THERMOCOUPLE	RTD'S
Accuracy	Limits of error wider than RTD	Limits of error smaller than thermocouples
Ruggedness	Excellent	Sensitive to strain, shock, and pressure
Temperature	-400° to 4200°F	-200° to 1500° F
Size	Can be as small as .01" sheath material, tip sensitive	Size limited to 1/16", temperature sensitive for length of bulb
Drift	Should be checked periodically, higher than RTD's	0.01 to 0.1°C per year, less drift than thermocouple
Resolution	Must resolve millivolts per degree, lower signal to noise ratio	Ohms per degree, much higher signal to noise ratio than thermocouple
Cold Junction Reference	Required	Not required
Lead wire	Must match lead wire calibration to thermocouple calibration	Can use copper lead wire for extension wire
Response	Can be made small enough for millisecond response time	Thermal mass restricts time to seconds or more
Cost	Low	Higher than thermocouples

Why a 3 minute egg in Denver, Colorado is softer than a 3 minute egg in Denver, North Carolina.

BOILING POINT OF WATER

ALTITUDE FT	B>P> °F	ATM. PRESS. PSIA	ALTITUDE FT	B>P> °F	ATM. PRESS. PSIA
0	212	14.7	8000	198	10.98
1000	210	14.21	9000	196	10.58
2000	209	13.72	10000	194	10.19
3000	207	13.23	11000	192	9.81
4000	205	12.75	12000	191	9.45
5000	203	12.29	13000	189	9.09
6000	201	11.83	14000	187	8.75
7000	199	11.39	15000	185	8.41





LEADWIRE CONFIGURATION EXPLANATION

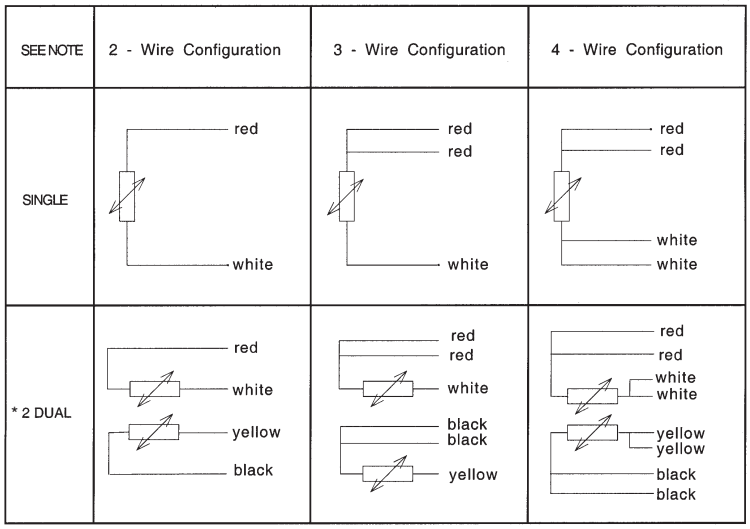
A resistance temperature detector determines the temperature by measuring resistance. The sensing element is usually a small diameter wire manufactured so that its resistance will change in a known and consistent manner. To measure the resistance accurately and consistently, other extraneous resistances must be compensated for or minimized. A major cause of extraneous resistance is leadwire in series with the RTD. The readout is the sum of the bulb resistance and the leadwire resistances. The leadwire resistance can be compensated in most applications by a three wire RTD leadwire configuration.

In the three wire configuration, the power supply is taken to one side of the resistance temperature detector. This puts the other two leadwires in opposite arms of the wheatstone bridge so that they cancel each other out and have little effect on the bridge output voltage. In the 3 wire configuration, the resistance of the lead wire length is compensated for in the Wheatstone bridge. This design is recommended for most industrial applications.

An even more accurate wire configuration is the 4 wire design. In this design, leadwires #1 and #2 are on one side of the power supply while leadwires #3 and #4 are on the other side of the power supply. All four leadwire resistances in this case are negated and the bulb resistance stands as the resistance input alone. We strongly recommend this design. You must have a good 4 wire input device. Call us for recommendations.

Note:
For numbering sequence of connectors and terminal blocks see Section 6.

***Note:**
The different colors for the 2nd set are used when the wire are not otherwise distinguishable



RTD Operation and Installation Instructions:

RTD's are installed by means of compression fittings, welded or spring-loaded NPT fittings, or bayonet fittings.

Follow these instructions for installation of an RTD with a 1/2" x 1/2" NPT fitting:

(1) Insert RTD into process hole or opening.

(2) Tighten probe into place by turning probe into threaded connection.

If cold-end termination of the RTD is wired into head and you have a spring loaded fitting, then the wires should be disconnected from the terminal block to prevent twisting and shorting.

ELECTRICAL:

Make sure the extension wire is clean so that a good electrical connection will result at the terminal block. We recommend the use of a lacquer, cement, or other moisture proof sealing to prevent oxidation and the loosening of terminals. Connect the positive extension wire to the positive RTD wire and the negative extension wire to the negative RTD wire. Wires are color coded for identification as follows:

When using THERMOCOUPLE STYLE PLUGS (6A type, see pg 6-3)

Two Wire Configuration:
Connect the white wire to the positive connection terminal and connect the red wire to the negative connection terminal.

Three Wire Configuration:
The two red wires are common. Connect the white wire to the largest pin connection terminal and the two red wires to the two small pin connection terminals. The second red wire is the compensating lead wire.

RESISTANCE CHARACTERISTICS

Characteristics

The temperature/resistance relationships and tolerances on this page are valid for the sensing resistor at its measuring points. For thermometers they are valid for the complete thermometer at its terminals.

In the case of two-wire connections the resistance values of the leads between the measuring point of the resistor and the terminals must be considered. They may be indicated on the thermometer and must be subtracted from measured values in ohms. In some cases it also may be advisable to consider the temperature coefficient of the leadwires and the temperature distribution along their length.

Temperature/resistance relationships

The temperature/resistance relationships used in this standard are as follows:

for the range of -200°C to 0°C:

$$R_t = R_o[1 + At + Bt^2 + c(t - 100°C)\, t^3]$$

for the range of 0°C to 850°C:

$$R_t = R_o(1 + At + Bt^2)$$

For the quality of platinum commonly used for industrial resistance thermometers, the values of the constants in these equations are:

$A = 3.9083 \times 10^{-3}\ °C^{-1}$ $\qquad$ $C = 4.183 \times 10^{-12}\ °C^{-4}$

$B = 5.775 \times 10^{-7}\ °C^{-2}$ $\qquad$ t = Modulus of temperature without sign

For resistance thermometers satisfying the above relationships, the temperature coefficient is defined as:

$$a = \frac{(R_{100} - R_0)}{100 \times R_0}$$

has the value $0.00385055°C^{-1}$

where

R_{100} is the resistance at 100°C;
R_0 is the resistance at 0°C.

These equations and coefficients are listed as the basis for the temperature / resistance tables in this book. The calibration of individual thermometers will yield different coefficients.

Values of temperatures in this book are based on the International Temperature Scale of 1990 (ITS 90).

Resistance values

Most resistors are constructed to have a nominal resistance of 100Ω. The resistance vs. temperature table is calculated for a resistance of 100.00 Ω at 0°C. For other nominal resistances R_{nom} such as 500 Ω or 1000Ω the table can be used by multiplying the table values with the factor $R_{nom}/100$.

General Requirements (Tolerances)

Sensing resistors

The tolerance values of wirewound resistors are classified in table 1 and the values of film resistors are classified in table 2.

Table 1: Tolerance classes for wound resistors

Tolerance class	Tolerance value (°C)	Temperature range of validity of tolerances
W 0.1	±(0.1°C + 0.0017 [t])	-50°C + 250°C
W 0.15	±(0.15°C + 0.002 [t])	-100°C to 450°C
W 0.3	±(0.3°C + 0.005 [t])	-196°C to 661°C
W 0.6	±(0.6°C + 0.01 [t])	-196°C to 661°C

Table 2: Tolerance classes for film resistors

Tolerance class	Tolerance value (°C)	Temperature range of validity of tolerances
F 0.1	±(0.1°C + 0.0017 [t])	-50°C + 250°C
F 0.15	±(0.15°C + 0.002 [t])	-50°C to 450°C
F 0.3	±(0.3°C + 0.005 [t])	-50°C to 661°C
F 0.6	±(0.6°C + 0.01 [t])	-50°C to 661°C

Table 3: Tolerance classes for thermometers (finished probes)

Tolerance * class	Tolerance values (°C)	
AA	±(0.1 °C + 0.0017 [t])	-50 to 250°C
A	±(0.13°C + 0.0017 [t])	-100 to 450°C
B	±(0.25°C + 0.0042 [t])	-196 to 600°C
C	±(0.6°C + 0.01 [t])	-196 to 600°C

* These tolerances meet or exceed ASTM / IEC thermometer class. They do not necessarily determine the working range of the thermometer.

RESISTANCE vs. RTD TEMPERATURE SPECIFICATIONS

Temperature (°C) vs. Resistance (Ω)

°C	0	-10	-20	-30	-40	-50	-60	-70	-80	-90	/C°
-200	18.52										
-100	60.26	56.19	52.11	48.00	43.88	39.72	35.54	31.34	27.10	22.83	.415
0	100.00	99.09	92.16	88.22	84.27	80.31	76.33	72.33	68.33	64.30	.357
°C	0	10	20	30	40	50	60	70	80	90	/C°
0	100.00	103.90	107.79	111.67	115.54	119.40	123.24	127.08	130.90	134.71	.385
100	138.51	142.29	146.07	149.83	153.58	157.33	161.05	164.77	168.48	172.17	.374
200	175.86	179.53	183.19	186.84	190.47	194.10	197.71	201.31	204.90	208.48	.361
300	212.05	215.61	219.15	222.68	226.21	229.72	233.21	236.70	240.18	243.64	.350
400	247.09	250.53	253.96	257.38	260.78	264.18	267.56	270.93	274.29	277.64	.339
500	280.98	284.30	287.62	290.92	294.21	297.49	300.75	304.01	307.25	310.49	.327
600	313.71	316.92	320.12	323.30	326.48	329.64	332.79	335.93	339.06	342.18	.316
700	345.28	348.38	351.46	354.53	357.59	360.64	363.67	366.70	369.71	372.71	.304
800	375.70	378.68	381.65	384.60	387.55	390.48					

JMS Type B (Industry standard)

Temperature (°C)	-250	-220	-200	-100	0	100	200	300	400	500	600	700	800	850
Tolerance (±°C)	1.6	1.4	1.3	0.8	0.3	0.8	1.3	1.8	2.3	2.8	3.3	3.8	4.3	4.6
(± Ω)	1.0	0.7	0.6	0.3	0.1	0.3	0.5	0.6	0.8	0.9	1.1	1.3	1.4	1.5

Temperature (°F) vs. Resistance (Ω)

°F	0	-10	-20	-30	-40	-50	-60	-70	-80	-90	/F°
-200	48.49										
-100	71.01	68.78	66.55	64.31	62.07	59.82	57.57	55.31	53.04	50.77	.225
0	93.03	90.85	88.66	86.47	84.27	82.07	79.87	77.66	75.45	73.23	.220
°F	0	10	20	30	40	50	60	70	80	90	/F°
0	93.03	95.21	97.39	99.56	101.73	103.90	106.06	108.22	110.37	112.53	.216
100	114.67	116.82	118.96	121.10	123.23	125.36	127.49	129.61	131.73	133.85	.213
200	135.96	138.07	140.18	142.28	144.38	146.48	148.57	150.66	152.74	154.82	.209
300	156.90	158.97	161.04	163.11	165.17	167.23	169.29	171.34	173.39	175.44	.206
400	177.48	179.52	181.56	183.59	185.61	187.64	189.66	191.68	193.69	195.70	.202
500	197.71	199.71	201.71	203.71	205.70	207.69	209.68	211.66	213.64	215.61	.199
600	217.58	219.55	221.51	223.47	225.43	227.39	229.34	231.68	233.23	235.17	.195
700	237.10	239.03	240.96	242.89	244.81	246.73	248.64	250.55	252.46	254.37	.192
800	256.27	258.16	260.06	261.95	263.83	265.72	267.60	269.47	271.34	273.21	.188
900	275.08	276.94	278.80	280.65	282.50	284.35	286.19	288.03	289.87	291.70	.185
1000	293.53	295.36	297.18	299.00	300.82	302.63	304.44	306.24	308.04	309.84	.181
1100	311.64	313.43	315.22	317.00	318.78	320.56	322.33	324.10	325.86	327.63	.177
1200	329.30	331.03	332.79	334.76	336.74	338.71	340.69	342.66	344.64	346.62	.169
1300	347.50	348.38	350.07	351.77	353.46	355.16	356.85	358.55	360.25	361.94	.162
1400	363.67	365.17	366.67	368.17	369.67	371.17	372.67	374.18	375.68	377.12	.150
1500	378.68	380.58	382.48	384.38	386.30	388.21	390.12				

JMS Type B (Industry standard)

Temperature (°F)	-200	-100	0	32	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1560
Tolerance (±°F)	1.8	1.1	0.7	0.6	0.7	0.9	1.5	2.0	2.7	3.3	3.9	4.5	5.4	6.0	6.5	7.0	7.6	8.4	9.0	9.4
(± Ω)		0.3	0.2	0.1	0.2	0.2	0.3	0.4	0.6	0.7	0.8	.09	1.0	1.1	1.1	1.2	1.3	1.4	1.5	1.5

Nominal Resistance

The platinum element of the standard industrial type RTD has a base reference resistance of 100 Ω at 0°C. Platinum 100 Ω, temperature coefficient = 0.00385/Ω/Ω/°C.
This meets the ASTM standard 1137 and also meets the IEC 751. All readings based on ITS 90 - International Temperature Scale 1990.

TEMPERATURE vs RESISTANCE TABLE

Din 43760, 100Ω Platinum RTD
Alpha=.00385

Temp. (degrees C)	0	(-10)	(-20)	(-30)	(-40)	(-50)	(-60)	(-70)	(-80)	(-90)
-200	18.53	14.36	10.41							
-100	60.20	56.13	52.04	47.93	43.80	39.65	35.48	31.28	27.05	22.78
0	100.00	96.07	92.13	88.17	84.21	80.25	76.28	72.29	68.28	64.25
	0	(10)	(20)	(30)	(40)	(50)	(60)	(70)	(80)	(90)
0	100.00	103.90	107.79	111.67	115.54	119.40	123.24	127.07	130.89	134.70
100	138.50	142.28	146.06	149.82	153.57	157.32	161.04	164.76	168.47	172.16
200	175.84	179.51	183.17	186.82	190.46	194.08	197.70	201.30	204.88	208.46
300	212.03	215.58	219.13	222.66	226.18	229.69	233.19	236.67	240.15	243.61
400	247.06	250.50	253.93	257.34	260.75	264.14	267.52	270.89	274.25	277.60
500	280.93	284.26	287.57	290.87	294.16	297.43	300.70	303.95	307.20	310.43
600	313.65	316.86	320.05	323.24	326.41	329.57	332.72	335.86	338.99	342.10

NOTE: Due to the interchangeability tolerance of the RTD's, the JMS type E matches both DIN 43760 / IEC 751, and British Standard BS 1904 curves.

BS 1904, 100Ω Platinum RTD
Alpha=.00385

Temp. (degrees C)	0	(-10)	(-20)	(-30)	(-40)	(-50)	(-60)	(-70)	(-80)	(-90)
-200	18.56	14.40	10.45							
-100	60.28	56.21	52.12	48.01	43.88	39.72	35.54	31.34	27.11	22.83
0	100.00	96.09	92.16	88.23	84.29	80.32	76.34	72.35	68.34	64.32
	0	(10)	(20)	(30)	(40)	(50)	(60)	(70)	(80)	(90)
0	100.00	103.90	107.79	111.67	115.54	119.40	123.24	127.07	130.89	134.70
100	138.50	142.29	146.06	149.82	153.57	157.31	161.04	164.76	168.46	172.16
200	175.83	179.50	183.16	186.82	190.45	194.07	197.69	201.29	204.88	208.46
300	212.02	215.58	219.12	222.66	226.18	229.69	233.19	236.68	240.16	243.61
400	247.08	250.52	253.95	257.37	260.77	264.17	267.56	270.94	274.29	277.64
500	280.98	284.31	287.67	290.93	294.22	297.50	300.76	304.02	307.27	310.51
600	313.72	316.93	320.12	323.31	326.50	329.60	332.80	335.90	339.10	342.20

NOTE: Due to the interchangeability tolerance of the RTD's, the JMS type E matches both DIN 43760 / IEC 751, and British Standard BS 1904 curves.

SAMA RC21-4 1966, 98.1Ω Platinum RTD
Alpha=.003923
JMS TYPE F [3-22]

Temp. (degrees C)	0	(-10)	(-20)	(-30)	(-40)	(-50)	(-60)	(-70)	(-80)	(-90)
-200	16.67									
-100	58.40	54.34	50.26	46.15	42.02	37.87	33.69	29.48	25.24	20.97
0	98.13	94.22	90.29	86.36	84.41	78.44	74.47	70.47	66.47	62.44
	0	(10)	(20)	(30)	(40)	(50)	(60)	(70)	(80)	(90)
0	98.13	102.03	105.92	109.80	113.67	117.52	121.37	125.20	129.02	132.83
100	136.63	140.41	144.19	147.95	151.70	155.44	159..17	162.89	166.06	170.29
200	173.97	177.64	181.30	184.95	188.58	192.22	195.83	199.43	203.02	206.60
300	210.17	213.73	217.27	220.80	224.33	227.84	231.34	234.83	238.30	241.77
400	245.22	248.66	252.09	255.51	258.92	262.32	265.70	269.07	272.43	275.78
500	279.12	282.45	285.76	289.07	292.36	295.64	298.91	302.17	305.42	308.65
600	311.88									

TEMPERATURE vs RESISTANCE TABLE

JISC 1604-1981, 100Ω Platinum RTD
Alpha=.003916
JMS TYPE G

Temp. (degrees C)	0	(-10)	(-20)	(-30)	(-40)	(-50)	(-60)	(-70)	(-80)	(-90)
-200	17.05									
-100	59.57	55.43	51.28	47.10	42.90	38.67	34.41	03.12	25.80	21.44
0	100.00	92.03	92.03	88.02	84.00	79.97	75.92	71.86	67.78	63.68
	0	(10)	(20)	(30)	(40)	(50)	(60)	(70)	(80)	(90)
0	100.00	103.97	107.93	111.87	115.81	119.73	123.64	127.54	131.42	135.30
100	139.16	143.01	146.85	150.68	154.49	158.30	162.09	165.87	169.64	173.40
200	177.14	180.87	184.60	188.30	192.00	195.69	199.36	203.03	206.68	210.31
300	213.94	217.56	221.16	224.75	228.33	231.90	235.46	239.00	242.53	246.05
400	249.56	253.06	256.55	260.02	263.48	266.93	270.37	273.80	277.21	280.61
500	284.00	287.38	290.75	294.11	297.45	300.78	304.10	307.41	310.71	313.99
600	317.27	320.53	323.78							

Laboratory Grade, 100Ω Platinum RTD
Alpha=.003925
JMS TYPE L

Temp. (degrees C)	0	(-10)	(-20)	(-30)	(-40)	(-50)	(-60)	(-70)	(-80)	(-90)
0	100.00	96.02	92.02	88.01	83.99	79.96	75.91			
	0	(10)	(20)	(30)	(40)	(50)	(60)	(70)	(80)	(90)
0	100.00	103.97	107.93	111.88	115.82	119.75	123.66	127.56	131.45	135.33
100	139.20	143.06	146.90	150.73	154.55	158.36	162.16	165.94	169.72	173.48
200	177.23	180.97	184.69	188.41	192.11	195.80	199.48	203.15	206.80	210.45
300	214.08	217.70	221.31	224.91	228.50	232.07	235.63	239.19	242.72	246.25
400	249.76	253.27	256.76	260.24	263.71	267.16	270.61	274.04	277.46	280.88
500	284.27	287.66	291.03	294.40	297.75	301.09	304.42	307.73	3011.04	314.33
600	317.61	320.88	324.14	327.38	330.62	333.84	337.05	340.25	343.44	346.61

NOTE: Based on NIST Supplementary ITS-90. These values were available at time if publication but subject to approval by ASTM as laboratory grade.

Uncommon American 100Ω Platinum RTD
Alpha=.003902
JMS TYPE H

Temp. (degrees C)	0	(-10)	(-20)	(-30)	(-40)	(-50)	(-60)	(-70)	(-80)	(-90)
-100	59.69									
0	100.00	96.03	92.06	88.06	84.06	80.04	76.01	71.96	67.89	63.80
	0	(10)	(20)	(30)	(40)	(50)	(60)	(70)	(80)	(90)
0	100.00	103.96	107.90	111.83	115.75	119.66	123.55	127.44	131.31	135.17
100	139.02	142.86	146.68	150.50	154.30	158.09	161.87	165.64	169.39	173.14
200	176.87	180.59	184.30	188.00	191.68	195.35	199.02	202.67	206.31	209.93
300	213.55	217.15	220.74	224.32	227.89	231.45	234.99	238.52	242.05	245.56
400	249.05	252.54	256.01	259.48	262.93	266.37	269.79	273.21	276.62	280.01
500	283.39	286.76	290.11	239.46	296.79	300.12	303.43	306.73	310.01	313.29
600	316.55	319.80	323.04	326.27	329.49	332.70				

NON STANDARD RESISTORS

NON STANDARD, BUT COMMONLY USED RTD'S

*Letter Designation	Standard	Alpha	Resistor Tolerance at 0°C	Reference page
F	SAMA	.003923	0.1	3-22
G	JISC	.003916	0.1	3-21
L	NIST	.003925	0.007	3-21
H	NONE	.003902	0.15	3-21

* May be used for symbol #2 (page 3-1)

ADDITIONAL RTD ELEMENT TYPES

The following are available in addition to the RTD element types listed on page 3-1. Elements may be specified with an "X" in the part number.

ALPHA	RESISTANCE VALUE	TOLERANCE
Platinum - 0.003750	1000 ohms @ 0 deg. C	±0.2%
Platinum - 0.003850	10 ohms @ 0 deg.C	±0.2%
Platinum - 0.003850	10 ohms @ 20 deg. C	±0.2%
Platinum - 0.003850	10 ohms @ 25 deg. C	±0.2%
Platinum - 0.003850	20 ohms @ 0 deg. C	±0.2%
Platinum - 0.003850	50 ohms @ 0 deg. C	±0.2%
Platinum - 0.003850	200 ohms @ 0 deg. C	±0.1%
Platinum - 0.003850	500 ohms @ 0 deg. C	±0.1%
Platinum - 0.003850	1000 ohms @ 0 deg. C	±0.1%
Platinum - 0.003900	100 ohms @ 0 deg. C	±0.2%
Platinum - 0.003900	130 ohms @ 0 deg. C	±0.1%
Platinum - 0.003910	8 ohms @ 0 deg. C	±0.5%
Platinum - 0.003910	10 ohms @ 0 deg. C	±0.5%
Platinum - 0.003910	32 ohms @ 0 deg. C	±0.5%
Platinum - 0.003910	98.129 ohms @ 0 deg. C	±0.1%
Platinum - 0.003910	100 ohms @ 0 deg. C	±0.5%
Platinum - 0.003910	500 ohms @ deg. C	±0.5%
Platinum - 0.003920	100 ohms @ 0 deg. C	±0.1 deg. C
Platinum - 0.003920	200 ohms @ 0 deg. C	±0.1 deg. C
Platinum - 0.003920	500 ohms @ 0 deg. C	±0.1 deg. C
Platinum - 0.003926	25.5 ohms @ 0 deg. C	±0.1%
Platinum - 0.003926	100 ohms @ 0 deg. C	±0.5%
Platinum - 0.003926	200 ohms @ 0 deg. C	±0.5%
Platinum - 0.003926	470 ohms @ 0 deg. C	±0.5%
Platinum - 0.003926	500 ohms @ 0 deg. C	±0.5%
Nickel - N/A	110 ohms @ 0 deg. C	±0.5%
Ni Fe - N/A	1000 ohms deg. @ 21.1 deg. C	±0.5%
Ni Fe - N/A	2000 ohms @ 21.1 deg. C	±0.5%
Copper - N/A	100 ohms @ 25 deg.C	±0.2%

RESISTANCE / TEMPERATURE TABLE

COPPER 10Ω AT 25°C

°C	0	1	2	3	4	5	6	7	8	9
-190	1.471	1.430	1.389	1.348	1.306	1.265	1.223	1.182	1.140	1.009
-180	1.884	1.843	1.802	1.761	1.719	1.678	1.637	1.596	1.554	1.513
-170	2.295	2.254	2.213	2.172	2.131	2.090	2.049	2.008	1.967	1.925
-160	2.705	2.664	2.623	2.582	2.541	2.500	2.459	2.418	2.377	2.336
-150	3.112	3.072	3.031	2.990	2.949	2.909	2.868	2.827	2.786	2.745
-140	3.519	3.478	3.437	3.397	3.356	3.316	3.275	3.234	3.194	3.153
-130	3.923	3.883	3.842	3.802	3.762	3.721	3.681	3.640	3.600	3.559
-120	4.326	4.286	4.246	4.206	4.165	4.125	4.085	4.044	4.004	3.964
-110	4.728	4.688	4.648	4.608	4.567	4.527	4.487	4.447	4.407	4.366
-100	5.128	5.088	5.048	5.008	4.968	4.928	4.888	4.848	4.808	4.768
-90	5.526	5.486	5.446	5.407	5.367	5.327	5.287	5.247	5.208	5.168
-80	5.923	5.883	5.844	5.804	5.764	5.725	5.685	5.645	5.606	5.566
-70	6.318	6.279	6.239	6.200	6.160	6.121	6.081	6.042	6.002	5.962
-60	6.712	6.672	6.633	6.594	6.554	6.515	6.476	6.436	6.397	6.358
-50	7.104	7.064	7.025	6.986	6.947	6.908	6.869	6.830	6.790	6.751
-40	7.490	7.451	7.413	7.374	7.335	7.296	7.258	7.220	7.181	7.142
-30	7.876	7.838	7.799	7.761	7.722	7.683	7.645	7.606	7.568	7.529
-20	8.263	8.224	8.185	8.147	8.108	8.070	8.031	7.992	7.954	7.915
-10	8.649	8.610	8.572	8.533	8.494	8.456	8.417	8.378	8.340	8.301
0	9.035	9.996	9.958	8.919	8.881	8.842	8.805	8.765	8.726	8.687
0	9.035	9.074	9.112	9.151	9.189	9.228	9.267	9.305	9.344	9.383
10	9.421	9.460	9.498	9.537	9.576	9.614	9.653	9.692	9.730	9.769
20	9.807	9.846	9.885	9.923	9.962	10.000	10.039	10.078	10.116	10.155
30	10.194	10.232	10.271	10.309	10.348	10.387	10.425	10.464	10.502	10.541
40	10.580	10.618	10.657	10.696	10.734	10.773	10.811	10.850	10.889	10.927
50	10.966	11.005	11.043	11.082	11.120	11.159	11.198	11.236	11.275	11.313
60	11.352	11.391	11.429	11.468	11.507	11.545	11.584	11.622	11.661	11.700
70	11.738	11.777	11.816	11.854	11.893	11.931	11.970	12.009	12.047	12.086
80	12.124	12.163	12.202	12.240	12.279	12.318	12.356	12.395	12.433	12.472
90	12.511	12.549	12.588	12.627	12.665	12.704	12.742	12.781	12.820	12.858
100	12.897	12.935	12.974	13.013	13.051	13.090	13.129	13.167	13.206	13.244
110	13.283	13.322	13.360	13.399	13.437	13.476	13.515	13.553	13.592	13.631
120	13.669	13.708	13.746	13.785	13.824	13.862	13.901	13.940	13.978	14.017
130	14.055	14.094	14.133	14.171	14.210	14.248	14.287	14.326	14.364	14.403
140	14.442	14.480	14.519	14.557	14.596	14.635	14.673	14.712	14.751	14.789
150	14.828	14.867	14.906	14.945	14.984	15.022	15.061	15.100	15.139	15.178
160	15.217	15.256	15.295	15.334	15.373	15.412	15.451	15.490	15.529	15.568
170	15.607	15.646	15.685	15.724	15.736	15.802	15.840	15.879	15.918	15.957
180	15.996	16.035	16.074	16.113	16.152	16.191	16.230	16.269	16.308	16.347
190	16.386	16.425	16.464	16.503	16.542	16.581	16.620	16.659	16.698	16.737
200	16.776	16.815	16.854	16.893	16.932	16.971	17.010	17.049	17.088	17.127
210	17.166	17.205	17.244	17.283	17.321	17.360	17.399	17.348	17.477	17.516
220	17.555	17.594	17.633	17.672	17.711	17.750	17.789	17.828	17.867	17.906
230	17.945	17.984	18.023	18.062	18.101	18.140	18.179	18.218	18.257	18.296
240	18.335	18.374	18.413	18.452	18.491	18.530	18.569	18.608	18.648	18.687
250	18.726	18.765	18.804	18.843	18.882	18.921	18.960	18.999	18.038	18.077
260	19.116									

RESISTANCE / TEMPERATURE TABLE

NICKEL 120Ω AT 0°C

°C	0	1	2	3	4	5	6	7	8	9
-70	73.10	72.45	71.80	71.15	70.50	69.85	69.20	68.55	67.90	67.25
-60	79.62	78.97	78.31	77.66	77.01	76.36	75.71	75.06	74.40	73.75
-50	86.17	85.51	84.86	84.20	83.55	82.89	82.84	81.58	80.93	80.27
-40	92.76	92.10	91.44	90.78	90.12	89.46	88.80	88.14	87.48	86.83
-30	99.41	98.74	98.07	97.41	96.74	96.07	95.41	94.75	94.08	93.42
-20	106.15	105.47	104.79	104.11	103.44	102.77	102.09	101.42	100.75	100.08
-10	113.00	112.31	111.62	110.93	110.25	109.56	108.87	108.19	107.51	106.83
0	120.00	119.29	118.58	117.88	117.17	116.47	115.77	115.08	114.38	113.69
0	120.00	120.71	121.42	122.13	112.85	123.57	124.28	125.00	125.72	126.45
10	127.17	127.90	128.63	129.36	130.09	130.82	131.56	132.29	133.03	133.77
20	134.52	135.26	136.01	136.76	137.51	138.26	139.02	139.77	140.53	141.29
30	142.06	142.82	143.59	144.36	145.13	145.90	145.68	147.46	148.23	149.01
40	149.79	150.58	151.36	152.15	152.94	153.74	154.53	155.33	156.13	156.93
50	157.74	158.55	159.36	160.17	160.98	161.80	162.62	163.44	164.26	165.08
60	165.90	166.73	167.56	168.38	169.21	170.05	170.88	171.72	172.56	173.40
70	174.25	175.10	175.95	176.80	177.66	178.51	179.37	180.24	181.10	181.97
80	182.84	183.71	184.59	185.46	186.34	187.22	188.10	188.98	189.87	190.75
90	191.64	192.53	194.32	193.42	195.21	196.11	197.01	197.91	198.82	199.73
100	200.64	201.55	202.46	203.38	204.30	205.22	206.14	207.06	207.99	208.92
110	209.85	210.78	211.72	212.66	213.60	214.54	215.49	216.44	217.39	218.34
120	219.29	220.25	221.21	222.17	223.14	224.10	225.07	226.04	227.01	227.99
130	228.96	229.94	230.92	231.90	232.89	233.88	234.87	235.86	236.85	237.85
140	238.85	239.85	240.85	241.86	242.86	243.87	244.88	245.89	246.91	247.93
150	248.95	249.97	251.00	242.02	253.05	254.09	255.12	256.16	257.21	258.25
160	259.30	260.35	261.40	262.45	263.51	264.57	265.63	266.60	267.76	268.83
170	269.91	270.98	272.06	273.14	274.22	275.30	276.39	277.48	278.57	279.67
180	280.77	281.87	282.98	284.09	285.21	286.33	287.45	288.57	289.70	290.83
190	291.96	293.10	294.24	295.38	296.52	297.67	298.82	299.97	301.13	302.29
200	303.46	304.62	305.80	306.97	308.15	309.34	310.52	311.72	312.91	314.11
210	315.31	316.52	317.72	318.94	320.15	321.37	322.59	323.82	325.05	326.29
220	327.53	328.77	330.02	331.27	332.52	335.05	333.78	336.32	337.59	338.86
230	340.14	314.42	342.71	344.00	345.30	346.59	234.90	349.20	350.51	351.82
240	353.14	354.46	355.79	357.12	358.45	359.79	361.13	362.47	363.82	365.18
250	366.53	376.89	369.26	370.62	372.00	373.37	374.75	376.13	377.52	378.91
260	380.31	381.70	385.11	384.52	385.93	387.34	388.77	390.19	391.62	393.05
270	394.49	395.93	379.38	398.82	400.28	401.73	403.19	404.66	406.12	407.60
280	409.07	410.55	412.03	413.52	415.01	416.51	418.01	419.51	421.02	422.53
290	424.05	425.57	427.09	428.62	430.16	431.70	433.24	434.78	436.33	437.89
300	439.44	441.00	442.57	444.13	445.70	447.28	448.86	450.44	452.02	453.61
310	455.20	456.80	458.40	460.00	461.60	463.20	464.80	466.40	468.00	46.60
320	471.20									

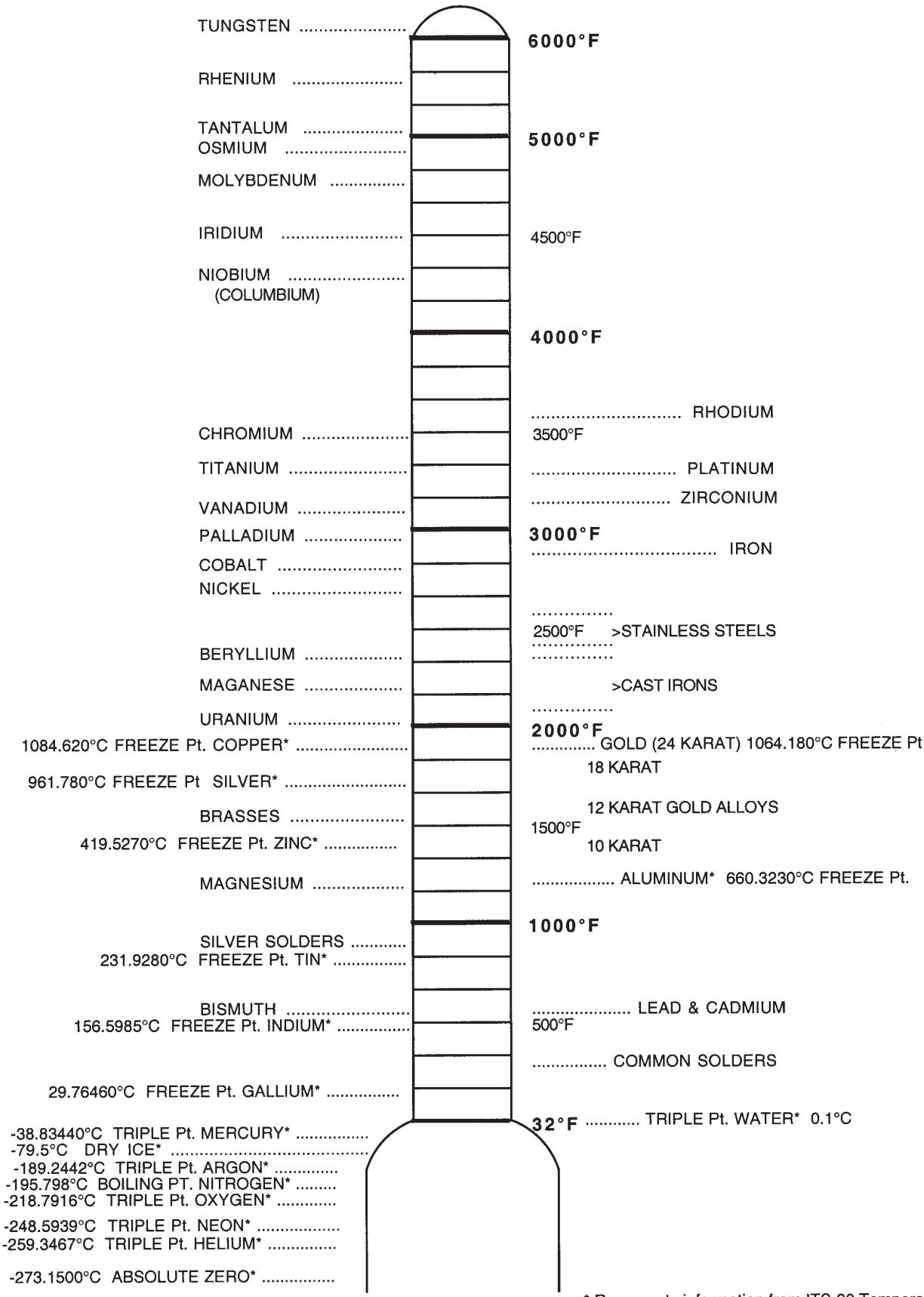
TEMPERATURE CONVERSION TABLE

Read known temperature in bold face type.
Corresponding temperature in degrees
Fahrenheit will be found in column to the right
Corresponding temperature in degrees
Centigrade will be found in column to the left.

C.		F.	C.		F.
0.56	1	1.8	3.33	6	10.8
1.11	2	3.6	3.89	7	12.6
1.67	3	5.4	4.44	8	14.4
2.22	4	7.2	5.00	9	16.2
2.78	5	9.0	5.56	10	18.0

0 to 100						100 to 1000						1000 to 2000						2000 to 3000					
C.		F.	C.		F.	C.		F.	C.		F.	C.		F.	C.		F.	C.		F.	C.		F.
—17.8	0	32	10.0	50	122.0	38	100	212	260	500	932	538	1000	1832	816	1500	2732	1093	2000	3632	1371	2500	4532
—17.2	1	33.8	10.6	51	123.8	43	110	230	266	510	950	543	1010	1850	821	1510	2750	1099	2010	3650	1377	2510	4550
—16.7	2	35.6	11.1	52	125.6	49	120	248	271	520	968	549	1020	1868	827	1520	2768	1104	2020	3668	1382	2520	4568
—16.1	3	37.4	11.7	53	127.4	54	130	266	277	530	986	554	1030	1886	832	1530	2786	1110	2030	3686	1388	2530	4586
—15.6	4	39.2	12.2	54	129.2	60	140	284	282	540	1004	560	1040	1904	838	1540	2804	1116	2040	3704	1393	2540	4604
—15.0	5	41.0	12.8	55	131.0	66	150	302	288	550	1022	566	1050	1922	843	1550	2822	1121	2050	3722	1399	2550	4622
—14.4	6	42.8	13.3	56	132.8	71	160	320	293	560	1040	571	1060	1940	849	1560	2840	1127	2060	3740	1404	2560	4640
—13.9	7	44.6	13.9	57	134.6	77	170	338	299	570	1058	577	1070	1958	854	1570	2858	1132	2070	3758	1410	2570	4658
—13.3	8	46.4	14.4	58	136.4	82	180	356	304	580	1076	582	1080	1976	860	1580	2876	1138	2080	3776	1416	2580	4676
—12.8	9	48.2	15.0	59	138.2	88	190	374	310	590	1094	588	1090	1994	866	1590	2894	1143	2090	3794	1421	2590	4694
—12.2	10	50.0	15.6	60	140.0	93	200	392	316	600	1112	593	1100	2012	871	1600	2912	1149	2100	3812	1427	2600	4712
—11.7	11	51.8	16.1	61	141.8	99	210	410	321	610	1130	599	1110	2030	877	1610	2930	1154	2110	3830	1432	2610	4730
—11.1	12	53.6	16.7	62	143.6	100	212	413	327	620	1148	604	1120	2048	882	1620	2948	1160	2120	3848	1438	2620	4748
—10.6	13	55.4	17.2	63	145.4	104	220	428	332	630	1166	610	1130	2066	888	1630	2966	1166	2130	3866	1443	2630	4766
—10.0	14	57.2	17.8	64	147.2	110	230	446	338	640	1184	616	1140	2084	893	1640	2984	1171	2140	3884	1449	2640	4784
—9.44	15	59.0	18.3	65	149.0	116	240	464	343	650	1202	621	1150	2102	899	1650	3002	1177	2150	3902	1454	2650	4802
—8.89	16	60.8	18.9	66	150.8	121	250	482	349	660	1220	627	1160	2120	904	1660	3020	1182	2160	3920	1460	2660	4820
—8.33	17	62.6	19.4	67	152.6	127	260	500	354	670	1238	632	1170	2138	910	1670	3038	1188	2170	3938	1466	2670	4838
—7.78	18	64.4	20.0	68	154.4	132	270	518	360	680	1256	638	1180	2156	916	1680	3056	1193	2180	3956	1471	2680	4856
—7.22	19	66.2	20.6	69	156.2	138	280	536	366	690	1274	643	1190	2174	921	1690	3074	1199	2190	3974	1477	2690	4874
—6.67	20	68.0	21.1	70	158.0	143	290	554	371	700	1292	649	1200	2192	927	1700	3092	1204	2200	3992	1482	2700	4892
—6.11	21	69.8	21.7	71	159.8	149	300	572	377	710	1310	654	1210	2210	932	1710	3110	1210	2210	4010	1488	2710	4910
—5.56	22	71.6	22.2	72	161.6	154	310	590	382	720	1328	660	1220	2228	938	1720	3128	1216	2220	4028	1493	2720	4928
—5.00	23	73.4	22.8	73	163.4	160	320	608	388	730	1346	666	1230	2246	943	1730	3146	1221	2230	4046	1499	2730	4946
—4.44	24	75.2	23.3	74	165.2	166	330	626	393	740	1364	671	1240	2264	949	1740	3164	1227	2240	4064	1504	2740	4964
—3.89	25	77.0	23.9	75	167.0	171	340	644	399	750	1382	677	1250	2282	954	1750	3182	1232	2250	4082	1510	2750	4982
—3.33	26	78.8	24.4	76	168.8	177	350	662	404	760	1400	682	1260	2300	960	1760	3200	1238	2260	4100	1516	2760	5000
—2.78	27	80.6	25.0	77	170.6	182	360	680	410	770	1418	688	1270	2318	966	1770	3218	1243	2270	4118	1521	2770	5018
—2.22	28	82.4	25.6	78	172.4	188	370	698	416	780	1436	693	1280	2336	971	1780	3236	1249	2280	4136	1527	2780	5036
—1.67	29	84.2	26.1	79	174.2	193	380	716	421	790	1454	699	1290	2354	977	1790	3254	1254	2290	4154	1532	2790	5054
—1.11	30	86.0	26.7	80	176.0	199	390	734	427	800	1472	704	1300	2372	982	1800	3272	1260	2300	4172	1538	2800	5072
—0.56	31	87.8	27.2	81	177.8	204	400	752	432	810	1490	710	1310	2390	988	1810	3290	1266	2310	4190	1543	2810	5090
0	32	89.6	27.8	82	179.6	210	410	770	438	820	1508	716	1320	2408	993	1820	3308	1271	2320	4208	1549	2820	5108
0.56	33	91.4	28.3	83	181.4	216	420	788	443	830	1526	721	1330	2426	999	1830	3326	1277	2330	4226	1554	2830	5126
1.11	34	93.2	28.9	84	183.2	221	430	806	449	840	1544	727	1340	2444	1004	1840	3344	1282	2340	4244	1560	2840	5144
1.67	35	95.0	29.4	85	185.0	227	440	824	454	850	1562	732	1350	2462	1010	1850	3362	1288	2350	4262	1566	2850	5162
2.22	36	96.8	30.0	86	186.8	232	450	842	460	860	1580	738	1360	2480	1016	1860	3380	1293	2360	4280	1571	2860	5180
2.78	37	98.6	30.6	87	188.6	238	460	860	466	870	1598	743	1370	2498	1021	1870	3398	1299	2370	4298	1577	2870	5198
3.33	38	100.4	31.1	88	190.4	243	470	878	471	880	1616	749	1380	2516	1027	1880	3416	1304	2380	4316	1582	2880	5216
3.89	39	102.2	31.7	89	192.2	249	480	896	477	890	1634	754	1390	2534	1032	1890	3434	1310	2390	4334	1588	2890	5234
4.44	40	104.0	32.2	90	194.0	254	490	914	482	900	1652	760	1400	2552	1038	1900	3452	1316	2400	4352	1593	2900	5252
5.00	41	105.8	32.8	91	195.8				488	910	1670	766	1410	2570	1043	1910	3470	1321	2410	4370	1599	2910	5270
5.56	42	107.6	33.3	92	197.6				493	920	1688	771	1420	2588	1049	1920	3488	1327	2420	4388	1604	2920	5288
6.11	43	109.4	33.9	93	199.4				499	930	1706	777	1430	2606	1054	1930	3506	1332	2430	4406	1610	2930	5306
6.67	44	111.2	34.4	94	201.2				504	940	1724	782	1440	2624	1060	1940	3524	1338	2440	4424	1616	2940	5324
7.22	45	113.0	35.0	95	203.0				510	950	1742	788	1450	2642	1066	1950	3542	1343	2450	4442	1621	2950	5342
7.78	46	114.8	35.6	96	204.8				516	960	1760	793	1460	2660	1071	1960	3560	1349	2460	4460	1627	2960	5360
8.33	47	116.6	36.1	97	206.6				521	970	1778	799	1470	2678	1077	1970	3578	1354	2470	4478	1632	2970	5378
8.89	48	118.4	36.7	98	208.4				527	980	1796	804	1480	2696	1082	1980	3596	1360	2480	4496	1638	2980	5396
9.44	49	120.2	37.2	99	210.2				532	990	1814	810	1490	2714	1088	1990	3614	1366	2490	4514	1643	2990	5414
			37.8	100	212.0				538	1000	1832				1093	2000	3632				1649	3000	5432

FREEZING TEMPERATURE OF METALS



* Represents information from ITS-90 Temperaure Scale.

THE INTERNATIONAL SYSTEM OF UNITS (SI)

The information provided below is for convenient reference in providing product specification is SI.

SI Base Units
SI is founded on seven base units:

Quantity	Name of Unit	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	centigrade or fahrenheit	C or F
amount of substance	mole	mole
luminous intensity	candela	cd

There are also two supplementary units:

Quantity	Name of Unit	Symbol_____ ___
plane angle	radian	rad
solid angle	steradian	sr

SI Derived Units
Derived units are formed with base and/or supplementary units.

Quantity	Name	Symbol	Equivalent to __
force	newton	N	$kg \cdot m/s^2$
pressure	pascal	Pa	N/m^2
work, energy, quantity of heat	joule	J	N•m
power, heat flow rate	watt	W	J/s
quantity of electricity	coulomb	C	A•s
electrical potential	volt	V	V/A
electric resistance	ohm	Ω	V/A
electric capacitance	farad	F	C/V
electric conductance	siemens	S	A/V
magnetic flux	weber	Wb	V•s
inductance	henry	H	Wb/A
magnetic flux density	tesla	T	Wb/m^2
frequency	hertz	Hz	1/s
luminous flux	lumen	lm	cd•sr
illuminance	lux	lx	lm/m^2
activity	becquerel	Bq	1/s
absorbed dose	gray	Gy	J/kg

Common Prefixes

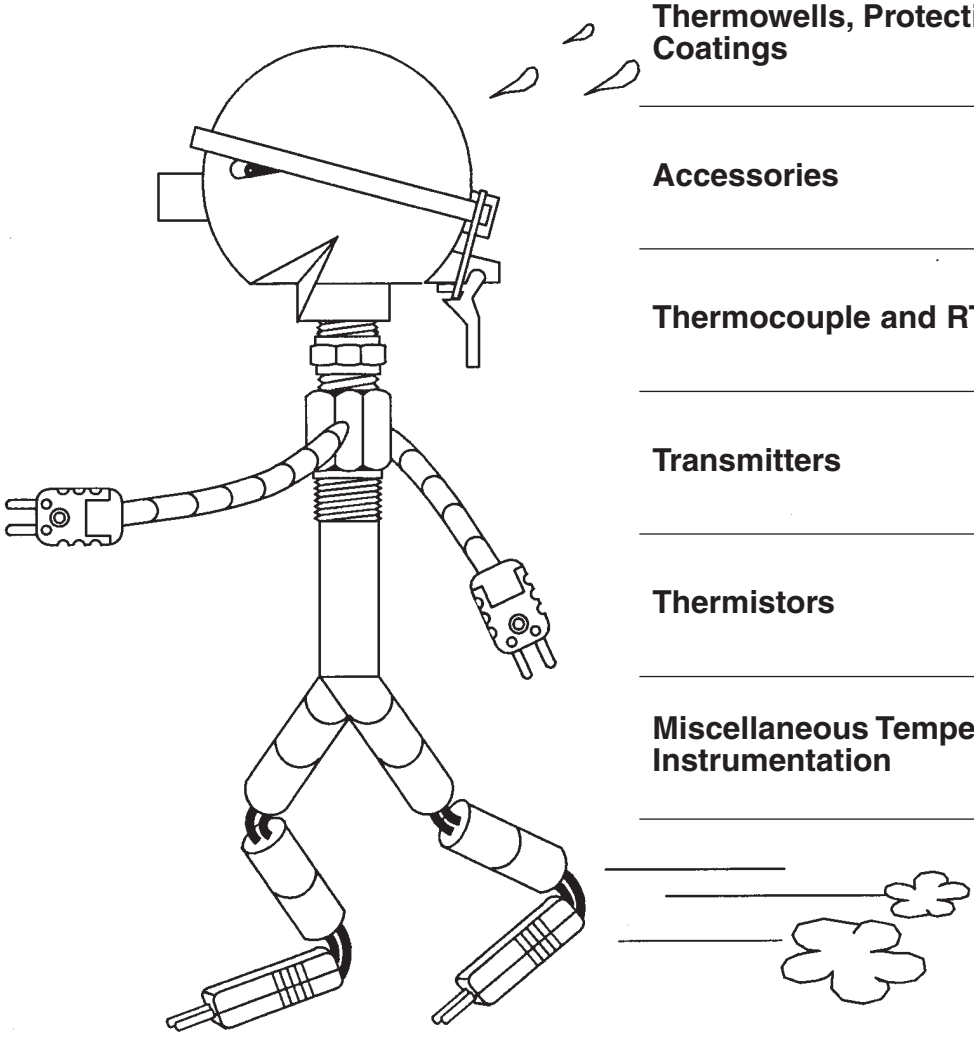
Prefix	Symbol	Means Multiple by	Or by
mega	M	1,000,000	10^6
kilo	k	1,000	10^3
hecto*	h	100	10^2
deka*	da	10	10
deci*	d	0.1	10^{-1}
centi*	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	u	0.000,000,1	10^{-6}

*should be avoided when possible

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Thermocouple and RTD Wire	7
Transmitters	8
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Swifty Sensor



JMS Southeast, Inc.
Temperature Measurement



SECTION 4

Specialty Sensors





SPECIALTY SENSORS

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Continuous Thermocouple Transducer Cable 15
Special and Exotic Thermocouple Selections 17

JMS Southeast endeavors to manufacture very unique sensors to satisfy our customers' application needs. If you don't find the sensor you desire, please contact JMS for assistance.

CUSTOM DESIGN OFF THE SHELF TIME!

For other types of sensors/transducers (infrared, mercury and glass, bimetals, etc.) not manufactured by but available through JMS, See Section 10.

JMS offers 7 different reference probes for laboratory use...

STANDARD PLATINUM RESISTANCE THERMOMETERS

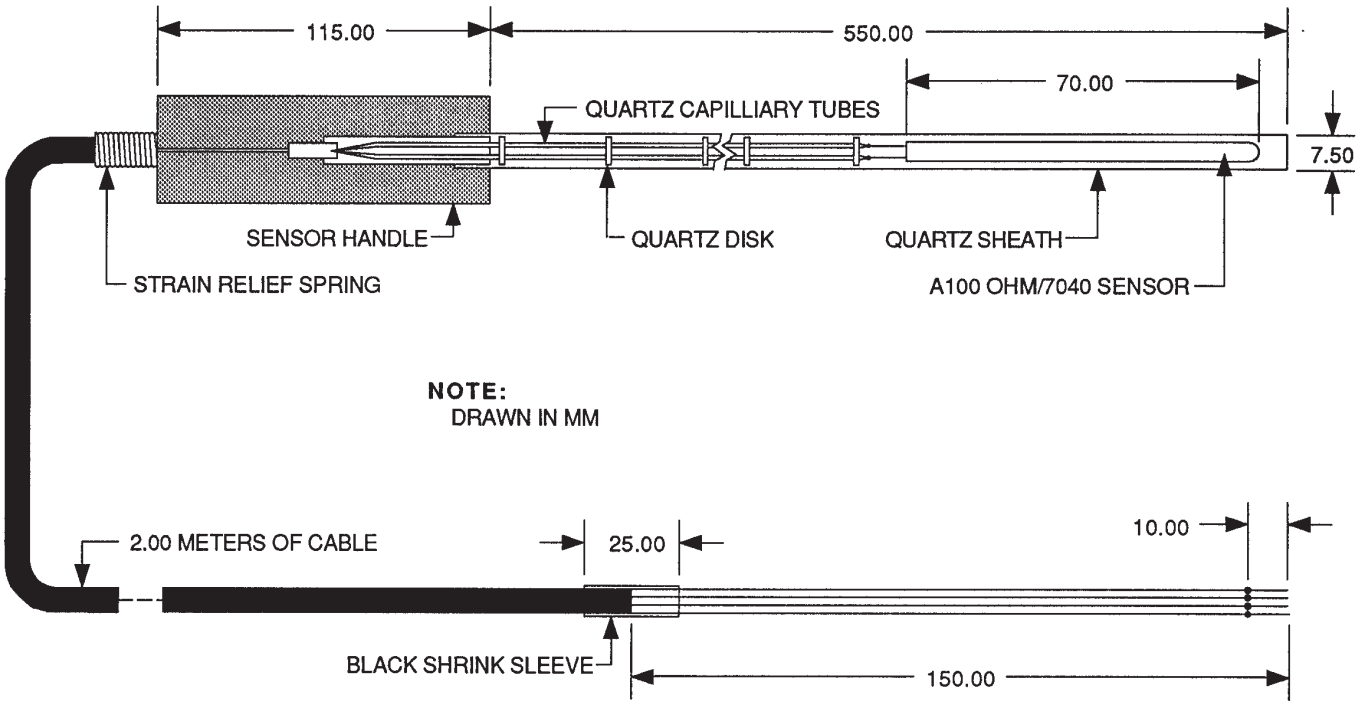
The first and most accurate of the laboratory probes is the SPRT. It has the tightest specifications and is also the most fragile and expensive. Typical drift rates are about 0.001°K annually or about 0.002°C after 100 hours at 660°C.

The SPRT allows the user to realize ITS 90. Our most common unit is the 4ZP model which allows the realization from the boiling point of nitrogen (-195.798°C) to the zinc freezing point (419.527°C). The JMS 4AP unit allows the user to realize ITS 90 from 0°C to the freezing point of aluminum (660.323°C).

Model # [3-21]	R@0°C*	Alpha Coefficient*
4ZP25.5C**	25.5Ω	.003925
4ZP100C**	100Ω	.003925
4AP25.5**	25.5Ω	.003925

* Calibration report will document the exact numbers along with the TPW/MPG ratios.

** The "C" in the part number indicates we will provide calibration. If you intend to send the probe to NIST or some other lab for calibration / certificate, omit the "C"

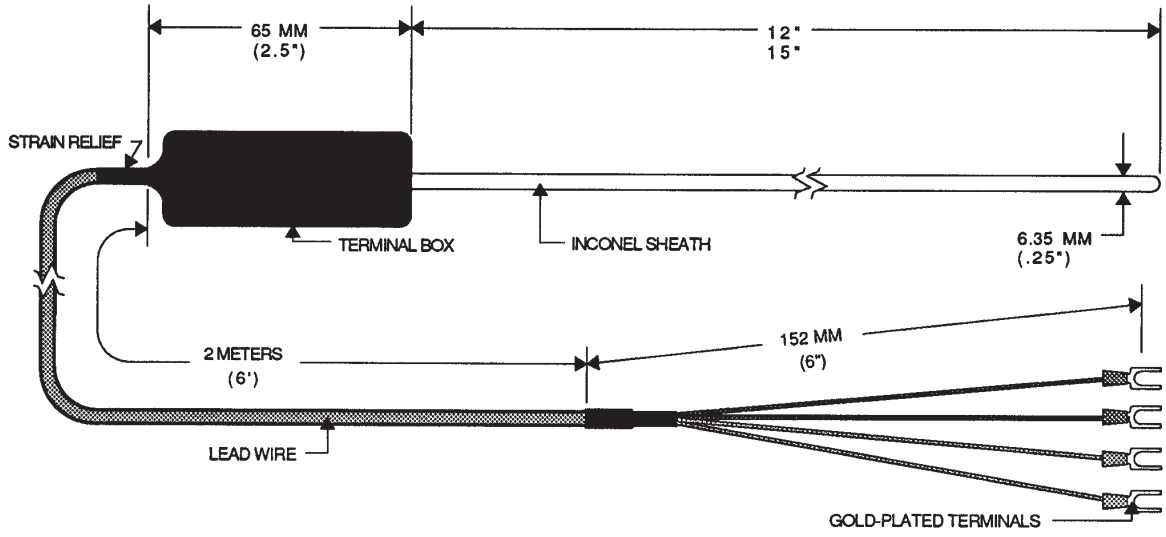


Note: ITS 90 says that an SPRT should have a resistance at melting point of gallium greater than 1.11807 times it's water triple point resistance. That means that you should not use an RTD with a 0.00385 alpha coefficient as an SPRT. However the experience of JMS Southeast indicates that they are great as secondary standards and are described on the following pages.

SECONDARY STANDARD RTD'S

These sensors are intended to be used as the standard for a working laboratory. For instance, JMS uses these types of probes as the reference for our day to day comparison calibrations done on the sensors you use in your processes. We use the SPRT mentioned on the previous page to calibrate and validate this secondary standard.

The secondary standard covers the full range from -200°C to 660°C. It is only slightly more drift prone than the SPRT. (<0.003°C per year or <0.005°C after 500 hours @ 600°C (estimated)) It is much more rugged than the SPRT it has an Inconel 600 sheath, which might not break if dropped on a laboratory floor.



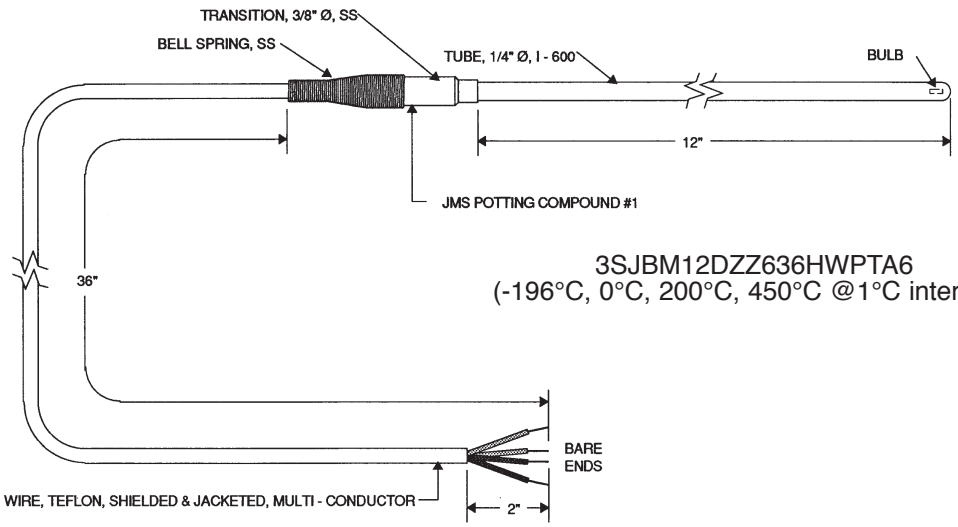
It can be manufactured to any length using the following part numbers:

4SS (length in inches) 25.5 C* (25.5Ω@0°C)
4SS (length in inches) 100 C* (100Ω@0°C)

*indicates a standard calibration will be done using 5 points between -200°C and 600°C. If you intend to send to another lab for calibration, omit the "C".

PRECISION INDUSTRIAL RTD

Our Precision Industrial RTD can be specified by using the pages from the regular RTD section. They can be made in almost any size or shape.

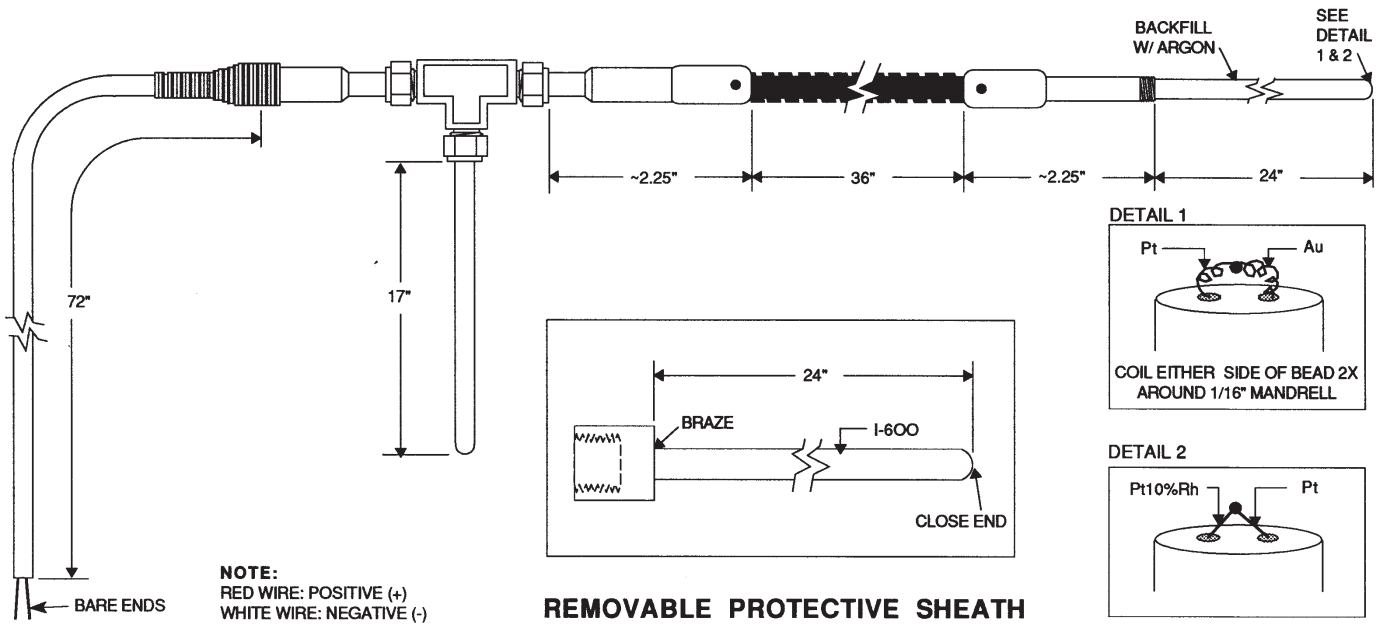


3SJBM12DZZ636HWPTA6
(-196°C, 0°C, 200°C, 450°C @1°C intervals)

JMS STANDARDS THERMOCOUPLE

IPTS 68 allowed the use of type S thermocouples as a method to realize the temperatures above the range of an RTD. ITS 90 does not speak to the use of thermocouples, but they are recognized by many labs as a secondary standard and are great for comparison calibrations. ASTM and NIST still and will continue to recognize the use of Pt/Au and Pt/PtRh in laboratories, and NIST has defined the millivolt tables (Seebeck Coefficients) which are included in section 1 of this catalog. These tables are taken from ASTM E-1751 and ASTM E-230.

Use the appropriate drawing number to order.



These two referenced sensors are an excellent choice for comparing calibration equations in an industrial facility. An accurate and traceable millivolt meter plus one of these probes is all you need to do a totally accurate and effective standards traceable calibration.

Comparison of compositions of probes

JMS Part #4PTAUC*	JMS Part #4PTRHC*
Pt/Au	Pt/PtRh
0 - 1000°C	0 - 1450°C
Non alloyed metals	Higher range
Calibration extremely close to standard	
±0.2°C or better	±1.0°C or better

*A calibration is supplied with any probe and for no calibration, omit the C in the part #.

See Section 1 for temperature / EMF Tables.

SINTERING, FURNACE & GLASS THERMOCOUPLES

#1	SERIES
4G	Sintering, furnace & glass thermocouple (Purged and packed with high temperature inert gas.)

#2	TYPE
S	Platinum/Platinum 10% Rhodium
R	Platinum/Platinum 13% Rhodium
B	Platinum 6% Rhodium/Platinum 30% Rhodium
C	Tungsten 5% Rhenium/Tungsten 26% Rhenium
X	Other, specify

#3	OUTSIDE DIAMETER
B	1/4" (Standard)
C	3/16"
D	1/8"
E	1/16"
F	1/25"
X	Other, specify
Z	N/A

#4	SHEATH MATERIAL
A	Platinum - 10% Rhodium
B	Platinum - 20% Rhodium
R	Molybdenum (purged)
S	Tantalum
T	Titanium
M	Inconel 600
X	Other, specify

#5	THERMOCOUPLE JUNCTION
G	Grounded
U	Ungrounded (Standard)

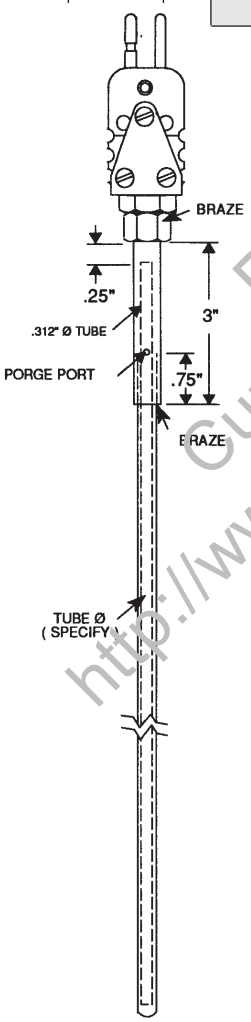
#6	IMMERSION LENGTH
__"	Length in inches

#7	INSULATION
M	MgO
A	Al2O3 (Standard)
B	BeO
H	HfO2
X	Other, specify

#8	FITTINGS
Z	No Fitting (Standard)
F	Reverse mounted steel plug fixed for attaching head
G	Fixed stainless steel to sheath } Fit on .312 diameter section of drawing.
H	Compression fitting ss w/ ss ferrule } Fit on .312 diameter section of drawing.
X	Other, specify

#9	PROCESS NPT
A	1/2
B	1/4
C	1/8
X	Other, specify
Z	N/A (Standard)

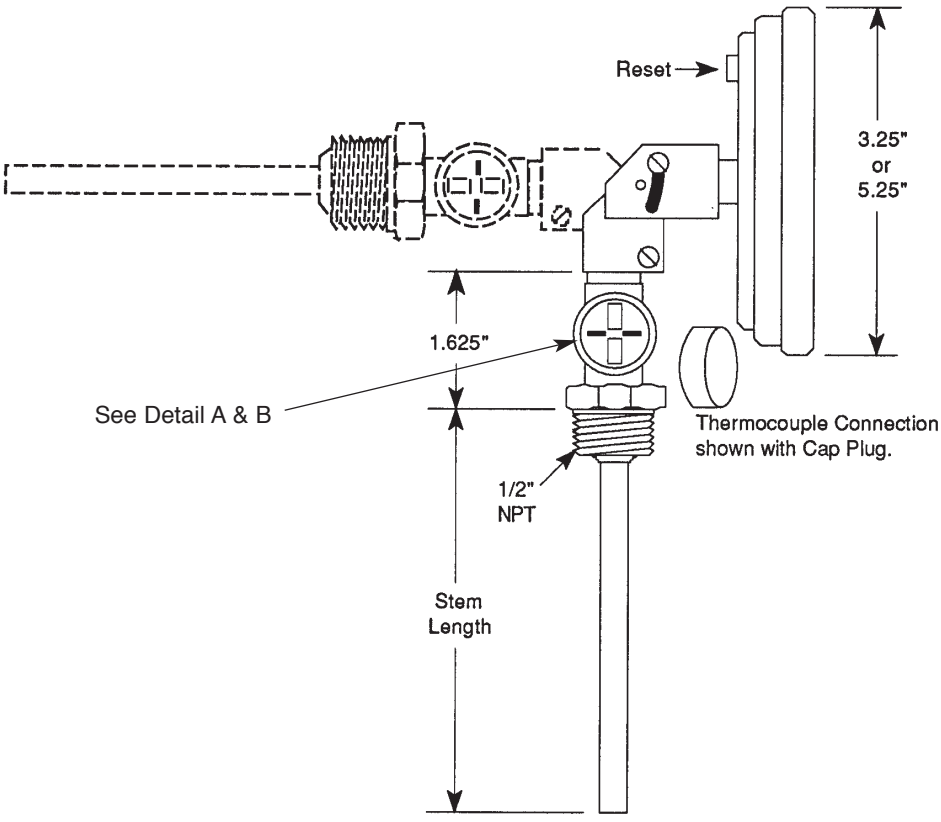
#10	COLD END TERMINATION
C	Standard plug
F	Hi temp std plug (Standard)
I	Explosion proof Nema 7 head
L	Aluminum head w/ hinged cover
M	Aluminum head w/ screw cover & chain
N	Cast iron head w/ screw cover
X	Other, specify



4G	S	B	R	U	14"	A	Z	A	F	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

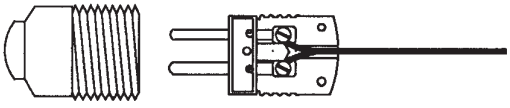
ANALOG BEMOMETER



Unites Bimetal with Either Thermocouple or RTD Technology!

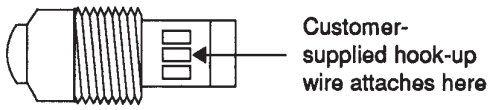
- **Bimetal Dependability**
- **Thermocouple / RTD Accuracy**
- **Direct AND Electronic Reading**
- **Easy To Use**
- **Easy To Calibrate**
- **Two Sensors in One Instrument**

Thermocouple Connection



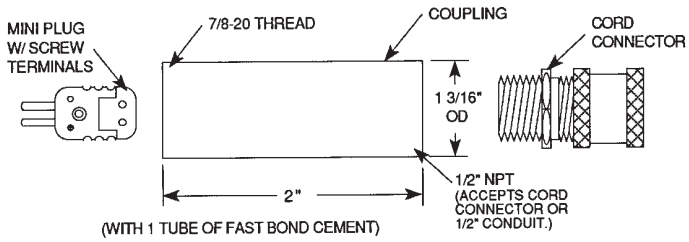
Subminiature T/C Plug
(Shown with cover off)

RTD Terminal Block Connection (3 pos.)



Permanent Wiring Kit

Detail A



Detail B

This thermometer combines the convenience, simplicity, and self-powered actuation of a bimetal thermometer with the digital accuracy and data acquisition capabilities of a thermocouple or RTD. With standards traceable to the NIST, this new instrument offers simplified calibration for ISO 9000 compliance and other statistical process control requirements. It is also ideal in applications requiring easy and quick readability while still affording a means of electronic data acquisition. There is no need to add access points or thermowells to your existing process in order to gain different types or readings. Plus two temperature sensors to work at each location.

This is available with a 3" or 5" dial, in a Back Connected or Adjustable angle case, 1/4" stem diameter in lengths to 12", 1/2" NPT connection, in ranges from -100°F (-70°C) to 500°F (260°C), with Fahrenheit, Celsius and Dual Scale Dials available. Thermocouple output may be accessed via a plug-in connector; RTD output is accessed by a terminal block. Both have 1/2" conduit threaded mounting and a plastic cap standard. Optional weatherproof housing is available. Construction is of type 304 series stainless steel with a glass crystal. It is hermetically sealed per ASME B40.3 standard. It also comes with a one-year warranty.

ANALOG BEMOMETER

How To Order Your Adjustable Angle Bemometer:

KEY MODEL NUMBER: ***30 060 0 01 K - PWK*** *(Optional)*
Permanent Wiring Kit

Table 1: Basic Model
Table 2: Stem Length
Table 3: Scale Type (F, C or F&C)
Table 4: Range
Table 5: Sensor Type

Table 1 - Model

KEY	DESCRIPTION
30	3” Back connection (with reset)
32	3” Adjustable angle (with reset)
50	5” Back connection (with reset)
52	5” Adjustable angle (with reset)

Table 2 - Stem Length

KEY	DESCRIPTION - Max. 12”
4	
6	
9	Length in inches
12	
X	Other, specify

Table 3 - Scale Type

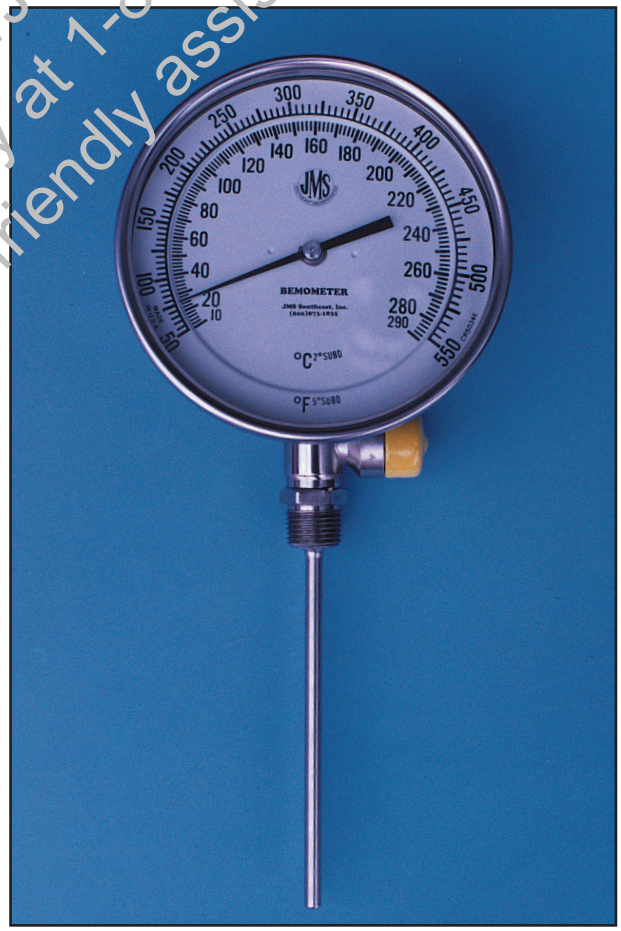
KEY	DESCRIPTION
0	Dual scale Fahrenheit and Celsius
1	Single scale Celsius only
2	Single scale Fahrenheit only

Table 4 - Standard Ranges

KEY	DESCRIPTION		
	Dual scale F/C	Celsius only	Fahrenheit only
01	-100/150F & -70/70c	-70/70c	-100/150
02	-40/120F & -40/50C	-50/50C	-40/120F
03	25/125F & -5/50C	0/50C	25/125F
04	0/140F & -20/60C		0/140F
05	0/200F & -15/90C	0/100C	0/200F
06	0/250F & -20/120C	-20/120C	0/250F
07	20/240F & -5/115C		20/240F
08	50/300F & 10/150C	0/150C	50/300F
09	50/400F & 10/200C	0/200C	50/400F
10	50/500F & 10/260C	0/250C	50/500F

Table 5 - Sensor Type

KEY	DESCRIPTION
J	Thermocouple output, Type J
K	Thermocouple output, Type K
E	Thermocouple output, Type E
T	Thermocouple output, Type T
3	100Ω PTD output, 3 wire



Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

COMBINATION THERMOCOUPLES AND RTD'S

JMS Southeast, Inc., manufactures a sensor that contains both a thermocouple and an RTD. The standard design allows the user to check and validate readings with one sensor while using another type for control or monitoring. Although two thermocouples can be used simultaneously, it is not advisable to use the thermocouple and RTD at the same time.

This type of sensor can be used in applications that require two different inputs. One advantage of this system is that the conditions which adversely affect a thermocouple may not affect the RTD and vice versa. Therefore, combination sensors provide a back-up sensor in the same probe. In extremely high temperature applications, this procedure is not recommended. JMS Southeast can also manufacture triple elements of just about any combination. Contact JMS for details.

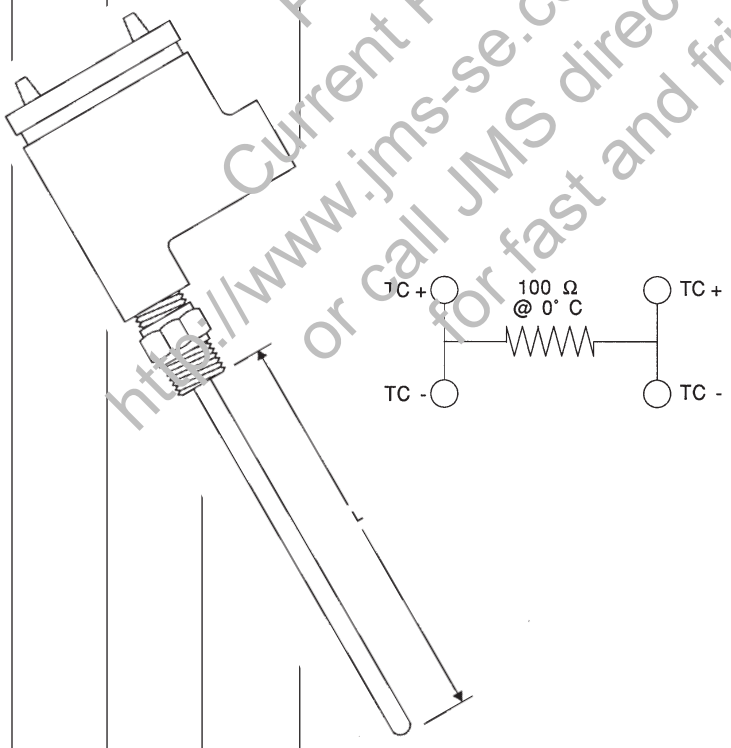
There are three types of popular transmitters which accept this sensor directly. We recommend our 8B (AI-2000) and the 8A (AI-1000).

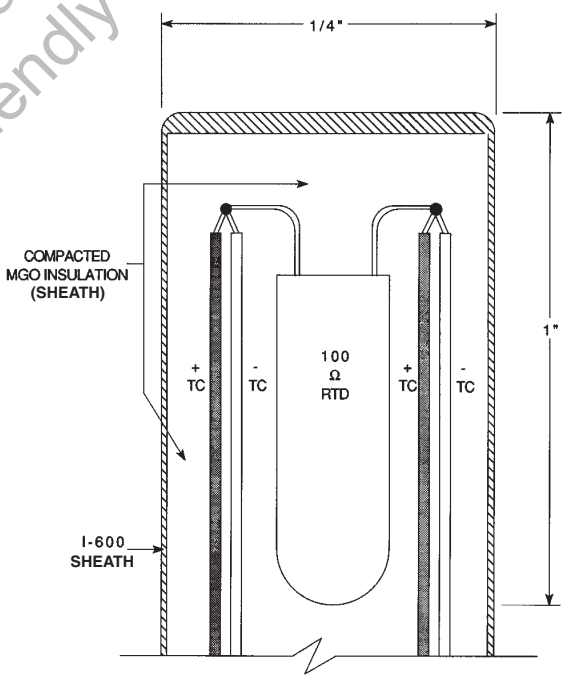
#1	SERIES
4C	Combination, 4 wire, dual element, 1/4" diameter, ungrounded/ non isolated thermocouple and RTD

#2	THERMOCOUPLE TYPE
J	Dual element J thermocouple
K	Dual element K thermocouple
T	Dual element T thermocouple
N	Dual element N thermocouple
X	Other, specify

#3	RTD TYPE
3	Single element 100Ω Platinum RTD (.00385)
X	Other, specify

#4	TEMPERATURE LIMITS
1	Hollow tube < 550° F (T/C's and RTD's are not electrically connected)
2	Sheath <1200°F (Type K & N thermocouples only)





4C	J	3	1	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

COMBINATION THERMOCOUPLES AND RTD'S

#5	IMMERSION LENGTH (L)
--"	Immersion in inches

#6	STANDARD INDUSTRIAL FITTING
S	Spring loaded 1/2"x x1/2" NPT SS fitting
W	Welded 1/2" x 1/2" NPT SS fitting
B	Bayonet style (standard) 1/2" process connection
	COMPRESSION FITTINGS
H	Stainless steel with SS ferrule - 1/8" NPT
M	Stainless steel with SS ferrule - 1/4" NPT
P	Stainless steel with SS ferrule - 1/2" NPT
X	Other, specify

#7	LEAD WIRE INSULATION AND LENGTH IN INCHES [3-2]
Z	No lead wire
1__"	Kapton - Standard for hollow tube
3__"	Teflon
6__"	Kapton/flex armor overall
X	Other, specify

#8	TYPE OF TRANSITION [1-16, 3-14]	
T	3/8" OD	**Note:** For extra high humidity / moisture environments, put a "2" after your selection. [See page 3-14] For high temperature at the transition area use X + type of transition and maximum temperature.
X	Other,specify	
Z	No transition	

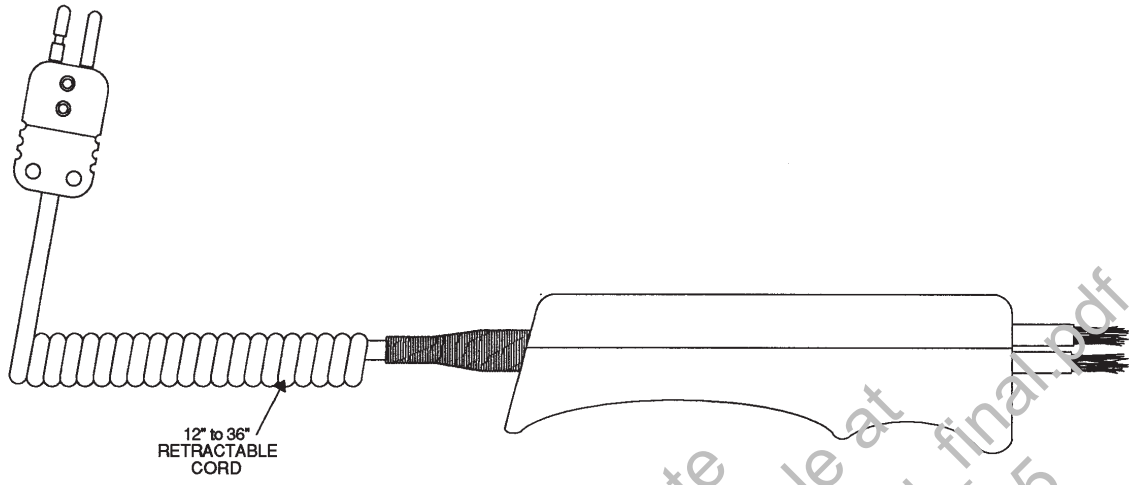
#9	COLD END TERMINATION [SEE SECTION 6] Pick as many as applicable	
A	Bare ends	Use double symbol here for matching female connector. i.e. W/WW (male with matching female).
I	Explosion proof Nema 7 head (6I / 6B2)	
K	Spade lugs (6S_)	
L	Aluminum head w/ hinged cover (6L / 6N1B)	
M	Aluminum head w/ screw cover & chain (6M / 6G)	
N	Cast iron head w/ screw cover (6N / 6G)	
O	Open ceramic terminal block (6N)	
Q	Black nylon Nema 4 head (6Q / 6C)	
R	High dome head (6R)	**Note:** For any other cold end termination, use appropriate part numbers from section 6 in place of symbol #9.
V	Hermetic connector (6DC) Male*	
W	Microphone style connector (6DA) Male*	
X	Other, specify	

#10	TAGGING AND CALIBRATION OPTIONS (USE ONLY IF APPLICABLE)
___	See page 4-9 #14 for ordering selections.

12"	W	Z	Z	N		

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/JMS_Catalog_final.pdf
or call JMS directly at 1-800-826-1835
for fast and friendly assistance

BRUSH THERMOCOUPLES



SECTION 4

The JMS Brush Thermocouple can be used in applications in which a surface temperature of a stationary or moving electrically conducting surface is needed.

True temperature measurement of a surface is very hard to obtain. Previous designs called for the probe to fully contact with as small a junction as possible, spring load with as even pressure as possible, insulate around the surface to be measured, or combinations of all these methods.

All of the above methods have proven to have their own particular faults. When compared to an infrared sensor, which does accurately measure surface temperature (unit must have correct emissivity adjustment), most of these above mentioned sensors either read much hotter or colder than the infrared. However, even the infrared style exhibits problems when emissivity levels fall beneath .4 or less (most metallic surfaces).

JMS has applied for a patent on this brush sensor because of its unique design and widespread application, i.e., molds, rolls, bearings, nozzles, plates, dies, engines, etc., it is usually preferred in a hand held design, but can be adapted for permanent mounting.

Standard calibration for this sensor is usually K because of its resistance to corrosion and stiffness. But any type thermocouple may utilize this design. Call or write for further information.

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-876-1835
for fast and friendly assistance.

#1	SERIES
4B	Specialty brush sensor

#2	TYPE
J	Iron/Constantan
K	Chromel/Alumel (Standard)
X	Other, specify

#3	DESIGN
S	Standard handle, 12" polyvinyl coil cord. Length will stretch from 12" to 36"
X	Other, specify

#4	COLD END TERMINATION
A	Bare ends
B	Miniature plug (Standard)
C	Standard plug

#5	REPLACEMENT BRUSHES
0	None
1 +	Number of sets of replacement brushes

For replacement brushes only, use part #4B___ZZ.

4B	K	S	B	2	

PAD RTD'S

The JMS pad RTD is a speciality sensor which provides a fast response surface measurement. It is a 100 ohm platinum RTD with an alpha of .00385 Ω/Ω/°C. Pad material is fiberglass coated with a silicon rubber.

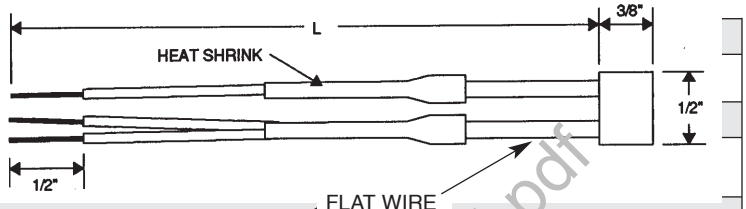
The pad RTD has an effective operating range from -200°C to 250°C and its tolerance is .1%. Additional teflon leadwire is configured as a 3 wire RTD.

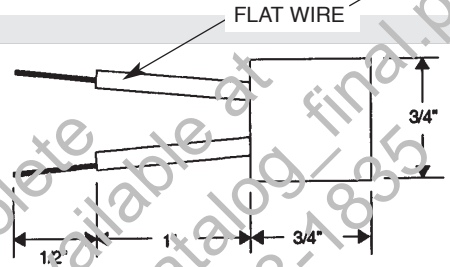
#1	SERIES
4PAD	JMS pad RTD

#2	PAD DIMENSIONS
T	3/4" x 3/4", .05" Thick
L	1/2" W x 3/8" L, .05" Thick

#3	LENGTH OF LEADWIRE
Z	Standard 1"
X	Other, specify length in inches

4PAD	T	Z





MULTIPOINT SENSOR ASSEMBLIES

A multipoint sensor allows the measurement of a temperature profile across a large area. Thermocouples or RTD's are arranged with measuring junctions at various points along a pipe, allowing the measurement of various points from a complete assembly.

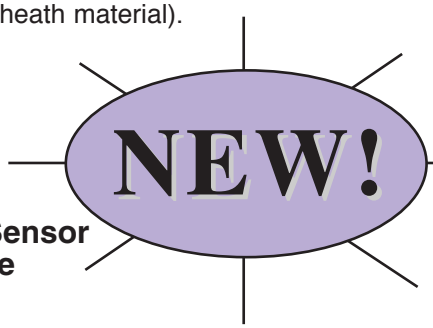
Many elements can be spaced along a probe. This opens up possibilities for improved profiling in catalytic reactors, for example, where flow interference prevents inserting large numbers of individual probes.

Multipoint probes can also be used to give a temperature profile where stratification of a tanks contents may be of concern.

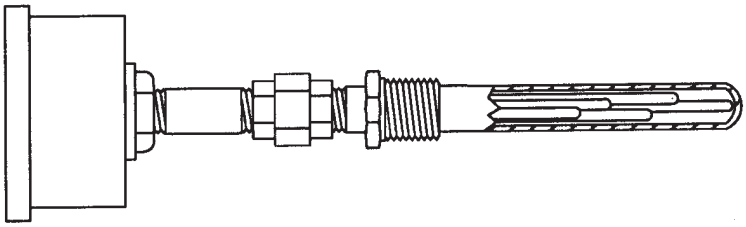
JMS will custom design your assembly to give you the most accurate temperature measurement for your process.

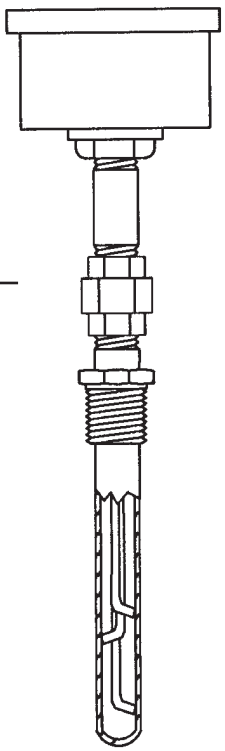
The following information and/or drawing is needed to properly design your assembly.

—Thermocouple calibration or RTD element type
—Outside diameter of pipe and pipe material.
—Number of elements required and lengths.
—Junction style of thermocouple.
—Sensor material (base wire, 316 SS tubing, or sheath material).
—Overall length of the entire assembly.
—Process connection.
—Accuracy required.
—Cold-end termination.
—Maximum operating temperature.



Removable / Replaceable Sensor Design - Now Available





Note: JMS has a proprietary design which assures consistent response time for each probe, plus removability for recalibration. Call and ask about it!

Part Numbers Obsolete
Current Part Numbers available at
http://www.jmsse.com/pdf/JMS_Catalog_final.pdf
or call JMS directly @ 1-800-873-1835
for fast and friendly assistance.

HAND HELD SENSORS

DESCRIPTION
The standard JMS hand held sensor is 316 stainless steel.

#1	SERIES
4H	Hand held sensor

#2	TYPE
J	Iron/Constantan, standard limits of error
K	Chromel/Alumel, standard limits of error
T	Copper/Constantan, standard limits of error
E	Chromel/Constantan, standard limits of error
3	RTD 100Ω Platinum .00385 alpha, 3 wire, .12% accuracy
X	Other, specify

#3	OUTSIDE DIAMETER
A	3/8" (.375")
B	1/4" (.250")
C	3/16" (.188")
D	1/8" (.125")
E	1/16" (.063")
X	Other, specify

#4	LENGTH OF SHEATH [L]
--"	Length in inches

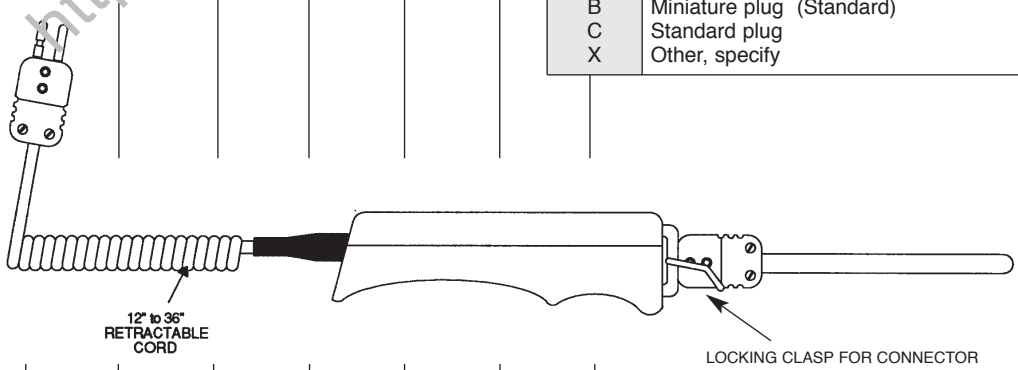
#5	MEASURING JUNCTION
G	Grounded
U	Ungrounded (RTD's are always ungrounded)
E	Exposed
X	See order symbols on Page 1-13 for special junctions such as pointed tip and gas/air.

#6	PRESENCE OF HANDLE
H	Handle
X	Other, specify
Z	N/A

#7	LEAD WIRE INSULATION AND LENGTH IN INCHES
S	Coil-cord, length will stretch from 12" to 36" (Standard)
2__"	20 awg PVC
3__"	20 awg Teflon
5__"	20 awg Kapton
6__"	20 awg Glass braid/Flexible armor overall
7__"	20 awg Teflon/Flexible armor overall
8__"	20 awg Glass braid/Stainless steel overbraid
9__"	3 conductor Teflon with overall jacket of Teflon (RTD only)
10__"	3 conductor Teflon/Stainless steel overbraid with overall jacket of Teflon. (RTD only)
X	Other, specify

#8	COLD END TERMINATION
A	Bare ends
B	Miniature plug (Standard)
C	Standard plug
X	Other, specify

Other styles of hand-held sensors are available. Contact JMS Southeast, Inc. for your custom design.



4H	J	B	6"	G	H	9-36"	B	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

SURFACE PROBES

JMS offers this standard surface probe as an option to the brush sensor (also included in this section) for surface temperature measurements.

Most all of these types of probes have a common weakness. Since the tips must remain in contact with the surface being measured, the tips are prone to damage and failure. Unlike our competitors, our design allows you to easily replace the tip and get back to business.

#1	SERIES
4	Surface Measurement Thermocouple

#2	STYLE
A	Hand Held
B	Permanent Mount

#3	TYPE
J	Iron/Constantan, standard limits of error
K	Chromel/Alumel, standard limits of error
X	Other, specify

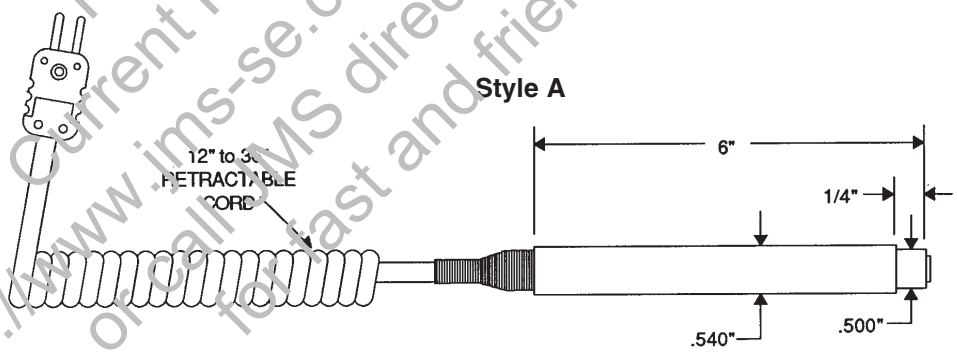
#4	LENGTH
2	Standard
X	Other, specify

#5	LEAD WIRE INSULATION AND LENGTH IN INCHES
S	Standard retractable cord. 12" - 36" long (PVC)
X	Other, specify
Z	N/A (For Style B)

#6	COLD END TERMINATION
B	Miniature plug (Standard for Style A)
X	Other, specify
Z	N/A (For Style B)

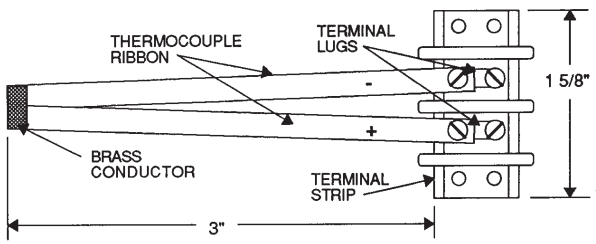
#7	# OF REPLACEMENT TIPS
0	None
1 - 9	Number of tips

Style A



Enlarged End View

Style B



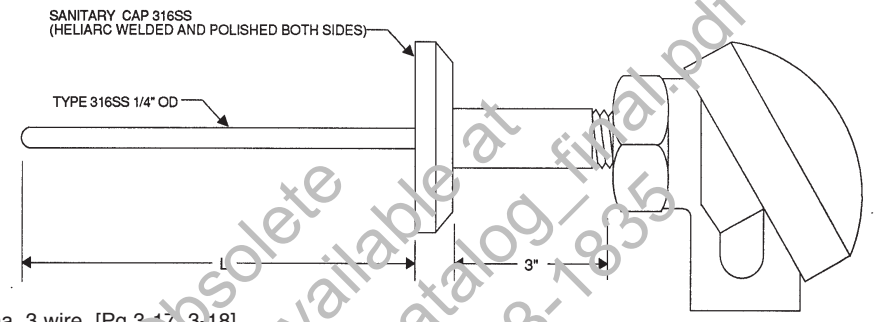
4	A	J	2	S	B	1	

Part Numbers Obsolete
Current Part Numbers available at
http://www.ims-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

3A APPROVED SANITARY SENSORS

CIP (clean-in-place) line of 3-A certified sanitary thermocouples and RTD's from JMS are specially designed to meet the needs of the food, dairy, beverage, pharmaceutical, chemical and cosmetic industries. They are ideally suited for a number of applications where corrosion and contamination are factors. They are fabricated from stainless steel using a method assuring imperfection-free surfaces.

Units may be supplied utilizing sanitary caps from Alloy Products, Cherry-Burrell or Lapish Tri-Clover, or spring loaded fittings in sanitary thermowells. Each design is polished to a No. 4 finish to assure that there are no pits, folds or crevices. The exterior nipple, also stainless steel, can be joined to a coated or plastic connection head, designed to withstand caustic washdown. A typical RTD or Thermocouple may be used with a sanitary thermowell, see pages 1-1 and 3-1.



SECTION 4

#1	SERIES
4A	Sanitary Sensors

#2	TYPE
J	Iron/Constantan
K	Chromel/Alumel
T	Copper/Constantan
E	Chromel/Constantan
3	RTD 100Ω Platinum .00385 alpha, 3 wire [Pg 3-17, 3-18]
X	Other, specify

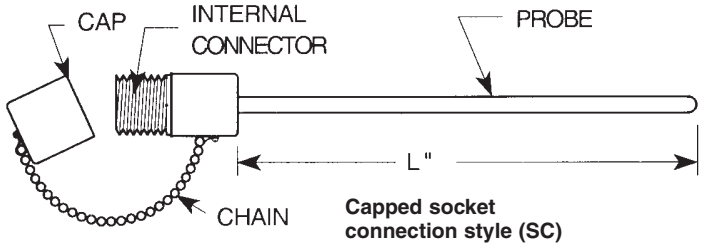
#3	LIMITS OF ERROR	ELEMENT CONSTRUCTION
1	Standard	Single
2	Standard	Dual
3	Special	Single
4	Special	Dual
X	Other, specify	

#4	MEASURING JUNCTION
G	Grounded
U	Ungrounded
I	Isolated
	Note: RTD is always ungrounded from tubing.

#5	IMMERSION LENGTH (L)
--"	Length in inches

#6	SANITARY CAP OPTIONS - CLAMP FITTINGS
A	Alloy Products (K16A)
B	Cherry-Burrell (16AI-14I) (Must specify standard or screwed)
T	Tri-Clover (16 AMP)
	SANITARY CAP OPTIONS - BEVEL SEAT FITTINGS
U	Alloy Products (16APV with No. 13H Nut) } SEE NOTE 1
V	Cherry-Burrell (16A-14 with No. 13H Nut) } SEE NOTE 1
Y	Tri-Clover (16A with No. 13H Nut) } SEE NOTE 1
	STANDARD INDUSTRIAL FITTINGS
R	Spring loaded with 1/2" x 1/2" NPT 4" nipple (To be used with a sanitary thermowell. See page 5-5.)
X	Other, specify
Z	N/A

Note 1: All caps are mounted facing the hot end unless specified here.
ie. Use X + brand of cap + reverse mount

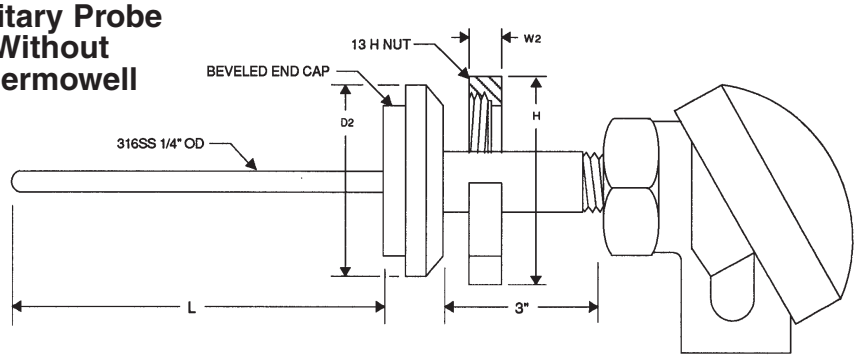


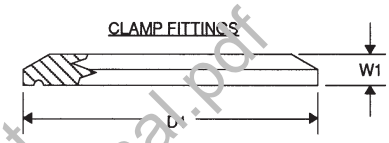
Capped socket connection style (SC)

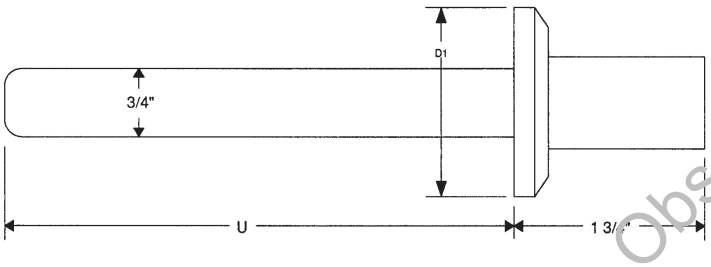
4A	J	1	G	12"	A	

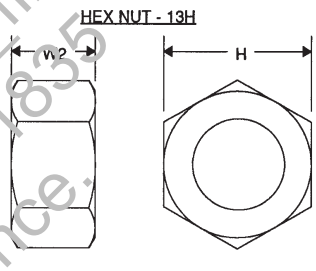
Part Numbers Obsolete
Current part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

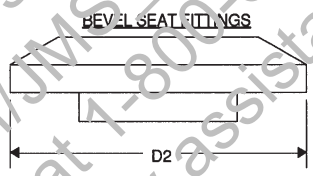
Sanitary Probe Without Thermowell











Standard Industrial Sanitary Thermowells

[See 5-5 and 5-6 for ordering info on TWells]

#7	CAP TUBE SIZE	CLAMP FITTING A (inches)	B	BEVEL SEAT FITTING A (inches)	B	HEX NUT - 13H A (inches)	B
15	1 1/2"	.250	1.984	1.844	N/A	31/32	2.4062
20	2"	.250	2.516	2.375	N/A	.250	3
25	2 1/2"	.250	3.047	2.906	N/A	.250	3.5938
30	3"	.250	3.579	3.438	N/A	.250	4.1875
40	4"	.312	4.682	4.500	N/A	.312	5.4375
Z	Not Applicable						
X	Other, specify						

#8	FINISH
H	#4 Finish (Standard)
E	Electropolish
P	Passivate (includes #4 Finish)

#9	LEAD WIRE TYPE AND LENGTH IN INCHES	MAX. TEMP. °F
Z	No lead wire	
1__"	Glass braid	900°F
3__"	Teflon	400°F
X	Other, specify	

#10	COLD END TERMINATION
A	Bare ends
6P	Epoxy coated cast head with gasket
WP	White plastic head (3A Standard)
SC	Capped socket connection (with mating connection) - See Pg. 4-13
X	Other, specify*

***When specifying another style connection head or no head, be sure to observe requirements and restrictions as imposed by the 3-A Standard #09-09.**

15	H	3-36"	A	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

CONTINUOUS THERMOCOUPLE TRANSDUCER CABLE

FTLD® - The Heat-Seeking Thermocouple

SECTION 4

Introduction

The FLTD Continuous Thermocouple® is a temperature measuring sensor, which takes the form of a thin flexible cable. Like its predecessor CT²C®, it is a heat-seeking thermocouple, using similar thermo-electric techniques, but designed especially to reveal changes in the narrow band of temperatures only a few degrees above normal ambient.

FTLD is able to measure the maximum temperature detected between its two ends, then track any increase, even if the position of the "hot-spot" changes. Such ability offers an immense opportunity to prevent loss due to overheat, in commercial as well as industrial applications.

This advanced form of dector permits the design of overheat warning systems, which are highly sensitive to early departures from normal, yet exhibit an extraordinary freedom from false alarms.

Operating Principle

A Circuit formed from two dissimilar wires joined at both ends, develops an emf (voltage) proportional to the difference in the two junction temperatures. This is the long established Thermo-electric effect, and today the junctions are known as the "Measuring Junction". See diagrams below.

Although an FTLD sensor performs like a normal thermocouple, the measuring junction is not formed by directly joining the two wires. More remarkably, the Measuring Junction is not fixed, but becomes concentrated at the hottest point within the insulation resistance when subjected to an increase in temperature.

The nature of the insulation causing this phenomenon is such that the voltage developed between the two wires always relates to the highest temperature along the cable sheath.

Features

Stable

Moisture resistant

Sensor needs no power

Virtually free from false alarms

Ambient temperature compensation

Early warning of abnormal temperature

Alarm point unaffected by cold weather

Simple apparatus (Hazardous Area)

User adjustable alarm settings

No site calibration

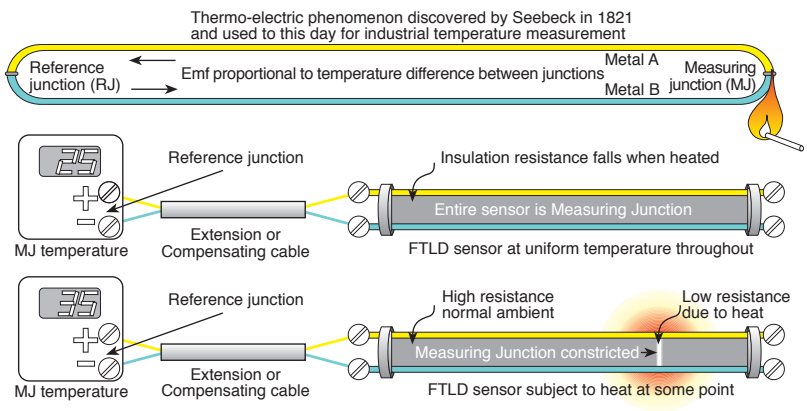
Advantages

Self-generating temperature sensor
Measures maximum temperature
Initial site temperature check not needed
Visible operating status
Optional rate of change alarm (same unit)
Alarm settings directly in degrees
Alarms can be set before installation
Interchangeable sensors
Sensor not microphonic
System check facility in sub zero band
Alarm units for mains power or low voltage
Sensor need not be near alarm unit

Specification

Protective sheath -	Dual layer PTFE
Measuring element -	Type "K" thermocouple - insulated
Sensor output -	Millivolts DC related to maximum cable temperature
Normal operating range -	-29 to 80°C (-20 to 176°F)
Survival range -	-40 to 200°C (-40 to 392°F)
EMI protection -	Twisted cores & metallised tape tube
Insulation -	Glass fibre impregnated with special insulating material
Minimum bend radius -	40 mm
Construction -	Twisted pair, NTC insulation, EMI screen, outer sheath
Sizes -	3.5mm OD approx. Cut to length as required
Minimum length -	15 meters
Hazardous area use -	Measuring element is "Simple Apparatus"

FTLD® - System Operating Principle



By measuring both the sensor output and the temperature at its own terminals the instrument is able to compute the hot spot temperature and make automatic compensation for ambient temperature changes

FTLD® - Prevention of Loss due to Overheat

Think of your sphere of work, look around you - is there more you can do?

The Application

Temperature rise due to unrestrained release of physical or chemical energy, is a regular cause of serious loss in industry, commerce and everyday life. It is responsible for countless incidents, the financial consequences of which range from minor to catastrophic.

One common example of temperature rise ending in loss, is combustion. Some others are wear, distortion, fracture, melting, drying, and seizure.

Breakdown at temperatures well below the boiling point of water, is an area of particular concern - one where losses from shutdown can be enormous. For example, temperatures at which ordinary heat detectors remain dormant, can destroy the electronics crucial to computers, communications and data handling equipment.

For many years point type temperature detectors of various types, including conventional thermocouples, have been used to monitor processes and plant risk from heat induced damage. In almost every case the inevitable compromise between numbers (cost), and detector coverage (efficiency), has defeated the exercise.

FTLD offers a very powerful and cost effective alternative to any currently available system, by eliminating the question of where to place the sensor; by constantly monitoring maximum temperature in the area covered; and by possessing such stability, that false alarms are virtually non-existent.

Very often, a loss-inducing condition begins with temperature rising very slowly above normal for the installation at risk. This is the time when corrective action has the greatest chance of success. An FTLD system capitalizes on this opportunity by alerting operating personnel to the onset of a dangerous condition, some time before the main danger temperature alarm is initiated.

Areas of Risk

Storage & Maintenance

Foodstuffs, Beverages & Medicines
Wines & Spirits
Coal, Gas & Oil
Fabric, Timber & Building Materials
Clothing
Paper & Board
Aircraft, Ship & Vehicle Maintenance

Communications

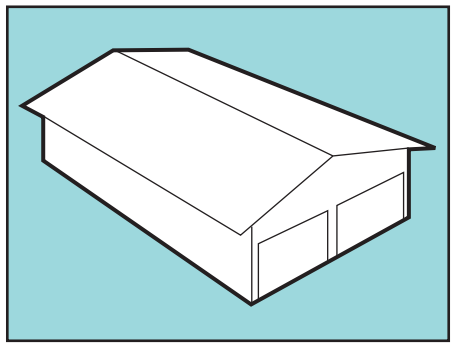
Telephone Exchanges
Computer Installations
Radio, Radar & Television Stations
Television& Film Studios
Data & Signal Cable Ducts
Instrumentation & Control Rooms
Civil & Defense Facilities

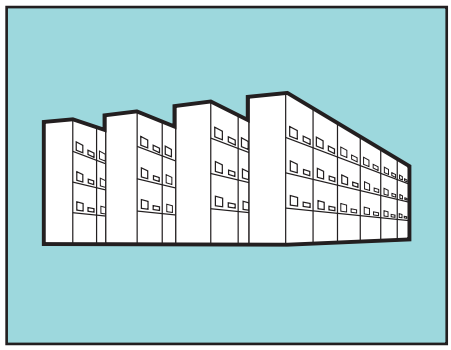
Services

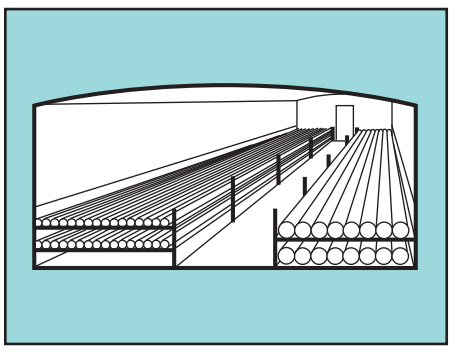
Food Production & Supply
Manufacturing Facilities
Rail, Road & Cable Tunnels
Fuel, Water & Sewage Treatment
Airports, Seaports, Rail & Bus Stations
Hospitals, Schools & Universities
Shopping, Sports & Leisure Centers

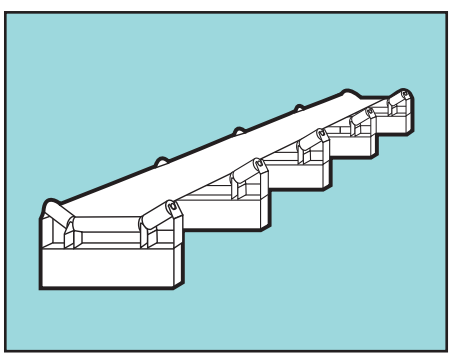
Materials Handling

Oil & Gas Pumps & Valves
Coal Conveyors & Silos
Electricity Sub-stations
Air, Sea & Land Vehicles
Agriculture
Ship, Aircraft & vehicle Loading
Goods & Mail Distribution









ASK ABOUT OUR HIGH TEMPERATURE VERSION < 1800°F.

EXOTIC THERMOCOUPLE SELECTIONS

JMS Southeast can provide a variety of exotic thermocouple designs and materials. The following information explains some of our capabilities. Please contact JMS Southeast for ordering information on these assemblies.

SENSOR TYPES

TYPE		THERMOELEMENTS	MAX. TEMP.°C
S		Platinum/Platinum 10% Rhodium	1600
B		Platinum 6% Rhodium/Platinum 30% Rhodium	1600
R		Platinum/Platinum 13% Rhodium	1600
W5 (C)	Not ANSI	Tungsten 5% Rhenium/Tungsten 26% Rhenium	2200
W3 (D)		Tungsten 3% Rhenium/Tungsten 26% Rhenium	2200
W (G)		Tungsten/Tungsten 26% Rhenium	2200

(See Pg. 1-1 for standard materials.)

SHEATH MATERIAL

SHEATH MATERIALS	RECOMMENDED* TEMPERATURE °C	RECOMMENDED* TEMPERATURE °F	MELTING** POINT °C	MELTING** POINT °F	WORKING ENVIRONMENT
Aluminum	427	800	660	1220	I
Boron Nitride	2000	3632	3000	5432	I, V, O***
Brass	371	700	1000	1832	I, V
Columbium (Niobium)	1981	3600	2468	4474	V
Copper	316	600	1083	1981	I, V
Graphite	3000	5425	3652	6606	I, V
Hastelloy X	1204	2200	1260-1354	2300-2470	O, I, V
Hastelloy C	1093	2000	1149	2100	O, R, I, V
Inconel 702	1204	2200			O, I
Molybdenum	2204	4000	2610	4730	I, V, R
Platinum	1677	3050	1760	3200	O, I, V
Silicon Nitride	1750	3182	1900	3452	I, V
Silicon Carbide	2200	3992	2700	4892	I, V
S/S 310	1149	2100	1399	2550	O, I, V
Tantalum	2483	4500	3000	5425	I, V
Titanium	850	1562	1675	3047	I, V
Tungsten	3000	5425	3315+	6000+	I, V, R

V=Vacuum I=Inert O=Oxidizing R=Reducing-Hydrogen

*Recommended temperatures indicated are for supported vertical installations and may be reduced if used in an unsupported horizontal direction.

**The melting points listed may not be always considered accurate as some materials sublime before melting.

**Boron Nitride may be used to 850°C in an oxidizing environment.

INSULATION MATERIAL

INSULATION MATERIALS		RECOMMENDED* TEMPERATURE °C	RECOMMENDED* TEMPERATURE °F	MELTING** POINT °C	MELTING** POINT °F	WORKING ENVIRONMENT
Magnesium Oxide	MgO	2300	4172	2800	5072	I, O
Alumina Oxide	Al_2O_2	1900	3452	2050	3722	V, I, O
Hafnia Oxide	HfO_2	2400	4352	2812	5094	O, V, I
Boron Nitride	Bn	2000	3632	3000	5432	V, I, O

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Accessories 6

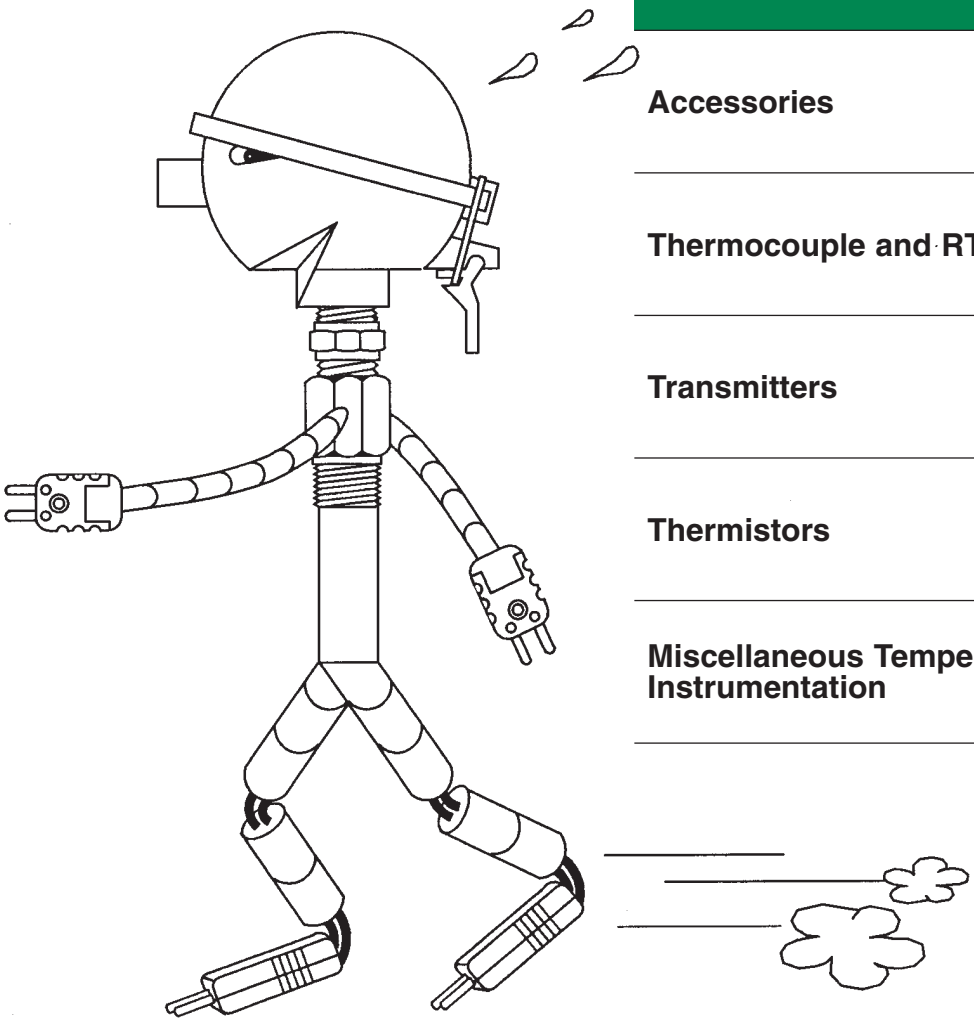
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Miscellaneous Temperature Instrumentation 10

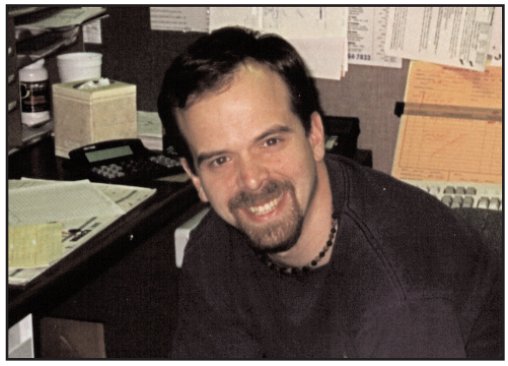
Swifty Sensor



Notes

1-800-873-1835

JMS Southeast, Inc.
Temperature Measurement



Thermowells, Protection Tubes, and Coatings

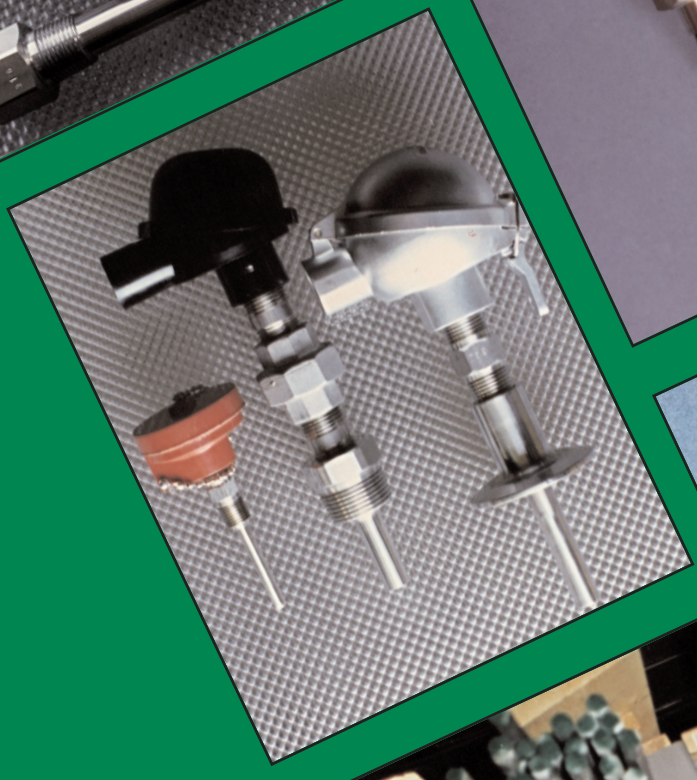
SECTION 5

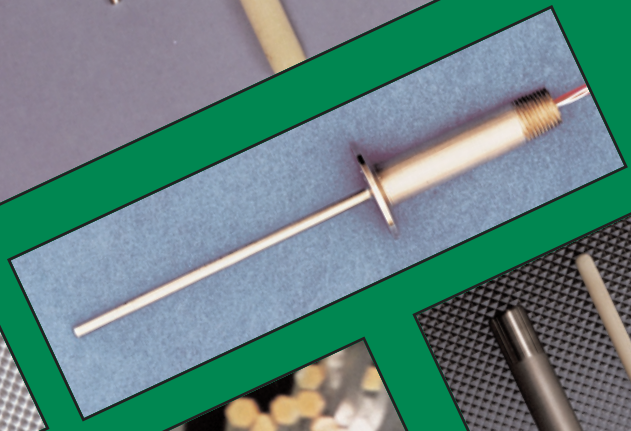


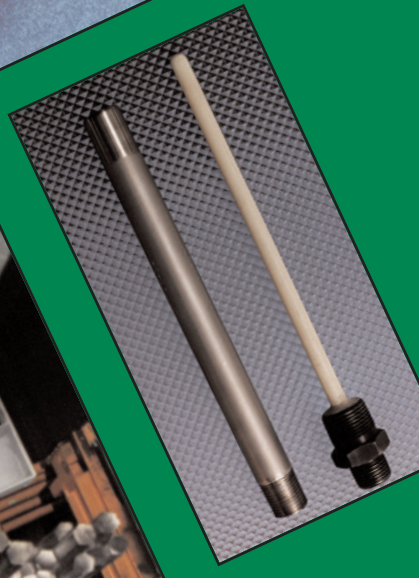


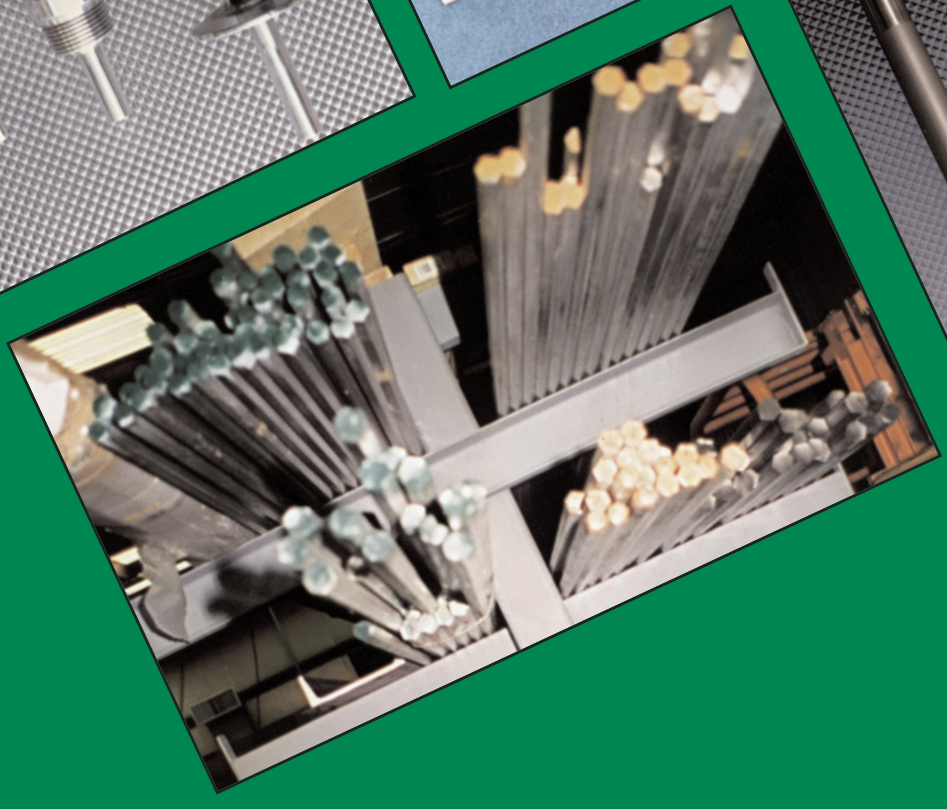












THERMOWELLS

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THREADED AND SOCKET WELD THERMOWELLS

#1	SERIES [See pages 20-24 for complete information on dimensions, velocity ratings, and pressure ratings)
5	Thermowells - Add "W" here for a plug with a chain attached to well. (i.e. 5W)

#2	THREADED WELLS / EXTERNAL THREAD	SOCKET WELL WELDELET SIZE
1	1/2" NPT	N/A
2	3/4" NPT (**Standard**)	3/4" (**Standard**)
3	1" NPT	1"
4	1 1/2" NPT	1 1/2"
X	Other, specify	

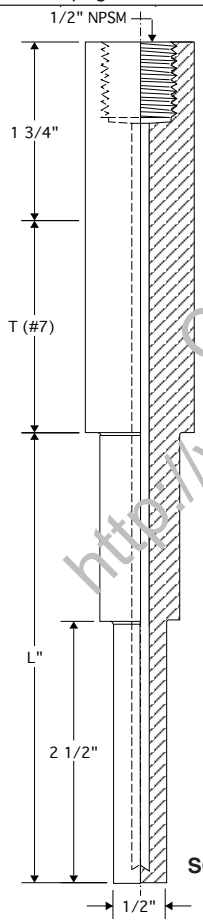
#3	SHANK STYLE [15]
A	Step shank (**Standard**)
S	Straight shank
T	Tapered shank
B	Built up step shank (Recommended for over 22 1/2", see drawing on 5-2) (Other shank styles are available)
X	Other, specify

#4	THREADED OR SOCKET WELD WELLS
T	Threaded well design
S	Socket well design
W	Weld-in (Tapered shank standard)
X	Other, specify

#5	BORE SIZE
2	.260" ID used for .250" OD sensors (**Standard**)
3	.385" ID used for .375" OD sensors (straight or tapered only)
X	Other, specify

***Note:** JMS recommendes the use of the "Built Up" design if longer than 22 1/2" See page 5-2 for drawing.

#6	U (INSERTION) DEPTH [15]	STANDARD "P" DIMENSION	SENSOR LENGTH NO LAG	SENSOR LENGTH WITH LAG
B	2 1/2"	2	4	6
C	4 1/2"	3	6	9
D	6"	3	7 1/2	10 1/2
E	7 1/2"	3	9	12
F	10 1/2"	3	12	15
G	13 1/2"	3	15	18
H	16 1/2"	3	18	21
*I	22 1/2"*	3	24	27
X	Other, specify			



#7	T (LAG) EXTENSION [15]
T	Standard lag (For length see Table in Symbol #6)
U	N/A (No lag)
X	Other, specify

#8	WELL MATERIAL [31-34]
E	F22
F	F11
G	Carbon steel
H	304 Stainless steel
I	Low Carbon 304 Stainless steel
J	310 Stainless steel
K	316 Stainless steel (**Standard**)
L	Low Carbon 316 Stainless steel
M	Inconel 600
N	Monel
Q	Hastelloy C
S	Titanium
X	Other, specify (i.e.: Teflon, PVC, Nickel, etc.)

#9		TAGGING OPTIONS
1	STAMPING	Stamped on well (**Standard**)
X		Other
Z		N/A **Note:** You must always specify information required on tag.

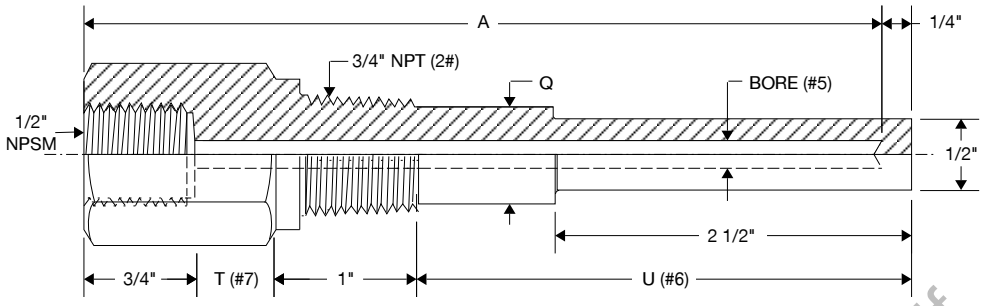
[ ]BRACKETS INDICATE PAGE NUMBERS ON WEB OR FULL CATALOG FOR ADDITIONAL TECHNICAL INFORMATION WWW.JMS-SE.COM

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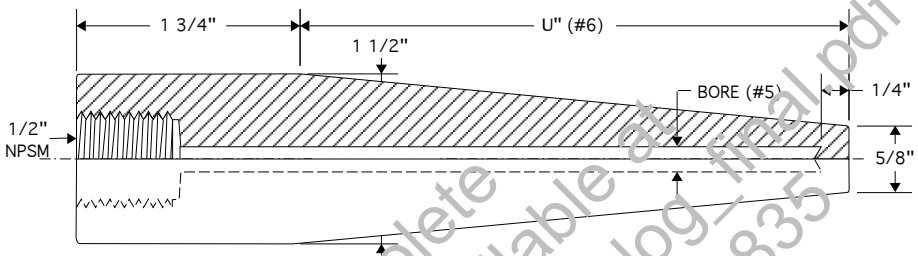
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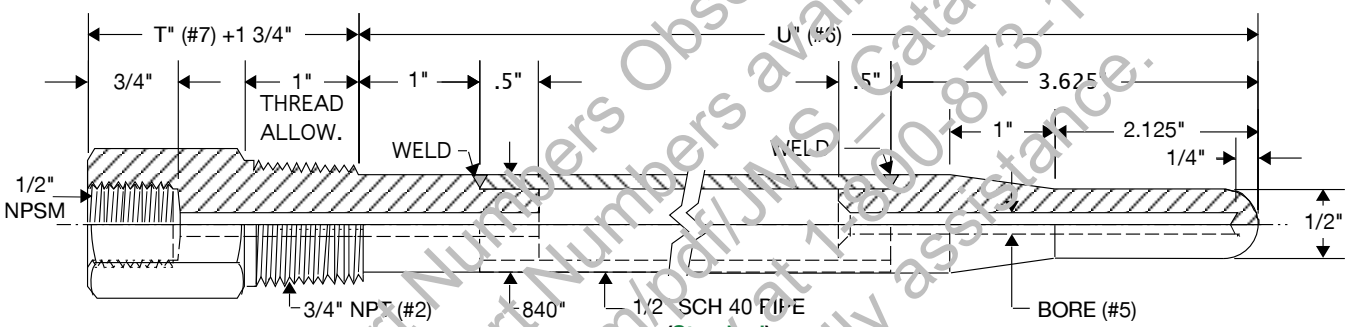
THREADED AND SOCKET WELD THERMOWELLS

THREADED WELL WITH LAG EXTENSION
(SERIES 52AT2)



WELD-IN THREADED WELL
(SERIES 54TW2)





(SERIES 52BT2)

Current Part Numbers Obsolete
Part Numbers available at
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LIMITED SPACE THERMOWELLS

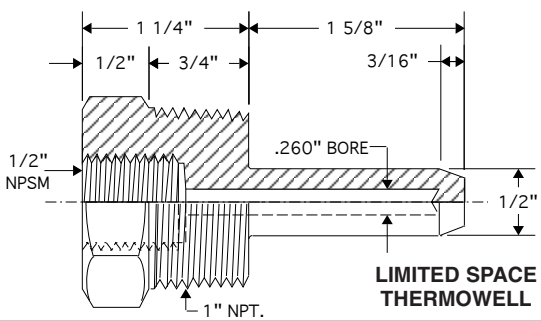
#1	SERIES
5L	Limited Space Thermowells - Add "W" here for a plug with a chain attached to well. (i.e. 5LW)

#2	WELL MATERIAL
H	304 Stainless steel
K	316 Stainless steel
M	Inconel 600
X	Other, specify

#3		TAGGING OPTIONS
1	STAMPING	Stamped on well (**Standard**)
X		Other
Z		N/A

Note: You must always specify information required on tag

Note:
Immersion length of a spring-loaded sensor to fit this well is 2 1/2".



LIMITED SPACE THERMOWELL

5L	M	1	

FLANGED THERMOWELLS

#1	SERIES [See pages 25-27 for complete information on dimensions, velocity ratings, and pressure ratings)
5T	Thermowells - Add "W" here for a plug with a chain attached to well. (i.e. 5TW)

#2	CONFIGURATION
A	Step shank (**Standard**)
S	Straight shank
T	Tapered shank

#3	BORE SIZE
2	.260" ID used for .250" OD sensors (**Standard**)
3	.385" ID used for .375" OD sensors (straight or tapered only)
X	Other, specify

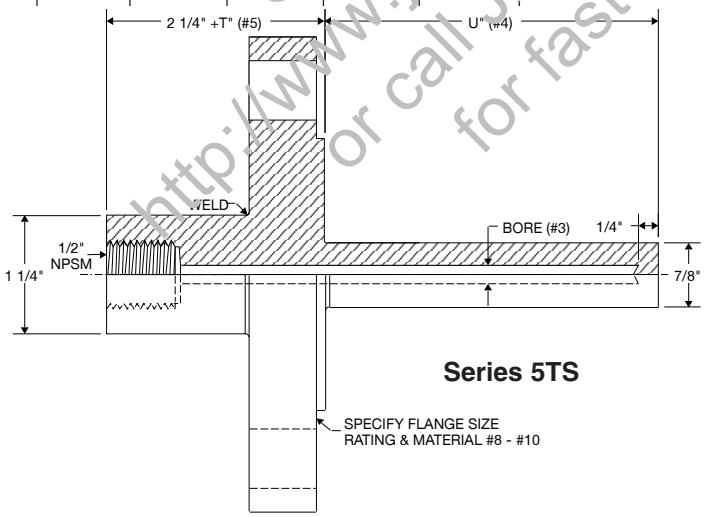
#4	U (INSERTION) DEPTH [15]	"U" DIMENSION	SENSOR LENGTH
A	2"	2"	4"
B	4"	4"	6"
C	7"	7"	9"
D	10"	10"	12"
E	13"	13"	15"
F	16"	16"	18"
G	22"*	22"	24"
X	Other, specify		

Note: Over 22" use "Built Up" design. See page 5-2 for drawing.

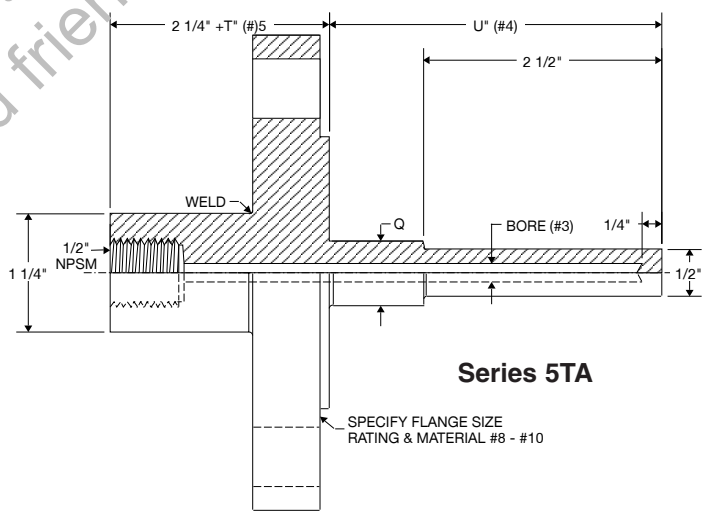
#5	T (LAG) EXTENSION [15]
T=__"	Length in inches
Z	N/A (**Standard**)

#6	WELL MATERIAL [31,34]		
G	Carbon steel	P	Molybdenum
H	304 Stainless steel	Q	Hastelloy C
I	Low Carbon 304 Stainless steel	R	Tantalum
J	316 Stainless steel	S	Titanium
K	316 Stainless steel	X	Other, specify
L	Low Carbon 316 Stainless steel		
M	Inconel 600		
N	Monel		
O	Hastelloy B		

Note: Special jackets and coating are available for thermowells. Call our engineering department for more information. See pages 5-35 - 5-39.



Series 5TS



Series 5TA

5T	A	2	C	Z	H	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

SECTION 5

FLANGED THERMOWELLS

#7	SIZE OF FLANGE		
3	1”	7	Van Stone 1 1/2” (1.900”)
4	1 1/2”	X	Other, specify
5	2”		
6	Van Stone 1” (1.315”)		

#8	*FLANGE RATING
A	150*
B	300*
C	400*
D	600*
E	900*
F	1500*
X	Other, specify

*Pounds rating per ANSI B-16.5

#9	FACING
1	Raised face (**Standard**)
2	Flat face

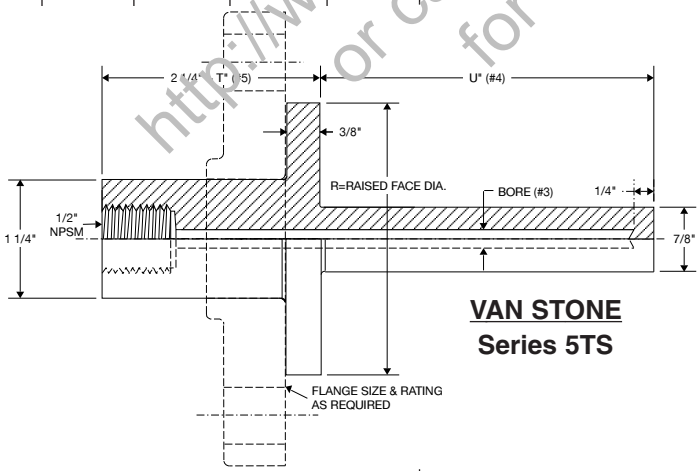
#10	FLANGE MATERIAL [31-34]
G	Carbon steel
H	304 Stainless steel
I	Low Carbon 304 Stainless steel
J	310 Stainless steel
K	316 Stainless steel
L	Low Carbon 316 Stainless steel
M	Inconel 600
N	Monel*
O	Hastelloy B*
P	Molybdenum*
Q	Hastelloy C*
R	Tantalum*
S	Titanium*
X	Other, specify

*An economical alternative is available for these materials. Rather than using the exotic material for the entire well, a less expensive material such as carbon steel or stainless steel can be used for the bulk of the well and a jacket of the exotic metal can be applied to all wetted parts. Use symbol “X” and specify jacket design and material. See pages 5-35 through 5-39.

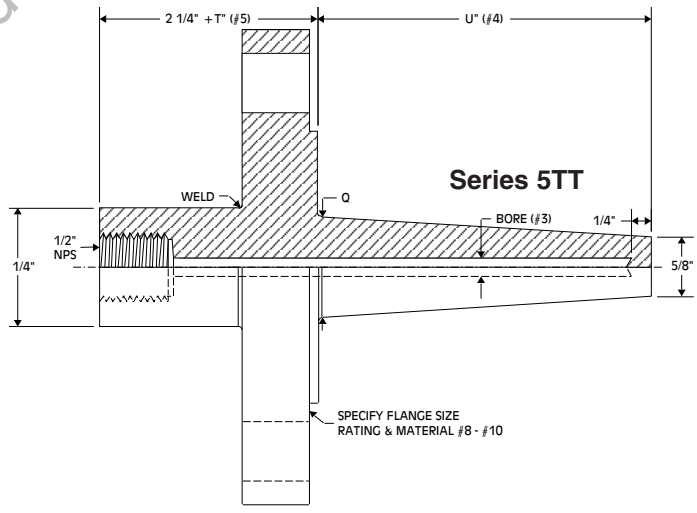
#11	TAGGING OPTIONS
STAMPING	
1	Stamped on well (**Standard**)
X	Other
Z	N/A

Note: You must always specify information required on tag

Note: For complete information on flange dimensions see page 5-27.



VAN STONE
Series 5TS



Series 5TT

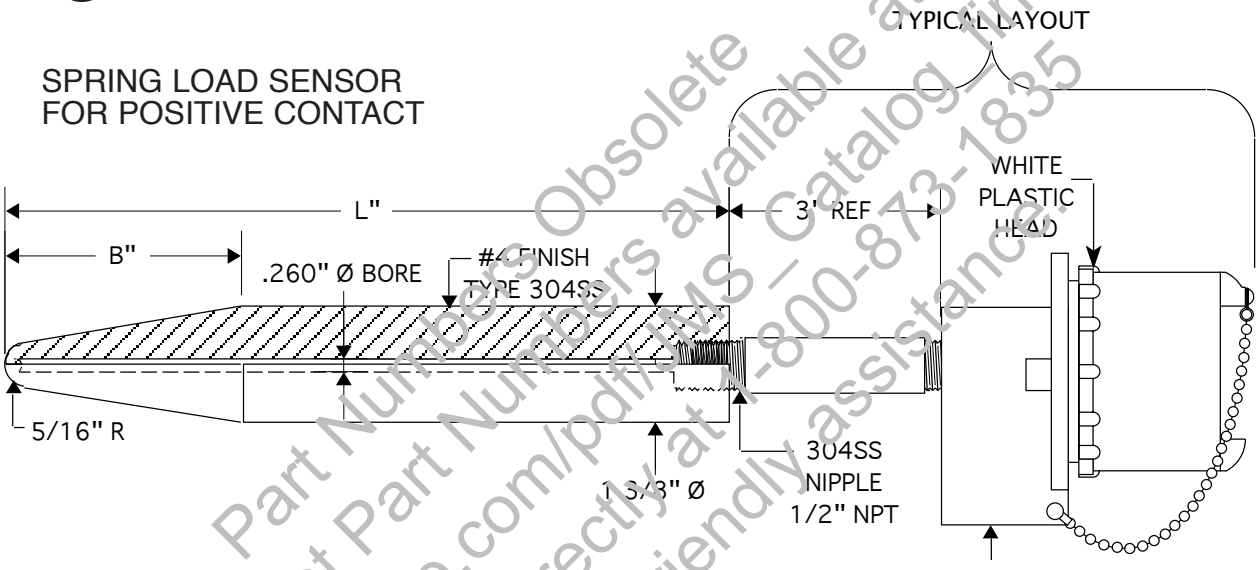
4	A	1	H	1	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

3-A CERTIFIED SANITARY THERMOWELLS

Designed to be used with the sanitary 3-A certified probes (pages 4-13 and 4-14) these thermowells may be welded to a tank or vat with a full crevice-free fillet weld to avoid cracks or crevices. Each well is fabricated from Type 304 stainless steel and polished to a No. 4 finish. Use standard thermocouples and RTD's with these thermowells (1-1 and 1-3 , 2-1 and 2-2).

SPRING LOAD SENSOR
FOR POSITIVE CONTACT



Replacement sensor part number's:
Thermocouple: 1(insert type or T/C)1BKU(insert length)EZ76GZA
RTD: 3ESBK(insert length)BEZ34ZWZA

Current Part Numbers available at www.imsse.com/pdf/IMS_Catalog_final.pdf
http://www.imsse.com/pdf/IMS_Catalog_final.pdf
or call IMS directly at 1-800-873-1835
for fast and friendly assistance.

#1	SERIES
5C	3-A Certified Sanitary Thermowells - Add "W" here for a plug with a chain attached to well. (i.e. 5CW)

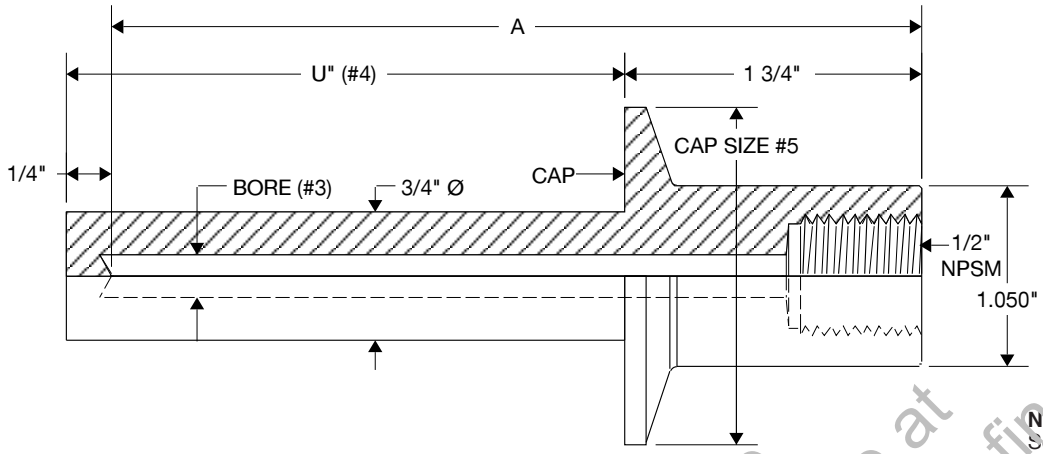
#2	L, THERMOWELL LENGTH	B, TAPER LENGTH	REPLACEMENT SENSOR LENGTH (SPRING LOADED)
10 1/8	10 1/8"	3 1/4"	14 1/8"
11 7/8	11 7/8"	5"	15 1/2"
13 1/8	13 1/8"	3 3/4"	17 1/8"
14 1/8	14 1/8"	6 1/16"	18 1/8"
16 5/8	16 5/8"	9 9/16"	20 5/8"

#3		TAGGING OPTIONS
1	STAMPING	Stamped on well (**Standard**)
X		Other
Z		N/A **Note:** You must always specify information required on tag

Note: Does not include head and nipple.
Thermowell Only

5C	10 1/8	1	

SANITARY THERMOWELLS



Note: Straight Shank shown. See page 5-20 for details.

#1	SERIES
5F	Sanitary Thermowells - Add "W" here for a plug with a chain attached to well. (i.e. 5F-W)

#2	STYLE [25-27]
A	Step shank (**Standard**)
S	Straight shank
T	Tapered shank

#3	BORE SIZE
2	.260" ID
3	.385" ID
X	Other, specify

#4	U (INSERTION) DEPTH [15]
B	2 1/2"
C	4 1/2"
D	6"
E	7 1/2"
X	Other, specify

"U" DIMENSION	SENSOR LENGTH
2 1/2"	4"
4 1/2"	6"
6"	7 1/2"
7 1/2"	9"

#5	CAP SIZE [SECTION 4]
A	1"
B	1 1/2"
C	2"
X	Other, specify

#6	BRAND OF CAP
T	Tri-clover (16 AMP)
A	Alloy Products (K16A)
B	Cherry Burrell (16AI - 14I)
X	Other, specify

All caps are mounted facing the hot end - unless specified here. ie. Use X + brand of cap + reverse mount

#7	MATERIAL
H	304 Stainless steel
K	316 Stainless steel
L	Low Carbon 316 Stainless steel
M	Inconel 600
X	Other, specify

#8	POLISH
H	High polish (#4 Finish) **Standard**
E	Electropolish or (8G finish)
P	Passivate (After #4 Finish)

#9		TAGGING OPTIONS
1	STAMPING	Stamped on well (**Standard**)
X		Other
Z		N/A **Note:** You must always specify information required on tag

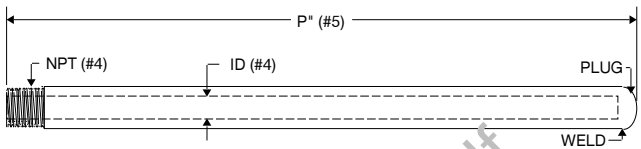
5F	A	2	D	A	T	K	H	1	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

METAL PROTECTION TUBES

#1	SERIES
5P	Metal protection tube - Add "W" here for a cap and chain to fit over open end. (i.e. 5PW)

#2	RESPONSE TYPE
1	Fast response tip
2	Standard response tip



Style 5P2Z

#3	ATTACHING DEVICES
B	Carbon steel bushing
K	Stainless steel bushing
J	Cast iron floor flange
Z	N/A
X	Other, specify (i.e.: 3" 150 lb raised face.)

#4	**NOMINAL SIZE	I.D.	O.D.	N.P.T. [30]	STANDARD BUSHING PROCESS CONNECTION	STANDARD FLOOR FLANGE SIZE
18	1/8"	.269	.405	1/8"	1/4" NPT	3"
14	1/4"	.364	.540	1/4"	1/2" NPT	3"
Standard 12	1/2"	.622	.840	1/2"	3/4" NPT	3"
34	3/4"	.824	1.050	3/4"	1" NPT	4"
10	1"	1.049	1.315	1"	1-1/4" NPT	4"
X	Other, specify					

**Refers to schedule 40 pipe. For other pipe schedules, use "X" in the above symbol and specify the pipe schedule in description. Ex.: 5P1BX12100, X=12 Schedule 80 pipe.

#5	OVERALL LENGTH (P)
A	12"
B	18"
C	24"
D	30"
E	36"
F	48"
G	60"
X	Other, specify

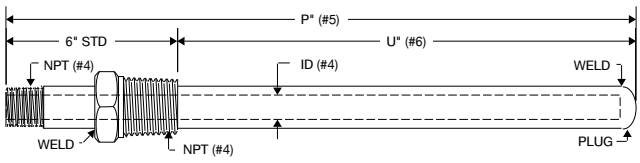
Note: Bends and elbows are available. Call your salesperson for drawing(s).

#6	FIXED OR ADJUSTABLE MOUNTING METHOD
—	Insert "U" dimension. (Only if using a permanently fixed attaching device. See drawing below)
Z	N/A (Bushing if specified will be adjustable)

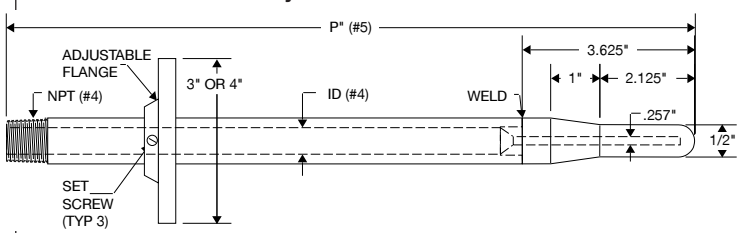
#7	PROTECTION TUBE MATERIAL [31-34]
C	Carbon steel
H	304 Stainless steel
J	310 Stainless steel
K	316 Stainless steel - (Standard)
M	Inconel 600
P	446 Stainless steel
X	Other, specify

#8		TAGGING OPTIONS
1	STAMPING	Stamped on well (Standard)
X		Other
Z		N/A **Note:** You must always specify information required on tag

Style 5P2B12A9K



Style 5P1J12BZH



5P	2	B	12	A	9"	K	1	

Part Numbers Obsolete
Current Part Numbers Available at
http://www.jms-se.com/pdf/JMS_Catalog_5_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

SECTION 5

CERAMIC PROTECTION TUBES

Alumina and mullite protection tubes are used at high temperatures that have a small slope of temperature change. Any thermocouple type can be used in these ceramic tubes; however, platinum-rhodium and chromel-alumel are used most often due to their high operating temperature range. "Alumina" is an alumina oxide ceramic (99.7% Al2O3) and "mullite" is a compound of alumina and silica. Alumina tubes can be used at 3400°F (1870°C) and mullite tubes can be used at 3100°F (1700°C). They are somewhat gas tight, sensitive to thermal shock, and can crack if one end of the tube is heated at a different rate than the other. If the tube is exposed to a significant sharp decline or rise in temperature, the tube may crack.

Platinum-Rhodium thermocouples should always be protected in a ceramic protection tube. Alumina should be used rather than mullite for all atmospheres except oxidizing, where mullite can be used. The silicon from the mullite can contaminate the platinum-rhodium thermocouple.

We recommend that the user preheat the entire tube to ≈ 900°F before installing it into a hot process environment.

#1	SERIES
5D	Ceramic Protection Tubes - Add "W" here for a cap and chain to fit over open end. (i.e. 5DW)

#2	MATERIAL
A	Alumina
M	Mullite

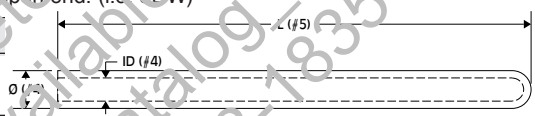
#3	ATTACHING DEVICE
O	No mounting fitting
P	Open both ends, no mounting fitting
C	Collar* (See chart below for collar dimensions)
B	Mounting bushing (Standard)
S	Carbon steel mounting sleeve - (4" long sleeve is standard)
X	Other, specify

#4	TUBE SIZE I.D. x O.D.	*COLLAR OUTSIDE FOR APPROPRIATE TUBE SIZE
14	1/4" x 3/8"	5/8"
38	3/8" x 1/2"	3/4"
76	7/16" x 11/16"	1"
12	1/2" x 3/4" (**Standard**)	1 1/8"
34	3/4" x 1"	1 3/8"
10	1" x 1 1/4"	1 3/4"
X	Other, specify	

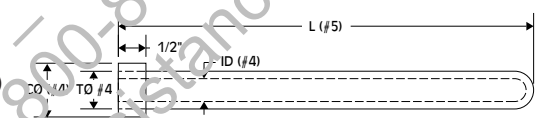
#5	LENGTH (L)
A	6"
B	12" (**Standard**)
C	18"
D	24" (**Standard**)
E	30"
F	36"
X	Other, specify

#6	TAGGING OPTIONS	
STAMPING	1	Stamped on well (**Standard**)
	X	Other
	Z	N/A **Note:** You must always specify information required on tag

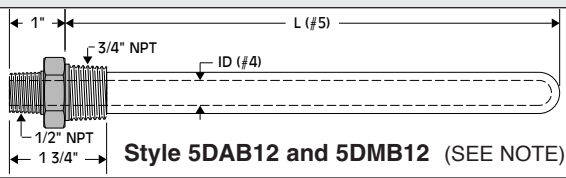
Style 5DAO and 5DMO



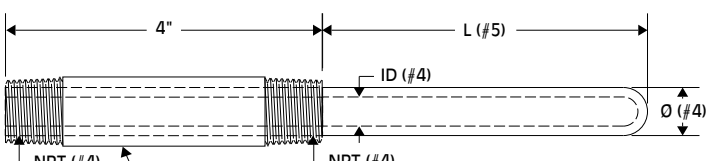
Style 5DAC and 5DMC



Style 5DAB12 and 5DMB12 (SEE NOTE)



NOTE:
Bushings are always 1/2" NPT head connection, and 3/4" NPT process connection.
Bushings are not standard for 3/4" x 1" or 1" x 1 1/4" ceramic tubes.
For tubes smaller than 11/16" OD, the "L" length will equal the total length including the bushing.



CS sleeve for tube NPT will equal tube OD (ie: 1" OD will use 1" NPT threads). It can be used to attach adjustable flanges and bushings as shown on page 5-7. Use "X" in symbol number 3 and describe.

5D	A	B	12	B	1	

Part Numbers Obsolete
Current Part Numbers available at
www.ims-se.com/pdf/IMS_Catalog_final.pdf
or call IMS directly at 1-800-873-1835
for fast and friendly assistance!

MULLITE/ALUMINA PROTECTION TUBES

The composition of this tube is 80% alumina and 20% silica. This protection tube has excellent thermal shock characteristics (3.0 x 10 -6 in/in/ degrees F). It can be characterized as a mullite tube with a higher percentage of alumina than a typical mullite tube would have. It has an outer diameter of 3/4" and an inner diameter of 1/2". It is a light green color. When fully supported, the tube can be exposed to 2900 degrees F. This protection tube is a compromise between mullite and alumina yielding a high quality ceramic tube with excellent thermal shock resistance. Due to the silica content, a platinum/rhodium thermocouple should not be used in it without a primary alumina tube to insulate the thermocouple.

#1	SERIES
59	Mullite / Alumina Ceramic Protection Tube - Add "W" here for a cap and chain to fit over open end. (i.e. 59W)

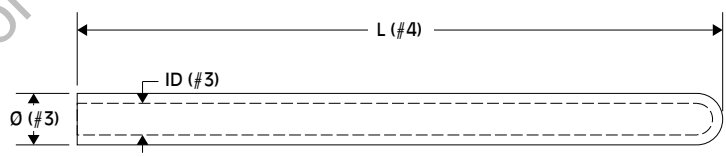
#2	TUBE STYLE
B	Mounting Bushing - (1/2" NPT head connection and 3/4" NPT process connection)
Z	No Bushing
X	Other, specify

#3	NOMINAL TUBE SIZE	
	I.D.	O.D.
14	1/4"	3/8"
56	5/16"	1/2"
38	3/8"	1/2"
76	7/16"	11/16"
12	1/2"	3/4" (Standard)

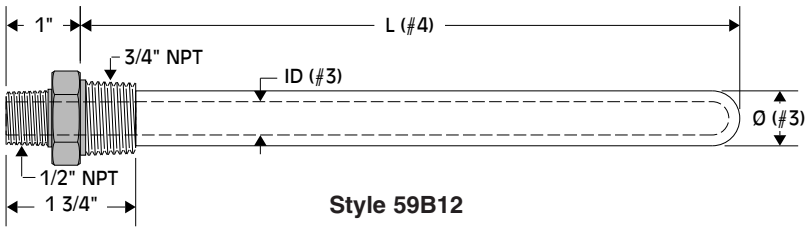
#4	TUBE LENGTH (OVERALL)
A	12" (**Standard**)
B	18"
C	24" (**Standard**)
D	36"
X	Other, specify

#5	TAGGING OPTIONS	
1	STAMPING	Stamped on well (**Standard**)
X		Other
Z		N/A **Note:** You must always specify information required on tag

NOTE:
Bushings are always 1/2" NPT head connection, and 3/4" NPT process connection.
Bushings are not standard for 3/4" x 1" or 1" x 1 1/4" ceramic tubes.
For tubes smaller than 11/16" OD, the "L" length will equal the total length including the bushing.



Style 59Z12



Style 59B12

59	B	12	12"	1	

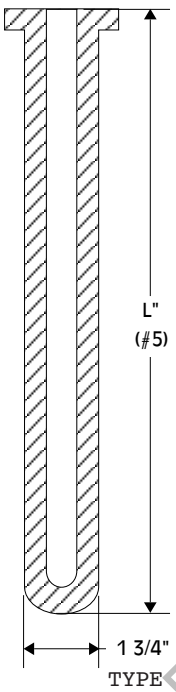
Part Numbers Obsolete
Current Part Numbers available at
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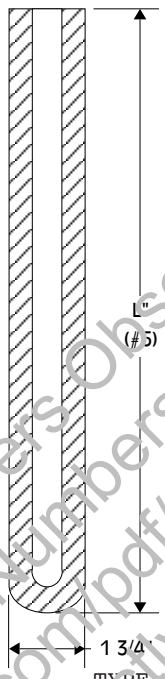
BONDED SILICON CARBIDE PROTECTION TUBES

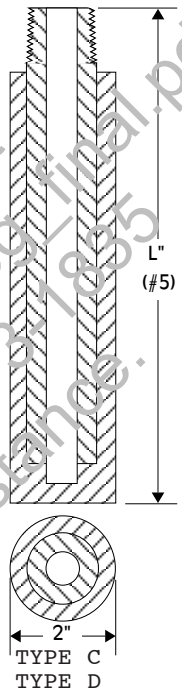
Silicon carbide protection tubes provide excellent thermal conductivity for quick response to temperature changes. They can be used to replace cast iron tubes, eliminating the possibility of iron pick-up. Spread surface treatment assures adequate protection of the thermocouple.

JMS Southeast offers two types of silicon carbide protection tubes. Type A and B are dense silica bonded silicon carbide and are manufactured with a flange or a plain end as the following drawings indicate.

Type C and D are carbon bonded silicon carbide and graphite. They are manufactured with a black steel pipe located down the center. They have a 1/2" or 3/4" NPT connection to thread into place instead of a flange for mounting as Type A.







Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

#1	SERIES
5B	Protection Tube - Add "W" here for a cap and chain to fit over open end. (i.e. 5BW)

#2	MATERIAL
SC	Silicon carbide

#3	MOUNTING
F	Flange silicon carbide tube (1" I.D. x 1 3/4" O.D.)
P	Plain end silicon carbide tube (1" I.D. x 1 3/4" O.D.)
C	1/2" NPT threaded silicon carbide tube with reinforced pipe
D	3/4" NPT threaded silicon carbide tube with reinforced pipe

#4	SIZE
2	1/2" I.D. x 2" O.D.
3	3/4" I.D x 2" O.D.
4	1" I.D. x 1 3/4" O.D. (for symbols F & P above)

#5	LENGTH (L)
A	18"
B	24"
X	Other, specify

5B	SC	F	4	18"	

SECTION 5

BONDED SILICON CARBIDE PROTECTION TUBES

TYPE 5BSCF CLASSIFICATION

Physical Data: (Typical)	**English Units**	**S.I. Units**
Porosity:	14-17%	14-17%
Bulk Density:	161-168 lb/ft3	2,570-2,690 kg/m3
True Specific Gravity:	.112-.113 lb/in3	3.10-3.12 gm/cm3
Crushing Strength (RT):	14000-18000 psi	96.5-124.0 MPa
Modulus of Rupture (RT):	3000-4000 psi	20.7-27.6 MPa
Modulus of Elasticity (RT):	9-13 x 106 psi	62-90 kPa
Load Test, Fail Temperature with 25 psi (172 kPa) Load:	Above 3000°F	Above 1650°C
Coef. of Thermal Expansion: (100 to 1000°C)	2.6 x 10-6/°F	4.7 x 10-6/K
Thermal Conductivity:	BTU/hr/ft2/°F/in 105	W/mK 15.1

Chemical Analysis: (Typical)		
Silicon Carbide	(SiC)	86.10%
Silica	(SiO2)	11.75%
Alumina	(Al2O3)	0.78%
Iron Oxide	(Fe2O3)	1.05%
Lime	(CaO)	0.21%
Magnesia	(MgO)	0.10%
Alkalies	(Na2O, K2O)	Trace

SECTION 5

CARBON BONDED SILICON CARBIDE & GRAPHITE

TYPE 5BSCP, 5BSCC CLASSIFICATION

Physical Data: (Typical)	**English Units**	**S.I. Units**
Porosity:	27-33%	27-33%
Bulk Density:	112-125 lb/ft3	1800-2000 kg/m3
Crushing Strength (RT):	1500 psi	10.3 MPa
Modulus of Rupture (2250°F):	200-500 psi	1.4-3.4 MPa
Coef. of Thermal Expansion:	1.5 x 10-6/°F	2.7 x 10-6/K
Specific Heat	0.20 BTU/lb/°F	.84 kJ/kgK
Thermal Conductivity:	105 BTU/ft2/hr/°F/in	15.1 W/mK
Electrical Resistivity (@ RT) 0.012 ohm-cm (@ 2200°F)	0.0076 ohm-cm	
Thermal Shock Resistance	Excellent	

Chemical Analysis: (Typical)		
Silicon Carbide	(SiC)	44.52%
Carbon	(C)	28-36%
Silica	(SiO2)	11%
Alumina	(Al2O3)	5%
Iron Oxide	(Fe2O3)	0.7%
Glaze	–	3%

The information contained in this data sheet has been determined through the application of accepted engineering practice and is believed to be reliable. Since the conditions of application and use of our products are beyond our control, no warranty is expressed or implied regarding accuracy of the information, the results to be obtained from the use of the product, or that such use will not infringe on any patent. This information is furnished with the express condition that you will make your own tests to determine the suitability of the product for your particular use.

SILICON NITRIDE PROTECTION TUBE

SIALON

JMS Southeast, Inc. offers a protection tube for use in molten non-ferrus materials such as molten aluminum, brass, and copper. This special JMS protection tube material is a solid solution of alumina oxide in silicon nitride. Maximum temperature is 1250°C (2280°F) in molten metals. The physical properties are shown below.

TYPICAL PHYSICAL PROPERTIES (SIALON)

Bulk Density		(g/cm^3)	3.25
App. Specific Gravity		(g/cm^3)	3.26
Porosity		(%)	<1
Cold Bend Strength	(25°C)	(MPa)	945
		(kpsi)	137
Hot Bend Strength	(1200°C)	(MPa)	560
		(kpsi)	81
Elastic Modulus		(GPa)	288
		(x 10^6 psi)	42
Ther. Exp. Coeff. (20-1000°C)		(x 10^{-6}°C^{-1})	3.04
Thermal Conduct	(400°C)	(W/mK)	21.3
Critical ΔT		(°C)	950
Hardness (VRN, 1 kg Load)			1650

Obsolete Part Numbers
Current Part Numbers available at http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835 for fast and friendly assistance.

#1	SERIES
5E	Silicon Nitride Protection Tube (Sialon)

#2	TUBE SIZES	BUSHING	THREAD SIZE
1	28mm OD x 16mm ID (1.1" OD x .630" ID)	1 1/4"	1 1/4"
2	22mm OD x 12mm ID (.866" OD x .472" ID)	1"	1"
3	16mm OD x 9mm ID (.630" OD x .354" ID)	3/4"	3/4"
4	12.5mm OD x 6.5mm ID (.492" OD x .256" ID)	1/2"	1/2"
X	Other, specify		

#3	TOTAL TUBE LENGTH
A	5.91" (150mm)
B	11.81" (300mm)
C	15.75" (400mm)
D	17.72" (450mm)
E	23.62" (600mm)
X	Other, specify

#4	TUBE STYLE
B	Mounting bushing
S	Carbon steel mounting sleeve - (4" long sleeve is standard)
X	Other, specify
Z	No fitting

5E	1	A	S

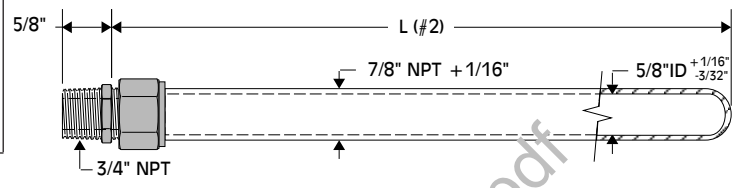
SECTION 5

MCPT - METAL CERAMIC PROTECTION TUBES

#1	SERIES
5G	Metal Ceramic Protection Tube 5/8" ID x 7/8" OD, 3/4" NPT Conduit Connector

#2	LENGTH (L)
1	9"
2	12"
3	18" (**Standard**)
4	30" (**Standard**)
5	36"
6	48" (**Standard**)
X	Other, specify

Note: Length measured from bottom of threads to closed end.



5G	3	

The MCPT consists of a hard abrasion-resistant chromium and alumina oxide material. It has good strength at temperatures where many high-temperature metals melt. It is more susceptible to thermal shock than a metal protection tube, however, more resistant to shock than a ceramic protection tube.

The MCPT exhibits good wear resistance and abrasion resistance. It has a hardness of Rockwell C37, which indicates the crushing strength of the material rather than the true hardness of the entire body.

This protection tube serves as an excellent option in the following applications:

RECOMMENDED APPLICATIONS

1. Molten copper and brass to 2100°F intermittent and continuous immersions.
2. Corrosive SO_2 and SO_3 gas (to 2200°F) and SO_3 and HF gas (to 2000°F).
3. Open hearth furnace checker chambers to 2200°F.
4. Steel mill soaking pits to 2200°F.
5. Pelletizing chamber of Taconite refining operation to 2100°F.
6. Molten zinc to 1600°F.
7. Molten lead to 650°F.
8. Basic steels and slags to 300°F (intermittent and 2200°F (continuous in open hearth and general foundry practices).
9. Calcining kilns to 2200°F.
10. Barium titanate (barium oxide service to 2200°F).
11. Magnesium oxide calcining kilns.
12. Fluid bed cement process with severe corrosion and temperature to 2200°F (fluid method of producing builder's cement).
13. Gas and ethylene cracking atmosphere.
14. Atmosphere directly upon burning sodium (1800-2200°F).
15. Oil fired furnace chambers.
16. Atmosphere directly above molten glass in an open hearth glass furnace.
17. Molten silver solder.
18. Molten tin.
19. Borax flux.
20. Copper matte.
21. Boiling sulphuric acid-97%.
22. Blast furnace stove dome and bustle pipes.

NON-RECOMMENDED APPLICATIONS

1. Molten aluminum.
2. Cryolite.
3. Tin (stannous) chloride (750°F).
4. Acid slag.
5. Carbide slag.
6. Molten glass.
7. Boiling sulphuric acid-10%.
8. Carburizing atmospheres.
9. Nitriditing atmospheres.
10. Barium chloride salt bath.
11. Sodium Nitrate-nitrate salt bath.

This protection tube is most commonly used in molten metal applications. It is less common than ceramic and metal protection tubes in industrial application.

—5/8" I.D. x 7.8" O.D., 3/4" conduit connector.
—Any length.
—Accepts 8 gauge wire or smaller
—Superior oxidation resistance up to 2200°F.
—Above 2800°F, softening begins.
—Suggested pre-heating of tube to 900°F if application involves immersion in molten metal 2000°F or higher.
—Impermeable except under high vacuum.
—Maximum recommended continuous operating temperature is 2500°F.

Note: A special fitting is available that is recommended for extreme conditions. See page 5-14 for additional information.

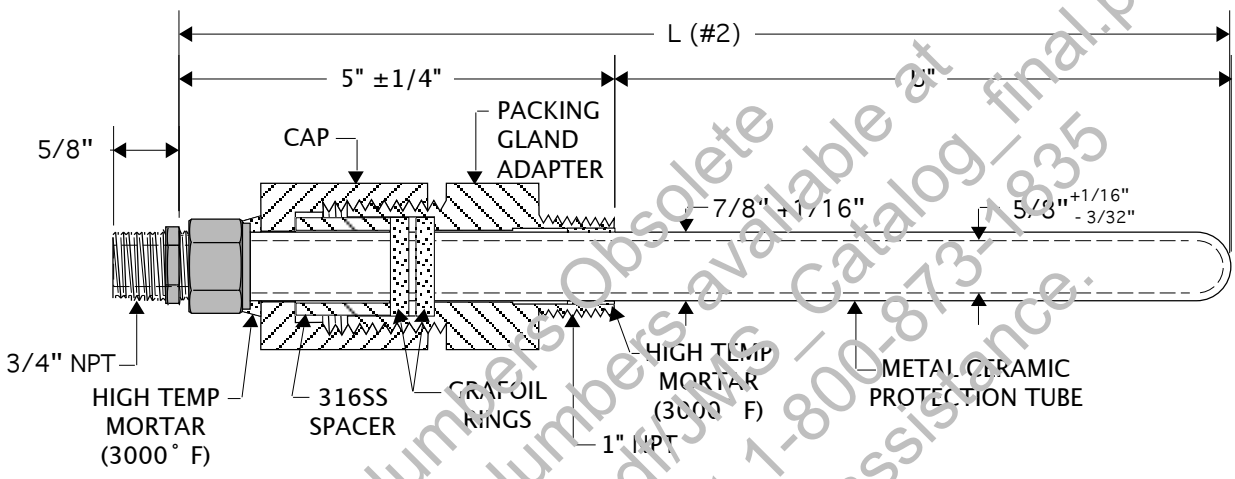
*UCAR® LT-1 Metal Ceramic is a product of Union Carbide Corp.

Current Part Numbers Obsoleted
http://www.jms-sc.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

MCPT WITH OPTIONAL FITTING

JMS Southeast, Inc. offers the special optional fitting pictured below for mounting the metal ceramic protection tube in high temperature sealed environments.

The minimum “U” length available is 2.35”.



Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

#1	SERIES
5J	Metal Ceramic Protection Tube With Optional Fitting

#2	LENGTH (L)
1	9”
2	12”
3	18” (**Standard**)
4	30” (**Standard**)
5	36”
6	48” (**Standard**)
X	Other, specify

5J	3	

GENERAL THERMOWELL INFORMATION

THERMOWELLS

Process Connection

Provides a means of mounting, supporting, and/or sealing the thermowell into the process system.

Types:

Threaded: Standard N.P.T.'s are 1/2", 3/4", and 1".
Socket Weld: Standard pipe sizes are 3/4" and 1" nominal. JMS socket wells are 3000lb rated. Other rating must be separately specified.
Flanged Welded: Large variety of flange sizes and pound ratings available.

Shank Construction

Straight: The outside diameter is the same size along the immersion length.
Step: The outside diameter at the end of the well is 1/2" to provide quicker response time.

Tapered: Used for high velocity applications. The outside diameter decreases gradually along the immersion length.

Q Dimension

The thickest part of the shank of the well on the hot side of the process con nection or flange. Its dependent on the bore size and the process connection size.

Bore Size

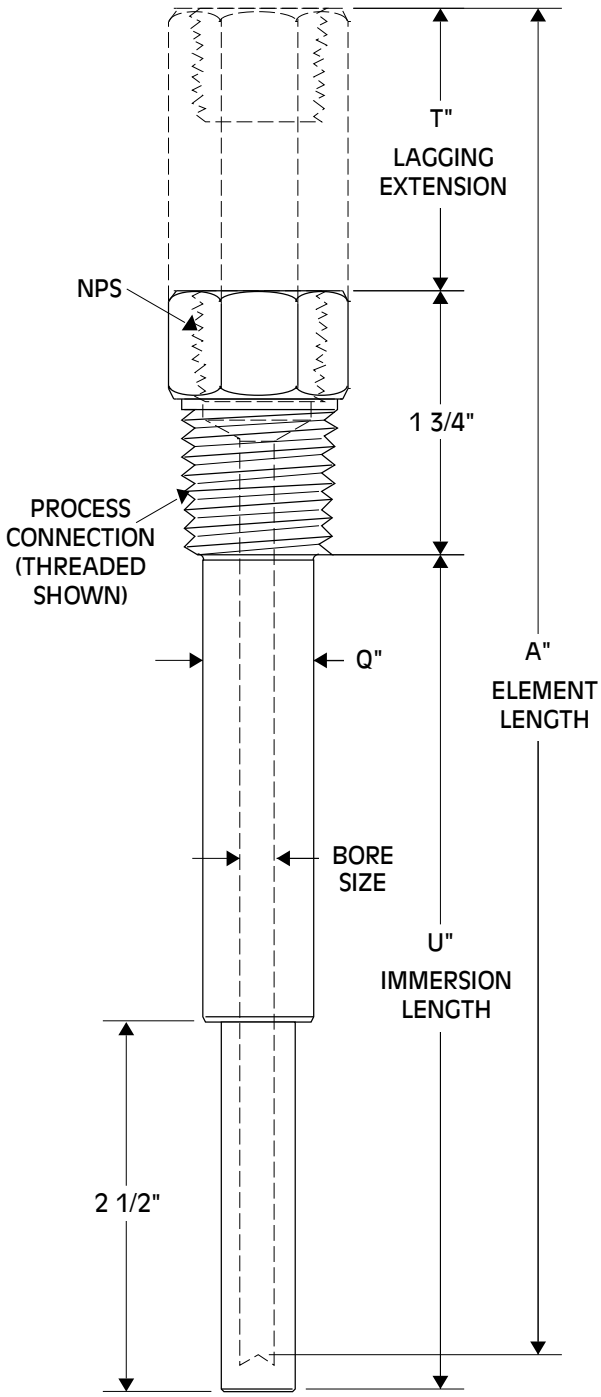
The inside diameter of a thermowell. Standard bore sizes are .260 and .385.

Immersion ("U") Length

Immersion length of the thermowell. The "U" length is measured from the bottom of the process connection to the tip of the thermowell.

Lagging Extension ("T") Length

The lagging extension exists behind the process connection and is used to extend the hex length and enable the probe to extend through insulation or walls.



Note:
JMS has a complete design guide on disc for your use. Call and ask for the Thermowell Design Guide.

Note: Design program on page 5-17.

STANDARD THERMOWELL MANUFACTURING TOLERANCES

JMS Thermowells meet or exceed the following standards:
(Copies are available from JMS Southeast, Inc., ANSI, or the issuing body.)

ASME B40.9 - Thermowells for Thermometer and Electrical Temperature Sensors
SAMA RC17-10-1963 - Bushings and Wells for Temperature Sensing Elements
ISA 1.02.01 - Thermowells
IEC 61520 - Functional Dimensions of Metal Thermowells for Thermometer Sensors

The following specifications are for .260 and .385 bore thermowells:
Lengths: ±1/16" on lengths 12" or less
±1/8" on lengths 12" or over
Wells up to 38" bore depths are drilled from solid bar stock to specified tip thickness (1/4" standard). A built-up design is necessary after 38 1/4" overall length.



Bore I.D. Tolerance:
±.001

O.D. Tolerances:
Fractional: ±.015
Decimal: ± .005 on .000 place
± .010 on .00 place

Concentricity of Bore to O.D.:
± 10% of minimum wall thickness

End Thickness:
Gun drill bottom, 1/4" ± 1/16".

Male Threads (NPT):
± 1 turn of thread gauge

Female Threads:
1/2" NPS standard, 1/2" NPT available upon request

Radius Under Threads and Flanges:
1/8" is standard, ± 1/16"
1/16" on Van Stone

Lagging Extension:
Lagging on wells is left as hex and is not turned. For material not available in hex, round bars with wrench flats will be furnished.

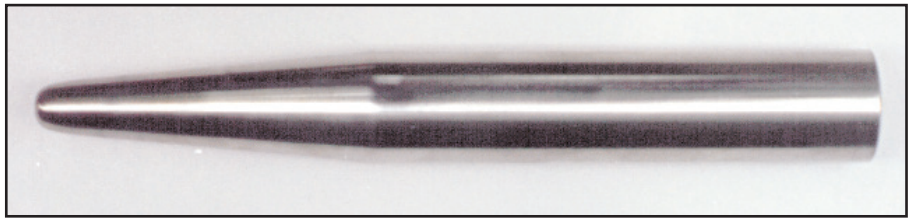
End of Wells:
Break corners. No burrs.

Wetted Surfaces Finish for "U" Dimension
63 ST is our standard surface finish. A mirror polish is available upon request. 8 RMS is our standard for a mirror polish, and must be specified on the order. Electropolish or electroplating is also available. There is an additional charge for mirror, electropolish or electroplating.

Stamping:
Material code and type of material is stamped on hex or round.

Flanged Wells:
Made in accordance with ANSI B16.5 with serrated raised face. We also furnish 125 RMS smooth face which must be specified when needed. Other surface finishes are available upon request.

Weld Configuration:
Front groove welds are 1/4" wide by 5/16" deep. Rear groove welds are 1/8" wide by 1/8" deep "V". Welds are machined, leaving 1/4" radius. Full penetration welds are available upon request.



Design Procedure***

The purpose of this design procedure is to enable the user to determine if a well selected for thermometry considerations is strong enough to withstand specific application conditions of temperature, pressure, velocity, and vibration. Well failures are caused by forces imposed by static pressure, steady state flow, and vibration. Separate evaluations of each of the above effects should be made in order to determine the limiting condition. This design procedure does not allow for effects due to corrosion or erosion.

The natural frequency of a well designed in accordance with Fig. 1.1 and of the dimensions given in Table 1.1 is given by the following equation:

$$f_n = \frac{K_f}{L^2}\sqrt{\frac{E}{\gamma}} \quad \ldots\ldots [1]$$

where

f_n = natural frequency of the well at use temperature, cycles per sec

L = length of well as given in Fig. 1.1, in.

E = modulus of elasticity of well material at use temerature, psi

γ = specific weight of well material at use temperature, lb per cu in.

K_f = a constant obtained from Table 1.2

The wake or Strouhal frequency is given by:

$$f_w = 2.64\frac{V}{B} \quad \ldots\ldots [2]$$

where

f_w = wake frequency, cycles per sec

V = fluid velocity, fps

B = diameter at tip (Fig. 1.1), in.

The ratio of wake to natural frequency (f_w/f_n) shall not exceed 0.8, and when this condition is met, the Magnification Factor, relationship of dynamic to static amplitude is given by:

$$F_M = \frac{(f_w/f_n)^2}{1-(f_w/f_n)^2} = \frac{r^2}{1-r^2} \quad \ldots\ldots [3]$$

For $r \leq 0.8$

where

F_M = magnification factor, dimensionless

r = frequency ratio, (fw/fn), dimensionless

STRESS ANALYSIS

The maximum pressure that a thermometer, well can with stand for a given material at a given temperature shall be computed from the following:

$$P = K_1 S \quad \ldots\ldots [4]$$

where

P = maximum allowable static gage pressure, psi

S = allowable stress for material at operating temperature as given in the ASME Boiler and Pressure Vessel or Piping Codes, psi

K_1 = a stress constant obtained from Table 1-3.

The maximum length that a thermometer well can be made for a given service is dependent upon both vibratory and steady state stress. The necessity for keeping the frequency ratio at 0.8 or less imposes one limitation on maximum length. The other limitation is one of steady state stress considerations, as given by the following equation:

$$L_{max} = \frac{K_2}{V}\sqrt{\frac{v(S - K_3 P_0)}{1 + F_M}} \quad \ldots\ldots [5]$$

where

L_{max} = maximum value of L (as shown in Fig. 1.1) for a given service, in.

V = fluid velocity, fps

v = specific volume of the fluid, cu ft per lb.

S = allowable stress for material at operating temperature as given in the ASME Boiler and Pressure vessel or Piping Codes, psi

P_0 = static operating gage pressure, psi

F_M = magnification factor as computed from Eq [3]

K_2, K_3 = stress constants obtained from Table 1-3.

TABLE 1.1 WELL DIMENSIONS. IN IN.

Dimension	Nominal Size of Sensing Element
	1/4
A (minimum)	13/16
B (minimum)	5/8
d (minimum)	0.254
d (maximum)	0.262

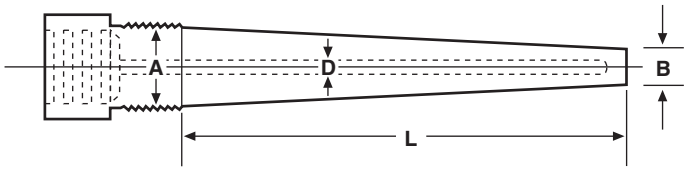
TABLE 1.2 VALUES OF K_f

Well Length L, in.	Kf
2½	2.06
4½	2.07
7½	2.08
10½	2.09
16	2.09
24	2.09

TABLE 1.3 VALUES OF STRESS CONSTANTS

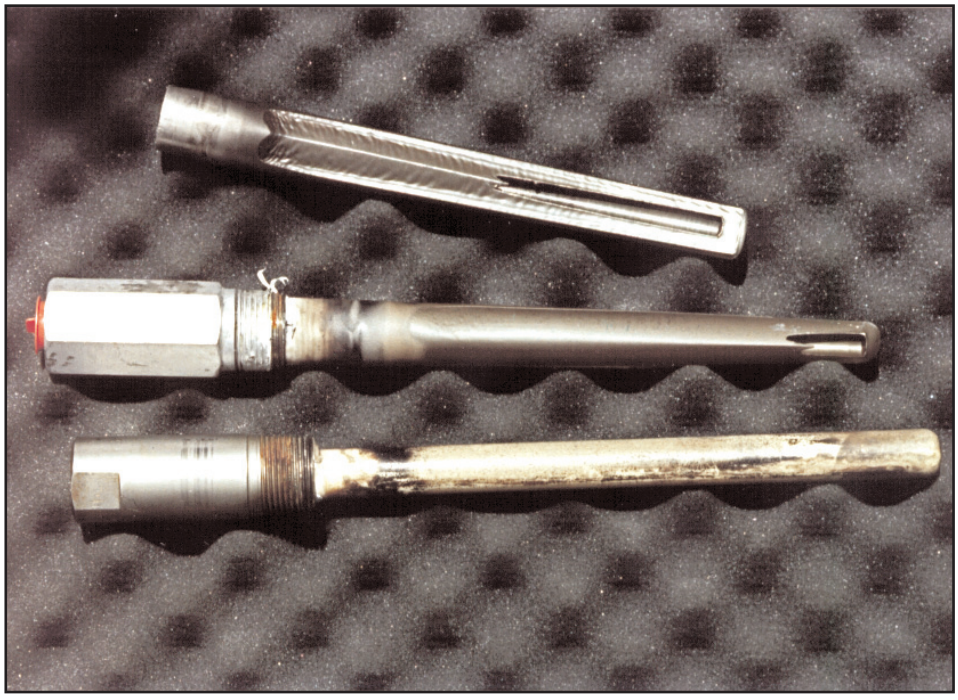
Stress Constant	
K_1	0.412
K_2	37.5
K_3	0.116

*** Power Test Code Thermometer Wells, J.W. Murdock, Journal of Engineering for Power, Trans. ASME, vole. 81, 1959.



Replaced by ASME 19.3
ASME 19.3TW-2010
For Details see:
www.jms-se.com/SwiftyCalc

THERMOWELL DESIGN GUIDELINES



Note: For high erosion and low pressure applications, ask for JMS drawing #8135. For high erosion and high pressure applications, ask for JMS drawing #11468. These are JMS-SE proprietary designs.

Table 4: Allowable Stress Values (PSI)[1]

MATERIAL	TEMPERATURE °F						
	0	300	500	700	900	1100	1300
Aluminum (1100)	2,350	1,850	--	--	--	--	--
Aluminum (6061-T6)	6,000	5,000	--	--	--	--	--
Nickel	10,000	10,000	9,500	--	--	--	--
Steel[2]	11,250	11,000	10,250	9,000	7,750	6,500	--
304SS	18,750	13,750	11,400	10,500	10,000	8,250	--
316SS	18,750	16,400	15,500	15,100	11,650	8,500	3,400
310SS	18,750	14,600	12,600	11,300	10,300	9,450	3,500
321 - 347SS	18,750	15,300	13,500	12,200	11,300	9,100	4,000
410SS	15,000	13,800	12,850	12,050	9,650	2,900	2,200
446SS	17,500	16,100	15,000	--	--	--	--
A182-F11	16,150	16,150	16,150	16,150	13,100	4,000	--
A182-F22	17,500	17,500	17,500	17,500	14,000	4,200	--
Copper	6,000	5,000	--	--	--	--	--
Admiralty Brass	10,000	10,000	--	--	--	--	
Monel 400	16,600	13,600	13,100	13,100	8,000	--	--
Inconel 600	20,000	18,800	18,500	18,500	16,000	3,000	4,150
Incoloy 800[3]	15,600	12,100	10,400	9,600	9,100	8,800	--
Hastelloy B[4]	25,000	24,750	21,450	--	--	--	--
Hastelloy X[5]	23,350	18,850	16,000	15,500	15,500	15,500	9,500

1. Values from ASME Boiler and Pressure Vessel Code Section VIII - Unfired Pressure Vessels, 1965.
2. ASME Spec. Min, Tensile = 45,000 PSI
3. ASME Code (See Note 1), Case 1325 (special ruling)
4. ASME Code (See Note 1), Case 1323 (special ruling)
5. ASME Code (See Note 1), Case 1321 (special ruling)

Note:
JMS has a complete design guide on disc for your use. Call and ask for the Thermowell Design Guide.

3 IMPORTANT THINGS TO REMEMBER WHEN ATTEMPTING TO DETERMINE THE INSERTION LENGTH OF A THERMOWELL

THERMOWELL SELECTION CRITERIA

1. Selecting the proper insertion length is critical to the accuracy of your sensor. In considering length, it is important to allow the entire sensitive portion of the sensor to extend into the medium being measured. The proper length for a sensor installed into a liquid is the sensitive portion plus at least 5 x Ø. For gas or air, a probe should be installed a minimum of 10 x Ø plus the sensitive length.

Generally, wire wound RTD's have a sensitive portion around 5/8". Shorter sensitive lengths are available with thin film and ceramic RTD's upon request. Both thermocouples and thermistors have small sensitive lengths so they are the best choice when working with short insertion lengths.

Note: It is important to consider the amount of the well passing through insulation, walls, fittings, etc., when determining the proper insertion length.

2. In selecting a thermowell, vibration is an important variable to be considered. When thermowells fail, they most often fail due to the vibrational effects they encounter. The pressure and temperature of a process does not usually have as much effect on the life of the thermowell as the fluid velocity of the media.

The media, flowing by the well forms a turbulent wake which has a definite frequency based on the diameter of the well and the flow of the fluid. The well must have sufficient stiffness so the wake frequency will never equal the natural frequency of the well itself. The flowing liquid generates a wake frequency around the well called the Von Karman Trail. Ask us about our Thermowell Program.

The tapered thermowell provides greater stiffness for the same sensitivity than straight thermowells.

The thermowell material chosen is mainly based on the corrosion conditions of the process and temperature range of the operation.

Pressure and velocity flow tables follow to aid our customers as a guide in the selection of thermowells.

Wells are safe if the resonant frequency is below the natural frequency of the well and if the fluid velocity is changing or fluctuating through the critical velocity point.

The values are very conservative and intended as a guide only.

JMS Southeast will be happy to assist you in the event of questions concerning your application and the selection of thermowells.

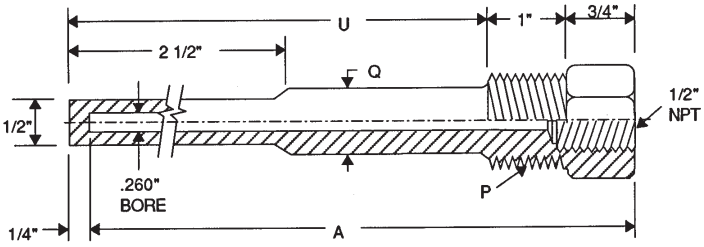
3. Ask for our design disk which calculates the stem loss temperature errors and velocity ratings for all common matrials and mounting methods for thermowells.



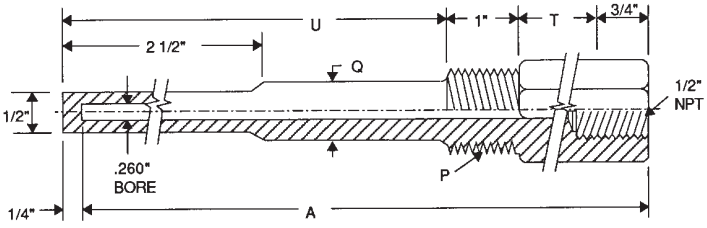
Note:
JMS has a complete design guide on disc for your use. Call and ask for the Thermowell Design Guide.

THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

STANDARD THREADED
STEP SHANK .260" BORE THERMOWELLS
FOR 1/4" DIAMETER ELEMENTS



SERIES 51AT, 52AT, 53AT



SERIES 51AT, 52AT, 53AT with Lag

STEP SHANK .260 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	SHANK DIA Q
½'' NPT	51AT-U 2½	4	2½	1/2
	-U 4½	6	4½	5/8
	-U 7½	9	7½	5/8
	-U 10½	12	10½	5/8
	-U 13½	15	13½	5/8
	-U 16½	18	16½	5/8
	-U 22½	24	22½	5/8
3/4'' NPT	52AT-U 2½	4	2½	1/2
	-U 4½	6	4½	3/4
	U 7½	9	7½	3/4
	U 10½	12	10½	3/4
	-U 13½	15	13½	3/4
	-U 16½	18	16½	3/4
	-U 22½	24	22½	3/4
1'' NPT	53AT-U 2½	4	2½	1/2
	-U 4½	6	4½	7/8
	-U 7½	9	7½	7/8
	-U 10½	12	10½	7/8
	-U 13½	15	13½	7/8
	-U 16½	18	16½	7/8
	-U 22½	24	22½	7/8

STEP SHANK WITH LAG EXTENSION .260 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	LAG EXT. T	SHANK DIA Q
½'' NPT	51AT-U 2½ T2	6	2½	2	1/2
	-U 4½ T3	9	4½	3	5/8
	-U 7½ T3	12	7½	3	5/8
	-U 10½ T3	15	10½	3	5/8
	-U 13½ T3	18	13½	3	5/8
	-U 19½ T3	24	19½	3	5/8
3/4'' NPT	52AT-U 2½ T2	6	2½	2	1/2
	-U 4½ T3	9	4½	3	3/4
	-U 7½ T3	12	7½	3	3/4
	-U 10½ T3	15	10½	3	3/4
	-U 13½ T3	18	13½	3	3/4
	-U 19½ T3	24	19½	3	3/4
1'' NPT	53AT-U 2½ T2	6	2½	2	1/2
	-U 4½ T3	9	4½	3	7/8
	-U 7½ T3	12	7½	3	7/8
	-U 10½ T3	15	10½	3	7/8
	-U 13½ T3	18	13½	3	7/8
	-U 19½ T3	24	19½	3	7/8

MAXIMUM FLUID VELOCITY FEET PER SECOND

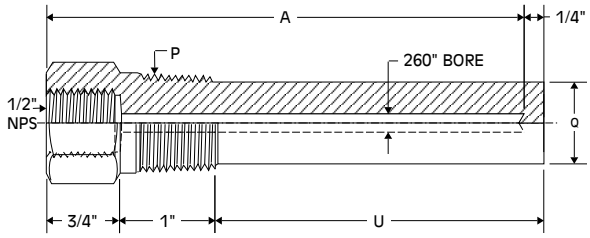
Well Type	Material	INSERTION LENGTH-"U" 2½	4½	7½	10½	13½	16½	19½	22½
½''-260 Bore and ½''-260 Bore with Lag Extension	Brass	207 (59.3)	75.5 (32.2)	27.3 (19.7)	13.9	8.4	5.6	4.1	3.0
	Carbon Steel	290 (106)	105 (59)	38.2 (36.3)	19.4	11.8	7.8	5.7	4.2
	A.I.S.I. 304 & 316	300 (148)	109 (82.2)	39.5	20.1	12.2	8.1	5.9	4.4
	Monel	261 (118)	95 (65.5)	34.4	17.5	10.5	7.1	5.2	3.8
¾''-260 Bore and ¾''-260 Bore with Lag Extension	Brass	207 (59.3)	89.1 (39.8)	32.2 (23.9)	16.4	9.9	6.6	4.8	3.6
	Carbon Steel	290 (106)	123 (71.2)	44.9 (42.7)	22.8	13.8	9.3	6.7	4.9
	A.I.S.I. 304 & 316	300 (148)	128 (99.3)	46.4	23.6	14.3	9.6	6.9	5.1
	Monel	261 (118)	112 (79.8)	40.6	20.7	12.4	8.3	6.1	4.5
1''-260 Bore and 1''-260 Bore with Lag Extension	Brass	207 (59.3)	102 (47.6)	37.0 (28)	18.8	11.4	7.6	5.5	4.1
	Carbon Steel	290 (106)	143 (84.3)	51.6 (50.6)	26.2	15.9	10.6	7.6	5.7
	A.I.S.I. 304 & 316	300 (148)	148 (117)	53.5	27.2	16.5	11.0	7.9	5.9
	Monel	261 (118)	128 (93.3)	46.7	23.7	14.4	9.5	6.9	5.1

PRESSURE (LB. PER SQ. INCH)-TEMPERATURE

Material	Temperature—°F 70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
Carbon Steel	5200	5000	4800	4600	3500	1500	—
A.I.S.I. 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

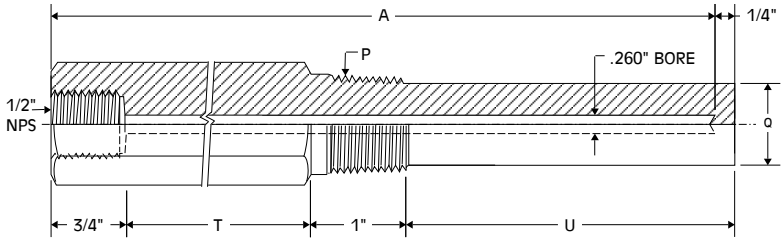
NOTE:
THE VALUES IN PARENTHESIS REPRESENT SAFE VALUES FOR WATER FLOW WHILE THE VALUES NOT IN PARENTHESIS MAY BE USED FOR STREAM, AIR, GAS AND FLUIDS WITH SIMILAR DENSITY

STANDARD THREADED
STRAIGHT SHANK .260" BORE THERMOWELLS FOR 1/4" DIAMETER ELEMENTS



SERIES 51ST, 52ST, 53ST

Note:
JMS has a complete design guide on disc for your use. Call and ask for the Thermowell Design Guide.



SERIES 51ST, 52ST, 53ST with Lag

THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

STRAIGHT SHANK .260 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	SHANK DIA Q
½" NPT	51ST-U 2½	4	2½	5/8
	-U 4½	6	4½	5/8
	-U 7½	9	7½	5/8
	-U 10½	12	10½	5/8
	-U 13½	15	13½	5/8
	-U 16½	18	16½	5/8
	-U 22½	24	22½	5/8
3/4" NPT	52ST-U 2½	4	2½	3/4
	-U 4½	6	4½	3/4
	U 7½	9	7½	3/4
	U 10½	12	10½	3/4
	-U 13½	15	13½	3/4
	-U 16½	18	16½	3/4
	-U 22½	24	22½	3/4
1" NPT	53ST-U 2½	4	2½	7/8
	-U 4½	6	4½	7/8
	-U 7½	9	7½	7/8
	-U 10½	12	10½	7/8
	-U 13½	15	13½	7/8
	-U 16½	18	16½	7/8
	-U 22½	24	22½	7/8

STRAIGHT SHANK WITH LAG EXTENSION .260 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	LAG EXT. T	SHANK DIA Q
½" NPT	51ST-U 2½ T2	6	2½	2	5/8
	-U 4½ T3	9	4½	3	5/8
	-U 7½ T3	12	7½	3	5/8
	-U 10½ T3	15	10½	3	5/8
	-U 13½ T3	18	13½	3	5/8
	-U 19½ T3	24	19½	3	5/8
3/4" NPT	52ST-U 2½ T2	6	2½	2	3/4
	-U 4½ T3	9	4½	3	3/4
	-U 7½ T3	12	7½	3	3/4
	-U 10½ T3	15	10½	3	3/4
	-U 13½ T3	18	13½	3	3/4
	-U 19½ T3	24	19½	3	3/4
1" NPT	53ST-U 2½ T2	6	2½	2	7/8
	-U 4½ T3	9	4½	3	7/8
	-U 7½ T3	12	7½	3	7/8
	-U 10½ T3	15	10½	3	7/8
	-U 13½ T3	18	13½	3	7/8
	-U 19½ T3	24	19½	3	7/8

MAXIMUM FLUID VELOCITY FEET PER SECOND

Well Type	Material	INSERTION LENGTH-"U" 2½	4½	7½	10½	13½	16½	19½	22½
½"-260 Bore and ½"-260 Bore with Lag Extension	Brass	207 (59.3)	75.5 (32.2)	27.3 (19.7)	13.9	8.4	5.6	4.1	3.0
	Carbon Steel	290 (106)	105 (59)	38.2 (36.3)	19.4	11.8	7.8	5.7	4.2
	A.I.S.I. 304 & 316	300 (148)	109 (82.2)	39.5	20.1	12.2	8.1	5.9	4.4
	Monel	261 (118)	95 (65.5)	34.4	17.5	10.5	7.1	5.2	3.8
¾"-260 Bore and 1"-260 Bore with Lag Extension	Brass	207 (59.3)	89.1 (39.8)	32.2 (23.9)	16.4	9.9	6.6	4.8	3.6
	Carbon Steel	290 (106)	123 (71.2)	44.9 (42.7)	22.8	13.8	9.3	6.7	4.9
	A.I.S.I. 304 & 316	300 (148)	128 (99.3)	46.4	23.6	14.3	9.6	6.9	5.1
	Monel	261 (118)	112 (79.8)	40.6	20.7	12.4	8.3	6.1	4.5
1"-260 Bore and 1"-260 Bore with Lag Extension	Brass	207 (59.3)	102 (47.6)	37.0 (28)	18.8	11.4	7.6	5.5	4.1
	Carbon Steel	290 (106)	143 (84.3)	51.6 (50.6)	26.2	15.9	10.6	7.6	5.7
	A.I.S.I. 304 & 316	300 (148)	148 (117)	53.5	27.2	16.5	11.0	7.9	5.9
	Monel	261 (118)	128 (93.3)	46.7	23.7	14.4	9.5	6.9	5.1

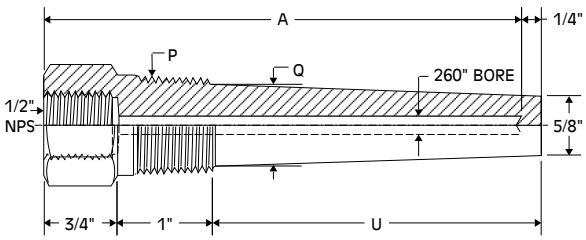
Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

PRESSURE (LB. PER SQ. INCH)-TEMPERATURE

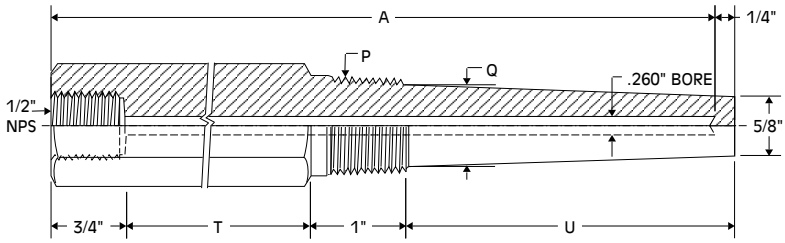
Material	Temperature—°F 70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
Carbon Steel	5200	5000	4800	4600	3500	1500	—
A.I.S.I. 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

STANDARD THREADED
TAPERED SHANK .260" BORE THERMOWELLS
FOR 1/4" DIAMETER ELEMENTS



SERIES 52TT, 53TT



SERIES 52TT, 53TT with Lag

TAPERED SHANK .260 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	SHANK DIA Q
¾'' NPT	52TT-U 2½	4	2½	7/8
	-U 4½	6	4½	7/8
	-U 7½	9	7½	7/8
	-U 10½	12	10½	7/8
	-U 13½	15	13½	7/8
	-U 16½	18	16½	7/8
	-U 22½	24	22½	7/8
1'' NPT	53TT-U 2½	4	2½	1 1/16
	-U 4½	6	4½	1 1/16
	U 7½	9	7½	1 1/16
	U 10½	12	10½	1 1/16
	-U 13½	15	13½	1 1/16
	-U 16½	18	16½	1 1/16
	-U 22½	24	22½	1 1/16

TAPERED SHANK WITH LAG EXTENSION .260 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	LAG EXT. T	SHANK DIA Q
¾'' NPT	52TT-U 2½ T2	6	2½	2	7/8
	-U 4½ T3	9	4½	3	7/8
	-U 7½ T3	12	7½	3	7/8
	-U 10½ T3	15	10½	3	7/8
	-U 13½ T3	18	13½	3	7/8
	-U 19½ T3	24	19½	3	7/8
1'' NPT	53TT-U 2½ T2	6	2½	2	1 1/16
	-U 4½ T3	9	4½	3	1 1/16
	-U 7½ T3	12	7½	3	1 1/16
	-U 10½ T3	15	10½	3	1 1/16
	-U 13½ T3	18	13½	3	1 1/16
	-U 19½ T3	24	19½	3	1 1/16

MAXIMUM FLUID VELOCITY FEET PER SECOND

Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

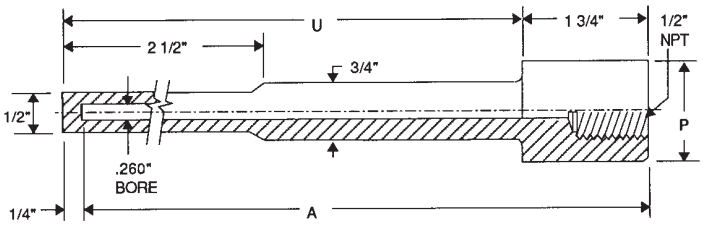
Well Type	Material	INSERTION LENGTH-"U" 2½	4½	7½	10½	13½	16½	19½	22½
¾''-260Bore and ¾''-260 Bore with Lag Extension	Brass	305 (97.5)	93.8 (54.1)	33.9	17.1	10.5	7.0	5.0	3.7
	Carbon Steel	386 (175)	180 (97.2)	65.3 (58.3)	33.0	20.1	13.4	9.6	7.1
	A.I.S.I. 304 & 316	440 (243)	197 (135)	71.2	36.0	22.0	14.7	0.5	7.8
	Monel	354 (195)	155 (108)	56.1	28.4	17.3	11.6	7.5	5.6
1''-260 Bore and 1''-260Bore with Lag Extension	Brass	354 (161)	108 (89.5)	39.4	19.8	12.2	8.1	5.8	4.3
	Carbon Steel	448 (289)	209 (161)	75.7	38.4	23.3	15.5	11.1	8.2
	A.I.S.I. 304 & 316	490 (403)	228 (225)	82.5	41.8	25.5	17.1	12.2	9.1
	Monel	410 (322)	179 (178)	65.1	33.0	20.1	13.5	8.7	6.5

PRESSURE (LB. PER SQ. INCH)-TEMPERATURE

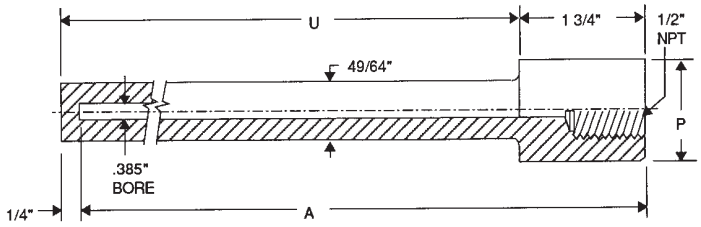
Material	Temperature—°F 70°	200°	400°	600°	800°	1000°	1200°
Brass	5300	4750	1100	—	—	—	—
Carbon Steel	5950	5750	5450	5250	4000	1750	—
A.I.S.I. 304	7800	7050	6400	6150	6000	5190	1875
A.I.S.I. 316	7800	7800	7250	7100	6950	5800	2720
Monel	7450	6850	6150	6100	5940	175	—

THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

SOCKET-WELD
.260" BORE, .385" BORE THERMOWELLS
FOR 1/4" AND 3/8" DIAMETER ELEMENTS



SERIES 52AS, 53AS



SERIES 52SS, 53SS

SOCKET-WELD THERMOWELLS .260 BORE

PIPE SIZE P	SYMBOL	STEM LGTH. A	LENGTH INSERT U
¾'' Nominal (1.050 Dia.)	52AS-U 2½	4	2½
	-U 4½	6	4½
	-U 7½	9	7½
	-U 10½	12	10½
	-U 13½	15	13½
	-U 16½	18	16½
	-U 22½	24	22½
1'' Nominal (1.315 Dia.)	53AS-U 2½	4	2½
	-U 4½	6	4½
	U 7½	9	7½
	U 10½	12	10½
	-U 13½	15	13½
	-U 16½	18	16½
	-U 22½	24	22½

SOCKET-WELD THERMOWELLS .385 BORE

PIPE SIZE P	SYMBOL	STEM LGTH. A	LENGTH INSERT U
¾'' Nominal (1.050 Dia.)	52SS-U 2½	4	2½
	-U 4½	6	4½
	-U 7½	9	7½
	-U 10½	12	10½
	-U 13½	15	13½
	-U 16½	18	16½
	-U 22½	24	22½
1'' Nominal (1.315 Dia.)	53SS-U 2½	4	2½
	-U 4½	6	4½
	U 7½	9	7½
	U 10½	12	10½
	-U 13½	15	13½
	-U 16½	18	16½
	-U 22½	24	22½

MAXIMUM FLUID VELOCITY FEET PER SECOND

Well Type	Material	INSERTION LENGTH-"U" 2½	4½	7½	10½	13½	16½	22½
¾''-260 Bore	Carbon Steel	290 (106)	123 (71.2)	44.9 (42.7)	22.8	13.8	9.3	4.9
	A.I.S.I.—304 & 316	300 (148)	128 (99.3)	46.4	23.6	14.3	9.6	5.1
1''-260 Bore	Carbon Steel	290 (106)	143 (84.3)	51.6 (50.6)	26.2	15.9	10.6	5.7
	A.I.S.I.—304 & 316	300 (148)	148 (117)	53.5	27.2	16.5	11.0	5.9
¾''-385 Bore and 1''-385 Bore	Carbon Steel	426 (260)	192 (144)	69.5	35.4	20.5	14.3	7.7
	A.I.S.I.-304 & 316	449 (360)	199	71.9	36.6	21.2	14.8	8.0

Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

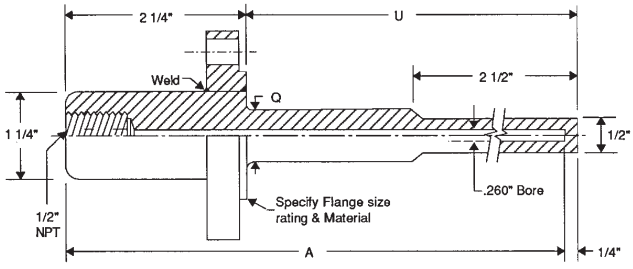
PRESSURE (LB. PER SQ. INCH)-TEMPERATURE

Material	Temperature—°F 70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
Carbon Steel	5200	5000	4800	4600	3500	1500	—
A.I.S.I. 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

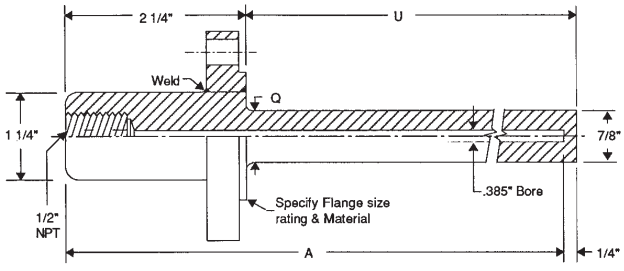
THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

FLANGED

STRAIGHT AND STEP SHANK .260" BORE, .385" BORE THERMOWELLS FOR 1/4" AND 3/8" DIAMETER ELEMENTS



SERIES 5T2A



SERIES 5TS3

FLANGED THERMOWELLS .260 BORE

SYMBOL	ELEM. LGTH. A	INSERT LGTH. U	SHANK DIA. Q
5TA2-U 2	4	2	¾
-U 4	6	4	¾
-U 7	9	7	¾
-U 10	12	10	¾
-U 13	15	13	¾
-U 16	18	16	¾
-U 22	24	22	¾

FLANGED THERMOWELLS .385 BORE

SYMBOL	ELEM. LGTH. A	INSERT LGTH. U	SHANK DIA. Q
5TS3-U 2	4	2	7/8
U 4	6	4	7/8
-U 7	9	7	7/8
-U 10	12	10	7/8
-U 13	15	13	7/8
-U 16	18	16	7/8
-U 22	24	22	7/8

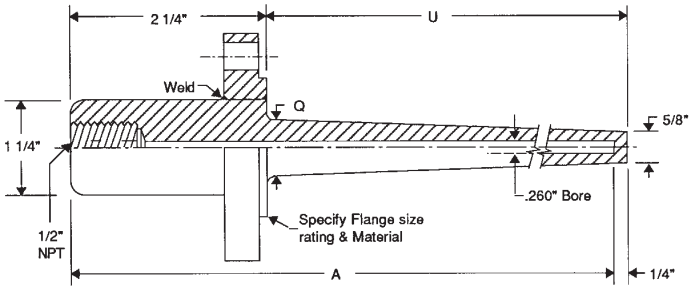
MAXIMUM FLUID VELOCITY FEET PER SECOND

Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

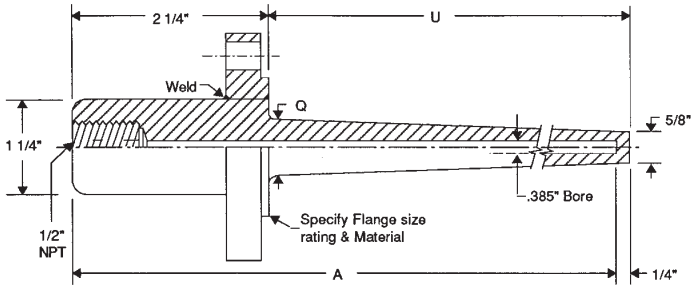
Well Type	Material	INSERTION LENGTH-"U" 2	4	7	10	13	16	22
5TA2 and 5TS2	Carbon Steel	404 (129)	184 (71.2)	67.0 (42.7)	34.0	20.6	13.7	7.4
	A.I.S.I. 304 & 316	430 (179)	192 (99.3)	69.7 (59.6)	35.4	21.5	14.3	7.7
	Monel	350 (143)	168 (79.8)	61 (47.7)	31.0	18.8	12.5	6.7
5TA3 and 5TS3	Carbon Steel	410 (152)	248 (84.3)	91.3 (50.6)	45.7	27.6	18.5	10.0
	A.I.S.I. 304 & 316	444 (211)	258 (117)	95.2 (70.3)	47.6	28.8	19.3	10.4
	Monel	338 (168)	226 (93.3)	83.3 (56.0)	41.6	25.2	16.9	9.1

THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

FLANGED
TAPERED SHANK .260" BORE, .385" BORE THERMOWELLS FOR 1/4" AND 3/8" DIAMETER ELEMENTS



SERIES 5TT2



SERIES 5TT3

FLANGED THERMOWELLS .260 BORE

SYMBOL	ELEM. LGTH. A	INSERT LGTH. U	SHANK DIA. Q
5TT2-U 2	4	2	
-U 4	6	4	Specify
-U 7	9	7	Q
-U 10	12	10	Dimensions
-U 13	15	13	when
-U 16	18	16	making
-U 22	24	22	order

FLANGED THERMOWELLS .385 BORE

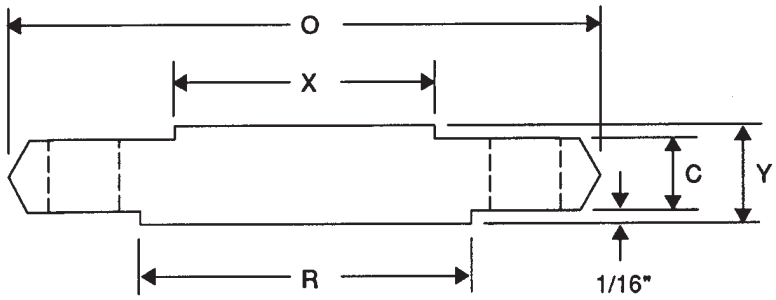
SYMBOL	ELEM. LGTH. A	INSERT LGTH. U	SHANK DIA. Q
5TT3-U 2	4	2	
-U 4	6	4	Specify
-U 7	9	7	Q
-U 10	12	10	Dimensions
-U 13	15	13	when
-U 16	18	16	making
-U 22	24	22	order

MAXIMUM FLUID VELOCITY FEET PER SECOND

Well Type	Material	INSERTION LENGTH-"U" 2	4	7	10	13	16	22
5TT2	Carbon Steel	603 (273)	227 (125)	74 (67)	36	21	14	7.5
	304 & 316	687 (379)	249 (170)	81	39.8	23.6	15.5	8.2
	Monel	553 (304)	196 (136)	64	31	18	12	6
5TT3	Carbon Steel	550 (356)	241 (144)	78.9	38	22.8	15	7.9
	304 & 316	648 (467)	257 (194)	83.8	41	24	16	8.4
	Monel	531 (398)	217 (169)	71	34.8	20.6	13	7

Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

DIMENSIONS FOR THERMOWELL FLANGES

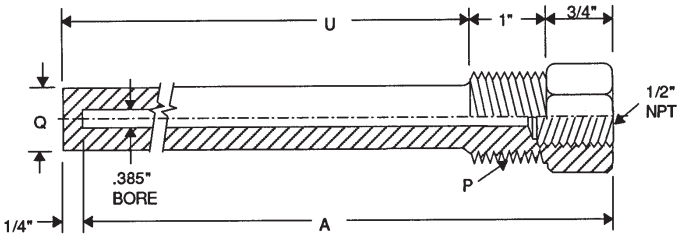


150 POUND 1/16" RAISED FACE MATERIALS AVAILABLE INCLUDE	Flange Size	Weight in lbs.	O Outside Diameter	C Thickness	X Diameter of Hub	Y Length	R Diameter of Raised Face
Carbon Steel							
304 Stainless Steel	1/2	1.05	3.50	.44	1.19	.62	1.38
Low Carbon 304 Stainless Steel	3/4	1.50	3.88	.50	1.50	.62	1.69
310 Stainless Steel	1	2.25	4.25	.56	1.94	.69	2.00
316 Stainless Steel	1 1/4	3.13	4.62	.62	2.31	.81	2.50
Low Carbon 316 Stainless Steel	1 1/2	3.97	5.00	.69	2.56	.88	2.88
Inconel 600	2	6.50	6.00	.75	3.06	1.00	3.62
Monel	2 1/2	9.30	7.00	.88	3.56	1.12	4.12
Hastelloy B	3	10.4	7.50	.94	4.25	1.19	5.00
Molybdenum	4	17.6	9.00	.94	5.31	1.31	6.19
Hastelloy C	5	19.0	10.00	.94	6.44	1.44	7.31
Tantalum	6	31.6	11.00	1.00	7.56	1.56	8.50
Titanium	8	53.6	13.50	1.12	9.69	1.75	10.62
300 POUND 1/16" RAISED FACE MATERIALS AVAILABLE INCLUDE	Flange Size	Weight in lbs.	O Outside Diameter	C Thickness	X Diameter of Hub	Y Length	R Diameter of Raised Face
Carbon Steel							
304 Stainless Steel	1/2	1.60	3.75	.56	1.50	.88	1.38
Low Carbon 304 Stainless Steel	3/4	3.03	4.62	.62	1.88	1.00	1.69
310 Stainless Steel	1	3.94	4.88	.69	2.12	1.06	2.00
316 Stainless Steel	1 1/4	4.50	5.25	.75	2.50	1.06	2.50
Low Carbon 316 Stainless Steel	1 1/2	7.38	6.12	.81	2.75	1.19	2.88
Inconel 600	2	8.28	6.50	.88	3.31	1.31	3.62
Monel	2 1/2	13.1	7.50	1.00	3.94	1.50	4.12
Hastelloy B	3	17.5	8.25	1.12	4.62	1.69	5.00
Molybdenum	4	31.2	10.00	1.25	5.75	1.88	6.19
Hastelloy C	5	41.6	11.00	1.38	7.00	2.00	7.31
Tantalum	6	55.2	12.50	1.44	8.12	2.06	8.50
Titanium	8	96.0	15.00	1.62	10.25	2.44	10.62

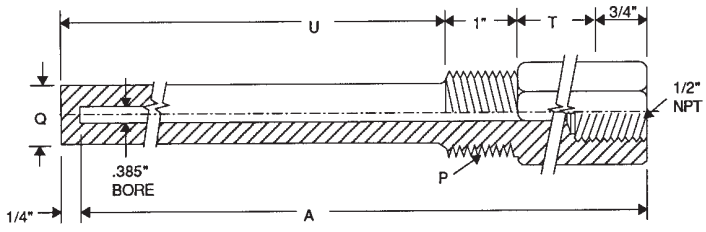
Dimensions are in inches.

THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

STANDARD THREADED
STRAIGHT SHANK .385" BORE THERMOWELLS
FOR 3/8" DIAMETER ELEMENTS



SERIES 52ST, 53ST



SERIES 52ST, 53ST with Lag

STRAIGHT SHANK .385 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	SHANK DIA Q
¾" NPT	52ST-U 2½	4	2½	49/64
	-U 4½	6	4½	49/64
	-U 7½	9	7½	49/64
	-U 10½	12	10½	49/64
	-U 13½	15	13½	49/64
	-U 16½	18	16½	49/64
	-U 22½	24	22½	49/64
1" NPT	53ST-U 2½	4	2½	7/8
	-U 4½	6	4½	7/8
	U 7½	9	7½	7/8
	U 10½	12	10½	7/8
	-U 13½	15	13½	7/8
	-U 16½	18	16½	7/8
	-U 22½	24	22½	7/8

STRAIGHT SHANK WITH LAG EXTENSION .385 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	LAG EXT. T	SHANK DIA Q
¾" NPT	52ST-U 2½ T2	6	2½	2	49/64
	-U 4½ T3	9	4½	3	49/64
	-U 7½ T3	12	7½	3	49/64
	-U 10½ T3	15	10½	3	49/64
	-U 13½ T3	18	13½	3	49/64
	-U 19½ T3	24	19½	3	49/64
1" NPT	53ST-U 2½ T2	6	2½	2	7/8
	-U 4½ T3	9	4½	3	7/8
	-U 7½ T3	12	7½	3	7/8
	-U 10½ T3	15	10½	3	7/8
	-U 13½ T3	18	13½	3	7/8
	-U 19½ T3	24	19½	3	7/8

MAXIMUM FLUID VELOCITY FEET PER SECOND

Material	INSERTION LENGTH-"U"							
	2½	4½	7½	10½	13½	16½	19½	22½
Brass	290 (145)	150 (80)	54.1 (48)	27.6	16.7	11.1	8.0	6.0
Carbon Steel	326 (260)	192 (144)	69.5	35.4	20.5	14.3	10.3	7.7
A.I.S.I.-304 & 316	349 (360)	199	71.9	36.6	21.2	14.8	10.7	8.0
Monel	316 (320)	189 (178)	68.1	34.8	20.8	14.0	10.0	7.5

Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

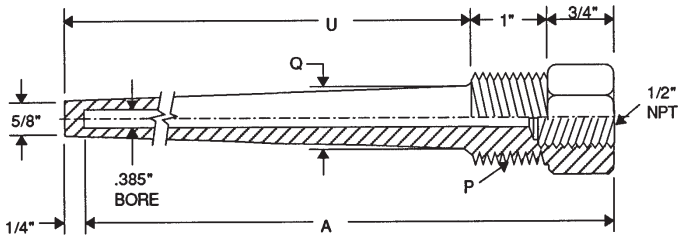
PRESSURE (LB. PER SQ. INCH)-TEMPERATURE

Material	Temperature—°F						
	70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
Carbon Steel	5200	5000	4800	4600	3500	1500	—
A.I.S.I. 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

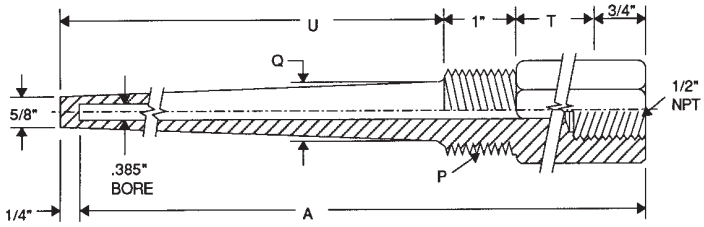
SECTION 5

THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

HEAVY DUTY THREADED
TAPERED SHANK .385" BORE THERMOWELLS
FOR 3/8" DIAMETER ELEMENTS



SERIES 52TT, 53TT



SERIES 52TT, 53TT with Lag

TAPERED SHANK .385 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	SHANK DIA Q
¾" NPT	52TT-U 2½	4	2½	7/8
	-U 4½	6	4½	7/8
	-U 7½	9	7½	7/8
	-U 10½	12	10½	7/8
	-U 13½	15	13½	7/8
	-U 16½	18	16½	7/8
	-U 22½	24	22½	7/8
1" NPT	53TT-U 2½	4	2½	1 1/16
	-U 4½	6	4½	1 1/16
	U 7½	9	7½	1 1/16
	U 10½	12	10½	1 1/16
	-U 13½	15	13½	1 1/16
	-U 16½	18	16½	1 1/16
	-U 22½	24	22½	1 1/16

TAPERED SHANK WITH LAG EXTENSION .385 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	LAG EXT. T	SHANK DIA Q
¾" NPT	52TT-U 2½ T2	6	2½	2	7/8
	-U 4½ T3	9	4½	3	7/8
	-U 7½ T3	12	7½	3	7/8
	-U 10½ T3	15	10½	3	7/8
	-U 13½ T3	18	13½	3	7/8
	-U 19½ T3	24	19½	3	7/8
1" NPT	53TT-U 2½ T2	6	2½	2	1 1/16
	-U 4½ T3	9	4½	3	1 1/16
	-U 7½ T3	12	7½	3	1 1/16
	-U 10½ T3	15	10½	3	1 1/16
	-U 13½ T3	18	13½	3	1 1/16
	-U 19½ T3	24	19½	3	1 1/16

MAXIMUM FLUID VELOCITY FEET PER SECOND

Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

Well Type	Material	INSERTION LENGTH-"U" 2½	4½	7½	10½	13½	16½	19½	22½
¾"-385 Bore	Brass	276 (127)	124 (79)	44	22	13	8	6	4
and	Carbon Steel	352 (228)	191 (114)	689	35	21	14	10	7.5
¾"-385 Bore with Lag Extension	304 & 316	415 (299)	203 (154)	73.2	37.3	22.5	15	11	8
	Monel	340 (255)	172 (134)	62	31	19	12.8	8	6
1"-385 Bore	Brass	321 (150)	129 (83.5)	46.8	23.6	14.5	9.6	6.9	5.1
and	Carbon Steel	410 (270)	249 (150)	90.3	45.6	27.8	18.5	13.2	9.8
1"-385 Bore with Lag Extension	304 & 316	483 (350)	272 (208)	97.3	49.7	30.4	20.3	14.5	10.7
	Monel	396 (306)	214 (167)	77.5	39.2	23.8	16	10.3	7.7

PRESSURE (LB. PER SQ. INCH)-TEMPERATURE

Material	Temperature—°F 70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
Carbon Steel	5200	5000	4800	4600	3500	1500	—
A.I.S.I. 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

DECIMAL EQUIVALENTS OF PIPE SIZES

Dimensions in Inches - Wall Thickness of:

PIPE SIZE	OUTSIDE DIAMETER	SCH 40 / INSIDE DIAMETER	SCH 80 / INSIDE DIAMETER	SCH 160 / INSIDE DIAMETER
1/8	.405	.068 / .269	.095 / .215	N/A
1/4	.540	.088 / .384	.119 / .302	N/A
3/8	.678	.091 / .493	.126 / .423	N/A
1/2	.840	.109 / .622	.147 / .548	.187 / .466
3/4	1.050	.113 / .824	.154 / .742	.218 / .614
1	1.315	.133 / 1.049	.179 / .957	.250 / .815
1 1/4	1.660	.140 / 1.380	.191 / 1.278	.250 / 1.160
1 1/2	1.900	.145 / 1.610	.200 / 1.500	.281 / 1.338
2	2.375	.154 / 2.067	.218 / 1.939	.343 / 1.689
6	6.625	.280 / 6.065	.432 / 5.761	.718 / 5.189
9	9.625	.342 / 8.941	.500 / 8.625	N/A
12	12.750	.406 / 11.938	.687 / 11.376	1.312 / 10.126
24	24.000	.375 / 23.25	500 / 23.00	2.344 / 19.312

THEORETICAL BURSTING AND COLLAPSING PRESSURES FOR PIPE

Stainless Steel (ASTM-A-312)

NOMINAL SIZE (INCHES)	SCHEDULE NUMBER	OUTSIDE DIAMETER (INCHES)	WALL THICKNESS (INCHES)	INSIDE DIAMETER (INCHES)	INTERNAL PRESSURE, PSI BURSTING	EXTERNAL PRESSURE, PSI COLLAPSING
1/8	40 80	0.405 0.405	0.068 0.095	0.269 0.215	25,185 35,185	10,761 15,441
1/4	40 80	0.540 0.540	0.088 0.119	0.384 0.302	24,444 33,055	10,415 14,445
3/8	40 80	0.678 0.678	0.091 0.126	0.493 0.423	20,192 27,876	8,397 12,021
1/2	40 80	0.840 0.840	0.109 0.147	0.622 0.548	19,464 26,250	8,084 11,260
3/4	40 80	1.050 1.050	0.113 0.154	0.824 0.742	16,142 22,000	6,529 9,271
1	40 80	1.315 1.315	0.133 0.179	1.049 0.957	15,171 20,418	6,075 8,530
1 1/4	40 80	1.660 1.660	0.140 0.191	1.380 1.278	12,650 17,259	3,895 7,052
1 1/2	40 80	1.900 1.900	0.145 0.200	1.610 1.500	11,447 15,789	4,332 6,364

NOTE: Burst Pressures for Stainless Steel in above chart were calculated using the specified minimum tensile strength, 75,000 p.s.i.

The information and data presented herein are typical or average values and are not a guarantee of maximum or minimum values. Applications specifically suggested for material described herein are made solely for the purpose of illustration to enable the reader to make his own evaluation and are not intended as warranties, either express or implied, of fitness for these or other purposes.

THEORETICAL BURSTING PRESSURES FOR TUBING (ASTM-A-632)

Corresponding to a fiber stress in wall of 10,000 pounds per square inch

OUTSIDE DIAMETER (INCHES)	WALL THICKNESS - DECIMAL INCH						
	BWG EQUIVALENT						
	.020 25	.028 22	.035 20	.049 18	.065 16	.095 13	.120 11
1/8	3200	5200	5600	7840			
3/16	2133	2987	3933	5227			
1/4	1600	2240	2800	3920	5200	7600	
5/16	1280	1792	2240	3136	4160	6100	
3/8	1057	1493	1867	2613	3467	5067	6400
1/2	800	1120	1400	1960	2600	3800	4800

The table (S=10,000) affords easy calculations with appropriate multipliers shown below. For theoretical bursting pressures, use tensile values. For theoreticalbulging pressures, use yield values. Working pressures will vary depending upon safety factors required for environmental conditions involved as determined by your design engineer and appropriate codes.

Material	Tensile (Multiplier)	Yield (Multiplier)
6061-T6 Aluminum	42,000 psi (x 4.2)	35,000 psi (x3.5)
Annealed Low Carbon Steel	55,000 psi (x 5.5)	25,000 psi (x 2.5)
Annealed 18-8 Stainless	75,000 psi (x 7.5)	30,000 psi (x3.0)
1/8 Hard 18-8 Stainless	105,000 psi (x 10.5)	75,000 psi (x7.5)
Cold Dr. 21-6-9 Stainless	142,000 psi (x 14.2)	120,000 psi (x 12.0)

The above table is based on the best known and most widely used formula for calculating the bursting pressure of tubes, namely Barlow's: $P=\frac{2St}{D}$

P = Internal pressure in p.s.i S = Fiber stress of tube in p.s.i. t = Wall thickness in inches D = Outside diameter in inches

The information and data presented herein are typical of averaging values and are not a guarantee of maximum or minimum values. Applications specifically suggested for material described herein are made solely for the purpose of illustration to enable the reader to make his own evaluation and are not intended as warranties, either express or implied, of fitness for these or other purposes.

To print, right click or press ctrl + P

MATERIAL SELECTION INFORMATION

The following information is a guide line for selecting thermocouple, RTD and thermowell materials based on the process fluid. Factors such as catalytic reaction, contaminations and electrolysis are taken into consideration. However, in many cases there are even more variables which must be examined.

These suggestions are to be used only as guide lines and are based on the most economical material selection. JMS Southeast will not take any responsibility if these recommendations are not satisfactory for specific applications. Consult JMS Southeast for special applications and our engineering department will assist you in your selection.

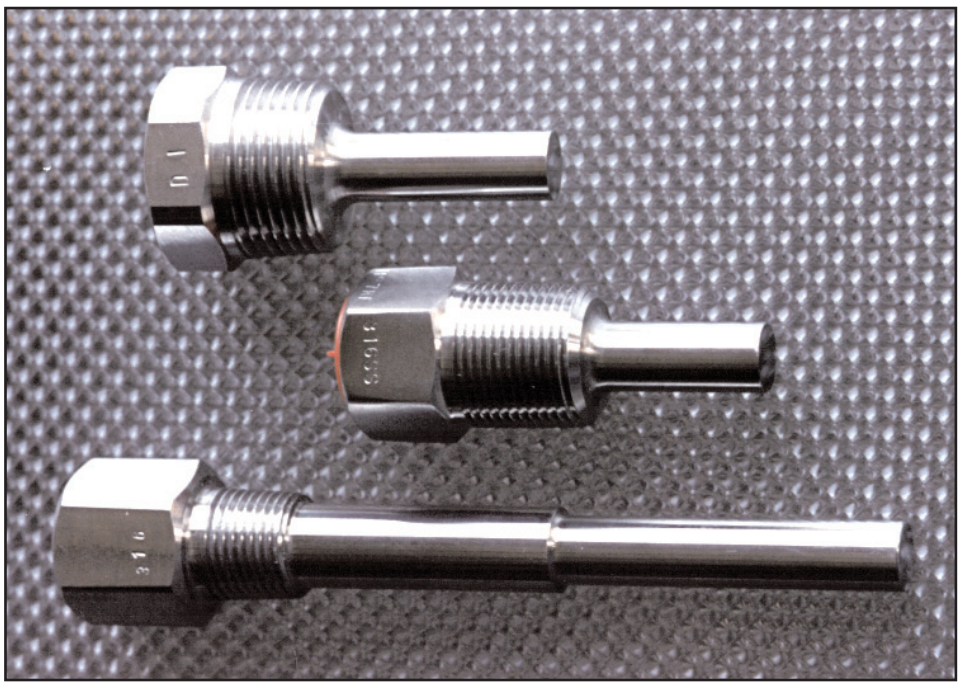
SUBSTANCE	CONDITIONS	RECOMMENDED METAL
Acetate Solvents	Crude or Pure	Monel or Nickel
Acetic Acid	10% - 70°F	304 Stainless Steel
" "	50% - 70°F	304 Stainless Steel
" "	50% - 212°F	316 Stainless Steel
" "	99% - 70°F	430 Stainless Steel
" "	99% - 212°F	430 Stainless Steel
Acetic Anhydride		Monel
Acetone	212°F	304 Stainless Steel
Acetylene		304, Monel, Nickel
Alcohol Ethyl	70°F	304 Stainless Steel
" "	212°F	304 Stainless Steel
Alcohol Methyl	70°F	304 Stainless Steel
" "	212°F	304 Stainless Steel
Aluminum	Molten	Cast Iron
Aluminum Acetate	Saturated	304 Stainless Steel
Aluminum Sulphate	10% - 70°F	304 Stainless Steel
" "	Saturated 70°F	304 Stainless Steel
" "	10% - 212°F	316 Stainless Steel
" "	Saturated 212°F	316 Stainless Steel
Ammonia	All concentrations 70°F	304 Stainless Steel
Ammonium Chloride	All concentrations 212°F	316 Stainless Steel
Ammonium Nitrate	All concentrations 70°F	304 Stainless Steel
" "	All concentrations 212°F	304 Stainless Steel
Ammonium Sulphate	5% - 70°F	304 Stainless Steel
" "	10% - 212°F	316 Stainless Steel
" "	Saturated 212°F	316 Stainless Steel
Aniline	All concentrations 70°F	304 Stainless Steel
Amylacetate		Monel
Asphalt		Steel (C1018)
		Phosphor Bronze, Monel, Nickel
Barium Carbonate	70°F	304 Stainless Steel
Barium Chloride	5% - 70°F	Monel
" "	Saturated 70°F	Monel
" "	Aqueous - Hot	316 Stainless Steel
Barium Hydroxide		Steel (C1018)
Barium Sulphite		Nichrome
Benzaldehyde		Steel (C1018)
Benzene	70°F	304 Stainless Steel
Benzine		Steel (C1018)
		Monel, Inconel
Benzol	Hot	304 Stainless Steel
Boracic Acid	5% Hot or Cold	304 Stainless Steel
Bromine	70°F	Tantalum
Butadiene		Brass, 304
Butane	70°F	304 Stainless Steel
Butylacetate		Monel
Butyl Alcohol		Copper
Butylenes		Steel (C1018), Phosphor Bronze
Butyric Acid	5% - 70°F	304 Stainless Steel
" "	5% - 150°F	304 Stainless Steel
Calcium Bisulfite	70°F	316 Stainless Steel
Calcium Chlorate	Dilute 70°F	304 Stainless Steel
" "	Dilute 150°F	304 Stainless Steel
Calcium Hydroxide	10% - 212°F	304 Stainless Steel
" "	20% - 212°F	304 Stainless Steel
" "	50% - 212°F	317 Stainless Steel
Carbolic Acid	All 212°F	316 Stainless Steel
Carbon Dioxide	Dry	Steel (C1018), Monel
Carbon Dioxide	Wet	Aluminum, Monel, Nickel
Carbon Tetrachloride	10% - 70°F	Monel
Chlorex Caustic		316SS, 317SS
Chlorine Gas	Dry 70°F	317 Stainless Steel
" "	Moist 70°F	Hastelloy C
" "	Moist 212°F	Hastelloy C
Chromic Acid	5% - 70°F	304 Stainless Steel
" "	10% - 212°F	316 Stainless Steel
" "	50% - 212°F	316 Stainless Steel
Citric Acid	15% - 70°F	304 Stainless Steel
" "	15% - 212°F	316 Stainless Steel
" "	Concentrated 212°F	317 Stainless Steel
Coal Tar	Hot	304 Stainless Steel
Coke Oven Gas		Aluminum
Copper Nitrate		304, 316
Copper Sulphate		304, 316
Core Oils		316 Stainless Steel
Cottonseed Oil		Steel (C1018), Monel, Nickel
Creosols		304 Stainless Steel
Creosote Crude		Steel (C1018), Monel Nickel
Cyanogen Gas		304 Stainless Steel
Dowtherm		Steel (C1018)
Epsom Salt	Hot and Cold	304 Stainless Steel
Ether	70°F	304 Stainless Steel
Ethyl Acetate		Monel
Ethyl Chloride	70°F	304 Stainless Steel
Ethylene Glycol		Steel (C1018)
Ethyl Sulphate	70°F	Monel
Ferric Chloride	1% - 70°F	316 Stainless Steel
" "	5% - 70°F	Tantalum
" "	5% - Boiling	Tantalum
Ferric Sulphate	5% - 70°F	304 Stainless Steel
Ferrous Sulphate	Dilute 70°F	304 Stainless Steel
Formaldehyde		304 Stainless Steel
Freon		Steel (C1018)
Formic Acid	5% - 70°F	316 Stainless Steel
" "	5% - 150°F	316 Stainless Steel
Gallic Acid	5% - 70°F	Monel
" "	5% - 150°F	Monel
Gasoline	70°F	304 Stainless Steel
Glucose	70°F	304 Stainless Steel
Glycerine	70°F	304 Stainless Steel
Glycerol		304 Stainless Steel
Heat Treating		446 Stainless Steel
Hydrobromic Acid	48% - 212°F	Hastelloy B
Hydrochloric Acid	1% - 70°F	Hastelloy C
" "	1% - 212°F	Hastelloy B
" "	5% - 70°F	Hastelloy C
" "	5% - 212°F	Hastelloy B
" "	25% - 70°F	Hastelloy B
" "	25% - 212°F	Hastelloy B
Hydrocyanic Acid		316 Stainless Steel
Hydrofluoric Acid		Hastelloy C
Hydrogen Peroxide	70°F	316 Stainless Steel
" "	212°F	316 Stainless Steel
Hydrogen Sulphide	Wet and dry	316 Stainless Steel
Iodine	70°F	Tantalum
Kerosene	70°F	304 Stainless Steel
Lactic Acid	5% - 70°F	304 Stainless Steel
" "	5% - 150°F	316 Stainless Steel
" "	10% - 212°F	Tantalum
Lacquer	70°F	316 Stainless Steel
Latex		Steel (C1018)
Lime Sulphur		Steel (C1018), 304, Monel
Linseed Oil	70°F	304 Stainless Steel
Magnesium Chloride	5% - 70°F	Monel
" "	5% - 212°F	Nickel
Magnesium Sulphate	Cold and Hot	Monel
Malic Acid	Cold and Hot	316 Stainless Steel
Mercury		Steel (C1018), 304, Monel
Methane	70°F	Steel (1020)
Milk		304, Nickel
Mixed Acids (Sulphuric and Nitric — all temp. and %)		Carpenter #20
Molasses		Steel (C1018), 304, Monel, Nickel
Muriatic Acid	70°F	Tantalum
Naphtha	70°F	304 Stainless Steel
Natural Gas	70°F	304 Stainless Steel
Neon	70°F	304 Stainless Steel
Nickel Chloride	70°F	304 Stainless Steel
Nickel Sulphate	Hot and Cold	304 Stainless Steel
Nitric Acid	5% - 70°F	304 Stainless Steel
" "	20% - 70°F	304 Stainless Steel
" "	50% - 70°F	304 Stainless Steel
" "	50% - 212°F	304 Stainless Steel
" "	65% - 212°F	316 Stainless Steel
" "	Concentrated - 70°F	304 Stainless Steel
" "	Concentrated - 212°F	Tantalum
Nitrobenzene	70°F	304 Stainless Steel
Nitrous Acid		304 Stainless Steel
Oleic Acid	70°F	316 Stainless Steel
Oleum	70°F	316 Stainless Steel
Oxalic Acid	5% - Hot and Cold	304 Stainless Steel
" "	10% - 212°F	Monel
Oxygen	70°F	Steel (C1018)
Oxygen	Liquid	304 Stainless Steel
Palmitic Acid		316 Stainless Steel
Petroleum Ether		304 Stainless Steel
Phenol		304 Stainless Steel
Pentane		304 Stainless Steel
Phosphoric Acid	1% - 70°F	304 Stainless Steel
" "	5% - 70°F	304 Stainless Steel
" "	10% - 70°F	316 Stainless Steel
" "	10% - 212°F	Hastelloy C
" "	30% - 70°F	Hastelloy B
" "	30% - 212°F	Hastelloy B
" "	85% - 70°F	Hastelloy B
" "	85% - 212°F	Hastelloy B
Picric Acid	70°F	304 Stainless Steel
Potassium Bromide	70°F	316 Stainless Steel
Potassium Carbonate	1% - 70°F	304 Stainless Steel
Potassium Chlorate	70°F	304 Stainless Steel
Potassium Chloride	5% - 70°F	304 Stainless Steel
" "	5% - 212°F	304 Stainless Steel
Potassium Hydroxide	5% - 70°F	304 Stainless Steel
" "	25% - 212°F	304 Stainless Steel
" "	50% - 212°F	316 Stainless Steel
Potassium Nitrate	5% - 70°F	304 Stainless Steel
" "	5% - 212°F	304 Stainless Steel
Potassium Permanganate	5% - 70°F	304 Stainless Steel
Potassium Sulphate	5% - 70°F	304 Stainless Steel
" "	5% - 212°F	304 Stainless Steel
Potassium Sulphide	70°F	304 Stainless Steel
Propane		304 Stainless Steel
Pyrogallic Acid		304 Stainless Steel
Quinine Bisulphate	Dry	316 Stainless Steel
Quinine Sulphate	Dry	304 Stainless Steel
Resin		304 Stainless Steel
Rosin	Molten	304 Stainless Steel
Sea Water		Monel
Salammoniac		Monel
Salicylic Acid		Nickel
Shellac		304 Stainless Steel
Soap	70°F	304 Stainless Steel
Sodium Bicarbonate	All concentrations 70°F	304 Stainless Steel
" "	5% - 150°F	304 Stainless Steel
Sodium Bisulphate		Monel
Sodium Carbonate	5% - 70°F	304 Stainless Steel
" "	5% - 150°F	304 Stainless Steel
Sodium Chloride	5% - 70°F	316 Stainless Steel
Sodium Chloride	5% - 150°F	316 Stainless Steel
" "	Saturated - 70°F	316 Stainless Steel
" "	Saturated - 212°F	316 Stainless Steel
Sodium Fluoride	5% - 70°F	Monel
Sodium Hydroxide		304 Stainless Steel
Sodium Hypochlorite	5% still	316 Stainless Steel
Sodium Nitrate	Fused	317 Stainless Steel
Sodium Peroxide		304 Stainless Steel
Sodium Phosphate		Steel (C1018)
Sodium Silicate		Steel (C1018)
Sodium Sulphate	70°F	304 Stainless Steel
Sodium Sulphide	70°F	316 Stainless Steel
Sodium Sulphite	150°F	304 Stainless Steel
Steam		304 Stainless Steel
Stearic Acid		304 Stainless Steel
Sulphur Dioxide	Moist Gas - 70°F	316 Stainless Steel
" "	Gas - 575°F	304 Stainless Steel
Sulphur	Dry - Molten	304 Stainless Steel
"	Wet	316 Stainless Steel
Sulphuric Acid	5% - 70°F	Carp. 20, Hastelloy B
" "	5% - 212°F	Carp. 20, Hastelloy B
" "	10% - 70°F	Carp. 20, Hastelloy B
" "	10% - 212°F	Carp. 20, Hastelloy B
" "	50% - 70°F	Carp. 20, Hastelloy B
" "	50% - 212°F	Carp. 20, Hastelloy B
" "	90% - 70°F	Carp. 20, Hastelloy B
" "	90% - 212°F	Hastelloy D
Tannic Acid	70°F	304 Stainless Steel
Tar		Steel (C1018), 304, Monel, Nickel
Tartaric Acid	70°F	304 Stainless Steel
" "	150°F	316 Stainless Steel
Tin	Molten	Cast Iron
Tolvene		Aluminum, Phosphor Bronze, Monel
Trichloroethylene		Steel (C1018)
Turpentine		304 Stainless Steel
Varnish		304 Stainless Steel
Vegetable Oils		Steel (C1018), 304, Monel
Vinegar		304 Stainless Steel
Water	Fresh	Copper, Steel (C1018), Monel
Water	Salt	Aluminum Brass, Monel
Whiskey, Wine		304, Nickel
Xylene		Copper
Zinc	Molten	Cast Iron
Zinc Chloride		Monel
Zinc Sulphate	5% - 70°F	304 Stainless Steel
" "	Saturated - 70°F	304 Stainless Steel
" "	25% - 212°F	304 Stainless Steel

MATERIAL SELECTION INFORMATION

METALLIC THERMOWELL MATERIALS

SUMMARY TABLE

DESIGNATION	NOMINAL COMPOSITION	MAXIMUM TEMP. (cont. serv. air)	MELTING POINT
304SS	18% Chromium 9% Nickel	1652°F	2600 - 2750°F
310SS	25% Chromium 20% Nickel	2100°F	2500 - 2550°F
316SS	18% Chromium 12% Nickel 2-3% Molybdenum	1700°F	2500 - 2550°F
304LSS	Similar to 304SS with reduced carbon	800°F	2600 - 2750°F
Inconel 600	76% Nickel 15.5% Chromium 8.0% Iron	2100°F	2470 - 2575°F
Hastelloy B3	65% Nickel 28% Molybdenum 1.5% Cr 1.5% Iron	800°F	2500 - 2585°F
Hastelloy C276	57% Nickel 16% Molybdenum 15.5% Chromium 4% Tungsten 5% Iron	800°F	2415 - 2500°F
Monel	65% Nickel 32% Copper	1000°F	2450°F



MATERIAL SELECTION INFORMATION

COMPARATIVE CORROSION RATINGS

For Carbon Steel, Inconel, Monel, Nickel, 303 Stainless Steel, 304 Stainless Steel, 316 Stainless Steel, and Teflon.

The data in this chart is reprinted here with the permission of Hoke, Inc., One Tenakill Park, Cresskill, New Jersey 07626.

This chart is a guide to the selection of a corrosion resistant protection tube. Changes in temperature, concentration, pressure, agitation, aeration, and impurities can nullify these ratings. The only way to determine the suitability of a protection material in a media is by performance tests. Mechanical strength of the protection tube must also be considered. Unless otherwise marked, all pressures and temperatures are atmospheric. This listing does not imply that other materials are not suitable for use in the media listed.

IDENTIFICATION OF TRADENAMED MATERIALS

Inconel, Monel . . . . . International Nickel Co.
Teflon . . . . . E.I. DuPont

RATINGS

A Substantial Resistance-Preferred material of construction.
B Moderate Resistance-Satisfactory for use under most conditions; very slight swelling for elastomers.
C Questionable Resistance-Use with caution.
D Inadequate Resistance-Not recommended.
X No information available

LIMITATIONS

1. To 220° F.
2. Subject to stress corrosion at high temperatures and in concentrated solutions.
3. Subject to pitting at air solution line when solution is allowed to dry on metal surface.

Corrosive Media	Carbon Steel	Inconel	Monel	Nickel	303 & 304 Stainless Steel	316 Stainless Steel	Teflon
Acetate Solvents, Crude	D	A	B	B	A	A	A
Acetate Solvents, Pure	C	A	A	A	A	A	A
Acetaldehyde, 100%	X	B	A	B	A	A	A
Acetic Acid, 95%	D	A	A	A	B	A	A
Acetic Acid Vapors, 100%, Hot	B	B	B	B	D	E	A
Acetic Anhydride, Boiling	D	A	A	B	B	A	A
Acetone	B	A	A	A	A	A	A
Alcohols	B	A	A	A	A	A	A
Alum. Potassium, 10%	D	B	B	B	B-3	A	A
Aluminum Chloride, 10%	D	B	B	B	D	C-3	A
Aluminum Choloride, 10%, Boiling	D	C	C	B	D	D	A
Aluminum Sulfate, 10%	D	A	A	A	C	B	A
Aluminum Sulfate, <10%, Boiling	D	B	B	B	D	B	A
Aluminum Sulfate, >10%, Boiling	D	B	B	B	D	B	A
Amines	B	A	A	A	A	A	A
Ammonia, Anhydrous	B	A	A	A	A	A	A
Ammonium Chloride, 10%	C	A	A	A	B-3	A	A
Ammonium Chloride, <10%, Boiling	D	B	B	B	D	C-3	A
Ammonium Chloride, >10%, Boiling	D	C	B	B	D	C-3	A
Ammonium Hydroxide, Hot	B	A	D	D	A	A	A
Ammonium Nitrate	B	A	C	C	A	A	A
Ammonium Persulfate, 5%	D	A	D	D	A	A	A
Ammonium Phosphate, Dibasic, 5%	D	A	B	C	A	A	A
Ammonium Sulfate, <10%	C	B	A	B	B	B	A
Ammonium Sulfate, >10%, Boiling	D	B	B	B	C-3	B-3	A
Ammonium Sulfite, Boiling	D	D	C	D	C	B	A
Aniline Hydrochloride	D	B	B	B	D	C	A
Antimony Trichloride	D	B	B	B	D	C	A
Asphalt	B	A	A	B	A	A	A
Barium Chloride, 5%	C	A	A	A	A	A	A
Barium Chloride, >5%, Hot	D	B	A	A	C-3	B-3	A
Barium Hydroxide	C	A	A	A	A	A	A
Barium Nitrate	C	B	C	C	A	A	A
Beer, 160°F	C	A	A	A	A	A	A
Beet Sugar, Liquor, Hot	B	A	A	A	A	A	A
Benzene, Hot	B	A	A	A	A	A	A
Benzoic Acid	B	A	A	A	A	A	A
Blood	D	A	A	A	A	A	A
Borax, Hot	B	A	A	B	A	A	A
Boric Acid, 5%, Hot	D	A	B	B	B	B	A
Bromine, Dry Gas	D	B	A	A	D	D	A
Bromine, Moist Gas	D	D	C	C	D	D	A
Buttermilk	D	A	A	A	A	A	A
Butyric Acid, Dilute	X	A	A	A	A	A	A
Butyric Acid, Hot, Conc.	D	B	B	C	C	B	A
Calcium Bisulfite, Hot	D	D	D	D	C	B	A
Calcium Chloride, Dilute	C	A	A	A	B-3	A-3	A
Calcium Hydroxide, 10%, Boiling	D	A	A	A	A	A	A
Calcium Hydroxide, 20%, Boiling	D	A	A	A	A	A	A
Calcium Hydroxide, 30%, Boiling	D	A	A	A	C	B	A
Calcium Hypochloride, <2%	C	B	C	C	C-3	B-3	A
Carbolic Acid, 90%	C	A	B	A	A	A	A
Carbon Dioxide, Dry	B	A	A	A	A	A	A
Carbon Disulphide	B	A	B	B	A	A	A
Carbon Tetrachloride, Dry, Hot	C	A	A	A	B	A	A
Carbonic Acid, Saturated	D	A	A	A	A	A	A
Chloroacetic Acid	D	B	B	B	D	C	A
Chloric Acid	D	C	C	C	D	C	A
Chlorinated Water, Sat.	D	C	C	C	D	C-3	A
Chlorine, Dry Gas	B	A	A	A	B	B	A
Chlorine, Moist Gas	D	D	C	C	D	C	A
Chlorosulfonis Acid, Dilute	D	B	B	A	D	B	A
Chromic Acid, Dilute	B	B	B	B	B	A	A
Chromic Acid, >10%, Boiling	D	C	C	D	C	B	A
Chromic Acid, >10%, Boiling	D	C	D	D	D	C	A
Citric Acid, Dilute	D	A	A	B	A	A	A
Citric Acid, Hot, Concentrated	D	B	B	B	C	B	A
Copper Nitrate, Hot, Concentrated	D	C	D	D	A	A	A
Copper Sulfate, Hot, Concentrated	D	B	C	C	B	A	A
Creosote, Hot	B	A	A	A	A	A	A
Cupric Chloride, <2%	D	C	B	B	B-3	B-3	A
Cupric Chloride, 5%	D	D	D	C	D	C-3	A
Dichlorethane, Boiling	D	B	A	A	B	B	A
Ethyl Chloride	A	A	A	A	A	A	A
Ethylene Glycol	A	A	A	A	A	A	A
Fatty Acids, 145°F	C	A	A	A	B	A	A
Ferric Chloride, <1%	D	B	C	B	C-3	B-3	A
Ferric Chloride, >1%	D	D	D	D	D	D	A
Ferric Chloride, <1%, Boiling	D	D	D	D	D	D	A
Ferric Chloride, >1%, Boiling	D	D	D	D	D	D	A
Ferric Nitrate, 5%	D	C	D	D	B	A	A
Ferric Sulfate, 5%	D	B	C	C	B-3	A	A
Ferrous Sulfate, 10%	C	B	A	A	A	A	A
Fluorine, Dry Gas	C	A	A	A	C	B	A
Fluorine, Dry, 300°F	D	B	A	A	D	C	D
Fluorine, Moist Gas	D	B	A	B	D	D	A
Formaldehyde, 40%	C	A	A	A	B	A	A
Formic Acid, <50%	D	A	B	B	B	A	A
Formic Acid, >50%	D	B	B	B	B	A	A
Formic Acid, <50%, Hot	D	B	B	B	B	A	A
Formic Acid, >50%, Hot	D	B	B	B	C	B	A
Freon, Wet	C	B	A	A	C	C	A
Fuel Oil, 140°F	A	A	B	B	A	A	A
Furfural	B	B	B	B	B	B	A
Gasoline, refined	A	A	A	A	A	A	A
Glycerine	A	A	A	A	A	A	A
Hydrochloric Acid, <1%	D	B	B	B	D	B	A
Hydrochloric Acid, 1-20%	D	C	B	B	D	D	A
Hydrochloric Acid, >20%	D	D	D	C	D	D	A
Hydrochloric Acid, <1/2%, 175°F	D	C	B	B	D	D	A
Hydrochloric Acid, 1/2-2%, 175°F	D	D	C	C	D	D	A
Hydrochloric Acid, >2%, 175°F	D	D	D	D	D	D	A

MATERIAL SELECTION INFORMATION

Corrosive Media	Carbon Steel	Inconel	Monel	Nickel	303 & 304 Stainless Steel	316 Stainless Steel	Teflon
Hydrochloric Acid, <1/4%, Boiling	D	C	B	B	D	D	A
Hydrochloric Acid, 1/4-1%, Boiling	D	C	C	C	D	D	A
Hydrochloric Acid, >1%, Boiling	D	D	D	D	D	D	A
Hydrofluoric Acid, <40%	C	C	B	B	D	D	A
Hydrofluoric Acid, >40%	C	C	B	C	D	D	A
Hydrofluoric Acid, Boiling	D	D	B	C	D	D	A
Hydrofluosilic Acid	D	B	A	B	D	C	A
Hydrogen Chloride, Dry	B	A	A	A	D	C	A
Hydrogen Chloride, Moist	D	D	C	C	D	D	A
Hydrogen Fluoride, Dry	C	A	A	A	D	C	A-1
Hydrogen Peroxide, Boiling	D	B	B	B	C	B	A
Hydrogen Sulfide, Dry	B	A	A	A	A	A	A
Hydrogen Sulfide, Moist	C	A	B	B	B	A	A
Iodine, Dry	D	A	A	A	D	B	A
Kerosene	A	A	A	A	A	A	A
Lactic Acid, 5%	D	A	B	B	B	A	A
Lactic Acid, 10%	D	A	B	B	B	A	A
Lactic Acid, Boiling, 5%	D	B	C	C	C	B	A
Lactic Acid, Boiling, 10%	D	B	C	C	D	B	A
Lead Acetate, Hot	D	B	B	C	A	A	A
Magnesium Chloride, Hot, 5%	D	A	A	A	C-3	B-3	A
Magnesium Hydroxide	B	A	A	A	A	A	A
Magnesium Sulfate	B	B	A	B	A	A	A
Magnesium Sulfate, Boiling	C	C	A	B	A	A	A
Mercury	B	A	B-2	A	A	A	A
Mercuric Chloride, <2%	D	D	D	D	D	D	A
Mercuric Chloride, <1/2%, Boiling	D	D	D	D	D	D	A
Mercuric Cyanide	D	B	D	B	B	B	A
Methyl Chloride, Dry	D	A	A	A	B	B	A
Milk	D	A	B	B	A	A	A
Molasses	B	A	A	A	A	A	A
Naptha	B	A	A	A	A	A	A
Nickel Chloride	D	B	B	B	C-3	B-3	A
Nickel Sulfate, Boiling	D	B	A	A	C	C	A
Nitric Acid, 20%	D	B	D	D	A	A	A
Nitric Acid, Fuming	D	B	D	D	B	B	A
Nitric Acid, Boiling, 20%	D	C	D	D	A	A	A
Nitric Acid, Boiling, 65%	D	D	D	D	B	B	A
Nitric Acid, Boiling, Conc.	D	D	D	D	D	D	A
Nitrous Acid	D	B	C	C	B	B	A
Oxalic Acid, <10%	C	A	A	A	A	A	A
Oxalic Acid, 10%	C	A	A	A	A	A	A
Oxalic Acid, Boiling, 10%	D	A	A	B	D	C	A
Oxalic Acid, Boiling, 50%	D	B	B	C	D	C	A
Phosphoric Acid (Ortho), <10%	D	A	B	B	B	A	A
Phosphoric Acid (Ortho), 10-50%	D	A	B	C	C	A	A
Phosphoric Acid (Ortho), >50%	D	A	B	C	C	A	A
Phosphoric Acid (Ortho), <20%, 175°F	D	C	B	D	D	A	A
Phosphoric Acid (Ortho), >20%, 175°F	D	D	B	D	D	B	A
Phosphoric Acid (Ortho), <10%, Boiling	D	D	C	D	D	B	A
Phosphoric Acid (Ortho), 85%, Boiling	D	D	D	D	D	C	A
Picric Acid	C	D	D	D	A	A	A
Potassium Bromide	D	A	A	A	C-3	B-3	A
Potassium Carbonate	B	A	A	A	A	A	A
Potassium Chlorate	B	A	B	B	A	A	A
Potassium Chloride	D	A	A	B	A-3	A-3	A
Potassium Chloride, Hot	D	B	A	B	C-3	B-3	A
Potassium Cyanide	B	B	B	B	B	B	A
Potassium Dichromate, Conc.	C	B	B	C	A	A	A
Potassium Ferricyanide, 5%	C	B	B	B	A	A	A
Potassium Ferrocyanide, 5%	C	X	B	B	A	A	A
Potassium Hydroxide, 50%	B	A	A	A	A	A	A
Potassium Hydroxide, 30%, 175°F	D	A	A	A	A	A	A
Potassium Hydroxide, 50%, 175°F	D	A	A	A	B	A	A
Potassium Hydroxide, 30%, Boiling	D	A	A	A	B	A	A
Potassium Hydroxide, 50%, Boiling	D	A	A	A	B	A	A
Potassium Hypochlorite, Dilute	D	X	D	C	C-3	B-3	A
Potassium Permanganate, Dilute	B	B	A	A	A	A	A
Potassium Sulfate, Dilute	B	A	A	A	A	A	A
Potassium Sulfate, Dilute, Boiling	D	B	B	B	B	B	A
Potassium Sulfide, Saturated	C	A	C	A	A	A	A

Corrosive Media	Carbon Steel	Inconel	Monel	Nickel	303 & 304 Stainless Steel	316 Stainless Steel	Teflon
Propane, Liquid and Gas	B	A	A	A	A	A	A
Pyrogallic Acid	B	B	A	A	A	A	A
Rosin, Molten	D	A	A	A	A	A	A
Salicylic Acid	D	B	B	B	B	B	A
Silver Bromide	D	C	B	C	B-3	A-3	A
Silver Chloride	D	C	B	C	D	D	A
Silver Nitrate	X	A	C	D	A	A	A
Sodium Acetate	C	A	A	A	A	A	A
Sodium Bisulfate	D	B	A	B	B	B	A
Sodium Bisulfate, 140°F	D	C	B	C	B	B	A
Sodium Bromide, Dilute	X	B	A	B	B-3	A-3	A
Sodium Carbonate, 5%, Hot	B	A	A	A	A	A	A
Sodium Chloride, Dilute	C	A	A	A	A	A	A
Sodium Chloride, Saturated, Boiling	D	A	A	A	C-3	B-3	A
Sodium Cyanide	B	B	A	B	B	B	A
Sodium Fluoride, 5%	D	B	A	A	B-3	A-3	A
Sodium Hydroxide, 50%	B	A	A	A	A	A	A
Sodium Hydroxide, <40%, 175°F	D	A	A	A	A	A	A
Sodium Hydroxide, 40-80%, 175°F	D	A	A	A	A	A	A
Sodium Hydroxide, <30%, Boiling	D	A	B	A	A	A	A
Sodium Hydroxide, >30%, Boiling	D	A	B	A	C	B	A
Sodium Hydroxide, Molten	D	B	B	A	D	D	D
Sodium Hypochlorite (Still), 5%	D	C	C	C	C-3	B-3	A
Sodium Hyposulfite	D	B	A	A	B	A	A
Sodium Nitrate	B	A	B	A	B	A	A
Sodium Perborate	C	A	B	B	A	A	A
Sodium Peroxide	C	A	B	B	A	A	A
Sodium Phosphate, Tribasic	C	A	A	A	A	A	A
Sodium Silicate	B	A	B	B	A	A	A
Sodium Sulfate (All concentrations)	B	B	A	A	B	A	A
Sodium Sulfate, Hot	D	B	A	B	C	B	A
Sodium Sulfide, Saturated	B	A	B	A	B-3	A	A
Sodium Sulfite, Hot	D	C	B	C	B	A	A
Sodium Thiosulfate	D	B	B	B	B	A	A
Stannic Chloride, <5%	D	D	B	B	D	D	A
Stannic Chloride, >5%	D	D	C	D	D	D	A
Stannic Chloride, SG 1.21, Boiling	D	D	D	D	D	D	A
Stannous Chloride, Saturated	D	B	B	B	D	B	A
Steam, 212°F	A	A	A	A	A	A	A
Steam, 600°F	C	A	A	A	A	A	D
Sulfite, Liquors	D	D	D	D	C	B	A
Sulfur, Molten, 266°F	B	A	A	A	B	A	A
Sulfur, Chloride	D	B	B	B	D	C	A
Sulfur Dioxide, 250°F, Dry	B	B	B	B	A	A	A
Sulfur Dioxide, Moist	D	D	D	D	B	A	A
Sulfuric Acid, <2%	D	B	B	B	C	B	A
Sulfuric Acid, 2-40%	D	B	B	B	D	D	A
Sulfuric Acid, 40%	D	B	B	B	D	D	A
Sulfuric Acid, Concentrated	B	B	D	D	B	B	A
Sulfuric Acid, <10%, Boiling	D	C	B	D	D	D	A
Sulfuric Acid, 10-80%, Boiling	D	D	C	D	D	D	A
Sulfuric Acid, Concentrated, Boiling	D	D	D	D	D	D	A
Sulfurous Acid, Saturated	D	D	D	D	B	B	A
Tannic Acid, 10%	D	B	A	A	A	A	A
Tar, Hot	B	A	B	B	A	A	A
Tartaric Acid, 120°F	D	A	A	A	B	A	A
Toluene	A	A	A	A	A	A	A
Trichlorethylene	B	A	A	A	A	A	A
Turpentine	B	A	A	A	A	A	A
Varnish, Hot	C	A	A	A	A	A	A
Vegetable Oils	B	A	B	B	A	A	A
Vinegar	D	A	A	A	A	A	A
Water, Acid Mine	D	A	C	C	A-3	A-3	A
Water, Boiler Feed	B	A	A	A	A	A	A
Water, Distilled	D	A	A	A	A	A	A
Water, Salt Sea	D	B	A	C	C-3	B-3	A
Whiskey, Boiling	D	A	C	B	A	A	A
Wine	D	A	C	B	A	A	A
Xylene, Boiling	X	A	A	B	A	A	A
Zinc Chloride, 5%	D	B	B	B	C-3	B-3	A
Zinc Chloride, 5%, Boiling	D	D	B	C	D	D	A
Zinc Sulfate, Boiling	D	B	A	B	A	A	A

CERAMIC AND METAL COATINGS

FOR THERMOWELLS, PROTECTION TUBES, AND BARE SENSORS

Increasing numbers of industrial firms are specifying reliable, high quality thermal coating for repair, restoration and enhancement of mechanical or process equipment. Knowledgeable operations personnel regularly take advantage of the many cost savings and performance improvements now available from these processes and materials; some of which were previously used only for aerospace applications.

BACKGROUND AND USES

Thermal spraying is a process which uses combustion, electric arc or gas plasma, combined with an inert feeder gas, to apply a wide variety of molten metals, ceramics, oxides, and carbides to a target substrate. Combining various substrates with particular coatings allows engineers to choose from using a coated component instead of a solid one.

Some of the major use categories for thermal spray coatings are to increase wear resistance, prevent corrosion, provide thermal barriers or electrical insulation, and restore parts to their original dimensions. In concert with each of these categories, advanced finishing techniques provide a broad spectrum of surface finishes ranging from 1 RMS to over 300 RMS to meet virtually any requirement.

Plasma Arc Spray

Plasma arc spraying is the workhorse of the thermal spray processes. The material to be sprayed is introduced in powder form in the plasma gas stream either in the torch nozzle or just outside the nozzle. The velocity of the plasma stream that exits the nozzle is about the velocity of sound in air. The velocity of spray is usually increased by constricting the torch nozzle. Argon and helium are popular plasma gases, and if these are properly used, the spray deposit will contain very little oxide. This is a process advantage over thermal spray processes that use air as gas to produce the consumable spray. The intense heat of the plasma does not produce substantial substrate heating. Most of the heat to the substrate comes from the heat from the impinging consumable droplets and substrate temperatures usually do not get over 250 degrees F. When substrate heating becomes a consideration, on for example thin wall tubes, auxiliary jets of inert gas are used for substrate cooling. Hundreds of powder consumables are available. They fall into four different categories: metals, ceramics (primarily oxides and carbides), cermets and composites. The most popular ceramic coatings are aluminum oxide and chromium oxide. They are used mostly for wear applications. Ceramics such as yttria-stabilized zirconia and magnesium zirconate are used for thermal barrier applications. The most popular cermet consumable used in plasma spraying is tungsten carbide/cobalt. The mechanical, physical, and chemical properties of a thermal spray deposit may be different from the properties of the same material in bulk. Plasma spraying has been so extensively used in critical components that there is significant data on the properties of many deposits. In general, the differences between spray and bulk properties are inconsequential.

CERAMIC AND METAL COATINGS

Thermal Combustion Spray

Thermal combustion jet spraying was first offered on a commercial basis in 1981. The consumable to be sprayed is introduced into the center of the jet stream from a powder feeder using a carrier that is compatible with the fuel gas mixture. Bond strength is the product of the particle velocity and temperature. The deposit densities are about 95% or better and porosity of the coating can be as little as 0.5%.

Thermal Combustion Wire Process

The materials that can be sprayed with the wire flame spray process include any material that can be made into flexible wire that will melt in the oxyacetylene flame. Many consumables are available, but the commonly sprayed materials are zinc and aluminum, and are used primarily for corrosion protection. The bronzes and hard steels are used for wear protection, and the soft steels and molybdenum are used as rebuilding material for repair jobs. There is no thickness limit to this process, and deposits as thick as 0.25: have been made. A common thickness for wire spray deposits is 0.030" to 0.050" for wear applications and rebuilding. For corrosion applications, deposits can be as thin as 0.001".

QUALITY ASSURANCE PROGRAM

JMS Southeast, Inc. employs one of the most rigorous Quality Assurance programs in the industry. Our specially formulated powders can be traced from the location where they are mined, through each refining process, to the finished product ready for use at our plant. Each coating application undergoes analysis by either the metallographic or petrographic laboratory prior to release. This assures our customers of receiving consistently reproducible coatings of the highest quality.

CUSTOMER SERVICE

Because we use state-of-the-art coating systems, waste is virtually eliminated and high coating speeds are attained. These factors allow us to offer the highest quality coatings at the most competitive prices available today.

INDUSTRIAL PRODUCTS

Almost any industry can benefit from JMS Southeast's coating experience and service. We have wells and other coated parts for the Textile Industry, Power Industry, Petrochemical Industry, Pulp and Paper, Steel Industry, Aluminum Plants, Glass Plants and Wire Drawing Industry just to name a few.

JMS also has the capabilities to teflon coat any thermowells, protection tubes or sensors as needed. Teflon coating will prolong the life of the sensor by protecting it from many forms of chemical attack.

Pleas contact JMS for prices on our many coatings services.

FREQUENTLY USED COATINGS

COATING DESIGNATION	NOMINAL CONSTITUENTS	COMMENTS
	PLASMA SPRAYS	
USSE-115-P	Molybdenum	Hardness, 350 DPH Bond Strength, 8300 psi
USSE-280-P	Cobalt-Chromium-Alumni-num-Yttrium (Co-Cr-Al-Y)	Bond strength 5000 psi
USSE-462-P	Tungsten-Carbide Chrome-Carbide Nickel	Hardness, 800 DPH Bond strength, 8700 psi Porosity, less than 3%
USSE-601-P	Aluminum Oxide	Hardness, 1100 DPH Bond strength, 7000 psi Porosity, less than 4%
USSE-660-P	Zirconium Dioxide-Yttria	Hardness, 260 DPH Bond varies between 2200 psi and 6300 psi
	THERMAL HVOF COMBUSTION SPRAYS	
USSE-205-M	Stellite 6-type Alloy	Hardness, 390 DPH Bond strength, 11,000 psi
USSE-230-M	Hastelloy-B-2 Type Alloy	Hardness, 315 DPH Bond strength, 10,000 psi
USSE-231-M	Hastelloy-C-276 Type Alloy	Hardness, 170 DPH Bond strength, 10,000 psi
USSE 282-M	Cobalt-Chrome-Aluminum-Yttrium (Co-Cr-Al-Y)	Hardness, 170 DPH Bond strength, 8000 psi
USSE-422-M	Cr3 C2-Ni Cr	Hardness, 870 DPH Porosity, less than 1% Bond strength, 10,000 psi
USSE-445-M	WC-9 Co	Hardness, 1220 DPH Porosity, less than 1% Bond strength 11,000 psi
USSE-475-M	Tungsten Carbide 10 Cobalt-4Chrome	Hardness, 390 DPH Bond strength, 11,000 psi
	WIRE TORCH	
USSE-118-W	Stellite 6-Type Alloy	Hardness, 390 DPH Bond strength, 4000 psi
USSE-206-W	Molybdenum	Hardness, 245 DPH Bond strength, 6000 psi
USSE-240-W	Monel-type composition	Hardness, 150 DPH Bond strength, 4300 psi
USSE-257-W	Nickel-Chrome	Hardness, 195 DPH Bond strength, 4000 psi

ADDITIONAL COATINGS

The following list includes an abbreviated list of additional coatings that are available. Although this list is not all inclusive, it does cover the majority of available coatings.

These lists of coating are for reference only. Please contact JMS's Engineering Department for application assistance. Our qualified staff will help you select the best coating for your application.

COATING DESIGNATION	NOMINAL CONSTITUENTS
PLASMA SPRAY	
USSE-120-P	Nickel
USSE-245-P	Nickel-Aluminum
USSE-247-P	NIckel-Graphite
USSE-255-P	Nickel-Chrome
USSE-420-P	Chrome Carbide-Ni Chrome
USSE-446-P	Tungsten Carbide-9 Cobalt
USSE-456-P	Tungsten Carbide-12 Cobalt
USSE-461-P	Tungsten Carbide-17 Cobalt
USSE-476-P	Tungsten Carbide-Cobalt-Chrome
USSE-610-P	Titanium Dioxide
USSE-615-P	Chrome Oxide
USSE-616-P	Chrome Oxide
USSE-680-P	Zirconium Dioxide-Calcium Oxide
USSE-701-P	Aluminum Oxide-40 Titanium Dioxide Ceramlon
THERMAL HVOF COMBUSTION SPRAY	
USSE-234-M	403 Stainless Steel
USSE-236-M	316 Stainless Steel
USSE-242-M	420 Stainless Steel
USSE-259-M	Nickel-Chrome
USSE-450-M	WC-1Z Co
USSE-460-M	WC-17 Co
USSE-463-M	Tungsten Carbide-Chrome Carbide-10 Nickel
USSE-481-M	TiC-60-Ni
WIRE TORCH	
USSE-101-W	Aluminum
USSE-122-W	Nickel
USSE-125-W	Zinc
USSE-208-W	Bronze
USSE-209-W	Aluminum-Bronze

TEMPERATURE COLOR SCALE*

Color	°F	°C
Black Heat	800 - 900	430 - 480
Faint Red	900 - 1050	480 - 570
Blood Red	1050 - 1170	570 - 630
Dark Cherry Red	1170 - 1240	630 - 670
Medium Cherry Red	1240 - 1370	670 - 740
Cherry or Dull Red	1370 - 1540	740 -840
Bright Red	1540 - 1650	840 - 900
Red-Orange	1650 - 1730	900 - 940
Orange	1730 - 1810	940 - 990
Lemon Yellow	1810 - 1880	990 - 1080
Light Yellow	1880 - 2190	1080 - 1200
White	2190 & above	1200 & above

*Observations made in a relatively dark place with no eyeshades. Observations in lighter areas will tend to shift temperatures higher.

JMS COATINGS APPLICATION CHECKLIST

The information requested below is a minimum requirement to enable JMS to provide a suitable application solution, particularly in the case of exotic metal and/or elements.

Jacket	____
Coating	____

1. Maximum temperature sensor will be exposed to:_____
   Continuous _____ Intermittent _____
2. Normal operating temperature _____
3. Process conditions:
   a) Gas, liquid, etc. _____
      (Please provide chemical concentration where possible)
   b) Approximate flow rate _____
   c) Special pressure or vibration considerations _____
   d) Any abrasive conditions _____
4. Temperature element details - RTD or Thermocouple type, etc. (This information is also requested in cases where JMS has been asked to supply only the thermowell.)

Platinum RTD	_____	E Thermocouple	_____
J Thermocouple	_____	R,B,S,Thermocouple	_____
K Thermocouple	_____	Other	_____

5. If a metal other than listed in the JMS catalog is specified (ex. - nickel or black steel), we need to know the content or appropriate ASTM, UNS, AISI-SAE number. _____
6. Is thermal shock a possibility? _____ Is the temperature cycled frequently? _____
   Does the probe remain immersed? _____
7. If in gas environment, is it oxidizing, reducing, or inert? _____
8. If this is to be a replacement application, information regarding the successes/failures of other units could be beneficial. When possible, please provide any manufacturer and part number information.
9. Other Comments _____
   _____

SECTION 5

THERMAL PROCESSING / HEAT TREATING (ANNEALING)

If you wish to have your sensor annealed, you need to provide JMS with the correct time, temperature profiles.

All temperature treating processes start at room temperature.

Select Atmosphere: inert, vacuum, or ambient air

Select Portion of sensor to be temperature treated: hot end only, entire sensor, or component of sensor prior to assembly

Stage #1 Increase / decrease temperature to _____° F / C at a rate of _____° F/ C per minute. (Or instant, or doesn't matter)

Stage # 2 Allow to set at that temperature for _____hours / minutes.

Stage # 3 Increase / decrease temperature to _____° F / C at a rate of _____° F / C per minute. (Or instant, or doesn't matter)

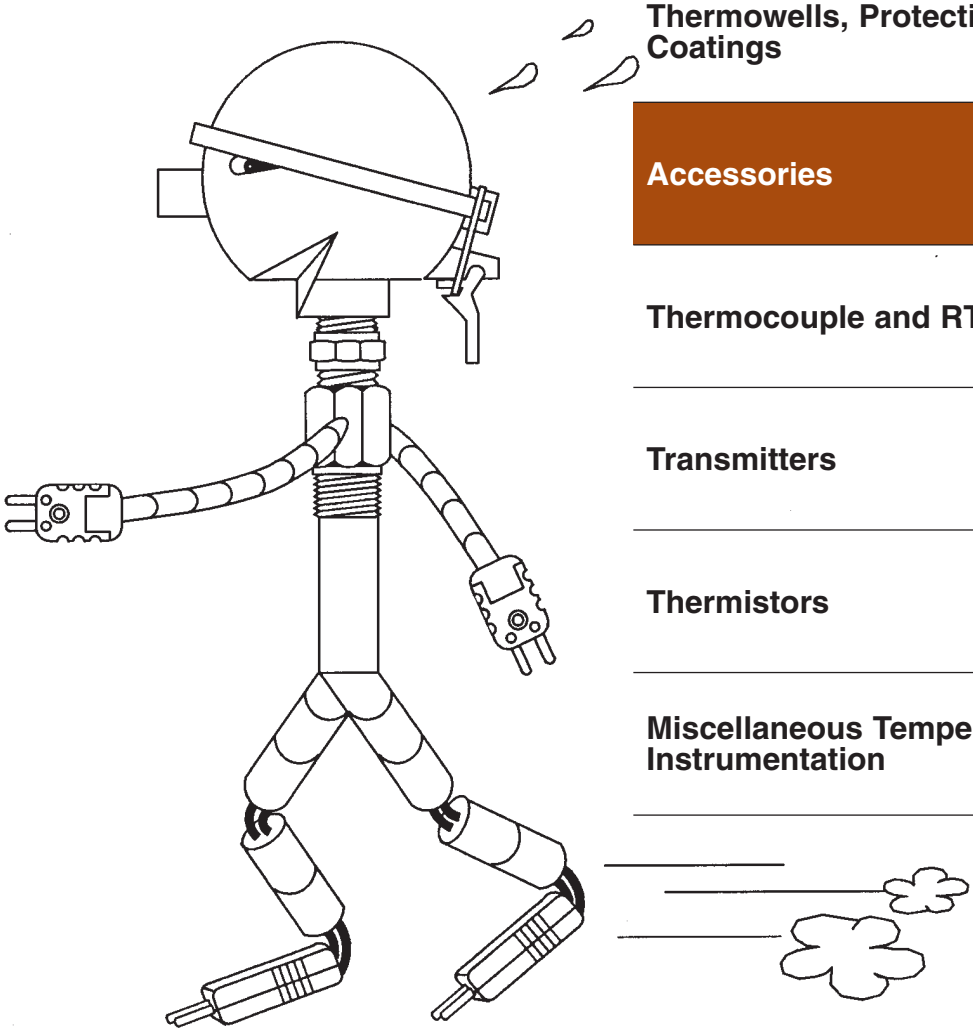
Note: If water or other liquid quenching is required, please describe.

Specify if parts should be cleaned (buffed) free of any accumulated tarnishing caused by this process.

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Swifty Sensor



Notes

1-800-873-1835

JMS Southeast, Inc.
Temperature Measurement



Accessories

SECTION 6

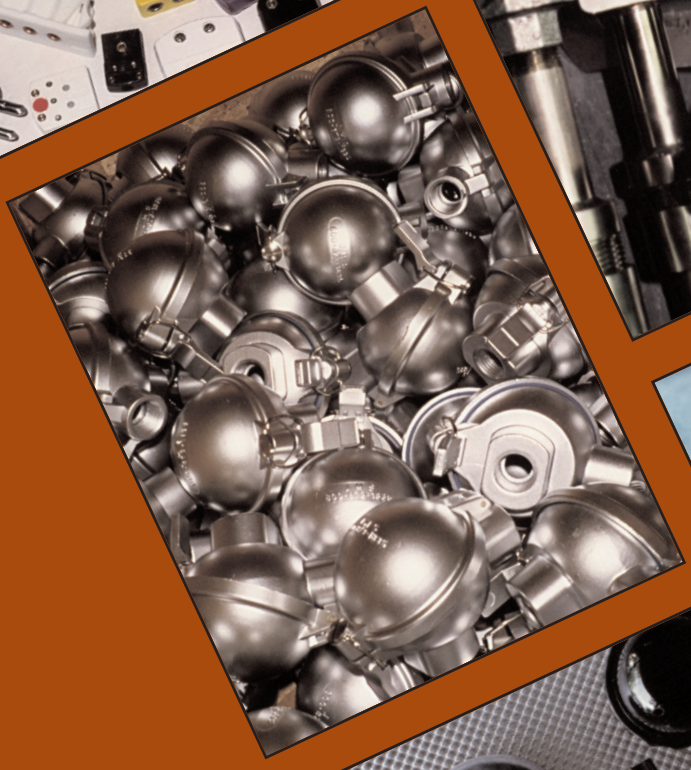


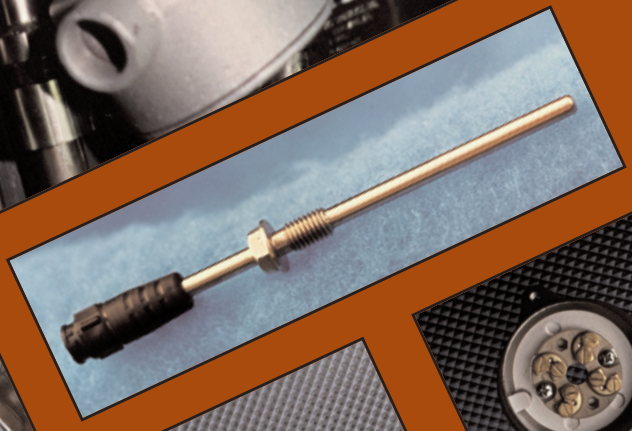
















ACCESSORIES

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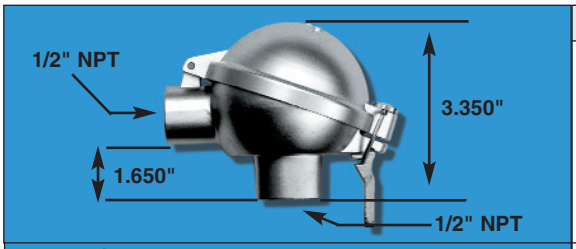
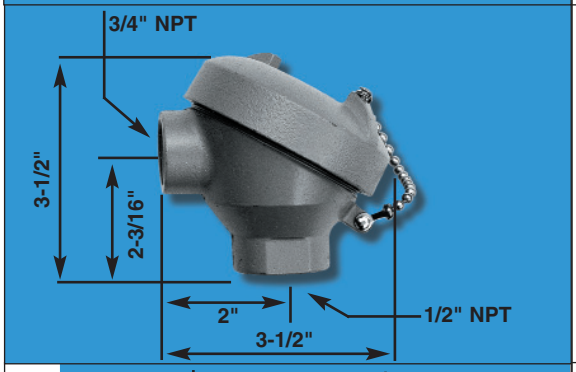
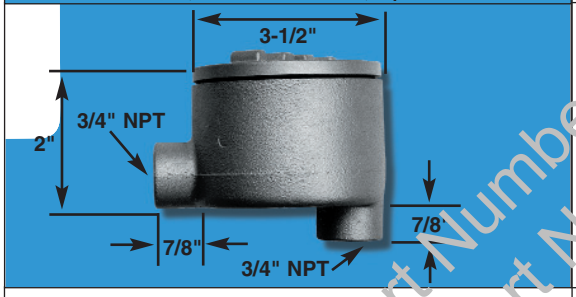
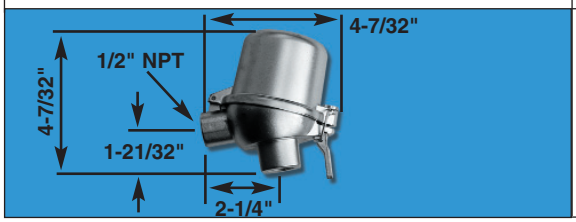
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CONNECTION HEADS

	SYMBOL	DESCRIPTION	FEATURES
	6L	General purpose aluminum head with hinged cover 1/2" x 1/2" connection (**Standard**)	*Corrosion resistant *Moisture resistant *Dust resistant *Durable **NEMA 4 compliance
	6M	General purpose aluminum head with cap and chain 1/2" x 3/4" connection	*Corrosion resistant *Moisture and Dust resistant *Durable **Nema 4
	6N	General purpose cast iron head with cap and chain 1/2" x 3/4" connection	*Rugged construction *Moisture and Dust resistant *Outdoor application **Nema 4
	6SS	General purpose 316L stainless steel head with cap and chain 1/2" x 3/4" connection	*Chemical and Corrosion resistant *Moisture and Dust resistant *Outdoor application **Nema 4X
	6I	Explosion proof head 3/4" x 3/4" connection	*Explosion proof rated for Class I, Groups B, C, D Class I, II, Groups E, F, G, Class III *Moisture resistant *Dust resistant *Cast iron with aluminum cover *UL + CSA Approved
	6ISS	Explosion proof stainless steel head 1/2" x 3/4" connection	*Nema 4x *FM *CSA
	6IA	Explosion proof aluminum head 1/2" x 3/4" connection	*Nema 4 *FM *CSA
	6R	High dome, general purpose head with hinged cover, 1/2" x 1/2" connection	*Corrosion resistant *Moisture resistant *Dust resistant *Durable **NEMA 4 compliance
	6RV	High dome, general purpose head with hinged window cover, 1/2" x 1/2" connection	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_Intro1.pdf
or call JMS directly at 1-800-873-7655
for fast and friendly assistance!

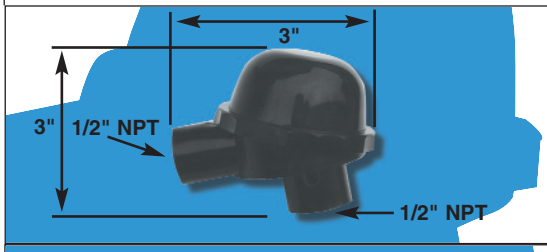
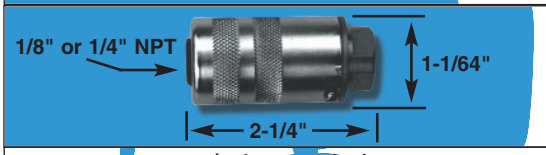
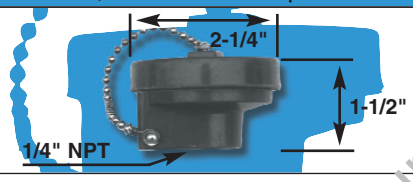
* Standard gaskets included in the heads are rated to 100˚ C

NOTE: These heads do not include terminal blocks. Terminal blocks can be ordered on page 6-3.

See page 6-16 and 6-17 for FM classifications.

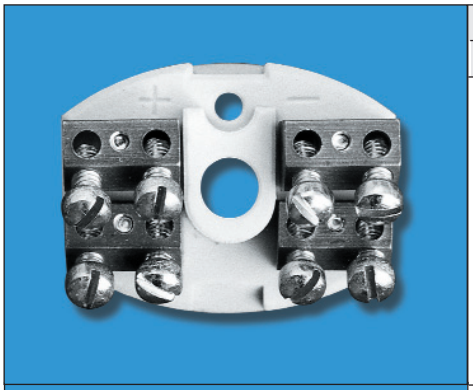
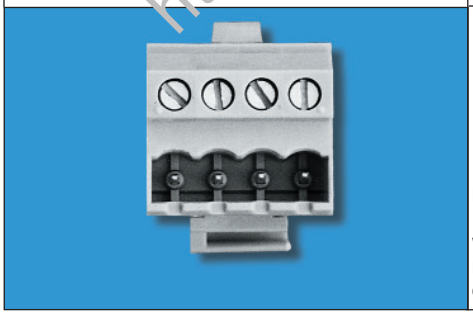
**The statement of compliance does not imply that the products have been approved by UL, CSA or FM, but designed to meet applicable requirements.

CONNECTION HEADS

	SYMBOL	DESCRIPTION	FEATURES
	6WP	White plastic screw-top head (polypropylene) 1/2" x 3/4" connection	*Moisture resistant *Dust resistant *Excellent corrosion resistant *Very light weight *NEMA 4X rated
	6Q	Black plastic (polyamid 6) head 1/2" x 1/2" connection	*Moisture resistant *Dust resistant *Excellent corrosion resistant *Very light weight *NEMA 4 rated
	6S	Cylinder style head	*Small and light weight
	6T 6U	Miniature molded head Hi temp miniature head	*Weatherproof
	60B	90° Pulling Elbow Malleable Iron / Zinc plated 1/2" x 1/2" connection **Wire nuts not included**	*Raintight *Smal and light weight *UL Listed: E-11853 *CSA Certified: 9795

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

TERMINAL BLOCKS

	SYMBOL / # OF TERMINALS	DESCRIPTION
	6G2 6G4	Ceramic block with brass terminals for type 6M and 6N connection heads. For use with 8 gauge to 14 gauge wires. (See pg. 1-4) Temperature rating of 200°C. Dimensions: 6G2 Height = .790” Width = 2.00” Depth = 1.544” 6G4 Height = 1.146” Width = 2.00” Depth = 1.544”
	6B4 6B6	Ceramic block with brass terminal plate for type 6L, 6M, 6N, 6Q, and 6R connection heads. For use with maximum 20 gauge wire. (See pg. 1-4) Temperature rating of 200°C. Dimensions: 6B4 Diameter = 1.62” Depth = .6” 6B6 Diameter = 1.62” Depth = .6”
	6C8	Ceramic block with nickel plated brass terminal post for type 6L and 6Q connection heads. The terminal posts provide easy access to the wires. For use with maximum 18 gauge wire. Temperature rating of 200°C. Dimensions: 6C8 Diameter = 1.662” Depth = .995”
	6BB4 6BB6	Bakelite terminal block with nicked plated brass terminal post for type 6IA and 6ISS connection heads. For use with maximun 20 gauge wire. Temperature rating of 130˚ C. Dimensions: 6BB4 Diameter = 1.96” Depth = .9056”
	6PT2 6PT3 6PT4 (shown) 6PT6 6PT8 **Note:** If not specified, you will receive both male and female components.	Unpluggable terminal blocks for easy calibration and removal of sensors. Terminal body is made of 6.6 Polyimide material, with corrosion proof screw clamp parts. For use with 18 gauge to 24 gauge wires. It is standard with 6R, 6I and 6P connection heads. Temperature rating of 100°C.

*** Insert number of terminals behind symbol to complete part number (i.e. 6PT4 or 6M4J).**
See page 6-18 for pin connections.
See page 6-5 for thermocouple compensated DIN Rail terminal block.

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

PLUGS AND JACKS

Connector bodies are molded of glass filled thermoset compounds (will not melt) for high strength and dependability. The standard connectors will withstand ambient temperatures to 400°F continuous and 500°F intermittent. High temperature connectors will withstand ambient temperatures to 800°F continuous and 1000°F intermittent. Standard plugs are color coded per ANSI standards. High temperature plugs are color coded rust. High temperature connectors have nickel plated prongs; and therefore, are good for use in corrosive environments. Other high temperature plugs and jacks are made of ceramic material and can be color coded.

Alloys of prongs match ANSI calibrations to maintain sensing accuracy. Alloys and polarity are identified by symbols molded into the body.

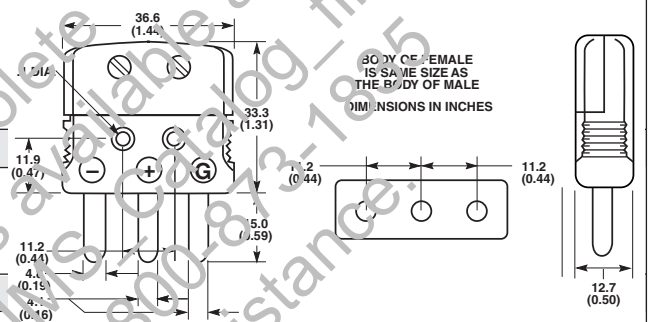
#1	SERIES
6A	Accessories Plugs and Jacks

#2	CONNECTOR STYLE	
1	Standard	<425°F
2	High temp	<800°F
3	Heavy Duty (Solid Pin)	<425°F
4	Heavy Duty (Jab In & Solid Pin)	<425°F (Std Size Only)
5	Ultra High temp	<1200°F
6	Low Noise	<425°F

#3	COLD END TERMINATION
B	Mini Plug
D	Mini Jack
C	Standard Plug
E	Standard Jack

Note: Add a "W" to symbol #2 for a write-on window connector.

#4	# OF CIRCUITS
2	2 Pole
3	3 Pole



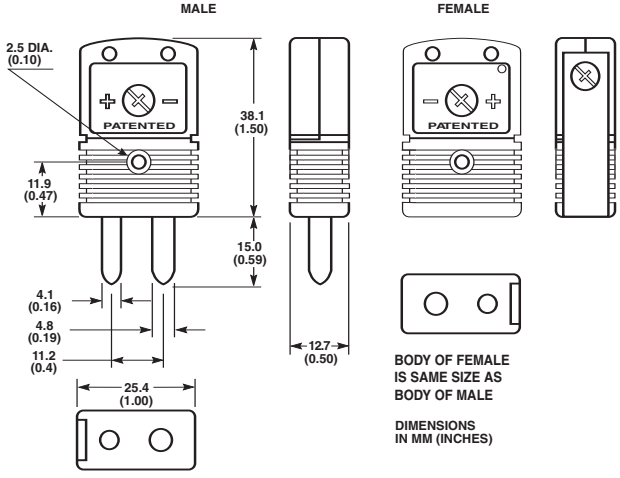
6A1C3A & 6A1E3A

#3	TYPE	COLOR CODE
J	Iron/Constantan	Black
T	Copper/Constantan	Blue
K	Chromel/Alumel	Yellow
E	Chromel/Constantan	Purple
S	Copper/#11 Alloy	Green
R	Copper/#11 Alloy	Green
N	Nicrosil/Nisil	Orange
W	Copper/#11 Alloy	Brown
A	Copper/Copper (For Type B and RTD's)	White

Note: Although available, these connectors are not recommended for RTD's.

Note: Call our Engineering dept. for high temp. vacuum applications and multi-pin connectors. Thermocouple plugs are normally two pin and RTD plugs are three pin. See page 6-7 for preferred RTD connector.

Note: See page 6-18 and 6-19 on the web for plug wiring standards.



6A6C2J & 6A6E3J

6A	1W	C	2	J	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jmsco.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1855
for fast and friendly assistance.

SECTION 6

SUPPORT ACCESSORIES FOR PLUGS AND JACKS

TUBE ADAPTER FOR USE WITH PLUG OR JACK ON SHEATH

Nickel plate steel construction compression fitting. Always used with high temp. connectors and dual connectors mounted to sheath, may be specified on standard plugs and jacks.

SYMBOL	
SINGLE	DUAL
6V063S	6V063D
6V125S	6V125D
6V188S	6V188D
6V250S	6V250D

OUTSIDE TUBE DIAMETER

1/16”
1/8”
3/16”
1/4”



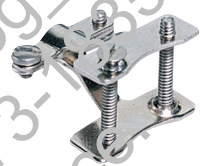
CABLE CLAMP FOR USE WITH PLUG AND JACK WITH LEAD WIRE

Nickel plated steel. For cable up to 3/8” diameter. Always used to support plug mounted on wire lead.

SYMBOL
6H

DESCRIPTION

Cable Clamp



WATER RESISTANT NEOPRENE BOOT FOR USE WITH PLUG AND JACK

SYMBOL
6WPB

DESCRIPTION
Flexible moisture proof boot for connector and wire connection

MAX. TEMP.
212°F



PANEL ADAPTOR

SYMBOL
6ACL

DESCRIPTION
Panel Adaptor

JACK NOT INCLUDED

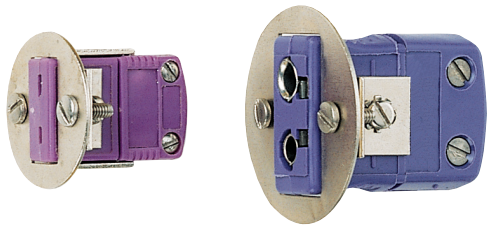


ROUND SINGLE CIRCUIT PANEL JACK

Designed for mounting into an instrument case or control panel from the front. Fits in a standard 3/4” knockout (1 1/8” diameter). Polarity and color coded for identification.

SYMBOL		DESCRIPTION	MAX. TEMP.
6RSC	(Standard)	Round Single Circuit Panel Jack	400°F
6RMC	(Mini)		

JACK NOT INCLUDED

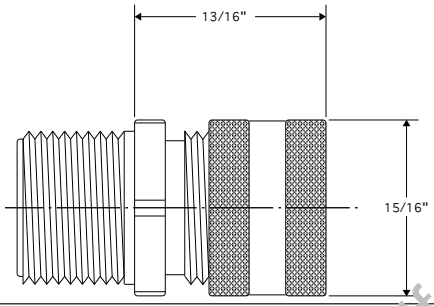


Part Numbers Obsolete
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for fast and friendly assistance.

SUPPORT ACCESSORIES

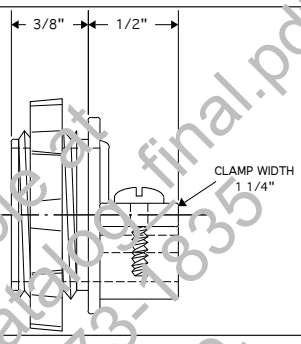
CORD CONNECTOR FOR USE WITH ATTACHING HEAD ASSEMBLIES AND FLEX ARMOR

SYMBOL	DESCRIPTION	MAX. TEMP.
6CC	Cord Connector	250°F



JUNCTION BOX CONNECTOR

SYMBOL	DESCRIPTION	MAX. TEMP.
6JBC	Junction Box Connector	250°F



PLUG LOCK

SYMBOL	DESCRIPTION
6FCL	Plug Lock



Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

COMPENSATED DIN RAIL THERMOCOUPLE CONNECTIONS

In thermocouple circuits the wires of the thermocouple are connected to extension wires. This is exactly the application for thermocouple terminal blocks.

Extension wires are made of materials which have the same EMF characteristics as the thermocouple. These thermocouple terminal blocks are made up of materials matching the composition of the extension wires.

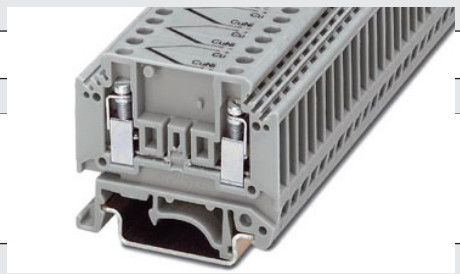
The thermocouple terminal block pair is clearly marked on the top with an indication of the material on the metal bars. The insulating housing is made of unbreakable polyamid 6.6 and has the universal footing for mounting on all EM/DIN rails. Temperature rated to 200° C. These blocks allow the terminals to be integrated in a panel mounting or other rail layout.

#1	SERIES
6DR	Din Rail Mountable Thermocouple Connections

#2	TYPE OF EXTENSION WIRE
J	Iron/Constantan
T	Copper/Constantan
K	Chromel/Alumel
E	Chromel/Constantan
R	Copper/Copper Nickel

#3	NO. OF PAIRS
#	Number of pairs of terminals

#4	ACCESSORIES (MAY SELECT MORE THAN ONE)
COVER --	Number of end covers
PLATE --	Number of partition plates for separation of terminal groups
CLAMP --	Number of end clamps for end support of terminal grouping



6DR	J	4	COVER 2

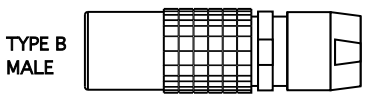
SECTION 6

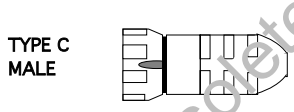
QUICK CONNECTORS

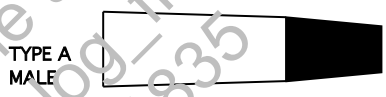
These self-latching quick connectors are designed to assure continuous and accurate temperature monitoring. Available for either thermocouples or RTD's, these connectors overcome the potential connector measurement errors unique to either method of temperature measurement.

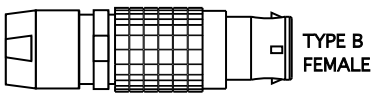
In thermocouple circuits the wires of the thermocouple are connected to extension wires. The extension wires are made of materials which, up to 200 degrees C, have the same EMF characteristics as the corresponding thermocouple wire. By using connector pins of the same material as the extension wire the creation of a second thermocouple junction is avoided and the integrity of the signal is maintained.

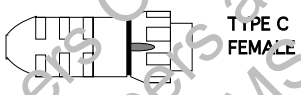
Screwed connections in an RTD circuit offer a site for oxidation. This will cause an imbalanced bridge and will severely degrade the accuracy of the reading. The soldered connection used in these connectors eliminates this possibility.

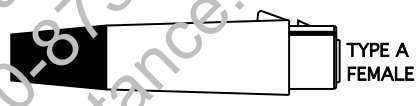












#1	SERIES
6D	Quick Connectors

#2	TYPE OF CONNECTOR
A	US microphone style connector (Standard)
B	DIN-IEC microphone style connector
C	Molded / Hermetic connector

#3	DESCRIPTION
2	2 wire RTD or T/C compensated
3	3 wire RTD
4	4 wire RTD
X	Other, specify

Note: See page 6-17 through 6-19 for pin connections.

#4	TERMINATION
C	Plug (male)
S	Jack (female)
P	Panel mounted jack
X	Other, specify

Note: If you can see the pins it is a male (plug)

#5	# OF CIRCUITS
S	Single
D	Dual
X	Other, specify

#6	INSERT ALLOY
J	Iron/Constantan*
T	Copper/Constantan*
K	Chromel/Alumel*
E	Chromel/Constantan*
S	Gold Plated - Standard for Type C (above)
C	Chrome Plated - Standard for Type A (above)
X	Other, specify

* Signifies not available for Type A or C connectors.

See page 6-19 for plug wiring standards.
See pages 6-17 & 6-18 for other sensor connections.

6D	B	2	C	S	J	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

EXTENSION ASSEMBLIES

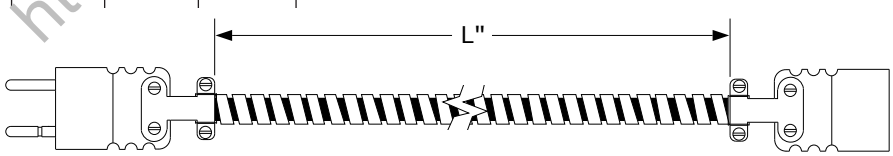
#1	SERIES
6E	Extension Assembly

#2	TYPE
J	Iron/Constantan
T	Copper/Constantan
K	Chromel/Alumel
E	Chromel/Constantan
N	Nicrosil/Nisil
*R	Platinum/Platinum 13% Rhodium
*S	Platinum/Platinum 10% Rhodium
3	100Ω Platinum RTD (.00385 alpha, 3 wire)
X	Other, specify
	*Available in glass braid only.

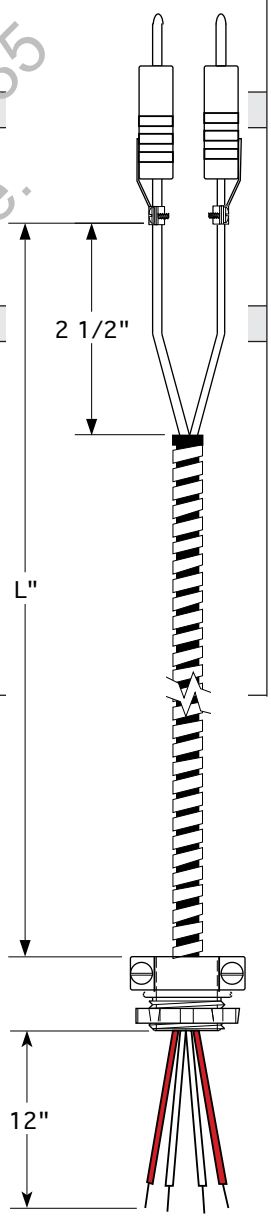
#3	ELEMENT CONSTRUCTION
1	Single
2	Dual - single connector
3	Dual - dual two connectors
X	Other, specify

#4	LEAD WIRE TYPE & LENGTH IN INCHES
1 __"	20 awg Glass braid
2 __"	20 awg PVC
3 __"	20 awg FEP Teflon
4 __"	20 awg Hi-temp glass braid
5 __"	20 awg Kapton
6 __"	20 awg Glass braid / flexible armor overall (Standard)
X __"	Other, specify

#5	COLD END TERMINATION (CHOOSE A MINIMUM OF TWO OPTIONS)
A	Bare ends
B	Miniature plug
C	Miniature jack
C	Standard plug
E	Standard jack
F	Hi-temp std plug
G	Hi-temp std jack
W	Type A plug (6DA) [See pg 6-7]
V	Type A jack
T	Junction box connector
K	Spade lugs
X	Other, specify
	Note: All plugs and jacks will be mounted with a cable clamp for mechanical strength.



Single Extension with Plug & Jack



Dual Extension with Plugs & Junction Box Connector

6E	J	1	6-36"	CH	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jmsales.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

MULTICIRCUIT PANEL WITH MOUNTING FRAME

Multicircuit panels are molded of glass-filled thermoset compounds for high strength and dependability. Panels will withstand ambient temperature of 425°F continuous and 500°F intermittent. One-piece mounting frame is made of 3/32" thick rigid steel with flat black finish. Horizontal mounting style is standard.

#1	SERIES
6PM	Multicircuit Panel

#2	FRAME STYLE
1	Standard Frame (Maximum number of jacks per row is 24)
2	19" Rack (Maximum number of jacks per row is 22)

#3	TYPE
S	Standard
M	Mini
U	Universal

#4	DESCRIPTION
1 2 3 4	Number of horizontal rows
X	Other, specify

19" RACK

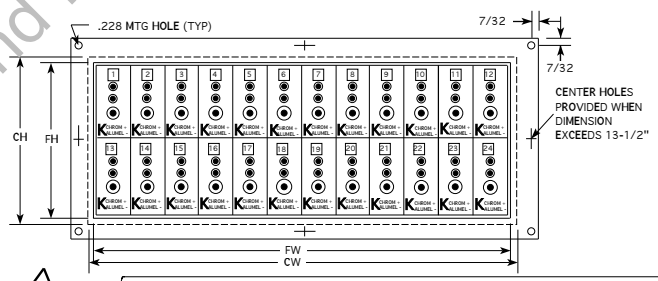
NUMBER OF ROWS	STANDARD HEIGHT
1	3 1/2"
2	3 1/2"
3	5 1/4"
4	7"

#5	DESCRIPTION
#	Total number of circuits
X	Other, specify

Note: We assume an even number of circuits per row.

#6	TYPE	COLOR CODE
J	Iron/Constantan	Black
T	Copper/Constantan	Blue
K	Chromel/Alumel	Yellow
E	Chromel/Constantan	Purple
R	Platinum/Platinum 13% Rhodium	Green
S	Platinum/Platinum 10% Rhodium	Green
A	Copper/Copper	White

#7	# OF POLES
2	2 poles
3	3 poles



Typical arrangement layout. Contact our engineering department for specific drawings.

NUMBER OF ROWS	FH / CH	CIRCUITS PER ROW (TOTAL CIRCUITS)																						
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	FH = 2 3/16" CH = 2 7/16"	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
2	FH = 4 3/8" CH = 4 5/8"	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
3	FH = 6 9/16" CH = 6 13/16"	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72
4	FH = 8 3/4" CH = 7"	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96
5	FH = 10 15/16" CH = 11 3/16"	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
6	FH = 13 1/8" CH = 13 3/8"	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126	132	138	144
7	FH = 15 5/16" CH = 15 9/16"	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147	154	161	168
8	FH = 17 1/2" CH = 17 3/4"	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160	168	176	184	192
9	FH = 19 11/16" CH = 19 15/16"	18	27	36	45	54	63	72	81	90	99	117	117	126	135	144	153	162	171	180	189	198	207	216
10	FH = 21 7/8" CH = 22 1/8"	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240

6PM	1	S	3	12	K	2

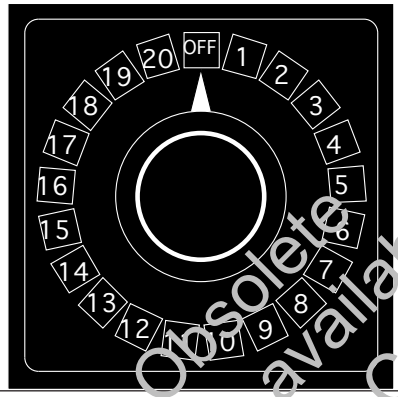
Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

SECTION 6

ROTARY SELECTOR SWITCHES

The JMS Deluxe Switch has an integral face plate and screw/solder terminals.
Terminals are silver plated brass numbered circuits with polarity identification.
Blades and contacts are silver plated with self-cleaning wiper action.
The “OFF” position has terminals available for shorting input circuit when using the switch with a digital meter.
Order numbers 63-2 through 63-10 are break before make.
Order numbers 63-12 through 65-40 and 6R-6 through 6R-36 are make before break.
“Break before make” indicates the previous circuit is broken before the next contact is made.
“Make before break” indicates the second contact is made before the first contact is broken.

SYMBOL	NO. POS.
	2 POLE
63-2	2
63-3	3
63-4	4
63-5	5
63-6	6
63-8	8
63-10	10
63-12	12
63-14	14
63-16	16
63-18	18
63-20	20

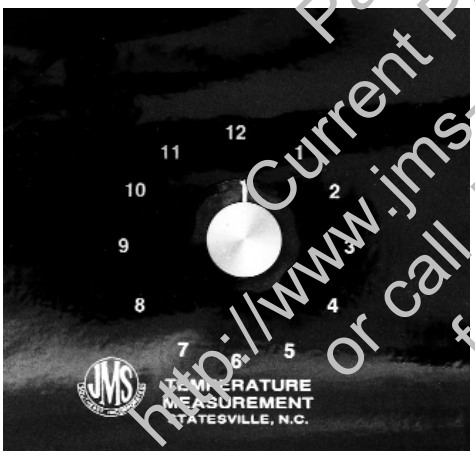


SYMBOL	NO. POS.
	2 POLE
65-24	24
65-28	28
65-32	32
65-36	36
65-40	40
	3 POLE
6R-6	6
6R-12	12
6R-24	24
6R-28	28
6R-32	32
6R-36	36

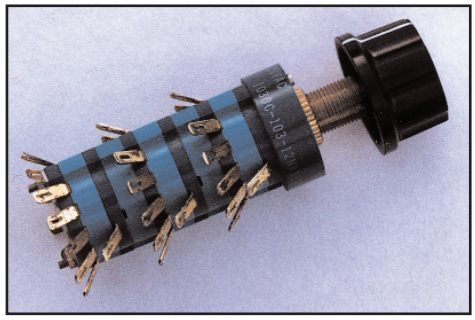
The JMS economy switch has an adhesive backed face plate for the panel. Terminals are gold plated brass numbered circuits. Contacts are the self-cleaning wiper action type. Standard switch is “break before make”, however, “make before break” can be supplied upon request.

JMS Southeast stocks both two pole and three pole twelve point economy switches.

#1	DESCRIPTION
6ET12	2 pole 12 point JMS economy switch
6ER12	3 pole 12 point JMS economy switch

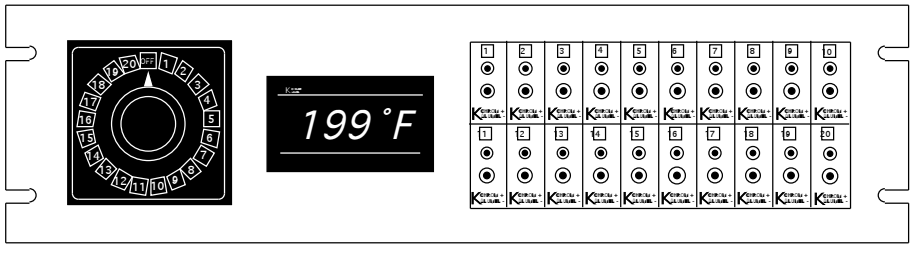


SWITCH MOUNTING



19” JACK PANELS WITH CONNECTORS

Call our engineering department for specific drawings.

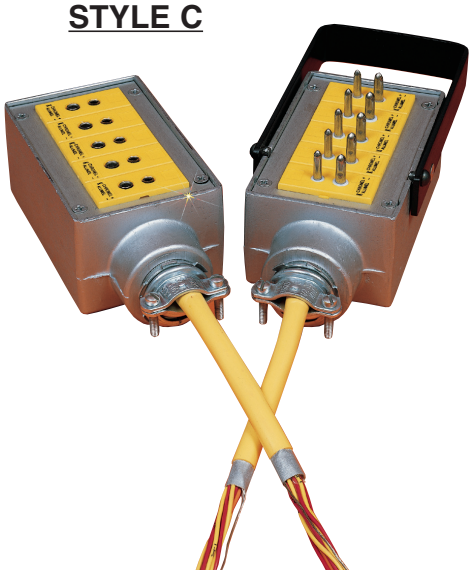


Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1635
for fast and friendly assistance.

JACK PANEL OR PLUG PANEL CONDUIT BOXES

SECTION 6

STYLE C



STYLE J



#1	SERIES
6PB	Jack Panel or Plug Panel Conduit Boxes

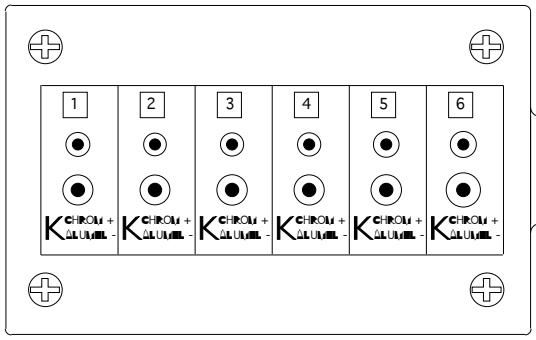
#2	TYPE	COLOR CODE
J		
T		
K		
E		
R		
S		
3		

#3	DESCRIPTION
1	Number of circuits.
2	
3	
4	
5	
6	

Note: Wire hubs are opposing when mates are connected. Male is left handed and the (Female is ALWAYS right!)

#4	BOX STYLE
C	Conduit box cast aluminum - locking handle is standard on male box. (1-5 circuits)
D	Junction box molded fiberglass (1 - 6 circuits)
E	Junction box cast aluminum (1-6 circuits)
J	Junction box - standard mini flat pin connectors (1-6 circuits)
X	Other, specify
Z	No Box

#5	CONNECTION TYPE
M	Male (Plug)
F	Female (Jack)



STYLE D, E

Iron/Const
Black
Copper/Constantan
Blue
Chromel/Alumel
Yellow
Chromel/Constantan

6PB	K	6	J	M	

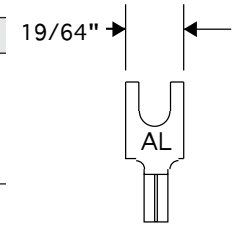
Part Numbers Obsolete
Current Part Numbers available at
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SPADE LUGS

Spade lugs are offered in compensating alloys. Spade lugs accept 18 gauge wire or smaller for crimp connections. Each lug has stamped-in designation of thermocouple alloy type.

#1	SERIES
6SL	Spade Lug

#2	THERMOCOUPLE ALLOY
AL	Alumel
CH	Chromel
CO	Constantan
CP	Copper
IR	Iron



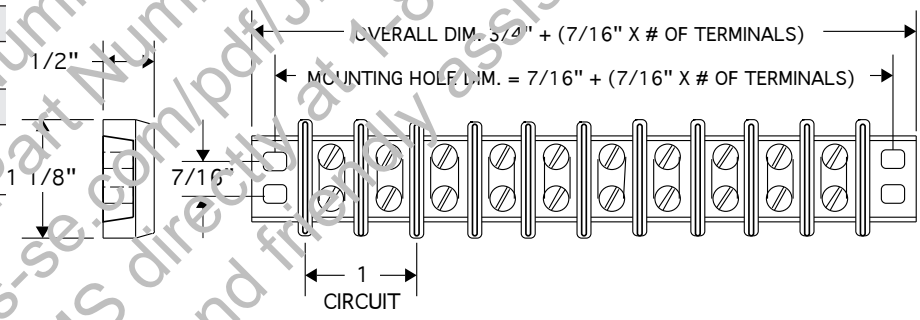
6SL	CH	

TERMINAL STRIPS

JMS terminal strips are manufactured of general purpose bakelite and will withstand temperatures from 40°F to 250°F. Terminal strips are nickel-plated brass. Order thermocouple compensated lugs separately.

#1	SERIES
6TS	Terminal Strip

#2	# OF CIRCUITS
#	Number of circuits (4screws = 1 circuit)



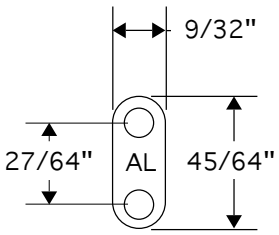
6TS	6	Note: There is a maximum of 10 circuits per strip.

TERMINAL LUGS

Terminal lugs are available in thermocouple compensating alloys. They are intended for use with JMS Southeast terminal strips. Each lug is marked with thermocouple alloy.

SERIES
Terminal Lug

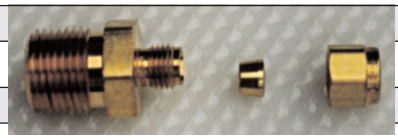
#2	THERMOCOUPLE ALLOY
AL	Alumel
CH	Chromel
CO	Constantan
CP	Copper
IR	Iron



6TL	IR	

Part Numbers Obsolete
Current Part Numbers available at
www.jms-se.com/pdf/JMS_Catalog_final.pdf
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http://www.jms-se.com/pdf/JMS_Catalog_final.pdf

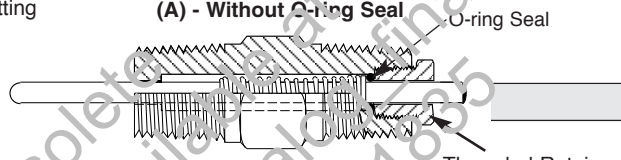
#1	SERIES
6F	Attaching Device (Fittings)



COMPRESSION FITTING

#2	TYPE
D	Bayonet oil sealed assembly } Used with type 6R, 6P, and 6I heads
B	Bayonet assembly }
W	1/2" x 1/2" stainless steel for welding
S	1/2" x 1/2" spring-loaded stainless steel
C	1/2" x 1/2" spring-loaded stainless steel w/ oil ring
E	Adjustable spring
A	Spring-loaded w/ threaded retainer
H	Stainless steel ferrule } Compression Style Fitting
I	Teflon ferrule }
J	Lava ferrule }
K	Nylon ferrule }
L	Brass ferrule }

(C) - Spring-loaded w/ plug & (A) - Without O-ring Seal

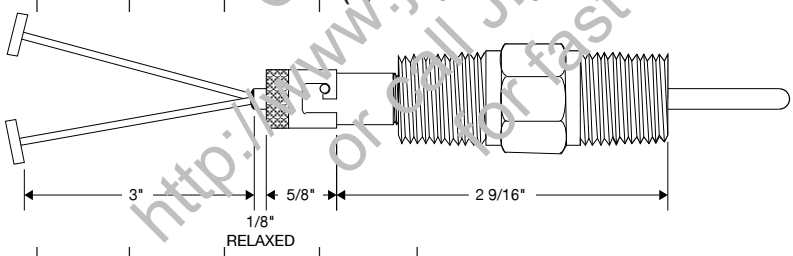


#3	OUTSIDE DIAMETER OF TUBE
A	3/8" (.375")
B	1/4" (.250")
C	3/16" (.188")
D	1/8" (.125")
E	1/16" (.063")
X	Other, specify

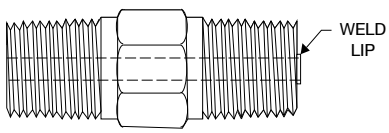
#4	PROCESS NPT ON FITTING
	(Must be specified for compression fittings, symbols 6FH, 6FJ, 6FK)
L	1/8" NPT
M	1/4" NPT
P	1/2" NPT
X	Other, specify
Z	N/A

#5	FITTING MATERIAL
K	Stainless steel (Standard)
B	Brass
T	Teflon
X	Other, specify

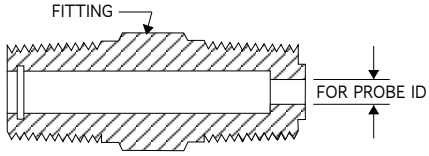
(B) - BAYONET ASSEMBLY



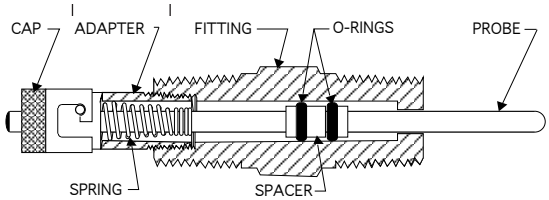
(W) - WELDED FITTING



(S) - SPRING LOADED FITTING



(D) - BAYONET OIL SEALED ASSEMBLY (25 PSI)



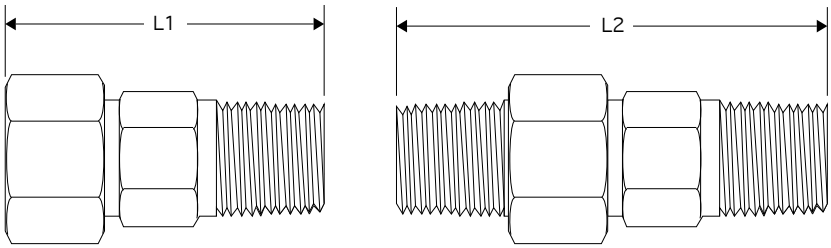


(E) - COMPRESSION SPRING

6F	H	B	M	K

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

MULTICONDUCTOR FEEDTHROUGHS



*** MODEL TO INCLUDE**
L1 (CAP) OR L2 (CAP)
+
TEFLON FERRULE (T)
OR
STAINLESS STEEL FERRULE (S)

TO ORDER (Specify model number) Example: 6FT143L1T

SHEATH DIAMETER	MODEL NUMBER *	DIAMETER OF PROBE INCHES	NUMBER OF PROBES	THREAD NPT	LENGTH L1	LENGTH L2*	ACROSS FLATS HOUSING	ACROSS FLATS CAP
1/25”	6FT0403 (L1 OR L2) (T OR S)	.040	3	1/4”	2”	2 1/2”	3/4”	7/8”
	6FT0405 (L1 OR L2) (T OR S)	.040	5	1/4”	2”	2 1/2”	3/4”	7/8”
	6FT0406 (L1 OR L2) (T OR S)	.040	6	1/2”	2 5/8”	3 3/8”	1 1/8”	1 3/8”
	6FT0408 (L1 OR L2) (T OR S)	.040	8	1/2”	2 5/8”	3 3/8”	1 1/8”	1 3/8”
	6FT04010 (L1 OR L2) (T OR S)	.040	10	3/4”	2 13/16”	3 1/2”	1 1/4”	1 1/2”
	6FT04012 (L1 OR L2) (T OR S)	.040	12	3/4”	2 13/16”	3 1/2”	1 1/4”	1 1/2”
	6FT04016 (L1 OR L2) (T OR S)	.040	16	3/4”	2 13/16”	3 1/2”	1 1/4”	1 1/2”
1/16”	6FT1163 (L1 OR L2) (T OR S)	.062	3	1/4”	2”	2 1/2”	3/4”	7/8”
	6FT1165 (L1 OR L2) (T OR S)	.062	5	1/4”	2”	2 1/2”	3/4”	7/8”
	6FT1166 (L1 OR L2) (T OR S)	.062	6	1/2”	2 5/8”	3 3/8”	1 1/8”	1 3/8”
	6FT1168 (L1 OR L2) (T OR S)	.062	8	1/2”	2 5/8”	3 3/8”	1 1/8”	1 3/8”
	6FT11610 (L1 OR L2) (T OR S)	.062	10	3/4”	2 13/16”	3 1/2”	1 1/4”	1 1/2”
	6FT11612 (L1 OR L2) (T OR S)	.062	12	3/4”	2 13/16”	3 1/2”	1 1/4”	1 1/2”
	6FT11616 (L1 OR L2) (T OR S)	.062	16	3/4”	2 13/16”	3 1/2”	1 1/4”	1 1/2”
1/8”	6FT183 (L1 OR L2) (T OR S)	.125	3	1/2”	2 5/8”	3 3/8”	1 1/8”	1 3/8”
	6FT184 (L1 OR L2) (T OR S)	.125	4	1/2”	2 5/8”	3 3/8”	1 1/8”	1 3/8”
	6FT186 (L1 OR L2) (T OR S)	.125	6	3/4”	2 13/16”	3 1/2”	1 1/4”	1 1/2”
	6FT188 (L1 OR L2) (T OR S)	.125	8	3/4”	2 13/16”	3 1/2”	1 1/4”	1 1/2”
3/16”	6FT3163 (L1 OR L2) (T OR S)	.188	3	1/2”	2 5/8”	3 3/8”	1 1/8”	1 3/8”
	6FT3165 (L1 OR L2) (T OR S)	.188	5	3/4”	2 13/16”	3 1/2”	1 1/4”	1 1/2”
1/4”	6FT143 (L1 OR L2) (T OR S)	.250	3	3/4”	2 13/16”	3 1/2”	1 1/4”	1 1/2”

Part Numbers Obsolete
Current Part Numbers available at
http://www.imse.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-876-1935
for fast and friendly assistance.

NEMA TYPE ENCLOSURES

The following table is based on ANSI/UL 50-1989 and is reprinted with permission of Underwriters Laboratories, Inc.

NUMBER	INTENDED USE AND DESCRIPTION
1	Indoor use primarily to provide a degree of protection against contact with the enclosed equipment and against a limited amount of falling dirt.
2	Indoor use to provide a degree of protection against limited amounts of falling water and dirt.
3	Outdoor use to provide a degree of protection against wind-blown dust, rain, and sleet; undamaged by the formation of ice on the enclosure.
3R	Outdoor use to provide a degree of protection against falling rain and sleet; undamaged by the formation of ice on the enclosure.
3S	Outdoor use to provide a degree of protection against windblown dust, rain, and sleet; external mechanisms remain operable while ice laden.
4	Indoor or outdoor use to provide a degree of protection against splashing water, wind blown dust and rain, and hose-directed water; undamaged by the formation of ice on the enclosure.
4X	Indoor or outdoor use to provide a degree of protection against splashing water, wind blown dust and rain, and hose-directed water; undamaged by the formation of ice on the enclosure; resists corrosion.
6	Indoor or outdoor use to provide a degree of protection against the entry of water during temporary submersion at a limited depth; undamaged by the formation of ice on the enclosure.
6P	Indoor or outdoor use to provide a degree of protection against the entry of water during prolonged submersion at a limited depth.
11	Indoor use to provide by oil immersion a degree of protection of the enclosed equipment against the corrosive effects of corrosive liquids and gases.
12,12K	Indoor use to provide by oil immersion a degree of protection against dust, falling dirt, and dripping noncorrosive liquids.
13	Indoor use to provide by oil immersion a degree of protection against dust and spraying of water, oil, and noncorrosive coolants.

HAZARDOUS (CLASSIFIED) LOCATIONS

There are definitions essential to understanding the use of Thermocouples and RTDs in hazardous (classified) locations.

Encapsulation: An international term describing a type of protection in which the parts could ignite an explosive atmosphere by either sparking or heating are enclosed in an encapsulant in such a way that this explosive atmosphere cannot be ignited. This type of protection is referred to by CENELEC as "Ex m" in draft Standard EN50028.

Explosion Proof Enclosure: An enclosure that is capable of withstanding an explosion of a gas or vapor within it and of preventing the ignition of an explosive gas or vapor that may surround it and that operates at such an external temperature that a surrounding explosive gas or vapor will not be ignited thereby. This type of enclosure is similar to a flameproof enclosure.

Explosion Proof Equipment (Apparatus): Equipment or apparatus enclosed in an explosion proof enclosure.

Explosion Proof Seal / Cable: A cable terminator filled with compound and designed to contain an explosion in the enclosure to which it is attached or to minimize passage of flammable gases or vapors from one location or another. A conduit seal may also be used as a cable seal. This method differs from the international method which requires cable glands.

Hermetically Sealed Device: A device that is sealed against the entrance of an external atmosphere and in which the seal is made by fusion. Continuous soldering, brazing, welding and the fusion of glass to metal are examples of recognized methods.

Nonincendive Circuit: AA circuit in which any arc or thermal effect produced in normal operating conditions of the equipment is not capable, under prescribed conditions, of igniting the specified inflammable gas, vapor-in-air mixture, combustible dusts, or ignitible fibers or flyings.

Nonincendive Equipment: Equipment having electrical/electronic circuitry and components that are incapable under normal conditions, of causing ignition of a specified flammable gas or vapor-in-air mixture due to arcing or thermal effect. This type of protection is referred to by IEC as "Ex n." Ex n protection is limited to gas and vapor hazards.

Simple Apparatus (as applied to intrinsic safety): A device that will not generate nor store more than 1.2V., 100mA, 25mW, or 20μJ. Examples are switches, thermocouples, light-emitting diodes, and resistance temperature devices.

At the publication of this catalog, JMS has submitted complete sensor assemblies to FM for testing and approval as meeting all the requirements for Class I, Division II suitability. The approval designs are readily available by drawing and can be ordered thru your salesperson by drawing number 11400.

It should be noted that a hermetically sealed, incapsulated, simple apparatus with explosion proof seals containing nonincendive circuits rates as a nonincendive piece of equipment. Therefore, thermocouples and RTDs so built require no external marking at all. However, the CYA principle might dictate such markings and they are offered by JMS.

(1) Group D equipment shall be permitted for this atmosphere if such equipment is isolated in accordance with Section 501-5(a) of National Electric Code by sealing all conduits 1/2 inch size or larger.

(2) Group C equipment shall be permitted for this atmosphere if such equipment is isolated in accordance with Section 501 -5(a) of National Electric Code by sealing all conduits 1/2 inch size or larger.

(3) For classification of areas involving ammonia atmosphere, see Safety Code for Mechanical Refrigeration (ANSI/ASHRAE 15-1978) and safety requirements for the Storage and Handling of Anhydrous Ammonia (ANSI/CGA G2.1-1972).

(4) A saturated hydrocarbon mixture boiling in the range 20-135 degree C. (68 - 275 degrees F.) Also known by the synonyms benzine, ligroin, petroleum ether, or naphtha.

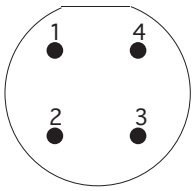
Compliances:
JMS explosion proof products are designed to fulfill the applicable Underwriter's Laboratories and Canadian standards requirements and National Electrical Code Article 500 Hazardous (Classified) Location installations. Where statement of compliances is used in this catalog in reference to UL, CSA, or FM listed standards numbers, it is for identification of products shown in catalog having met design criteria and company tested.

(The statement of compliances does not imply that the products have been approved by Underwriters' Laboratories, Canadian Standards Association or Factory Mutual). Such approvals are covered by listing published by Underwriters' Laboratories, Canadian Standards Association and Factory Mutual and are available upon request.

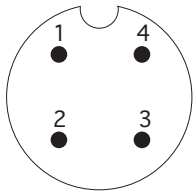
*Taken from NFPA 497M-1983

***See page 8-24 and 8-25 for more details**

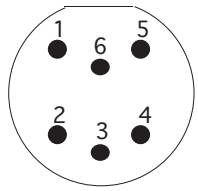
LATCHING PLUG WIRING STANDARDS



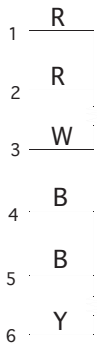
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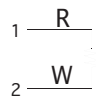
TYPE C



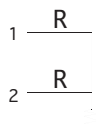
DUAL 3 WIRE RTD



2 WIRE RTD



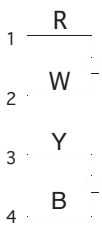
3 WIRE RTD



4 WIRE RTD



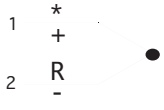
DUAL 2 WIRE RTD



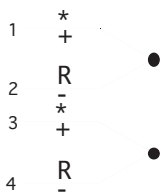
THERMOCOUPLE

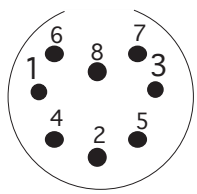
* APPROPIATE POSTIVE COLOR CODE FOR THERMOCOUPLE TYPE

SINGLE



DUAL





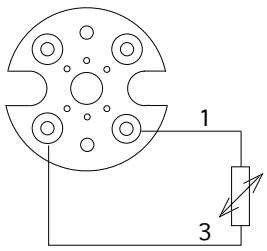
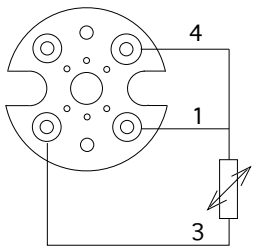
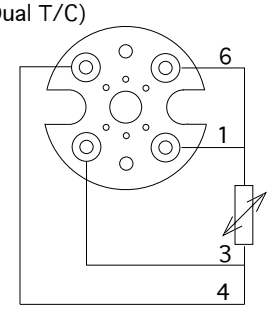
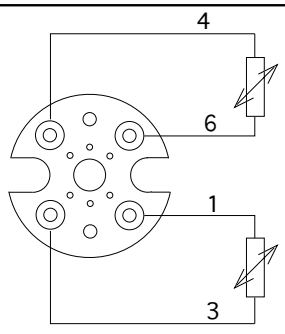
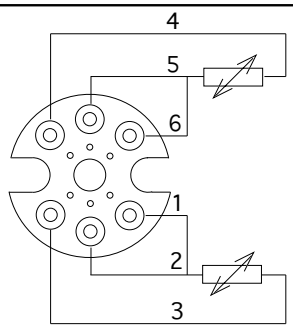
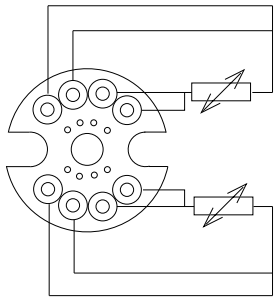
DUAL 4 WIRE RTD
(TYP A ONLY)

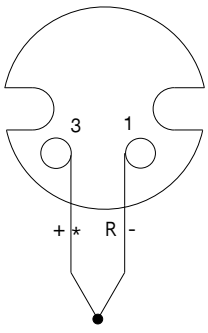


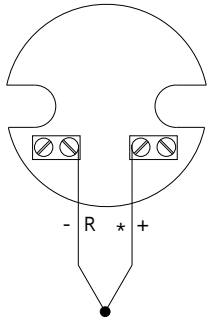
SECTION 6

TERMINAL WIRING STANDARDS

FOR TERMINAL BLOCK 6G, 6B + 6C

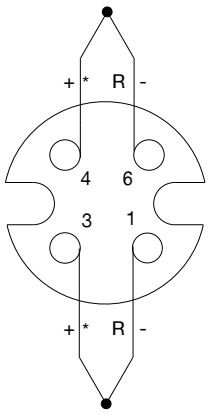
6C Terminal Blocks	2 - Wire Configuration	3 - Wire Configuration	4 - Wire Configuration
1 x pt 100	(or Single T/C) 		(or Dual T/C) 
2 x pt 100			

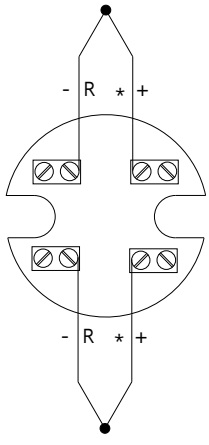


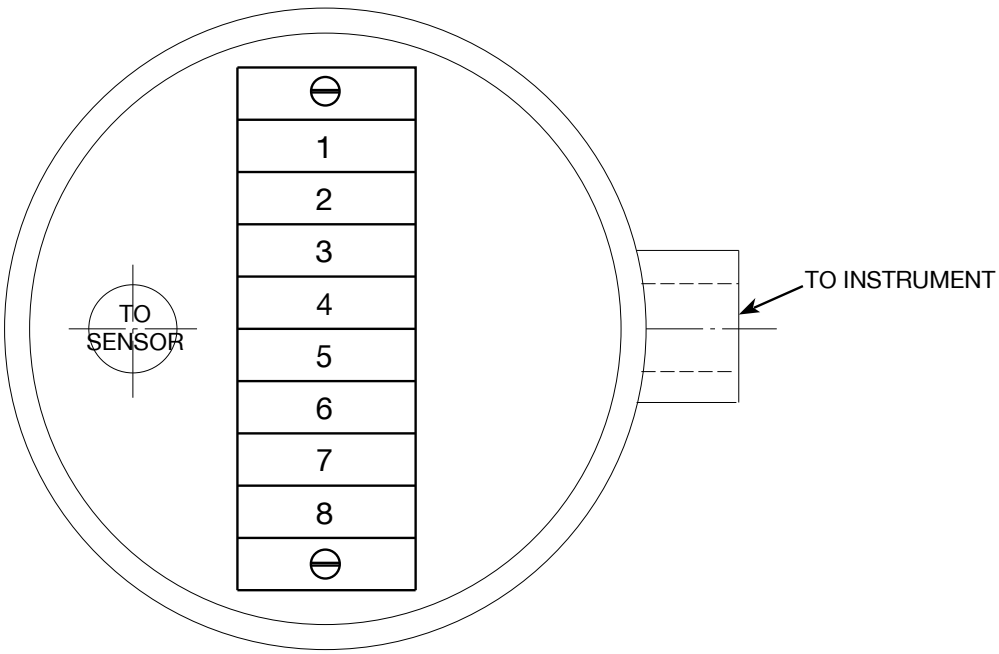


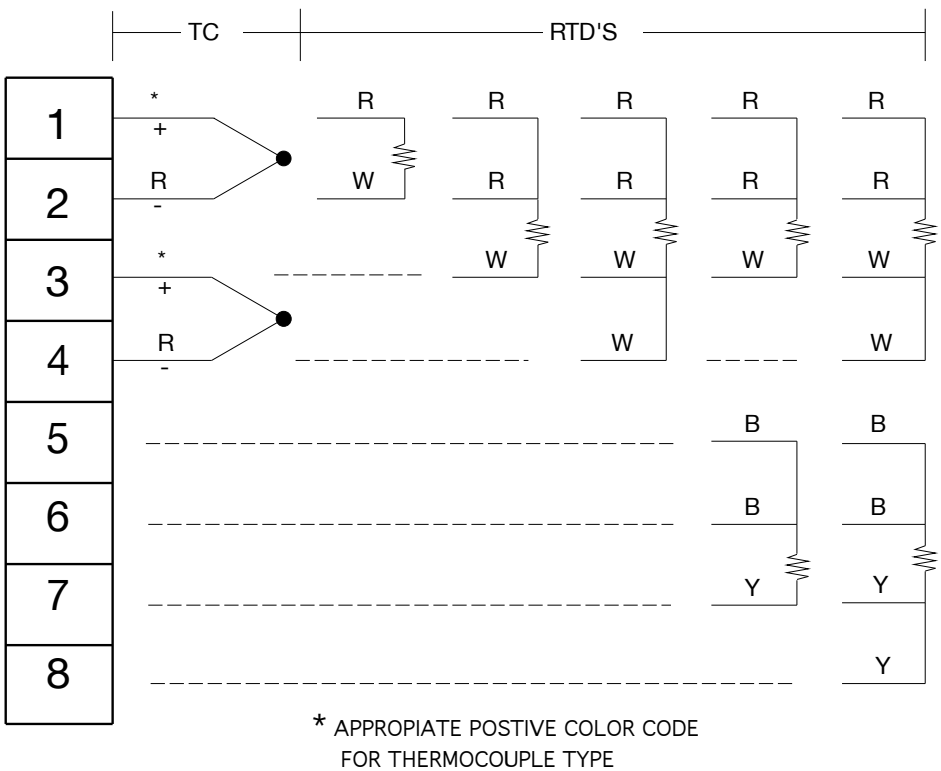
THERMOCOUPLE

* APPROPIATE POSTIVE COLOR CODE FOR THERMOCOUPLE TYPE









Nominal sequence for plugs, terminal blocks and connectors.

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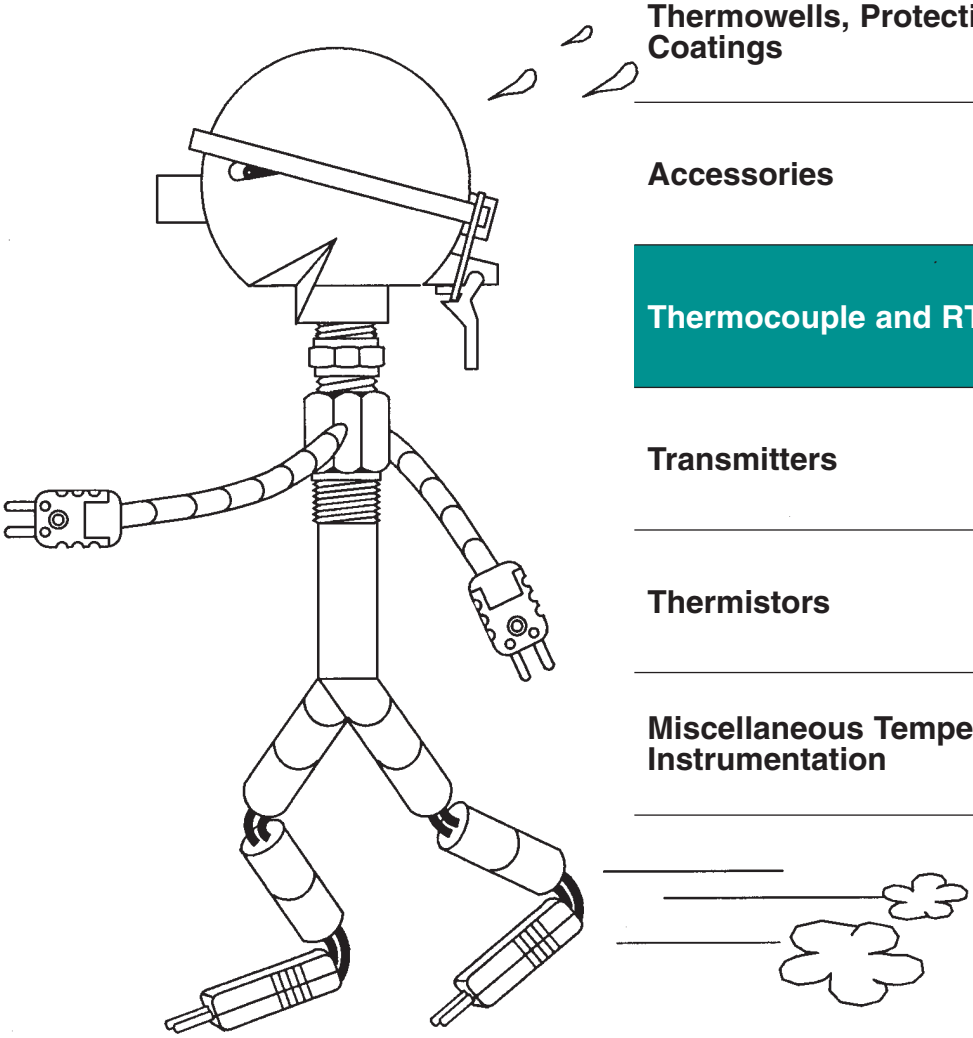
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Notes

1-800-873-1835

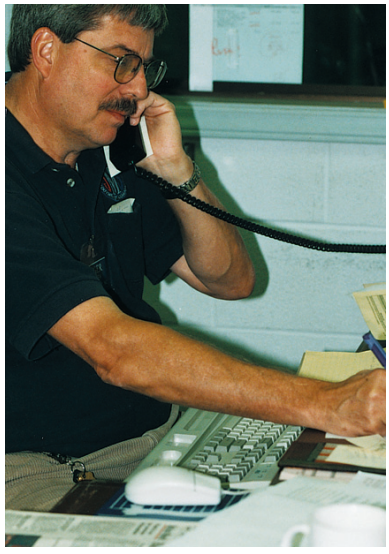
JMS Southeast, Inc.
Temperature Measurement



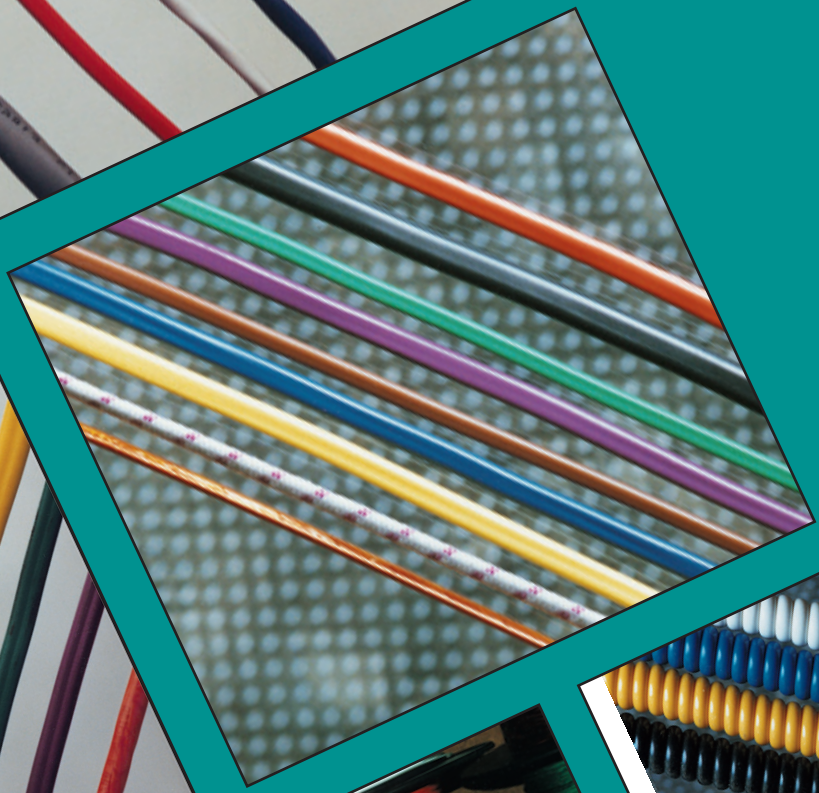
Thermocouple and RTD Wire

SECTION 7

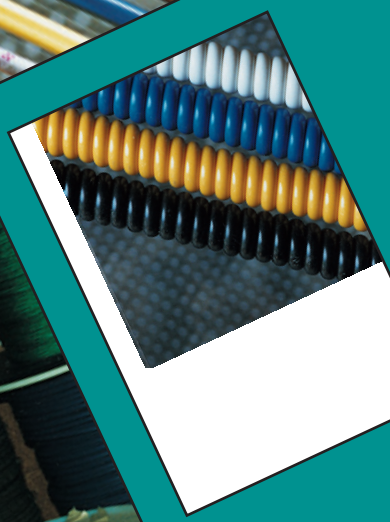


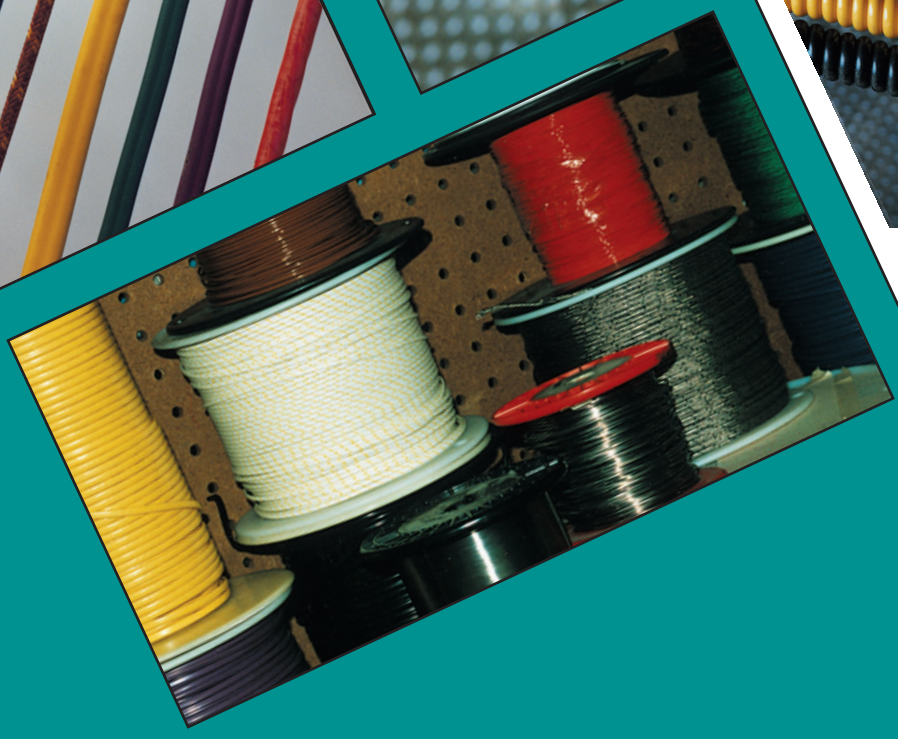












THERMOCOUPLE AND RTD WIRE

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THERMOCOUPLE WIRE

#1	SERIES [6, 7]
7	Thermocouple Wire

#2	TYPE		
EXTENSION GRADE [10]	THERMOCOUPLE GRADE [9]		
JX	J	Iron/Constantan	
KX	K	Chromel/Alumel	
TX	T	Copper/Constantan	
EX	E	Chromel/Constantan	
NX	N	Nicrosil/Nisil	
RX	--	Copper/#11 Alloy	
SX	--	Copper/#11 Alloy	
BX	–	PCLW 630 / Copper (special order only)	} It is common practice to use plain copper wire for type "B" extension. Use type CX from this selection.
CX	–	Copper / Copper*	

#3	INSULATION	
*PP	Polyvinyl chloride	
PC	Polyvinyl chloride rip cord	
*PA	Polyvinyl chloride with twisted conductors aluminized mylar shield and drain wire	} Extension Grade Only
*KK	Kapton	
NN	Nylon	
*TF	Fused teflon	
*TT	Extruded teflon	
*GG	Fiberglass braid	
*GS	Fiberglass braid with SS overbraid	
*HG	High temp. fiberglass braid	
*HS	High temp. fiberglass braid with SS overbraid	
RR	Refrasil	
*NE	Nextel - Heavy weave (for light weave, use X and specify lower weave #)	
X	Specify insulation	

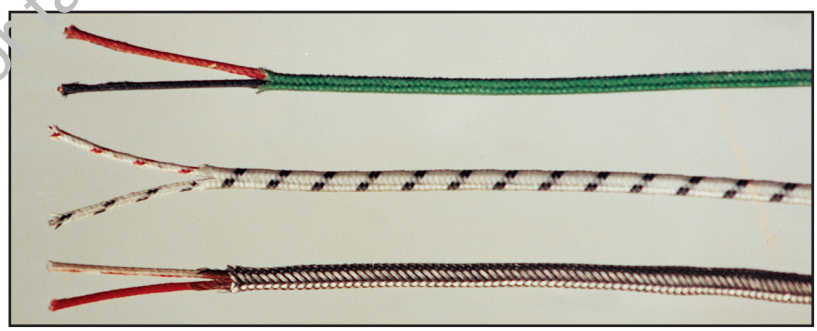
*Standard stock items in 20 gauge. Other insulation and gauge sizes available.

#4	WIRE GAUGE
16	16 gauge
20	20 gauge
24	24 gauge
28	28 gauge
30	30 gauge
X	Specify gauge

#5	WIRE CONSTRUCTION
1	Solid (standard)
2	Stranded

[ ]BRACKETS INDICATE PAGE NUMBERS ON WEB OR FULL CATALOG FOR ADDITIONAL TECHNICAL INFORMATION WWW.JMS-SE.COM

Unit of Measure = Feet



7	J	TT	20	1	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

Note: For special limits of error thermocouple wire use a double calibration symbol. Polyvinyl chloride wire and type R and S fiberglass wire are ordinarily manufactured in extension grade. Kapton, nylon, teflon, fiberglass braid, refrasil, and nextel are ordinarily manufactured in thermocouple grade.

NON-INSULATED SINGLE CONDUCTOR THERMOCOUPLE WIRE

#1	SERIES [7-11]
7N	Non-Insulated Thermocouple Wire

#2	TYPE
JP	Iron
JN	Constantan
KP	Chromel
KN	Alumel
EP	Chromel
EN	Constantan
NP	Nicrosil
NN	Nisil
TP	Copper
TN	Constantan
SP*	Platinum 10% Rhodium
SN*	Platinum
RP*	Platinum 13% Rhodium
RN*	Platinum
BP*	Platinum 30% Rhodium
BN*	Platinum 6% Rhodium
W0*	Tungsten
W3*	Tungsten 3% Rhenium
W5*	Tungsten 5% Rhenium
W25*	Tungsten 25% Rhenium
W26*	Tungsten 26% Rhenium

New Type N (Nicrosil/Nisil) bare wire now available, specify as NP (Nicrosil) or NN (Nisil).

#3	WIRE GAUGE
8	8 gauge
14	14 gauge
16	16 gauge
20	20 gauge
24	24 gauge (**JMS standard for SP, SN, RP, RN, BP, & BN**)
28	28 gauge
30	30 gauge
X	Other, specify

Unit of Measure = Feet

* Unit of Measure = Inches

Note: See pages 7-16 and 7-17 for weight per unit of measure

7N	RN	20	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

MULTI-CONDUCTOR EXTENSION CABLE

Each conductor is insulated with polyvinyl chloride or teflon. An aluminum backed *Mylar tape serves as an electrostatic shield. A solid 20 gauge tinned-copper drain wire is over the bundle in direct contact with the aluminum/mylar shield, thus minimizing any stray EMF's.

Conductors are color coded and numbered for identification. All conductors are insulated with an outer jacket of polyvinyl chloride or teflon insulation approximately .0245" thick.

Multipair extension cable can be manufactured with various quantities of pairs and insulation types. Contact JMS Southeast sales office for any requirements you may have.

*Mylar is a trademark of DuPont Company.

#1	SERIES [6, 7]
7M	Multi-Conductor Thermocouple Extension Cable

#2	TYPE
J	Iron/Constantan
K	Chromel/Alumel
T	Copper/Constantan
E	Chromel/Constantan
R	Copper/#11 Alloy
S	Copper/#11 Alloy
B	PCLW 630 / Copper
2	2 wire RTD (also used for type B thermocouples)
3	3 wire RTD
4	4 wire RTD
X	Other, insert calibration needed

Note: Conductors are 20 gauge solid.

#3	# OF PAIRS	ESTIMATED O.D.	EST. SHIPPING WT. LBS. PER 1000 FEET
2	2 (non-standard)	.370	53
4	4	.390	80
8	8	.480	131
12	12	.592	198
16	16	.653	245
20	20	.630	285
24	24	.770	338
X	Other, specify		

Note: Add "S" for stranded conductors

#4	INSULATION
P	Polyvinyl chloride
T	Teflon - extruded
X	Other, specify

#5	ALUMINUM MYLAR SHIELD
I	Individual pair and overall
O	Overall only
Z	Not applicable

Unit of Measure = Feet

7M	J	4	P	I	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jmsse.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

RTD WIRE

#1	SERIES
7R	RTD Wire

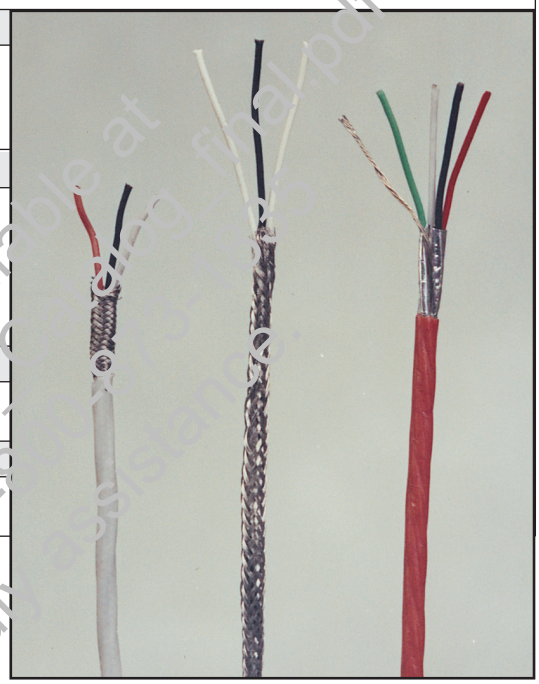
#2	INSULATION
PP	Polyvinyl chloride
GG	Fiberglass insulated (Standard)
GS	Fiberglass braid with stainless steel overbraid (available in 3 conductor, 24 awg, Nickel plated copper)
KK	Kapton insulated
*TT	Extruded Teflon singles, Teflon wrap overall (**Standard**) (Conductors properly color coded as per ASTM E1137 & IEC 751)
X	Other, specify

#3	NUMBER OF CONDUCTORS
2	Two conductors (also used for type B thermocouples)
3	Three conductors
4	Four conductors
X	Other, specify

#4	WIRE GAUGE
16	16 gauge
20	20 gauge
24	24 gauge (**Standard**)
28	28 gauge
30	30 gauge
X	Specify gauge

#5	WIRE CONSTRUCTION
1	Solid
2	Stranded (**Standard**)

#6	SHIELD
N	No shield
A	Aluminum Mylar shield



Unit of Measure = Feet

* RTD extension wire is any normal electrical wire. However, color codes for RTD's are specified and maintained by ASTM E1137 & IEC 751. Insulation types maintained in our inventory are teflon for single or dual, 3 or 4 wire RTD's, 24 awg. Also, fiberglass, 4 wire, 24 awg.

RED WHITE RED RED WHITE

COLOR CODES

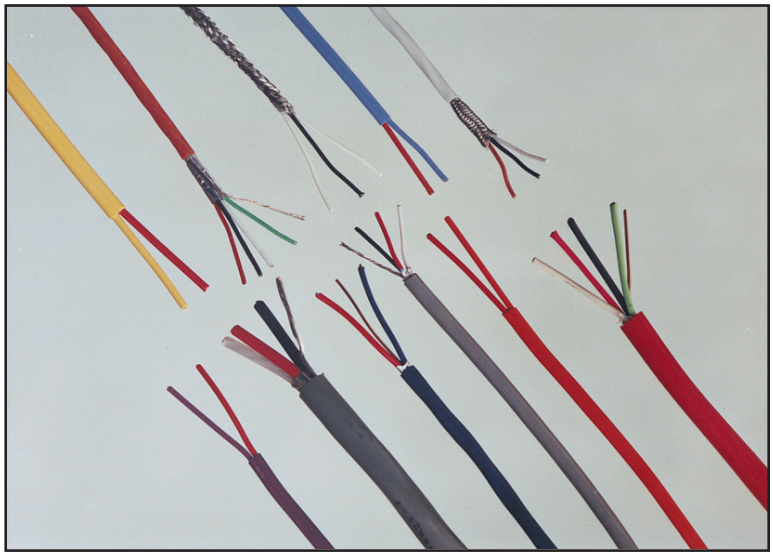
RED RED WHITE WHITE R R W W RS RS WS WS

DUAL ELEMENT

7R	TT	3	24	2	N	

Part Numbers Obsolete
Current Part Numbers available at
http://www.jmsse.com/pdf/JMS_obsolete_final.pdf
or call JMS directly at 1-800-345-1815
for fast and friendly assistance.

WIRE INSULATION MATERIAL



WIRE INSULATION MATERIAL

TEFLON INSULATED WIRE

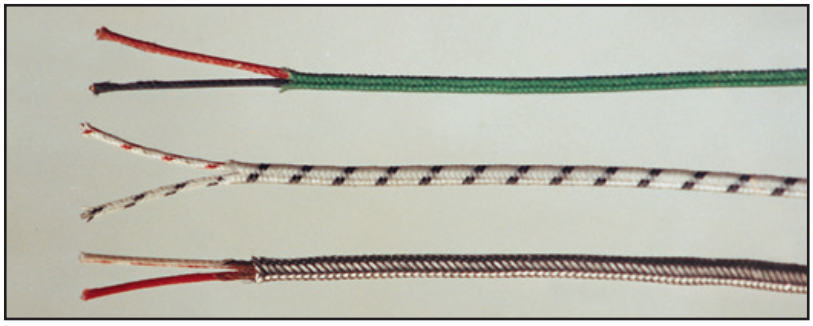
Teflon (extruded) Teflon (extruded) - TT

Color-coded teflon (FEP)* is extruded on the positive and negative conductors and outer jacket. This insulation is unaffected by most corrosive substances, outdoor weather, or lubricants. It is flame resistant and heat aging will not cause embrittlement or cracking. Excellent for cryogenic applications. Offered in thermocouple grade. Temperature rating: Continuous: Up to 400°F and 200°C.

Teflon (Fused TFE Tape) Teflon (Fused TFE Tape) TF

TFE tape is spirally applied to the conductor and heated. This process fuses the tape into a homogeneous layer of TFE. Fused teflon wire offers good abrasion resistance and excellent resistance to both moisture and chemicals. Offered in thermocouple grade. Temperature rating: Continuous: Up to 500°F and 260°C.

*DuPont Trademark



FIBROUS INSULATED WIRE

Fiberglass Braid-GG

Glass braid on individual conductors with glass braid outer jacket. Designed for continuous use in high temperature applications. Poor abrasion and moisture resistance. Offered in thermocouple grade. Temperature rating: Continuous: Up to 900°F and 482°C. Intermittent: Up to 1000°F and 529°C.

Hightemp Fiberglass Braid-HG

A high temperature fiberglass braid is applied over each conductor and then impregnated with a binder. Although the binder improves resistance to abrasion and moisture, it is destroyed above 400°F (204°C). Offered in thermocouple grade. Temperature rating: Continuous: Up to 1300°F and 705°C. Intermittent: Up to 1600°F and 871°C.
We recommend SS overbraid with this wire.

Fiberglass Braid with Stainless Steel Overbraid-GS and HS

A stainless steel overbraid is applied to fiberglass wire to increase the wires resistance to abrasion, mechanical and physical damage. It may be applied to 14 through 30 gauge conductors.

Refrasil-RR

Vitreous silica is applied on both positive and negative conductors with a vitreous silica outer jacket. Refrasil is not color coded. Used in high temperature applications. Moisture and abrasion resistance only fair. Offered in thermocouple grade. Temperature rating: Continuous: Up to 1600°F and 871°C. Intermittent: Up to 1800°F and 982°C. We recommend SS overbraid with this wire.

Nextel-NE

A high temperature ceramic fiber is applied over each conductor and then overall. Nextel is not colored coded. Although nextel is not recommended for use with platinum thermocouples, it can be used as an excellent option for other high temperature applications. Its use is limited by the temperature rating of the thermocouple wire it insulates. It is frequently used in furnace and traveling thermocouple applications. Temperature rating: Continuous: Up to 2200°F. Trademark of Sumitomo Corporation. We recommend SS overbraid with this wire.

NOISE IN THERMOCOUPLE CIRCUITS

The reduction of electrical noise pickup by instrument circuits is an important consideration in temperature measurement. Noise obscures small changes in signal level. Electrical noise comes in the form of static, magnetic, common mode and crosstalk.

Static noise is capacitively coupled to the wires in an instrument circuit from power lines or other voltage sources. This type of noise can be reduced or eliminated by the use of a shield placed around the wires.

Magnetic noise occurs when a current goes through a conductor. This can occur around power lines, relays, motors, generators, etc. Twisting the extension wire can minimize this noise, by canceling out these magnetic currents.

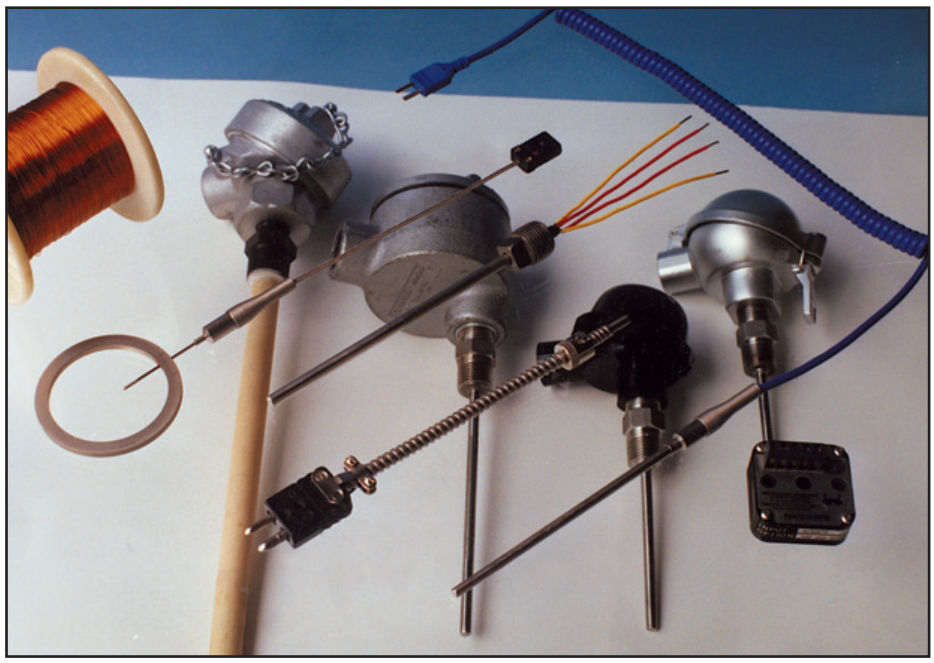
Common Mode noise is dependent upon the electrical connections in the instrument circuit and occurs when different locations in a plant are at different ground potentials. This type of noise is especially detrimental to grounded thermocouples. If the thermocouple is electrically grounded at the measuring point and if the instrument is also grounded, a current will flow between the thermocouple and instrument, which are at different electrical potentials. To combat this problem many instrument manufacturers have neither of their input terminals grounded, incurring a high common mode rejection rating of the system. Another type of common mode noise is created through capacitance which exists between the thermocouple conductors and any metal object near it. The metal objects, being at a different potential than the thermocouple tip, allows currents to flow into the conductors causing a voltage drop along the conductors. This drop adds to the EMF signal and produces noise. The best way to combat this noise problem is to shield the extension wire from the thermocouple to the control instrumentation. The shield is at the same potential for this entire length. The only ground connection in the shield should be at the thermocouple.

Finally, cross talk noise occurs when signals in adjacent pairs of wires transfer to each other. The most common method to eliminate this noise problem in multipair cable is to individually shield each pair of wires and ground each shield individually.

JMS Southeast, Inc., can provide you with shielded and nonshielded thermocouple extension wire ranging from a single pair to 36 pair cable.

Please contact us for any thermocouple wire needs you may have.

Note: When using shielded wire with your sensor, we attach the shield to the tube or sheath with which the sensor is built. The drain wire is bare and left accessible to the end user. If you do not want the shield electrically connected to the sheath or tube, please specify a “Floating Shield” and we will accommodate you. (Normally the drain wire on grounded/shielded thermocouples is left unconnected at the instrument to avoid ground loops.)



THERMOCOUPLE TYPE INFORMATION

JMS offers thermocouples and wire in the following types. Listed below are suggested criteria to consider in selecting the desired type for your application. Contact JMS Southeast if additional information is required.

(J)–Iron vs Constantan
May be used in vacuum, oxidizing, reducing, and inert atmospheres. Heavier gauge wire is recommended for long term life above 1000°F since the iron element oxidizes rapidly at these temperatures.

(T)–Copper vs Constantan
May be used in vacuum, oxidizing, reducing, and inert atmospheres. It is resistant to corrosion in most atmospheres. High stability at sub-zero temperatures and its limits of error are guaranteed at cryogenic temperatures.

(K)–Chromel vs Alumel
Recommended for continuous use in oxidizing or inert atmospheres up to 2300°F (1260°C), especially above 1000°F. Cycling above and below 1800°F (1000°C), is not recommended due to EMF alteration from hysteresis effects. Should not be used in sulfurous or alternating reducing and oxidizing atmospheres unless protected with protection tubes. Fairly reliable and accurate at high temperatures.

(E)–Chromel vs Constantan
May be used in oxidizing or inert atmospheres, but not recommended for alternating oxidizing or inert atmospheres. Not subject to corrosion under most atmospheric conditions. Has the highest EMF produced per degree than any other standard thermocouple and must be protected from sulfurous atmospheres.

(S,R)–Platinum vs Platinum Rhodium
Recommended for use in oxidizing or inert atmospheres. Should not be used in reducing atmospheres, or in contact with any metallic protection tube. Continuous use at very high temperatures may cause excessive grain growth and drifts in calibration.

(N)–Nicrosil vs Nisil
May be used in oxidizing, dry reducing, or inert atmospheres. Must be protected in sulfurous atmospheres. Very reliable and accurate at high temperatures. Can replace Type K thermocouples in many applications.

(W)–Tungsten vs Rhenium
Recommended for use in vacuum, high purity hydrogen, or pure inert atmospheres. May be used at very high temperatures (2316°C). This wire is inherently brittle.

THERMOCOUPLE GRADE VS EXTENSION GRADE WIRE

Thermocouple wire or extension grade wire is recommended to connect thermocouples to the control instrumentation. The thermocouple wire insulation depends upon the environment in which it exists. The calibration of the wire must correlate to the thermocouple calibration. Other considerations in choosing thermocouple extension grade or thermocouple grade wire are temperature range, service, life, and location (conduit, moist atmosphere, etc.).

Thermocouple extension wire should not be used to manufacture a thermocouple, but to transmit the signal from the thermocouple to the instrumentation. An extension grade thermocouple may not be within ANSI standard limits or error.

Thermocouple grade wire can be used to connect the thermocouple to the instrumentation. It is slightly more expensive than the extension grade wire and it is not usually the most economical option for long runs.

ACCURACY OF JMS THERMOCOUPLE WIRE

JMS insulated and bare thermocouple wire is matched to meet standard or special limits of error for temperatures above 32°F (0°C), as given in ANSI MC 96.1 and shown in tables below.

LIMITS OF ERROR FOR THERMOCOUPLE WIRE

THERMOCOUPLE TYPE		°F.				
WIRE ALLOY	ANSI TYPE SYMBOL	TEMPERATURE RANGE °F	STANDARD LIMITS	ORDER CODE	SPECIAL LIMITS	ORDER CODE
Iron (+) vs. Constantan (-)	J	+32° to +545° +545° to +1400°	±4° ±.75%	J	±2° ±.4%	JJ
Chromel™ (+) vs. Alumel ™ (-)	K	-330° to -165° -165° to +32° +32° to +545° +545° to +2300°	±2% ±4° ±4° ±.75%	K	 ±2° ±.4%	KK
Copper (+) vs. Constantan™ (-)	T	-330° to -85° -85° to +270° +270° to +660°	±1.5% ±1.8° ±.75%	T	±.8% ±.9° ±.4%	TT
Chromel™ (+) vs. Constantan™ (-)	E	-330° to -270° -270° to +480° +480° to +640° +640° to +1600°	±1% ±3° ±3° ±5%	E	±1.8° ±1.8° ±.4% ±.4%	EE
Nicrosil™ (+) vs. Nisil™ (-)	N	+32° to +545° +545° to +2300°	±4° ±.75%	N	±2° ±.4%	NN

THERMOCOUPLE TYPE		°C.				
WIRE ALLOY	ANSI TYPE SYMBOL	TEMPERATURE RANGE °C	STANDARD LIMITS	ORDER CODE	SPECIAL LIMITS	ORDER CODE
Iron (+) vs. Constantan (-)	J	0° to +285° +285° to +750	±2.2° ±.75%	J	±1.1° ±.4%	JJ
Chromel™ (+) vs. Alumel ™ (-)	K	-200° to -110° -110° to 0° 0° to +285° +285° to +1250	±2% ±2.2° ±2.2° ±.75%	K	 ±1.1° ±.4%	KK
Copper (+) vs. Constantan™ (-)	T	-200° to -65° -65° to +130° +130° to +350°	±1.5% ±1° ±.75%	T	±.8% ±.5° ±.4%	TT
Chromel™ (+) vs. Constantan™ (-)	E	-200° to -170° -170° to +250° +250° to +340° +340° to +900°	±1% ±1.7° ±1.7° ±5%	E	±1° ±1° ±.4% ±.4%	EE
Nicrosil™ (+) vs. Nisil™ (-)	N	0° to +285° +285° to +1250°	±2.2° ±.75%	N	±1.1° ±.4%	NN

ACCURACY OF JMS EXTENSION WIRE

Thermocouple extension wire has approximately the same thermoelectric characteristics as thermocouple wire, but its accuracy is guaranteed over a more limited range of temperatures. Thermocouple extension wire can offer advantages in cost when used for connections between thermocouples and instruments. For base metal types of thermocouples, extension wire is of substantially the same composition as the corresponding thermocouple type. For noble metal types, however, an entirely different alloy is formulated to match the noble metal characteristics over a specified temperature range. This is necessary due to the high cost of the noble metals which would otherwise be necessary for the interconnection. The "X" in the ordering codes denotes extension grade wire.

LIMITS OF ERROR FOR THERMOCOUPLE EXTENSION WIRE

THERMOCOUPLE TYPE		°F.				
EXTENSION WIRE ALLOY	ANSI TYPE SYMBOL	TEMPERATURE RANGE °F	STANDARD LIMITS	ORDER CODE	SPECIAL LIMITS	ORDER CODE
Copper vs. Constantan™	TX	-75° to +210°	±2°	TX	±1°	TTX
Iron vs. Constantan™	JX	+32 to +400°	±4°	JX	±2°	JJX
Chromel™ (+) vs. Constantan™	EX	+32 to +400°	±3°	EX	±2°	EEX
Chromel™ vs. Alumel™	KX	+32 to +400°	±4°	KX	±2°	KKX
Nicrosil™ vs. Nisil™	NX	+32 to +400°	±4°	NX	±2°	NNX
Copper vs. Copper Alloy	SX	+75 to +400°	±12°	SX		
Copper vs. Copper Alloy	RX			RX		
PCLW630 vs. Copper	BX	+32 to +400°	±4°	BX		
Copper vs. Copper	2CU	+32 to +150°	±2°	BX		
Alloy 203 vs. Alloy 225	W3X	+32 to +500°	±12°	W3X		
Alloy 405 vs. Alloy 426	W5X	+32 to +1600°	±12°	W5X		

THERMOCOUPLE TYPE		°C.				
EXTENSION WIRE ALLOY	ANSI TYPE SYMBOL	TEMPERATURE RANGE °C	STANDARD LIMITS	ORDER CODE	SPECIAL LIMITS	ORDER CODE
Copper vs. Constantan™	TX	-60° to +100°	±1°	TX	±.5°	TTX
Iron vs. Constantan™	JX	+0 to +200°	±2.2°	JX	±1.1°	JJX
Chrome™l (+) vs. Constantan™	EX	0 to +200°	±1.7°	EX	±1.1°	EEX
Chromel™ vs. Alumel™	KX	0 to +200°	±2.2°	KX	±1.1°	KKX
Nicrosil™ vs. Nisil™	NX	0 to +200°	±2.2°	NX	±1.1°	NNX
Copper vs. Copper Alloy	SX	+25 to +200°	±7°	SX		
	RX			RX		
PCLW630 vs. Copper	BX	0 to +200°	±2.2°	BX		
Copper vs. Copper	2CU	0 to 65°	±1°	BX		
Alloy 203 vs. Alloy 225	W3X	0 to 260°	±7°	W3X		
Alloy 405 vs. Alloy 426	W5X	0 to 870°	±7°	W5X		

Special Note: Using Cu/ Cu wire for type B thermocouples can introduce an error from 7°F to 85°F(3.7°C to 48°C) if the connection point is from 212 - 572°F (100 - 300°C). Up to 99% of these errors are avoided by using the appropriate extension wire.

ANSI COLOR CODE FOR THERMOCOUPLE AND THERMOCOUPLE EXTENSION WIRE

ANSI TYPE	EXTENSION WIRE ALLOYS	POLARITY	THERMOCOUPLE WIRE COLOR		T/C EXTENSION WIRE COLOR	
			INDIVIDUAL	OVERALL	INDIVIDUAL	OVERALL
J	Iron Constantan	+JP -JN	White Red	Brown	White Red	Black
K	Chromel Alumel	+KP -KN	Yellow Red	Brown	Yellow Red	Yellow
T	Copper Constantan	+TP -TN	Blue Red	Brown	Blue Red	Blue
E	Chromel Constantan	+EP -EN	Purple Red	Brown	Purple Red	Purple
N	Nicrosil Nisil	+NP -NN	Orange Red	Brown	Orange Red	Orange
RSX	Copper Copper Alloy	+RSP -RSN			Black Red	Green
BX	PCLW630 / Copper Copper	+BP -BN			Grey Red	Grey
*W3X	Alloy 203; Alloy 405	+WP			White / Red	
*W5X	Alloy 225; Alloy 426	-WN			Red	White / Red

*= Not ANSI

UPPER TEMPERATURE LIMITS FOR BARE THERMOCOUPLE WIRE

ANSI TYPE	THERMOCOUPLE TYPE	THERMOCOUPLE WIRE COLOR					
		8 AWG	14 AWG	16 AWG	20 AWG	24 AWG	28 AWG
J	Iron - Constantan	1400°F (760°C)	1100°F (600°C)	900°F (500°C)	900°F (500°C)	700°F (370°C)	700°F (370°C)
K	Chromel - Alumel	2300°F (1260°C)	2000°F (1100°C)	2000°F (1100°C)	1800°F (1000°C)	1600°F (870°C)	1600°F (870°C)
T	Copper - Constantan	--	700°F (370°C)	500°F (260°C)	500°F (260°C)	400°F (200°C)	400°F (200°C)
E	Chromel - Constantan	1600°F (870°C)	1200°F (650°C)	1000°F (550°C)	1000°F (550°C)	800°F (430°C)	800°F (430°C)
N	Nicrosil - Nisil	2300°F (1260°C)	2000°F (1100°C)	2000°F (1100°C)	1800°F (1000°C)	1600°F (870°C)	1600°F (870°C)

Catalog Number	Gauge Size	Conductors	*Ohms	Primary Insulation	Outer Jacket	Min.-Max. O.D.	Est. Shpg. Wt. per M
ANSI: TYPE, J - Iron / Constantan							
GG210J	20	Solid	.357	Glass Braid	Glass Braid	.059 x .105”	8 lbs.
GG202J	20	Stranded	.317	Double Glass Braid	Glass Braid	.075 x .137”	9lbs.
KK201J	20	Solid	.357	Fused Kapton Tape	None, Twisted	.087”	10 lbs.
NN201J	20	Solid	.357	Nylon	Nylon	.068 x .120”	11 lbs.
TF201J	20	Solid	.357	(TFE) tape, Teflon	(TFE) tape, Teflon	.065 x .110”	10 lbs.
TX201J	20	Solid	.357	Extruded (FEP) Teflon	Extruded (FEP) Teflon	.072 x .124”	11 lbs.
GG241J	24	Solid	.877	Glass Braid	Glass Braid	.047 x .081”	4 lbs.
KK241J	24	Solid	.877	Fused Kapton Tape	None, Twisted	.063”	5 lbs.
PP241J	24	Solid	.877	Polyvinyl Chloride	None, Rip-Cord	.048 x .096”	4 lbs.
TF241J	24	Solid	.877	(TFE) tape, Teflon	(TFE) tape, Teflon	.047 x .078”	5 lbs.
GG261J	26	Solid	1.394	Glass Wrap	Glass Braid	.040 x .065”	3 lbs.
GG281J	28	Solid	2.216	Glass Wrap	Glass Braid	.037 x .059”	3 lbs.
GG301J	30	Solid	3.520	Glass Wrap (Braid avail.)	Glass Braid	.033 x .053”	3 lbs.
ANSI: TYPE, K - Chromel / Alumel							
GG201K	20	Solid	.590	Glass Braid	Glass Braid	.059 x .105”	8 lbs.
GG202K	20	Stranded	.538	Double Glass Braid	Glass Braid	.075 x .137”	9 lbs.
KK201K	20	Solid	.590	Fused Kapton Tape	None, Twisted	.087”	10 lbs.
RR201K	20	Solid	.590	Vitreous Silica Braid	Vitreous Silica Braid	.102 x .174”	16 lbs.
TF201K	20	Solid	.590	(TFE) tape, Teflon	(TFE) tape, Teflon	.065 x .110”	10 lbs.
TX201K	20	Solid	.590	Teflon Extruded (FEP)	Teflon Extruded	.072 x .124”	11 lbs.
GG241K	24	Solid	1.490	Glass Braid (Wrap avail.)	Glass Braid	.047 x .081”	4 lbs.
PP241K	24	Solid	1.490	Polyvinyl-Rip Cord Const.	None	.048 x .096”	4 lbs.
GG261K	26	Solid	2.370	Glass Wrap	Glass Braid	.040 x .065”	3 lbs.
GG281K	28	Solid	3.770	Glass Braid (Wrap avail.)	Glass Braid	.039 x .064”	3 lbs.
GG301K	30	Solid	5.980	Glass Wrap	Glass Braid	.033 x .053”	2 lbs.
ANSI: TYPE, T - Copper / Constantan							
GG201T	20	Solid	.298	Glass Braid (Wrap avail.)	Glass Braid	.059 x .105”	5 lbs
TF201T	20	Solid	.298	(TFE) tape, Teflon	(TFE) tape, Teflon	.065 x .110”	10 lbs.
TX201T	20	Solid	.298	Extruded Teflon (FEP)	Extruded Teflon	.072 x .124”	11 lbs.
GG241T	24	Solid	.753	Glass Braid (Wrap avail.)	Glass Braid	.047 x .081”	4 lbs.
NN241T	24	Solid	.753	Nylon	Nylon	.060 x .095”	6 lbs.
PP241T	24	Solid	.753	Polyvinyl Rip Cord Const.	None	.048 x .096”	3 lbs.
TF241T	24	Solid	.753	(TFE) tape, Teflon	(TFE) tape, Teflon	.047 x .078”	5 lbs.
GG281T	28	Solid	1.905	Glass Braid (Wrap avail.)	Glass Braid	.039 x .064”	3 lbs.
GG301T	30	Solid	3.025	Glass Wrap	Glass Braid	.033 x .053”	2 lbs.
ANSI: TYPE, E - Chromel / Constantan							
GG201E	20	Solid	.704	Glass Braid	Glass Braid	.059 x .105”	8 lbs.
GG241E	24	Solid	1.780	Glass Braid	Glass Braid	.047 x .081”	4 lbs.

*ohms per double foot at 20°C (68°F).

Catalog Number	Gauge Size	Conductors	*Ohms	Primary Insulation	Outer Jacket	Min.-Max. O.D.	Est. Shpg. Wt. per M
ANSI: TYPE, J - Iron / Constantan							
PP161JX	16	Solid	.137	Polyvinyl Chloride	Polyvinyl Chloride	.111 x .188”	27 lbs.
PA161JX	16	Solid	.137	PVC/Alum. Mylar Shield (Twisted)	PVC	.222”	28 lbs.
PA201JX	20	Solid	.357	PVC/Alum. Mylar Shield (Twisted)	PVC	.184”	20 lbs.
PP201JX	20	Solid	.357	Polyvinyl Chloride	Polyvinyl Chloride	.095 x .158”	14 lbs.
PP202JX	20	Stranded	.317	Polyvinyl Chloride	Polyvinyl Chloride	.115 x .190”	14 lbs.
PX201JX	20	Solid	.357	(FEP) Extruded Teflon	Extruded Teflon	.072 x .124”	11 lbs.
ANSI: TYPE, K - Chromel / Alumel							
PA161KX	16	Solid	.233	PVC/Alum. Mylar Shield (Twisted)	PVC	.222”	28 lbs.
PP161KX	16	Solid	.233	Polyvinyl Chloride	Polyvinyl Chloride	.116 x .188”	27 lbs.
PA201KX	20	Solid	.590	PVC/Alum. Mylar Shield (Twisted)	PVC	.184”	20 lbs.
PP201KX	20	Solid	.590	Polyvinyl Chloride	Polyvinyl Chloride	.195 x .158”	14 lbs.
PP202KX	20	Stranded	.538	Polyvinyl Chloride	Polyvinyl Chloride	.115 x .190”	14 lbs.
ANSI: TYPE, T - Copper / Constantan							
PP141TX	14	Solid	.074	Polyvinyl Chloride	Polyvinyl Chloride	.130 x .226”	37 lbs.
PA161TX	16	Solid	.118	PVC/Alum. Mylar Shield (Twisted)	PVC	.222”	20 lbs.
PP161TX	16	Solid	.118	Polyvinyl Chloride	Polyvinyl Chloride	.111 x .188”	28 lbs.
PA201TX	20	Solid	.298	PVC/Alum. Mylar Shield	PVC	.184”	20 lbs.
PP201TX	20	Solid	.298	Polyvinyl Chloride	Polyvinyl Chloride	.095 x .158”	15 lbs.
ANSI: TYPE, E - Chromel / Constantan							
PA161EX	16	Solid	.278	PVC/Alum. Mylar Shield (Twisted)	PVC	.222”	20 lbs.
PP201EX	20	Solid	.704	Polyvinyl Chloride	Polyvinyl Chloride	.095 x .158”	15 lbs.
ANSI: TYPE, S and R - Platinum / Rhodium							
PP161SX	16	Solid	.016	Polyvinyl Chloride	Polyvinyl Chloride	.116 x .250”	27 lbs.
GG201SX	20	Solid	.040	Glass Braid	Glass Braid	.059 x .105”	8 lbs.
PP201SX	20	Solid	.040	Polyvinyl Chloride	Polyvinyl Chloride	.095 x .158	14 lbs.

*ohms per double foot at 20°C (68°F).

COMPARISON OF WIRE GAUGES

Standard Wire Gauges in Approximate Decimals of an Inch and mm.

American or Brown and Sharp Wire Gauge	Diameter Inches	Diameter Millimeters	British Standard or Imperial	US Standard
1	0.2893	7.348	.300	.281
2	0.2576	6.544	.276	.266
3	0.2294	5.827	.252	.250
4	0.2043	5.189	.232	.234
5	0.1819	4.621	.212	.219
6	0.1620	4.115	.192	.203
7	0.1443	3.665	.176	.188
8	0.1285	3.264	.160	.172
9	0.1144	2.906	.144	.156
10	0.1019	2.588	.128	.141
11	0.0907	2.304	.116	.125
12	0.0808	2.053	.104	.109
13	0.0720	1.829	.092	.0938
14	0.0641	1.628	.080	.0781
15	0.0571	1.450	.072	.0703
16	0.0508	1.291	.064	.0625
17	0.0453	1.150	.056	.0563
18	0.0403	1.024	.048	.0500
19	0.0359	0.9116	.040	.0438
20	0.0320	0.8118	.036	.0375
21	0.0285	0.7230	.032	.0344
22	0.0253	0.6438	.028	.031
23	0.0226	0.5733	.024	.0281
24	0.0201	0.5106	.022	.0250
25	0.0179	0.4547	.020	.0219
26	0.0159	0.4049	.018	.0188
27	0.0142	0.3606	.0164	.0172
28	0.0126	0.3211	.0148	.0156
29	0.0113	0.2859	.0136	.0141
30	0.0100	0.2546	.0124	.0125
31	0.0089	0.2268	.0116	.0109
32	0.0080	0.2019	.0108	.0102
33	0.00708	0.178	.010	.0094
34	0.00630	0.152	.0092	.0086
35	0.00561	0.138	.0084	.0078
36	0.00500	0.127	.0076	.0066
37	0.00445	0.1131	.0068	.0070
38	0.00397	0.1007	.006	.0063
39	0.00353	0.08969	.0052	--
40	0.00314	0.07987	.0048	--

THERMOCOUPLE WIRE SIZES, RESISTANCES, AND WEIGHTS

NOMINAL RESISTANCE AND WEIGHTS

BARE THERMOCOUPLE WIRE AND EXTENSION WIRE
CONDUCTORS BASED ON OHMS PER FOOT AT 70°F

GAUGE	8		14		16		20		24		28		30		38	
B & S DIAMETER	.128		.064		.051		.032		.020		.012		.010		.004	
CONDUCTOR	RES.	FT.	RES.	FT.	RES.	FT.	RES.	FT.	RES.	FT.	RES.	FT.	RES.	FT.	RES.	FT.
Copper	.0006	20	.003	80	.004	127	.010	322	.026	816	.065	2076	.103	3296	.659	20970
Iron	.004	22	.015	91	.003	145	.059	365	.149	926	.376	2356	.598	3741	3.83	23740
Constantan	.018	20	.072	81	.114	128	.291	324	.725	821	1.85	2090	2.94	3318	18.7	21110
Chromel	.026	20	.104	82	.165	130	.415	329	1.05	834	2.70	2121	4.03	3368	27.04	21430
Alumel	.011	20	.043	83	.069	132	.113	334	.438	846	1.11	2153	1.76	3419	11.26	21750
#11 Alloy	.002	20	.007	80	.010	125	.027	322	.070	815	.175	2075	.275	3295	--	20955
Platinum	.004	.56	.016	2.22	.025	3.71	.066	9.17	.166	23.5	--	65.2	.633	93.9	4.15	587
Plat. - 6%	--	.58	--	2.31	--	3.85	--	9.54	--	24.4	--	67.8	--	97.6	--	610
Plat. - 10%	.007	.60	.028	2.37	.044	3.97	.119	9.82	.298	25.2	--	69.8	1.19	100.5	7.45	628
Plat. - 13%	.008	.61	.031	2.43	.049	4.06	.124	10.0	.312	25.7	--	71.4	1.25	102.8	7.80	642
Plat. - 30%	--	.68	--	2.70	--	4.51	--	11.2	--	28.6	--	79.1	--	114.3	--	715

NOTE: All footages stated are in pound units except platinum calibrations which are in troy ounce units

GAUGE CONSTRUCTION CIRCULAR MILS	14 16/26* 4006	16 7/24 2828	17 19/30 1911	20 7/28 1119
CALIBRATION	RES.	RES.	RES.	RES.
Copper	.003	.004	.005	.009
Iron	.015	.021	.031	.054
Constantan	.073	.104	.165	.263
Chromel	.105	.150	.222	.380
Alumel	.004	.063	.094	.158

THERMOCOUPLE WIRE SIZE AND RESISTANCE TABLE

RESISTANCE IN OHMS PER DOUBLE FOOT AT 68°F.

AWG NO.	DIAMETER (inches)	TYPE K Chromel / Alumel	TYPE J Iron / Constantan	TYPE T Copper / Constantan	TYPE E Chromel / Constantan	TYPE S Pt / Pt 10% Rh	TYPE R Pt / Pt 13% Rh	TYPE C* W5% Re / W26% Re	TYPE G* W / W26% Re	TYPE D* W3% Re / W25% Re
6	0.162	0.023	0.014	0.012	0.027	0.007	0.007	0.009	0.008	0.009
8	0.128	0.037	0.022	0.019	0.044	0.011	0.011	0.015	0.012	0.015
10	0.102	0.058	0.034	0.029	0.069	0.018	0.018	0.023	0.020	0.022
12	0.081	0.091	0.054	0.046	0.109	0.028	0.029	0.037	0.031	0.035
14	0.064	0.146	0.087	0.074	0.175	0.045	0.047	0.058	0.049	0.055
16	0.051	0.230	0.137	0.117	0.276	0.071	0.073	0.092	0.078	0.033
18	0.040	0.374	0.222	0.190	0.448	0.116	0.119	0.148	0.126	0.138
20	0.032	0.586	0.357	0.298	0.707	0.185	0.190	0.235	0.200	0.220
24	0.0201	1.490	0.878	0.7526	1.78	0.464	0.478	0.594	0.560	0.560
26	0.0159	2.381	1.405	1.204	2.836	0.740	0.760	0.945	0.803	0.890
30	0.0100	5.984	3.551	3.043	7.169	1.85	1.91	2.38	2.03	2.26
32	0.0080	9.524	5.599	4.758	11.31	1.96	3.04	3.8	3.22	3.60
34	0.0063	15.17	8.946	7.66	18.09	4.66	4.82	6.04	5.10	5.70
36	0.0050	24.08	14.20	12.17	28.76	7.40	7.64	9.6	8.16	9.10
38	0.0039	38.20	23.35	19.99	45.41	11.6	11.95	15.3	12.9	15.3
40	0.00315	60.88	37.01	31.64	73.57	18.6	19.3	24.4	20.6	23.0
44	0.0020	149.6	88.78	76.09	179.2	74.0	76.5	60.2	51.1	56.9
50	0.0010	598.4	355.1	304.3	716.9	185	191	240	204	227
56	0.00049	2408	1420	1217	2876	740	740	1000	850	945

BASE METAL THERMOCOUPLE WIRE FT. / LB.

ANSI CODE	WIRE TYPE	ELEMENT POLARITY	AWG	WIRE FT. / LB
JP	Iron	Positive (+)	8 14 20 24 28 30	22.8 91.2 365.0 925.0 2353.0 3767.0
JN	Constantan	Negative (-)	8 14 20 24 28 30	20.2 80.9 324.0 821.0 2089.0 3316.0
KP	Chromel	Positive (+)	8 14 20 24 28 30	21 83 331 838 2089 3316
KN	Alumel	Negative (-)	8 14 20 24 28 30	21 83 331 838 2130 3370
EP	Chromel	Positive (+)	20 24 30	328 833 3364
EN	Constantan	Negative (-)	20 24 30	324 821 3316
TP	Copper	Positive (+)	20 24 30	324 820 3294
TN	Constantan	Negative (-)	20 24 30	324 821 3316

HIGH TEMPERATURE THERMOCOUPLE WIRE

ANSI CODE	CODE TYPE	ELEMENT POLARITY	AWG	WIRE IN / T. OZ
SP	Pt-10% Rh	Positive (+)	16 20 24 26 28	46.4 118.0 302.2 480.0 715.2
SN	Pt	Negative (-)	16 20 24 26 28	43.3 110.0 281.6 432.0 666.6
RP	Pt-13% Rh	Positive (+)	16 20 24 26 28	47.4 120.4 308.3 468.0 729.8
RN	Pt	Negative (-)	16 20 24 26 28	43.3 110.0 281.6 432.0 666.6
BP	Pt-30% Rh	Positive (+)	16 20 24 28	52.7 134.0 343.1 812.3
BN	Pt-6% Rh	Negative (-)	16 20 24 28	45.2 114.8 394.0 695.8
CP	Tungsten 5% Rhenium	Positive (+)	24	308.7
CN	Tungsten 26% Rhenium	Negative (-)	24	304.3

Pt = Platinum
Rh = Rhodium

Notes

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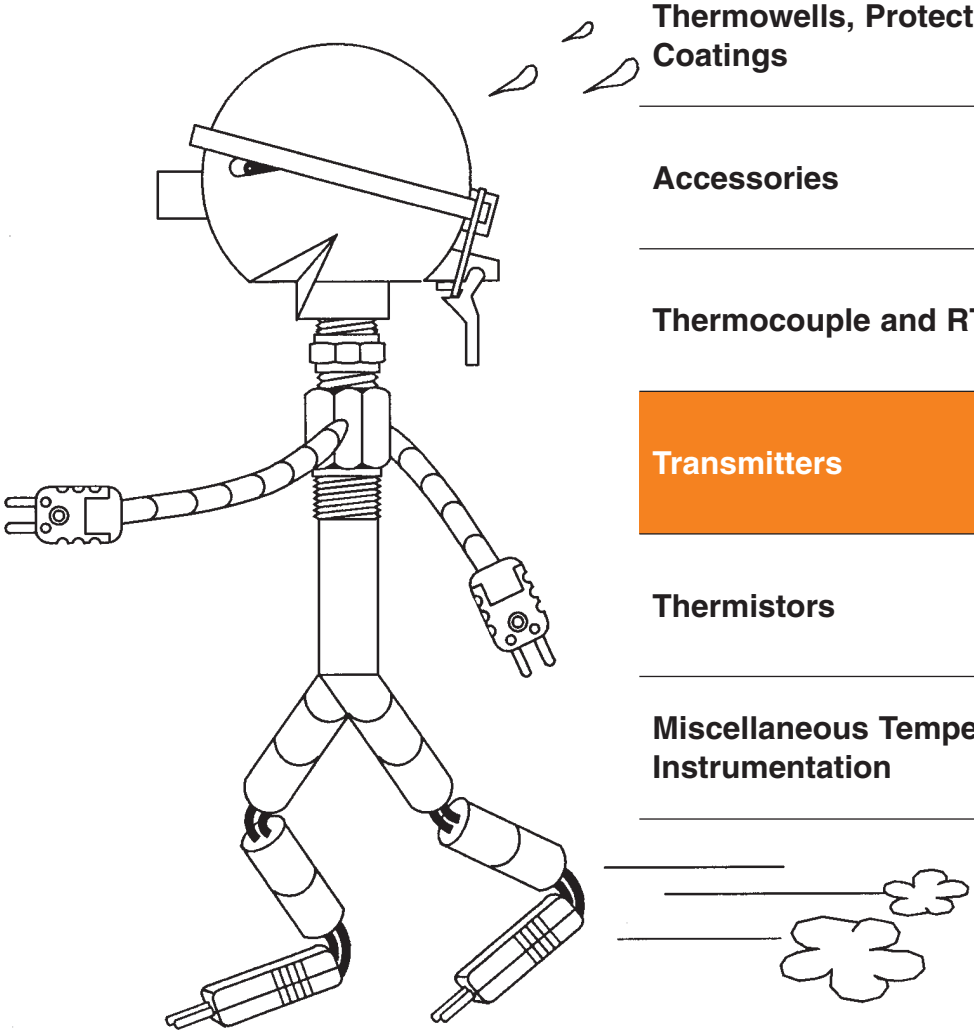
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1-800-873-1835

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Swifty Sensor



Notes

1-800-873-1835

JMS Southeast, Inc.
Temperature Measurement





Transmitters



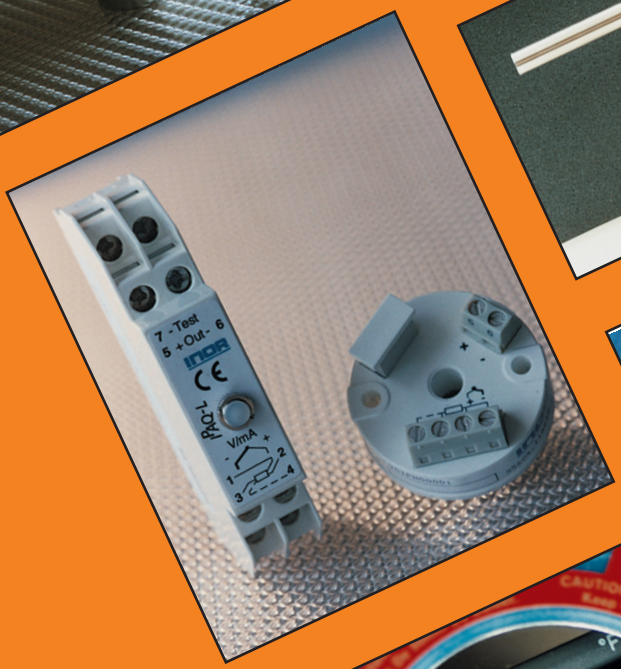


SECTION 8


TempIR
Pt100 4w 0-150°C


PERCENT
JMS SOUTHEAST, INC.
TEMPERATURE MEASUREMENT


SAF 9900
1236
VIEW SETPOINT
DECREASE
INCREASE
SP2 SP1


7 - Test
5 + Out - 6
V/mA






SAF 9900
2.16
VIEW SETPOINT
DECREASE
INCREASE
SP2 SP1
PRESS

TRANSMITTERS

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NON-ISOLATED TRANSMITTERS

JMS non-isolated transmitters can be mounted in the following JMS heads; 6L-General purpose aluminum head with hinged cover and 6I-Explosion proof head. See appropriate sensor section for complete assembly information.

JMS Southeast carries non-standard transmitters. Contact JMS for options other than those listed for the standard transmitters or for any additional information.

#1	SERIES [12, 13]
8N	Transmitter, Non-Isolated

#2	INPUT
*J	Iron/Constantan thermocouple
*T	Copper/Constantan thermocouple
*K	Chromel/Alumel thermocouple
*E	Chromel/Constantan thermocouple
*S	Platinum 10% Rhodium/Pure Platinum thermocouple
*R	Platinum 13% Rhodium/Pure Platinum thermocouple
*B	Platinum 6% Rhodium/Platinum 30% Rhodium thermocouple
*N	Nicrosil/Nisil thermocouple
*W	Tungsten/Tungsten 26% Rhenium thermocouple
3	3 wire, 100Ω, Platinum, a=.00385, RTD (3 - Wire Standard, for 2 or 4 Wire use X)
X	Other, specify

} Although non-isolated transmitters are available for thermocouples, JMS always recommends the customer use isolated transmitters for their application. See page 8-2 for isolation values to 3750 volts

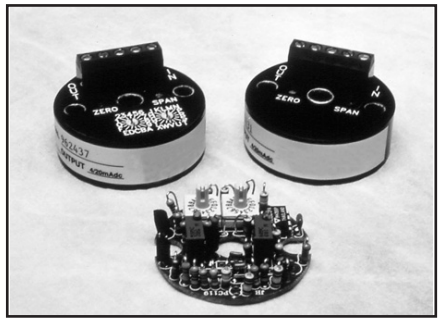
#3	TEMPERATURE RANGE
-- to --°C	List desired temperature span
-- to -- °F	List desired temperature span
X	Other, specify

#4	OUTPUT
4	4 to 20 mA
X	Other, specify

#5	MOUNTING
A	Dual mounting bracket
B	Dual mounting bracket with 12" cuttable mounting track
X	Other, specify
Z	N/A

} For panel mounting

[ ]BRACKETS INDICATE PAGE NUMBERS ON WEB OR FULL CATALOG FOR ADDITIONAL TECHNICAL INFORMATION WWW.JMS-SE.COM



8N

*All non-isolated thermocouple transmitters should be used with ungrounded junctions to prevent ground loops and noise interference.

8N	3	50-150F	4	Z	

Part Numbers Obsolete
Current Part Numbers available at
www.jms-se.com/pdf/JMS_Catalog_Intro.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

ISOLATED TRANSMITTERS

These transmitters can be mounted in the JMS explosion proof head. See appropriate sensor section for complete assembly information. Input to output isolation eliminates ground loop errors and permits direct transmission of a signal to a receiver where common mode voltages up to 3700 volts RMS may exist.

JMS Southeast also carries non-standard transmitters. Options other than those listed are available. Contact JMS for information.

#1	SERIES [14, 15, 16, 17]
8	Transmitter

#2	TYPE OF TRANSMITTER	I / O ISOLATION	HART
H	Standard TempIR	1500 VAC	No
C	CAL 9400 (See pg. 8-5, 8-6)	1000 VAC	No
A	AI-1000 (See pg. 8-8, 8-9)	500 VAC	No
S	AI-1500 (See pg. 8-10, 8-11)	500 VAC	Yes
B	AI-2000 (See pg. 8-12)	850 VAC	No
I	TempIR with Hart Protocol	1500 VAC	Yes
E	Intrinsically safe TempIR	3750 VAC	No
D	TempIR / Hart / Intrinsically safe	3750 VAC	Yes
X	Other		

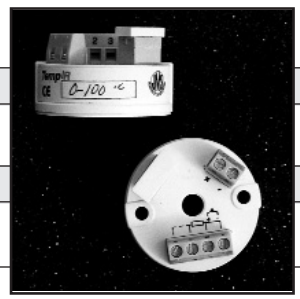
Note: H, I, & E are available in slim pack Din Rail mounting package. See WEB for details. Use "R" in front of type to specify in symbol #2.

#3	INPUT
J	Iron/Constantan thermocouple
T	Copper/Constantan thermocouple
K	Chromel/Alumel thermocouple
E	Chromel/Constantan thermocouple
S	Platinum 10% Rhodium/Pure Platinum thermocouple
R	Platinum 13% Rhodium/Pure Platinum thermocouple
B	Platinum 6% Rhodium/Platinum 30% Rhodium thermocouple
N	Nicrosil/Nisil thermocouple
W	Tungsten/Tungsten 26% Rhenium thermocouple
3	3 wire, 100Ω, Platinum, α=.00385, RTD (2 - Wire Standard. If 2 or 4 Wire use X)
X	Other, specify
Z	N/A

#4	TEMPERATURE RANGE
-- to --°C	List desired temperature span
-- to -- °F	List desired temperature span
X	Other, specify
Z	N/A

#5	OUTPUT		
4	4 to 20 mA	P	Profibus
X	Other, specify	F	Fieldbus

#6	SOFTWARE
Z	Yes - range at factory No - range at factory



8H

Part Numbers Obsolete
Current Part Numbers available at
www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

Wireless Transmitters

AVAILABLE NOW !!!

Call our Engineering Dept.
Wireless Transmitters

8	H	J	50-150°F	4	Z	

INTEGRAL TRANSMITTERS WITH HOUSING AND INDICATOR

#1	SERIES [18]
888	Transmitter (Includes housing). Use 88Z to exclude housing.

#2	TYPE OF TRANSMITTER [8-18]	STANDARD HOUSING WITH INDICATOR	
H	Isolated	RV	* See picture below
N	Non-isolated	RV	** See drawing below
A	AI-1000 (See pg. 8-8, 8-9)	G	Choose Housing Type in Symbol #7
S	AI-1500 (Hart) (See pg. 8-10, 8-11)	G	
B	AI-2000 (See pg. 8-12)	H	Note: You may also use selections from page 8-2, symbol #2.
X	Other, specify (i.e. Different housing from section 6 or customer supplied transmitters, etc.)		

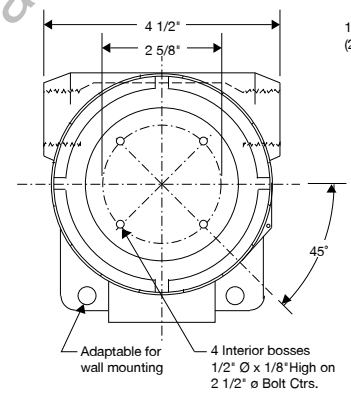
#3	INPUT
J	Iron/Constantan thermocouple
T	Copper/Constantan thermocouple
K	Chromel/Alumel thermocouple
E	Chromel/Constantan thermocouple
S	Platinum 10% Rhodium/Pure Platinum thermocouple
R	Platinum 13% Rhodium/Pure Platinum thermocouple
B	Platinum 6% Rhodium/Platinum 30% Rhodium thermocouple
N	Nicrosil/Nisil thermocouple
C	Tungsten 5% Rhenium/Tungsten 26% Rhenium thermocouple
3	3 wire,100Ω, Platinum, a=.00385, RTD (3 wire Standard, if 2 wire use X)
4	4 wire, 100Ω, Piatinum, a=.00385, RTD
X	Other, specify

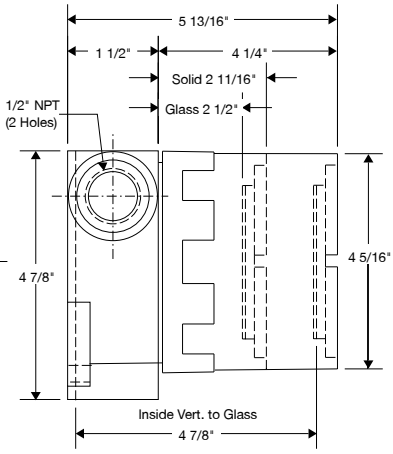
#4	TEMPERATURE RANGE
-- to --°C	List desired temperature span
-- to -- °F	List desired temperature span
X	Other, specify

#5	OUTPUT
4	4 to 20 mA
X	Other, specify

#6	INDICATION
D	Digital (Standard)
A	Analog (0 to 100% of scale is standard for analog indication. If actual temperature indication is required add an "X" and specify in description.)
Z	No indication





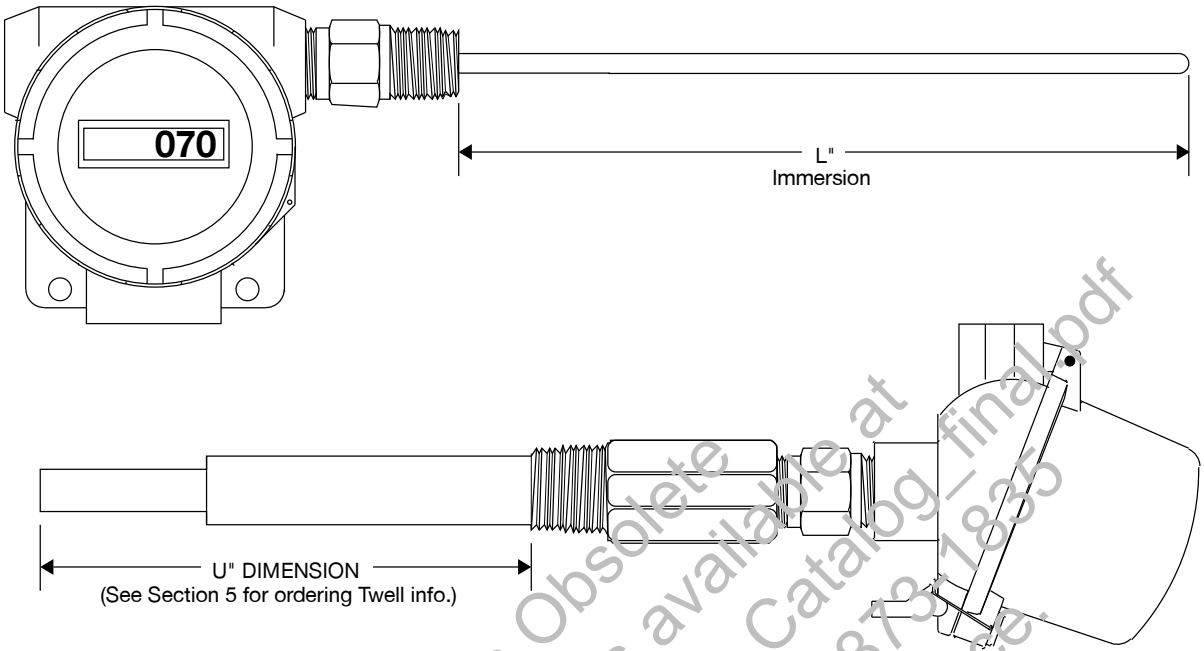


888	A	J	0-300°F	4	D	

Note: For standard thermocouple or RTD assemblies for the above transmitter see next page. Please see thermocouple, RTD or thermowell section for any assemblies other than those offered on the next page.

Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

INTEGRAL TRANSMITTERS WITH HOUSING AND INDICATOR



Part Numbers Obsolete
Current Part Numbers available at
http://www.jms-se.com/pdf/JMS_Catalog_final.pdf
or call JMS directly at 1-800-873-1835
for fast and friendly assistance.

The 888 series specified with these ordering symbols include a temperature sensor assembly with an integral transmitter and indicator.

The assemblies are 316 stainless steel and 1/4" outside diameter. Thermocouples have ungrounded junctions. RTD's have a 3 wire configuration and a 0.00385 alpha. The most popular assembly features a spring-loaded fitting with a thermowell. Although other thermowells are available, the standard well is 316 stainless steel, .260 Bore.

For assemblies other than those listed please consult the appropriate sensor section or contact JMS Southeast.

#7	HOUSING	WORKS WITH (SELECTION #2)
G	888 2 1/2" Height, Window, short dome	H, N, A & S
H	888 4 1/4" Height, Window, high dome	H, N, A, S & B
RV	High dome head w/ hinged cover & Window (6RV) Nema 4	H & N
X	Other, specify	

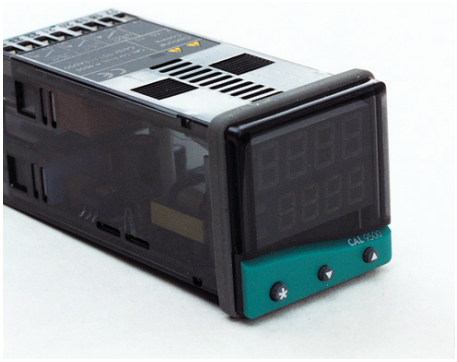
#8	FITTING TYPE { 6-13}
S	Spring loaded 1/2" x 1/2" NPT
W	Welded 1/2" x 1/2" NPT
N	Nipple-Union-Nipple - 6" (NUN6G1)
X	Other, specify
Z	N/A

#9	IMMERSION LENGTH IN INCHES (L)	THERMOWELL (U) DIMENSION
4	4"	2 1/2"
6	6"	4 1/2"
7	7 1/2"	6"
9	9"	7 1/2"
12	12"	10 1/2"
X	Other, specify	--
Z	N/A - No well necessary, or if well is already installed	

#10	THERMOWELL
A	3/4" Process thread, stepped shank (**Standard**)
B	3/4" Process thread, tapered shank
X	Other, specify
Z	N/A

R	S	6"	Z	

SECTION 8



The NEW Dual Display CAL 9500

Temperature Controller

With 4-20 mA Retransmission

Dual-display 1/16 DIN Autotune Temperature Controller with Windows™ based Charting and logging

Introducing the most versatile CAL controller of them all, featuring permanent displays of both process and setpoint temperature, together with triple outputs inviting a choice from different combinations of 4-20 mA, relay and SSR driver devices.

In addition, the CALCOMMS™ software package is designed for PC supervision of up to 32 Model 9500 controllers. It is affordable, easy to use and is an ideal way of providing temperature records for management requirements.

CAL 9500

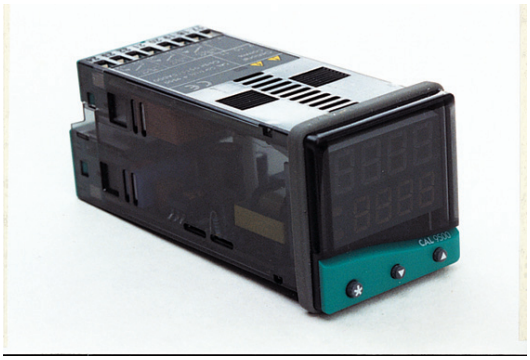
- **Dual four digit display**
- **Full PID Autotune**
- **Ramp / Soak**
- **5 Alarm configurations**
- **PID Heat-Cool**
- **Sleeve mounting**
- **3 year warranty**

CALCOMMS™

- **WindowsTM based logging and charting software**
- **Instrument configuration and remote setpoint adjustments**
- **Recipe / profile save and recall**
- **Instrument cloning**
- **Selectable scan rate**
- **Alarms**

CAL 9500

FRONT



SIDE VIEW



BACK



SPECIFICATIONS

Thermocouples

9 types	B,E,J,K,L,N,R,S,T
Standards:	IPTS68/DIN 43710
External resistance	100 Ω Maximum
CJC rejection	20:1 (0.05° / °C) typical

Resistance temperature detectors (RTD)

RTD-2/Pt 100 2 wire	
Standards:	DIN 43760 (100Ω 0°C/138.5Ω 100°C Pt)
Bulb current:	0.2mA maximum

Linear process inputs

mV range:	0 to 50mV (0to 20mV, 4 to 20mV)

Applicable to all inputs SM = sensor maximum

Calibration accuracy	±0.25% SM ± 1°C
Sampling frequency:	input 10Hz, CJC 2 sec.
Common mode rejection:	Negligible effect up to 140dB, 240V, 50-60Hz
Series mode rejection:	60dB, 50-60Hz
Temperature coefficient:	150ppm/°C SM
Reference conditions:	22°C±2°C, rated voltage after 15 minutes setting time

Output devices

SSd/SSd1/SSd2:	solid state relay driver: To switch a remote SSR 5Vdc +0/-15% 15mA non-isolated
Miniature power relay:	form A/SPST contacts (AgCdO)
r-LY and rLY1:	2A/250ac resistive load
r-LY2:	1A/250ac resistive load

General

Displays:	Upper, 4 Digits high brightness green LED. 10mm (0.4") high. Lower, 4 Digits high brightness orange LED. 9mm (0.35") high Digital range - 199 to 9999 Hi-res mode - 199.9 to 999.9
	LED output indicators - flashing SP1 square-green; SP2 round-red
Keypad:	3 full travel elastomeric push buttons

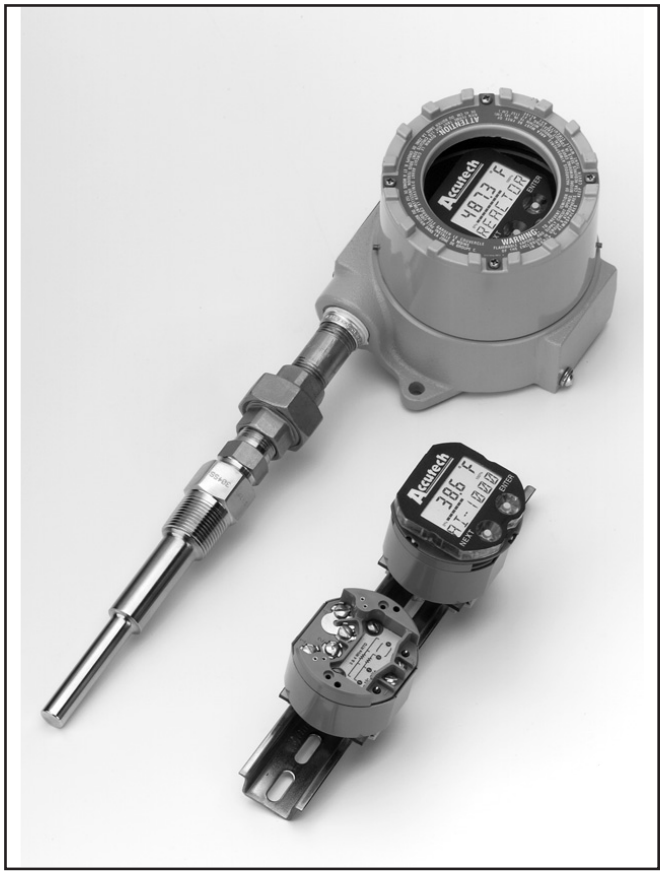
Environmental

Humidity:	Max 80%
Altitude:	up tp 2000m
Installation:	Categories II and III
Pollution:	Degree II
Protection:	NEMA 4X, IP66
EMC emission:	EN50081-1 FCC Rules 15 subpart J Class A
EMC immunity:	EN50082-2
Ambient:	0-50°C (32-130°F)
Mouldings:	Flame retardant polycarbonate

Mechanical:

	Front facia 51.0 x 51.0mm (includes gasket) Sleeve length 106.7mm (with gasket fitted) Instrument 44.8 x 44.8mm (1/16th DIN) Overall length 116.2mm
Weight:	130g (4.2oz)

Model AI-1000 Revision 2 Programmable Temperature Transmitter



The **AI-1000 R2** Programmable Temperature Transmitter combines the best features from smart and analog designs. It's fast, easy-to-use and competitively priced – like an analog transmitter. The AI-1000 R2 is microprocessor-based, highly accurate and accepts a wide variety of inputs – like a smart transmitter. Configure this transmitter with its optional plug-in display or with a PC using the windows-based Accutech Transmitter Manager software. The AI-1000 R2 accepts a wide variety of thermocouples and 2-, 3- and true 4-wire RTD measurements. Span the transmitter anywhere within the sensor's usable range – with no minimum span. Mount the AI-1000 R2 wherever you need it – head mount, yoke mount, panel or wall mount. Its versatility and compact design allow for one transmitter to fit all your needs.

Model AI-1500 HART®, Smart Temperature Transmitter



The **AI-1500** HART® Smart Temperature Transmitter offers superior performance and unmatched versatility in smart transmitter designs. Automatic self-calibration, digital ambient temperature compensation and fast update speeds put the AI-1500 ahead of the competition. Configure this smart transmitter with its optional plug-in display, an HC275 HART® Communicator or a PC using the windows-based Accutech Transmitter Manager software. Head, yoke, panel or wall mount the AI-1500 to suit any application. The AI-1500 is simply the best transmitter available in its class.

AI-1000 TEMPERATURE TRANSMITTER

Model
AI-1000 Revision 2
Programmable Temperature Transmitter

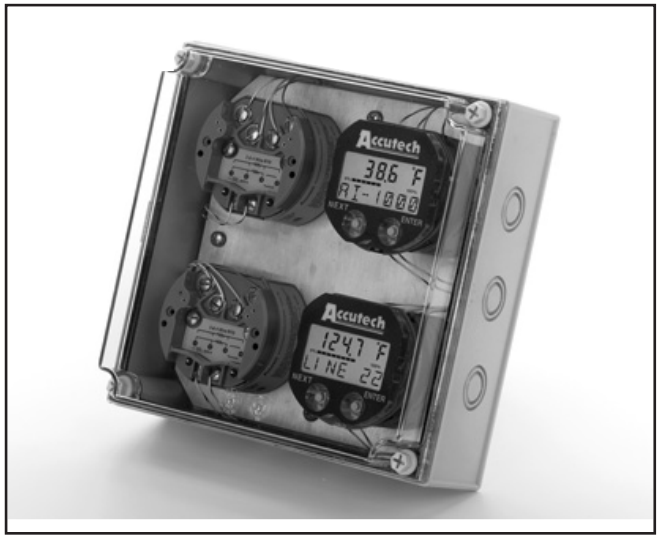
Highlights

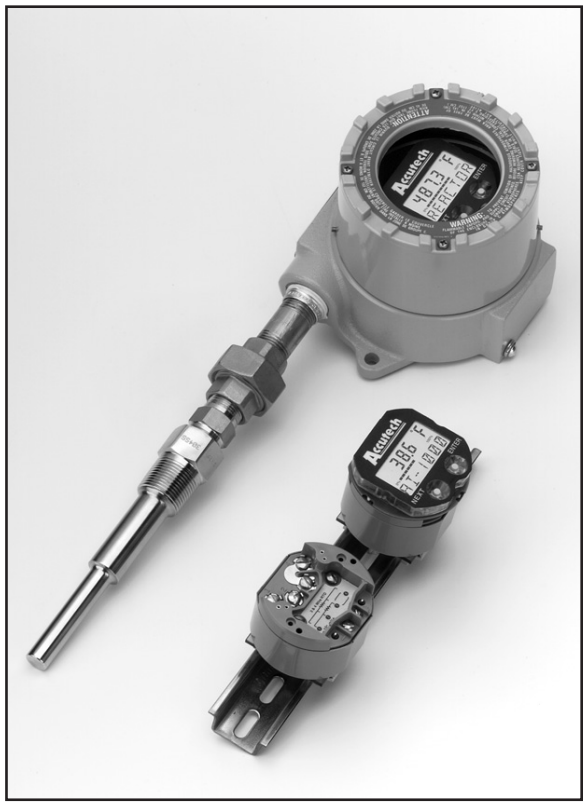
- **Exceptional Speed and Accuracy**
- **Guaranteed Measurement Stability**
- **Automatic Self-Calibration**
- **Automatic Cold-Junction Compensation**
- **Digital Ambient Temperature Compensation**
- **Accepts virtually any Thermocouple or RTD**
- **Set-up is fast and easy, no hand-held required**
- **Display Mode or PC Configuration**
- **Competitive Pricing**
- **Total Installation Flexibility**

The Accutech AI-1000 Revision 2 Programmable Temperature Transmitter combines the best features of analog and smart designs. It's fast, accurate, versatile and easy-to-use. It will give substantial benefits in a wide range of process industry applications.

Exceptional Capabilities
Capabilities that were once available only in high-priced "Smart" transmitters are now available in the compact, competitively priced AI-1000 R2.

Exceptional Long-term Stability
Accutech pioneered technology for automatic self-calibration. This capability is now available in a compact field transmitter. Automatic self-calibration to on-board reference standards increases measurement reliability and significantly reduces maintenance costs. The digital ambient temperature compensation virtually eliminates ambient temperature drift.





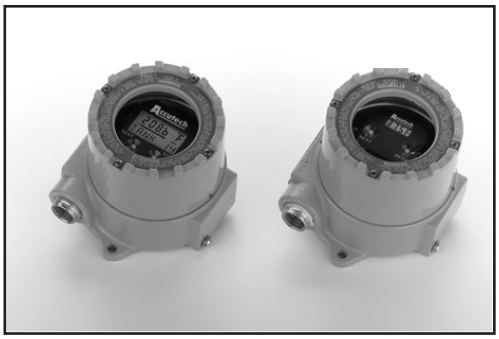
The AI-1000 R2 measurement stability exceeds all transmitters in its price class.

Tremendous Versatility
A single AI-1000 R2 transmitter will take virtually any thermocouple, RTD, millivolt or ohm input. It will give you linearized output over any part of the sensor range. The AI-1000 R2 allows you to dramatically reduce inventory and spare parts. You can configure it exactly the way you want. You can even re-configure the transmitter as your needs change! You do not need to stock two transmitter types, one for field mounting and one for panel mounting. One AI-1000 R2 will do it all.

Optional Plug-In Display and Set-Up Tool
The unique, time and cost-saving display options allow you to program and read any AI-1000 R2. No hand-held terminal is required. If you do not need the local read-out, you can unplug the display once you have completed the set-up. You can take it with you!



AI-1000 SPECIFICATIONS





AI-1000 Revision 2 Specifications

Thermocouple Sensors:

NIST Types B, C, E, J, K, N, R, S, & T; DIN Types L & U

RTD Resistance Sensors:

100Ω	Pt DIN curve (α=0.00385)	2, 3 or 4 wire
100Ω	Pt SAMA RC21-4 curve (α=0.003923)	2, 3 or 4 wire
100Ω	Ni DIN curve*	2, 3 or 4 wire
120Ω	Ni MINCO curve*	2, 3 or 4 wire
10Ω	Cu Curve CR228/229*	2, 3 or 4 wire

* PC Configuration

Millivolt Input Range: -15 to +115 mV DC

Thermocouple and RTD Linearization: Linear output with temperature conforms to NIST and DIN curves within ±0.05 °C.

Custom Linearization: Programmable, up to 22 points.*
* PC Configuration

Output: Two wire, 4-20mA

Output Ranging Adjustments:

Analog Zero: 100% of sensor range – Non-interacting
Analog Full-scale: Normal or Reverse acting

Minimum Output Span: None.

Output Resolution: 3.6μA

Transmitter Accuracy: Includes transmitter repeatability and hysteresis effects, rated under reference conditions of 24 °C with a supply voltage of 30 VDC.

Digital Accuracy: ±0.025% of the millivolt or ohm equivalent input reading, or the accuracy from the EGU Equivalent Table, whichever is greater. For thermocouples, add ±0.5 °C for cold junction measurement effect.

D/A Conversion: ±0.06% of the output span.

Analog Accuracy: Sum of the Digital and the D/A conversion errors.

Repeatability: Half of the digital accuracy value.

EGU Equivalent Table

T/C Types	Accuracy	RTD Sensors	Accuracy
B	±0.6 °C	100Ω Pt	±0.08 °C
C, R, S	±0.5 °C	100Ω Ni	±0.08 °C
E,J, K, N	±0.2 °C	120Ω Ni	±0.08 °C
L	±0.4 °C	10Ω Cu	±0.6 °C
T (> -150 °C)	±0.3 °C		
U (> -100 °C)	±0.4 °C		
Millivolt input	±0.006 mV	Ohm input	±0.002 Ω

Dynamic Response:

Start-up Time: 7 seconds.

Ambient Temperature Gradient: Automatic Compensation to 20 °C per hour change.

Update Time: 0.15 second.

Response to Step Input: 0.25 second, minimum; 1 second, typical.

Cold Junction Compensation: Self-correcting to ±0.5 °C

Ambient Operating Temperature: -40 to 85 °C (-40 to 185 °F)

Ambient Storage Temperature: -40 to 85 °C (-40 to 185 °F)

Ambient Temperature Stability: Self-correcting over the operating temperature.

Long Term Stability: Less than 0.05% of reading plus ±3.6μA per year.

Automatic Diagnostics: Every 3 seconds, self-checks for zero, span, cold junction temperature, sensor and transmitter malfunction.

Failsafe: User selectable; 3.6mA, 23mA, or OFF.

Interchangeability: All units interchangeable without field calibration.

EMI / RFI Immunity:

Operating Conditions: Industrial Environment
Immunity According to: EN 50082-1[1]
IEC 100-4-3 30 V/m 80-1000MHz
Emission According to: EN 55011, Group 1, Class A
EN 50081-2

Isolation: 500 VAC

Common Mode Rejection: 120 dB

Reverse Polarity Protection: 42 VDC applied with either polarity.

Power and Load:

Supply Voltage (no load): 12 to 42 VDC (30 VDC for I.S.)
Supply Voltage (with load): V_{Supply} = (12) + (R_{Load} in KΩ) x (23mA)
Supply Voltage Effect: Less than ±0.005% of Span/Volt.

Approvals: FM/CSA Non-Incendive rating. Intrinsic Safety optional.

Dimensions: Diameter: 2.35"
Height: 1.55" (with DK-1 or DK-2: 1.95")

Weight: 6 oz. (Electronics module only)

Standard Configuration: Type J T/C input. Analog output, 40 to 200 °F. HI failsafes. Configuration parameters may be field programmed via Display Mode with optional DK-1 or DK-2 Display / Keyboards or with a PC using an LSK Modem and Accutech Transmitter Manager Software. See Price List.

Options: Displays, Enclosures, Sensors, and Thermowells available from Accutech. See Price List.

Specifications subject to change without notice.

AI-1500 TEMPERATURE TRANSMITTER

Model AI-1500 HART®, Smart Temperature Transmitter



The Accutech AI-1500 Smart Temperature Transmitter is unique. It's easy to use and moderately priced - like an analog transmitter. It's also versatile, linear, and based on microprocessor logic.

The exceptional versatility of the AI-1500 not only lets you configure your transmitters exactly the way you want them; it also dramatically reduces back-up stock and spare parts. The AI-1500 is fully HART®, compliant and can be used with any HART®, compliant device (such as the HC275 HART®, Communicator).

Superior Performance

- **Exceptional Speed and Accuracy**
- **Guaranteed Measurement Stability**
- **Automatic Self-Calibration**
- **Automatic Cold-Junction Compensation**
- **Digital Ambient Temperature Compensation**

Unmatched Versatility

- **Accepts virtually any Thermocouple or RTD**
- **Fully HART® Compliant**
- **Suitable for Field or Panel Mounting**

Simple Operation

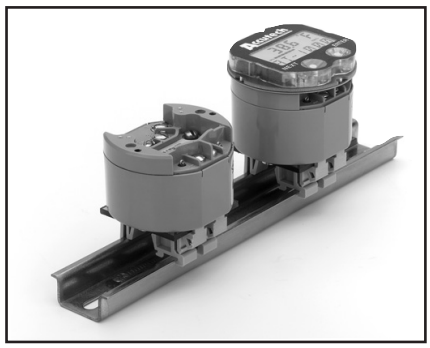
- **Fast and Easy Set-up**
  - **– Use Hand-held, Display, or PC**
- **Optional Plug-In LCD Displays**

The AI-1500 can be mounted in explosion proof and weatherproof enclosures, as well as on a DIN rail for panel mounting applications. Local indication can be added at any time by simply plugging in one of the two optional displays. One transmitter on the shelf can back up the needs of an entire facility.

Automatic self-calibration every three seconds to on-board reference standards increases process measurement reliability and significantly reduces ongoing maintenance costs. Digital ambient temperature compensation completely characterizes each transmitter for performance in ambient environments from -40 to +185 °F, resulting in greatly reduced measurement drift.

In direct comparisons, the AI-1500 offers dramatically improved performance and outstanding value over competitive analog, programmable, and smart transmitters. Its stability, accuracy, versatility, reliability, and ease-of-use yield real benefits in process industry applications.

For over ten years, we have had a single focus - building the finest microprocessor-based industrial process instrumentation. This dedication to and knowledge of the industrial environment is built into every Accutech product. As a result, the AI-1500 is not only the best temperature transmitter available, the price and delivery are unmatched.



AI-1500 SPECIFICATIONS

SENSOR INPUT	RANGE, °F	ACCURACY	RANGE,°C	ACCURACY
Thermocouple Type B	+ 109 to + 3,308 °F	± 0.99 °F	+ 43 to + 1,820 °C	± 0.55 °C
Thermocouple Type C	+ 32 to + 4,208 °F	± 0.72 °F	0 to + 2,320 °C	± 0.40 °C
Thermocouple Type E	- 454 to + 1,832 °F	± 0.18 °F	- 270 to + 1,000 °C	± 0.10 °C
Thermocouple Type J	- 346 to + 2,129 °F	± 0.27 °F	- 210 to + 1,200 °C	± 0.15 °C
Thermocouple Type K	- 454 to + 2,502 °F	± 0.27 °F	- 270 to + 1,372 °C	± 0.15 °C
Thermocouple Type L	- 328 to + 1,652 °F	± 0.27 °F	- 200 to + 900 °C	± 0.15 °C
Thermocouple Type N	- 454 to + 2,372 °F	± 0.36 °F	- 270 to + 1,300 °C	± 0.20 °C
Thermocouple Type R	- 58 to + 3,214 °F	± 0.81 °F	- 50 to + 1,768 °C	± 0.45 °C
Thermocouple Type S	- 58 to + 3,214 °F	± 0.90 °F	- 50 to + 1,768 °C	± 0.50 °C
Thermocouple Type T	- 454 to + 752 °F	± 0.18 °F	- 270 to + 400 °C	± 0.10 °C
Thermocouple Type U	- 328 to + 1,112 °F	± 0.18 °F	- 200 to + 600 °C	± 0.10 °C
100Ω Platinum RTD DIN Curve (α = 0.00385)	- 328 to + 1,562 °F	± 0.09 °F	- 200 to + 850 °C	± 0.05 °C
100Ω Platinum RTD SAMA Curve (α = 0.003923)	- 328 to + 1,202 °F	± 0.09 °F	- 200 to + 650 °C	± 0.05 °C
Call Factory for 100Ω Ni, 120Ω Ni, and 10Ω Cu				
Millivolt	- 15 to 115mV	± 0.006 mV		
Ohm	0 to 500 Ω	± 0.002 Ω		

TRANSMITTER ACCURACY: ± 0.01% of the millivolt or ohm equivalent input reading, or the value from the Accuracy Table, whichever is greater; plus ±0.04% of the span. For thermocouples, add ±0.5°C (0.9∞F) for cold junction effect.
Accuracy includes transmitter repeatability, hysteresis and linearity as well as A/D conversion error, analog output error, line voltage effects, humidity effect under non-condensing conditions, vibration effect to 2g's & 500Hz.

TRANSMITTER AMBIENT TEMPERATURE EFFECT:
One-half the transmitter accuracy per 28°C (50°F)

TRANSMITTER REPEATABILITY: One-half the transmitter accuracy.

COLD-JUNCTION COMPENSATION: Digital self-correcting over the ambient temperature range to ±0.5°C.

LINEARIZATION: Thermocouple and RTD linearization to ±0.05°C. Custom linearization with 22 point curve via HART® Communications.

OUTPUT: Analog, Two wire 4 to 20mA.
Digital, HART, simultaneous communication

OUTPUT RANGING ADJUSTMENTS:
Analog Zero: 100% of Sensor range – Noninteracting
Analog Full-scale: Normal or Reverse Acting

LONG TERM STABILITY: Stability deviation per year is less than: (0.04% of output the span + 0.05% of the millivolt or ohm equivalent reading)

OPERATING TEMPERATURE RANGE:
-40°C to +85°C -40°F to + 185°F Electronics
-20°C to +70°C - 4°F to + 158°F Display (Full Visibility)
-40°C to +85°C -40°F to + 185°F Display (With reduced visibility)

STORAGE TEMPERATURE RANGE: -50°C to +85°C; -58°F to +185°F

DAMPING: User selectable time constant (63%) from 0 to 32 sec.

FAILSAFE: User settable from 3.6mA or 23mA.

MOUNTING POSITION: No effect on measurement value.

WEIGHT: AI-1500: 6 oz. XP-FN & FG: 2_ lbs. WP-HEAD: 12 oz

ISOLATION: Input to Output 500VAC

INPUT IMPEDANCE: Greater than 1 MΩ

POWER SUPPLY: The transmitter operates on 12 to 42 VDC (30VDC for I/S installations) with no load. Transmitter is protected against reverse polarity connection.

LOAD LIMITATIONS: Loop resistance including optional indicator:
R(KΩ) = (Supply Voltage - 12 VDC) / (23mA)

INTERCHANGEABILITY: Fully interchangeable without field calibration

ELECTROMAGNETIC COMPATIBILITY (CE COMPLIANCE):
Transmitter operates within specification in fields from 20 to 1,000MHz with field strengths to 30V/m. Meets EN 50082-1 Generic Immunity Standard and EN 55011 Compatibility Emissions Standard.

DYNAMIC RESPONSE:
UPDATE RATE: 150 milliseconds (7 times per second), typical.
RESPONSE TO STEP CHANGE: 250 milliseconds, minimum; 1 second, typical.
START-UP TIME: 7 sec. Operation to specification less than 30 sec.
AMBIENT TEMPERATURE CHANGE: Self-correcting for ambient temperature changes up to 20°C/hr.

HAZARDOUS LOCATION CERTIFICATIONS:
Explosion Proof: Explosion Proof Housings available with and without windows; CSA and FM approved for Class I, Div I & Div II, Groups B, C, & D; Class II, Div I & II, Groups E, F & G, Class III and are rated for NEMA 4X and NEMA 7 environments.
Nonincendive: Transmitter is CSA and FM rated nonincendive in Class I, Div II, Groups A, B, C & D; Class II, Div II, Groups F & G, Class III, Div II, CENELEC Ex N IIC T4-T6 certification pending.
Intrinsic Safety: The Intrinsically Safe Rated Model AI-1500 I/S is CSA and FM rated Intrinsically Safe for Class I, Div I, Groups A, B, C & D & Class II, Div I, Groups E, F, & G, & Class III, Div I, when installed per AIC Drawing 6022588, Rev A. See manual for details.
CENELEC EEx ia IIC T4-T6 Intrinsically safe certification pending.

OPTIONS:
INTRINSIC SAFETY: Order the AI-1500 I/S
HOUSINGS:
XP-FN: NEMA 7 Explosion-Proof, NEMA 4X Housing
XP-FG: NEMA 7 Explosion-Proof, NEMA 4X with Window
XP-HEAD: NEMA 7 Explosion-Proof, Rain-tight Head
WP-HEAD: IP66 Weatherproof Head
DISPLAYS:
DK-1: One-Line Local Display and Keyboard
DK-2: Two-Line Smart Local Display and Keyboard
THERMOWELLS: Order as required. See Accutech Bulletin PROB
SENSORS: Order as required. See Accutech Bulletin PROB
EXPLOSION-PROOF CERTIFICATION: Consult factory for details
MOUNTING: PY-2 2" Pipe Yoke for XP-FN & XP-FG housings
DIN-KIT R2 DIN Rail Mounting Adapter

STANDARD CONFIGURATION:
Sensor Input J Type Thermocouple
LRV (4mA) 40°F Lower Range Value
URV (20mA) 200°F Upper Range Value
Damping 0 seconds
Output Linear with Temperature
Failsafe Upscale (23mA)

ORDERING INFORMATION: Please order Model AI-1500.
Specify custom configuration, options and companion products as desired.

NOTE: Please note that specifications are determined with the factory default software settings or with the various software parameters set to optimize the performance for a given specification.

HART® is a registered trademark of HART Communications Foundation.
Specifications subject to change without notice.

AI-2000 TEMPERATURE TRANSMITTER

Model
AI-2000 Revision 4
Smart Temperature Transmitter

Highlights

- **Guaranteed Measurement Stability**
- **Digital Ambient Temperature Compensation**
- **Automatic Self-Calibration**
- **Two Year Calibration Warranty**
- **Accepts virtually any Thermocouple or RTD**
- **Local and Remote Communication**
- **No need for Software Upgrades**
- **Explosion Proof Head or Pipe Mounting**
- **DIN Rail mounting capabilities**
- **Meets highest performance accuracy requirements**
- **Truly Smart – Use Smart Communications® or Display Mode Configuration**
- **21 point custom linearization capabilities**
- **RTD-CAL available for industry leading system accuracy**

The AI-2000 Rev. 4 was introduced in 1991 and set the standard for accuracy and stability for temperature measurement in industrial process applications. Its automatic self-calibration and digital ambient temperature compensation has been unrivaled in the process instrumentation marketplace. The AI-2000 Rev. 4 was the first transmitter to offer a 2 year calibration guarantee traceable to NIST standards. Now, the AI-1500 extends this same unique guarantee to three years.



Hundreds of process facilities worldwide depend on the AI-2000 Rev. 4 for their critical temperature measurements. The Stability, Accuracy, Versatility and Ease-of-use of the AI-2000 Rev. 4 allows process facilities to make better products. Off-the-shelf delivery and competitive pricing give customers the flexibility and confidence to standardize on the AI-2000 Rev. 4 Smart Temperature Transmitter.

AI-2000 Rev. 4 Specifications:

DIGITAL OUTPUT ACCURACY: ±0.04% of the millivolt or ohm equivalent reading, or the accuracy from the table below, whichever is greater, plus the effect of a cold junction measurement error of ±0.25°C (±0.45°F) if using a thermocouple sensor.

INPUT	DIGITAL ACCURACY		INPUT	DIGITAL ACCURACY	
B T/C	±0.8°C	±1.44°F	S T/C	±0.6°C	±1.08°F
E T/C	±0.2°C	±0.36°F	T T/C	±0.2°C	±0.36°F
J T/C	±0.2°C	±0.36°F	Millivolt	±0.008 mV	
K T/C	±0.2°C	±0.36°F	Pt RTD DIN	±0.1°C	±0.18°F
N T/C	±0.2°C	±0.36°F	Pt RTD (US)	±0.1°C	±0.18°F
R T/C	±0.6°C	±1.08°F	Ni RTD	±0.1°C	±0.18°F

LINEARIZATION: Thermocouple and RTD linearization to ±0.05°C. Custom linearization user programmable at 21 points.

OUTPUT: Analog, Two-wire 4 to 20mA
Digital, Two-wire (RS-232, 300 baud with CA-100 adapter)

OUTPUT RANGING ADJUSTMENTS:

Analog Zero:	100% of Sensor range – Noninteracting
Analog Full-scale:	Normal or Reverse Acting
Digital Mode:	°C, °F, °K, °R, mV (no ranging req'd)

ANALOG ACCURACY: Digital accuracy plus ±4 μA

REPEATABILITY: One-half the respective accuracy

DYNAMIC RESPONSE:
Turn-on Time: Less than 5 seconds after power-up
Ambient Temperature Gradient: Automatic compensation to 20°C/hour change
Update Time: 0.15 second; Digital, 1 second
Response To Step Input: Analog; 0.25 second, typical Digital; 1 second,
typical, to 95% of final value, 5 seconds, to stated accuracy

COLD JUNCTION COMPENSATION: Automatic correction to ±0.25°C

AMBIENT OPERATING TEMPERATURE: -40 to+167°F (-40 to +75°C)

AMBIENT STORAGE TEMPERATURE: -58 to+185°F (-50 to +85°C)

AMBIENT TEMPERATURE STABILITY: Self-correcting over the ambient
Temperature

LONG TERM STABILITY: Less than 0.5% of reading plus ±2.1 mA per year

AUTOMATIC DIAGNOSTICS: Every 3 seconds, self-checks for zero, span, cold junction, calibration references, malfunction, and sensor failure

EMI/RFI IMMUNITY: Less than 0.5% of reading (SAMA PMC 33.1c test method) 20 kHz to 1000 MHz, 10 V/meter

ISOLATION: 850 VDC or peak AC

WARRANTY: 2 Year NIST Traceable Guarantee with Certificate of Conformance

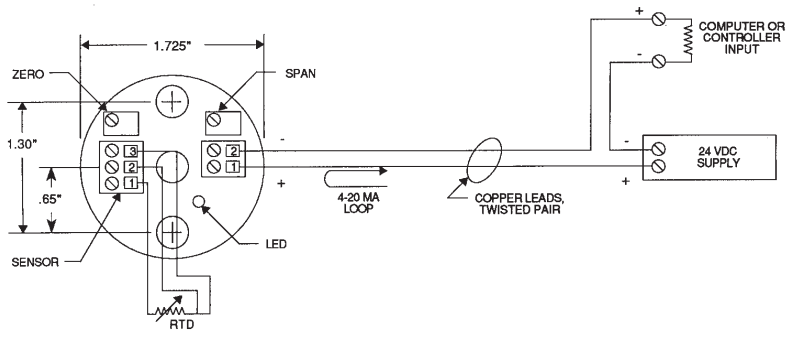
Specifications subject to change without notice.

NON-ISOLATED TRANSMITTERS

The series N transmitter is a non-isolated 2 wire temperature transmitter. The transmitters are completely potted in a special epoxy with only the screw terminals exposed. **Specification of two wire non-isolated transmitters are as follows:**

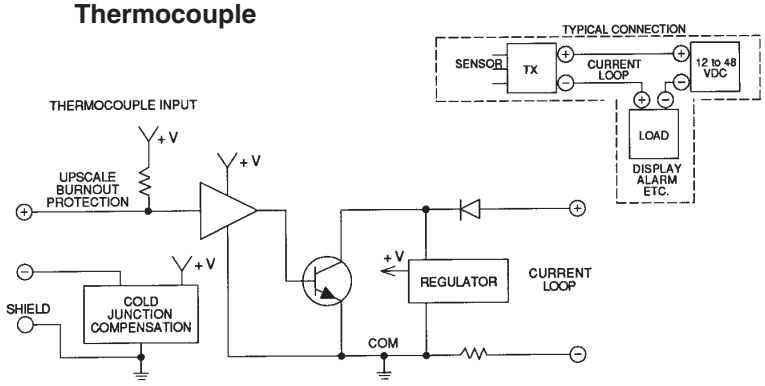
OUTPUT:
4/20mA, two-wire (loop-powered) output
ACCURACY:
±0.1% of span or better (factory calibration)
OPEN INPUT:
Offscale high output (T/C, RTD only)
TEMPERATURE:
±(0.02% + 1uV/°C or better
STABILITY:
-40 to +80°C (-40 to 176°F)
POWER:
Loop Powered. 12V min, 36V max at output
INPUTS:
DC spans 2mV to 250V, or 1 to 100mA current thermocouple minimum span

Installation Instructions:



Block Diagrams and Terminal Connections

Thermocouple



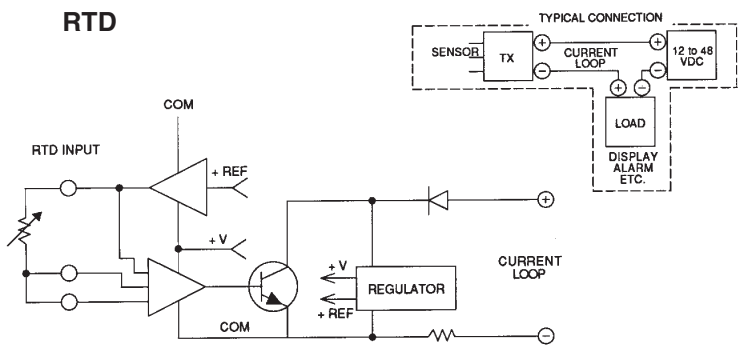
Series: 8N

Wiring: For a thermocouple input, the first two terminals looking at the transmitter from the front, are for the (+) and (-) output signal. The thermocouple shield, if used, should be connected to the third terminal from the left. The (-) negative thermocouple lead (usually red), should be connected into the fourth terminal. The (+) positive thermocouple lead should be connected to the fifth terminal.
<u>This transmitter is not recommended for grounded thermocouples.</u>

Series: 8N

For an RTD input, the power supply and output are connected on terminals one and two as described above. The negative/common leads (red) should be connected to terminals 2 and 3. The positive (white) lead should be connected to terminal 1.

RTD



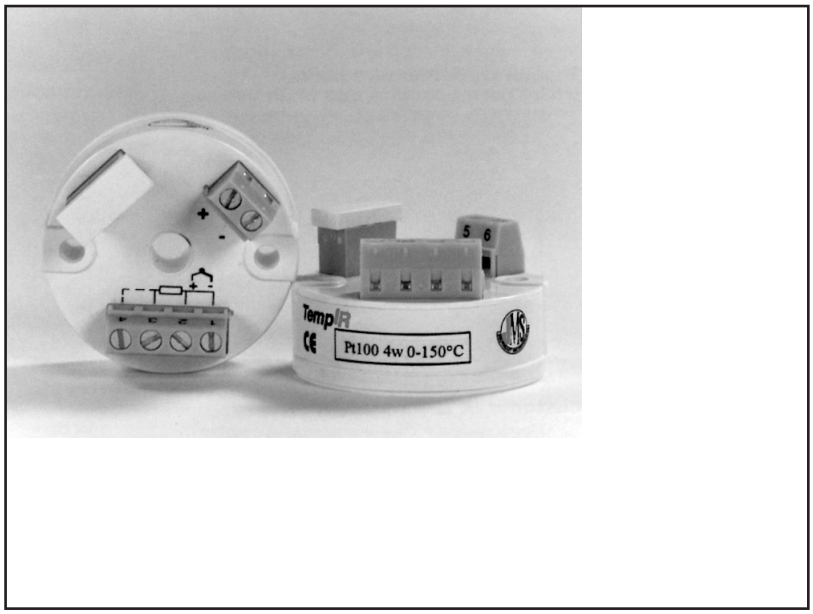
SECTION 8

ISOLATED TRANSMITTERS

The JMS 8H, I, and E series isolated transmitter (TempIR) is a 2-wire loop-powered intelligent transmitter. Small size and extreme versatility makes the TempIR an ideal choice for all industrial instrumentation. The transmitter is manufactured for inputs from a wide range of RTD's, thermocouples, plain mV, and resistance. A customized linearization can easily be generated.

A wide power supply range allows for high load in the output loop, e.g. long output leads and multiple instruments. TempIR is configured with TemPRO, the general software to configure the entire temp-family. The program is Windows driven and easy to use. The configuration can be performed on-line, with in and outputs connected. While receiving new parameters, the transmitter will freeze the output signal and return to normal operation after completed transmission of the new parameters.

The 8H series transmitters are microcontroller based and do multiple measurements beyond the standard measurements. One of these controls is to monitor the isolation resistance of the sensor and the sensor leads. This function named, TempIRsense, is available for thermocouples and 3-wire RTD's (see page 8-25 and 8-26 for a technical note).



Performance and design:

- **Excellent stability**
  Long-term stability 0.1% / year.
- **Enhanced total system accuracy**
- **Input-output isolation 1500 VAC**
  Eliminates measuring errors due to ground loops.
- **High load capacity**
  Only 6.5 V voltage drop over the transmitter allows for high loads.
- **Designed for harsh conditions**
  Operation temperature: -40 to +85°C, -40 to +185°F.
  Excellent EMC performance.
  Durable, shockproof design.
- **Simplified mounting and connection**
  For DIN B head or larger.
  Large center hole (dia. 7mm / 0.28 inch).

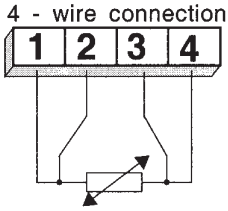
Standard Inputs for:

- **RTD's, Thermocouples, mV and resistance**
  Reduced inventory costs.
  Simplified plant engineering.
- **True on-line configuration**
  Full access to all features while in operation.
- **Customized 40 point linearization**
- **TempIRsense, unique monitoring of insulation resistance**
  Detects low sensor isolation (see below).
  Selectable sensor break action.
- **Simplified loop check-up**
  The transmitter works as an accurate current generator.
- **Easy to configure**
- **On-screen indications and line recording**
  Valuable tools for temporary measurements.

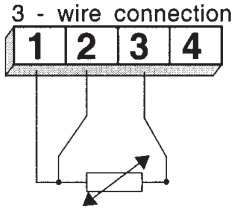
INPUTS

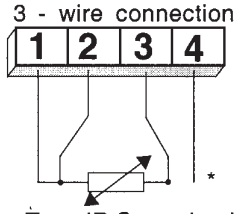
RTD

Pt100, Pt1000, Ni100, Ni1000, PtX, D100
4 - wire connection



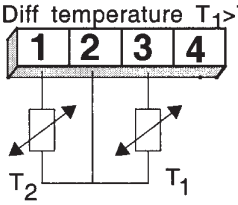
Pt100, D100
3 - wire connection





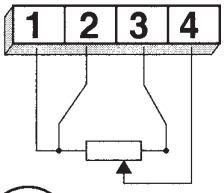
* TempIR Sense lead

Pt100
Diff temperature $T_1 > T_2$

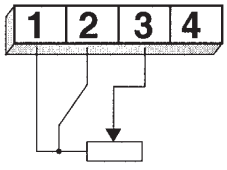


Potentiometer

4 - wire connection

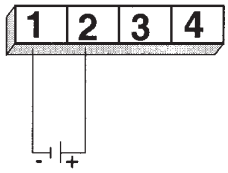


3 - wire connection



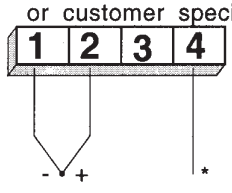
Voltage

millivolt



Thermocouple

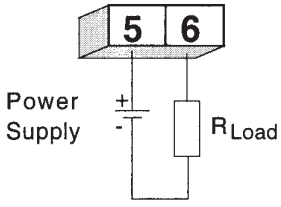
AE, B, E, J, L, N, R, S, T, U
or customer specific



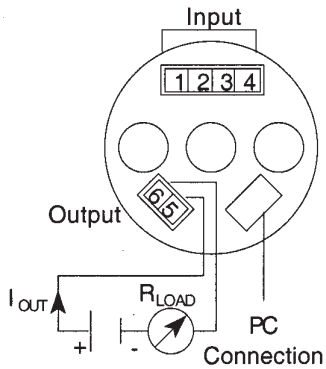
* TempIR Sense lead

OUTPUT

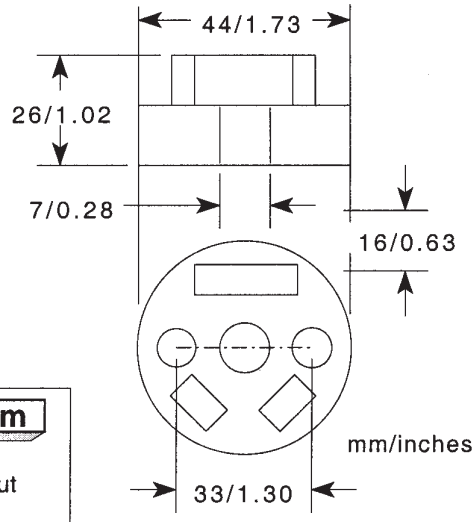
4-20mA Output



Connections

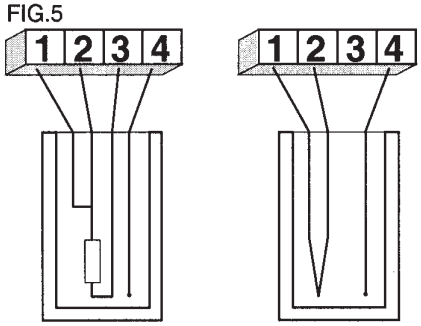


Dimensions



Dimensions

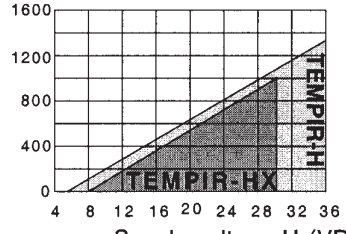
FIG.5



* TempIR Sense

Output load diagram

FIG.6
Permissible R_{LOAD} at 22 mA output



$R_{LOAD} = (U-6.5)/0.022$ (TEMPIR - H)
$R_{LOAD} = (U-8)/0.022$ (TEMPIR - HX)

Specifications

Pt100	3, 4 wire	-200 to +1000°C -328 to +1832°F
Pt1000	3, 4 wire	-200 to +200°C -328 to +392°F
Ni100	3, 4 wire	-60 to +250°C -76 to +482°F
Ni1000	3, 4 wire	-60 to +150°C -76 to +302°F
Potentiometer	3, 4 wire	0 - 2000Ω
Sensor Current		approx. 0.4mA
mAx. Permissible Lead Resistance		25 Ω/lead

T/ C	B, E, J, K, L, N, R, S, T, U
Voltage Input	-10 -500 mV
Input Resistance	>10 Mohm
Total permissible lead resistance for both input leads	500 ohms

	User definable settings
Sensor break detection	3.5 - 22.8 mA
TempIRsense, sensor isolation monitoring	3.5 - 22.8 mA

Zero adjustments		no limitation
Minimum ranges	Pt100, Pt1000	
	Ni100, Ni1000	10°C, 18°F
	Potentiometer	10Ω
	T/C, mV	2 mV

Straight, reversed or any intermediate value	4 - 20 mA
Resolution	5μA
Min output signal	appr. 3.5mA
Max output signal	appr. 23 mA

Selectable filter time for low pass filter	0-60 s
Scan time	appr. 0.5 s
Rise time 10 -90 %	appr. 0.3 s
Transformer Isolation In- Out	1500 VAC 1 min

Power supply polarity protected	6.5-36 VDC 10-36 VDC

Linearity	RTD, mV T/C	0.05%[1] 0.1%[1]
Calibration	Pt100, Pt1000 Ni100, Ni1000 Potentiometer mV, T/C	The larger of 0.1°C 0.2°F or 0.05%[1] The larger of 0.1Ω or 0.5%[1] The larger of 20μV or 0.05%[1]
Cold Junction Compensation	T/C	0.5°C, 0.9°F
Temperature Drift		The larger of 0.005 °C/°C, 0.005 °F/°F or 0.005 %/°C, 0.003%/°F
Cold Junction Compensation	T/C	0.02°C/°C, 0.02°F/°F
Lead Wire Resistance Influence:		
RTD 3-wire		See Table 1
RTD 4-wire		negligible
Thermocouple		negligible
Load influence		negligible
Power supply influence		negligible
Long term drift, 25°C, 77°F		typ 0.1%[1]/year

Ambient Temperature	-40 to +85°C -40 to +185°C

Emission, EN 50081-2 Industrial Environment	30-230 MHz, 30dB (μV/m) 230-1000MHz, 37dB (μV/m)
Immunity, EN50082-2 Industrial Environment	RF, air, 80-1000MHz, AM RF, air, 900 MHz, pulse modulated (GSM cellular telephone) RF, cables, 0.15-80 MHz, ESD 4kV contact, 8kV contact, 8kV air discharge Fast transients, cables, 2kV
HF immunity tested for 10v/m	up to 1000MHz

Material	PC +ABS, UL V0
Mounting	DIN B-head or larger
Weight	appr. 50g

[1] selected maximum signal

ISOLATED TRANSMITTERS

The JMS 8H, I, and E are available in a Universal Intelligent 2-wire DIN Rail Transmitter. The combination of competitive pricing, functionality and simple configuration has made these DIN rail transmitters the leading transmitter for industrial temperature measurements.

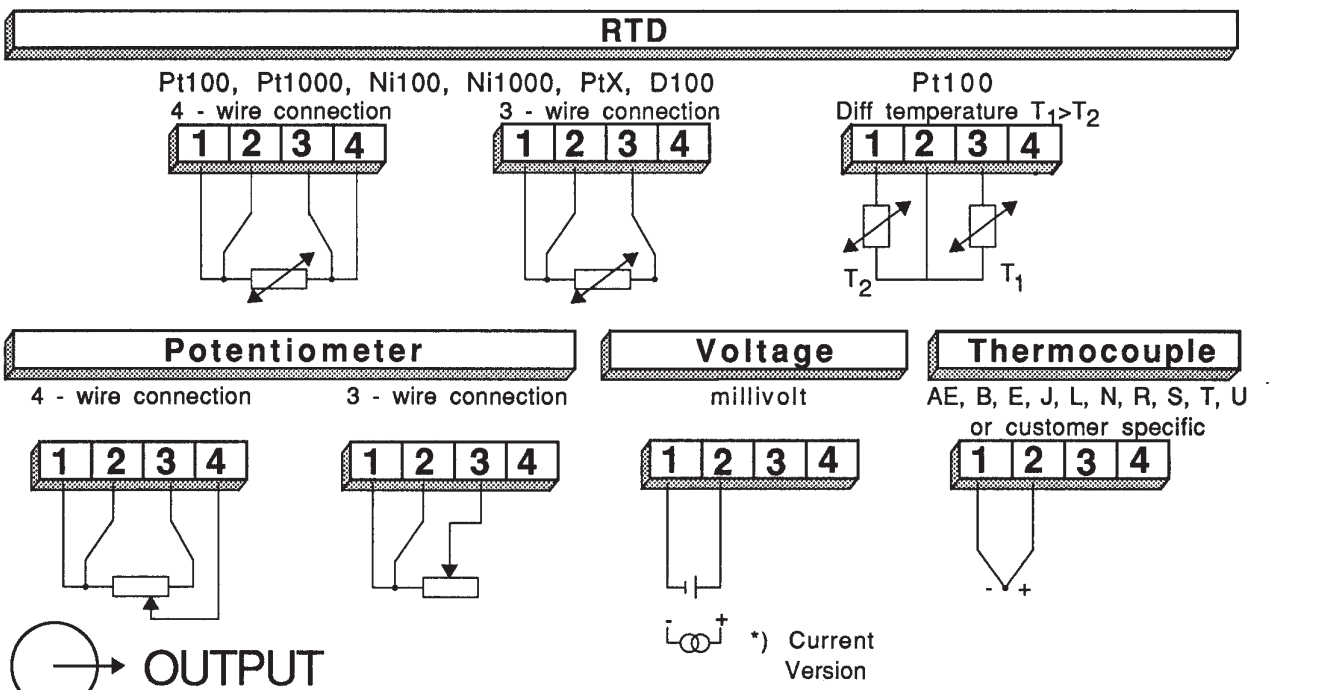
Performance and design:

- Excellent Stability
- Long-term stability 0.1% / year
- Input-Output isolation 1500 VAC
- High load capacity
- Designed for harsh conditions
- Space Saving and simple mounting

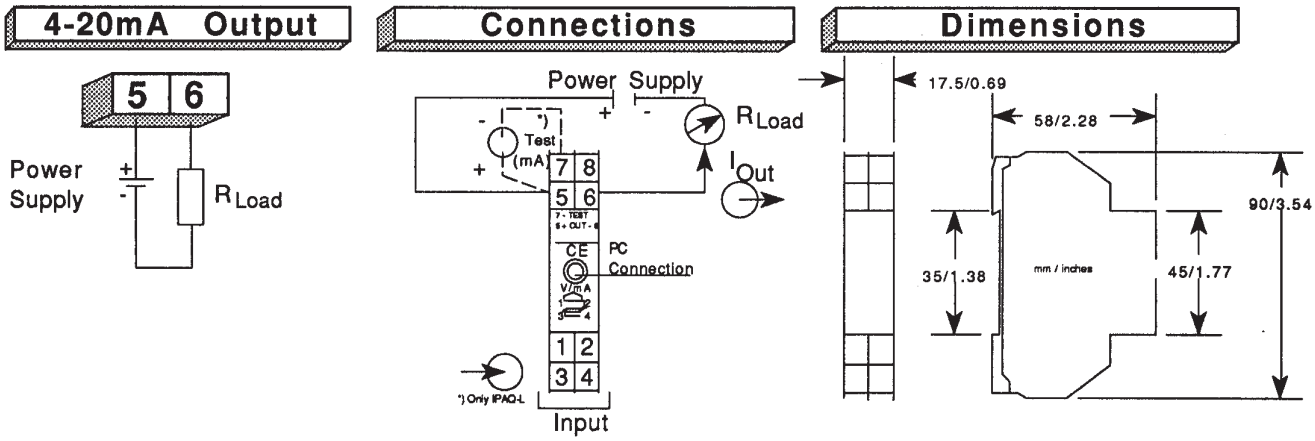
Functions:

- Input for RTD's, T/C's and mV and resistance
- Input for mA
- True on-line communication
- Sensor Diagnostics
- Simplified loop check-up
- On-screen indications and line recording

INPUTS



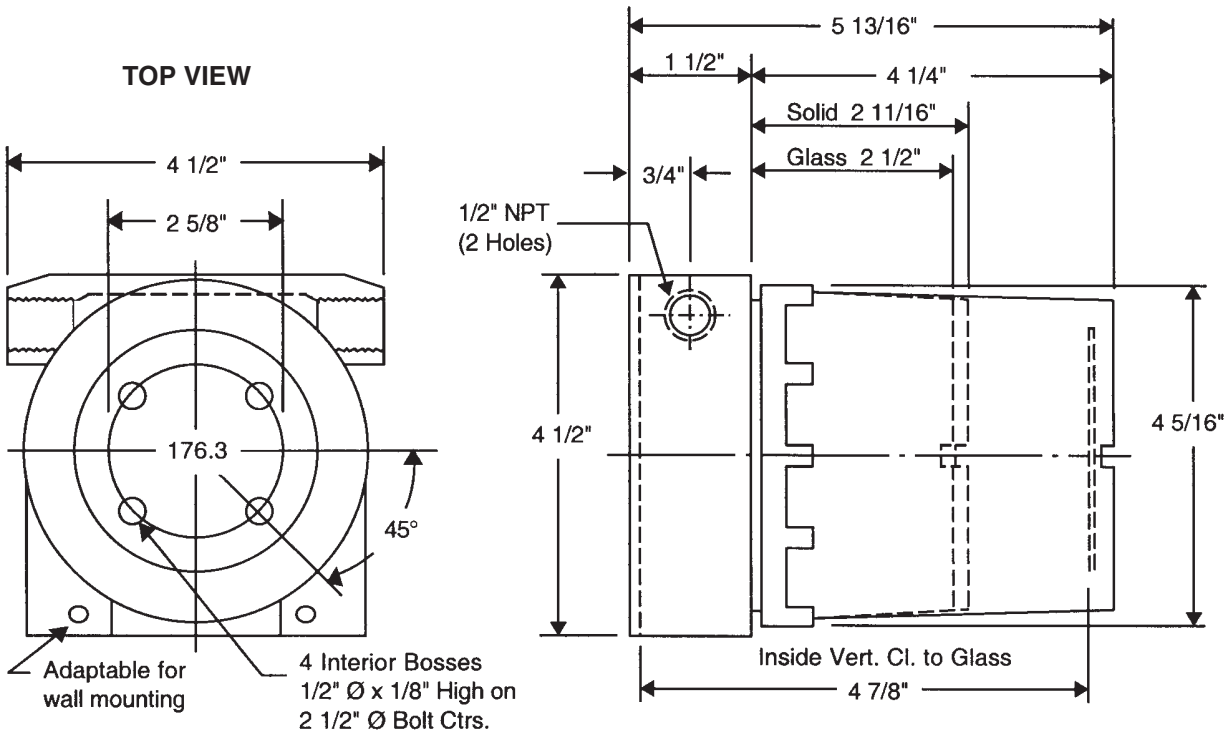
OUTPUT



SECTION 8

MODEL 888

- Thermocouple and RTD input.
- RFI sensitive.
- Continuous span and zero field adjustability to 10% of designated span.
- Acceptable for hazardous locations. May be used in Class 1, Groups B, C, D, Class II, Groups E, F, F, and Class III, NEMA 4. See section 8 page 23 and 24 for FM classifications.
- On thermocouple model, cold junction compensation is included.
- Analog or digital temperature indication.
- Isolated or non-isolated transmitter.
- 5 year warranty.



SPECIFICATION

- *Isolation:
  1kV optical isolation peak to peak.
- *Calibration Accuracy:
  +/- 0.1% of calibrated span of output.
- *Linearity/Repeatability for RTD transmitters:
  +/- 0.1%
- *Inputs:
  RTD, thermocouple, millivolt signal, DC voltage and milliamp signal.
- Stability:
  +/- 0.2% of calibrated span for 6 months.
- Outputs:
  4-20 mA DC.
- Span:
  Specify span needed.
- Power Supply:
  24 VDC +/- 10% regulation.
- Noise Rejection:
  Extremely high common mode and normal mode rejection.
- Span and Zero:
  Adjustable continuously to 10% or range designated.
- Approximate Output Limits:
  3.8 mA DC minimum and 26 mA DC maximum. Upscale burn-out.
- Turn-on time:
  2 seconds, no warm up required.

*Indicates **"twice as good".**

SECTION 8

TemPRO - The user friendly software for TempIR

TemPRO 4.03 is the software with which all user-configurable parameters in TempIR can be reached. TemPRO 4.03 is compatible with windows 3.1 and Windows 95. The software lets you prepare configurations, save them as files and transfer them to any TempIR transmitter. The program is menu-driven and easy to learn. In addition, TemPRO 4.03 configures all products of the Temp family.

Software Features

Engineered Units

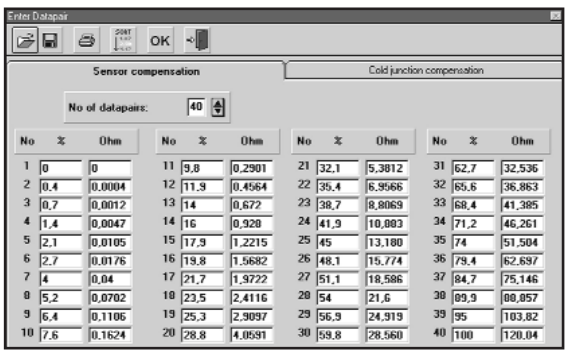
• Ability to use engineering units for directly specifying custom ranges.
• Can be changed instantly by re-arranging the engineering unit.

Customized Linearization

•Utilized in two ways: either by entering datapairs or entering coefficients of a polynomial.

Datapairs

• Up to 40 datapairs can be entered to describe the input signal.
• Up to 7 datapairs can be entered to describe the cold junction compensation of a thermocouple.
• See Fig. 1



Documentation

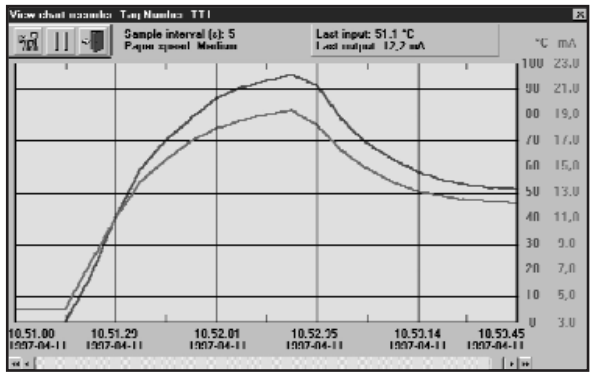
• Configuration protocols can be printed for future use.
• Protocols are time stamped for traceability and furnished with user space for calibration notes.
• Up to 128 characters, for documentation purposes, can be stored in the configuration file.

On Screen Indication

• TemPRO 4.03 will show the measuring values on screen in real time.
• Updating time is user selected.
• Values are displayed in numericals, meters, or bargraphs.
• A lineprinter simulation is a useful feature for startup procedure, etc.
• See Fig. 4

Utilities

• Field calibration permits adjustment of the transmitter in one or two points.
• For this function the sensor / transmitter is subjected to a calibration source (i.e. oven).
• °C, °F are selectable at any time.



Software Requirements

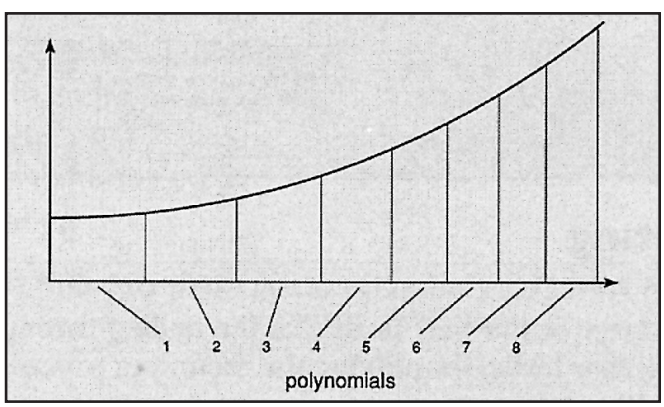
• TemPRO 4.03 is a Windows program.
• Runs on a PC with Win 3.1 or higher or Windows 95.
• Minimum processor requirements are 486, at least 3 MB free hard disk space and a VGA display (640 x 480).

Polynomial

• For polynomial coefficients a sensor can be described by third order polynomials.
• The signal to be linearized can be divided into a maximum of 8 parts where each part is individually described by a separate polynomial of the highest possible accuracy.
•Interesting parts of the signal can be linearized with a higher degree of accuracy.
• The cold junction compensation of a thermocouple can be divided into a maximum of 4 polynomial parts.
• See Fig. 2

File Handling

•Configuration files can be stored for future use.
•TemPRO 4.03 has the ability to save configuration data in ASCII text format.



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The influence of insulation resistance on temperature measurements

Technical Note

How to get an early warning of low insulation resistance

This Technical Note describes how the insulation resistance influences the measurements on RTD's and thermocouples and how to get an early warning regarding errors due to low insulation.

The structure of an RTD and a thermocouple have properties which can lead to erroneous measurements. This is independent of brand and type. One of the most common sources of error is the insulation in the thermometer, which, if too low, can give a serious degradation of the measurement. Insulation can be lowered by moisture, heat, vibration. Physical or chemical influence or radioactive influence. This Technical Note will give an explanation to the necessity of keeping an eye on the insulation resistance.

RTD's

The RTD element is a low-resistance sensor and a too low insulation resistance will influence the measurement. Figure 1shows the electrical schematic for an RTD and the insulation resistance connected to a temperature transmitter.

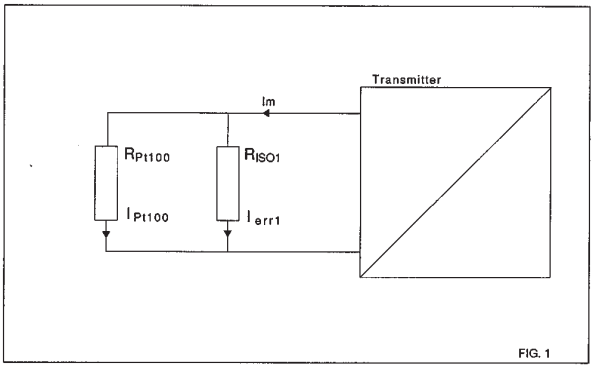


FIG. 1

The measuring current goes through the RTD element, but a negligible fraction is normally passing through the high insulation resistance Riso 1. When the insulation is lowered, a greater fraction of the current will pass through the insulation. As a result of this, the measured voltage over the combined resistance of RTD and insulation resistance will be lower than if the insulation resistance was sufficiently high. This will give a too low measured temperature value and this is not dependent on whether the transmitter is isolated or not. If the transmitter is without galvanic isolation between input and output, a low insulation resistance between sensor and earth can carry a part of the measuring current. This will also give a too low indicated temperature. With an isolated transmitter this will not happen. Please see Figure 2.

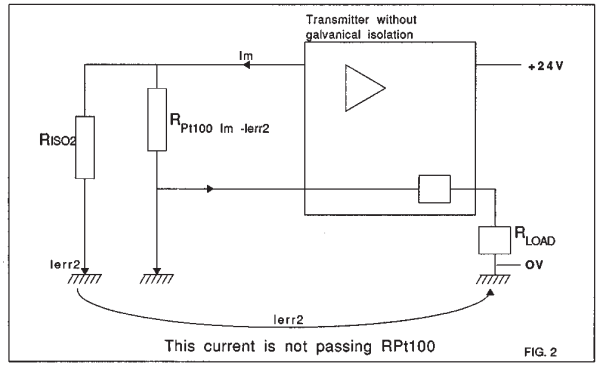


FIG. 2

Thermocouples

Low insulation in thermocouple sensors will give other errors. EMF from the thermocouple is not particularly sensitive for low insulation. The problem is rather that a low insulation will give a new measuring point on the location of the low insulation. If this location is near the intended measuring point, the error will be negligible. If the low insulation is in a location where the temperature differs from the measuring point, there is a possibility of a significant error. Low insulation in thermocouples can also give problems with the indication of sensor breakage. Pleas see Figure 3.

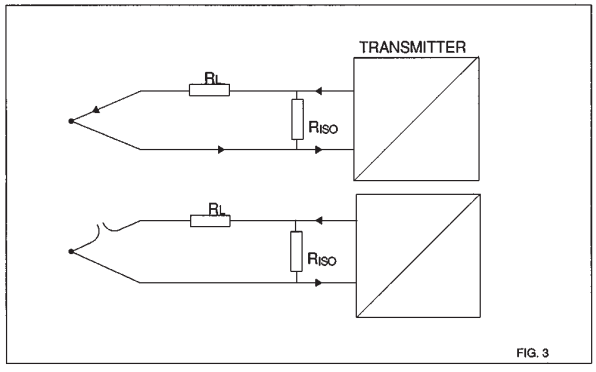


FIG. 3

Monitoring the insulation resistance

The TempIR transmitter is microcontroller based and does a couple of measurements and controls beyond the standard measurements. One of these controls is to monitor the insulation resistance of the sensor. To accomplish this the sensor must be furnished with an extra conductor. Under certain circumstances there is a possibility of using the cable shield. See below. When the insulation resistance is too low, the TempIRsense will signal this with a twinkling LED (on some models) and the output signal will go to a preprogrammed value.

RTD's

For RTD's the limit in insulation is 500 Kohm. By 400°C the added error is 0.4°C. If the insulation is lowered to 100Kohm there will be an added error of 1.6°C. See Figure 4

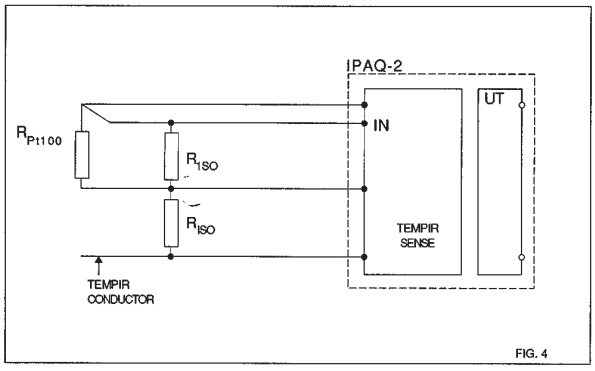


FIG. 4

Thermocouples

For thermocouples the limit of low insulation is 50 Kohm. The added error depends on the relation between the lead resistance R and the insulation resistance Risq. The error is also dependent on the temperature difference between the measuring point and the location of the low insulation. Under the following circumstances, measuring temperature 1000°C, ambient temperature 25°C and R equals 50 Ohm there will be an error of 1% if the insulation resistance is 5Kohm. This equals 10°C. It is assumed that the low insulation is in the are with 25°C.

Sensor Solution

TempIRsense is applicable for 3-wire RTD's and thermocouples. For correct usage the sensor must have an extra conductor. This conductor will have a separate terminal and go through the sensor all the way to the sensor element. See Figure 5.

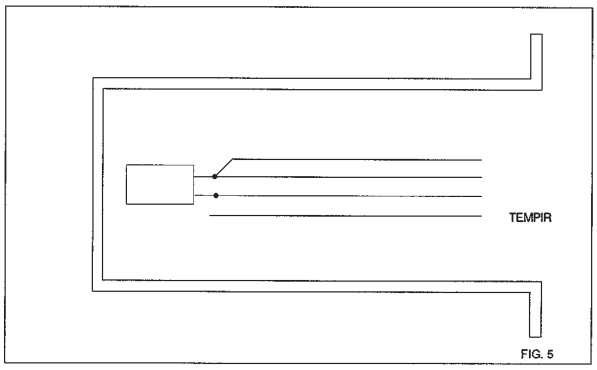


FIG. 5

Mineral insulated RTD's and thermocouples use an unconnected conductor. Due to the low insulation resistance in mineral insulated thermocouples at high temperatures, it is not useful to monitor the high temperature end, above 5-600°C depending on application. Instead, it is important to monitor connections and cables from the sensor to the transmitter. It is not recommended to use the housing of the sensor as the monitoring conductor.

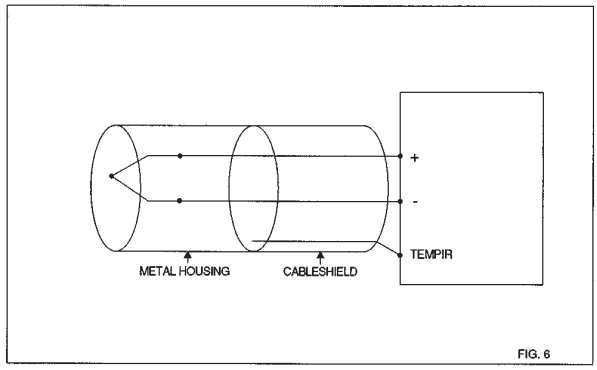


FIG. 6

One task of the housing is to keep interference outside the measurements. Connecting the housing to the TempIRsense terminal can lead to erroneous measurements. This is also applicable to cable sensors. See Figure 6.

Conclusion

Full control over
sensor and connection

Too low insulation resistance in temperature sensors can give erroneous measurement independent of brand and type. TempIRsense gives the possibility of substituting sensors with low insulation resistance in 3-wire RTD's and thermocouples in time. TempIRsense does not only monitor the sensor but also the conductors from the sensors terminal to the transmitter terminals. This gives full control on the condition of the measuring chain from measuring point to transmitter.

Causes of low insulation

- Moisture
- Contamination
- Physical influence (wear, jamming)
- Chemical influence (corrosion)
- Vibration
- Radioactive radiation

Examples of errors

RTD @ 400°C

Insulation Riso	Error
500K	0.4°C
100K	1.6°C
50K	3.1°C
10K	15°C

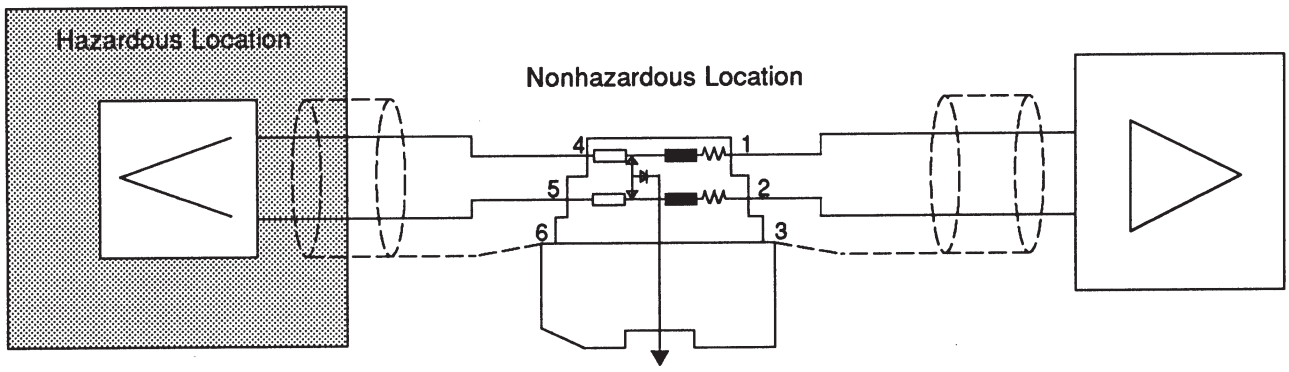
Thermocouple type K @1000°C

Insulation Riso	Error
50K	1°C
20K	2°C
5K	10°C

Ref: See Sensors Magazine, April 1995 Issue.
See Measurements & Control, September 1997 Issue. p. 276.

INTRINSICALLY SAFE TEMPERATURE MEASUREMENT CIRCUITS

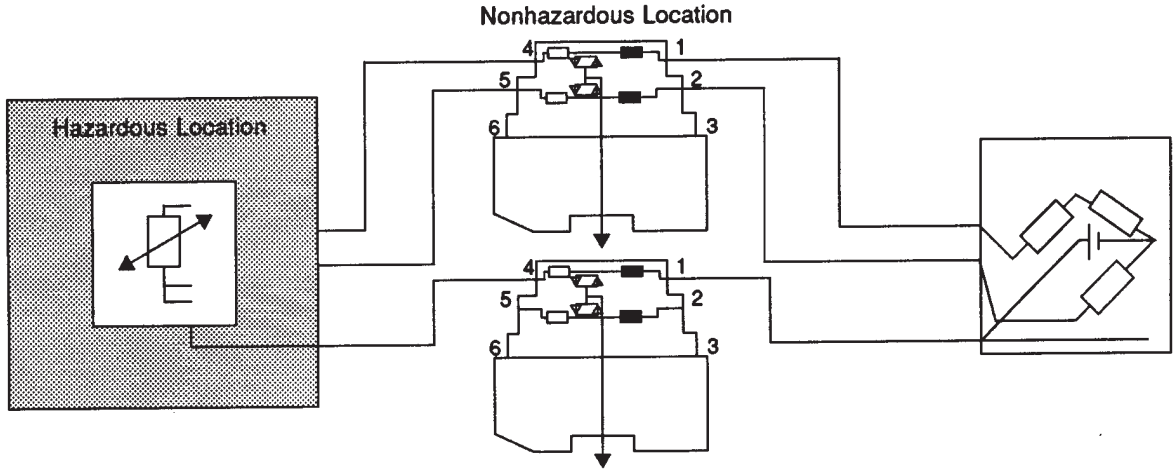
Thermocouple Input for Hazardous Location Groups A - G [using Intrinsic Safety Barriers]



Intrinsic Safety Barrier Selection

Intrinsic Safety Barrier Part Number	Rated Voltage [V]	Maximum Voltage [V max]	Fuse Current [I]	Safety Barrier Resistance [R]	Maximum Leakage Current	Safety Barrier Temperature Coefficient	
					At 7.2V:	Max.	Min.
MTL 7060ac	7.2V	8.4V	50mA	101Ω	10μA	1.050	354
MTL 7160ac	7.2V	8.7V	50mA	1101.1Ω	10μA	(PPM/°C)	

RTD Input for Hazardous Location Groups A - G [using Intrinsic Safety Barriers]



Intrinsic Safety Barrier Selection

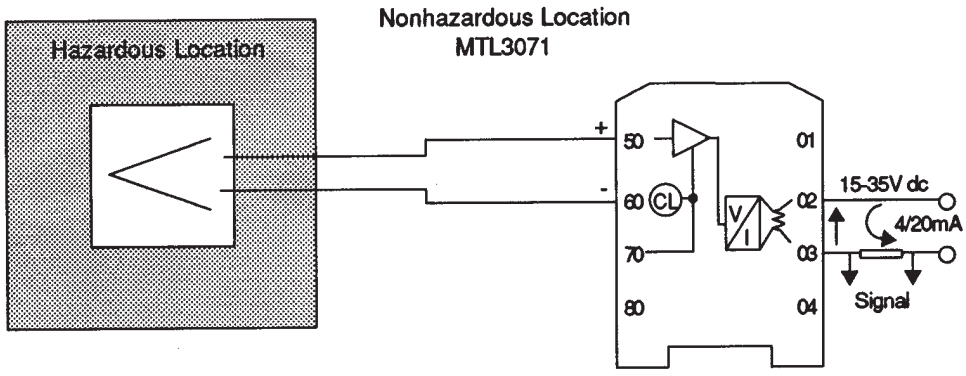
Intrinsic Safety Barrier Part Number	Rated Voltage [V]	Maximum Voltage [V max]	Fuse Current [I]	Safety Barrier Resistance [R]	Maximum Leakage Current	Safety Barrier Temperature Coefficient	
					At 0.6V:	Max.	Min.
MTL 7055ac	0.6V	3.0V	100mA	24Ω*	1μA	973	202
						(PPM/°C)	

*24Ω ±0.15Ω @ 20°C, Channels track within 0.15Ω from -20 to +60°C

JMS recommends and uses MTL Intrinsic Safety and Galvanic Isolation Barriers

ISOLATED INTRINSICALLY SAFE TEMPERATURE

Thermocouple Input for Hazardous Location Groups A - G [using Galvanic Isolation Devices]



Technical Data

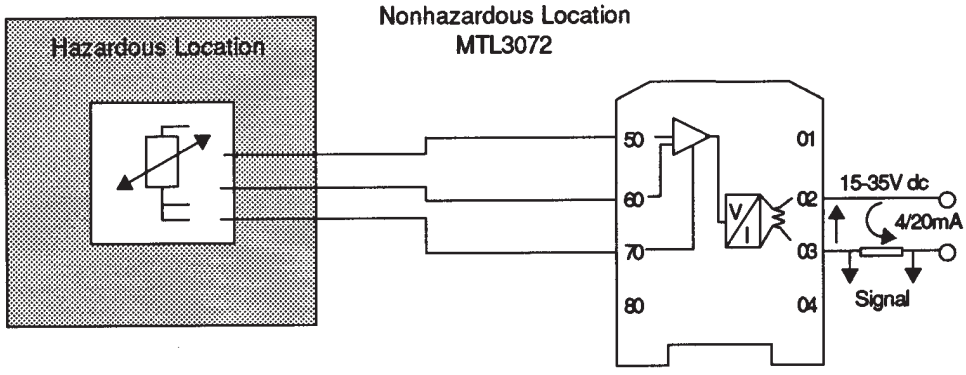
Rated Supply Voltage	24V (15 to 35Vdc)
Protection Fuse	50 mA
Power Consumption	0.46 watts max.

Input Data
- T/C type: J, K, E, T, R, N (or mV)
- Span: 4-60mV
- Zero: -12 to +60mV

Load Specification
- 4-20mA

A simple apparatus is a device which will not generate nor store more than 1.2 V, 0.1A, 25mW, or 20 uJ. Some examples include switches, RTDs, thermocouples, and LEDs. Since these devices cannot contribute energy of sufficient magnitude to ignite a hazardous mixture under a fault condition, they may be connected to a certified intrinsically safe circuit, via an associated apparatus, without the evaluation of a third party testing agency.

RTD Input for Hazardous Location Groups A - G [using Galvanic Isolation Devices]



Technical Data

Rated Supply Voltage	24V (15 to 35Vdc)
Protection Fuse	50 mA
Power Consumption	0.46 watts max.
Current Supplied to Field	400μA
Line Resistance:	100Ω max. each line

Input Data
- RTD: 2-3 wire 100Ω Platinum
- Span: 25 to 800°C
- Zero: -200 to +400°C
- Potentiometer: 0-300Ω

Load Specification
- 4-20mA

For all practical reasons no electrical circuit is inherently intrinsically safe. An intrinsically safe system consists of an Associated Apparatus, either a simple or Intrinsically Safe Apparatus, and interconnecting wiring. When properly installed, the incidence of abnormal spark-causing conditions such as electrical equipment failure, miswiring, overvoltage application to the circuit, or grounding, shorting, or open-circuiting of any lead(s) in the presence of a hazardous mixture, shall not be of sufficient energy to cause ignition.

JMS recommends and uses MTL Intrinsic Safety and Galvanic Isolation Barriers

HAZARDOUS LOCATIONS AS CLASSIFIED IN NORTH AMERICA

Hazardous (Classified) Locations In Accordance with Article 500, National Electrical Code - 1990

Class I
Flammable Gases or Vapors

Division 1

- Exists under normal conditions
- May exist because of
  - repair operations
  - maintenance operations
  - leakage
- Released concentration because of
  - breakdown of equipment
  - breakdown of process
  - faulty operation of equipment
  - faulty operation of process which causes simultaneous failure or electrical equipment

Division 2

- Liquids and gases are in closed containers or the systems are:
  - handled
  - processed
  - used
- Concentrations are normally prevented by positive mechanical ventilation.
- Adjacent to Class I, Division 1 location

Group A: Atmospheres containing Acetylene

Group B: Atmospheres such as Butadiene, Ethylene Oxide, Propylene Oxide, Acrolein, or Hydrogen (or gases or vapors equivalent in hazard to hydrogen such as manufactured gas.)

Group C: Atmospheres such as Cyclopropane, Ethyl Ether, Ethylene, or gases or vapors equivalent in hazard.

Group D: Atmospheres such as Acetone, Alcohol, Ammonia, Benzine, Benzol, Butane, Gasoline, Hexane, Lacquer Solvent vapors, Naphtha, Natural Gas, Propane or gases or vapors equivalent in hazard.

*See page 6 - 16 for more details

HAZARDOUS LOCATIONS AS CLASSIFIED IN NORTH AMERICA

Class 2
Combustible Dusts

Division 1

- Exists under normal conditions
- Combustible mixture produced by:
  - mechanical failure of equipment or machinery
  - abnormal operation of equip ment and provide source of ignition from:
  - simultaneous failure of electrical equipment
  - simultaneous failure of opera tion of protection devices
  - other caused
- Electrically conductive dusts may be present

Division 2

- Not normally in the air
- Accumulations normally sufficient to interfere with normal operation of electrical equipment or other apparatus
- In the air as a result of infrequent malfunctioning of:
  - handling equipment
  - process equipment
- Accumulations are sufficient to interfere with the safe dissipation of heat from electrical equipment
- Accumulations may be ignited be abnormal conditions or failure of electrical equipment

Group E: Atmospheres containing combustible metal dusts (regardless of resistivity), dusts of similarly hazardous characteristics (<100 kΩ/cm) or electrically conductive dusts

Group F: Atmospheres containing combustible Carbon Black, Charcoal or Coke Dusts which have > 8% total volatile material or if these dusts are sensitized so that they present an explosion hazard and having a resistivity > 100 KΩ/cm but ≤ 100 MΩ/cm

Group G: Atmospheres containing combustible dusts having a resistivity > 100 KΩ/cm or electrically nonconductive dusts

Class 3
Ignitable Fibers or Flyings

Division 1

- Fibers or materials producing combustible flyings are manufactured, stored of handled

*See page 6 - 16 for more details

Not Grouped

- Manufacturers such as textile mills, cotton related mills or clothing plants
- Fibers and flyings include Rayon, Cotton, Sisal, Hemp, Jute and Spanish Moss

Division 2

- Fibers are handled except during the process of manufacture or are stored except during the process of manufacture

PLUG-IN SIGNAL CONDITIONERS

FEATURES:
- Isolate, Amplify and Convert Measurement Signals
- Quick-Check LED Output Indication (Most Models)
- 5 Amp, 230VAC Relay Contacts
- Plug-In: Replace without Rewiring
- Industry-Standard Printouts
- DIN/Surface/Track Mount Sockets Available
- AC and DC Powered Models Available
- Seven Year, Full Replacement Warranty



SINGLE ALARM

These Transmitters and Alarms amplify, translate, isolate, and alarm on most standard transducer signals as well as DC, AC and frequency inputs. Used in a variety if industrial and process applications, they provide low-cost answers to many measurement, monitoring and control needs.

The broad product range covers most standard transducers as well as some not-so-standard, such as thermistors and IC temperature sensors. All transmitters are available with optional input/output isolation, providing 1,000 Vrms isolation and better than 0.05% linearity. Red/green LEDs indicate alarm status and, on most transmitter models, provide a quick check of the output level.

Proven designs using low-drift ICs and circuitry provide accurate, stable operation. Quality and reliability are enhance by 100% burn-in and are backed by a seven-year, full replacement.

Available options include AC or DC power, reverse-acting outputs, and urethane coating.

SPECIFICATIONS:

Transmitter Outputs:	Voltage: 0/1v min, -10/+15v max Current: 0/1mA min, 0/25mA max
Accuracy:	±0.1% of span or better (AC inputs ±0.5% of span)
Temp. Stability:	±0.02%/°C or better, -10 to +60°C
Isolation:	Input/Output (optional) -1,000Vac rms Power -1,500Vac rms
Relay Contacts:	Single Alarm, DPDT (2 form C) Dual Alarm, one SPDT (1 form C) per trip point 5A max resistive @ 115/230Vac or 30Vdc, 1/8HP max AC inductive
Set Point Adjustment:	0% to 100% of range, with 0.1% resolution
Deadband Adjustment:	0.25% to 100% of range
Power:	AC: 115 or 230Vac, 2.5VA DC: 12 or 24Vdc, 2.5W

STANDARD TRANSMITTERS AND ALARMS:

INPUTS	TRANSMITTERS		ALARMS	
	Nonisolated	I/O Isolated	Single Trip	Dual Trip
DC (mV, V, mA, A)	JH4010	JH4300	JH1000	JH1020
DC (mV, low drift)	JH4050	JH4310	(Option S)	(Option S)
AC (mV, V, mA, A)	(special)	JH6010I, 6020I	JH1600	JH1620
Thermocouple	JH4100	JH4130	JH1200	JH1220
RTD	JH4001	JH4001I	JH1400	JH1420
Thermistor	JH4005, 4006	JH4005I, 4006I	JH1300, 1300L	JH1320, 1320L
IC Sensor	JH4007	JH4007I	JH1350	JH1370
Potentiometer	JH4003	JH4003I	JH1800	JH`820
Strain Gauge	JH4051	JH4051I	JH1500	JH1520
Frequency	JH7010	JH7010I	JH1700	JH1720



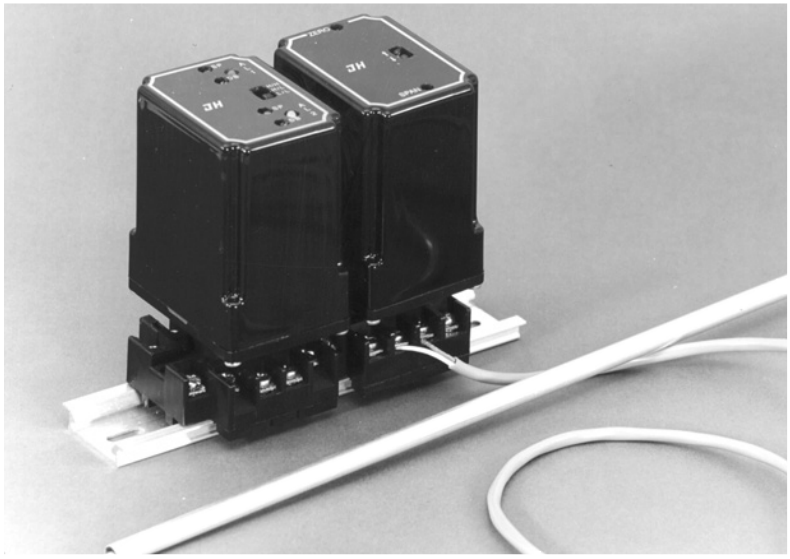
TRANSMITTER

SECTION 8

PLUG-IN SIGNAL CONDITIONERS

ADDITIONAL PRODUCTS:
- Switch-Selectable Inputs
- Loop Power for 2 Wire Transmitter
- Add, Subtract
- Multiply, Divide
- Square, Square Root
- Power Supply

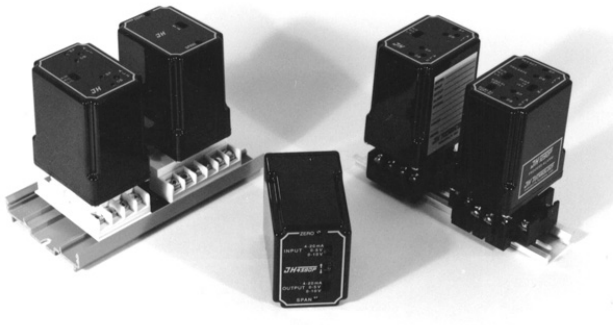
Special-function modules complement the product line, providing the “glue” often needed to complete your system requirements. Process Input Transmitters and Alarms provide top-access switches, allowing the user to select 0-5V, 0-10V or 4-20mA inputs and outputs. Alarms may be set for HI/HI, HI/LO or LO/LO trip, or switch to act as single-trip alarms. Loop-Input modules include 24V regulated excitation to power 4-20mA two-wire input sources.



GROUP with PROBE

Flow computations, averaging, ration measurement and other functions are made possible using the Math Function modules.

FUNCTIONS	TRANSMITTERS		ALARMS	
	Nonisolated	I/O Isolated	Single Trip	Dual Trip
DC Process Inputs (Switchable Selectable)		JH4380P		JH1090P
Loop Input (4-20mA with 24V excitation)	JH4015	JH4305	JH1005	JH1025
4-20mA Isolator (Low Cost)		JH4300C		
Add, Subtract	JH4400 Series	JH4400I Series	JH1100 (A,S)	JH1120 (A,S)
Multiply, Divide	JH4410, 4420	JH44410I, 4420I	JH1100 (M,D)	JH1120 (M,D)
Square, Sq. Root	JH4430, 4440	JH4430I, 4440I	(special)	(special)

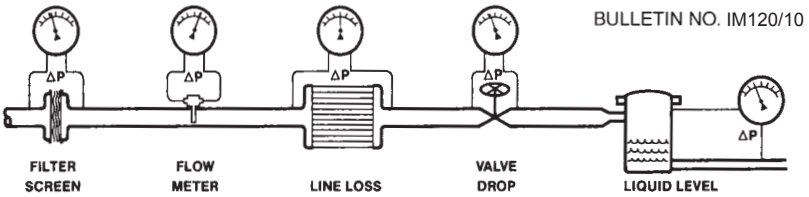


GROUP

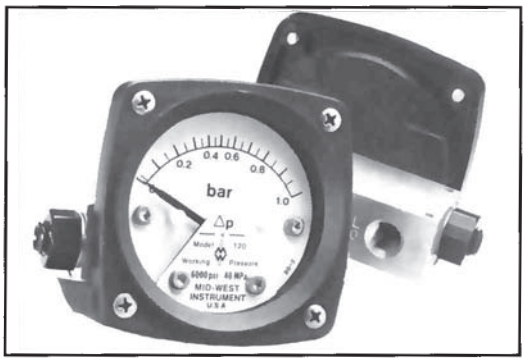
“ASK ABOUT SPECIALS”
Your needs often can be met by simple internal changes, with little impact on either price or delivery. If you don’t see what you need, please give us a call. We’ll work with you to find a solution.

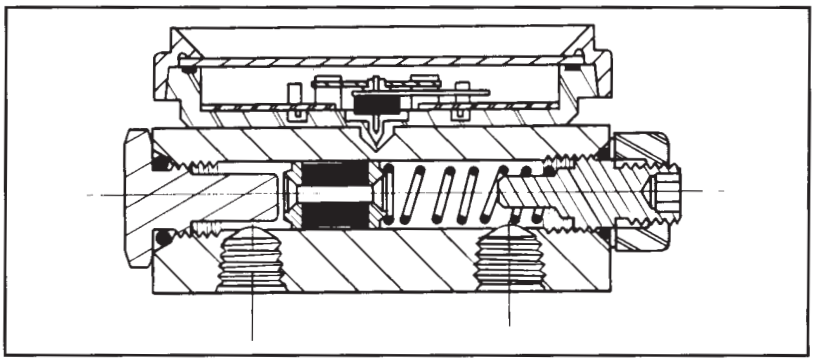
Mid-West®
Instrument

BULLETIN NO. IM120/10



Model 120 Series "Filter Minder"®
Installation and Operating Instructions





INSPECTION

Before installation check the nameplate on each instrument against the receiving paperwork and the intended application for correct part number, materials of construction, working pressure, dial range, etc. If equipped with switches, check electrical rating, type of enclosure, etc. Inspect for shipping damage and, if damaged, report it immediately.

NOTE - Before attempting repairs contact your local Mid-West Representative or our factory. Failure to do so will void any warranty.

PRODUCT DESCRIPTION

The Model 120 Series "Filter Minder"® is a rugged, medium-range differential pressure instrument available as a switch, a gauge, or both. See "Part Numbering System". (Fig. 4) for available options.

Differential pressure is sensed by the movement of a floating piston magnet against a calibrated spring. The magnetically coupled gauge pointer outside the pressure housing follows the movement of the piston magnet and indicates differential pressure on the dial scale.

When equipped with switches, a contact is made or broken by the magnetic field of the piston magnet. See Bulletin ELECIM120/latest for gauges with switches.

The unit provides full over-range protection to the rated working pressure of the housing in either direction.

The precise piston/bore fit allows minimal leakage from high to low sides. This leakage is only 5 to 15 SCFH air at ambient conditions and a pressure differential of 100 PSID.

INSTALLATION

Model 120 Series "Filter Minder"® is calibrated and tested prior to shipment and is ready for immediate installation. Use of the following installation procedures should eliminate potential damage and provide optimum trouble-free operation.

1. CONNECTIONS

1/4" FNPT are provided as standard but check paperwork for connections ordered. There are two connections on the housing identified as "hi" and "lo" for high pressure and low pressure (Fig. 2). Be sure these get plumbed to the proper connections on your system. Improper connection will not damage the instrument, but it will not function properly. Flexible tubing is recommended to minimize the effect of any vibration that may exist.

2. INSTRUMENT LOCATION

On liquid service the instrument should be mounted **below** the process connections to facilitate self-bleeding. On gas service it should be located **above** the process connections to promote self-draining. If the process contains particulates, a "pigtail" loop or drop leg (manometer "U-tube" configuration) in the tubing will minimize the possibility of it migrating into the instrument.

3. PANEL MOUNTING

Gauges with 2-1/2" dials can **only** be mounted through the **rear** of the panel. Make the proper panel cutout as indicated in (Fig.1). Remove the (4) bezel screws. Insert the gauge front through the rear of the panel and reinstall the bezel screws through the **front** of the panel and into the gauge bezel. Tighten the screws securely, alternating in a **diagonal** pattern.

Gauges with 3-1/2" dial should be mounted from the front of the panel. Contact factory for mounting information and dimensional data.

Gauges with 4-1/2" dial should be mounted from the **front** of the panel. Make the cutout as indicated in (Fig. 1). Insert the (4) panel mounting studs, finger tight, into the metal inserts located in the rear of the bezel. Insert the gauge through the panel, aligning the panel mounting studs with the holes in the panel. Install the (4) #8-32 nuts onto the studs and tighten securely.

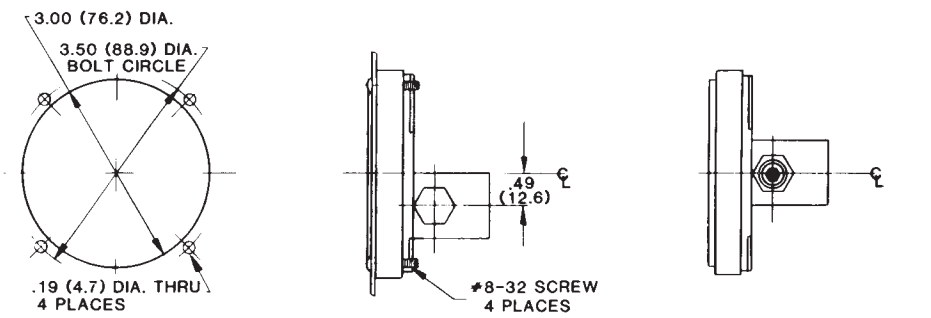
4. PIPE MOUNTING

An optional pipe mounting kit is available for mounting the gauge to a 2" vertical or horizontal pipe (Fig. 3).

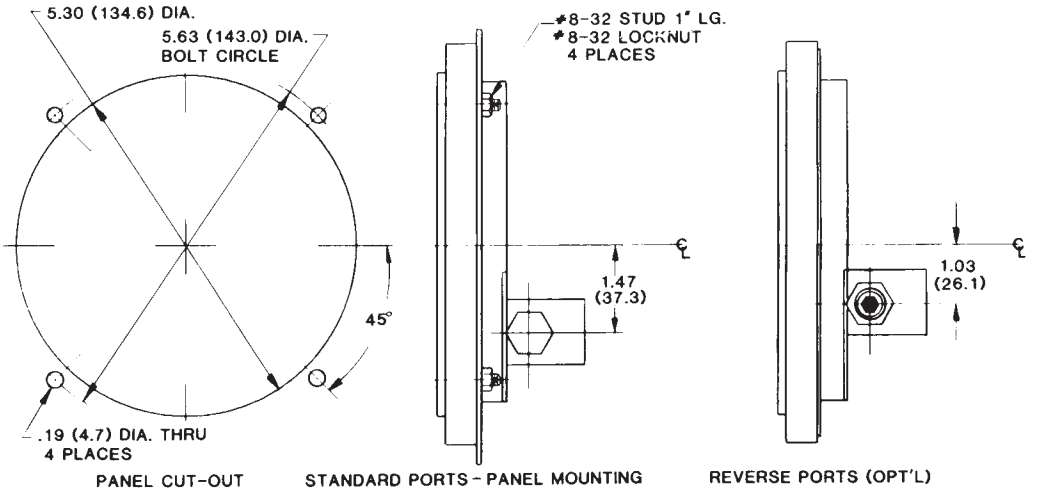
TROUBLE SHOOTING

1. **Gauge does not indicate differential.**
   - A. Check for proper hook up, high to "hi" and low to "lo".
   - B. Make certain block valves are open and, if using a 3-valve manifold, that the equalizer (balance) valve is closed.
   - C. If A & B check out correctly, loosen or disconnect the high pressure line to determine if there is pressure to the instrument.
   - D. If there is pressure to the instrument, check to determine that there is differential across the unit being monitored. If so, contact the factory for assistance and/or an "RGA" (return goods authorization) number to return the instrument for repair or replacement.

Model 120 2-1/2 Inch Dial (Std.)

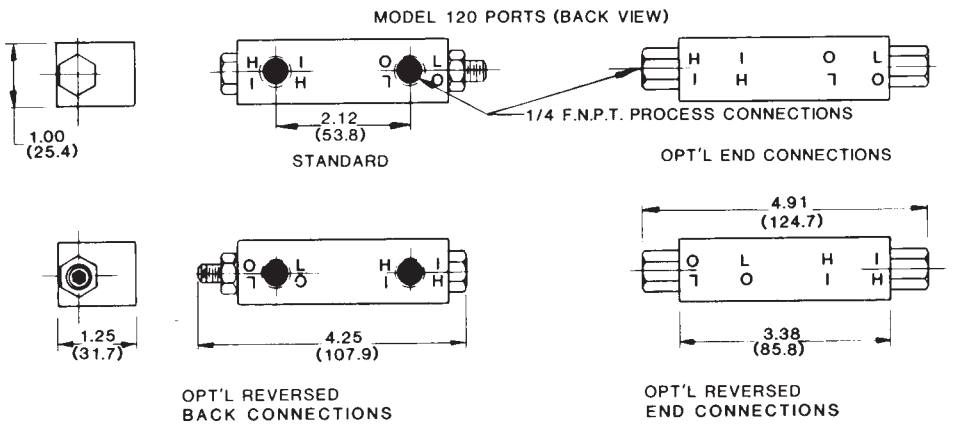


Model 120 4-1/2 Inch Dial (Opt'l)

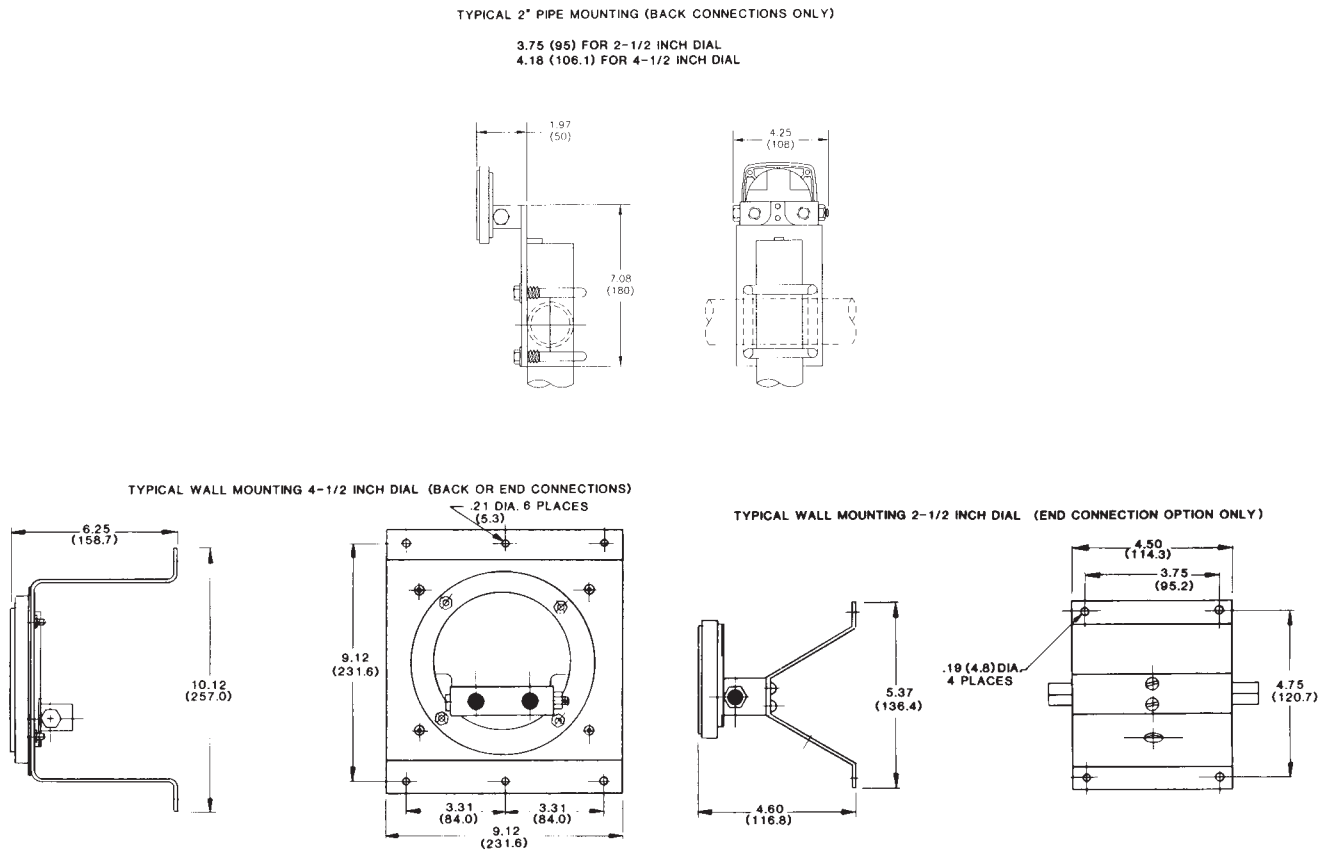


(Fig. 1)

Supplementary 120 Dimensional/Mounting Data



(Fig. 2)



(Fig. 3)

NOTES: 1. Drawings show standard gauge nominal dimensions. (not to scale)
2. Dimensions shown in parentheses are in millimeters.
3. Manufacturer reserves the right to change specifications without prior notice.

Standard Model Specifications

120-AA-00-OO 6000 P.S.I.G. Working Pressure Aluminum Body, Stainless Steel Piston,Ceramic Magnets, Buna N Seals, 2 1/2" Engineering Plastic Case with Shatter-Resistant Lens. 1/4 " FNPT Back Connections. Accuracy ±3-2-3% Full Scale (Ascending).

Part Numbering System:

1 2 0 — ☐ ☐ — ☐ ☐ — ☐ ☐ ☐ ☐ — ☐ ☐ ☐

1. BASIC MODEL NUMBER

2. MATERIAL
- A. Aluminum Body, S.S. Piston **(Standard)**
- S. 316 S.S. Body & S. S. Piston **(Standard)**
- M. Monel Body (See 120 ABM) (5000 P.S.I.G. working pressure)
- N. Aluminum Bronze Body (See 120 ABM) (5000 P.S.I.G. working pressure)
- Z. Special (Uncoded Options)

3. DIAL TYPE
- A. 2-1/2" Round Uni-Directional engrd. plastic housing assy. **(Standard)**
- C. 4-1/2" Round Uni-Directional engrd. plastic housing assy.
- E. 3-1/2" Round Uni-Directional anod. aluminum housing assy.
- G. 4-1/2" Round Uni-Directional anod. aluminum housing assy.
- T. Non-indicating differential pressure switch only (select appropriate electrical option)
- Z. Special (Uncoded Options)

4. SEALS
- 0. Buna N **(Standard)**
- 1. *Viton®
- 2. Neoprene
- 4. **Teflon®
- 5. Ethylene Propylene
- 6. Perfluoroelastomer
- 9. Special (Uncoded Options)

* Viton® is a Registered Trademark of DuPont Dow Elastomers

** Teflon® is a Registered Trademark of DuPont

5. CONNECTIONS

(NOTE: Models 120M and 120N available only with end connections)
- 0. 1/4" FNPT back connections **(Standard)**
- 2. 1/4" FNPT end connections
- 3. 1/4" Bottom connections
- 4. 1/2" FNPT end connections
- 6. 7/16" – 20 straight thread "O" ring port (back connection)
- 7. 1/2" FNPT stainless steel adaptors (back or bottom only) available on material A & S only)
- 9. Special (Uncoded Options)

6. OPTIONS (Up to four options)
- O. None **(Standard)**
- A. Reversed high/low process connections not available with electrical options J & K
- C. Mounting holes in gauge body for field mounting of electrical configuration options A & B
- D. Mounting holes in gauge body for field mounting of electrical configurations options L & M
- F. Pipe mounting kit (carbon steel) not available w/C ,D, E or F electrical switch options.
- G. Pipe mounting kit (stainless steel) (no back or bottom connections for C, D, E or F electrical switch options)

NOTE: Not all options available in combination with other options.
NOTE: Factory preset switches at no charge (specify setting)
NOTE: The use of diaphragm seals is not recommended for Model 120 series gauge. Attempts to install such seals on this gauge will void the warranty. Manufacturer reserves the right to change specifications without prior notice.
PROOF PRESSURE: 12,000 PSI for models 120A and 120S. 10,000 PSI for models 120M and 120N.

Mid-West Instrument, 6500 Dobry Dr., Sterling Heights, MI 48314
Tel: 586-254-6500 Fax: 586-254-6509
www.midwestinstrument.com

OPTIONS (Up to four options) (continued)
- L. Liquid Fill (Not available w/follower pointer) (Not available with 3 ½" dial)
- M. Maximum indicator follower pointer
- N. NACE
- Q. CRN (Canadian Registration Number) Available on Aluminum or S.S. body only
- S. Shatterproof lens (available only with 4 ½" metal front)
- T. Oxygen Cleaning
- U. S.S. tag and Wire
- V. S.S. tag and screw (contact factory on switch options)
- W. Wall mounting kit (not available with back connections) (not available with E or F Electrical Configuration)
- Z. Special (Uncoded Options)

7. ELECTRICAL CONFIGURATIONS
(NOTE: All options CE marked except E, F, J & K)
- O. None
- A. One (1) switch in STD, enclosure with grommet wire seal
- B. Two (2) switches in STD, enclosure with grommet wire seal
- C. One (1) switch in STD, enclosure with ¼" FNPT electrical connection NEMA 4X
- D. Two (2) switches in STD, enclosure with ¼" FNPT electrical connection NEMA 4X
- E. One (1) switch in general purpose enclosure, Division 2 Hazardous Locations [1] [3]
- F. Two (2) switches in general purpose enclosure, Division 2, Hazardous Locations [1] [3]
- G. One (1) switch & gauge in NEMA 4X plastic enclosure (not available with end connection)
- H. Two (2) Switches & Gauge in NEMA 4X Plastic Enclosure (Not available with end connections)
- J. One (1) Switch in Explosion Proof Enclosure with Glass Window Cover, Division 1, Hazardous Locations [2] [3]
- K. Two (2) switches in explosion proof enclosure with glass window cover , Division 1, Hazardous Locations [2] [3]
- L. One (1) switch in STD, enclosure with plug-in connector (DIN43650/IP65-PG11)
- M. Two (2) switches in STD. enclosure with plug-in connector (DIN43650/IP65-PG11)
- Z. Special

(Note: 7 and 8 up to three options)

8. ELECTRICAL SPECIFICATIONS (For Resistive Loads)
- A. S.P.D.T., 3W, 0.25 Amp., 125 VAC/VDC (Standard) (Switch adjustable range of 10-90%)
- E S.P.S.T. , 60W, 3.0 Amp., 240 VAC/VDC (Normally open) (Switch adjustable range of 25-95%)
- F. S.P.S.T., 60W, 3.0 Amp., 240 VAC/VDC (Normally closed) (Switch adjustable range of 25-95%)
- G. S.P.S.T., 60W, 3.0 Amp., 240 VAC/VDC One (1) Normally open, One (1) Normally closed (Switch adjustable range of 25-95%)
- H. S.P.D.T., 60W, 1.0 Amp., 240 VAC/VDC (Switch adjustable range of 25-100%)
- Z. Special (Uncoded Options)

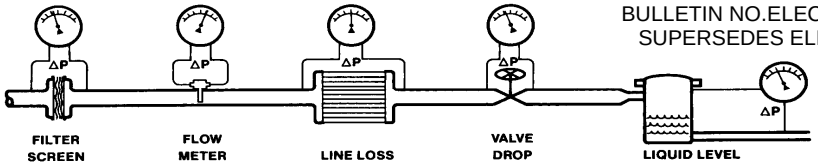
[1] Complete assembly 3rd party Certified Class I, Division 2, Groups A, B, C & D; Class II, Division 2 Groups F & G.
[2] Complete assembly 3rd party Certified Class I, Division 1, Groups C & D; Class II, Division 1, Groups E, F & G.
[3] 5000 PSIG SWP for Stainless Steel; 3000 PSIG SWP for Aluminum.

Temperature Limits: -40°F(-40°C) to +200°F(+93°C) These limits are based on the entire instrument being saturated to these temperatures. System (process) temperatures may exceed these limitations with proper installation. Contact our customer service representative for details.
STANDARDS: All model 120 Series differential pressure gauges either conform to and/or are designed to the requirements of the following standards:

ASME B1.20.1	NACE MR0175
ASME B40.100	NEMA Std. No. 250
CSA-C22.2 No. 14.25 and 30	SAE J514
EN-61010-1	UL Std. No. 50,508 and 1203

BULLETIN NO.ELEC IM120/09A
SUPERSEDES ELEC IM120/07C

Mid-West®
Instrument



Model 120 Electrical: Installation and Operating Instructions

ELECTRICAL

Gauges with switches have one or two hermetically sealed adjustable set point reed switch assemblies. Load ratings and capabilities for each switch type are defined as follows:

REED SWITCH RATINGS (Resistive Load)

Type	SPST	SPDT	SPDT
Option:	E ,F,G	H	A
*Power	60 W	60 W	3W
Max. Current	3.0 Amps	1.0 Amps	0.25 Amps
Max. Voltage VAC/VDC	240	240	125
**Setting (%F.S.)	25 to 95	25 to 100	10 to 90
Hysterisis (Max/Nom)	15% / 8% (F.S.)	20% / 13% (F.S.)	10% / 5% (F.S.)
Repeatability	1% F.S.	1% F.S.	1% F.S.
Leads 22 Awg.	(2), 24”	(3), 24”	(3), 24”

* Product of the switching voltage and current shall not exceed the power rating of the device.
** Except where otherwise noted

The SPDT switch ('A' or “H” Electrical Option) lead colors and associated functionality at '0' PSID is shown in Figure 1. SPST switches (' E', 'F', or 'G' Electrical Options) may be normally closed or normally open at '0' PSID dependent upon the option specified on the purchase order.

All switch types are field adjustable. The defined range of the adjustment is specified in the table above. All switches come with a decal to identify adjustment direction to increase the set point. **Do not use excessive force when rotating the adjustment screw as the adjustment mechanism may be damaged**. **Also note the location of the screw adjust (See Figure 4.) Do not mistake it for the calibration adjust for the gauge.**

Note: *Switches can be set below the defined minimum set point however, the switch may not remain activated at maximum PSID. If the unit is set below the defined minimum set point, the customer should verify that the switch remains activated from the set point to over range of the gauge.*

Provide standard protection techniques for the switch contacts for capacitive and inductive loads. Use current limiting techniques near the switch to protect the contacts due to high inrush (i.e.; in line resistor or inductor) for long cable interfaces. Provide clamping devices at or near inductive loads (i.e.; relay). **Maximum wire length between the 3W switch and its load, should not exceed 70 – 100 Feet**. **for 120 VAC** applications. Contact the factory for assistance regarding this condition.

Use the Mid-West Power Relay 1000TR or equivalent relay for loads above the switch rating,.

The following warnings apply to all gauge options with electrical interface:

WARNING: ELECTRICAL CONNECTIONS SHOULD BE PERFORMED BY QUALIFIED PERSONNEL AND MEET THE REPRESENTATIVE COUNTRY'S NATIONAL ELECTRICAL CODE.

WARNING: FAILURE TO CONNECT TO THE PROTECTIVE CONDUCTOR TERMINAL MAY RESULT IN A SHOCK HAZARD.

Grommet Wire / ¼” FNPT Wiring Interface

The standard switch enclosure is weather resistant with 24" flying lead wire interface. A rubber grommet provides the seal around the wires (See Figure 2). (Options A & B)

The conduit version provides a NEMA 4X rated environmental seal with a 1/4" FNPT wiring interface in the rear center of the gauge body (See Figure 3).(Options C & D)

A provision to connect a protective conductor terminal is provided on the High port end of the gauge body. A 6-32 screw, 18 Awg, 24 " long, green/yellow wire, and a #6 terminal is provided.

Standard location of a SPDT switch will be on the bottom of the gauge for a standard port gauge. For a reverse port gauge the switch will be on top. (See Figure 2). SPDT Switch leads are color coded and labeled as follows:

White- 1 or 2 Com **Black**- 1 or 2 NC **Red** - 1 or 2 NO

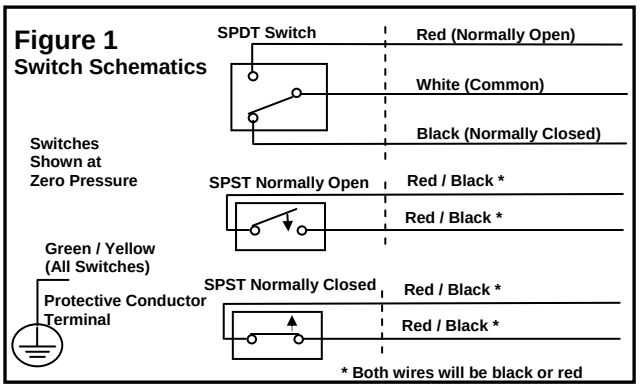
Location for the SPST switch will vary depending on the switch type required. A standard port gauge has the normally open switch located on the bottom of the gauge body and the normally closed switch located on the top. This applies to both a single switch unit or a double switch unit with one of each type ("G" option Electrical Specifications).

A reverse port gauge has the normally open switch located on the top and the normally closed switch located on the bottom. Leads are labeled as follows:

Single Switch Unit: 1NC or 1NO
Double Switch Units: 1NC or 1 NO and 2NC or 2NC

Deviations from the above configurations may exist. Therefore check the description block of your order to verify your configuration.

Figure 1
Switch Schematics



DIN Plug- in Connector (Options L & M)

The DIN interface conforms to DIN 43 650A / ISO 4400 and **when mated** provides an IP65 rated protection class. The right angle mating connector is supplied with the gauge upon order. Clocking (orientation) can be changed by prying out the insert and rotating the insert to the desired clocking (90 º increments). (See Figure 4)

Wiring for the SPDT bottom and top switch for the defined port configuration is as follows:

Standard Port. - 1.- Common, 2. - N.C., 3. - N.O.
Reverse Port - 1. - Common, 2. - N.O., 3. - N.C.

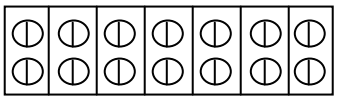
Wiring for the SPST switch is between terminals 1 & 2.

A protective conductor terminal is provided on the DIN connector.

NEMA 4X (Weatherproof Enclosure) (Options G & H)

The gauge and switch(es) are mounted inside the enclosure with the switch(es) wired to a seven (7) position terminal strip. The terminal strip connection uses 6-32 screws and is rated for use with wire up to 14 Awg.. An opening is provided on the bottom of the enclosure for a 1/2" flexible cable or conduit connection.

Access the terminal strip by removing the cover from the enclosure and loosening the (4) screws. Insert wires through an appropriate weatherproof connector (not supplied) into the enclosure and connect to the terminal strip. See the terminal strip diagram shown below or on the outside of the switch enclosure. Reinstall the cover and (4) screws (See Figures 5 & 6).



NO NC CM CM NC NO
SINGLE DOUBLE

Wiring to the terminal strip for SPST switches is defined by the functionality required. i.e.; a normally closed switch is wired between the CM and NC connections with the NO connection unused and a normally open switch is wired between the CM and NO connections with the NC connection unused.

Access holes and plugs are provided for external adjustment of the switches if required (Except Model 120 4 1/2" Dial). The cover for the Model 120 with 4 1/2" Dial must be removed to adjust the switch settings.

NEMA 7 (Explosion-proof) Enclosure (Options (J & K)

WARNING: THE COVER AND/OR SWITCH ADJUST ACCESS PLUGS MUST NEVER BE REMOVED WHEN THERE IS POWER TO THE UNIT. MAKE ALL ADJUSTMENTS IN A NONHAZARDOUS AREA.

The gauge and switches are mounted inside the enclosure (See Fig. 8). A 1/2"-14 FNPT conduit connection is provided in the bottom side of the enclosure. A proper explosion proof, dust tight, sealing fitting with appropriate sealing cement must be used when making connections to the 24", 18 Awg. wire leads. The leads are labeled and/or color coded as described in the grommet / conduit section.

Adjustment of the set point can be accomplished by removing the switch adjustment access plug(s). Insert the screw driver through the hole into the switch adjustment slot and rotate until the desired set point is reached. **Do not use excessive force**. **Reinstall the access plugs with at least 5 threads of engagement after completion.**

Enclosures with SPDT or SPST switches comply with NEC Class 1, Groups **C & D**; Class 2 Groups E,F, & G, NEMA 7 and 9. All switches are CSA / NRTL listed.

Division II Hazardous Ratings (Options E & F):

The **E & F** Electrical Configuration are 3RD party certified for **Class I, Division II, Groups A, B, C, & D, Class II, Groups F & G** hazardous environments. The CSA mark identifies the product has been tested to the applicable **US standards** and the applicable Canadian standards.

Interface is 24", 18 Awg. flying leads with ½" FNPT Conduit. (See Figure 7)

MISCELLANEOUS

Bi-directional Dial:
SPDT Switch units, with the bi-directional dial, require the following setting instructions:

1. If the switch is to operate for positive ΔP, rotate the adjusting screw Counter Clockwise (Red - NO, Black- NC, White- Common).
2. If the switch is to operate for negative ΔP, rotate the adjusting screw Clockwise (Red- NC, Black- NO, White -Common)

The functionality of SPST switches will be reversed for negative ΔP and positive ΔP. i.e.; a normally open switch (B option), will switch from open to closed for set points above 0 PSID, but will switch from closed to open for set points below 0 PSID.

TROUBLE SHOOTING

A. Switch doesn't function

   i. Make sure that the switch load does not exceed the specified wattage rating of the switch. (steady-state and transient). Contact factory for assistance for excessive loads, otherwise proceed to the next step.
   ii. Perform a continuity check of the switch contacts by trying to actuate the switch using an external magnet. An operational switch usually indicates a problem with the gauge. If not operational proceed to the next step.
   iii. Verify the reed switch wires are connected to the terminal strip (NEMA 4X enclosure only). Contact the factory for assistance if the switch is connected and/or request an "RGA" number.

C. Gauge accuracy and set point problems:
   i. Verify gauge is not in an electromagnetic / magnetic environment. i.e.; close proximity to high current power lines.
   ii. All others, contact the factory for assistance.

MOUNTING INFORMATION & DIMENSIONAL DATA

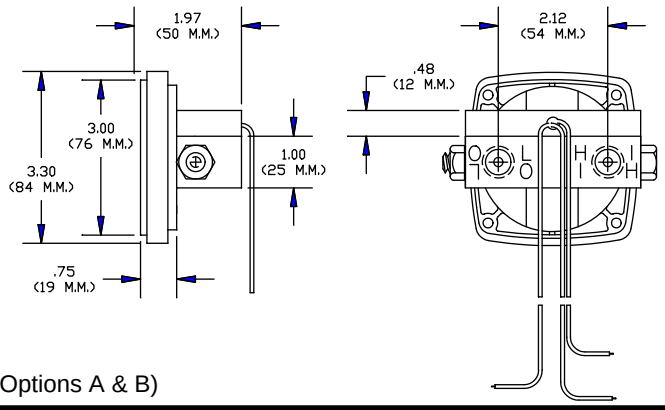


FIGURE 2
Model 120 Reverse Port
Grommet Interface Switch Options A & B)

NOT SHOWN: (Fig 2 & 3)
The Protective Conductor Terminal with a Green / Yellow Wire located on the High Port end of the gauge body.

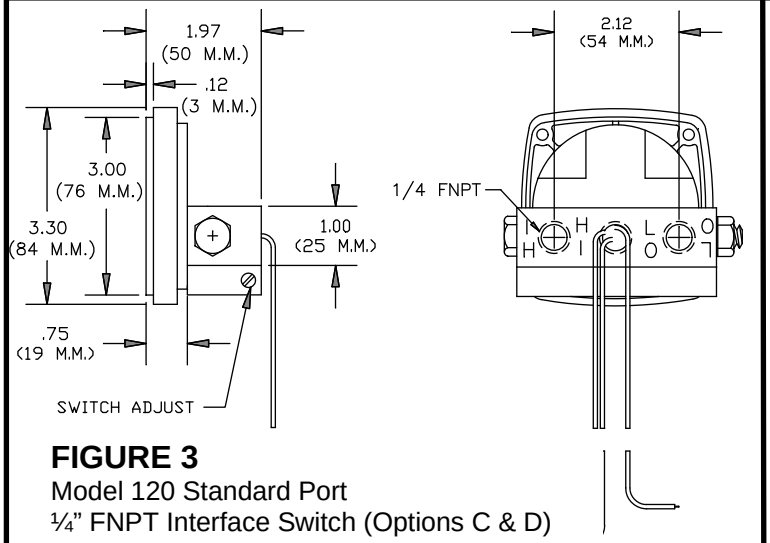


FIGURE 3
Model 120 Standard Port
¼" FNPT Interface Switch (Options C & D)

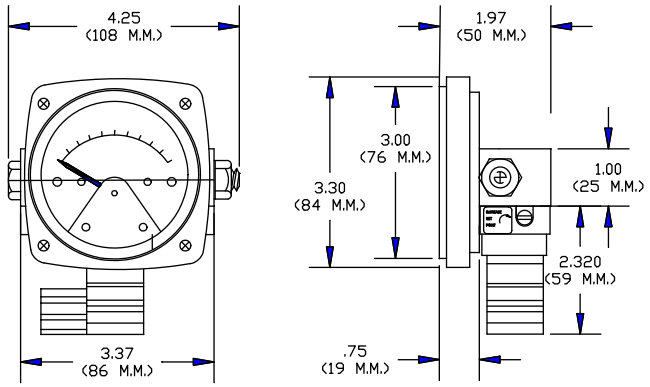


FIGURE 4
Model 120 Reverse Port
Din Connector Interface
Switch (Options L & M)

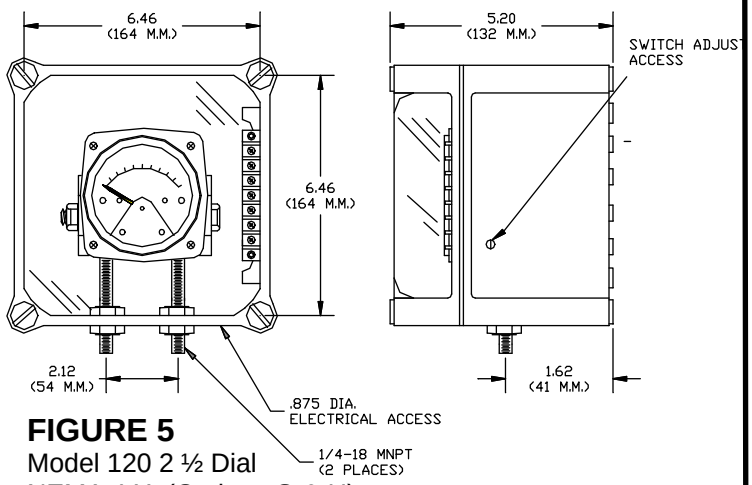


FIGURE 5
Model 120 2 ½ Dial
NEMA 4 X (Options G & H)

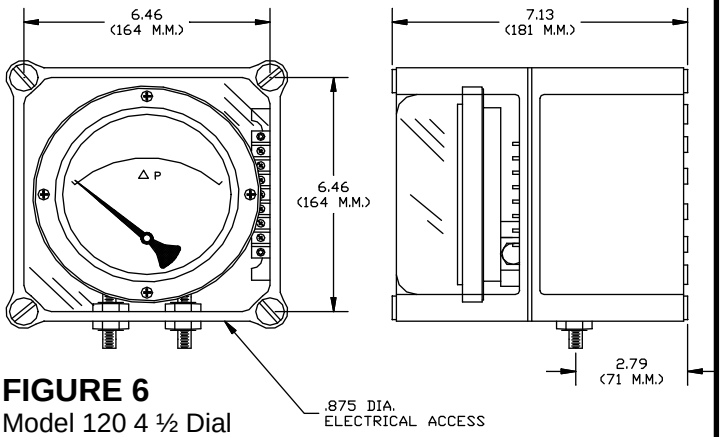
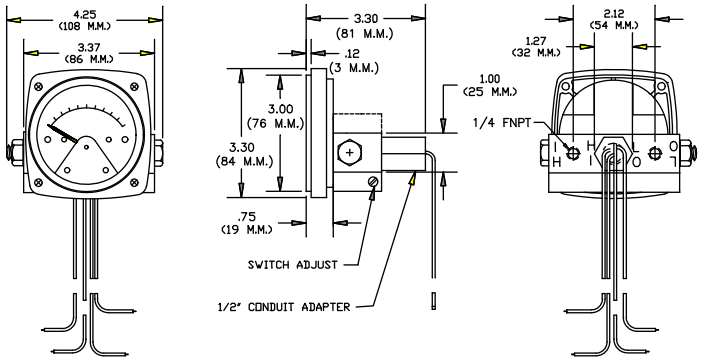


FIGURE 6
Model 120 4 ½ Dial
NEMA 4 X (Options G & H)

FIGURE 7
Model 120 2 ½ Dial Options (E & F)

Hazardous Locations,
Division II, Class I,
Groups A, B, C, D
Class II Groups F & G
(CSA Listed for all switch specifications)

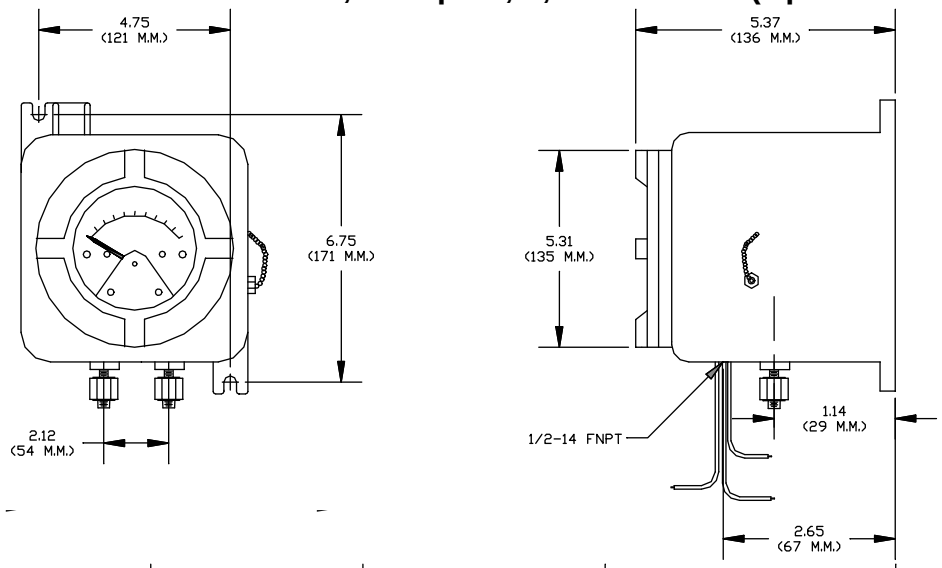


C SA US

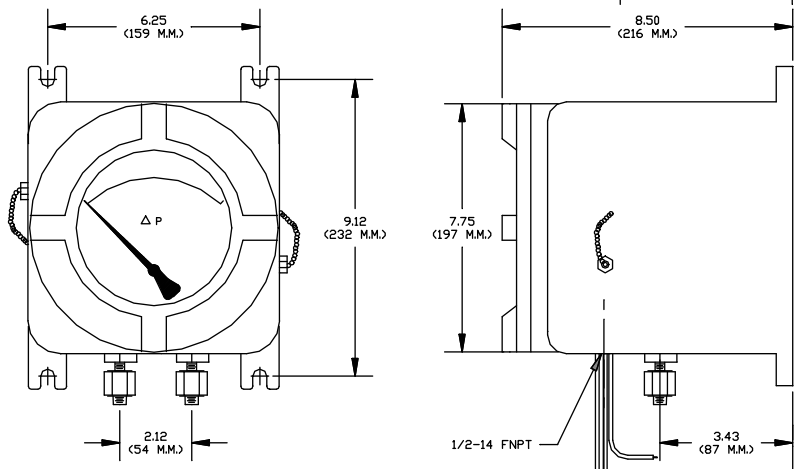
FIGURE 8

Explosion-Proof Enclosures Class I, Groups C & D, Class II, Groups E, F, & G (Options J & K)

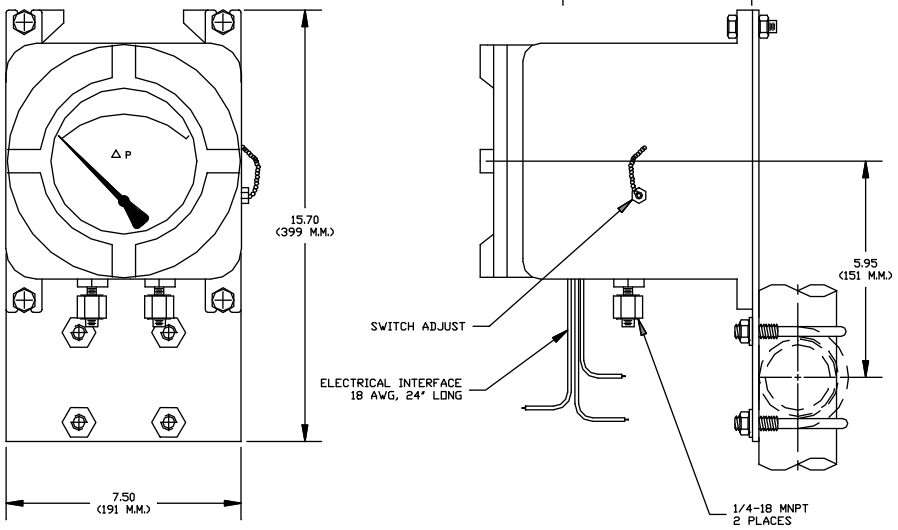
2 ½ Inch Dial



4 ½ Inch Dial



Typical 2" Pipe Mounting



Mid-West® Instrument
6500 Dobry Dr. Sterling Heights, MI 48314
(586)254-6500 FAX (586)254-6509
E-Mail: sales@midwestinstrument.com
Web Page: www.midwestinstrument.com

Warning: The suitability of the application and installation of this differential pressure switch is the responsibility of the end user. The applicable certifications, listings apply to the differential pressure switch only.

PENTAIR

KEYSTONE

K-LOK® Figures 360/362 – ASME 150
K-LOK® Figures 370/372 – ASME 300

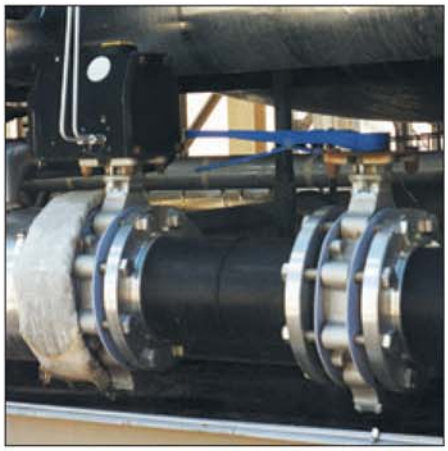
Features and benefits

- Integrally cast mounting pad provides direct mounting of many actuators.
- Rocker-shaped gland bridge compensates for uneven adjustment of gland nuts.
- Extended neck allows for two inches of pipeline insulation.
- Flattened body bore at shaft journal ports positions shaft bearings near disc, providing maximum shaft support.
- Disc taper pins are tangentially positioned half in disc and half in shaft, placing them in compression rather than shear, which eliminates potential for failure.
- Integrally cast disc position stop perfectly locates the disc in seat, achieving maximum seat and seal life.
- K-LOK polymer, elastomer, and fire-safe seats provide bi-directional, drop-tight closure in vacuum and throughout all pressure ranges, as well as at full rated differential pressure. A variety of materials allows optimum seat life in all applications.

General applications

- Airport refueling
- Hydrocarbon processing
- HVAC
- Chemical processing
- Purified gas
- Steam and vacuum services
- Potable water
- Food processing
- Sour gas
- Military
- Oxygen
- Pharmaceutical
- Ammonia
- Chlorine
- Reverse osmosis
- Category 'M' fluids
- Slurry
- Modulating control





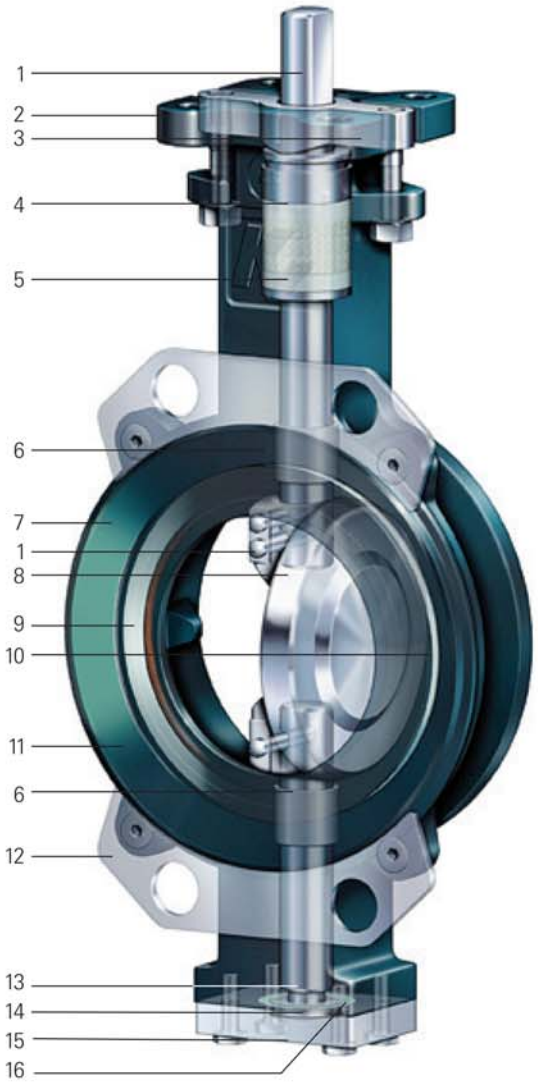
Technical data

Size range:	NPS 2 to NPS 36
Pressure rating:	ASME 150 and 300
Temperature rating:	-20°F to 1000°F
Fire-safe option	

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Materials

No.	Description	Material	Material standard
1	Shaft and taper pins	17-4 PH 316B SS NITRONIC 50® K-Monel® 500 Inconel® 718	ASTM A564 Condition H1075 or H1100 ASTM A276-316 Condition B (NPS 10 and smaller) ASTM A276-XM19 QQ-N-286 UNS N005500 Class A age-hardened
2	Body	Carbon steel Stainless steel Nickel aluminum bronze	ASTM A216-WCB ASTM A351-CF8M MIL B24480 CDA C95800/ASTM B148
3	Gland bridge	17-4PH stainless steel Carbon steel	
4	Packing gland follower	316 stainless steel	
5	Shaft packing	PTFE Graphite Style 9000 EVSP simplified	
6	Shaft bearing	316 stainless steel/Nitride, PTFE/Bronze, PTFE/Composite	
7	Body gasket	Non-asbestos fiber, Graphite PTFE	
8	Disc	316 stainless steel 316 stainless steel/ENP Monel®	ASTM A351-CF8M ASTM A351-CF8M/electroless nickel plated QQ-N-288 Composition A
9	Seat	Polymer Elastomer Metal Fire-safe	PTFE, RTFE, UHMWPE NBR, EPDM, Fluoroelastomer (FKM) 316 stainless steel, Monel® RTFE/316 stainless steel
10	Seat backing ring	Stainless steel	
11	Seat retainer ring	Carbon steel 316 Stainless steel Nickel aluminum bronze	
12	Flange locator plate	Stainless steel Carbon steel/zinc plated	
13	Disc locating shoulder	316 stainless steel	
14	Bottom cover gasket	Non-asbestos fiber or Graphite	
15	Bottom cover plate	316 stainless steel	
16	Thrust washer	Stainless steel/Nitride	



Recommended standards and specifications

ASME	B16.34	Steel valves
	B31.1	Power piping (Sect 107)
	B31.3	Chemical plant and petroleum refinery piping
	B16.5	Steel pipe flanges and flange fittings
MSS	SP-6	Standard finishes for pipe flanges
	SP-25	Standard marking systems for valves
	SP-55	Quality standard for steel casting
	SP-61	Pressure testing of steel valves
	SP-68	High pressure offset disc butterfly valves
API	609	Butterfly valves (most models)
	607	Fire-test for soft seated quarter-turn valves
	598	Valve inspection and test
BS	5146	Inspection and test of steel valves for the petroleum, petrochemical and allied industries
	4504	Flanges and bolting for pipes, valves and fittings
JIS	2215	Basic dimensions for steel pipe flanges
NSF/ANSI Standard 61		Potable water

Principles of operation

Double offset disc/shaft

K-LOK®'s unique two-piece shaft and double-offset disc/shaft design allows for high cycling and creates a lower disc profile with increased capacity and a range of 33:1.

In addition to increasing the flow area across the disc, this design minimizes wear points between seat and disc.

The first offset is achieved by locating the shafts downstream of the center-line of the seat. This allows for a totally unobstructed 360° sealing surface.

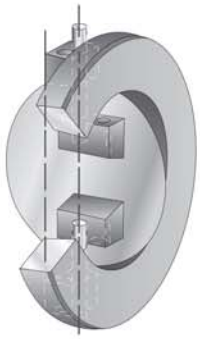
The second offset locates the shafts off-center of the vertical axis of the seat.

The combination of these two offsets creates a camming effect as the disc swings into and out of the seat. The disc lifts quickly out of the seat in the first few degrees of travel and does not contact the seat again until it is nearly closed. There are no wear points between the seat and disc, while operating torques are reduced and seat life is extended.

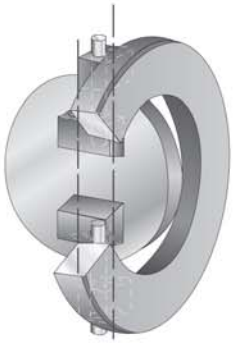
Double offset



First offset



Second offset

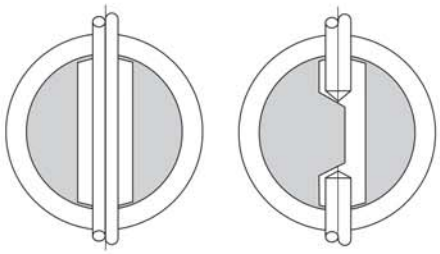


Two-piece shaft vs. one-piece shaft

K-LOK®'s disc geometry maximizes flow capacity by increasing the available flow area through the valve. This increase in disc efficiency results in a higher valve C_V.

Competitor
one-piece shaft

K-LOK®
two-piece shaft



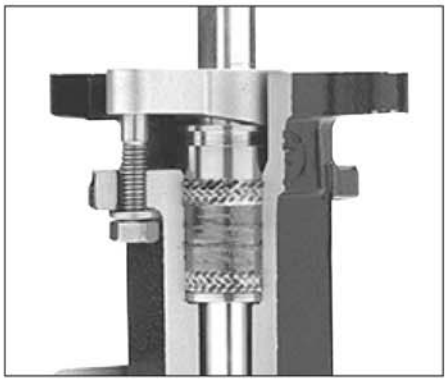
Aspect ratio = open area ÷ disc area

Fire-safe valve
API 607 4th edition approved by third party witness

The K-LOK® fire-safe design uses a stainless steel or alloy seat of convoluted shape that mates with an RTFE member. In the full-closed position, the K-LOK® provides continuous two-plane contact between the disc and both metal and RTFE seats. The fire-safe seat utilizes wire windings to provide the circumferential stiffness necessary to maintain interference between disc and seat.



Fire-safe seat



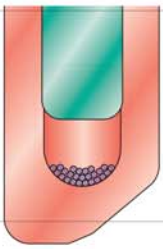
Fire-safe packing

K-LOK® fire-safe packing is composed of three rings of preformed graphite between one ring of woven graphite rope at the top and bottom.

This arrangement creates a superior, high temperature seal against the outer wall of the packing box and around the rotating shaft.

Seat materials

Seat	Material	Typical applications
1. RTFE	Reinforced polytetrafluoroethylene	HVAC, steam, chlorine, ammonia, nitrogen, water, gasoline, vacuum
2. PTFE	Polytetrafluoroethylene	Pharmaceuticals, air, potable water, dyes, white mediums
3. UHMWPE	Ultra high molecular weight polyethylene	Abrasives, suspended solids, scaling mediums
For seats 1 thru 3		
Wire wrap	Stainless steel braided wire	
Seat backing ring	Polyester or phenolic Stainless steel	General purpose services up to 200°F Steam, ammonia, elevated temperature services



Seat	Material	Typical applications
4. EPDM	–	Water based mediums, slurry applications, abrasives
5. NBR	–	Oil based mediums, slurry applications, abrasives
6. Fluoroelastomer (FKM)	–	Elevated temperatures, slurry applications, abrasives
For seats 4 thru 6		
Metal insert	Carbon steel	



Seat	Material	Typical applications
7. Metal	316 stainless steel or alloy (fash chrome coated)	High temperature, low temperature, abrasives, fly ash, slurries
8. Fire-safe	Reinforced polytetrafluoroethylene combined with 316 stainless steel (flash chrome coated)	Fire-safe installations, abrasives, slurries, steam
For seats 7 and 8		
Wire wrap	Stainless steel braided wire	



Seat design

The K-LOK® seat is a true interference seat design and does not rely on line pressure to assist in sealing. All seats seal drop-tight bi-directionally at low pressure as well as high pressure.

Polymer (PTFE, RTFE and UHMWPE) seats incorporate a stainless steel braided wire winding, enclosed in a U-shape envelope to provide seating energy and memory. This wire winding allows axial flexibility in both directions of flow. The winding also allows radial flexibility when the disc is not fully closed, reducing seat/disc interference, seat wear and shaft torque. When the disc closes, it provides circumferential stiffness and assures the required disc/seat seals tight.

Elastomer seats are molded around a stack of V-shaped steel rings that provide the same stability, support and flexure as the wire windings in polymer seats.

Metal seats employ a stainless steel or alloy ring of convoluted shape, reinforced by stainless steel wire windings. The thin, convoluted shape allows for expansion and contraction from thermal cycling. Long life is assured by flash coating the seat with chrome.



ASME/FCI 70-2 control valve seat leakage, tolerances, and test specifications

ASME B16.104-1976	Maximum leakage			Test medium	Pressure and temperature
Class VI	Nominal port diameter (NPS)	Bubbles per minute[3]	ml. per minute	Air or nitrogen	Service ΔP or 50 psig, whichever is lower, at 50°F to 125°F
	2	3	0.45		
	2½	4	0.60		
	3	6	0.90		
	4	11	1.70		
	6	27	4.00		
	8	45	6.75		
Class V	5 x 10^{-4} ml/min/psig/in. port dia.			Water	Service ΔP at 50°F to 125°F
Class IV	0.01% valve capacity at full travel			Air or water	Service ΔP or 50 psig, whichever is lower, at 50°F to 125°F

Notes:

1. K-LOK® polymer and elastomer seats meet or exceeds ASME Class VI shut-off.
2. K-LOK® metal seats and fire-safe seats (post fire exposure) meet or exceeds ASME Class IV shut-off.
3. Using the ASME/FCI specified calibrated measuring device.

Reference ASME/FCI 70-2 for further information.

C_v values vs. travel position

Size (NPS)	Angle of opening 10°	20°	30°	40°	50°	60°	70°	80°	ASME 150 90°	ASME 300 90°
2	6	10	19	34	51	78	105	134	163	160
2½	6	10	19	34	53	80	111	148	175	170
3	8	12	24	43	67	100	139	186	220	215
4	16	23	44	80	130	194	269	360	425	413
5	30	44	83	149	242	366	504	673	795	785
6	50	70	130	230	370	550	760	1,010	1,195	1,140
8	83	117	251	437	695	1,052	1,496	2,001	2,440	2,300
10	144	202	454	754	1,185	1,821	2,611	3,541	4,540	4,333
12	208	304	678	1,051	1,625	2,766	3,838	5,325	6,915	6,600
14	257	360	747	1,186	1,909	3,121	4,416	6,225	8,300	7,920
16	308	432	803	1,422	2,289	3,614	5,251	7,530	10,040	9,580
18	373	548	1,121	1,869	2,990	4,735	6,728	9,845	12,460	11,890
20	463	680	1,390	2,315	4,010	6,175	8,795	12,655	15,430	14,720
24	650	991	2,076	3,803	6,060	9,091	13,301	18,466	21,660	20,665
30	1,015	1,550	3,240	4,670	9,460	14,200	21,400	29,800	36,000	-
36	1,460	2,300	4,640	5,950	13,700	21,000	30,400	44,000	56,000	-

Vacuum rating

The combination of interference fit seats and bi-directional packing makes the K-LOK® especially well suited for vacuum service.

Standard K-LOK® high performance valves are rated to an absolute pressure of 4 x 10^{-5} inch Hg. Higher vacuum applications are available.

Seating and un-seating torque

Seating and un-seating torques are a function of the size of the valve and the shutoff pressure of the system.

Specific torque ratings can be found in the seating/un-seating chart at the intersection of the 'size' row and the 'shutoff pressure' column.

Torques listed are for PTFE and RTFE seated valves. For different seat materials, specific multipliers are to be used as stated.

All torques listed are for normal service conditions (i.e. operating frequency is a minimum of once per month; disc corrosion is expected to be mild or minor, the media is a clean gas, liquid or steam, and is non-abrasive) and chemical effects upon the seat are minor.

PTFE and RTFE bi-directional seating and un-seating torque values

Valve size (NPS)	Shaft mounting code (ASME) 150	300	Seating and un-seating torque (lbs in) System shutoff pressure (psig) 150	200	285	400	500	740
2	BAB	BAB	220	280	380	460	520	580
2½	BAB	BAB	220	280	380	460	520	580
3	BAC	BAC	250	320	430	520	590	650
4	BAD	BAD	475	600	820	995	1,120	1,235
5	BAD	BAD	925	1,125	1,350	1,570	1,750	1,900
6	CAD/CAE*	CAE	1,370	1,600	1,850	2,150	2,390	2,900
8	CAF	CAF	2,060	2,330	3,200	4,020	4,870	6,720
10	CAF/CAG*	CAG	3,340	3,650	4,700	6,250	7,450	9,850
12	DAG	DAG	4,590	5,250	6,400	8,160	9,690	12,940
14	DAH	DAJ	6,750	7,560	9,150	11,450	13,300	17,200
16	DAH	DAK	9,350	10,450	12,600	15,000	17,500	22,200
18	DAJ	DBA	11,900	13,300	15,800	19,500	21,900	28,500
20	DAK	LAX	15,600	17,500	21,000	25,200	28,700	36,140
24	DAK	MAY	21,700	25,340	30,600	36,900	42,100	54,000
30	MAZ	NAW	29,200	35,000	43,500	-	-	-
36	MBE	EBD	52,500	58,500	70,000	-	-	-

*CAE and CAG mounting codes apply for shaft mounting of UHMWPE, metal and fire-safe seats.

Notes:

1. Torques are applicable only to PTFE and RTFE seats in noncorrosive or non-abrasive services such as water. For fire-safe and metal seats, select only the torque for the valve at 285 psig and multiply by 2.0.
2. For other seat materials, select the torque applicable for the maximum differential pressure and multiply by the following factor:

EPDM/NBR/Fluoroelastomer (FKM):	x 1.4
UHMWPE (clean service):	x 1.3

3. For corrosive, abrasive or other services than water, multiply by the following factor:

High solids slurry:	x 1.5
Dry gas:	x 2.0
Dry powders:	x 2.7
Liquids other than water:	x 1.2
Lubricating fluids:	x 0.8

   For services that combine unfriendly conditions such as extreme temperatures and high solids, or corrosive with high temperatures, contact your sales representative.

Extension brackets for various temperatures

Pipeline fluid temperature	Required extension lengths (inches) Handle	Gear	Std. F79U/MRP	High temp. F79U/MRP	Standard F777
-100°F to 375°F	–	–	–	–	–
376°F to 460°F	4	–	–	–	4
461°F to 560°F	6	4	4	–	4
561°F to 650°F	6	4	4	–	4
651°F to 725°F	6	6	6	4	6
726°F to 825°F	8	8	8	6	8
826°F to 925°F	10	8	8	6	8
926°F to 1000°F	10	10	10	8	10

Notes:

1. Surrounding air temperature is assumed to be 70°F. For every degree over 100°F of the surrounding air, deduct 2 degrees from the maximum temperature ranges shown under the Pipeline fluid temperature column. (Example: 125°F external temperature reduces maximum temperature values under the Pipeline fluid temperature column to 325, 410, 510, 600, etc.)
2. Valves may be insulated or uninsulated.
3. Brackets may be open rectangular tubes or the standard closed Keystone tubular shaft extensions.
4. All actuators have a maximum service temperature (outside atmosphere). These temperature limitations apply regardless of K-LOK® extension lengths.

Flange gaskets

The K-LOK® high performance butterfly valve is designed to accommodate the use of standard, non-metallic gaskets for pipe flanges (such as compressed fiber, rubber, non-asbestos, flexible graphite, asbestos or equivalent gasket materials), meeting the dimensional requirements of ASME B16.21-1992. Metallic wound gaskets may also be used, however, please note that any valve with a bolted on retainer requires the wound gaskets material to be manufactured to the following dimensions (inches):

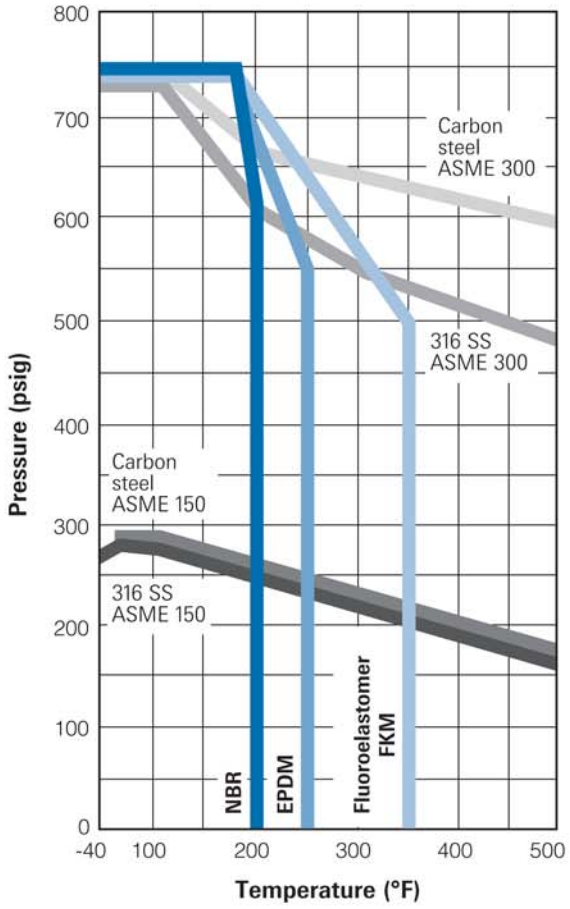
NPS	Outside diameter	Inside diameter
2	3 3/8	2 3/4
2 1/2	3 7/8	3 1/4
3	4 3/4	4
4	5	4 1/8
5	6 1/8	5 1/4
6	7 3/16	6 1/4
8	9 3/16	8
10	11 5/16	10 1/8
12	13	11 1/2
14	14 1/2	13
16	16 1/2	14 3/4
18	18	16
20	19 3/4	18
24	26 1/4	24
30	29 1/2	27 1/2
36	36 1/2	34 1/4

Pressure/temperature ratings for bodies, discs and seats

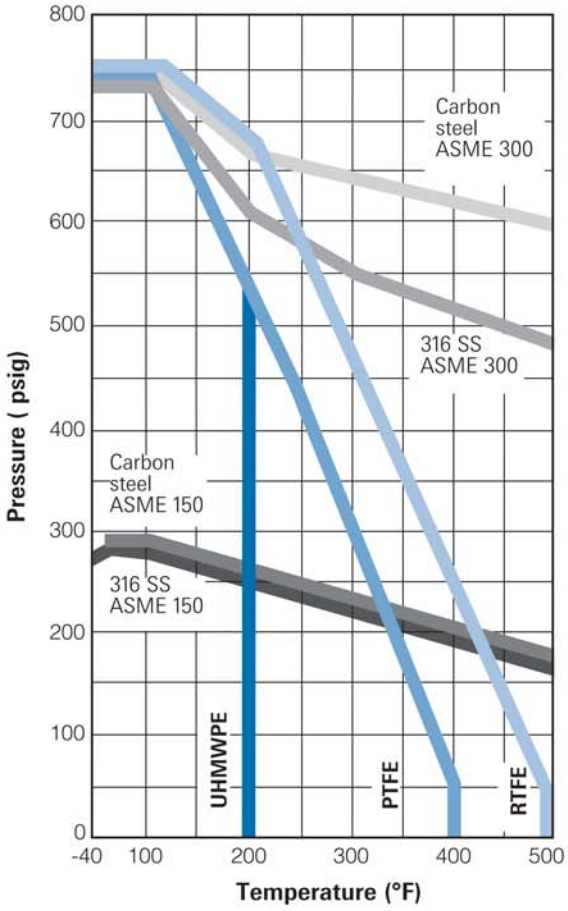
	Temperature (°F)															
Pressure (psi)	**40**	**-20**	**0**	**100**	**180**	**200**	**250**	**300**	**400**	**450**	**500**	**600**	**700**	**800**	**900**	**1000**
ASME 150 body (Fig. 360 wafer style & Fig. 362 lug style)																
Fig. 360/362 Carbon steel	285	285	285	270	260	245	230	200	185	170	140	110	80			
Fig. 360/362 Stainless steel	275	275	275	275	250	240	227	215	195	182	170	140	110	80	50	20
Fig. 360/362 Nickel aluminium bronze	250	250	250	250	240	235	222	210	180	170	160	150				
Fig. 360/362 Ductile iron	250	250	250	240	235	225	215	200	185	170	140					
ASME 300 body (Fig. 370 wafer style & Fig. 372 lug style)																
Fig. 370/372 Carbon steel	740	740	740	700	675	665	655	635	617	600	550	535	410			
Fig. 370/372 Stainless steel	720	720	720	720	645	620	590	560	515	497	480	450	430	415	395	365
Fig. 370/372 Nickel aluminium bronze	700	700	700	700	625	600	675	550	500	475	450	400				
Fig. 370/372 Ductile iron	640	640	640	610	600	583	565	525	510	495	465					
ASME 150 disc																
Fig. 360/362 Stainless steel	275	285	285	285	270	260	245	230	200	185	170	140	110	80	50	20
Fig. 360/362 Nickel aluminium bronze	250	250	250	250	240	235	222	210	180	170	160	150				
Fig. 360/362 Monel®	230	230	230	230	210	200	195	190	185	182	170	140	110	80		
Fig. 360/362 Ductile iron	250	250	250	240	235	225	215	200	185	170	140					
ASME 300 disc																
Fig. 370/372 Stainless steel	720	740	740	740	700	675	665	655	635	617	600	550	535	410	395	365
Fig. 370/372 Nickel aluminium bronze	700	700	700	700	625	600	575	500	500	475	450	400				
Fig. 370/372 Monel®	600	600	600	600	580	530	520	495	480	475	475	475	475	460		
Fig. 370/372 Ductile iron	640	640	640	610	600	583	565	525	510	495	465					
K-LOK® seats																
Teflon (TFE)	740	740	740	740	600	565	450	325								
Reinforced TFE (RTFE)	740	740	740	740	700	680	550	450	225	100						
UHMWPE	740	740	740	740	575	555										
NBR	740	740	740	625												
EPDM	740	740	740	740	740	675	550									
Metal - 316 SS	285	285	285	285	270	255	245	230	200	185	170	135	110	80	50	20
Monel®-400	285	285	285	285	270	255	245	230	200	185	170	135	110	80	50	20
Fire-safe - RTFE/316 SS	285	285	285	285	285	285	285	285	225	100						
Fire-safe - RTFE/Monel®	285	285	285	285	285	285	285	285	225	100						

Pressure/temperature ratings for seat materials

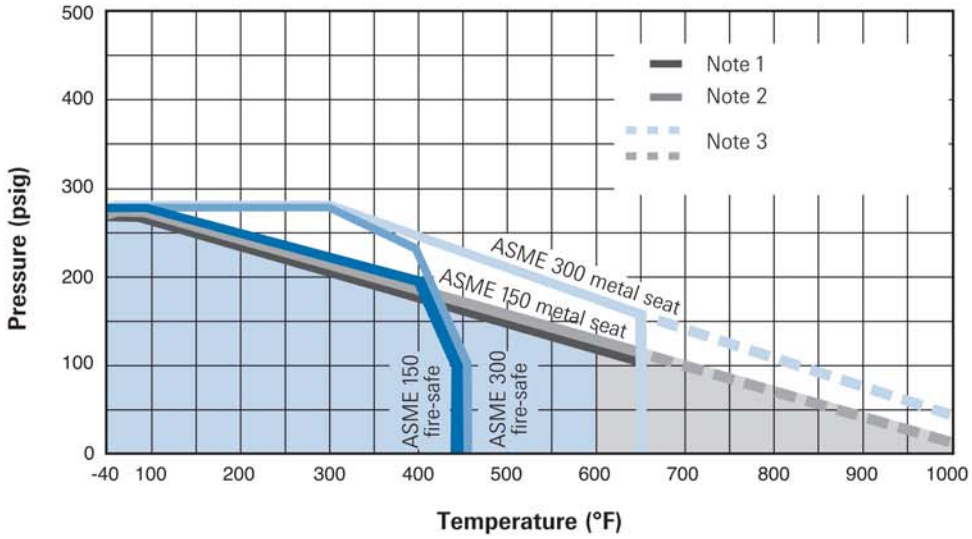
Elastomer seats



Polymer seats



Fire-safe and metal seats



Notes:
1. Carbon steel ASME 150 body
2. 316 SS ASME 150 body
3. For continuous service above 650°F, please consult your sales representative

Recommended flange bolt lengths

Lugged body ASME 150 - Fig. 362

Valve size (in.)	Hex head machine bolt Qty.	Size	Length (in.)	All thread Qty.	Size	Length (in.)
2	4	5/8 - 11UNC	x 1 3/4	4	5/8 - 11UNC	x 2 1/2
	4	5/8 - 11UNC	x 2	4	5/8 - 11UNC	x 2 3/4
2 1/2	8	5/8 - 11UNC	x 1 3/4	8	5/8 - 11UNC	x 2 1/2
3	4	5/8 - 11UNC	x 2	4	5/8 - 11UNC	x 2 3/4
	4	5/8 - 11UNC	x 1 1/2	4	5/8 - 11UNC	x 2 1/2
4	8	5/8 - 11UNC	x 2	8	5/8 - 11UNC	x 2 3/4
	8	5/8 - 11UNC	x 1 3/4	8	5/8 - 11UNC	x 2 1/2
5	16	3/4 - 10UNC	x 2	16	3/4 - 10UNC	x 3
6	8	3/4 - 10UNC	x 2 1/4	8	3/4 - 10UNC	x 3
	8	3/4 - 10UNC	x 2	8	3/4 - 10UNC	x 3 1/4
8	8	3/4 - 10UNC	x 2 1/2	8	3/4 - 10UNC	x 3 1/2
	8	3/4 - 10UNC	x 2	8	3/4 - 10UNC	x 3
10	12	7/8 - 9UNC	x 2 3/4	12	7/8 - 9UNC	x 4
	12	7/8 - 9UNC	x 2 1/4	12	7/8 - 9UNC	x 3 1/4
12	12	7/8 - 9UNC	x 3	12	7/8 - 9UNC	x 4
	12	7/8 - 9UNC	x 2 1/2	12	7/8 - 9UNC	x 3 3/4
14	12	1 - 8UN	x 3 1/2	12	1 - 8UN	x 4 3/4
	12	1 - 8UN	x 3	12	1 - 8UN	x 4 1/4
16	32	1 - 8UN	x 3	32	1 - 8UN	x 4
18	32	1 1/8 - 8UN	x 3 3/4	32	1 1/8 - 8UN	x 5
20	32	1 1/8 - 8UN	x 4	32	1 1/8 - 8UN	x 5 1/2
	8	1 1/8 - 8UN	x 3	8	1 1/8 - 8UN	x 4 1/2
24	20	1 1/4 - 8UN	x 5	20	1 1/4 - 8UN	x 6 1/2
	20	1 1/4 - 8UN	x 4 1/2	20	1 1/4 - 8UN	x 6
30	48	1 1/4 - 8UN	x 6	48	1 1/4 - 8UN	x 7 1/2
	8	1 1/4 - 8UN	x 4 1/2	8	1 1/4 - 8UN	x 6
36	28	1 1/2 - 8UN	x 7 1/2	28	1 1/2 - 8UN	x 9 1/2
	28	1 1/2 - 8UN	x 7	28	1 1/2 - 8UN	x 9
	4	1 1/2 - 8UN	x 5	4	2 - 8UN	x 7
	4	1 1/2 - 8UN	x 6	4	2 - 8UN	x 8

Lugged body ASME 300 - Fig. 372

Valve size (in.)	Hex head machine bolt Qty.	Size	Length (in.)	All thread Qty.	Size	Length (in.)
2	16	5/8 - 11UNC	x 2	16	5/8 - 11UNC	x 3
2 1/2	8	3/4 - 10UNC	x 1 3/4	8	3/4 - 10UNC	x 2 3/4
	8	3/4 - 10UNC	x 2	8	3/4 - 10UNC	x 2 3/4
3	8	3/4 - 10UNC	x 2 1/4	8	3/4 - 10UNC	x 3 1/4
	8	3/4 - 10UNC	x 1 3/4	8	3/4 - 10UNC	x 2 3/4
4	8	3/4 - 10UNC	x 2 1/2	8	3/4 - 10UNC	x 3 1/4
	8	3/4 - 10UNC	x 2	8	3/4 - 10UNC	x 3
5	8	3/4 - 10UNC	x 2 1/2	16	3/4 - 10UNC	x 3 1/2
	8	3/4 - 10UNC	x 2 1/4			
6	12	3/4 - 10UNC	x 2 3/4	24	3/4 - 10UNC	x 3 1/2
	12	3/4 - 10UNC	x 2 1/4			
8	12	7/8 - 9UNC	x 3 1/4	12	7/8 - 9UNC	x 4 1/2
	12	7/8 - 9UNC	x 2 1/2	12	7/8 - 9UNC	x 3 1/2
10	16	1 - 8UN	x 3 3/4	16	1 - 8UN	x 5
	16	1 - 8UN	x 3	16	1 - 8UN	x 4 1/4
12	16	1 1/8 - 8UN	x 4	16	1 1/8 - 8UN	x 5 1/2
	16	1 1/8 - 8UN	x 3 1/2	16	1 1/8 - 8UN	x 4 3/4
14	16	1 1/8 - 8UN	x 4 1/2	16	1 1/8 - 8UN	x 6
	16	1 1/8 - 8UN	x 4	16	1 1/8 - 8UN	x 5 1/2
	4	1 1/8 - 8UN	x 3 1/4	4	1 1/8 - 8UN	x 4 3/4
	4	1 1/8 - 8UN	x 3	4	1 1/8 - 8UN	x 4 1/2
16	16	1 1/4 - 8UN	x 5	16	1 1/4 - 8UN	x 6 1/2
	16	1 1/4 - 8UN	x 4 1/2	16	1 1/4 - 8UN	x 6
	8	1 1/4 - 8UN	x 3 1/2	8	1 1/4 - 8UN	x 5
18	40	1 1/4 - 8UN	x 5	40	1 1/4 - 8UN	x 6 1/2
	8	1 1/4 - 8UN	x 3 1/2	8	1 1/4 - 8UN	x 5
20	40	1 1/4 - 8UN	x 5 1/2	40	1 1/4 - 8UN	x 7
	4	1 1/4 - 8UN	x 4	4	1 1/4 - 8UN	x 5 1/2
	4	1 1/4 - 8UN	x 4 1/2	4	1 1/4 - 8UN	x 6
24	40	1 1/2 - 8UN	x 6	40	1 1/2 - 8UN	x 8
	4	1 1/2 - 8UN	x 5	4	1 1/2 - 8UN	x 7
	4	1 1/2 - 8UN	x 4 1/2	4	1 1/2 - 8UN	x 6 1/2
30	48	1 3/4 - 8UN	x 7	48	1 3/4 - 8UN	x 9
	8	1 3/4 - 8UN	x 5 1/2	8	1 3/4 - 8UN	x 7 1/2

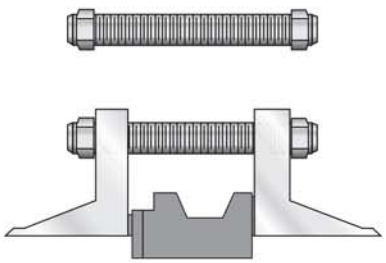
Wafer body ASME 150 - Fig. 360

Valve size (in.)	Hex head machine bolt Qty.	Size	Length (in.)	All thread Qty.	Size	Length (in.)
2	4	5/8 - 11UNC	x 5	4	5/8 - 1UNC	x 5 1/2
2 1/2	4	5/8 - 11UNC	x 4 1/2	4	5/8 - 11UNC	x 5
3	4	5/8 - 11UNC	x 4 1/2	4	5/8 - 11UNC	x 5 1/4
4	8	5/8 - 11UNC	x 4 3/4	8	5/8 - 11UNC	x 5 1/2
5	8	3/4 - 10UNC	x 5	8	3/4 - 10UNC	x 6
6	8	3/4 - 10UNC	x 5 1/4	8	3/4 - 10UNC	x 6
8	8	3/4 - 10UNC	x 5 3/4	8	3/4 - 10UNC	x 6 1/2
10	12	7/8 - 9UNC	x 6 1/4	12	7/8 - 9UNC	x 7
12	12	7/8 - 9UNC	x 7	12	7/8 - 9UNC	x 7 1/2
14	12	1 - 8UN	x 7 1/2	12	1 - 8UN	x 8 1/2
16	16	1 - 8UN	x 8	16	1 - 8UN	x 9
18	16	1 1/8 - 8UN	x 9 1/4	16	1 1/8 - 8UN	x 10 1/2
20	16	1 1/8 - 8UN	x 10	16	1 1/8 - 8UN	x 11
	4	1 1/8 - 8UN	x 3 1/2	4	1 1/8 - 8UN	x 5
	4	1 1/8 - 8UN	x 3	4	1 1/8 - 8UN	x 4 1/2
24	20	1 1/4 - 8UN	x 11 1/2	20	1 1/4 - 8UN	x 12 1/2
30	24	1 1/4 - 8UN	x 13 1/4	24	1 1/4 - 8UN	x 16
	4	1 1/4 - 8UN	x 3 1/2	4	1 1/4 - 8UN	x 5 1/4
	4	1 1/4 - 8UN	x 3 1/4	4	1 1/4 - 8UN	x 4 3/4
36	28	1 1/2 - 8UN	x 15	28	1 1/2 - 8UN	x 18 3/4
	4	1 1/2 - 8UN	x 5	4	1 1/2 - 8UN	x 6 3/4
	4	1 1/2 - 8UN	x 4	4	1 1/2 - 8UN	x 6

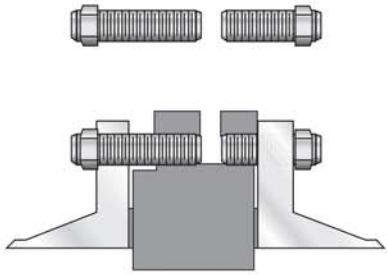
Wafer body ASME 300 - Fig. 370

Valve size (in.)	Hex head machine bolt Qty.	Size	Length (in.)	All thread Qty.	Size	Length (in.)
2	8	5/8 - 11UNC	x 5 1/4	8	5/8 - 11UNC	x 5 3/4
2 1/2	8	3/4 - 10UNC	x 4 3/4	8	3/4 - 10UNC	x 5 1/2
3	8	3/4 - 10UNC	x 5	8	3/4 - 10UNC	x 5 3/4
4	8	3/4 - 10UNC	x 5 1/2	8	3/4 - 10UNC	x 6 1/2
5	8	3/4 - 10UNC	x 6	8	3/4 - 10UNC	x 7
6	12	3/4 - 10UNC	x 6	12	3/4 - 10UNC	x 7
8	12	7/8 - 10UNC	x 7 1/4	12	7/8 - 9UNC	x 8
10	12	1 - 8UN	x 8 1/4	12	1 - 8UN	x 9 1/2
	4	1 - 8UN	x 3 7/8	4	1 - 8UN	x 4 7/8
	4	1 - 8UN	x 3 1/8	4	1 - 8UN	x 4 1/8
12	16	1 1/8 - 8UN	x 9	16	1 1/8 - 8UN	x 10
14	16	1 1/8 - 8UN	x 10 1/4	16	1 1/8 - 8UN	x 11 1/2
	4	1 1/8 - 8UN	x 3 1/4	4	1 1/8 - 8UN	x 4 3/4
	4	1 1/8 - 8UN	x 3	4	1 1/8 - 8UN	x 4 1/2
16	16	1 1/4 - 8UN	x 11 1/2	16	1 1/4 - 8UN	x 12 1/2
	4	1 1/4 - 8UN	x 3 1/4	4	1 1/4- 8UN	x 4 3/4
	4	1 1/4 - 8UN	x 3	4	1 1/4 - 8UN	x 4 1/2
18	20	1 1/4 - 8UN	x 12	20	1 1/4 - 8UN	x 13 1/2
	4	1 1/4 - 8UN	x 3 1/2	4	1 1/4 - 8UN	x 5
	4	1 1/4 - 8UN	x 3	4	1 1/4 - 8UN	x 4 3/4
20	20	1 1/4 - 8UN	x 13	20	1 1/4 - 8UN	x 14
	8	1 1/4 - 8UN	x 4	8	1 1/4 - 8UN	x 5 1/2
24	20	1 1/2 - 8UN	x 14 1/2	20	1 1/2 - 8UN	x 16
	4	1 1/2 - 8UN	x 4 3/4	4	1 1/2 - 8UN	x 6 1/2
	4	1 1/2 - 8UN	x 4 1/4	4	1 1/2 - 8UN	x 6 1/4
30	24	1 1/2 - 8UN	x 19	24	1 3/4 - 8UN	x 20 1/2
	8	1 3/4 - 8UN	x 5 1/2	8	1 3/4 - 8UN	x 7 3/4

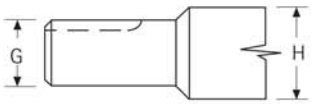
Wafer body



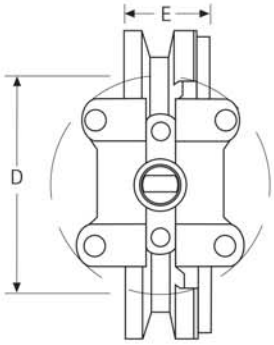
Lugged body



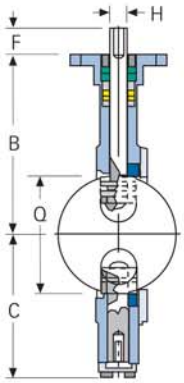
Dimensions – Wafer style



Upper shaft/keyway
NPS 8 to NPS 24



Top plate view



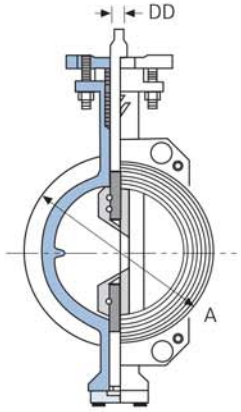


Figure 360, ASME Class 150, wafer style, dimensions (inches)

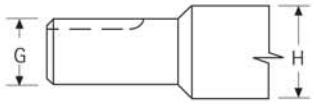
Size (NPS)	A	B	C	D	E	F	G	H	Q	Top plate drilling DD or keyway	Bolt circle	No. holes	Hole dia.	Wt. lbs.	Actuator code
2	4 1/8	6	4 1/4	4	2 3/8	1 1/4	N/A	9/16	1 7/8	3/8	3 1/4	4	7/16	8	BAB
2 1/2	4 1/8	6	4 1/4	4	1 7/8	1 1/4	N/A	9/16	2 5/16	3/8	3 1/4	4	7/16	9	BAB
3	5	6 5/8	4 13/16	4	1 7/8	1 1/4	N/A	5/8	2 3/4	7/16	3 1/4	4	7/16	12	BAC
4	6 3/16	7 1/2	5 13/16	4	2 1/8	1 1/4	N/A	3/4	3 11/16	1/2	3 1/4	4	7/16	20	BAD
5	7 1/4	7 9/16	5 13/16	4	2 1/4	1 1/4	N/A	3/4	4 3/4	1/2	3 1/4	4	7/16	25	BAD
6	8 19/32	8 3/4	6 15/16	6	2 1/4	1 1/4	3/4	7/8	5 5/8	1/2	5	4	9/16	32	CAD
6*	8 19/32	8 3/4	6 15/16	6	2 1/4	1 1/4	N/A	7/8	5 5/8	5/8	5	4	9/16	33	CAE
8	10 5/8	10 1/8	8 3/8	6	2 1/2	2	N/A	1 1/8	7 7/16	1/4 x 1/4 x 1 5/8	5	4	9/16	50	CAF
10	12 3/4	11 3/8	9 11/16	6	2 13/16	2	1 1/8	1 3/8	9 7/16	1/4 x 1/4 x 1 5/8	5	4	9/16	77	CAF
10*	12 3/4	11 3/8	9 11/16	6	2 13/16	3	N/A	1 3/8	9 7/16	5/16 x 5/16 x 2 5/8	5	4	9/16	78	CAG
12	14 3/4	13	10 7/8	8	3 3/16	3	1 3/8	1 1/2	11 1/4	5/16 x 5/16 x 2 5/8	6 1/2	4	13/16	124	DAG
14	16 1/4	13 1/4	11 7/8	8	3 5/8	3	N/A	1 5/8	12 5/16	3/8 x 3/8 x 2 5/8	6 1/2	4	13/16	141	DAH
16	18 1/2	14 1/2	12 7/8	8	4	3	1 5/8	1 3/4	14 1/8	3/8 x 3/8 x 2 5/8	6 1/2	4	13/16	230	DAH
18	21	16	13 7/8	8	4 1/2	4 1/16	N/A	1 7/8	15 15/16	1/2 x 3/8 x 4 1/16	6 1/2	4	13/16	305	DAJ
20	23	17 7/16	15 7/16	8	5	4 5/16	N/A	2 1/4	17 5/8	1/2 x 3/8 x 4	6 1/2	4	13/16	350	DAK
24	27 1/2	19 11/16	17 13/16	8	6 1/16	4 1/4	2 1/4	2 1/2	21 1/16	1/2 x 3/8 x 4	6 1/2	4	13/16	620	DAK
30	33 3/4	24 1/2	21 3/16	9 1/2	7 3/8	7	N/A	3	26 7/8	3/4 x 3/4 x 6	9 3/4	4	1 1/16	1,020	MAZ
36	40 1/4	28 3/8	24 11/16	9 1/2	8 1/2	8	N/A	3 1/2	33 5/16	7/8 x 7/8 x 5 11/16	9 3/4	4	1 1/16	1,850	MBE

Note: * E.N.P. discs require larger upper shaft connection diameters on NPS 6 and NPS 10 valve sizes for UHMWPE seat, metal seat and fire-safe seat trims.

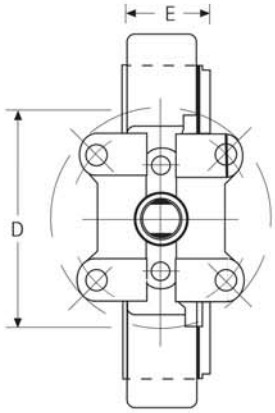
Figure 370, ASME Class 300, wafer style, dimensions (inches)

Size (NPS)	A	B	C	D	E	F	G	H	Q	Top plate drilling DD or keyway	Bolt circle	No. holes	Hole dia.	Tapped lug data No. holes	Bolt circle	Tap	Wt. lbs.	Actuator code
2	4 1/8	6	4 1/4	4	2 3/8	1 1/4	N/A	9/16	1 7/8	3/8	3 1/4	4	7/16	–	–	–	8	BAB
2 1/2	4 1/8	6	4 1/4	4	1 7/8	1 1/4	N/A	9/16	2 5/16	3/8	3 1/4	4	7/16	–	–	–	9	BAB
3	5	6 5/8	4 13/16	4	1 7/8	1 1/4	N/A	5/8	2 11/16	7/16	3 1/4	4	7/16	–	–	–	12	BAC
4	6 3/16	7 1/2	5 13/16	4	2 1/8	1 1/4	N/A	3/4	3 11/16	1/2	3 1/4	4	7/16	–	–	–	20	BAD
5	7 1/4	7 9/16	5 13/16	4	2 5/16	1 1/4	N/A	3/4	4 3/4	1/2	3 1/4	4	7/16	–	–	–	25	BAD
6	8 19/32	8 3/4	6 15/16	6	2 5/16	1 1/4	N/A	7/8	5 5/8	5/8	5	4	9/16	–	–	–	32	CAE
8	10 5/8	10 1/8	8 3/8	6	2 7/8	2	N/A	1 1/8	7 7/16	1/4 x 1/4 x 1 5/8	5	4	9/16	–	–	–	65	CAF
10	12 3/4	11 3/8	9 11/16	6	3 1/4	3	N/A	1 3/8	9 3/8	5/16 x 5/16 x 2 5/8	5	4	9/16	4	15 1/4	1-8UN	95	CAG
12	14 3/4	13	10 7/8	8	3 5/8	3	1 3/8	1 1/2	11 1/4	5/16 x 5/16 x 2 5/8	6 1/2	4	13/16	–	–	–	145	DAG
14	16 1/4	14 3/8	12 5/8	8	4 5/8	4 1/4	N/A	1 7/8	12	1/2 x 3/8 x 4 1/8	6 1/2	4	13/16	4	20 1/4	1 1/8-8UN	270	DAJ
16	18 1/2	16 1/16	13 3/4	8	5 1/4	4 1/8	N/A	2 1/4	13 5/8	1/2 x 3/8 x 4	6 1/2	4	13/16	4	22 1/2	1 1/4-8UN	305	DAK
18	21	17	15 1/8	8	5 7/8	4 7/32	N/A	2 1/2	15 7/16	5/8 x 5/8 x 4	6 1/2	4	13/16	4	24 3/4	1 1/4-8UN	385	DBA
20	23	20 3/16	16 3/4	7 1/2	6 1/4	6 1/2	N/A	2 3/4	17 1/4	5/8 x 5/8 x 6 3/8	8	4	13/16	4	27	1 1/4-8UN	450	LAX
24	27 1/4	23 3/8	19 13/16	9 1/2	7 1/8	6 13/16	N/A	3 1/2	20 3/4	7/8 x 7/8 x 5 11/16	9 3/4	4	1 1/16	4	32	1 1/2-8UN	770	MAY
30	33 3/4	26 5/8	24 9/16	10	9 1/2	7 7/8	N/A	4 1/2	26	1 x 1 x 6 1/2	10	4	1 1/8	4	39 1/4	1 3/4-8UN	1,100	NAW
36	40 1/4	30 7/8	28 7/16	12 1/4	10 3/4	8	N/A	5	32 7/16	1 1/4 x 1 1/4 x 7	12	4	1 1/8	4	46	2-8UN	1,590	EBD

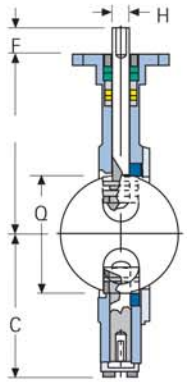
Dimensions – Lug style



Upper shaft/keyway
NPS 8 to NPS 24



Top plate view



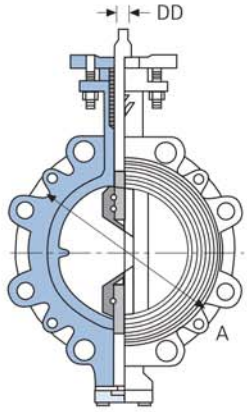


Figure 362, ASME Class 150, lug style, dimensions (inches)

Size (NPS)	A	B	C	D	E	F	G	H	Q	Top plate drilling DD or keyway	Bolt circle	No. holes	Hole dia.	Tapped lug data No. holes	Bolt circle	Tap	Wt. lbs.	Actuator code
2	4 1/8	6	4 1/4	4	2 3/8	1 1/4	N/A	9/16	1 7/8	3/8	3 1/4	4	7/16	4	4 3/4	5/8-11UNC	13	BAB
2 1/2	4 1/8	6	4 1/4	4	1 7/8	1 1/4	N/A	9/16	2 5/16	3/8	3 1/4	4	7/16	4	5 1/2	5/8-11UNC	14	BAB
3	5	6 5/8	4 13/16	4	1 7/8	1 1/4	N/A	5/8	2 3/4	7/16	3 1/4	4	7/16	4	6	5/8-11UNC	15	BAC
4	6 3/16	7 1/2	5 13/16	4	2 1/8	1 1/4	N/A	3/4	3 11/16	1/2	3 1/4	4	7/16	8	7 1/2	5/8-11UNC	26	BAD
5	7 1/4	7 9/16	5 13/16	4	2 1/4	1 1/4	N/A	3/4	4 3/4	1/2	3 1/4	4	7/16	8	8 1/2	3/4-10UNC	31	BAD
6	8 19/32	8 3/4	6 15/16	6	2 1/4	1 1/4	3/4	7/8	5 5/8	1/2	5	4	9/16	8	9 1/2	3/4-10UNC	40	CAD
6*	8 19/32	8 3/4	6 15/16	6	2 1/4	1 1/4	N/A	7/8	5 5/8	5/8	5	4	9/16	8	9 1/2	3/4-10UNC	41	CAE
8	10 5/8	10 1/8	8 3/8	6	2 1/2	2	N/A	1 1/8	7 7/16	1/4 x 1/4 x 1 5/8	5	4	9/16	8	11 3/4	3/4-10UNC	63	CAF
10	12 3/4	11 3/8	9 11/16	6	2 13/16	2	1 1/8	1 3/8	9 7/16	1/4 x 1/4 x 1 5/8	5	4	9/16	12	14 1/4	7/8-9UNC	106	CAF
10*	12 3/4	11 3/8	9 11/16	6	2 13/16	3	N/A	1 3/8	9 7/16	5/16 x 5/16 x 2 5/8	5	4	9/16	12	14 1/4	7/8-9UNC	107	CAG
12	14 3/4	13	10 7/8	8	3 3/16	3	1 3/8	1 1/2	11 1/4	5/16 x 5/16 x 2 5/8	6 1/2	4	13/16	12	17	7/8-9UNC	160	DAG
14	16 1/4	13 1/4	11 7/8	8	3 5/8	3	N/A	1 5/8	12 5/16	3/8 x 3/8 x 2 5/8	6 1/2	4	13/16	12	18 3/4	1-8UN	265	DAH
16	18 1/2	14 1/2	12 7/8	8	4	3	1 5/8	1 3/4	14 1/8	3/8 x 3/8 x 2 5/8	6 1/2	4	13/16	16	21 3/4	1-8UN	305	DAH
18	21	16	13 7/8	8	4 1/2	4 1/16	N/A	1 7/8	15 15/16	1/2 x 3/8 x 4 1/16	6 1/2	4	13/16	16	22 3/4	1 1/8-8UN	415	DAJ
20	23	17 7/16	15 7/16	8	5	4 5/16	N/A	2 1/4	17 5/8	1/2 x 3/8 x 4	6 1/2	4	13/16	20	25	1 1/8-8UN	500	DAK
24	27 1/2	19 11/16	17 13/16	8	6 1/16	4 1/4	2 1/4	2 1/2	21 1/16	1/2 x 3/8 x 4	6 1/2	4	13/16	20	29 1/2	1 1/4-8UN	750	DAK
30	33 3/4	24 1/2	21 3/16	9 1/2	7 3/8	7	N/A	3	26 7/8	3/4 x 3/4 x 6	9 3/4	4	1 1/16	28	36	1 1/4-8UN	1,360	MAZ
36	40 1/4	28 3/8	24 11/16	9 1/2	8 1/2	8	N/A	3 1/2	33 5/16	7/8 x 7/8 x 5 11/16	9 3/4	4	1 1/16	32	42 3/4	1 1/2-8UN	2,250	MBE

Note: * E.N.P. discs require larger upper shaft connection diameters on NPS 6 and NPS 10 valve sizes for UHMWPE seat, metal seat and fire-safe seat trims.

Figure 372, ASME Class 300, lug style, dimensions (inches)

Size (NPS)	A	B	C	D	E	F	G	H	Q	Top plate drilling DD or keyway	Bolt circle	No. holes	Hole dia.	Tapped lug data No. holes	Bolt circle	Tap	Wt. lbs.	Actuator code
2	4 1/8	6	4 1/4	4	2 3/8	1 1/4	N/A	9/16	1 7/8	3/8	3 1/4	4	7/16	8	5	3/4-10UNC	17	BAB
2 1/2	4 1/8	6	4 1/4	4	1 7/8	1 1/4	N/A	9/16	2 5/16	3/8	3 1/4	4	7/16	8	5 7/8	3/4-10UNC	18	BAB
3	5	6 5/8	4 13/16	4	1 7/8	1 1/4	N/A	5/8	2 11/16	7/16	3 1/4	4	7/16	8	6 5/8	3/4-10UNC	20	BAC
4	6 3/16	7 1/2	5 13/16	4	2 1/8	1 1/4	N/A	3/4	3 11/16	1/2	3 1/4	4	7/16	8	7 7/8	3/4-10UNC	26	BAD
5	7 1/4	7 9/16	5 13/16	4	2 5/16	1 1/4	N/A	3/4	4 3/4	1/2	3 1/4	4	7/16	8	9 1/4	3/4-10UNC	31	BAD
6	8 19/32	8 3/4	6 15/16	6	2 5/16	1 1/4	N/A	7/8	5 5/8	5/8	5	4	9/16	12	10 5/8	3/4-10UNC	55	CAE
8	10 5/8	10 1/8	8 3/8	6	2 7/8	2	N/A	1 1/8	7 7/16	1/4 x 1/4 x 1 5/8	5	4	9/16	12	13	7/8-9UNC	80	CAF
10	12 3/4	11 3/8	9 11/16	6	3 1/4	3	N/A	1 3/8	9 3/8	5/16 x 5/16 x 2 5/8	5	4	9/16	16	15 1/4	1-8UN	137	CAG
12	14 3/4	13	10 7/8	8	3 5/8	3	1 3/8	1 1/2	11 1/4	5/16 x 5/16 x 2 5/8	6 1/2	4	13/16	16	17 3/4	1 1/8-8UN	185	DAG
14	16 1/4	14 3/8	12 5/8	8	4 5/8	4 1/4	N/A	1 7/8	12	1/2 x 3/8 x 4 1/8	6 1/2	4	13/16	20	20 1/4	1 1/8-8UN	340	DAJ
16	18 1/2	16 1/16	13 3/4	8	5 1/4	4 1/8	N/A	2 1/4	13 5/8	1/2 x 3/8 x 4	6 1/2	4	13/16	20	22 1/2	1 1/4-8UN	432	DAK
18	21	17	15 1/8	8	5 7/8	4 7/32	N/A	2 1/2	15 7/16	5/8 x 5/8 x 4	6 1/2	4	13/16	24	24 3/4	1 1/4-8UN	550	DBA
20	23	20 3/16	16 3/4	7 1/2	6 1/4	6 1/2	N/A	2 3/4	17 1/4	5/8 x 5/8 x 6 3/8	8	4	13/16	24	27	1 1/4-8UN	850	LAX
24	27 1/4	23 3/8	19 13/16	9 1/2	7 1/8	6 13/16	N/A	3 1/2	20 3/4	7/8 x 7/8 x 5 11/16	9 3/4	4	1 1/16	24	32	1 1/2-8UN	1,278	MAY
30	33 3/4	26 5/8	24 9/16	10	9 1/2	7 7/8	N/A	4 1/2	26	1 x 1 x 6 1/2	10	4	1 1/8	28	39 1/4	1 3/4-8UN	2,450	NAW
36	40 1/4	30 7/8	28 7/16	12 1/4	10 3/4	8	N/A	5	32 7/16	1 1/4 x 1 1/4 x 7	12	4	1 1/8	32	46	2-8UN	2,850	EBD

Common available trims

Figure number	Valve type
F360	ASME Class 150, Wafer
F362	ASME Class 150, Full-lug
F370	ASME Class 300, Wafer
F372	ASME Class 300, Full-lug

To order a K-LOK®, specify the valve size, the valve figure number (listed above) and the specific application trim code. The most common codes, together with the materials of construction, are listed below.
(Example: NPS 10 F360-104)

General purpose trims (up to 250°F)

Trim code	SAP code	Body	Disc	Shaft	Seat/backing ring	Packing	Bearing	Body gasket
106	CES6TSG	Steel	316 SS/ENP	17-4PH SS	UHMWPE/SS	Teflon®	SS-nitrided	Graphite
107	SES6TSG	316 SS	316 SS/ENP	17-4PH SS	UHMWPE/SS	Teflon®	SS-nitrided	Graphite

General purpose trims (up to 500°F)

Trim code	SAP code	Body	Disc	Shaft	Seat/backing ring	Packing	Bearing	Body gasket
123	CES1TSG	Steel	316 SS/ENP	17-4PH SS	RTFE/SS	Teflon®	SS-nitrided	Graphite
124	SES1TSG	316 SS	316 SS/ENP	17-4PH SS	RTFE/SS	Teflon®	SS-nitrided	Graphite
158	CSS1TSG	Steel	316 SS	17-4PH SS	RTFE/SS	Teflon®	SS-nitrided	Graphite
159	SSS1TSG	316 SS	316 SS	17-4PH SS	RTFE/SS	Teflon®	SS-nitrided	Graphite

Metal seated – high temperature trims

Trim code	SAP code	Body	Disc	Shaft	Seat/backing ring	Packing	Bearing	Body gasket
113	CES14GSG	Steel	316 SS/ENP	17-4PH SS	316 SS chrome plated	Graphite	SS-nitrided	Graphite
114	SES14GSG	316 SS	316 SS/ENP	17-4PH SS	316 SS chrome plated	Graphite	SS-nitrided	Graphite

Corrosion resistant trims

Trim code	SAP code	Body	Disc	Shaft	Seat/backing ring	Packing	Bearing	Body gasket
133	SSP1TSG	316 SS	316 SS	316 SS Cond. B	RTFE/SS	Teflon®	SS-nitrided	Graphite
134	SSN1TSG	316 SS	316 SS	NITRONIC 50®	RTFE/SS	Teflon®	SS-nitrided	Graphite

Fire-safe trims

Trim code	SAP code	Body	Disc	Shaft	Seat/backing ring	Packing	Bearing	Body gasket
115	CES10GFG	Steel	316 SS/ENP	17-4PH SS and RTFE	316 SS chrome plated	Graphite	SS-nitrided/ RTFE-epoxy	Graphite
116	SES10GFG	316 SS	316 SS/ENP	17-4PH SS and RTFE	316 SS chrome plated	Graphite	SS-nitrided/ RTFE-epoxy	Graphite

Note:
Other trims are available; please contact your sales representative.

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PENTAIR

VALVES & CONTROLS

K-LOK® Installation, Operation, Maintenance and Troubleshooting



General

Suggested installation orientation is with valve shaft horizontal or inclined from vertical. Unless otherwise recommended by Pentair Valves & Controls, mount the valve in the preferred direction with the directional arrow pointing to the lower pressure side so that the front face of the disc will be upstream when the valve is in the closed position.

Thermal insulation of the body is mandatory for operating temperatures above 392°F [200°C].

K-LOK offers the following body styles:
Wafer – Figures 360 and 370.
Lug/Single Flange – Figures 362 and 372

Inspection

1. Carefully remove the valve from the shipping package (box or pallet) to avoid any damage to the valve and, in the case of automated valves, to the electric or pneumatic/hydraulic actuator or instrumentation.
2. Prior to installation, clean the inside of the valve. Insure that there are no solid objects such as pieces of wood, plastic or packing materials within the valve or on the valve seat.
3. Inspect the seat and disc edge to insure that they were not damaged in handling. This is especially important in the case of valves with “fail-open” actuators.
4. Confirm that the materials of construction listed on the valve nameplate are appropriate for the service intended and are as specified.
5. Locate the directional arrow on the body that defines the preferred mounting orientation in respect to the pressure. In most cases, the valve is properly installed when the actual fluid flow or high pressure is acting on the front face of the disc when the valve is closed.
6. Ensure that the packing gland bolting nuts are tight.

CAUTION
The valve should be installed in the closed position to insure that the seat and disc are not damaged during installation. Particular care should be taken with valves equipped with “fail open” actuators. Failure to insure proper handling may result in damage to the valve. If the pipe is lined, confirm that the disc rotation does not contact the lining during the opening stroke. Failure to confirm that the disc rotation does not contact the lining may result in damage to the valve.

IMPORTANT
Whenever possible, install the valve with the shaft in the horizontal position and, if possible, with the cast-in disc stop located top-side of the pipe. If the shaft cannot be positioned horizontally, position the shaft so that it is not on the vertical centerline in a horizontal pipe run. This will minimize any depositing of solid particles present in the fluid into the lower bearing.

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Installation

The valves are shipped with flange gasket surface protection. Before installing the valve, remove the protection and carefully clean and degrease both surfaces with a solvent.

Lug Series – Figure 362 and 372

1. Orient the valve with the directional flow arrow (preferred direction) pointing in the proper direction.
2. Insert the valve between the flanges until the two bottom holes in the valve align with the two lower flange holes.
3. Insert a bolt or stud through the flange and thread it into the holes in the valve body. This will allow the valve to center itself properly for the installation of the flange gaskets.
4. Install the flange gaskets and the remaining flange bolting.
5. Use the crossover method to tighten all flange bolting.

Wafer Series — Figure 360 and 370

1. Orient the valve with the directional flow arrow (preferred direction) pointing in the proper direction.
2. Insert the valve between the flanges until the alignment holes at either side of the valve match the corresponding holes in the flanges.
3. Insert a long bolt or stud through the flange and thread it through the alignment hole. This will allow the valve to center itself properly for the installation of the flange gaskets.
4. Install the flange gaskets and the remaining flange bolting.
5. Remove the long bolts/studs from the lower alignment holes and replace with correctly-sized bolts.
6. Using the crossover method, tighten all flange bolts.

Valve Checkout

1. Tighten the packing gland bolting just enough to prevent stem leakage. Over-tightening will decrease packing life and increase operating torque requirements.
2. Check the operation of the valve by stroking it to “full open” and “full close.” To determine the valve orientation of the disc, double D’s and keyways are aligned with the disc. The valve disc travels clockwise to close.
3. For automated valves, set the air pressure/electrical voltage for at least the minimum given to operate the actuator. For pneumatic actuators, do not apply more than 1.25 times the pressure for which the actuator was designed.

Note: for spring return actuators with positioners, overpressure will cause excessive time delay in the spring movement for the valve disc to travel out of the seat.

Operation

The K-LOK has been designed to require a minimum of maintenance. Generally, only maintenance on the packing box is required.

Maintenance

If shaft leakage is observed through the packing box, tighten the gland nuts.

Note: do not over-tighten packing box gland nuts. Over-tightening will increase the torque required to operate the valve. When tightening the gland nuts, use half-turn increments until leakage has stopped.

Disassembly

To begin disassembly, refer to the parts list (Figure 2) and proceed as follows:

Warning
Depressurize the valve and associated piping before disassembly. Failure to do so may cause serious personal injury and/or equipment damage.

1. Remove the valve from the line. Clean the valve according to proper cleaning procedures as outlined by the plant or according to a prescribed procedure.
2. Remove the actuator and relevant connecting key. Note the actuator position relative to the valve.

Caution
Throughout disassembly and assembly, always use cardboard or brass shims to protect the valve body, disc, flange and sealing surfaces from damage. Failure to do so may result in serious damage to the valve.

Removing the Disc-to-stem Tapered Pin Connections

1. Open the valve disc (2A) to its full open position.

Note: on valve sizes 10" and larger, it is recommended that two workers perform the disc tapered pin (2D) removal process.

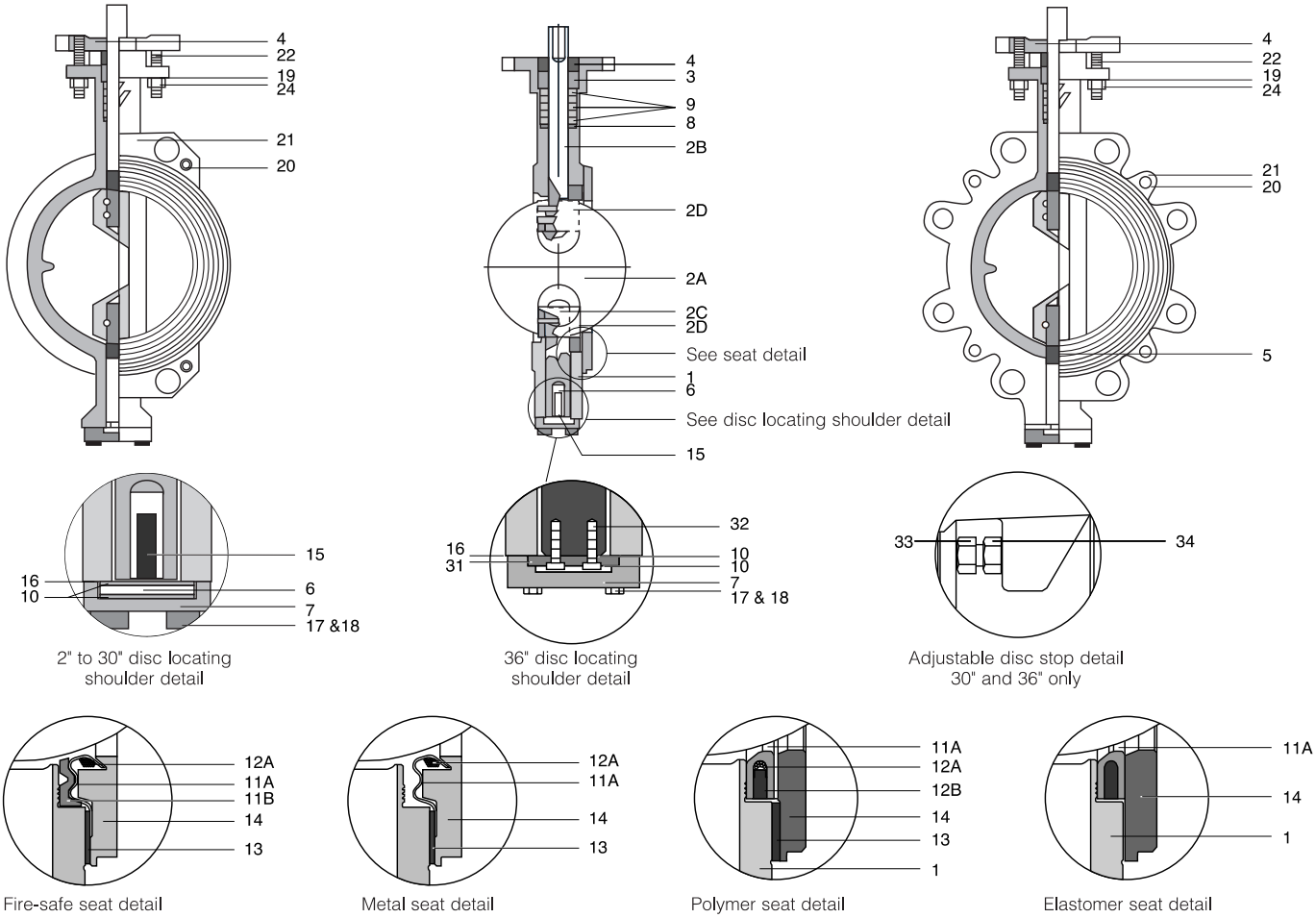
2. Place the disc in a vise.
3. Using a tool steel punch, locate the punch on the small end of the disc taper pin (2D) and then strike the punch with a heavy hammer. (See Figure 1.)



Figure 1 - shows the valve properly clamped in place

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Figure 2



Parts List

1.	Body	11A.	Seat	22.	Packing gland bridge stud
2A.	Disc	11B.	Fire-safe seat insert	23.	Key (8" to 36") (not shown)
2B.	Upper stem	12A.	Seat wire wrap	24.	Hex nut
2C.	Lower stem	12B.	Seat backing ring	25.	I.D. tag (not shown)
2D.	Taper pin, disc	13.	Seat retaining gasket	26.	Flow tag (not shown)
3.	Gland	14.	Seat retaining ring	27.	Strap tag (not shown)
4.	Gland bridge	15.	Taper pin shoulder (2" to 30")	28.	Strap tag (not shown)
5.	Bushing	16.	Gasket bottom cover	29.	Spacer (30" only)
6.	Disc locating shoulder (2" to 30")	17.	Hex head cap screw	30.	Screws (30 & 36") (not shown)
7.	Bottom cover	18.	Lock washer (ext. tooth)	31.	Thrust plate (36" only)
8.	Packing ring, anti-ext.	19.	Lock washer (spring)	32.	Screws (36" only)
9.	Packing set	20.	Hex soc. flat head screw	33.	Screw (30" & 36")
10.	Thrust washer	21.	Clip or locating plate	34.	Nut (30" & 36")

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Note: some of the weld on the three disc taper pins (2D) may need to be removed by grinding.

Warning
When placing the valve into the bench vise, make sure the small end of the disc (2A) taper pin faces the assembler.

Hold the punch with a punch holder or a pair of vise grips. Otherwise, serious injury may occur.

Removing the Bottom Cover Assembly

To disassemble the bottom cover assembly, remove the following bottom cover assembly components:

- bottom cover plate (7)
- thrust washer (10)
- bottom cover gasket (16)
- washer (18)
- screw (17)

Removing the Lower Stem Assembly

Caution
Throughout this operation, make sure the disc edges remain protected from contact with the body by installing cardboard at all disc hub areas. Failure to do so may cause damage to the disc sealing edge.

1. Spray penetrating oil into the disc hub where it meets the stem connection.
2. Locate a wedge-shaped chisel/punch between the disc locating shoulder (6) position and the body (1) bottom surface. (See Figure 3.)
3. Strike the chisel/punch to force the disc locating shoulder (6) away from the valve body (1) surface.
4. Continue to wedge apart the lower stem assembly, via the disc locating shoulder (6), until the lower stem (2C) is free of the disc (2A).
5. Lightly strike the backside of the disc hub area with a hammer if the stem is resistant to removal.

Removing the Packing Gland Assembly

1. Unthread the nuts (24) from the packing bridge studs (22).
2. Remove the packing gland bridge (4).

Removing the Upper Stem and Disc

Caution
Throughout this operation, make sure the disc edges remain protected from contact with the body by installing cardboard at all disc hub areas. Failure to do so may cause damage to the disc sealing edge. Protect the stem from the vise teeth to prevent damage and to eliminate potential for packing leakage

1. When removing the upper stem (2B) from the disc (2A), clamp the vise jaws on to the upper stem (2B) area above the valve body top plate.
2. Once the vise jaws are secure against the upper stem (2B), drive the wedge-shaped chisel/punch between the valve body (1) top plate and the bench vise. (See Figure 4.)
3. As the valve body (1) moves away from the bench vise, the upper stem (2B) is removed from the upper disc (2A) hub.
4. Continue to reposition the valve body (1) with the bench vise so as to allow removal of upper stem (2B).

Caution
Physically hold the disc to prevent the disc from falling and becoming damaged during removal. When both the upper stem (2B) and lower stem (2C) are removed from the disc (2A), the disc is unsupported.

Warning
Smaller discs may be removed by hand (2" to 8"). Remove larger discs with proper hoisting equipment. Failure to do so may result in personal injury or damage to equipment.

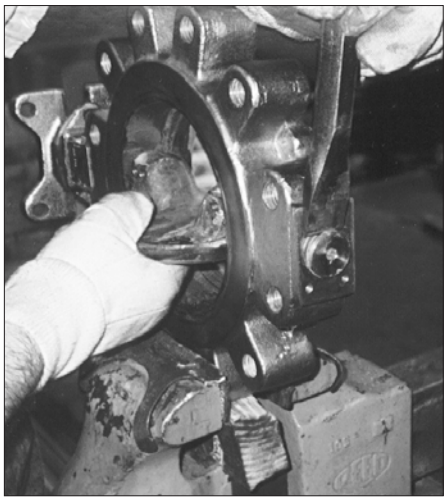


Figure 3 – Shows the proper placement of the disc locating shoulder and the body bottom surface.



Figure 4 – Shows how the upper stem is removed from the upper disk hub.

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Removing the Seat Retainer Ring

Remove the seat retainer ring (14) by removing the hex socket screws (20) or seat retainer screws (30) and the clips (21) for lugged body, or the locating plates (21) for the wafer body. (See Figure 5.)

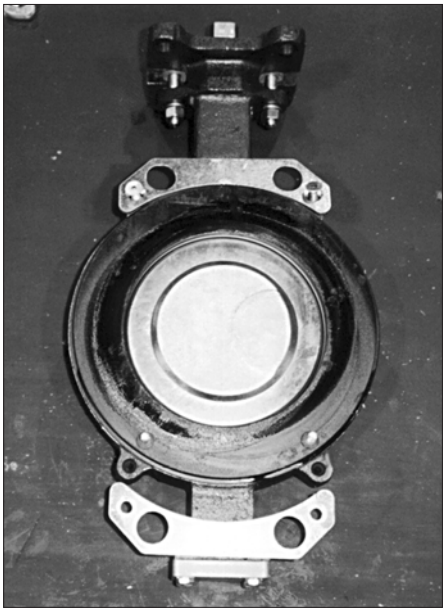


Figure 5 – Seat retainer ring and parts.

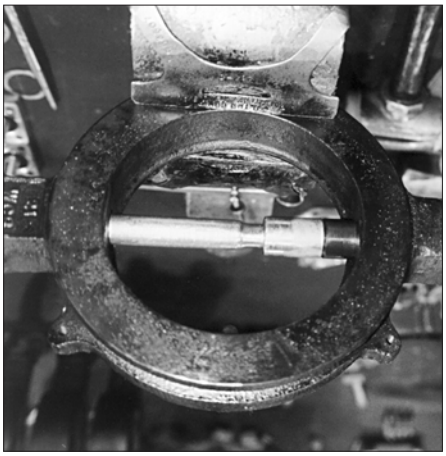


Figure 6 – Shows partial insertion of the stem bearing.

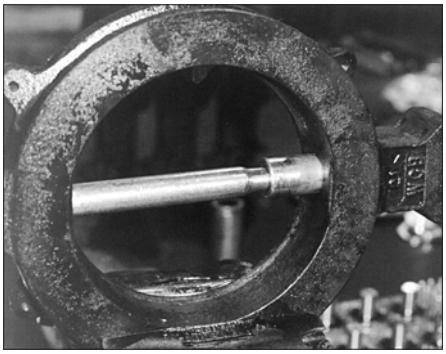


Figure 7 - Shows the stem bushing flush with the flow path surface.

Removing the Seat Retainer Gasket

Remove the seat retainer gasket (13). Use a powered wire brush tool to remove the gasket material that may have adhered to the mating body surfaces.

Removing the Seat Assembly

To remove the seat assembly, treat the seat (11) and its associated components as a single assembly by removing the following:

- seat (11)
- wire wrap (12A)
- seat backing ring (12B)

Removing the Packing Assembly Method 1: for Packing Replacement with Stem in Body

1. Using the screws, grab and remove each packing ring, one at a time.

Method 2: packing Removal with Stem Removed from Body

Note: to remove the packing set (9) with the upper stem (2B) still in the valve body (1), two long, slender screws are required. The screws must not have a diameter greater than 1/4" and must be at least six inches long. The most commonly used screws are "drywall screws."

1. To remove the packing set (9) with the upper stem removed, use a hook-type tool to pull out one packing ring at a time.

Removing the Stem Bushings

1. Insert the removal tool in the valve body (1) top plate area and down the upper stem journal until the tool

Note: a special bushing removal/installation tool is required to remove or install the stem bushings (5). The tool O.D. dimension should be as near in size as the valve stem bore I.D. dimension and have a Class 3 fit. Any Machinist Handbook can provide Class 3 tolerances.

contacts the upper stem bushing.

2. Remove the upper stem bushing (5) by striking the tool with a hammer.
3. Insert the removal tool in the valve body (1) bottom plate area and down the lower stem journal until the tool contacts the lower stem bushing.
4. Strike the tool until the lower stem bushing (5) is clear of the lower body stem journal.

Inspecting the Valve Components

1. After disassembly, visually inspect the seat retainer ring (14) and the bottom cover plate (7).
2. Make sure all body sealing surfaces:
   - are flat
   - are free of corrosion damage
   - have a smooth surface
   - are free of burrs.

Remove any burrs with fine grit sandpaper.

3. Inspect for scratches around disc edges:
   - If scratched, smooth the edge with fine grit sandpaper (220/400 wet/dry sandpaper)
   - Remove the scratch by using a blending motion and extend the smoothed area at least two inches above, below and around the original scratch
   - To polish the disc edge, use a powered wire brush
   - Finish sand or polish the edge on a lathe, as required.
4. Check to see that the upper and lower (2B, 2C) stem-to-bushing (5) contact locations are free of galling.
5. Check to see that the upper (2B) stem-to-packing (9) contact area is free of scratches.

Assembly

Note: if scratched or galled, these surfaces should be polished or replaced

Installing Stem Bushing

1. To avoid damaging the stem bushing (5), gently press the bushing into the stem body journal by lightly striking the bushing (5) with a rubber mallet.
2. Once the stem bushing (5) has been partially inserted into the valve body journal, insert the installation/removal tool against the upper stem bushing. (See Figure 6.)
3. Strike the tool with a hammer to continue inserting the stem bushing until it is flush with the body flowpath surface. (See Figure 7.)

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Installing the Disc/Stem Assembly

> ***Caution***
> To prevent damage to the disc, do not allow the disc edges to contact the body flowpath surface.

1. Install the upper stem (2B) and lower stem (2C) into the valve body stem journals with the pinning grooves position on top of the stem side view.

Note: the upper and lower stems are correctly installed when the lower ends of the stems are flush with the body flowpath surface.

2. While holding the disc (2A) with the backside of the disc facing up and the double pin hub facing toward the body (1) upper stem journal, position the disc (2A) in the body (1).
3. Push the stems (2B and 2C) into the disc (2A) hub stem holes.
4. If required, rotate the stems until the stem tapered pin holes are in alignment with the disc (2A) hub tapered pin holes.
5. Manually push the disc tapered pins (2D) to install them through the disc hub tapered pin holes.
6. Install the packing set (see Installing The Packing Set).
7. Carefully drive the tapered pins (2D) firmly into the connection with a punch and hammer.

Note: original disc/stem assemblies may use the disc locating shoulder assembly (6,10 and 15) installed with the lower stem (2C). In this case, the disc/stem assembly should already be centered and may not require any centering adjustment.

Installing the Packing Set

1. Install the anti-extrusion packing ring (8), packing set (9) and packing gland (3) into the upper journal of the valve body (1).
2. Keeping the disc assembly (2) in the closed position and closely centered in the body bore, tighten the packing nuts (24). Nuts have been correctly tightened when the packing gland plate (4) is flush with the valve body (1) top plate.

Installing the Disc Locating Shoulder Assembly

1. Place a thrust washer (10) over the disc locating shoulder (6) neck. If the thrust washer (10) has PTFE fabric on one side, install the thrust washer with the PTFE fabric side in contact with the disc locating shoulder.
2. Making sure the disc (2A) is in the closed position, center the disc with the body seat pocket.
3. Measure the gap between the body seat pocket ID and the disc OD before locking the disc into position. These measurements are to be made at the disc hub sections. The gap measurements are to be within 0.020 inches of each other. (See Figure 8.)
4. While keeping the disc centered, drive the disc locating shoulder (6) into the bottom hole of the lower stem (2C) until the disc locating shoulder (6) and the associated thrust washer (10) are pressing against the body (1) bottom surface.
5. Push the tapered pin (15) into the hole located in the bottom of the disc locating shoulder (6).
6. Lock the tapered pin (15) into position by driving it with a punch and hammer. (See Figure 9.)

Installing the Bottom Cover Assembly

1. Place the bottom cover gasket (16) around the disc locating shoulder (6).
2. Place a thrust washer (10) in the bottom cover plate (7). If the thrust washer (10) has PTFE fabric on one side, install the thrust washer with the PTFE fabric facing out from the bottom cover plate (7).
3. Align the bottom cover plate (7) with the body (1) bottom surface, making sure the bottom cover gasket (16) remains in alignment with the bottom cover plate (7) gasket groove.
4. Tighten the four bolts and washers (17, 18).

Installing the Standard Seat Assembly

1. Check to make sure the disc (2A) is in the closed position.
2. Make sure the disc is centered in relation to the body seat pocket.

Installing the Standard Seat Assembly

1. Check to make sure the disc (2A) is in the closed position.
2. Make sure the disc is centered in relation to the body seat pocket.
3. Reset the disc locating shoulder pin (15) into its correct locked position by using a hammer and punch.
4. Put the seat retainer gasket (13) on the valve body (1) gasket surface. (See Figure 10.)

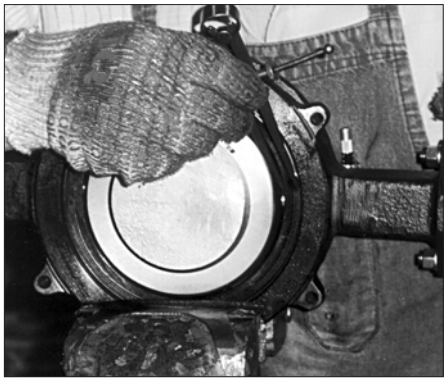


Figure 8 – Shows how to measure the gap between the body seat pocket ID and the disc OD

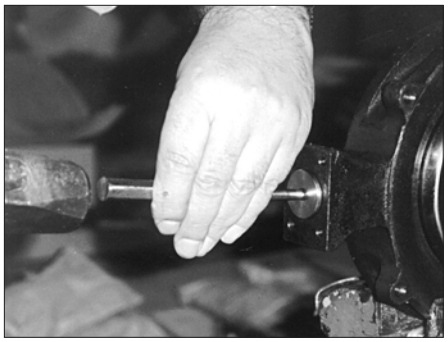


Figure 9 – Shows how to lock the tapered pin into position.

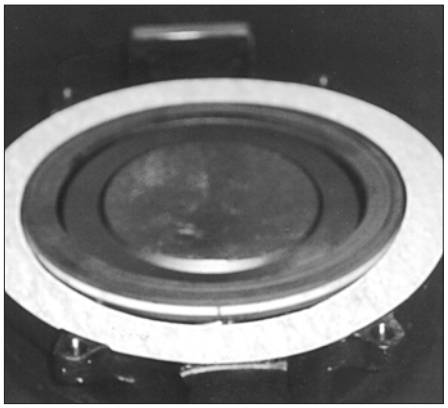


Figure 10 – Shows proper placement of seat retainer gasket.

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5. Install the seat assembly.6. Insure the disc (2A) is closed against the body (1) disc stop.

Note: elastomer seated trims do not require a seat retainer gasket (13).

6. Insure the disc (2A) is closed against the body (1) disc stop.
7. Place the seat retainer ring (14) on top of the seat retainer gasket (13) and seat assembly (11 and 12).
8. Place the locating plates (21) and/or clips (28 for wafer style; 21 for lug) on the valve body.
9. Install and tighten the screws (20 or 30).

Caution
The standard seat retainer screws provide only enough force to hold the seat retainer ring (14) for shipment and installation. If valve actuation is required before installation, press the seat retainer into the seat to prevent damage to the valve seat before actuation.

10. Press the seat retainer ring into the seat (11 and 12) and body (1) using two C-clamps to provide the needed compressive load. To press the seat retainer ring with the C-clamps, place the C-clamps on the valve assembly to allow an even load to be applied all around the seat retainer ring (14) and tighten until the seat retainer gasket (13) is compressed.
11. With the C-clamps pressing the seat retainer ring (14) into the gasket (11). Tighten the screws (20 or 30).

To install RTFE, PTFE and UHMWPE Seats:

1. Place the seat backing ring (12B) into the seat (11).
2. Press the backing ring into the seat (11) until no gaps are present between the backing splits.
3. Rotate the seat assembly until the seat backing ring (12B) splits align with the body stem journals.
4. Place the seat assembly (11 and 12) into the valve body (1) seat pocket. The seat assembly is correctly placed when the “V” groove on the side of the seat (11) is facing toward the assembler.

To install NBR, EPDM and Fluoroelastomer (FKM) seats:

1. Place the seat assembly (11) into the valve body (1) seat pocket.
2. Make sure the taper on the seat (11) ID is facing down toward the disc (2A) sealing surface.

To install Fire-safe Seats:

1. Place the RTFE seat insert (11A) into the grooves of the metal seat.
2. Place the seat assembly (11 and 12A) into the valve body (1) seat pocket.
3. Make sure the RTFE seat insert (11A) is facing down toward the disc (2A) sealing surface.

To install Metal Seats:

1. Place seat assembly (11 and 12A) into the valve body (1) seat pocket.

Installing Bi-directional Dead-end Service Polymer Seat Assembly

Additional steps are required before seat installation for RTFE, PTFE and UHMWPE polymer seats used in bi-directional dead-end service. (See Figure 11.) Before installing these types of seats, follow these steps:

1. If the valve requires an O-ring, place the O-ring in the seat pocket. Place a 1/4" diameter bead of CANNING™ Marston Hylomar Gasket and Joint Compound, (Type PL32 Heavy Sealant) or equivalent around the seat pocket ID corner.

Caution
Do not use any gasket sealant in valves being prepared for oxygen, chlorine or silicone-free service. Use of gasket sealant in such applications will result in damage to the valve.

2. Install the seat assembly.
3. To allow the seat retainer ring dead-end service bolts to pass through the gasket (13), modify the seat retainer ring gasket (13) by following these steps:
   a. Use the dead-end service seat retainer ring (14) to layout the bolt hole pattern.
   b. Using a hole punch, make the required holes in the gasket.

Caution
To prevent damage to the valve when clamping, protect the body flange surfaces from the vise clamping surfaces with cardboard or brass shims

TIG Welding of the Disc Taper Pins

1. After assembling and testing the valve, lock the three disc/stem taper pins (2D) by forcefully driving the tapered pins in place with a hammer and steel punch.
2. TIG weld the disc taper pins (2D). Weld using filler rod referenced in Table I.

Note: Sizes 14" to 24" body valves employ both clips (28 for wafer and 21 for lug) and locating plates (21) to retain the seat retainer ring (14). Size 30" and 36" wafer and lug body valves use seat retainer screws (30) instead of the hex socket flat head screws (20) with clips or locating plates. These seat retainer screws are located directly in the face of the seat. Two of these seat retainer screw holes are tapped. The two tapped holes allow the use of eye bolts so the seat retainer ring can be lifted to and from the body (1).

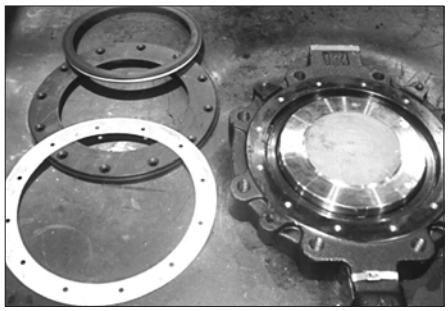


Figure 11 – Shows dead-end service seat assembly.

Table I

Stem and Pin Material	Filler Rod
17-4 pH 1075 HT	312 Stainless Steel
17-4 Ph 1160 DHT (NACE)	312 Stainless Steel
316 Stainless Steel Condition B	312 Stainless Steel
K Monel 500®	Monel®
Inconel®	Inconel

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Symptom	Possible cause	Resolution
Valve won't rotate	1. Actuator has failed 2. Valve packed with debris 3. Stem key has sheared	1. Repair or replace 2. Flush or clean valve to remove debris 3. Determine cause of shearing and correct, replace
Stem packing leaking	1. Gland flange bolting loose 2. Packing damaged	1. Tighten gland flange bolting 2. Depressurize valve and replace packing
Bottom cover gasket leaking	1. Bottom cover bolting loose 2. Gasket damage	1. Tighten bottom cover bolting 2. Remove valve from service and replace gasket
Valve leaking	1. Valve not fully closed 2. Debris trapped in valve 3. Seat or disc edge damaged 4. Actuator mechanical closure stop incorrect	1. Close valve 2. Cycle and flush to remove debris 3. Remove valve from service and replace seat and/or repair or replace disc 4. Adjust the stop to allow further closure
Jerky operation	1. Stem/bearing damaged 2. Actuator/stem adapter misaligned 3. Overtightened packing 4. Air supply inadequate	1. Disassemble valve and inspect for damage, repair or replace damaged parts, reassemble 2. Remove actuator mounting and realign 3. Loosen packing to hand tight, cycle valve, retighten 4. Increase air supply pressure

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PENTAIR

MORIN

B series - Ductile iron w/ stainless steel cylinders
C series - Ductile iron w/ carbon steel cylinders
Spring return and double acting actuators
Quarter-turn output torques to 1,400,000 lb.in.

Features and benefits

- Ductile iron housing, piston and end caps provide long product life with durable, cost effective operation.
- Output shaft made of high strength alloy steel or 17-4PH stainless transmits torque without fatigue.
- Sintered bronze bushings or PTFE composite on output shaft eliminate side loading of valve stem to maximize stem packing performance.
- Chrome-plated steel piston rod provides strength and corrosion resistance for enduring high cycle applications.
- Sintered bronze piston rod bushings provide low-friction support and precise alignment of the piston rod to increase efficiency. reduce maintenance and extend actuator life.
- Heat-treated stainless steel thrust pin and rollers transfer piston force to 17-4PH stainless steel or ductile iron yoke by rolling to reduce friction. for longer life and more efficient torque transmission.
- PTFE guide bands ensure low-friction piston guidance during operation to protect cylinder walls from potential scoring and extend seal performance with a continuous cylinder wiping action.
- Bi-directional travel stops provide accurate valve rotation adjustment.
- ISO 5211 mounting pattern promotes easier valve adaptation by utilizing internationally recognized standards.
- Both series B and C have been certified to SIL 3 ratings.
- Actuators are rated IP66.



Series B



Series C

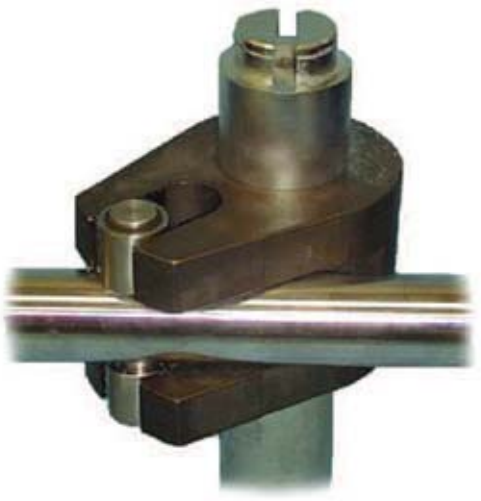


- NAMUR drive slot on output shaft enables accessory-driven components to maintain a compact assembly and eliminates the need for couplings.
- Tectyl-coated springs can be disarmed without special tools to safely and easily disassemble the actuator in the field. reducing down time and providing a 'man safe' spring.
- Easily removable housng cover provides effortless access for internal inspection of yoke mechanism.

Technical data

Supply pressure	: 40 to 160 psig (see torque chart. MORMC-0333)
Supply medium	: Air or any gas compatible with materials of construction
Temperature rating	
Standard range	: -20°F to 210°F
Optional range	: -65°F to 300°F
Angular rotation	: 90 degrees ± 8 degrees

Morin has a rugged heart



Morin scotch yoke

The heart of any scotch yoke actuator is the yoke. Morin uses either 17-4PH or ductile iron for this critical area as standard.

The yoke is the mechanism used to convert linear force to torque. The yoke is critical to actuator performance. It must be rugged, yet precisely machined to give long life at high efficiency. Morin understands this and ensures that all our yoke designs meet this test.

Principles of construction

Using high quality materials of construction and modern rugged design concepts Morin becomes the standard for low cost valve actuation while providing high quality performance.

The actuator housings are all machined from ductile iron castings. This produces a rugged, low cost product through reduced machining time and by eliminating wasteful excess material.

Any components that rotate or slide during operation, such as the high strength output shaft, chrome-plated piston rod, stainless steel thrust pin or the ductile iron piston, are all supported by replaceable friction reducing bearings.



Bi-directional travel stops

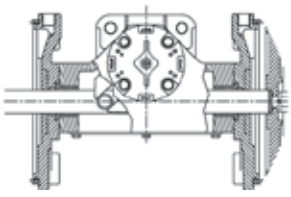
Adjustable stops on each end cap provide the flexibility of accurate valve rotation positioning at the end of the 'open' and 'close' stroke. Both stops are located on the cylinder centerline, the optimal position to maximize travel adjustment and eliminate any detrimental side loading on the travel stops. Adjustable from 82° to 98°.

Spring designed for safety

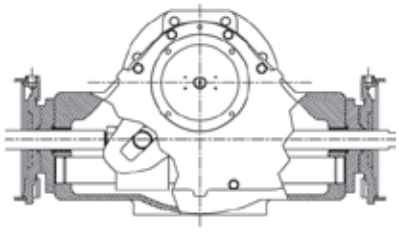
All spring return models incorporate a 'man safe' spring design that allows the actuator to be safely assembled and disassembled in the field without the need for special tools. The integral tie rods are bored and tapped to provide a means of loading and unloading the spring in a safe and convenient manner.

Morin understands actuator design

Morin understands that the most efficient design for one torque range is not the most efficient for another. Morin uses the standard scotch yoke design for lower torque ranges and a guide bar design for the higher torque ranges. This gives a rugged design with economic cost.

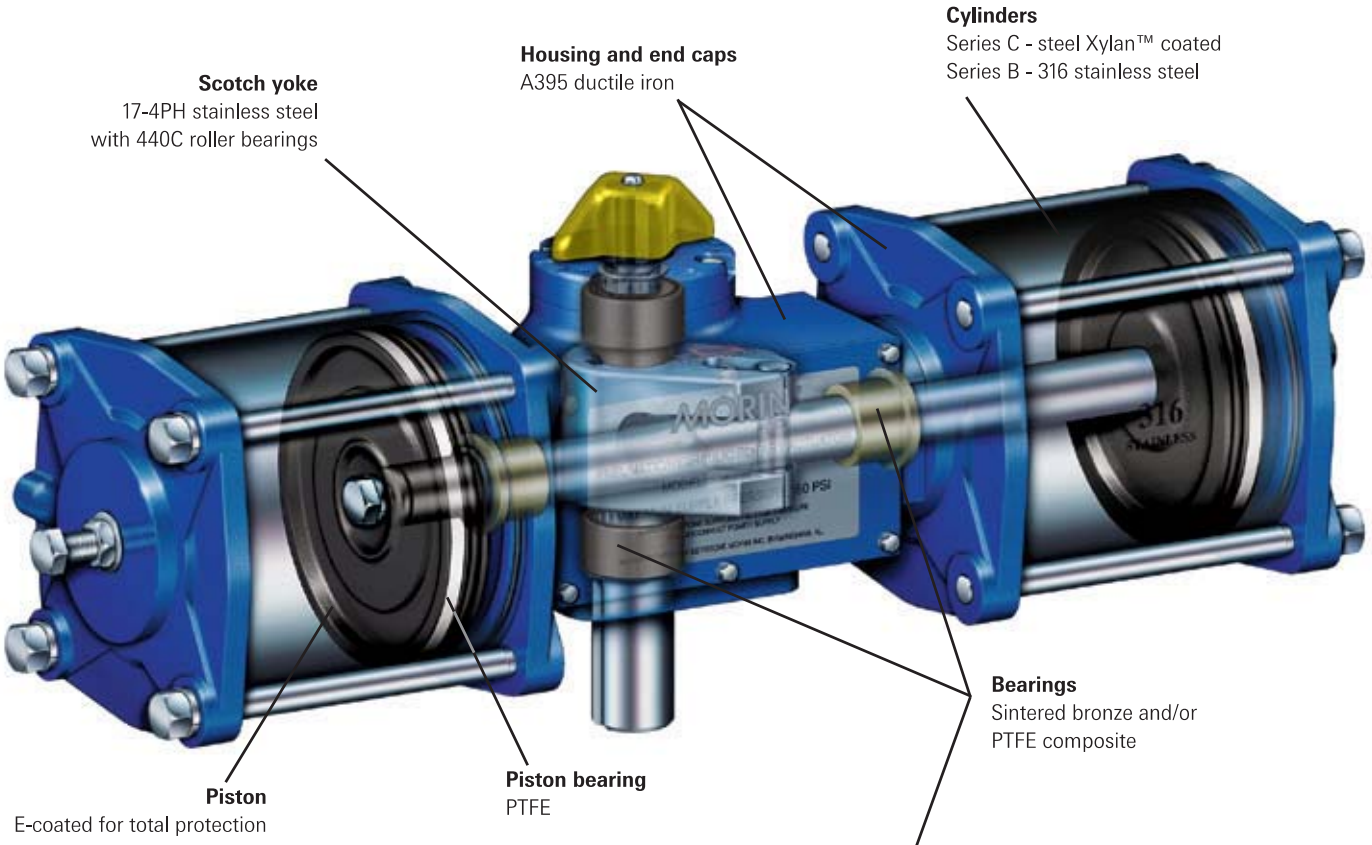


Standard design, scotch yoke



Guide bar design, scotch yoke

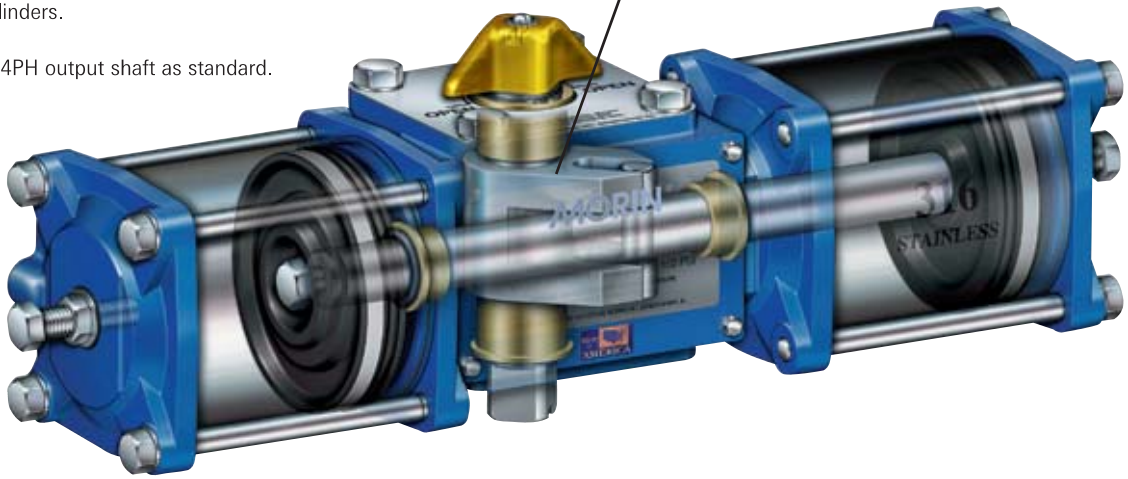
Superior materials of construction offer long life, and mean less downtime
Series B or C, models 135 to 1150



Series B, models 006 to 100

Morin series B uses construction identical to the series C, but with 316 stainless steel cylinders.

Models 006 to 100 use 17-4PH output shaft as standard.



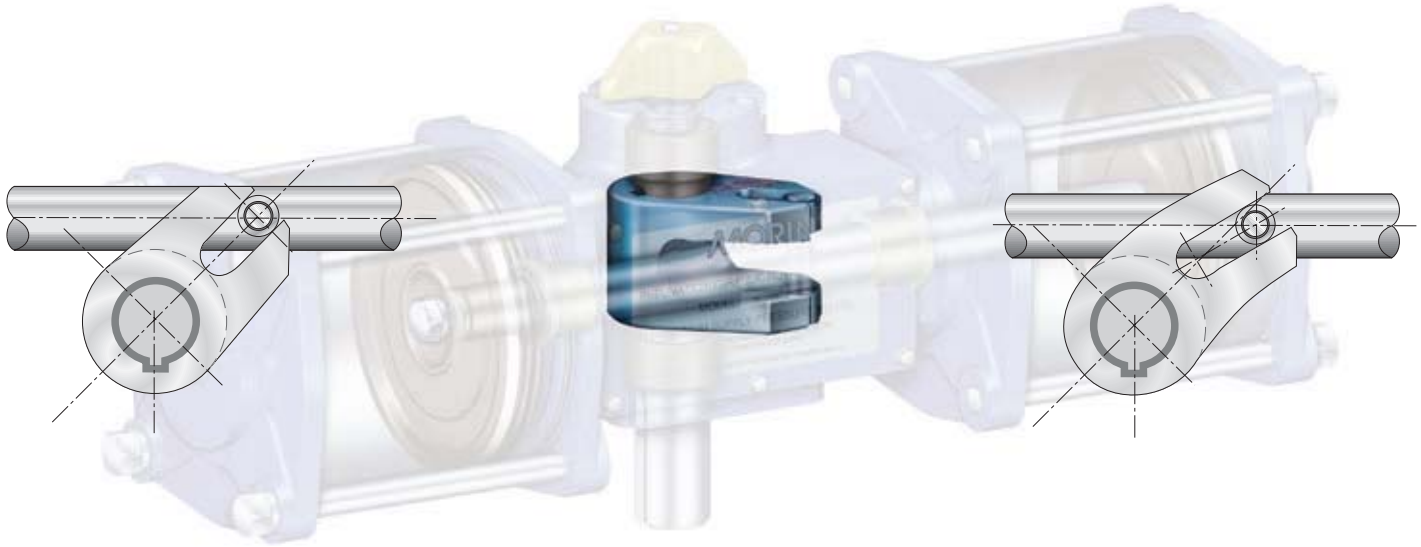
Note

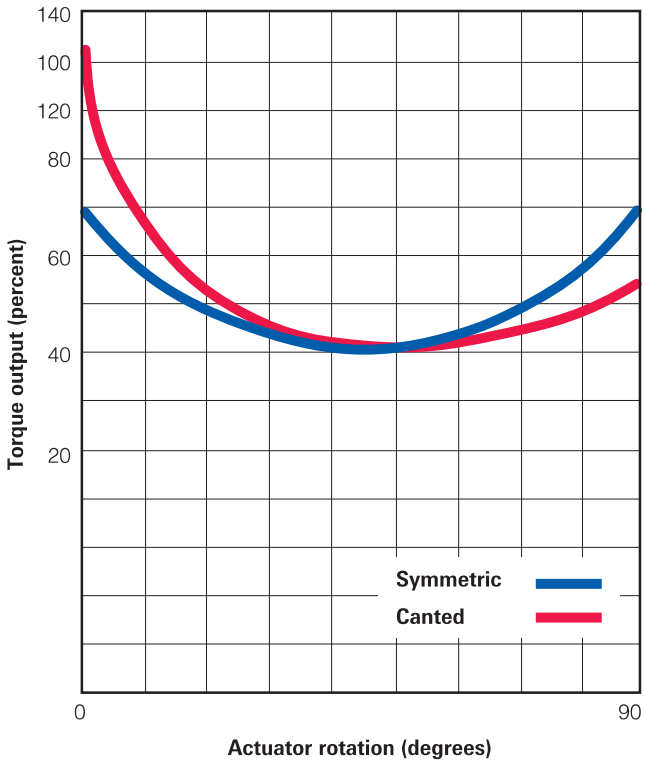
See Morin series B/C/S IOM for a complete bill of materials.

Symmetrical and canted yokes
It's about fitting the torque curve of the actuator to the valve . . .
It's about lower cost, lighter weight, smaller actuators . . .
It's about CHOICE . . .

Symmetric
Symmetrical yoke design offers the standard torque curve seen most often in relation to scotch yoke actuators. It offers the increased torque advantage at both ends of the 90° stroke as shown on the blue curve below. This torque curve covers most quarter-turn applications.

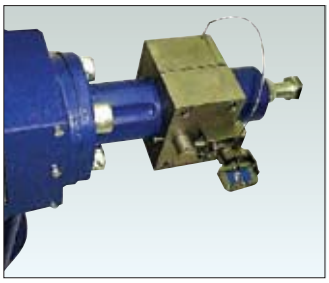
Canted
Canted yoke design moves the torque curve to where it's needed most, gaining as much as 35% more break and reseat torque for the same size actuator. The canted yoke curve is shown in red below. Canted yoke actuators allow selection of smaller, lighter, and less expensive actuator packages.





Options

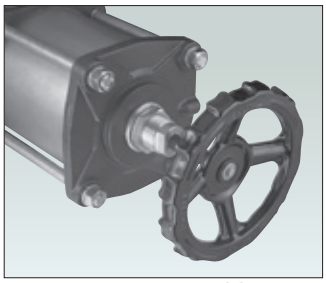
To provide the actuation package best suited for your application, the Morin line offers a full range of manual accessories.



Partial stroke test device (PSTD)
Provides a method of testing ESD packages without shutdown.



Lockout
Integral lockout allows safe shutdowns for maintenance and isolation of systems.



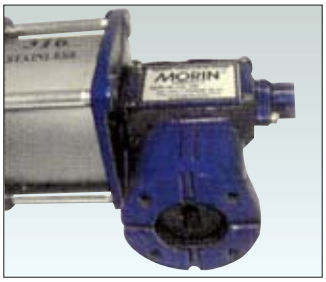
Jackscrew override (JSO)
Manual operation when power is lost. Simple and effective.



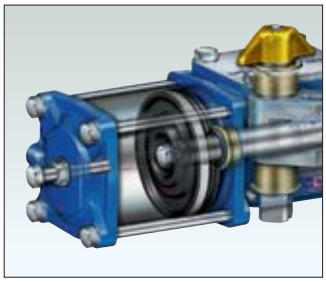
Hydraulic override (MHP)
Manual operation when power is lost. Includes speed controls.



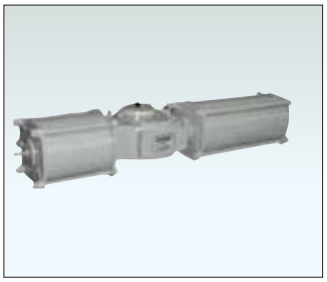
AWWA
Tested per American Waterworks Association C540. Available for pneumatic or water service operation.



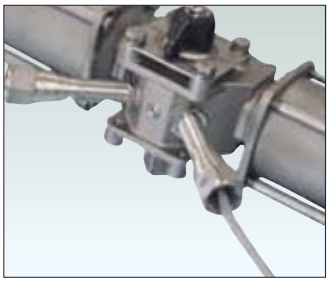
Direct mounting cast adapters
Many valve top works covered, including some ISO mounting. Assures economic but correct mounting alignment.



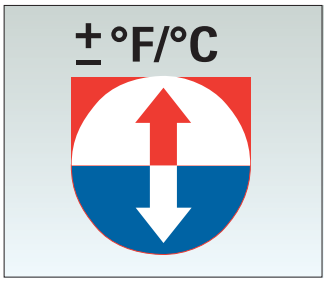
Full stroke adjuster
Provides mechanical control of maximum and/or minimum valve stroke.



Epoxy painting (EX)
Offshore rated, three-part coating system for high level of environmental protection.



Proximity switch preparation
Allows installation of cartridge style proximity switches. Leaves top works open for mounting of other devices.



High or low temperature ratings
Standard rating of -20°F to 210°F [-29°C to 99°C] covers most applications. Optional ratings down to -65°F [-54°C] and up to 300°F [149°C].



Optional certification for CE
Manufactured in accordance with the Pressure Equipment Directive 97/23/EC and ATEX 94/9/EC.

Mechanical data

Actuator model	Closing torque @ 80 psig Symmetrical	Canted	Number of pistons	Cylinder bore (inch)	Stroke (inch)	Volume[1] (cubic in) 90° stroke	Cycle time[2] (seconds) 90° stroke	Weight (lbs.)
Double acting								
006	600	-	1	2.750	2	12	0.5	11
015	1500	-	1	4.375	2	30	1	14
023	2300	2990	1	4.375	3	45	1	30
036	3960	5148	1	5.438	3	70	1.5	33
050	5000	6500	1	6.250	3	92	2.2	39
059	5900	7670	2	4.375/5.438	3	112	2.4	36
072	7920	9009 @ 70 psig	2	5.438	3	137	2.5	41
100	10000	9750 @ 60 psig	2	6.250	3	182	3	49
135	14175	18428	1	8.250	5	267	4.5	165
210	23100	30030	1	10.250	5	413	5	185
270	28350	36855	2	8.250	5	526	6	210
345	36225	41206 @ 70 psig	2	8.250/10.250	5	671	7	234
370	37000	51469	1	12.250	6	707	8	390
420	42000	40950 @ 60 psig	2	10.250	5	816	8.5	257
575	63825	82973	1	15.500	6	1132	9.5	519
740	77700	101010	2	12.250	6	1395	10	530
945	101115	98587 @ 60 psig	2	12.250/15.500	6	1820	11	653
1150	120750	98110 @ 50 psig	2	15.500	6	2245	12	775
1485	169523	247563	2	12.250	12	2791	20	1150
1935	221145	322950	2	12.250/15.500	12	3641	22	1250
2385	272767	398336	2	15.500	12	4491	24	1350
3071	347284	507157	2	19.250/15.500	12	5719	28	2055
3731	421874	616085	2	19.250	12	6947	31	2205
4534	512578	561408 @ 60 psig	2	19.250/23.00	12	8440	35	2550
5336	603282	550627 @ 50 psig	2	23.00	12	9934	39	2925
7114	793589	1099760	2	23.00	16	13245	50	4170
Spring return								
006	221	-	1	2.750	2	12	0.5	13
015	525	-	1	4.375	2	30	1	20
023	800	1120	1	4.375	3	45	1	38
036	1260	1764	1	5.438	3	70	1.5	46
046	1600	2240	2	4.375	3	88	2	47
058	1600	2240	2	5.438/4.375	3	112	2.3	54
059	1890	2646	2	4.375/5.438	3	112	2.4	54
072	2500	3500	2	5.438	3	137	2.5	60
100	3500	4900	2	6.250	3	182	3	68
135	5670	7938	1	8.250	5	267	4.5	210
210	8085	11319	1	10.250	5	413	5	235
270	10395	14553	2	8.250	5	526	6	250
344	12637	17692	2	10.250/8.250	5	671	7	315
345	13760	19264	2	8.250/10.250	5	671	7	315
370	14893	20850	1	12.250	6	707	8	540
420	15435	21609	2	10.250	5	816	8.5	379
575	21131	29583	1	15.500	6	1132	9.5	779
740	29785	41699	2	12.250	6	1395	10	660
944	27713	38798	2	15.500/12.250	6	1820	11	871
945	32303	45224	2	12.250/15.500	6	1820	11	871
1150	42263	59168	2	15.500	6	2245	12	1082
1485	59333	83066	2	12.250	12	2791	20	1950
1934	66750	103833	2	15.500/12.250	12	3641	22	2025
1935	71601	116849	2	12.250/15.500	12	3641	22	2095
2385	95469	133656	2	15.500	12	4491	24	2150
3071	119336	167070	2	19.250/15.500	12	5719	28	2475
3072	129199	180879	2	15.500/19.250	12	5719	28	2890
3731	147656	206718	2	19.250	12	6947	31	3115
4534	166113	232558	2	23.00/19.250	12	8440	35	3925
5336	211149	295608	2	23.00	12	9934	39	4425
6044	235995	330394	2	23.00/19.250	16	11254	44	6325
7114	277756	388859	2	23.00	16	13245	50	6950

Notes

1. Air consumption:
   Cubic inches in chart represent actual free air volume in cylinder between piston and end cap when furthest apart. Air consumption will vary depending on supply pressure. To determine standard cubic feet per minute use the following formula:

$$SCFM = \left(\frac{\text{Vol. in}^3}{1728}\right)\left(\frac{\text{Supply air barg} + 14.7}{14.7}\right)\left(\text{Strokes/min}\right)$$

   Example: Calculate SCFM for model 023 double acting using 80 pisg air supply and 5 strokes/minute.

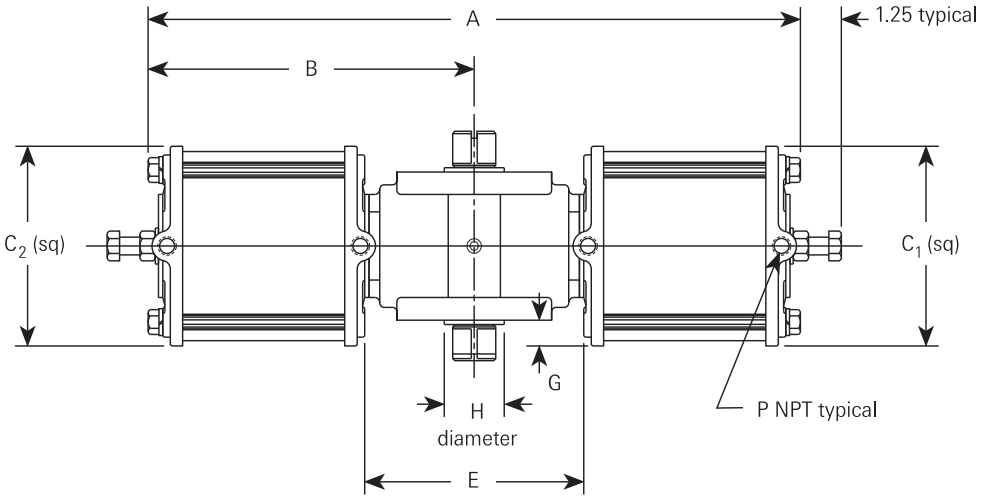
$$SCFM = \left(\frac{45}{1728}\right)\left(\frac{80 + 14.7}{14.7}\right)\left(5\right) \quad SCFM = 0.84$$

2. Cycle times shown represent average time to stroke 90 degrees using standard pilot valves and should be used as a guide only. Cycle times can be increased or decreased dramatically by using speed controls, oversized pilot valves or quick exhaust valves.

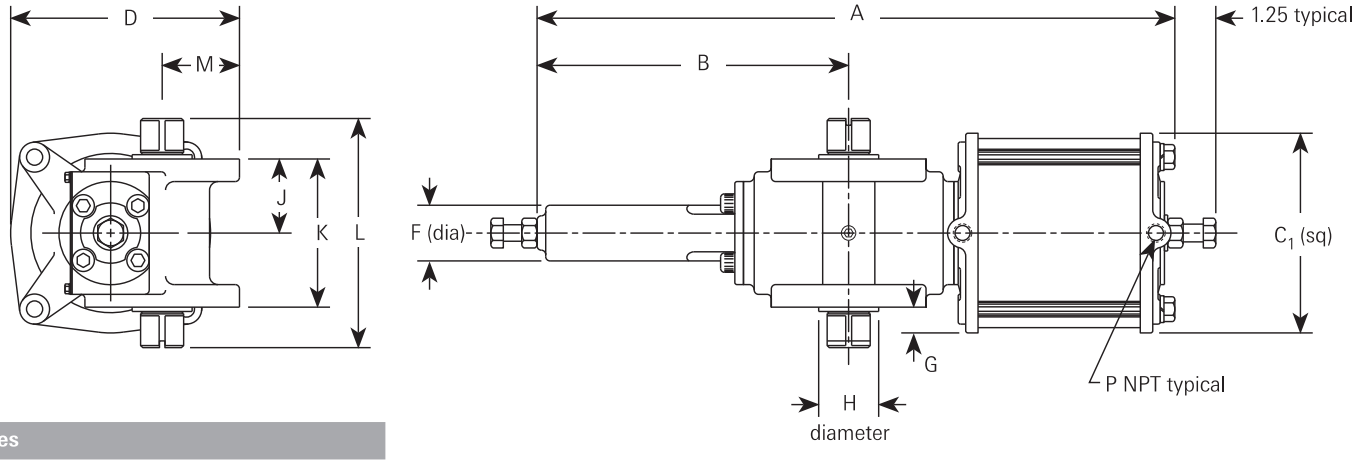
How to order

1. Double acting (symmetrical yoke) example:
   Air supply: 80 psig
   Break/end torque: 23,100 lb.in.
   B-210U-D000
   B : Series
   210 : Model number
   U : UNC mounting threads
   D : Double acting
   000 : No spring
2. Spring return (symmetrical yoke) example:
   Air supply: 80 psig
   End torque: 8085 lb.in.
   B-210U-S080
   B : Series
   210 : Model number
   U : UNC mounting threads
   S : Spring return
   080 : Spring set code
3. Double acting (canted yoke) example:
   Air supply: 80 psig
   Break (CCW) torque: 31,185 lb.in.
   End (CW) torque: 30,030 lb.in.
   B-210UC-D000
   B : Series
   210 : Model number
   U : UNC mounting threads
   C : Canted yoke
   D : Double acting
   000 : No spring
4. For all spring return models:
   - Use required torque to determine spring set code (see MORMC-0333).
   - All spring sets ending with '0' fail clockwise (40, 50, 60, etc.).
   - All spring sets ending with '1' fail counterclockwise (41, 51, 61, etc.).
   - All symmetrical yoke models between 006 and 100 may be mounted to fail clockwise or counterclockwise by 'flipping' along the longitudinal axis.

Series B dimensions
Models 046, 058, 059, 072 and 100



Models 006, 015, 023, 036 and 050



Notes

1. Shown without pointer for clarity.
2. For mounting dimensions, refer to page 10.

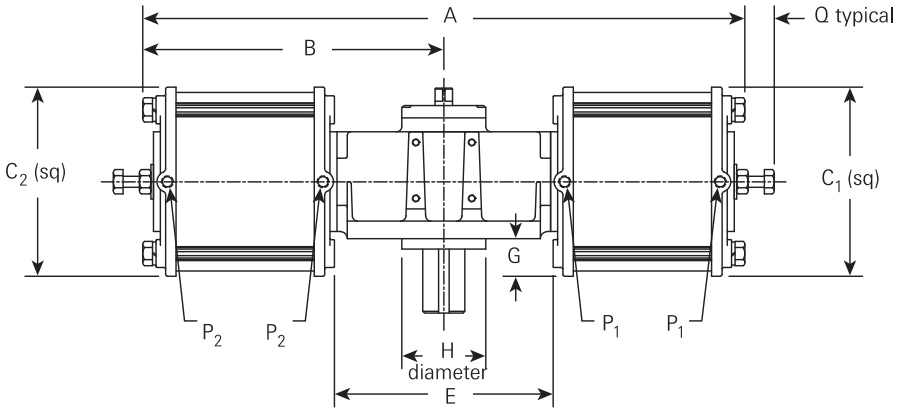
Dimensions (inches) double acting

Model	A	B	C_1	C_2	D	E	F	G	H	J	K	L	M	P
006DA	12.87	5.28	3.18	—	3.87	—	1.09	0.18	1.50	1.50	3.00	4.75	1.31	1/8
015DA	12.31	5.28	4.81	—	4.81	—	1.09	1.00	1.50	1.50	3.00	4.75	1.31	1/4
023DA	18.54	8.88	4.81	—	6.16	—	1.75	0.25	1.75	2.16	4.31	6.69	2.25	1/4
036DA	18.60	8.88	5.81	—	6.66	—	1.75	0.75	1.75	2.16	4.31	6.69	2.25	1/4
050DA	18.55	8.88	7.12	—	7.31	—	1.75	1.38	1.75	2.16	4.31	6.69	2.25	1/4
059DA	19.40	9.66	4.81	5.81	6.66	6.34	—	0.75	1.75	2.16	4.31	6.69	2.25	1/4
072DA	19.35	9.68	5.81	5.81	6.66	6.38	—	0.75	1.75	2.16	4.31	6.69	2.25	1/4
100DA	18.98	9.68	7.12	7.12	7.31	6.38	—	1.38	1.75	2.16	4.31	6.69	2.25	1/4

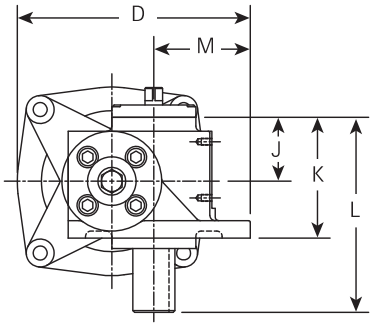
Dimensions (inches) spring return

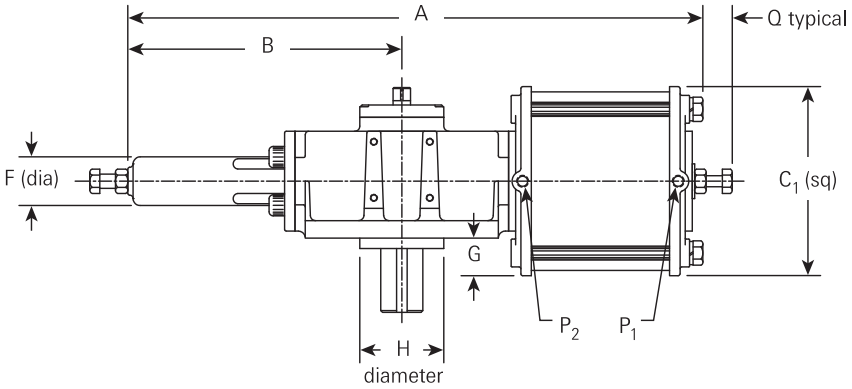
Model	A	B	C_1	C_2	D	E	F	G	H	J	K	L	M	P
006SR	12.87	5.28	3.18	—	3.87	—	1.09	0.18	1.50	1.50	3.00	4.75	1.31	1/8
015SR	14.50	5.28	4.81	—	4.81	—	1.09	1.00	1.50	1.50	3.00	4.75	1.31	1/4
023SR	21.95	8.88	4.81	—	6.16	—	1.75	0.25	1.75	2.16	4.31	6.69	2.25	1/4
036SR	23.65	8.88	5.81	—	6.66	—	1.75	0.75	1.75	2.16	4.31	6.69	2.25	1/4
046SR	22.73	9.66	4.81	4.81	6.16	5.58	—	0.25	1.75	2.16	4.31	6.69	2.25	1/4
058SR	22.79	9.73	5.81	4.81	6.66	5.58	—	0.75	1.75	2.16	4.31	6.69	2.25	1/4
059SR	24.44	9.66	4.81	5.81	6.66	5.44	—	0.75	1.75	2.16	4.31	6.69	2.25	1/4
072SR	24.45	9.68	5.81	5.81	6.66	5.44	—	0.75	1.75	2.16	4.31	6.69	2.25	1/4
100SR	24.51	9.73	7.12	7.12	7.31	5.44	—	1.38	1.75	2.16	4.31	6.69	2.25	1/4

Series B and C dimensions
Models 270, 344, 345, 420, 740, 944, 945 and 1150



Models 135, 210, 370 and 575





Notes

1. Shown without pointer for clarity.
2. For mounting dimensions, refer to pages 10-11.

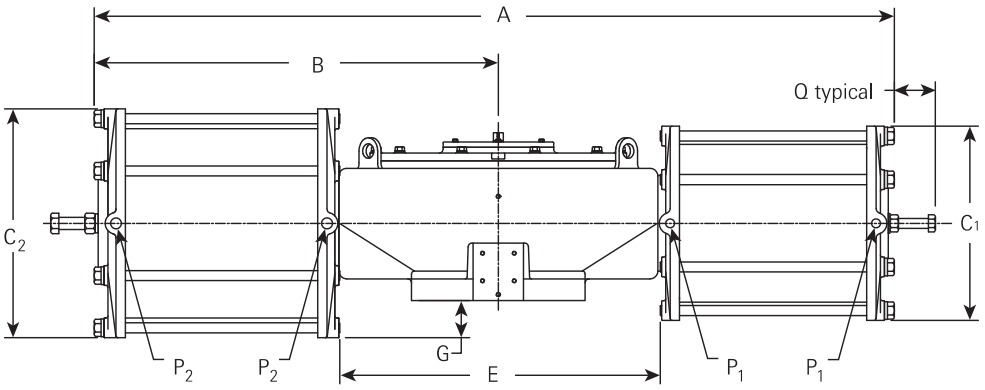
Dimensions (inches) double acting

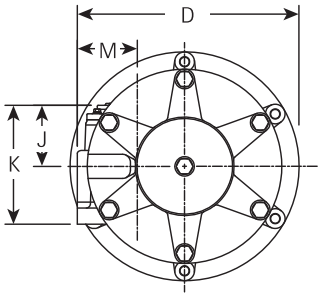
Model	A	B	C_1	C_2	D	E	F	G	H	J	K	L	M	P_1	P_2	Q
135DA	32.74	15.88	9.50	—	10.44	—	2.75	1.00	—	4.38	8.13	11.82	3.19	3/8	3/8	1.75
210DA	33.26	15.88	11.50	—	11.44	—	2.75	2.00	—	4.38	8.13	11.82	3.19	1/2	1/2	2.12
270DA	33.77	16.89	9.50	9.50	10.44	11.72	—	1.00	—	4.38	8.13	11.82	3.19	3/8	3/8	1.75
345DA	34.26	16.89	9.50	11.50	11.44	11.47	—	2.00	—	4.38	8.13	11.82	3.19	3/8	1/2	2.12
370DA	41.64	19.56	13.50	—	16.75	—	3.50	2.69	5.90	5.44	9.50	14.81	6.88	1/2	1/2	1.75
420DA	34.75	17.38	11.50	11.50	11.44	11.22	—	2.00	—	4.38	8.13	11.82	3.19	1/2	1/2	2.12
575DA	42.26	19.56	17.00	—	18.50	—	3.50	4.44	5.90	5.44	9.50	14.81	6.88	3/4	3/4	2.50
740DA	44.15	22.07	13.50	13.50	16.75	15.62	—	2.69	5.90	5.44	9.50	14.81	6.88	1/2	1/2	1.75
945DA	44.77	22.07	13.50	17.00	18.50	15.25	—	4.44	5.90	5.44	9.50	14.81	6.88	1/2	3/4	2.50
1150DA	45.39	22.69	17.00	17.00	18.50	14.88	—	4.44	5.90	5.44	9.50	14.81	6.88	3/4	3/4	2.50

Dimensions (inches) spring return

Model	A	B	C_1	C_2	D	E	F	G	H	J	K	L	M	P_1	P_2	Q
135SR	39.46	15.88	9.50	—	10.44	—	2.75	1.00	—	4.38	8.13	11.82	3.19	3/8	3/8	1.75
210SR	42.67	15.88	11.50	—	11.44	—	2.75	2.00	—	4.38	8.13	11.82	3.19	1/2	1/2	2.12
270SR	40.57	16.99	9.50	9.50	10.44	10.95	—	1.00	—	4.38	8.13	11.82	3.19	3/8	3/8	1.75
344SR	40.95	17.38	11.50	9.50	11.44	10.70	—	2.00	—	4.38	8.13	11.82	3.19	1/2	3/8	2.12
345SR	43.79	16.99	9.50	11.50	11.44	10.61	—	2.00	—	4.38	8.13	11.82	3.19	3/8	1/2	2.12
370SR	51.48	19.56	13.50	—	16.75	—	3.50	2.69	5.90	5.44	9.50	14.81	6.88	1/2	1/2	1.75
420SR	44.17	17.38	11.50	11.50	11.44	10.36	—	2.00	—	4.38	8.13	11.82	3.19	1/2	1/2	2.12
575SR	54.12	19.56	17.00	—	18.50	—	3.50	4.44	5.90	5.44	9.50	14.81	6.88	3/4	3/4	2.50
740SR	53.99	22.07	13.50	13.50	16.75	14.75	—	2.69	5.90	5.44	9.50	14.81	6.88	1/2	1/2	1.75
944SR	54.59	22.67	17.00	13.50	18.50	14.37	—	4.44	5.90	5.44	9.50	14.81	6.88	3/4	1/2	2.50
945SR	56.63	22.07	13.50	17.00	18.50	14.16	—	4.44	5.90	5.44	9.50	14.81	6.88	1/2	3/4	2.50
1150SR	57.22	22.69	17.00	17.00	18.50	13.79	—	4.44	5.90	5.44	9.50	14.81	6.88	3/4	3/4	2.50

Series B and C dimensions
Models 1485, 1934, 1935, 2385, 3071, 3072, 3731, 4534, 5336, 6044 and 7114





Notes

1. Shown without pointer for clarity.
2. For mounting dimensions, refer to pages 10-11.

Dimensions (inches) double acting

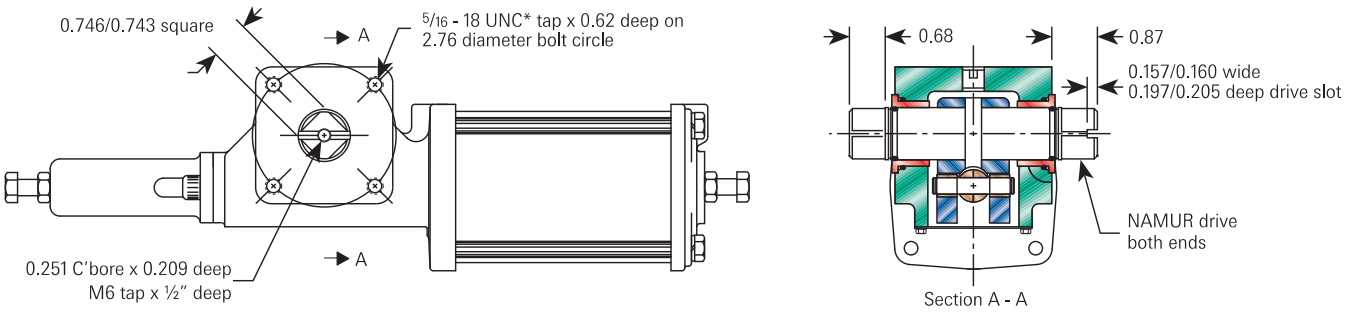
Model	A	B	C_1	C_2	D	E	F	G	H	J	K	L	M	P_1	P_2	Q
1485DA	77.15	38.58	13.50 Sq.	13.50 Sq.	21.57	33.44	—	0.56	—	7.96	15.30	—	7.58	1/2	1/2	2.12
1935DA	77.77	38.58	13.50 Sq.	17.00 Sq.	22.08	33.07	—	1.18	—	7.96	15.30	—	7.58	1/2	1/2	3.28
2385DA	78.39	39.20	17.00 Sq.	17.00 Sq.	22.08	32.69	—	1.18	—	7.96	15.30	—	7.58	3/4	3/4	2.67
3071DA	79.41	40.22	17.00 Sq.	24.62 Dia.	25.90	32.00	—	4.98	—	7.96	15.30	—	7.58	3/4	1	3.00
3731DA	80.44	40.22	24.62 Dia.	24.62 Dia.	25.90	31.32	—	4.98	—	7.96	15.30	—	7.58	1	1	3.00
4534DA	81.19	40.97	24.62 Dia.	29.00 Dia.	28.08	30.82	—	7.16	—	7.96	15.30	—	7.58	1	1	5.52
5336DA	81.94	40.97	29.00 Dia.	29.00 Dia.	28.08	30.32	—	7.16	—	7.96	15.30	—	7.58	1	1	5.52
6044DA	101.38	51.20	29.00 Dia.	24.62 Dia.	28.08	40.91	–	4.70	–	7.96	15.30	–	7.58	1	1	5.52
7114DA	102.40	51.20	29.00 Dia.	29.00 Dia.	28.08	40.41	—	4.70	—	7.96	15.30	—	7.58	1	1	5.52

Dimensions (inches) spring return

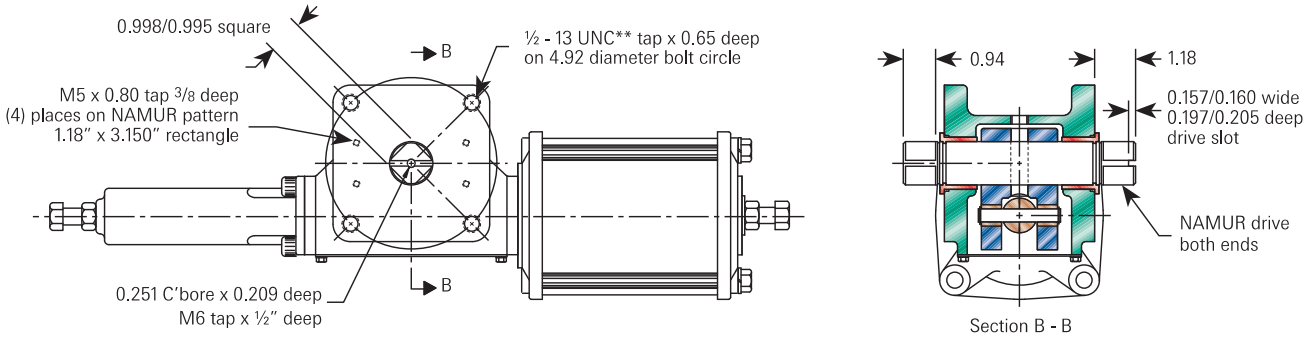
Model	A	B	C_1	C_2	D	E	F	G	H	J	K	L	M	P_1	P_2	Q
1485SR	93.49	38.58	13.50 Sq.	13.50 Sq.	21.57	32.57	—	0.56	—	7.96	15.30	—	7.58	1/2	1/2	3.54
1934SR	94.11	39.20	17.00 Sq.	13.50 Sq.	22.08	32.20	—	1.18	—	7.96	15.30	—	7.58	3/4	1/2	3.54
1935SR	94.11	38.58	13.50 Sq.	17.00 Sq.	22.08	31.98	—	1.18	—	7.96	15.30	—	7.58	1/2	1/2	6.78
2385SR	94.70	39.20	17.00 Sq.	17.00 Sq.	22.08	31.61	—	1.18	—	7.96	15.30	—	7.58	3/4	3/4	3.00
3071SR	95.72	40.22	24.62 Dia.	17.00 Sq.	25.90	30.92	—	4.98	—	7.96	15.30	—	7.58	1	3/4	3.33
3072SR	100.40	39.20	17.00 Sq.	24.62 Dia.	25.90	30.95	—	4.98	—	7.96	15.30	—	7.58	3/4	3/4	4.71
3731SR	101.43	40.22	24.62 Dia.	24.62 Dia.	25.90	30.27	—	4.98	—	7.96	15.30	—	7.58	1	1	4.71
4534SR	102.18	40.97	29.00 Dia.	24.62 Dia.	28.08	29.77	—	7.16	—	7.96	15.30	—	7.58	1	1	5.52
5336SR	107.24	40.97	29.00 Dia.	29.00 Dia.	28.08	29.27	—	7.16	—	7.96	15.30	—	7.58	1	1	5.52
6044SR	132.71	51.20	29.00 Dia.	24.62 Dia.	28.08	38.86	—	4.70	—	7.96	20.09	—	7.58	1	1	4.71
7114SR	138.41	51.20	29.00 Dia.	29.00 Dia.	28.08	39.15	—	4.70	—	7.96	20.09	—	7.58	1	1	5.52

Series B and C mounting details

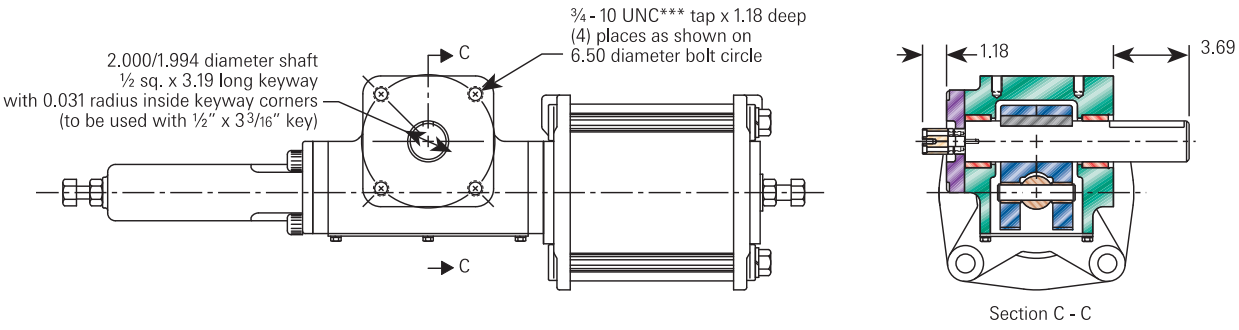
Models 006 and 015 - Top and bottom of housing (symmetrical) ISO 5211-F07



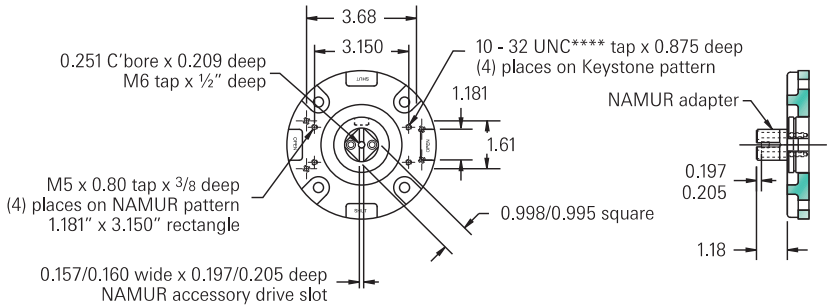
Models 023 through 100 - Top and bottom of housing (symmetrical) ISO 5211-F12



Models 135, 210, 270, 344, 345 and 420 - Bottom of housing ISO 5211-F16



Models 135, 210, 270, 344, 345 and 420 - Top of housing - Mounting details



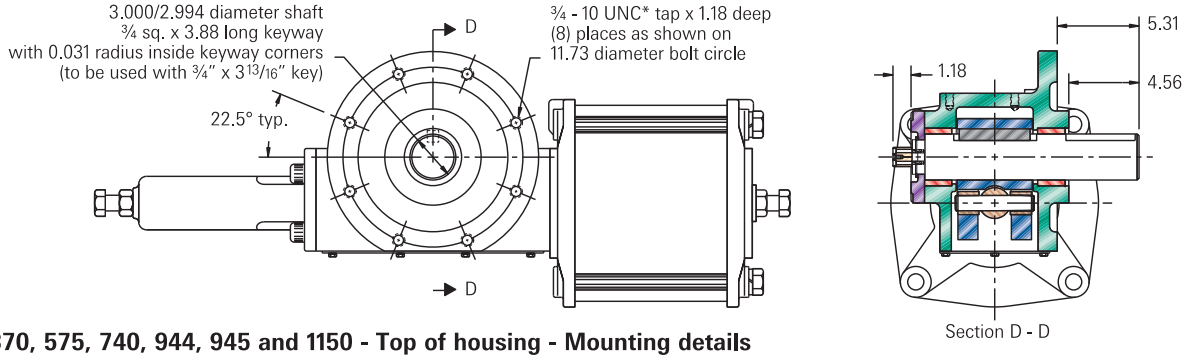
Metric thread option

Metric tap	Model number
* M8	006 and 015
** M12	023 to 100
*** M20	135 to 1150
**** M5	135 to 1150

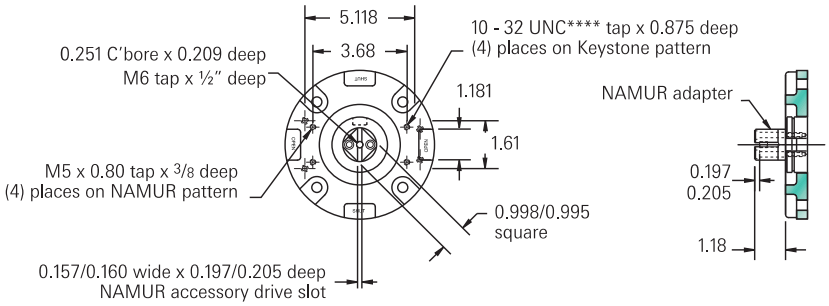
Replace 'U' with 'M' in order number designation (refer to page 6).

Series B and C mounting details

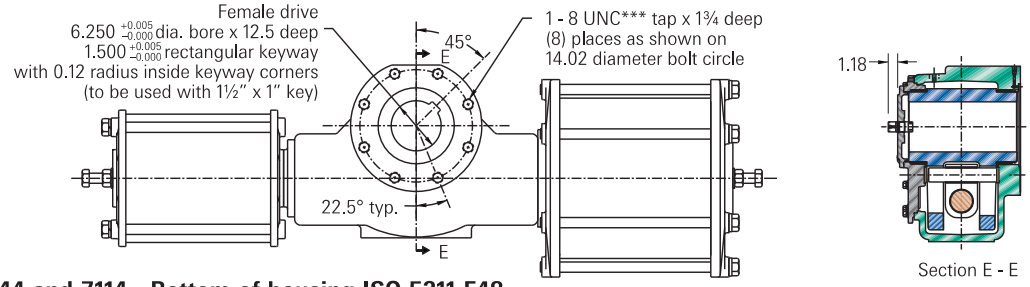
Models 370, 575, 740, 944, 945 and 1150 - Bottom of housing ISO 5211-F30



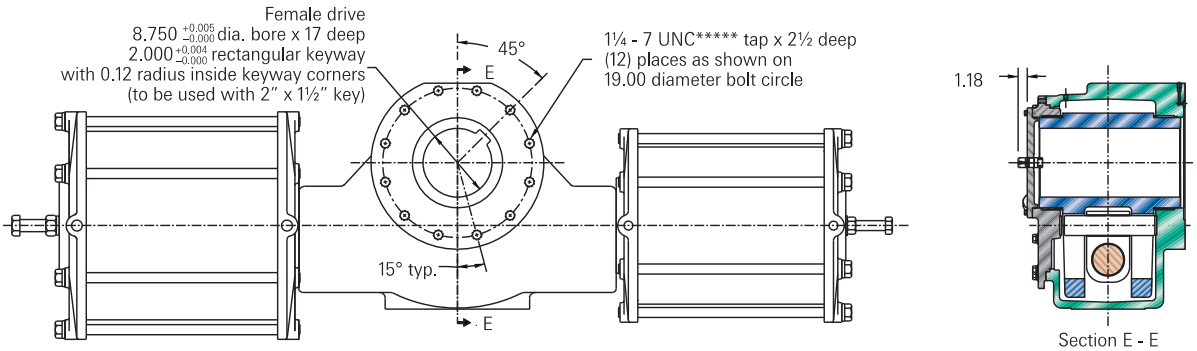
Models 370, 575, 740, 944, 945 and 1150 - Top of housing - Mounting details



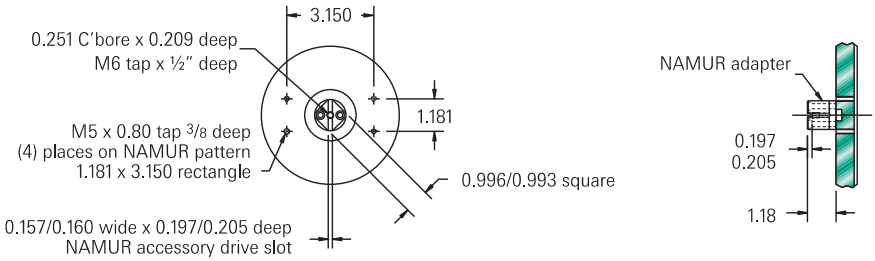
Models 1485, 1934, 1935, 2385, 3071, 3072, 3731, 4534 and 5336 - Bottom of housing ISO 5211-F35



Models 6044 and 7114 - Bottom of housing ISO 5211-F48



Models 1485, 1934, 1935, 2385, 3071, 3072, 3731, 4534, 5336, 6044 and 7114 - Top of housing - Mounting details

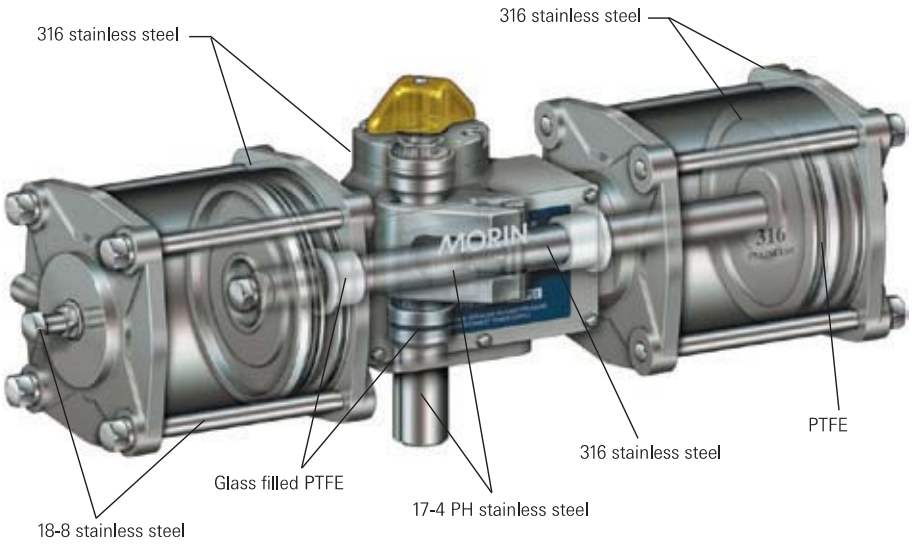


Metric thread option

Metric tap	Model number
* M20	370 and 575 to 1150
*** M30	1485 to 5336
**** M5	370 and 575 to 1150
***** M36	6044 and 7114

Replace 'U' with 'M' in order number designation (refer to page 6).

The series S actuator (all stainless)



Setting an unrivaled standard in actuation at a price unexpectedly
low for stainless steel.

- Up to 160 psig max operating pressure (see torque chart, MORMC-0333).
- Double acting break torques to 240,000 lb.in.
- Spring end torques to 104,125 lb.in.

For additional information, refer to datasheet MORMC-0024.

The series HP actuator



High pressure actuation with carbon steel cylinders for superior corrosion resistance.

- Up to 2250 psig max operating pressure (see torque chart, MORMC-0333).
- Double acting torques to 800,000 lb.in.
- Spring end torques to 400,000 lb.in.

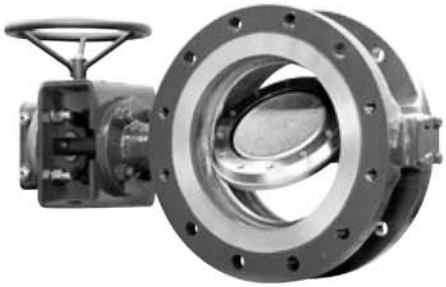
For additional information, refer to datasheet MORMC-0072.

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VANESSA SERIES 30,000

INSTALLATION AND MAINTENANCE INSTRUCTIONS

Installation and Maintenance Instructions Vanessa Series 30,000 - Basic configuration body style double flanged, wafer, lug and buttweld



Applicable product range

- Series 30,000 Basic configuration, double flanged body style, which can be installed between two flanges or stud-bolted to either flange.
- Series 30,000 Basic configuration, lug-single flange body style, which must be bolted to either flange.
- Series 30,000 Basic configuration, wafer body style, which can be installed between two flanges.
- Series 30,000 Basic configuration, buttweld ends, which must be welded to the line.

SECTION 1 - VALVE STORAGE

1.1 Preparation and preservation for shipment

All valves are properly packed in order to protect the parts that are subject to deterioration during transportation and storage on site. In particular, the following precautions should be taken:

1 The valves must be packed with the disc in the closed position. The flange sealing surfaces (raised faces) of the valves will be protected with suitable protective grease. The end faces of the valve must be protected with plastic or wooden discs fixed with straps.

2 Bare shaft valves: the ends of the shaft must be protected with plastic tubes.

3 Valves with actuators: in case of "fail open" pneumatic - hydraulic actuators with manual override, the manual override shall be used to manually close the valves and to lock them in position. If there is no manual override, cut outs are made in the flange protectors for the disc, and the disc is securely protected.

All actuated valves must be securely palleted or crated with particular attention, in order to ensure that parts of actuator (especially pneumatic piping or accessories) do not extend beyond the skid/crate.

4 The type of packing must be defined in the customer's order and will be appropriate to ensure safe transportation to final destination and eventual conservation before installation.

1.2 Handling requirements

A - Packed valves

Crates: Lifting and handling of the packed valves in crates will be carried out by a fork lift truck, by means of the appropriate fork hitches.

Cases: The lifting of packed valves in cases will be carried out in the lifting points and in the center of gravity position which have been marked. The transportation of all packed material must be carried out safely and following the local safety regulations.

B - Unpacked valves

1 The lifting and the handling of these valves has to be carried out by using appropriate means and by respecting the carrying limits. The handling must be carried out on pallets, protecting the machined surfaces to avoid any damage.

2 With large dimension valves, the sling and the hooking of the load must be carried out by using the appropriate tools (brackets, hook, fasteners, ropes) and load balancing tools in order to prevent them from falling or moving during the lifting and handling.

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1.3 Storage and preservation before installation

In case the valves have to be stored before installation, the storage has to be carried out in a controlled way, and has to be performed in accordance to the following criteria:

1 The valves have to be stocked in a closed, clean and dry storage room.
2 The disc must be in the closed position, and the end faces must be protected with plastic or wooden discs fixed with straps. If possible, keep the original protection.
3 Periodical checks have to be carried out in the storage area to verify that the above mentioned conditions are maintained.

NOTE

Storage in an open area for a limited period can be considered only in case the valves have appropriate packing (packed in cases lined with tarred paper, and contents well protected with barrier sacks).

CAUTION

For valve handling and/or lifting, the lifting equipment (fasteners, hooks, etc.) must be sized and selected while taking into account the valve weight indicated in the packing list and/or delivery note. Lifting and handling must be made only by qualified personnel.

Fasteners must be protected by plastic covers in sharp corner areas.

Caution must be taken during the handling to avoid that this equipment passes over the workers or over any other place where a possible fall could cause damage. In any case, the local safety regulations must be respected.

NOTE

Solutions A and C are applicable when the protrusion of the bottom hub from the flange or body is sufficient to position securely the lifting strap.
Solutions B and D are applicable when the protrusion of the bottom hub from the flanges is NOT sufficient to position securely the lifting strap.
In presence of solution B, insert a stud bolt and fix it securely with nuts as indicated in the drawing detail.
In presence of solution D, insert a lifting eyelet in the flange threaded holes close to the bottom hub and fix it securely as indicated in the drawing detail.

LIFTING AND HANDLING OF VALVES INSTALLED IN HORIZONTAL PIPELINE

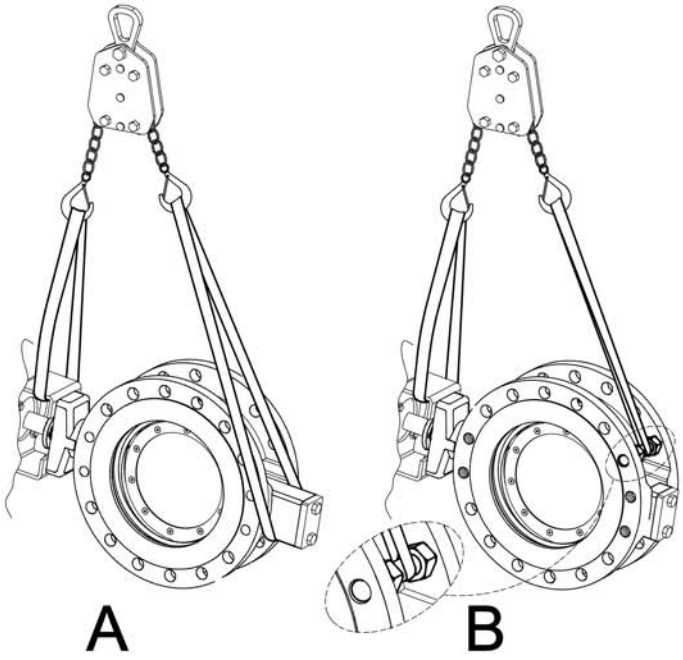


FIGURE NO. 1A

LIFTING AND HANDLING OF VALVES INSTALLED IN VERTICAL PIPELINE

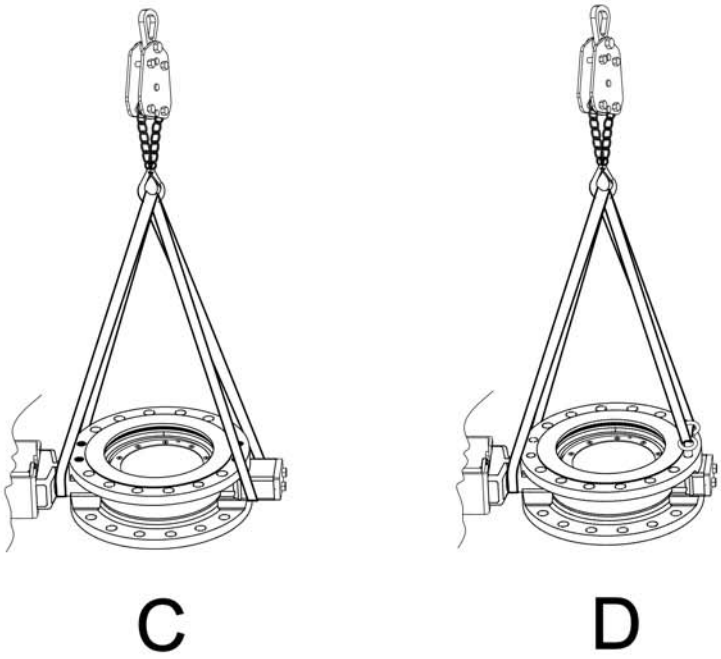


FIGURE NO. 1B

SECTION 2 - INSTALLATION

2.1 Valve inspection

1 Carefully remove the valve from the shipping package (box or pallet) avoiding any damage to the valve or, in case of automated valves, to the electric or pneumatic/ hydraulic actuator or instrumentation.
2 The valves are shipped with the ends protected with caps and a thin layer of protective grease. Before installing the valve, remove the caps and clean carefully, then de-grease both surfaces with a solvent. Clean the inside of the valve using an air line. Ensure that there are no solid objects such as pieces of wood, plastic or packing materials within the valve or on the valve seat.
3 Inspect the seal ring to ensure that it was not damaged during handling. This is especially important in case of valves shipped with the disc in the open position and with "fail-open" actuators.
4 Confirm that the materials of construction listed on the valve nameplate are appropriate for the service intended and are as specified.
5 Ensure that the packing gland adjusting nuts against the packing gland flange cannot be rotated by hand.

2.2 Valve installation

Vanessa recommends that the optimum valve installation is with the shaft in the horizontal plane, after which it is preferable to have the shaft at an angle so as to minimize any problem associated with solid particles present in the fluid that otherwise could deposit in the lower bearing area.

NOTE

The Vanessa valve is designed to withstand design differential pressure in both directions.

Isolating applications

The valve operating torque affects the sealing performances. Vanessa attached the indication plate ΔP (figure 2) on the upstream flange as a reference for the direction of the installation.
The best sealing performance, also for bi-directional service, will be maintained when pressure acts on the shaft side of the valve, which is recommended when the service tightness requirements are more stringent in one specific direction.

Control applications (uni-directional, where perfect sealing is not required)

The plate could be fixed on either flange indicating the preferred direction. Please respect the direction of installation indicated on the relevant flange. The selection of the actuator has been made for that specific direction of installation.

Unless otherwise recommended by Vanessa, the valve should be installed with the disc in the closed position to ensure that the seal ring in the disc is not damaged during installation. Particular care should be taken with those valves equipped with "fail-open" actuators.
For operating temperatures above 200°C (392°F) thermal insulation of the valve body is recommended.
If the valve has threaded tapped holes in the hub areas, Vanessa recommends to use hexagonal head bolts or shorter studs to connect the valve in this zone. The depth of the tapped holes in the bodies of all Series 30,000 valves is specified in the technical literature. Failure to use correct bolts/studs may result in damage to the valve.
If the valve has welded ends, perfectly clean and degrease the ends to be welded (of both valve and pipe), using a cloth with acetone or similar product. Insert correctly the valve between the edges of the pipe to be welded, taking care of the plate that indicates the preferential side for sealing. Carry out an initial accurate spot welding verifying the perfect alignment of the edge and axis of the valve. Carry out the welding of the edge proceeding in alternate way on both sides to reduce the tensions introduced by the welding. It is important to respect the interpass temperature which must not go above 150°C (302°F).
Handling and lifting of the valves during installation MUST be performed following the same criteria and instructions described in previous points "1.2 Handling requirements" and "1.3 Storage and preservation before Installation".

IMPORTANT

The valve trim is designed to withstand and to seal against the design differential pressure marked on the valve nameplate which data are supplied together with the present document.
Since it is impossible to maintain complete control on the external input forces to the trim coming from gear/actuator, the valve trim shall not be used as a final protective mean against the hazard caused by the closed valve upstream pressure.

IMPORTANT

It is recommended to perform piping flushing before installation of valve.
If this is not possible, the valves must be set with the disc in full open position before starting with flushing.

CAUTIONS

When the pipe is lined, be careful that the disc does not come into contact with the lining during its stroke, especially in lug and wafer body styles. This verification is very important to avoid any damage to the valve.



FIGURE 2

2.3 Valve verification

1 Tighten the packing just enough to prevent stem leakage. Over-tightening will decrease packing life and increase operating torque.
2 Check the operation of the valve by stroking it to "full open" and "full close". To verify the valve orientation, the disc position indicator mark on the shaft (during the normal open to close cycle) should rotate clockwise from a position in line with the pipe (see figure 3a) to a position parallel to the pipe flanges (see figure 3b).

IMPORTANT

If piping system is pressurized with water for testing, and in case the piping system has been shut down after testing for a long time, the following recommendations should be adopted:

a. Use corrosion inhibitor with water to pressurize the piping system.
b. After testing, the piping system should be depressurized and the test water completely drained.
c. After testing, valves must be maneuvered through a complete opening/closing cycle and disc left in half-open position. Apply a film of protective oil in the packing area by means of a paintbrush. The protective oil must fill the area between shaft and packing bushing.

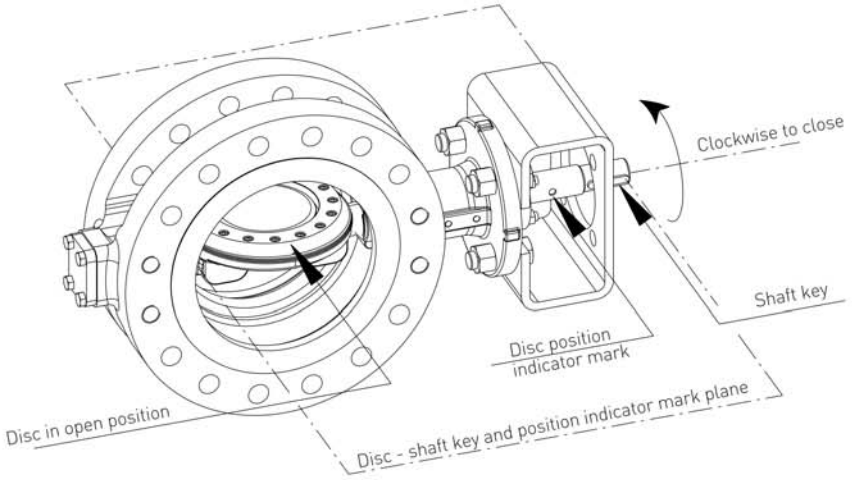


FIGURE NO. 3A

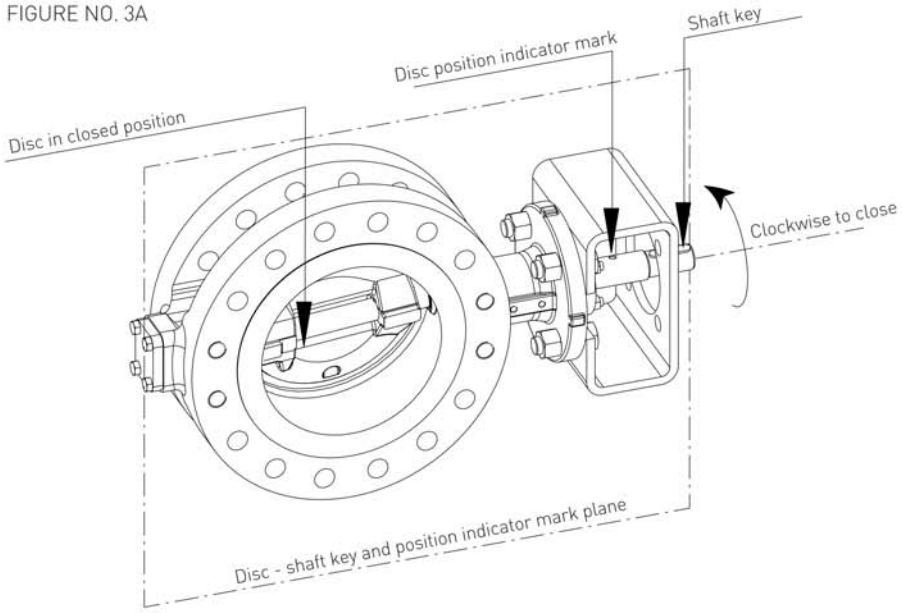


FIGURE NO. 3B

2.4 TROUBLESHOOTING GUIDE

Symptom	Possible cause	Resolution
Valve won't rotate	1. Packing is too tight	1. Loosen gland nuts
	2. Actuator has failed	2. Replace or repair
	3. Valve packed with debris	3. Flush or clean valve to remove debris
	4. Stem key has sheared	4. Determine cause of shearing and correctly replace stem key
	5. Fluid solidification between bearings and shaft	5. Flush bearings by flushing holes (if present)
Stem packing leaking	1. Gland flange nuts too loose	1. Tighten gland flange nuts
	2. Packing damaged	2. Replace packing - see Paragraph 3.1
Bottom flange gasket leaking	1. Bottom flange bolting loose	1. Tighten bottom flange bolting
	2. Spiral wound gasket damage	2. Replace gasket - see Paragraph 3.3
Valve leaking	1. Valve not fully closed	1. Close valve
	2. Debris trapped in valve	2. Cycle and flush (with valve open) to remove debris
	3. Actuator mechanical stops improperly set	3. Remove the stop for closure and reset properly
	4. Seal ring damaged	4. Replace seal ring - see Paragraph 3.2
Jerky operation	1. Packing is too tight	1. Loosen gland nuts, cycle valve, retighten
	2. Air supply inadequate	2. Increase air supply pressure and/or volume
	3. Actuator/stem adapter misaligned	3. Remove actuator mounting and realign

SECTION 3 - MAINTENANCE

The Vanessa Series 30,000 has been designed to require a minimum of maintenance.

WARNING!
Depressurize the line before starting any maintenance. Failure to do so may cause serious personal injury and/or equipment damage.

3.1 Packing maintenance

If shaft leakage is observed through the packing, tighten the gland nuts slowly and evenly until the leakage stops.

CAUTION
Do not over-tighten packing gland nuts. Over-tightening will increase the torque required to operate the valve.
When tightening the gland nut, use half-turn increments until leakage has stopped.

Please refer to the figure no. 4.
To replace the packing proceed as follows:

1 Remove the gear/actuator and relevant connecting keys (4f). Please note the actuator position relative to the valve position for reassembly of gear/actuator later.
2 Remove gland nuts (5d). If present, remove belleville springs (5n), taking care of noting their assembly configuration to reassemble them correctly (point 7).
3 Remove packing gland flange (5f), anti blow-out ring if present (5g), and gland bushing (5c).
4 Remove packing (5a). If valve is with packing flush option, remove lantern ring also (5h).
5 Carefully clean packing cavity and shaft (4a).
6 Apply a thin film of lubricant on each new packing ring (5a) surfaces (lubricant should be in accordance with Table IV). Insert new packing rings, paying attention to insert the two braided rings at the bottom and top of the entire packing. If valve is with packing flush option, insert the lantern ring (5h) in the same sequence as previously removed (or as indicated in figure 4). If the packing rings are of the split variety, install with splits staggered at 180° from each other.
7 Reassemble gland bushing (5c), anti blow-out ring if present (5g), and gland flange (5f). If present, assemble the belleville springs (5n), following the assembly configuration noted in the previous point 2, then assemble by hand the gland nuts (5d) without tightening (after applying a thin film of lubricant on the threads of the stud bolts, in accordance with Table IV).
8 Reassemble keys (4f) on the upper stem end.
9 Reassemble gear/actuator and close the valve.

CAUTION
Do not force actuator on the stem! This should be a free moving fit.

10 Tighten gland nuts (5d) in accordance to Table I (Torque values for gland nuts).
11 Cycle the valve.
12 Pressurize again the line.
13 If a leakage is detected, tighten the gland nuts slowly and evenly until the leakage stops.

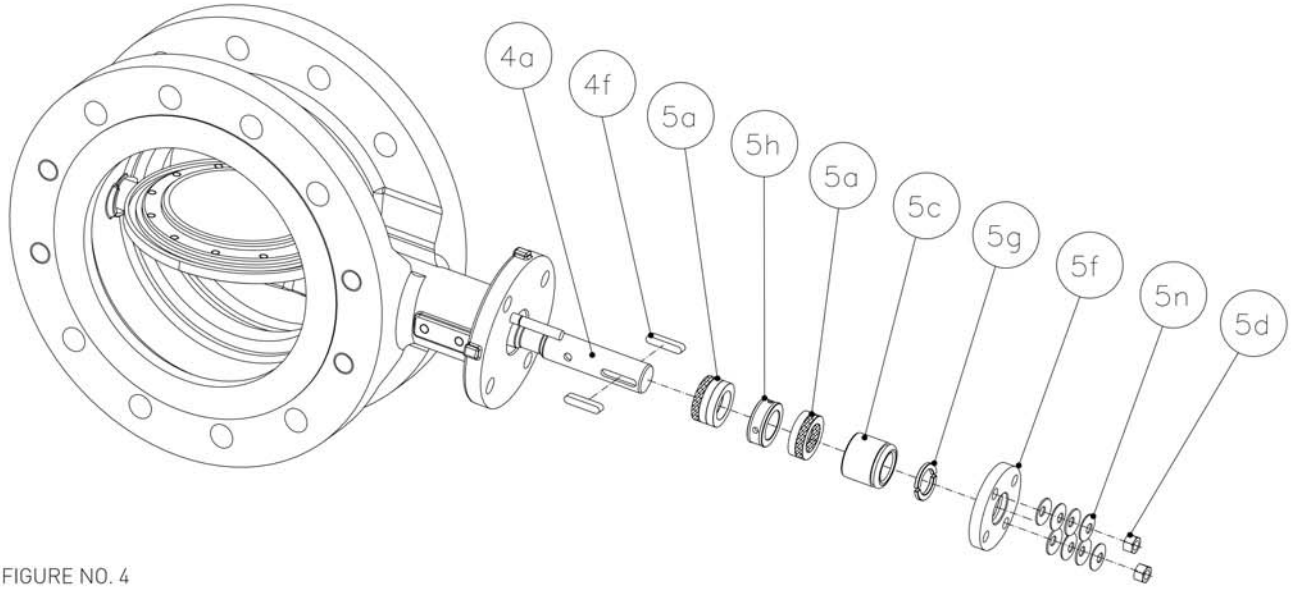


FIGURE NO. 4

3.2 Sealing elements maintenance

To replace the sealing elements proceed as follows (please refer to figure no. 5):

WARNING!

Depressurize the line before starting any maintenance. Failure to do so may cause seriouspersonal injury and/or damage to the valve.

1 Remove the valve with the disc in the closed position from line. Clean the valve according to proper cleaning procedure as outlined by the plant or according to a recommended procedure.
2 Open the valve a few degrees.
3 Loosen the seal retainer ring screws (2c).
4 Open valve to full open position.

NOTE

In small size valves it may be easier to unbolt the actuator and rotate the disc beyond the full-open position to provide more space to work with components.

5 Carefully remove the retainer ring screws (2c) with security washers (2d), then remove the seal retaining ring (2b).
6 Remove seal ring (3a) and spiral wound gasket (3b).
7 Inspect the body seat. Clean it, if necessary, with fine abrasive cloth (No. 600 or finer), after having cleaned it perfectly with solvent.
8 Inspect and clean the disc seal ring area and spiral wound gasket groove. No foreign particles must be present before spiral wound gasket and seal ring assembly.
9 Apply a thin film of lubricant on the surface area of the disc (2a) where seal ring (3a) and spiral wound gasket (3b) will be located (lubricant should be in accordance with Table IV).

CAUTION

Apply only a thin film of lubricant where indicated. Failure to do so will hinder the assembly and may cause damage to the valve.

10 Assemble the new spiral wound gasket (3b) in the disc groove, without forcing and taking care not to damage it.
11 Replace seal ring (3a) on the disc through the shaft side of the body. To properly locate the seal ring, there are two different solutions:
   • solution 1 - ref. to figure no. 6a: align the internal slot of the seal ring (3a) to the reference pin (F).
   • solution 2 - ref. to figure no. 6b: align the reference mark (C) on the seal ring (3a) with the relevant reference mark (D) on the disc.
12 Assemble the seal retainer ring (2b). There are two different solutions as per previous point 11:
   • solution 1 - ref. to figure no. 6a: make sure that the slot on the edge of the seal retainer ring (B) is in correspondence with reference pin (F).
   • solution 2 - ref. to figure no. 6b: ensure to locate the hole (E) of the seal retainer ring with the relevant marks on the disc (D) and seal ring (C).
13 Hand tighten all the fastening screws (2c), with relevant lock washers (2d) after applying Loctite® 270 or equivalent on the bottom side of the threads (they have to be perfectly cleaned with solvent before applying Loctite®). Then, verify that the seal ring can be moved freely by hand without rotating it.
14 Apply a thin film of lubricant to the body seat and to the external edge (sealing conical surface) of the seal ring (3a). Lubricant should be in accordance with Table IV.
15 Seat and unseat the valve twice.
16 Keep the valve in the closed position without applying torque. Tighten at least two retaining screws (2c) to avoid the seal ring moving from the position found.

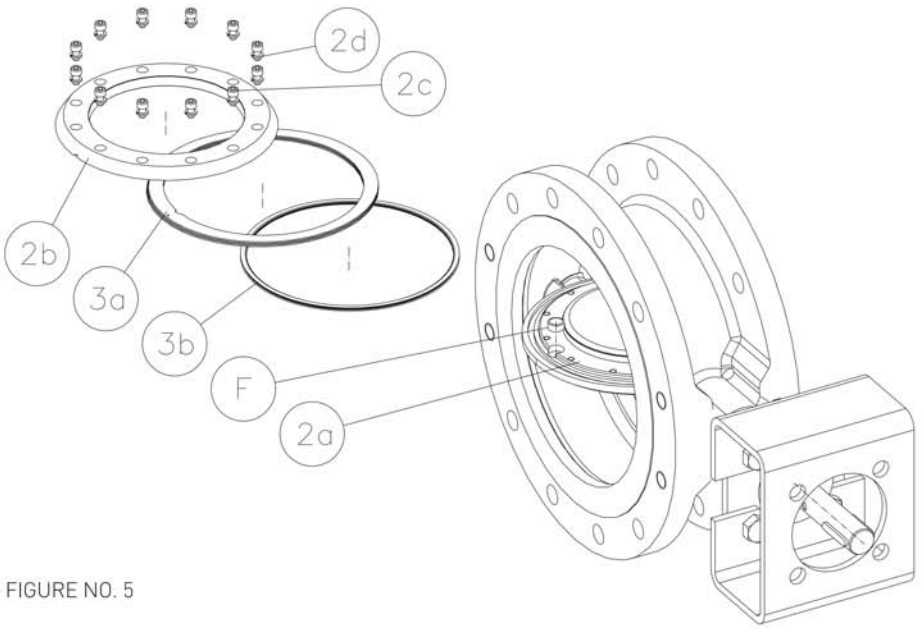


FIGURE NO. 5

17 Open the disc a few degrees and tighten, using a torque wrench, all screws (2c).
Use a torque value from Table III for valves according to solution 1 (ref. to figure no. 6a).
Use instead a torque value from Table II for valves according to solution 2 (ref. to figure no. 6b).
It is recommended to use the crossover method to tighten all retaining screws.

IMPORTANT!

• *Solution 1- ref. to figure no. 6a:*
The seal ring is supplied with an index marking (A). After the complete assembling, verify that the index marking (A) can be seen in the slot (B) of the seal retainer flange.
Slot (B) and marking (A) have to be perfectly aligned.
If not visible or not aligned, loosen the retaining screws, re-align the index marking and start again the procedure from point 12.

• *Solution 2 - ref. to figure no. 6b:*
The seal ring and the disc are completed with two reference markings, (C) and (D).
After the complete assembling, verify that both markings can be seen through the hole (E) of the seal retainer flange. The two markings have to be perfectly aligned.
If not visible or not aligned, loose the retaining screws, re-align the index markings and start again the procedure from point 12.

3.3 Bottom flange gasket maintenance

If necessary to replace the bottom spiral wound gasket, proceed as follows (see fig. no. 7):

1 Remove the bottom flange (6a).
2 Remove the spiral wound gasket (6c).
3 Inspect and clean the groove of the spiral wound gasket in the body and in the bottom flange.
4 Apply a thin film of lubricant on the bottom spiral wound gasket (6c), then insert it on the bottom flange (6a), centering and positioning all on the body bore (lubricant should be in accordance with Table IV). Rotate the bottom flange to accommodate the correct position and center the holes with the threaded holes on the body.
5 Apply a thin film of lubricant on the threads of the screws (6b), then introduce and tighten them using a torque value from Table III (lubricant should be in accordance with Table IV).

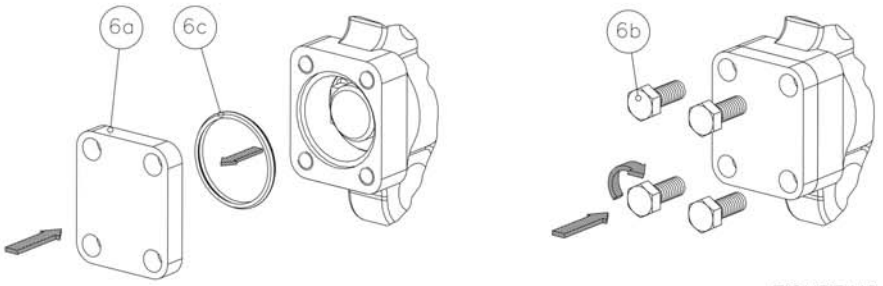


FIGURE NO. 7

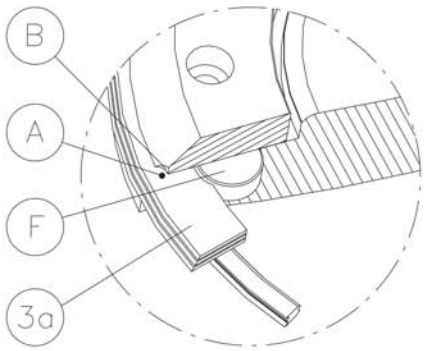


FIGURE NO. 6A

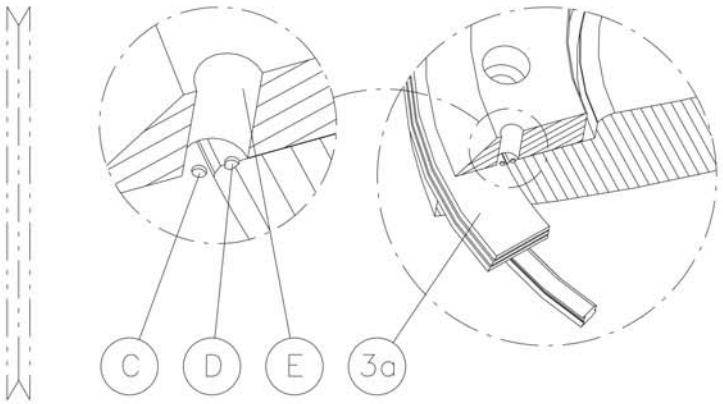


FIGURE NO. 6B

SECTION 4 - STANDARD OPTIONS

This section (4) is referred only to Vanessa products configured with the following options:
- bearing and packing flushing,
- live loaded packing.

4.1 Bearing and packing flushing

4.1.1 Bearing flushing

The bearing flushing option is obtained by adding two tapped holes, one in the bottom flange and one in the neck of the valve (see fig. 9). This option includes the introduction of a lantern ring at the bottom of the valve packing. Bearing flushing is recommended when the valve is installed in a service where the particles present in the fluid or the line fluid itself can migrate into the shaft/bearing area causing problems. A typical example is sulphur recovery services, where the sulphur in a liquid or gaseous state may enter this area and crystallise as a consequence of the plant shutdown.

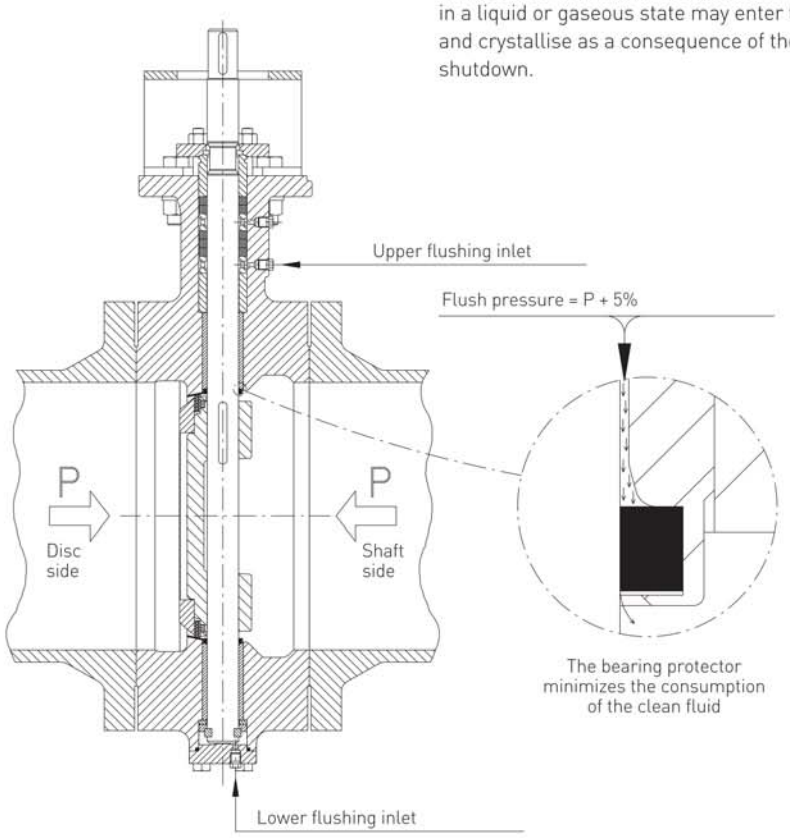


FIGURE NO. 8

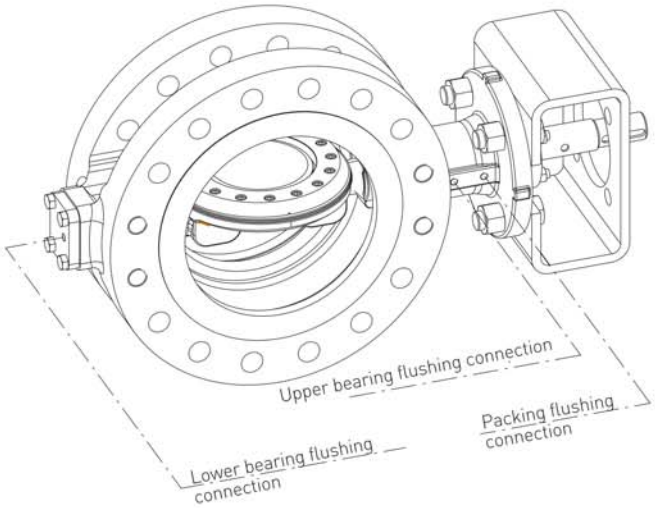


FIGURE NO. 9

This crystallisation may result in an increase in the torque requirement of the valve. Another example may be a fluid that contains particles (e.g. catalyst) that may cause similar problems to those highlighted above.
In these types of situations the bearing flushing may be used to introduce an inert fluid compatible with the process via the bearing flush taps (see fig. 8) so as to create a pressure barrier which prevents the introduction of the unwanted products from the line into the shaft/bearing area. The pressure of the flushing fluid must be slightly higher than the line pressure (i.e. P1 + approx 5%). This both acts as a safety measure and is a positive step in increasing the lifetime of the valve, as well as maintaining the constant torque requirement and hence operability of the valve.
The bearings may be continuously flushed, this is recommended by Vanessa for critical services such as described above. Periodic flushing may be used for less critical services in order to clean the bearing/shaft interface or in order to prepare the valve for a shutdown of the process.
The bearing flush taps may also be used to introduce a lubricant compatible with the process to the bearing areas for high cycle or dry gas service. The presence of the bearing protector drastically reduces the consumption of the flushing or lubricant by reducing the amount of fluid required to give efficient service (see fig. 8).
Further information is available from Vanessa on request.

4.1.2 Packing flushing
The packing flushing option is obtained by the introduction of a tapped hole that communicates directly to the packing set in the neck of the valve via a lantern ring. This option can be used to monitor the rate of emission of the line fluid toward the atmosphere (it is important to point out that the packing of the Vanessa valve fully complies with TA Luft and EPA requirements). This flush tap may also be used to capture and evacuate line fluid so as to prevent any atmospheric loss, with the lantern ring and split packing configuration acting as a double block and bleed unit.

A suitable fluid may also be introduced via the packing flush tap into the packing area so as to eliminate any possible fugitive emissions (see fig. 9). By keeping the fluid pressurized at a pressure that is higher with respect to the line pressure, the passage of any line fluid towards the atmosphere can be effectively blocked giving the valve excellent fugitive emissions control. However, the fluid used must be compatible with the line fluid as it may have the possibility of finding its way into the line as well as toward the atmosphere.

As with the bearing flushing option this may also be used to introduce a lubricant compatible with the process.

The type of lubricant used for flushing is at the clients' care. Vanessa may be contacted to supply further detailed, process specific information.

4.3 Live loaded packing
The live loaded packing option is designed to supplement the already excellent characteristics of the Vanessa valve packing. This option guarantees a constant compression of the packing set giving a further guarantee of the fugitive emissions control of the Vanessa valve. The fact that the packing is subject to a near constant force supplied by the Belleville washers reduces the maintenance cycle required by the packing (see fig. 10).

Care should be taken in replacing the Belleville springs as their order (parallel or series) should be noted.
The packing nuts should be tightened in accordance with Table I.

At this point it is worth mentioning that the TA Luft test has shown that the Vanessa Series 30,000 std. Packing is more than adequate in passing its stringent requirements.

The live loaded packing option should be considered in valves that are subject to severe cycling duty or valves that are subject to severe thermal cycles.
The drawing shows typical set ups for the live loaded packing option.

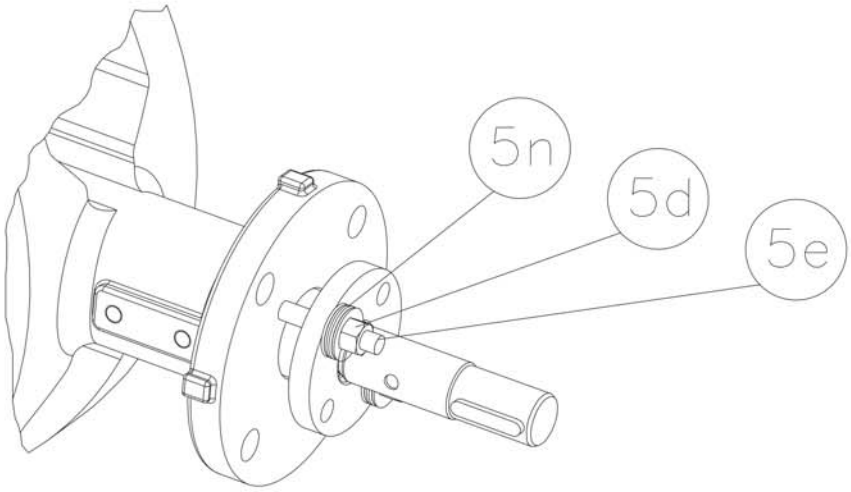


FIGURE NO. 10

TABLE I: Torque values for gland nuts

ND		Trim A		Trim B		Trim C		Trim D		Trim E	
in.	mm	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb
3	80	-	-	15	11	15	11	30	22	-	-
4	100	-	-	15	11	15	11	30	22	-	-
6	150	-	-	15	11	20	15	35	26	50	37
8	200	-	-	15	11	20	15	60	44	105	78
10	250	-	-	25	18	20	15	70	52	135	100
12	300	-	-	25	18	25	18	75	55	240	177
14	350	-	-	30	22	30	22	75	55	240	177
16	400	-	-	30	22	35	26	100	74	175	129
18	450	-	-	35	26	40	30	205	151	480	354
20	500	-	-	35	26	45	33	320	236	195	144
24	600	-	-	45	33	55	41	420	310	605	446
28	700	30	22	85	63	100	74	465	343	-	-
30	750	30	22	105	78	135	100	485	358	-	-
32	800	30	22	105	78	165	122	505	372	-	-
36	900	30	22	110	81	220	162	545	402	-	-
40	1000	30	22	110	81	225	166	-	-	-	-
42	1050	30	22	110	81	230	170	-	-	-	-
48	1200	30	22	110	81	235	173	-	-	-	-
54	1350	50	37	155	115	-	-	-	-	-	-
60	1500	65	48	160	118	-	-	-	-	-	-
64	1600	65	48	-	-	-	-	-	-	-	-
72	1800	65	48	-	-	-	-	-	-	-	-
84	2100	65	48	-	-	-	-	-	-	-	-

Note: the torque values are those suggested for the hydraulic test of the body.

TABLE II: Tightening torque values for bolts and screws

Bolt dimensions (mm)	Torque values Torque (Nm)	Torque (ft-lb)
8	12	9
10	24	18
12	41	30
14	66	49
16	103	76
18	142	105
20	201	148
22	274	202
24	348	257

TABLE III: General torque values for bolting

Bolt dimensions (mm)	Torque values Torque (Nm)	Torque (ft-lb)
6	10	7
8	20	15
10	45	33
12	70	52
14	110	81
16	175	129
18	235	173
20	335	247
22	370	273
24	460	339
27	595	439
30	760	561
33	785	579
36	1010	745
39	1315	970
42	1625	1199
45	2035	1501

TABLE IV: Lubrication

Type	Component to lubricate
Light mineral oil	1. Packing rings (5a) 2. Disc surface areas (2a) for seal ring and spiral wound gasket location 3. Spiral wound gasket (6c)
Molykote® - P74 (grease) or equivalent	1. Stud bolts/nuts (5d) 2. Screw (6b)
Molykote® spray - 321 R (dry lubricant) or equivalent	1. Seal ring (3a) 2. Body seat

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WESTLOCK
CONTROLS CORPORATION

ACCUTRAK ROTARY MODELS: 1040/9358/2004/9044/9468/5004 5044/2007/9479/5050 INSTALLATION AND OPERATIONS MANUAL

IOM: Tech-385		**Revision: B**	
Prepared By: Herb Tucker	**Date:** 8/23/05	**Drafting Work Order:** 19367	**ECN:** 11813
Reviewed By: Jim Kilian	**Date:** 12/7/11	**Approved By:** Tony Paolini	**Date:** 11/7/11

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Revision History

Revision
23 Aug, 2005 Initial release • 4/7/10 rev. A • 11/9/10 rev. B

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1. Introduction

1.1. Product Certification

1040/9358: CSA Type 4 (Cert. #LR 81057-3)
2004: CSA Type 4 (Cert. #LR 81057-7)
9044: NEMA 4, 4X (Cert. not applicable)
9468: FMc NI/I/2/ABCD/T4 0° C<= Ta<60° Type 4X, 6P, IP67; DIP/II/2/FG/ T4 0°C<=Ta<60°C (Cert. #3036618C)
5004/5044: FMc IS/I, II, III/1/ABCDEFG/T6 Ta=60°C Entity WD-11880, NI/I/2/ABCD/T5 Ta=60°C Entity WD-11880; Entity Parameters for P&F NJ2-V3-N, Vmax=16 V, Imax=25 mA, PI=34 mW, Ci=40 nF, Li=50 μH (Cert. #3008802); NJ2-11-N-G, Vmax=16 V, Ii=25 mA, PI=34 mW, Ci=30 nF, Li=50 μH
2007/9479: FMc XP/I/1/CD/T6 Ta=60°C, DIP/II/1/EFG/T6 TA=60°C; 9479 ONLY: N/I/I/2 ABCD/T4 Ta=60°C, Type 4, 4X (Cert. #3029311C)
5050: FM XP/I/1/CD/T6 Ta=50°C, DIP/II/1/EFG/T6 Ta=50°C, NI/I/2/ABCD/T4 Ta=50°C, Type 4, 4X (Cert. #3026687)

1.2. Warnings



- Never remove enclosure cover or make/break electrical connections with power connected to the unit.
- Perform all wiring in accordance with site and local codes and the National Electric Code ANSI-NFPA-70 (US) or the Canadian Electric Code Part I (Canada) for the appropriate area classifications.
- Confirm that the AccuTrak model being installed is approved for the hazardous area (see Product Certification section above or unit ID label).
- Confirm that supply power to switches is within rated specifications listed on the unit identification label.
- Protect the unit from exposure to aggressive substances or atmospheres to ensure that hazard rating is not compromised.

1.3. Description

AccuTrak valve position monitors are intended for use as both visual and electrical position indicators for discrete rotary devices, most commonly pneumatically actuated 2-way quarter-turn or 3-way valves. An AccuTrak monitor is not limited for use in only quarter-turn valve applications, but that application will be assumed for the purpose of this document. In addition to the monitoring features, AccuTrak monitors may serve as wiring junctions for accessories where additional terminals, conduit entries and wiring codes permit.

1.4. Principles of Operation

An AccuTrak monitor mounts to an actuator via a mounting kit, usually sold separately. The unit shaft couples to the actuator shaft directly via NAMUR adaptation, or via a coupling provided in the mounting kit. As the actuator

rotates the unit shaft, adjustable cams on the shaft actuate mechanical or proximity switches inside the unit enclosure, at the limits of rotary travel set by the customer. The switches are pre-wired to a terminal strip in the enclosure, permitting easy connection of switch output to external electrical monitoring systems or indication devices. The visual Beacon indicator on the enclosure cover indicates 90° rotary travel between OPEN and CLOSED valve positions, unless ordered optionally for other angular strokes or 3-way valve applications.

1.5. Special Features/Conditions

To avoid build-up and discharge of static electricity in a hazardous area, only clean Westlock units with a static-free cloth dampened with water. Avoid the use of alcohol-based cleaners.

2. Ordering

Ordering guides for all AccuTrak product series covered by this IOM are available through a local Westlock distributor, the current Westlock Controls catalog literature or the Westlock Controls website at www.westlockcontrols.com. Spare parts lists for refurbishments or repairs are also available for common AccuTrak models.

3. Definitions

NAMUR- This term, in the context of mounting brackets and shafts, refers to the NAMUR VDI/VDE 3845 standard for the dimensions of actuator output shafts and auxiliary equipment mounting hole patterns. In the context of inductive proximity sensors, NAMUR refers to conformance of the sensor to DIN 19 234, allowing its use with any NAMUR style amplifier/isolator.

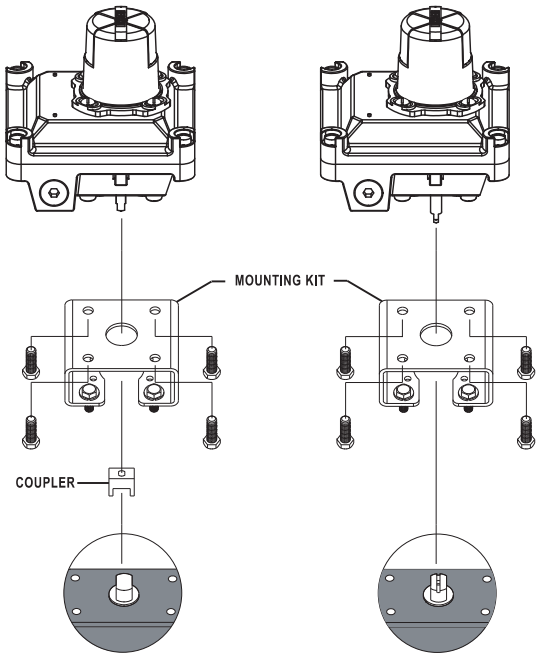
Switch- A manual or mechanically actuated device for making, breaking or changing the connections in an electric circuit. This term will be used also for magnetic or inductive proximity sensors for the purpose of this document.

4. Installation

4.1. *Mounting Instructions*

Required Tools: Open-end wrenches or adjustable wrench to fit all sizes of hex head bolts in the mounting kit.

1. Obtain a mounting kit suited for the actuator/valve, commonly available through a local Westlock Controls distributor.
2. Attach the mounting bracket and coupler (if required) to the unit housing with the hardware provided.
3. Attach the unit and mounting system to the actuator.
4. Ensure proper axial alignment between unit shaft, coupler and actuator shaft. Failure to ensure alignment could result in long-term stress-related failure of unit shaft in high cycle or high torque applications.



4.2. Calibration

Consult factory or a Westlock distributor for setting procedures of units with six switches or four switches and transmitter.

Note 1: Switch actuation can be confirmed using a signal detection device such as a multimeter or ohmmeter, set for “continuity”.

Note 2: For NAMUR P+F NJ2-V3-N type sensors, use test meter, P+F model #1-1350 or equivalent to check sensor actuation and calibration. If the proper meter is not available, contact the factory for additional assistance with the test procedure.

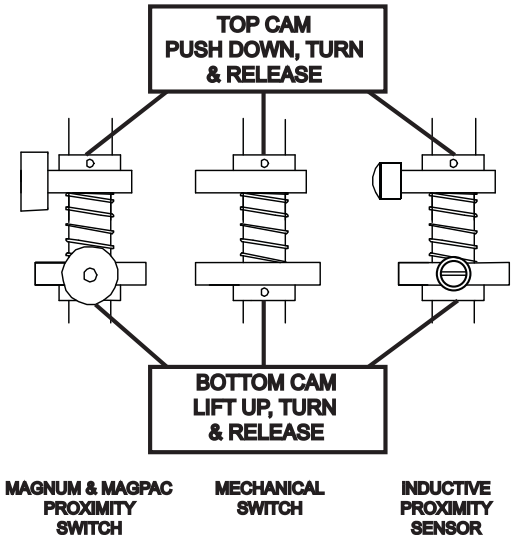
Note 3: Adjust cams by hand by pushing/pulling the cam against the shaft spring to disengage from the mating spline, rotating to adjust and re-engaging firmly onto spline.

Required Tools: Signal detection device (see note 1); slotted screw drivers for cover screws (M4, #10 or 5/16 by model)

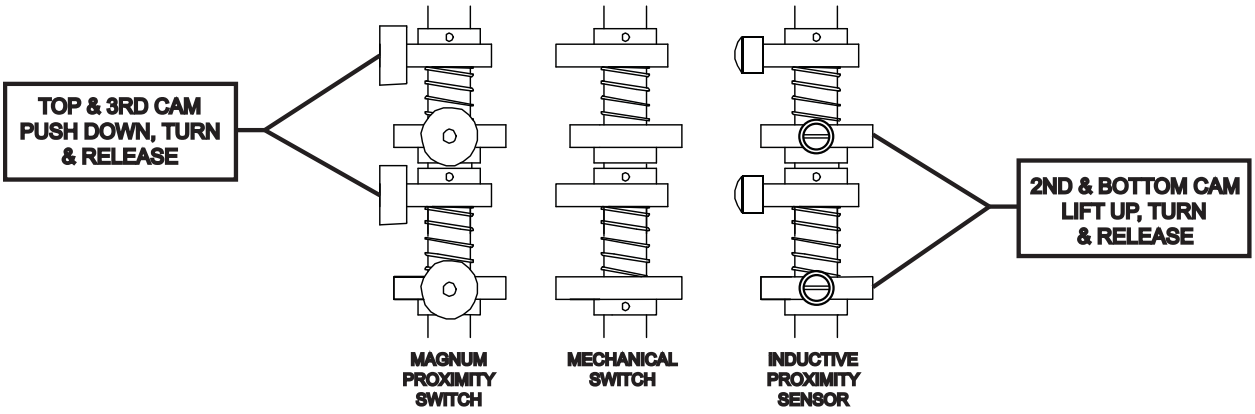
Switch Adjustment (two switches):

1. Remove unit cover as follows: loosen (but do not remove) captive screws, rotate cover slightly to grip corners, pull firmly.
   DO NOT PRY COVER WITH TOOLS.
2. With valve in the closed position, adjust bottom cam until bottom switch (#2) actuates.

3. Stroke valve to the open position, adjust top cam until top switch (#1) actuates.
4. Cycle actuator several times to confirm proper switch indication at each end of stoke. Finely adjust cams if necessary.
5. Skip to Field Wiring section or replace unit cover, applying approximately 20 in-lbs of torque to cover screws.



Switch Adjustment (four switches, no CS transmitter):
Follow steps as above for the calibration of two switches but adjust the first and third cams from the top for switches #1 and #2 and the second and fourth cams from the top for switches #3 and #4 (see illustration below).

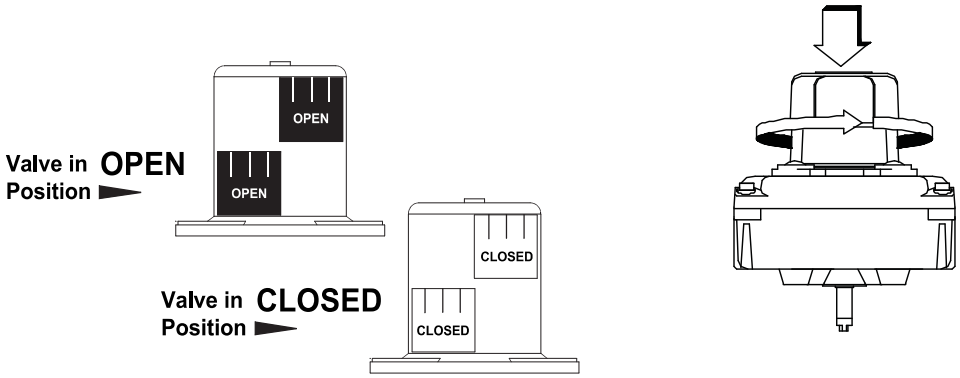


Transmitter setting (optional CS transmitter):
For the calibration of optional current signal (CS) transmitter, see Westlock Controls Installation/Operations Manual TECH-301, available through your local sales representative or at www.westlockcontrols.com.

Beacon Adjustment:

Note: Skip this step if cover is flat or Beacon already displays the correct valve status.
Required Tools: slotted screw driver for #12 screws.

1. For two-way OPEN/CLOSED: remove, rotate and re-fasten outer beacon to synchronize displayed position with valve position.
2. For three-way flow paths: remove, rotate and re-fasten outer beacon and/or inner beacon coupler to synchronize displayed flow path with valve/actuator flow path.



5. Field Wiring

STOP
WARNING

See the warnings section of this document for important warnings pertaining to the wiring of AccuTrak units. Remove and replace cover before and after wiring, per instructions given in the Switch Adjustment section above.

Required Tools: slotted screw drivers for terminal strip screws (#2), cover screws (M4, #10 or 5/16 by model), and grounding screw (#8 or M4 by model); wire strippers as required for field wires.

1. Wire the AccuTrak monitor strictly according to the wiring diagram on the inside of the enclosure cover.
2. Confirm that the ground wire is secure under the green grounding screw in the enclosure.
3. Seal all unused conduit entries as required with suitably certified plugs having an ingress protection rating of IP67 or better.
4. Ensure that only suitably certified cable glands are used, having an ingress protection rating of IP67 or better.
5. Ensure that the temperature rating of all field wiring meets the service temperature range of the application.

6. Maintenance and Repair

ATTENTION

Maintenance or repair of Westlock equipment must only be done by Westlock Controls or by qualified personnel that are knowledgeable about the installation of electromechanical equipment in hazardous areas. All parts

needed for repairs or maintenance must be purchased through a Westlock Controls authorized distributor to maintain warrantee and to ensure the safety and compliance of the equipment.

No routine maintenance of Westlock AccuTrak units is recommended when units are installed in environments for which they are designed. Severe environments may warrant regular replacement of field units every two to five years for maximum performance and safety.

Troubleshooting

Problem: *No signal at the control device*

- Check that power supply to the loop is functioning correctly and adequate to power all devices on the loop;
- Check that power being supplied to switches is within the rated specifications;
- Check wiring integrity immediately at the connection to the control device;
- Check field wiring coming into the AccuTrak terminal strip for proper connection and good wire preparation practices (approximately ¼" of insulation removed and all strands intact);
- Check that field wiring is no larger than 12AWG for proper fit in terminal strip and compliance with terminal strip rating;
- Check that wiring integrity is good between switches and terminal strip;
- Check that cams are set to trigger switches properly in each valve position (see Switch Adjustment section under installation);
- Use multimeter set for "continuity: to check for failed switch; observe continuity between common and normally open when triggered and between common normally closed when not triggered.

Problem: *Beacon does not display the correct flow path*

Reset Beacon per the Beacon Adjustment section under Calibration.

Problem: *Unit appears to be binding during valve stroke or unit shaft has broken*

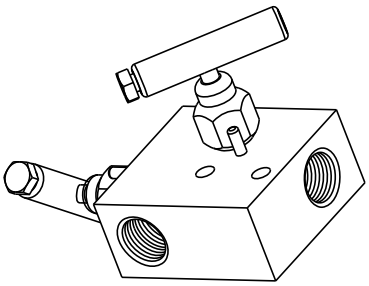
Carefully measure and adjust axial alignment of unit shaft, coupler and actuator shaft to eliminate lifting or twisting of the coupler during travel.

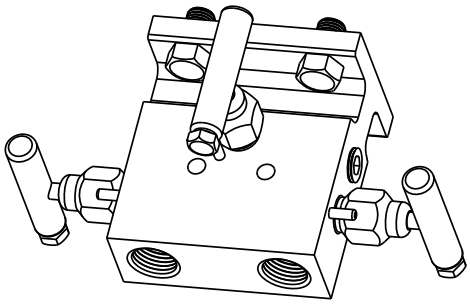
Problem: *Unit has signs of moisture ingress*

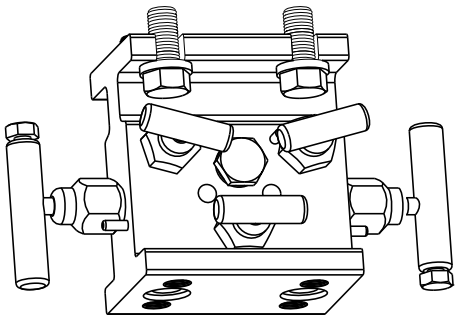
- Check torque on cover screws
- Check gaskets and sealing surfaces for debris and clean if necessary
- Check that conduit connections are properly sealed, including gland fittings and quick-disconnect receptacles
- Check that conduit pipes are properly pitched to direct condensing moisture away from units
- Check that all unused conduit entries are properly sealed with suitably certified plugs having an ingress protection rating of IP67 or better.

Instrument Manifolds

FOR THE PROCESS AND GAS INDUSTRIES







2, 3 and 5 Valve Manifold Designs

By-Pass Manifolds

Block & Bleed Manifolds

Purge Manifolds

Liquid Level Manifolds

Meter Manifolds

Miniature Manifolds

Pipe Mount Manifolds

Pressure & Pressure Instrument Manifolds

Short Mount Manifolds

Patented Pressure-Core™ Stem Seal System with 5-year Warranty

Rock Hard Carbide Ball Seats

Soft "Roddable" Seat Styles

Carbon Steel and 316 SS Standard Materials

Standard 316 SS meets NACE (MR0175 Latest Revision)

Specialty Alloys Available

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15 NPT x NPT
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Notes

Coplanar™ is a trademark of Rosemount®, Inc.
Rosemount® is a registered trademark of Rosemount®, Inc.

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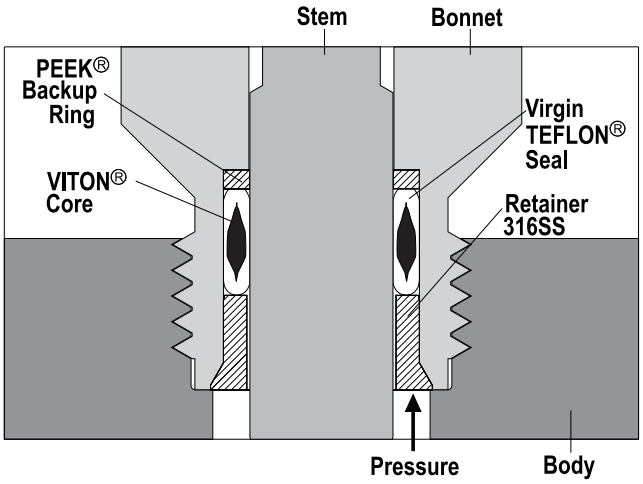
CODE "T"

Teflon® *Pressure-Core*™ Stem Seal
Bonnet and Packing Design

.125" 136" .187" .250" .375" ORIFICE

Pressure-Core™ Stem Seal

Compared to competitive valve designs, PGI's *Pressure-Core*™ Seal offers leak-free performance with no maintenance requirements. To support this claim, we tested the *Pressure-Core*™ Seal against the leading manufacturer's design. The tests simulated harsh plant operating environments and were performed by an independent laboratory in accordance with EPA Method 21.



P A T E N T E D

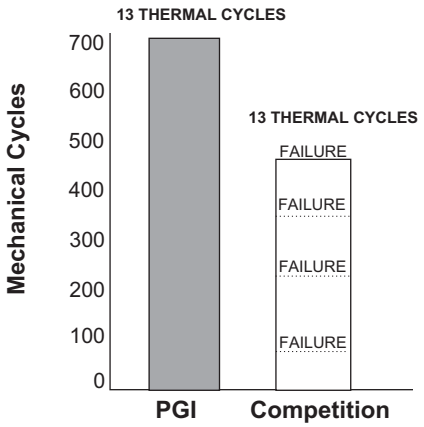
How We Do It!

The *Pressure-Core*™ Seal consists of an outer Teflon® shell with an elliptical shaped Viton® O-ring core. The encapsulated core is "live-loaded" and provides constant outward pressure against the Teflon® shell, which flexes under pressure like an O-ring. The Teflon® shell offers the desired chemical resistance without periodic gland tightening as in conventional designs.

Our test results indicate that you can have a reliable, affordable and virtually leak-free valve requiring no costly, time-consuming maintenance. We stand behind our claim with a **five year warranty**, far exceeding the industry standard.

5 year warranty

FUGITIVE EMISSIONS TEST RESULTS



See for yourself how our Pressure-Core Seal not only outperforms the leading manufacturer's design, but sets a new industry standard.

TEST PROCEDURE

Valves mechanically cycled 50 times (full open to full close) at 1,000 PSI methane, then heated to 400° F and air cooled to ambient. Procedure repeated until failure.

FAILURE CRITERIA

100 PPM Leak
(Competitor's Emission Seal Warranty)

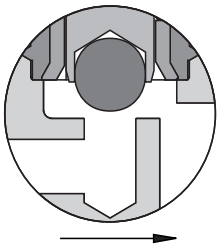
TEST RESULTS

PGI: The Pressure-Core Seal successfully completed **694** mechanical cycles and **15** thermal cycles. Maximum leakage throughout testing was **40** PPM.

Competition: The leading manufacturer's "low emissions" graphite design failed on the **89th** mechanical cycle and on average every **125** cycles throughout the testing. Repeated maintenance was required between each failure to readjust the valve packing.

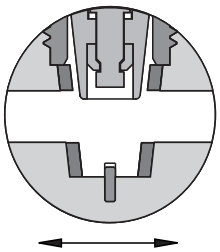
Seat Designs ~ Features and Benefits

.136" .187" .250" .375" ORIFICE



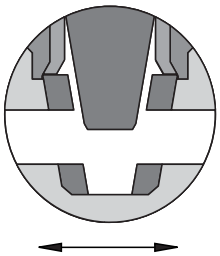
HARD BALL SEAT ~ .136" .187" .375" Orifice

FEATURES	BENEFITS
• PGI Standard Carbide *Ball* Seat	• Non-rotating ball eliminates seat galling and ball creasing • Leak free, bubble tight seating • Available in a variety of materials



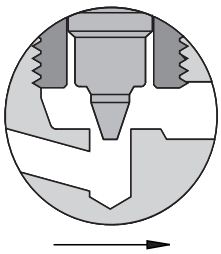
316 SS CONE SEAT ~ .375" Orifice

FEATURES	BENEFITS
• PGI 316 SS *Cone* Seat	• Non-rotating stem tip • Roddable straight-through design • Easily replaced • Bi-directional flow



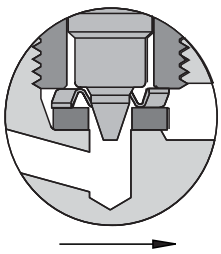
SOFT SEAT ~ .187" .250" .375" Orifice

FEATURES	BENEFITS
• PGI Soft *Cone* Seat	• Roddable straight-through design • Leak free, bubble tight seating • Easily replaced • Available in a variety of materials • Bi-directional flow



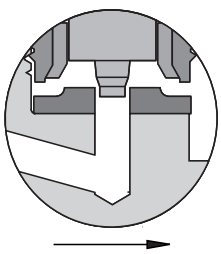
INTEGRAL METAL TO METAL SEAT ~ .136" Orifice [Mini Packed Valves]

FEATURES	BENEFITS
• PGI Integral Metal Seat	• Throtting and shut-off design • Interchangeable between soft or metal seats



SOFT "WASHER" SEAT ~ .136" Orifice [Mini Packed Valves]

FEATURES	BENEFITS
• PGI “Washer” Seat	• Throtting and shut-off design • Interchangeable between soft or metal seats • Easily replaced • Available in a variety of materials



SOFT "WASHER" SEAT ~ .125" .136" Orifice

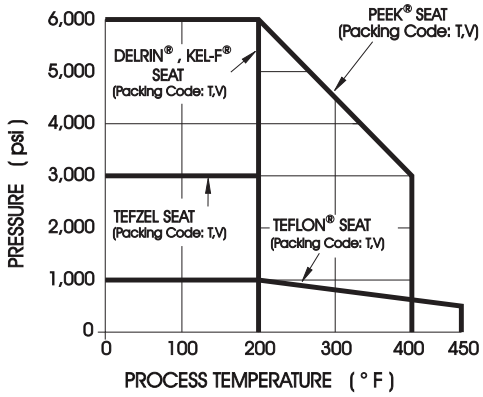
FEATURES	BENEFITS
• PGI “Washer” Seat	• Throtting and shut-off design • Four times the sealing area • Easily replaced • Available in a variety of materials

Pressure and Temperature Charts

.136" .187" .250" .375" ORIFICE

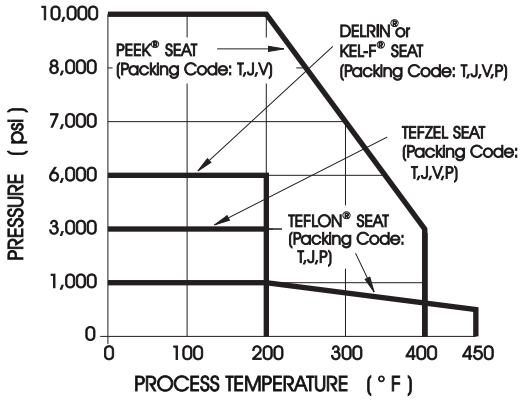
A CHART A

SOFT SEATS - .136" ORIFICE
"T" CODE = TEFLON® PRESSURE-CORE™ SEAL



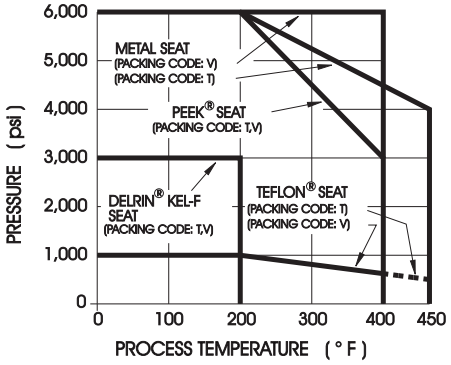
B CHART B

SOFT SEATS - .187" and .250" ORIFICE
All Materials



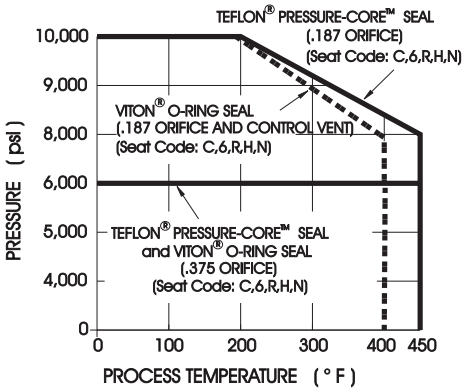
C CHART C

"MINI" SOFT and INTEGRAL METAL SEATS - .136" ORIFICE
"T" CODE = TEFLON® PACKED and
"V" CODE = VITON O-RING SEAL



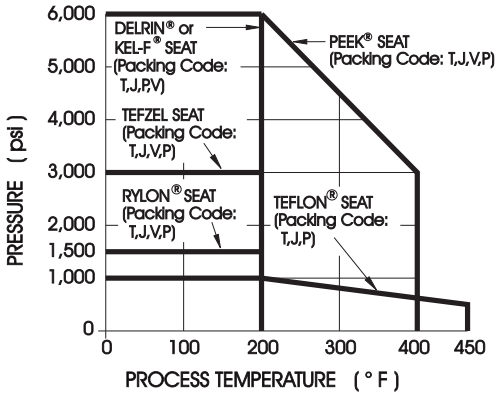
D CHART D

HARD SEATS - .187" and .375" ORIFICE
TEFLON® PRESSURE-CORE™ SEAL
and VITON O-RING SEAL
All Materials



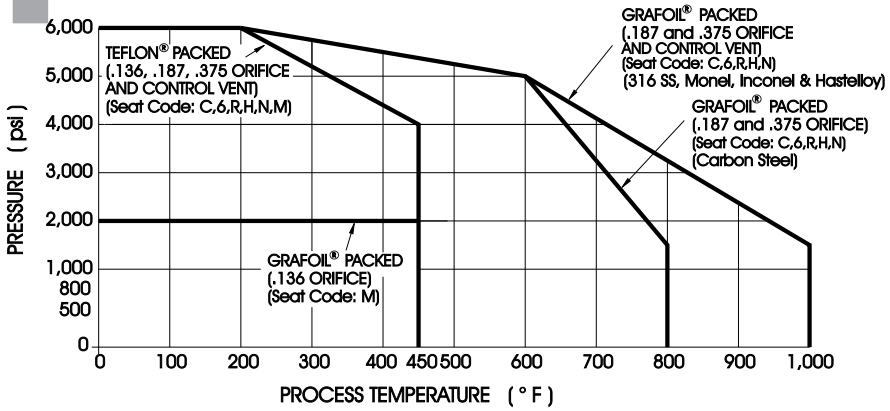
E CHART E

SOFT SEATS - .375" ORIFICE



F CHART F

GRAFOIL® AND TEFLON® PACKED
HARD SEATS - ALL ORIFICE SIZES



Manifold Seats & Seals

STANDARD BODY MATERIAL CODES			
CODE	MATERIAL	MAX TEMP	MIN TEMP
C	ASTM A108 - 1215 CS	500° F	- 20° F
S	ASTM A479 - 316 SS	1,000° F	- 100° F
P	ASTM A105 CF	800° F	- 20° F
Non-standard body and bonnet materials such as Monel®, Inconel®, Hastelloy-C®, etc. are available on special factory order and carry the 316 SS temperature rating.			

STANDARD STEM SEAL MATERIAL CODES			
CODE	SEAL DESCRIPTION	MAX TEMP	MIN TEMP
G	Grafoil® Packed Style	800° F (CS) 1,000° F (SS)	- 20° F - 80° F
J	Teflon® Pressure-Core Seal (Low Temperature)	450° F	- 50° F
T	Teflon® Pressure-Core Seal **(Standard)**	450° F	- 40° F
P	Teflon® Packed Style	450° F	- 80° F
K	Teflon® Pressure-Core Back-up	400° F	-40° F
V	Viton® O-Ring with filled Teflon Backup	400° F	- 15° F
Y	Graflon® Packed Style	600° F	- 40° F
T	"Mini" Teflon® Packed	450° F	- 15° F

STANDARD SOFT SEAT MATERIAL CODES			
CODE	MATERIAL	MAX TEMP	MIN TEMP
D	Delrin® Cone & Mini Washer	200° F	- 40° F
T	Teflon® Cone & Mini Washer	450° F	- 80° F
L	Rylon® *Cone (.375" Orifice)* and Tefzel Mini Washers -.136" Orifice (Standard)	200° F	- 40° F
Z	Tefzel Cone & Mini Washer	200° F	- 40° F
K	Kel-F® Cone & Mini Washer	200° F	- 100° F
P	PEEK® Cone & Mini Washer	400° F	- 40° F

SOFT SEAT PRESSURE / TEMPERATURE RATINGS		
CODE	SEAL DESCRIPTION	MAX PRESSURE
D	Delrin® Cone & Mini Washer	6,000 PSI @ 200° F
T	Teflon® Cone & Mini Washer	1,000 PSI @ 200° F
L	Rylon® *(.375" Orifice Cone Only)*	1,500 PSI @ 200° F
6	316 SS Cone *(.375" Orifice Only)*	6,000 PSI @ 200° F
Z	Tefzel Cone & Mini Washer	3,000 PSI @ 200° F
K	Kel-F® Cone & Mini Washer	6,000 PSI @ 200° F
P	PEEK® Cone	10,000 PSI @ 200° F
	PEEK® Mini Washer	6,000 PSI @ 200° F

STANDARD HARD SEAT MATERIAL CODES			
CODE	MATERIAL	MAX TEMP	MIN TEMP
C	Carbide® Ball Nickel / Chrome Binder	800° F (CS) 1,000° F (SS)	- 100° F
6	316 SS Cone *(.375" Orifice Block Valves Only)* .187" & .375" Ball		- 100° F
R	Ceramic Ball		- 100° F
M	Integral Metal to Metal Seat		- 100° F
N	Monel® Ball		- 100° F
H	Hastelloy-C® Ball		-100° F

HARD SEAT PRESSURE / TEMPERATURE RATINGS		
CODE	SEAL DESCRIPTION	MAX PRESSURE
C	Carbide® Ball	10,000 PSI @ 200° F
6	316 SS Cone *(.375" Orifice Only)*	6,000 PSI @ 200° F
R	Ceramic Ball	10,000 PSI @ 200° F
M	Integral Metal to Metal Seat	6,000 PSI @ 200° F
N	Monel® Ball	10,000 PSI @ 200° F
H	Hastelloy-C® Ball	10,000 PSI @ 200° F

Notes

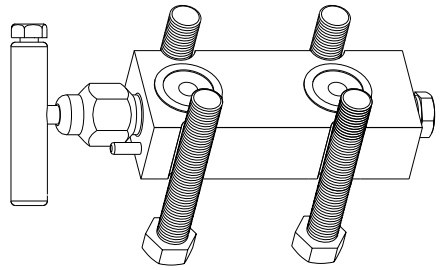
Monel® is a registered trademark of International Nickel Company.
Hastelloy® is a registered trademark of Haynes International.
Delrin®, Viton® and Teflon® are registered trademarks of the E.I. duPont de Nemours Company.
Grafoil® is a registered trademark of Union Carbide Corporation.
PEEK® is a registered trademark of ICI Americas, Inc.
Kel-F® is a registered trademark of the 3M Company.
Coplanar™ is a trademark of Rosemount®, Inc.
Rosemount® is a registered trademark of Rosemount®, Inc.
Parker® is a registered trademark of Parker Hannifin Corporation.
Swagelok® is a registered trademark of The Swagelok® Companies.

By-Pass Manifolds

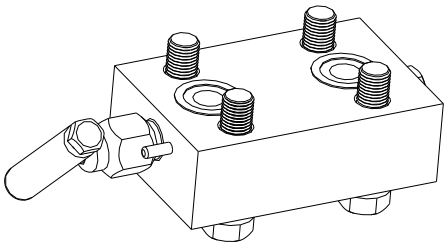
.187" ORIFICE

Description

Flange x Flange

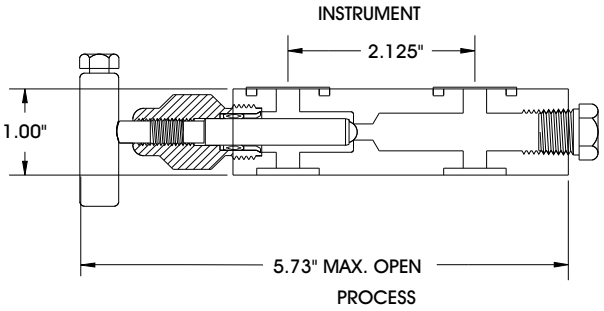


½" FNPT x Flange

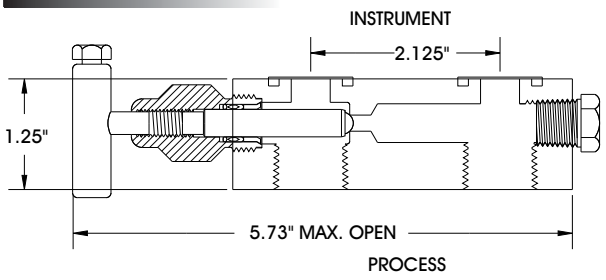


Body Style

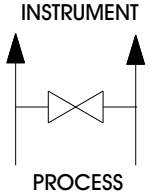
M-504 Hard Seat



M-514 Hard Seat



SEAT	MAX Cv RATINGS
Hard Ball	.53
Approx. Manifold Weight:	1.9 lbs each [M-504] 3.7 lbs each [M-514]



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	A105 CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A105-CF	ASTM A479-316	Consult Factory.	Consult Factory.
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM A479-316		
Stem	ASTM A582-303	ASTM A479-316	ASTM A479-316		
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM A479-316		
Handle Assembly	ASTM A108	ASTM A108	ASTM A582 (18-8)		
Plug	ASTM A108	ASTM F593 (18.8)	ASTM A182-F (18-8)		
Mounting Bolts	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM A449-TYPE 1		

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
M-504				-						
M-514				-						

BODY CODE	
[Std.] Carbon Steel	C
A105 Carbon Steel	P
[Std.] 316 SS	S

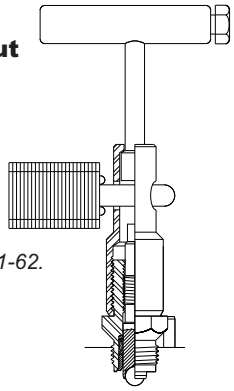
HARD SEAT CODE	
C	Carbide Ball [Std.]
R	Ceramic Ball
6	316 SS Ball

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Viton® O-Ring	V
Low-Temp Pressure-Core™	J

OPTION CODE	OPTION DESCRIPTION
GA	Anti-Tamper Bonnet
GJ	Bonnet Lock-Out (Lock Not Provided)
MH	Viton® O-Ring Flange Seals
M7	Required Slotting for Rosemount® 1151 Transmitters Series 6 & Above (Flange Manifolds Only)
TH	Hydrostatic Testing
W	Safety Bonnet Lock Plate
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)

OPTIONS

- **Bonnet Handle Lock-Out**
- Bonnet Lock Plates



See Options/Accessories Pages 61-62.

PRESSURE & TEMPERATURE

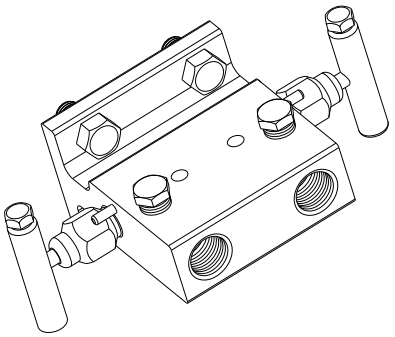
BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
Carbon Steel Code C	10,000 PSI @ 200° F 8,000 PSI @ 450° F	Not Available.
A105 Carbon Steel Code P	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 800° F
316 SS Code S	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	**Chart D**	**Chart F**

Liquid Level Manifolds

.187" ORIFICE

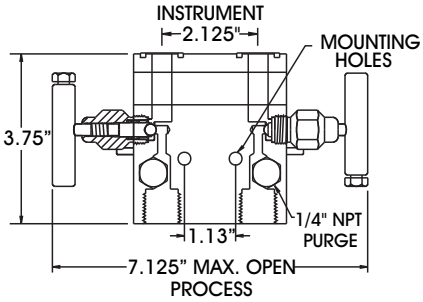
Description

½" FNPT x Flange

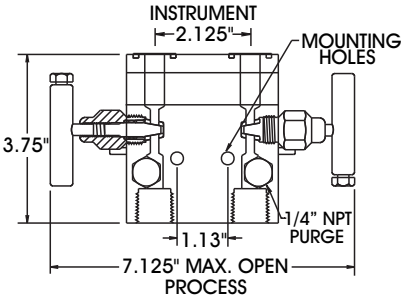


Body Style

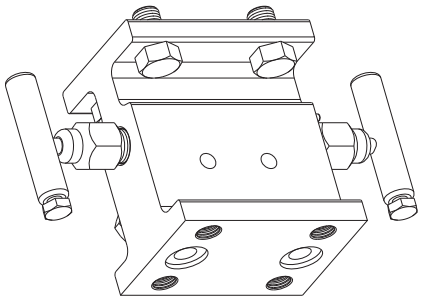
M-658 Hard Seat



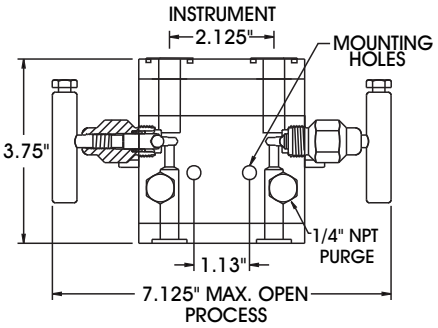
M-657 Soft Seat



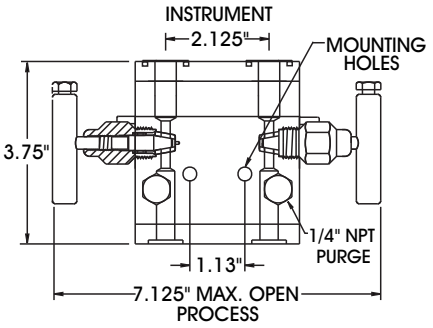
½" Flange x Flange



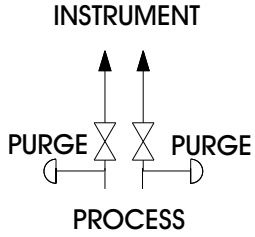
M-758 Hard Seat



M-757 Soft Seat



SEAT	MAX Cv RATINGS
Hard Ball	.53
Soft Cone	.83
Approx. Manifold Weight:	5.1 lbs each [M-657 / 658] 5.6 lbs each [M-757 / 758]



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	A105 CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A105-CF	ASTM A479-316	ASTM B164-N04400	ASTM A494 CW-12MW
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108	ASTM F593 (18.8)	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
Mounting Bolts	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM F593 (18-8)	ASTM F593 (18-8)

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Liquid Level Manifolds

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
M - 6 5 8										
M - 7 5 8				-						
Soft Seat										
M - 6 5 7										
M - 7 5 7				-						

BODY CODE	
[Std.] Carbon Steel	C
A105 Carbon Steel	P
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

HARD SEAT CODE	
[Std.] Carbide Ball	C
Ceramic Ball	R
316 SS Ball	6
Hastelloy-C®	H
K-Monel® Ball	N

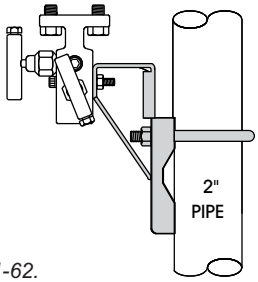
SOFT SEAT CODE	
D	Delrin® Cone [Std.]
K	Kel-F® Cone
P	PEEK® Cone
T	Teflon® Cone
Z	Tefzel Cone

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Viton® O-Ring	V
Low-Temp Pressure-Core™	J
Teflon® Packed [Hard Seat Only]	P

OPTION CODE	OPTION DESCRIPTION
AP7	½" Female Pipe Socket Weld (Process Ports)
AU7	½" Integral Tube Fitting - Parker® A-LOK Dual Ferrules (Process Ports)
AV7	½" Integral Tube Fitting - Swagelok® Dual Ferrules (Process Ports)
GA	Anti-Tamper Bonnet
GK	Bonnet Lock-Out (Lock Not Provided)
MH	Viton® O-Ring Flange Seals
TC	Steam Trace Block - Carbon Steel
TH	Hydrostatic Testing
TS	Steam Trace Block - 316 SS
VC	CS Versa-Mount Bracket
VS	316 SS Versa-Mount Bracket
VCH	CS Heavy-Duty Versa-Mount Bracket
VSH	316 SS Heavy-Duty Versa-Mount Bracket
W	Safety Bonnet Lock Plate
WA	CS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™
WAW3	300 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™
WAW9	316 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)

OPTIONS

- **Versa-Mount Brackets**
- Bonnet Handle Lock-Out
- Bonnet Lock Plates
- Steam Trace Block
- Integral Tube Fitting Connections



See Options/Accessories Pages 61-62.

PRESSURE & TEMPERATURE

BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
Carbon Steel Code C	10,000 PSI @ 200° F 8,000 PSI @ 450° F	Not Available.
A105 Carbon Steel Code P	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 800° F
316 SS Code S	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart F

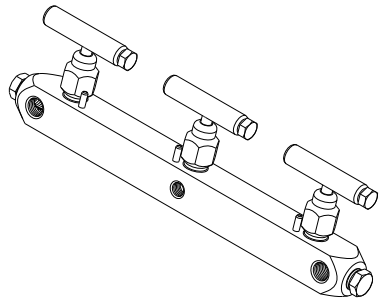
BODY MATERIAL	SOFT SEAT (Delrin) Teflon Pressure-Core	SOFT SEAT (Peek) Teflon Pressure-Core
Carbon Steel Code C	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
316 SS Code S	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
See Page 5:	Chart B	Chart B

Meter Manifolds

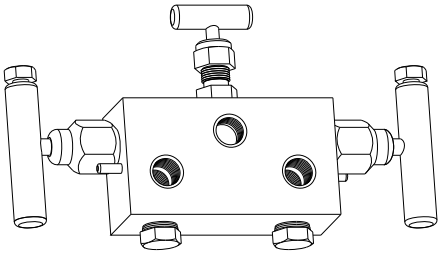
.187" ORIFICE

Description

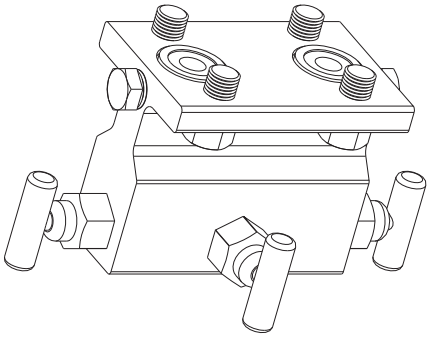
¼" FNPT x ¼" FNPT



¼" FNPT x ¼" FNPT

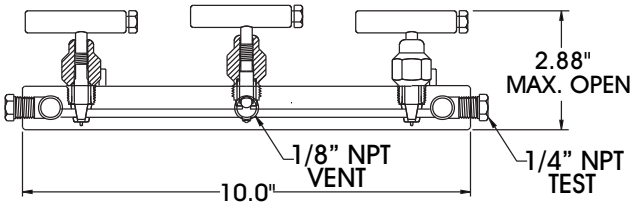


Flange x ¼" FNPT

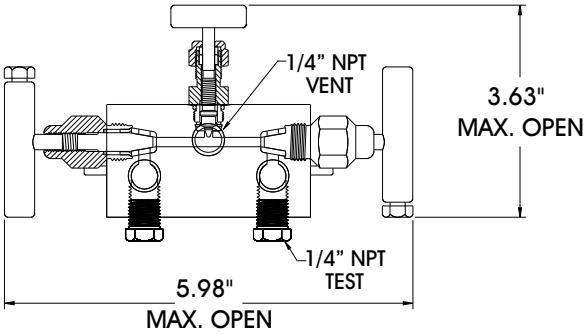


Body Style

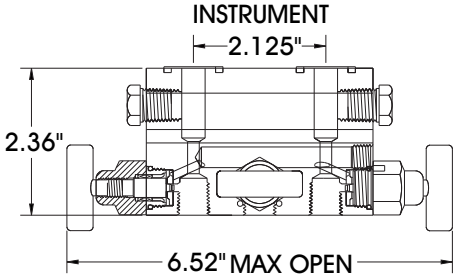
M-505 Soft Seat



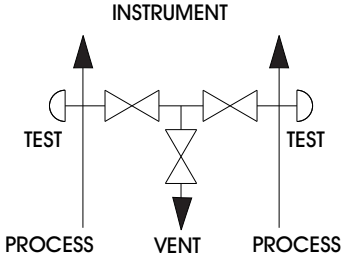
M-509 Soft Seat



M-923 Soft Seat



SEAT	MAX Cv RATINGS
Soft Cone	.83
Approx. Manifold Weight:	3.7 lbs each [M-505] 5.0 lbs each [M-509]



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A479-316	Consult Factory.	Consult Factory.
Bonnet	ASTM A108-1215	ASTM A479-316		
Stem	ASTM A582-303	ASTM A479-316		
Seal Retainer	ASTM A479-316	ASTM A479-316		
Handle Assembly	ASTM A108	ASTM A582 (18-8)		
Plug(s)	ASTM A108	ASTM A182-F (18-8)		

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Soft Seat										
M-505				-						
M-509				-						
M-923										

BODY CODE	
[Std.] Carbon Steel	C
[Std.] 316 SS	S

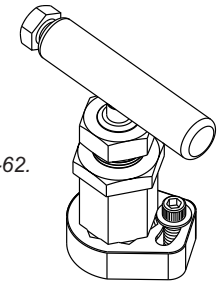
SOFT SEAT CODE	
D	Delrin® Cone/Washer [Std.]
K	Kel-F® Cone/Washer
P	PEEK® Cone/Washer
T	Teflon® Cone/Washer
Z	Tefzel Cone/Washer

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Viton® O-Ring	V
Low-Temp Pressure-Core™	J
Fluorosilicone Pressure-Core™	L

OPTIONS

- **Bonnet Lock Plates**
- Bonnet Handle Lock-Out

See Options/Accessories Pages 61-62.



OPTION CODE	OPTION DESCRIPTION
C4	(2) .187" Orifice Block Valves - 1/4" NPT F x M V-501CDT/SDT
GA	Anti-Tamper Bonnet (All Positions - M-505 Only)
*GC	Anti-Tamper Bonnet (Isolate Valve(s) Only - M-505 Only)
GD	Anti-Tamper Bonnet (Equalizer Valve(s) Only - M-505 & M-509 Only)
GE	Anti-Tamper Bonnet (Vent Valve Only - M-505 Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided - M-505 Only)
*GK	Bonnet Lock-Out (Isolate Valve Only - Lock Not Provided - M-505 Only)
GL	Bonnet Lock-Out (Equalizer Valve(s) Only - Lock Not Provided - M-505 & M-509 Only)
GM	Bonnet Lock-Out (Vent Valve Only - Lock Not Provided - M-505 Only)
MH	Viton® O-Ring Flange Seals (M-923 Only)
W	Safety Bonnet Lock Plate
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
XL	Clean for Critical Service (Oxygen or Chlorine)
	* Only with C4 Option on M-505.

PRESSURE & TEMPERATURE

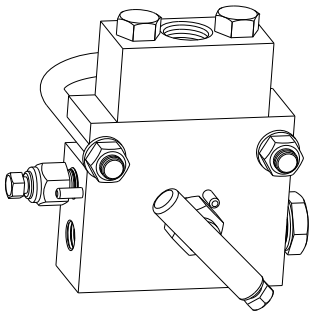
BODY MATERIAL	SOFT SEAT (Delrin) M-505	SOFT SEAT (Delrin) M-509
Carbon Steel	6,000 PSI @ 200° F Max.	3,000 PSI @ 200° F Max.
316 SS	6,000 PSI @ 200° F Max.	3,000 PSI @ 200° F Max.
See Page 5:	Chart B	Chart C

Pressure Instrument Manifolds

.187" ORIFICE

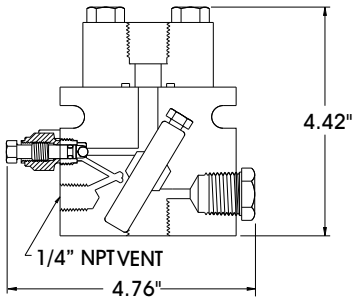
Description

½" FNPT x ½" FNPT

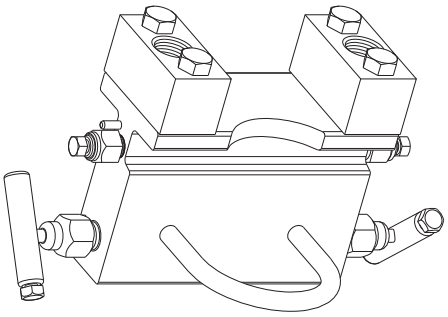


Single Instrument

M-598 Hard Seat

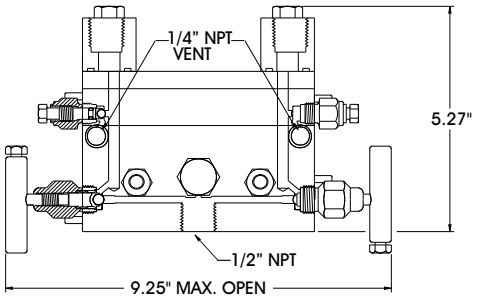


½" FNPT x (2) ½" FNPT



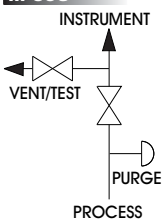
Dual Instrument

M-698 Hard Seat

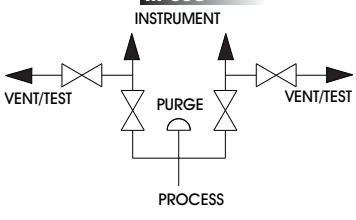


SEAT	MAX Cv RATINGS
Hard Ball / Cone	.53
Approx. Manifold Weight:	**5.0 lbs each [M-598] 10.0 lbs each [M-698]**

M-598



M-698



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	A105 CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A105-CF	ASTM A479-316	ASTM B164-N04405 or ASTM B164-N04400	ASTM B575-N10276 or ASTM A494 CW-12MW
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108	ASTM F593 (18.8)	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
Mounting Bolts	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM F593 (18-8)	ASTM F593 (18-8)
U-Bolts	ASTM A449-G15	ASTM A449-G15	300 SERIES SS	300 SERIES SS	300 SERIES SS

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
M - 5 9 8				-						
M - 6 9 8				-						

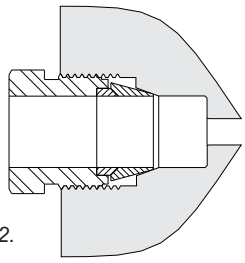
BODY CODE	
[Std.] Carbon Steel	C
A105 Carbon Steel	P
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

HARD SEAT CODE	
C	Carbide Ball [Std.]
R	Ceramic Ball
6	316 SS Ball
H	Hastelloy-C® Ball
N	K-Monel® Ball

STEM SEAL CODE		
Block Valve(s)	Vent Valve(s)	
[Std.] Teflon® Pressure-Core™	Viton® O-Ring [Std.]	T
Grafoil® Packed	Grafoil® Packed	G
Viton® O-Ring	Viton® O-Ring	V
Teflon® Packed	Teflon® Packed	P
Low-Temp Pressure-Core™	Fluorosilicone O-Ring	J

OPTIONS

- **Integral Tube Fitting Connections**
- Bonnet Handle Lock-Out
- Bonnet Lock Plates



See Options/Accessories Pages 61-62.

OPTION CODE	OPTION DESCRIPTION
CVSCF	Vent Valve Seal Material: Fluorosilicone O-Ring
CVSCG	Vent Valve Seal Material: Grafoil® Packed
CVSCP	Vent Valve Seal Material: Teflon® Packed
GC	Anti-Tamper Bonnet (Isolate Valve(s) Only)
GK	Bonnet Lock-Out (Isolate Valve(s) Only - Lock Not Provided)
TH	Hydrostatic Testing
W	Safety Bonnet Lock Plate
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)

PRESSURE & TEMPERATURE

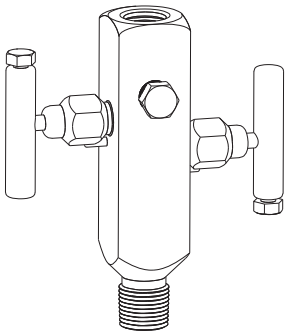
BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
Carbon Steel Code C	10,000 PSI @ 200° F 8,000 PSI @ 450° F	Not Available.
A105 Carbon Steel Code P	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 800° F
316 SS Code S	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart F

Two-Valve Block & Bleed Manifolds

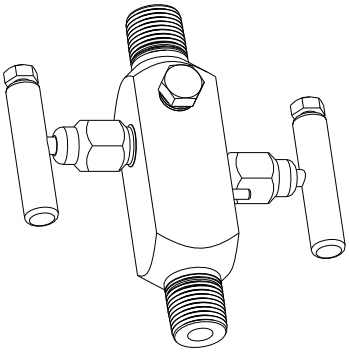
.187" ORIFICE

Description

½" MNPT x ½" FNPT

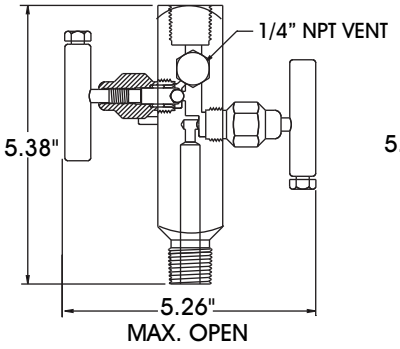


½" MNPT x ½" MNPT

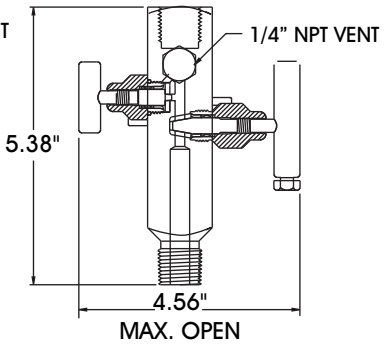


Body Style

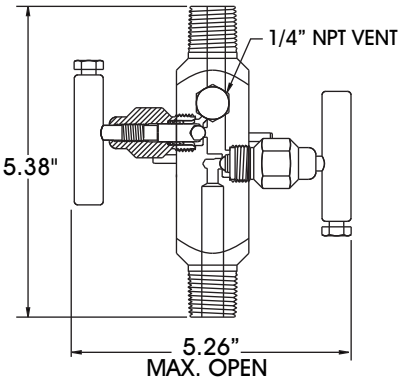
V-570 Hard Seat



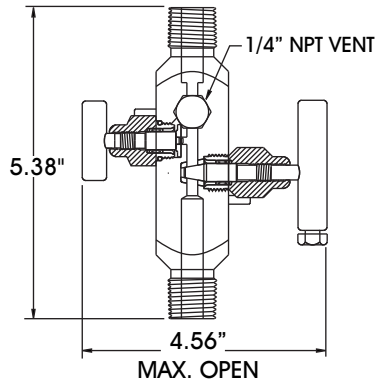
V-575 Soft Seat



V-612 Hard Seat

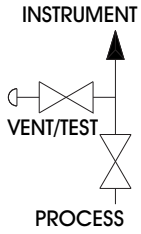


V-613 Soft Seat



Above drawings shown with P9 Pipe Plug Option.

SEAT	MAX Cv RATINGS
Hard Ball	.53
Soft Cone	.83
Approx. Manifold Weight:	**3.0 lbs each [V-570 / 575 / 612 / 613]**



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	A105 CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A105-CF	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108-1215	ASTM F593 (18.8)	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Two-Valve Block & Bleed Manifolds

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
V-570				-						
V-612				-						
Soft Seat										
V-575				-						
V-613				-						

BODY CODE	
[Std.] Carbon Steel	C
A105 Carbon Steel	P
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

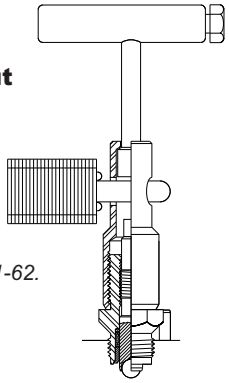
HARD SEAT CODE	
[Std.] Carbide Ball	C
Ceramic Ball	R
316 SS Ball	6
Hastelloy-C® Ball	H
K-Monel® Ball	N

SOFT SEAT CODE	
[Std.] Delrin® Cone / Washer	D
Kel-F® Cone / Washer	K
PEEK® Cone / Washer	P
Teflon® Cone / Washer	T
Tefzel Cone / Washer	Z

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Teflon® Packed [Hard Seat Only]	P
Viton® O-Ring	V
Low-Temp Pressure-Core™	J

OPTIONS

- **Bonnet Handle Lock-Out**
- Bonnet Lock Plates



See Options/Accessories Pages 61-62.

OPTION CODE	OPTION DESCRIPTION
AM7	½" Male Pipe Socket Weld (Process Port)
GA	Anti-Tamper Bonnet (All Positions - Hard Seats Only)
GC	Anti-Tamper Bonnet (Isolate Valve Only)
GE	Anti-Tamper Bonnet (Vent Valve Only - Hard Seats Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided - Hard Seats Only)
GK	Bonnet Lock-Out (Isolate Valve Only - Lock Not Provided)
GM	Bonnet Lock-Out (Vent Valve Only - Lock Not Provided - Hard Seats Only)
P9	¼" Hex Head Pipe Plug in Vent/Test Port
TH	Hydrostatic Testing
W	Safety Bonnet Lock Plate
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
XL	Clean for Critical Service (Oxygen or Chlorine)

PRESSURE & TEMPERATURE

BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
Carbon Steel Code C	10,000 PSI @ 200° F 8,000 PSI @ 450° F	Not Available.
A105 Carbon Steel Code P	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 800° F
316 SS Code S	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart F

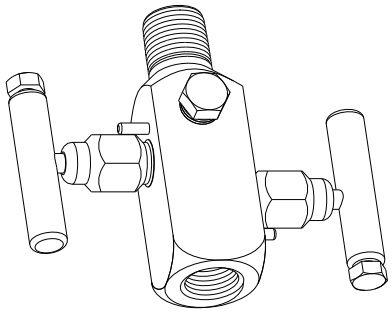
BODY MATERIAL	SOFT SEAT (Delrin) Teflon Pressure-Core	SOFT SEAT (Peek) Teflon Pressure-Core
Carbon Steel Code C	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
316 SS Code S	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
See Page 5:	Chart B	Chart B

Two-Valve Block & Bleed Manifolds

.187" ORIFICE

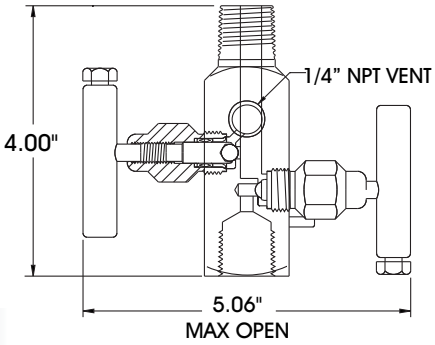
Description

½" FNPT x ½" MNPT

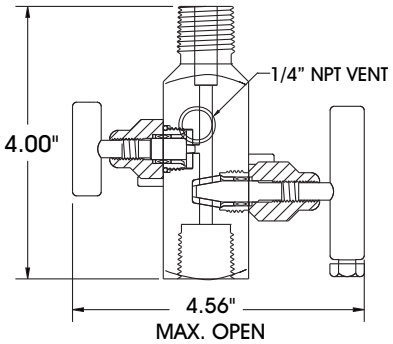


Body Style

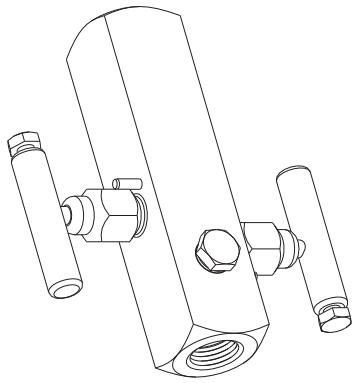
V-614 Hard Seat



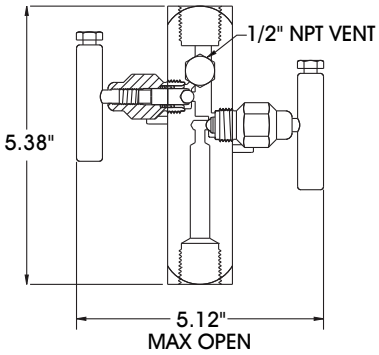
V-615 Soft Seat



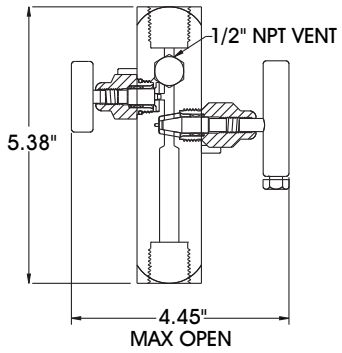
½" FNPT x ½" FNPT



V-626 Hard Seat

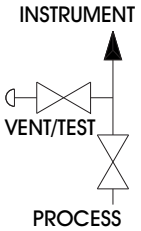


V-627 Soft Seat



Above drawings shown with P9 Pipe Plug Option.

SEAT	MAX Cv RATINGS
Hard Ball	.53
Soft Cone	.83
Approx. Manifold Weight:	3.0 lbs each [V-626 / 627] 2.4 lbs each [V-614 / 615]



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	A105 CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A105-CF	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108-1215	ASTM F593 (18.8)	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Two-Valve Block & Bleed Manifolds

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
V - 6 1 4				-						
V - 6 2 6				-						
Soft Seat										
V - 6 1 5				-						
V - 6 2 7				-						

BODY CODE	
[Std.] Carbon Steel	C
A105 Carbon Steel	P
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

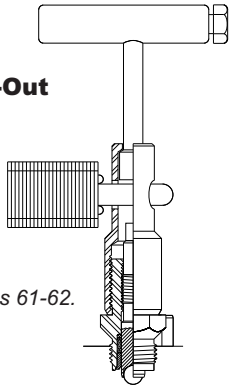
HARD SEAT CODE	
[Std.] Carbide Ball	C
Ceramic Ball	R
316 SS Ball	6
Hastelloy-C® Ball	H
K-Monel® Ball	N

SOFT SEAT CODE	
D	Delrin® Cone / Washer [Std.]
K	Kel-F® Cone / Washer
P	PEEK® Cone / Washer
T	Teflon® Cone / Washer
Z	Tefzel Cone / Washer

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Teflon® Packed [Hard Seat Only]	P
Viton® O-Ring	V
Low-Temp Pressure-Core™	J

OPTIONS

- **Bonnet Handle Lock-Out**
- Bonnet Lock Plates



See Options/Accessories Pages 61-62.

OPTION CODE	OPTION DESCRIPTION
AM7	½" Male Pipe Socket Weld (Process Port)
GA	Anti-Tamper Bonnet (All Positions - Hard Seats Only)
GC	Anti-Tamper Bonnet (Isolate Valve Only)
GE	Anti-Tamper Bonnet (Vent Valve Only - Hard Seats Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided - Hard Seats Only)
GK	Bonnet Lock-Out (Isolate Valve Only - Lock Not Provided)
GM	Bonnet Lock-Out (Vent Valve Only - Lock Not Provided - Hard Seats Only)
P9	¼" Hex Head Pipe Plug in Vent/Test Port
TH	Hydrostatic Testing
W	Safety Bonnet Lock Plate
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
XL	Clean for Critical Service (Oxygen or Chlorine)

PRESSURE & TEMPERATURE

BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
Carbon Steel Code C	10,000 PSI @ 200° F 8,000 PSI @ 450° F	Not Available.
A105 Carbon Steel Code P	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 800° F
316 SS Code S	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart F

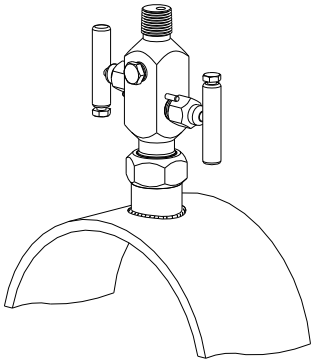
BODY MATERIAL	SOFT SEAT (Delrin) Teflon Pressure-Core	SOFT SEAT (Peek) Teflon Pressure-Core
Carbon Steel Code C	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
316 SS Code S	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
See Page 5:	Chart B	Chart B

Two-Valve Stabilized Block & Bleed Manifolds

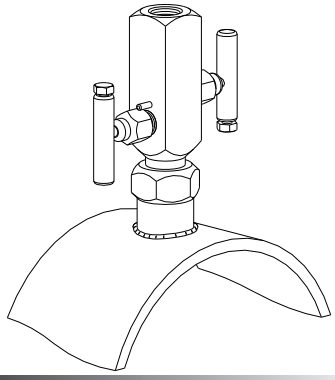
.187" ORIFICE

Description

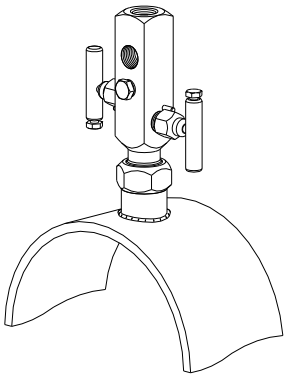
MNPT x ½" MNPT



MNPT x ½" FNPT

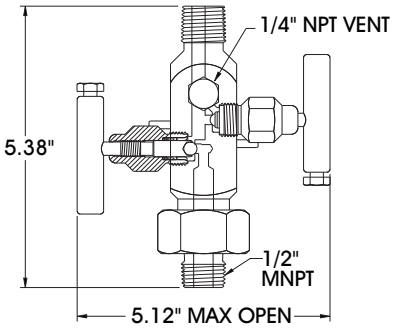


½" MNPT x (3) ½" FNPT

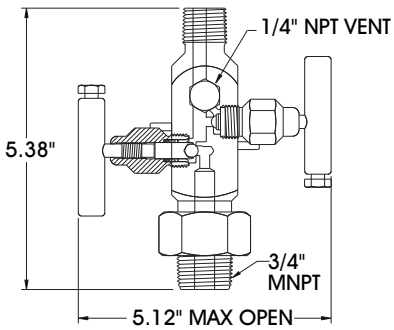


Body Style

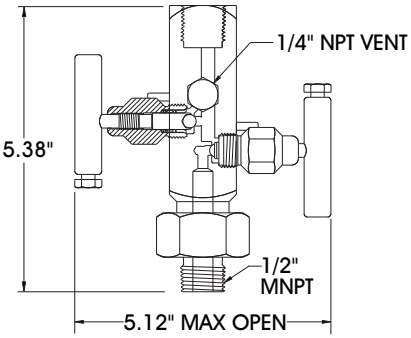
V-700 Hard Seat



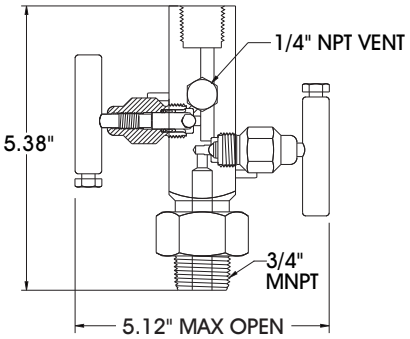
V-702 Hard Seat



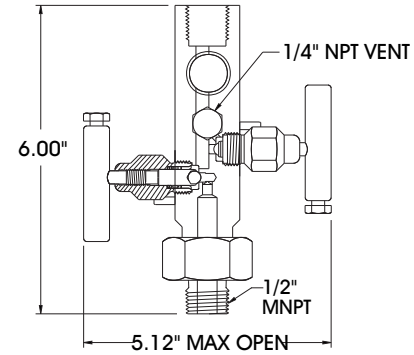
V-704 Hard Seat



V-706 Hard Seat

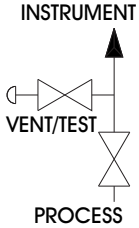


V-708 Hard Seat



All drawings shown with P9 Pipe Plug Option.

SEAT	MAX Cv RATINGS
Hard Ball	.53
Approx. Manifold Weight:	**3.0 lbs each [V-700 / 702 / 704 / 706]** **3.5 lbs each [V-708]**



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	Manifold not available in Carbon Steel.	ASTM A479-316	Consult Factory.	Consult Factory.
Bonnet		ASTM A479-316		
Stem		ASTM A479-316		
Seal Retainer		ASTM A479-316		
Handle Assembly		ASTM A582 (18-8)		
Plug(s)		ASTM A182-F (18-8)		

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Two-Valve Stabilized Block & Bleed Manifolds

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
V-700				-						
V-702				-						
V-704				-						
V-706				-						
V-708				-						

BODY CODE	
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

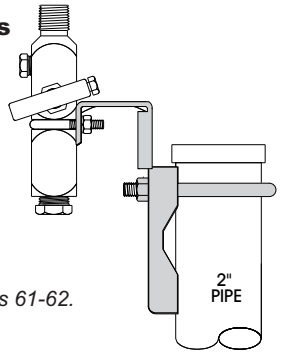
HARD SEAT CODE	
C	Carbide Ball [Std.]
R	Ceramic Ball
6	316 SS Ball

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Teflon® Packed	P
Viton® O-Ring	V
Low-Temp Pressure-Core™	J

OPTION CODE	OPTION DESCRIPTION
GA	Anti-Tamper Bonnet (All Positions - Hard Seats Only)
GC	Anti-Tamper Bonnet (Isolate Valve Only)
GE	Anti-Tamper Bonnet (Vent Valve Only - Hard Seats Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided - Hard Seats Only)
GK	Bonnet Lock-Out (Isolate Valve Only - Lock Not Provided)
GM	Bonnet Lock-Out (Vent Valve Only - Lock Not Provided - Hard Seats Only)
P9	¼" Hex Head Pipe Plug in Vent/Test Port
TH	Hydrostatic Testing
W	Safety Bonnet Lock Plate
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
XL	Clean for Critical Service (Oxygen or Chlorine)

OPTIONS

- **Versa-Mount Brackets**
- Bonnet Handle Lock-Out
- Bonnet Lock Plates
- Integral Tube Fitting Connections



See Options/Accessories Pages 61-62.

PRESSURE & TEMPERATURE

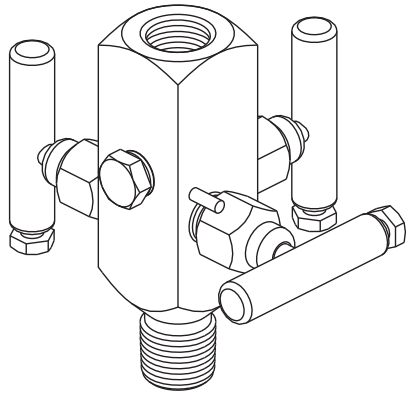
BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
316 SS	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart F

Three-Valve Double Block & Bleed Manifolds

.187" ORIFICE

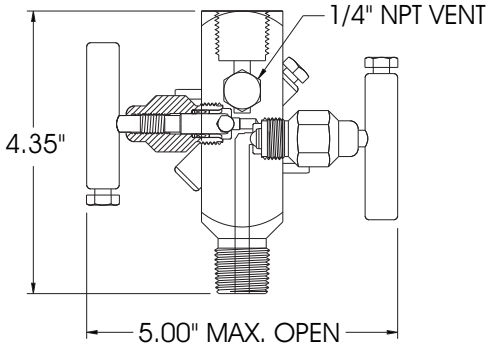
Description

½" MNPT x ½" FNPT

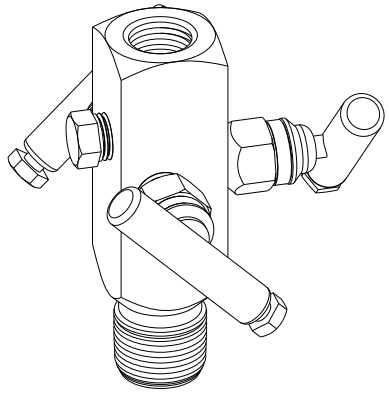


Body Style

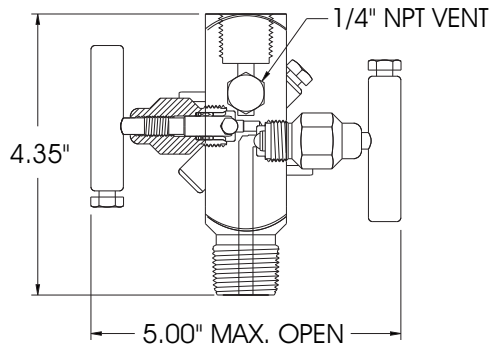
V-690 Hard Seat



¾" MNPT x ½" FNPT

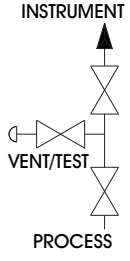


V-692 Hard Seat



Above drawings shown with P9 Pipe Plug Option.

SEAT	MAX Cv RATINGS
Hard Ball	.53
Soft Cone	.83
Approx. Manifold Weight:	**3.0 lbs each [V-690 / 692]**



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	Consult Factory.	ASTM A479-316	Consult Factory.	Consult Factory.
Bonnet		ASTM A479-316		
Stem		ASTM A479-316		
Seal Retainer		ASTM A479-316		
Handle Assembly		ASTM A582 (18-8)		
Plug(s)		ASTM A182-F (18-8)		

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Three-Valve Double Block & Bleed Manifolds

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
V-690				-						
V-692				-						

BODY CODE	
[Std.] 316 SS	S

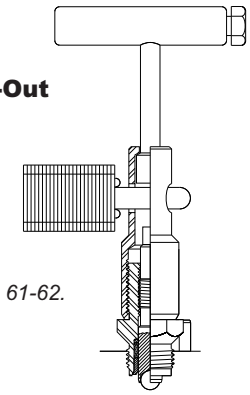
HARD SEAT CODE	
C	Carbide Ball [Std.]
R	Ceramic Ball
6	316 SS Ball

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Teflon® Packed	P
Viton® O-Ring	V
Low-Temp Pressure-Core™	J

OPTION CODE	OPTION DESCRIPTION
AM7	½" Male Pipe Socket Weld (Process Port)
GA	Anti-Tamper Bonnet (All Positions)
GC	Anti-Tamper Bonnet (Isolate Only)
GE	Anti-Tamper Bonnet (Vent Valve Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided)
GK	Bonnet Lock-Out (Isolate Only - Lock Not Provided)
GM	Bonnet Lock-Out (Vent Valve Only - Lock Not Provided)
P9	¼" Hex Head Pipe Plug in Vent/Test Port
TH	Hydrostatic Testing
W	Safety Bonnet Lock Plate
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
XL	Clean for Critical Service (Oxygen or Chlorine)

OPTIONS

- **Bonnet Handle Lock-Out**
- Bonnet Lock Plates



See Options/Accessories Pages 61-62.

PRESSURE & TEMPERATURE

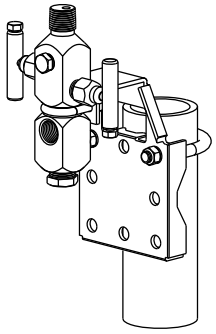
BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
316 SS	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart F

Two-Valve Versa-Mount Block & Bleed Manifolds

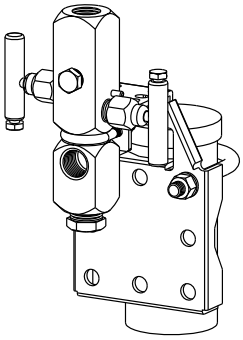
.187" ORIFICE

Description

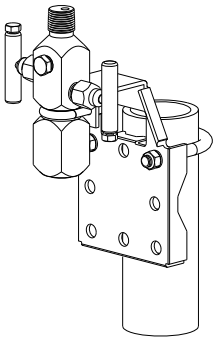
(2) ½" FNPT x ½" MNPT



(2) ½" FNPT x ½" FNPT



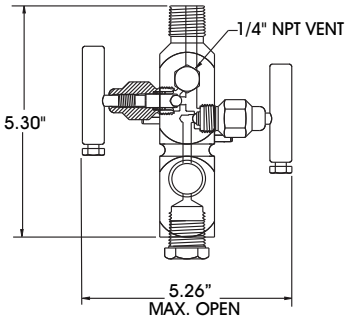
½" FNPT x ½" MNPT



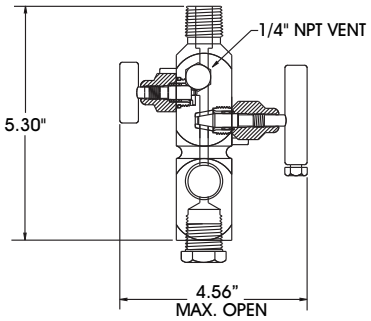
Above drawings shown with P9 Pipe Plug Option.

Body Style

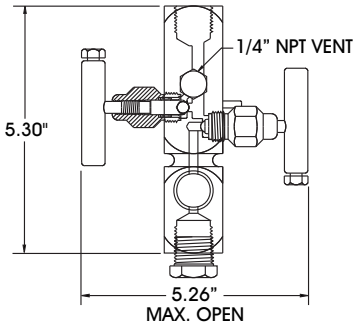
V-620 Hard Seat



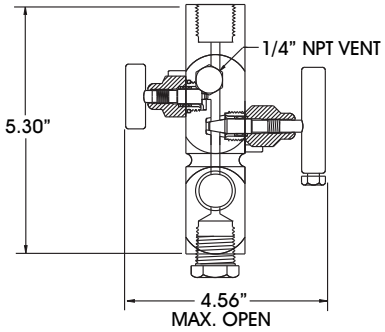
V-621 Soft Seat



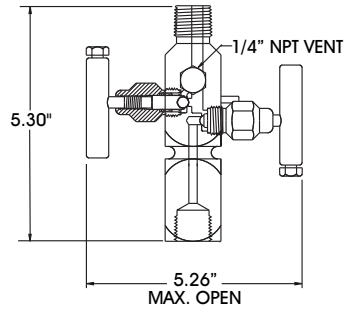
V-622 Hard Seat



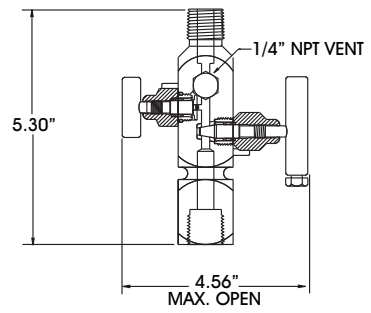
V-623 Soft Seat



V-624 Hard Seat

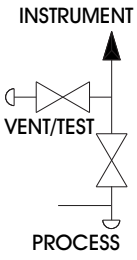


V-625 Soft Seat



SEAT	MAX Cv RATINGS
Hard Ball	.53

V-620 & V-622



V-624



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	A105 CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A105-CF	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108	ASTM F593 (18.8)	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
U-Bolts	300 SERIES SS	300 SERIES SS	300 SERIES SS	300 SERIES SS	300 SERIES SS

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Two-Valve Versa-Mount Block & Bleed Manifolds

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
V-620				-						
V-622										
V-624				-						
Soft Seat										
V-621				-						
V-623										
V-625				-						

BODY CODE	
[Std.] Carbon Steel	C
A105 Carbon Steel	P
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

HARD SEAT CODE	
[Std.] Carbide Ball	C
Ceramic Ball	R
316 SS Ball	6
Hastelloy-C® Ball	H
K-Monel® Ball	N

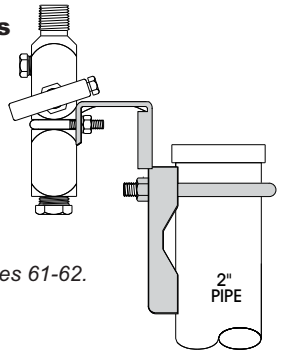
SOFT SEAT CODE	
D	Delrin® Cone / Washer [Std.]
K	Kel-F® Cone / Washer
P	PEEK® Cone / Washer
T	Teflon® Cone / Washer
Z	Tefzel Cone / Washer

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Teflon® Packed [Hard Seat Only]	P
Viton® O-Ring	V
Low-Temp Pressure-Core™	J

OPTIONS

- **Versa-Mount Brackets**
- Bonnet Handle Lock-Out
- Bonnet Lock Plates
- Integral Tube Fitting Connections

See Options/Accessories Pages 61-62.



OPTION CODE	OPTION DESCRIPTION
AU7	½" Integral Tube Fitting - Parker® A-LOK Dual Ferrules (Process Ports)
AV7	½" Integral Tube Fitting - Swagelok® Dual Ferrules (Process Ports)
GA	Anti-Tamper Bonnet (All Positions)
GC	Anti-Tamper Bonnet (Isolate Valve(s) Only)
GE	Anti-Tamper Bonnet (Vent Valve(s) Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided)
GK	Bonnet Lock-Out (Isolate Valve(s) Only - Lock Not Provided)
GM	Bonnet Lock-Out (Vent Valve(s) Only - Lock Not Provided)
P9	¼" Hex Head Pipe Plug in Vent/Test Port
TH	Hydrostatic Testing
VC	CS Versa-Mount Bracket
VS	316 SS Versa-Mount Bracket
VCH	CS Heavy-Duty Versa-Mount Bracket
VSH	316 SS Heavy-Duty Versa-Mount Bracket
W	Safety Bonnet Lock Plate
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
XL	Clean for Critical Service (Oxygen or Chlorine)

PRESSURE & TEMPERATURE

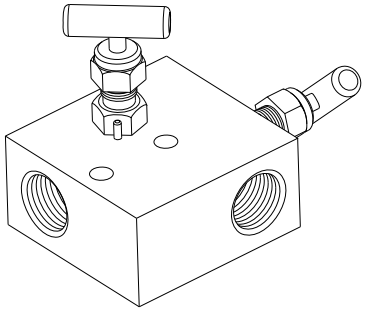
BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
Carbon Steel Code C	10,000 PSI @ 200° F 8,000 PSI @ 450° F	Not Available.
A105 Carbon Steel Code P	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 800° F
316 SS Code S	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart F

Two-Valve Block & Bleed Manifolds

.136" ORIFICE

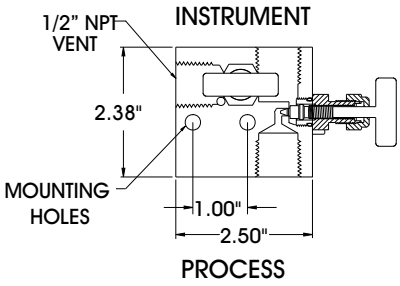
Description

½" FNPT x ½" FNPT

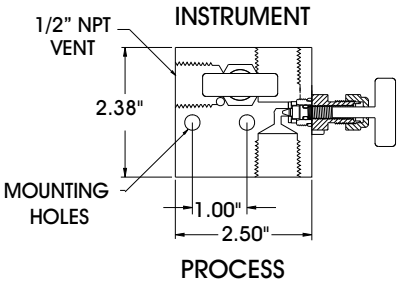


Body Style

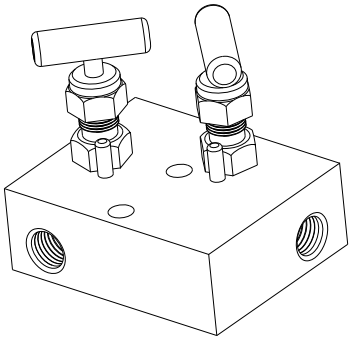
M-507 Hard Seat



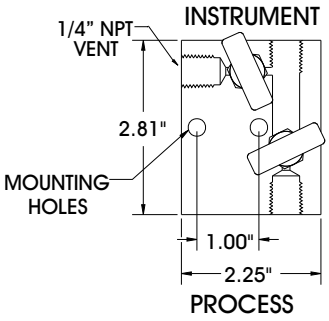
M-507 Soft Seat



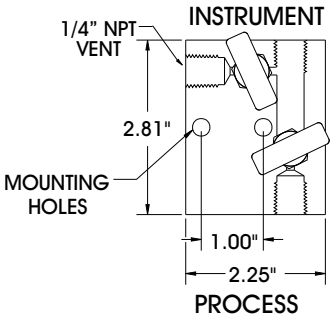
¼" FNPT x ¼" FNPT



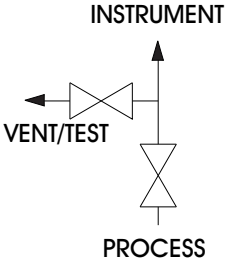
M-508 Hard Seat



M-508 Soft Seat



SEAT	MAX Cv RATINGS
Integral Metal	.25
Soft Washer	.22
Approx. Manifold Weight:	**2.7 lbs each [M-507] 2.4 lbs each [M-508]**



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A479-316	Manifold not available in Monel®.	Manifold not available in Hastelloy-C®.
Bonnet	ASTM A108-1215	ASTM A479-316		
Stem	ASTM A582-303	ASTM A479-316		
Seal Retainer	- - -	- - -		
Handle Assembly	ASTM A108	ASTM A582 (18-8)		
Plug(s)	- - -	- - -		
Mounting Bolts	- - -	- - -		

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Two-Valve Block & Bleed Manifolds

.136" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
M - 5 0 7				-						
M - 5 0 8				-						
Soft Seat										
M - 5 0 7				-						
M - 5 0 8				-						

BODY CODE	
[Std.] Carbon Steel	C
[Std.] 316 SS	S

HARD SEAT CODE	
[Std.] Integral Metal	M

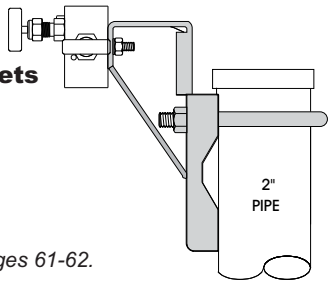
SOFT SEAT CODE	
D	Delrin® Washer [Std.]
K	Kel-F® Washer
P	PEEK® Washer
T	Teflon® Washer
Z	Tefzel Washer

STEM SEAL CODE	
[Std.] Teflon® Packed	T
Grafoil® Packed	G
Viton® O-Ring	V

OPTION CODE	OPTION DESCRIPTION
H5	CS Mini Round Handles
H6	SS Mini Round Handles
TH	Hydrostatic Testing
VC	CS Versa-Mount Bracket
VS	316 SS Versa-Mount Bracket
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
XL	Clean for Critical Service (Oxygen or Chlorine)

OPTIONS

- **Versa-Mount Brackets**



See Options/Accessories Pages 61-62.

PRESSURE & TEMPERATURE

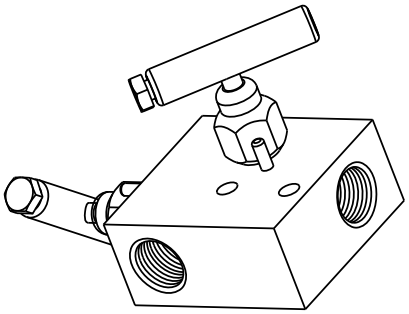
BODY MATERIAL	METAL SEAT Teflon Packed or Viton O-ring	METAL SEAT Grafoil Packed
Carbon Steel	6,000 PSI @ 200° F Max.	2,000 PSI @ 450° F Max.
316 SS	4,000 PSI @ 450° F Max.	2,000 PSI @ 450° F Max.
See Page 5:	Chart C	Chart F
BODY MATERIAL	**SOFT SEAT (Delrin) Teflon Packed or Viton O-ring**	**SOFT SEAT (Peek) Teflon Packed or Viton O-ring**
Carbon Steel	3,000 PSI @ 200° F Max.	6,000 PSI @ 200° F Max.
316 SS	3,000 PSI @ 200° F Max.	6,000 PSI @ 200° F Max.
See Page 5:	Chart C	Chart C

Two-Valve Block & Bleed Manifolds

.187" ORIFICE

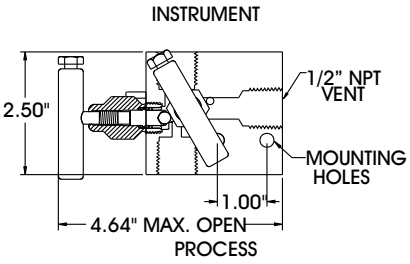
Description

½" FNPT x ½" FNPT

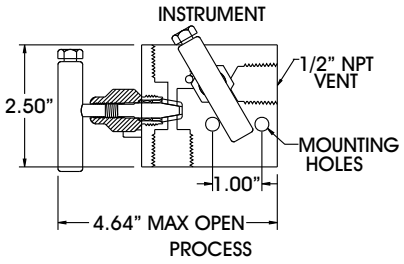


Body Style

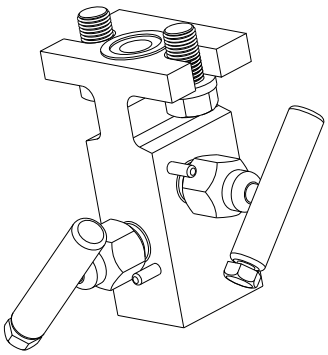
M-518 Hard Seat



M-517 Soft Seat

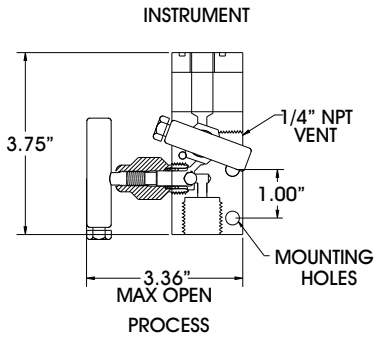


½" FNPT x Flange

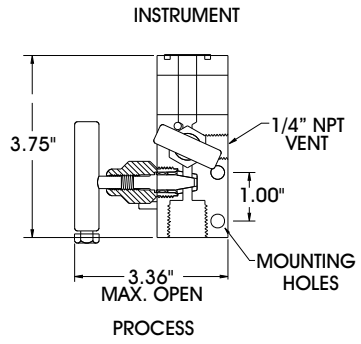


Slim Body Style

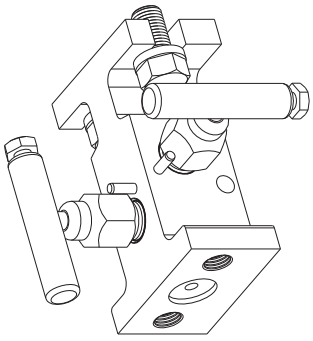
M-616 Hard Seat



M-615 Soft Seat

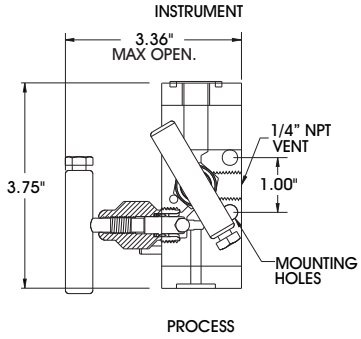


Flange x Flange

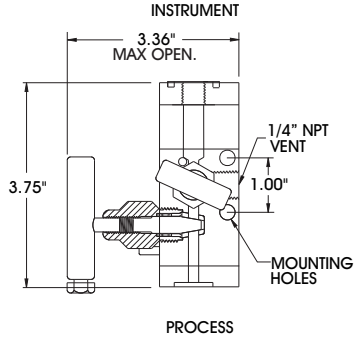


Slim Body Style

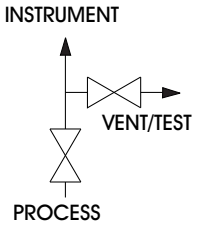
M-716 Hard Seat



M-715 Soft Seat



SEAT	MAX Cv RATINGS
Hard Ball	.53
Soft Cone	.83
Approx. Manifold Weight:	3.1 lbs each [M-517 / 518] 2.6 lbs each [M-615 / 616] 3.0 lbs each [M-715 / 716]



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	A105 CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A105-CF	ASTM A479-316	ASTM B164-N04405 or ASTM B164-N04400	ASTM B575-N10276 or ASTM A494 CW-12MW
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108	ASTM F593 (18.8)	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
Mounting Bolts	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM F593 (18-8)	ASTM F593 (18-8)

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Two-Valve Block & Bleed Manifolds

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
M - 5 1 8				-						
M - 6 1 6				-						
M - 7 1 6				-						
Soft Seat										
M - 5 1 7				-						
M - 6 1 5				-						
M - 7 1 5				-						

BODY CODE	
[Std.] Carbon Steel	C
A105 Carbon Steel	P
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

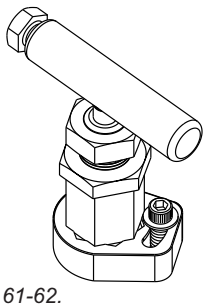
HARD SEAT CODE	
[Std.] Carbide Ball	C
Ceramic Ball	R
316 SS Ball	6
K-Monel®	N
Hastelloy-C®	H

SOFT SEAT CODE	
D	Delrin® Cone [Std.]
K	Kel-F® Cone
P	Peek® Cone
T	Teflon® Cone
Z	Tefzel Cone

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Viton® O-Ring	V
Low-Temp Pressure-Core™	J
Teflon® Packed [Hard Seat Only]	P

OPTIONS

- **Bonnet Lock Plates**
- Versa-Mount Brackets
- Bonnet Handle Lock-Out
- Steam Trace Block
- Integral Tube Fitting Connections



See Options/Accessories Pages 61-62.

OPTION CODE	OPTION DESCRIPTION
AU7	½" Integral Tube Fitting - Parker® A-LOK Dual Ferrules (Process Ports)
AV7	½" Integral Tube Fitting - Swagelok® Dual Ferrules (Process Ports)
GA	Anti-Tamper Bonnet (All Positions)
GC	Anti-Tamper Bonnet (Isolate Valve(s) Only)
GE	Anti-Tamper Bonnet (Vent Valve(s) Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided)
GK	Bonnet Lock-Out (Isolate Valve(s) Only - Lock Not Provided)
GM	Bonnet Lock-Out (Vent Valve(s) Only - Lock Not Provided)
ME	Slotted Instrument Flange Using Bolts over 3"
MH	Viton® O-Ring Flange Seals
MU	Dielectric Isolation (Flange Manifolds Only)
TC	Steam Trace Block - Carbon Steel
TH	Hydrostatic Testing
TS	Steam Trace Block - 316 SS
VC	CS Versa-Mount Bracket
VS	316 SS Versa-Mount Bracket
VCH	CS Heavy-Duty Versa-Mount Bracket
VSH	316 SS Heavy-Duty Versa-Mount Bracket
W	Safety Bonnet Lock Plate
WA	CS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW3	300 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW9	316 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)

PRESSURE & TEMPERATURE

BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
Carbon Steel Code C	10,000 PSI @ 200° F 8,000 PSI @ 450° F	Not Available.
A105 Carbon Steel Code P	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 800° F
316 SS Code S	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart F

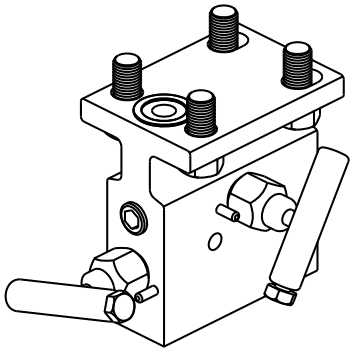
BODY MATERIAL	SOFT SEAT (Delrin) Teflon Pressure-Core	SOFT SEAT (Peek) Teflon Pressure-Core
Carbon Steel Code C	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
316 SS Code S	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
See Page 5:	Chart B	Chart B

Two-Valve Block & Bleed Manifolds

.187" ORIFICE

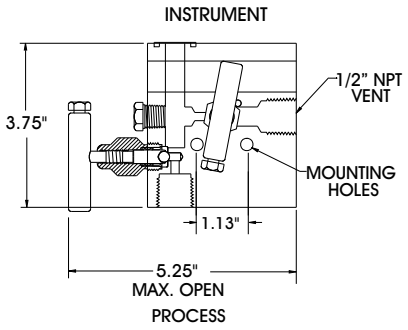
Description

½" FNPT x Flange

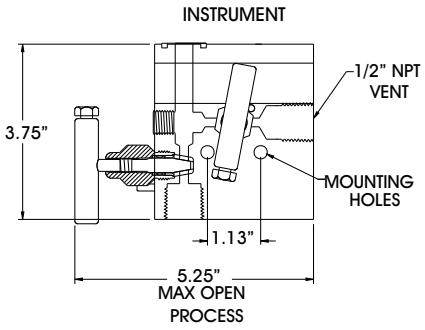


Body Style

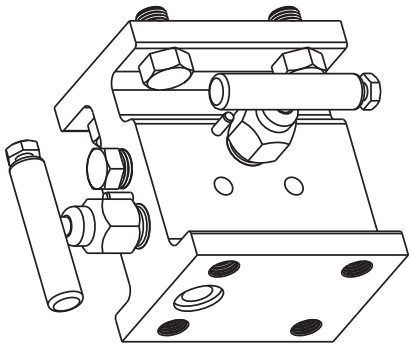
M-618 Hard Seat



M-617 Soft Seat

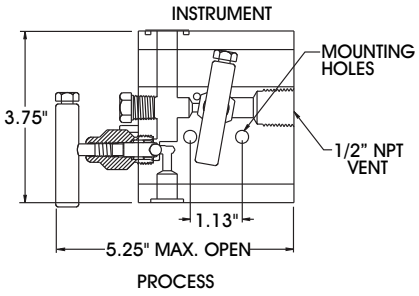


½" FNPT x Flange

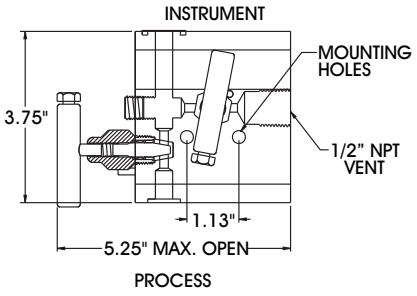


Slim Body Style

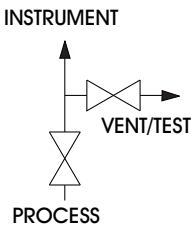
M-718 Hard Seat



M-717 Soft Seat



SEAT	MAX Cv RATINGS
Hard Ball	.53
Soft Cone	.83
Approx. Manifold Weight:	5.0 lbs each [M-617 / 618] 5.5 lbs each [M-717 / 718]



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	A105 CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A105-CF	ASTM A479-316	ASTM B164-N04405 or ASTM B164-N04400	ASTM B575-N10276 or ASTM A494 CW-12MW
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108	ASTM F593 (18.8)	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
Mounting Bolts	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM F593 (18-8)	ASTM F593 (18-8)

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Two-Valve Block & Bleed Manifolds

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
M - 6 1 8				-						
M - 7 1 8				-						
Soft Seat										
M - 6 1 7				-						
M - 7 1 7				-						

BODY CODE	
[Std.] Carbon Steel	C
A105 Carbon Steel	P
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

HARD SEAT CODE	
[Std.] Carbide Ball	C
Ceramic Ball	R
316 SS Ball	6
K-Monel®	N
Hastelloy-C®	H

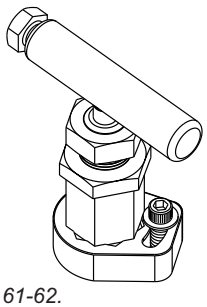
SOFT SEAT CODE	
D	Delrin® Cone [Std.]
K	Kel-F® Cone
P	Peek® Cone
T	Teflon® Cone
Z	Tefzel Cone

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Viton® O-Ring	V
Low-Temp Pressure-Core™	J
Teflon® Packed [Hard Seat Only]	P

OPTION CODE	OPTION DESCRIPTION
AU7	½" Integral Tube Fitting - Parker® A-LOK Dual Ferrules (Process Ports)
AV7	½" Integral Tube Fitting - Swagelok® Dual Ferrules (Process Ports)
GA	Anti-Tamper Bonnet (All Positions)
GC	Anti-Tamper Bonnet (Isolate Valve(s) Only)
GE	Anti-Tamper Bonnet (Vent Valve(s) Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided)
GK	Bonnet Lock-Out (Isolate Valve(s) Only - Lock Not Provided)
GM	Bonnet Lock-Out (Vent Valve(s) Only - Lock Not Provided)
ME	Slotted Instrument Flange Using Bolts over 3"
MH	Viton® O-Ring Flange Seals
MU	Dielectric Isolation (Flange Manifolds Only)
TC	Steam Trace Block - Carbon Steel
TH	Hydrostatic Testing
TS	Steam Trace Block - 316 SS
VC	CS Versa-Mount Bracket
VS	316 SS Versa-Mount Bracket
VCH	CS Heavy-Duty Versa-Mount Bracket
VSH	316 SS Heavy-Duty Versa-Mount Bracket
W	Safety Bonnet Lock Plate
WA	CS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW3	300 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW9	316 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)

OPTIONS

- **Bonnet Lock Plates**
- Versa-Mount Brackets
- Bonnet Handle Lock-Out
- Steam Trace Block
- Integral Tube Fitting Connections



See Options/Accessories Pages 61-62.

PRESSURE & TEMPERATURE

BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
Carbon Steel Code C	10,000 PSI @ 200° F 8,000 PSI @ 450° F	Not Available.
A105 Carbon Steel Code P	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 800° F
316 SS Code S	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart F

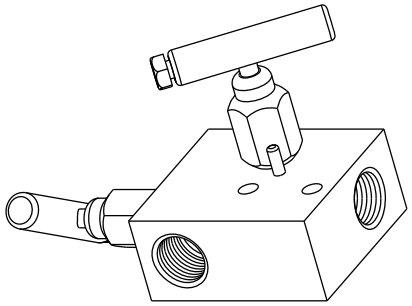
BODY MATERIAL	SOFT SEAT (Delrin) Teflon Pressure-Core	SOFT SEAT (Peek) Teflon Pressure-Core
Carbon Steel Code C	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
316 SS Code S	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
See Page 5:	Chart B	Chart B

Two-Valve Block & Bleed Manifolds

.250" ORIFICE

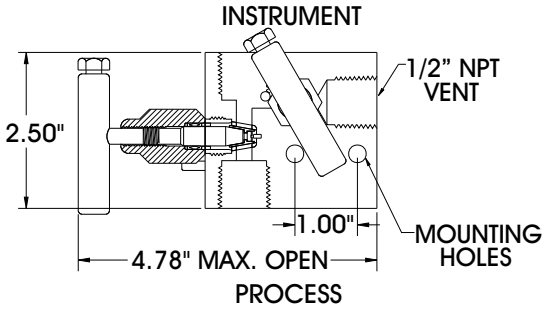
Description

½" FNPT x ½" FNPT

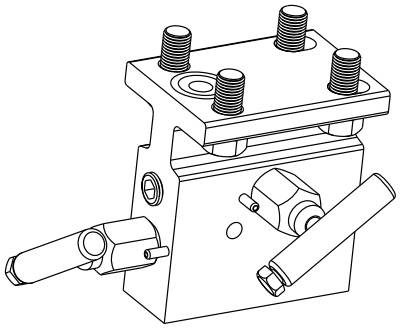


Body Style

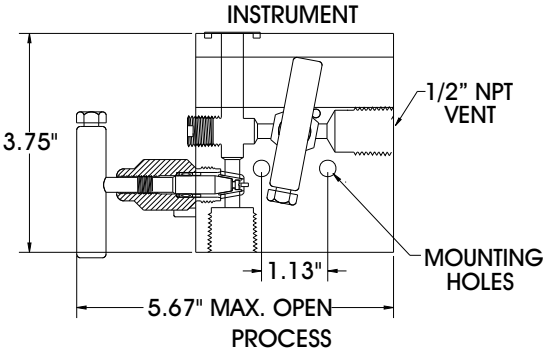
M2-517 Soft Seat



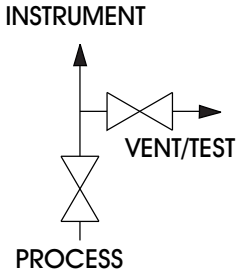
½" FNPT x Flange



M2-617 Soft Seat



SEAT	MAX Cv RATINGS
Soft Cone	.83
Approx. Manifold Weight:	**3.1 lbs each [M2-517] 5.1 lbs each [M2-617]**



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A479-316	ASTM B164-N04405 or ASTM B164-N04400	ASTM B574-N10276 or ASTM A494 CW-12MW
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
Mounting Bolts	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM F593 (18-8)	ASTM F593 (18-8)

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Two-Valve Block & Bleed Manifolds

.250" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Soft Seat										
M2-517				-						
M2-617				-						

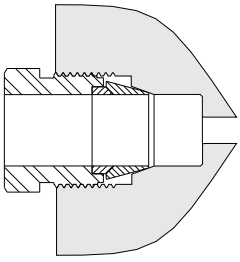
BODY CODE	
[Std.] Carbon Steel	C
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

	SOFT SEAT CODE
D	Delrin® Cone [Std.]
K	Kel-F® Cone
P	PEEK® Cone
T	Teflon® Cone
Z	Tefzel Cone

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Viton® O-Ring	V
Low-Temp Pressure-Core™	J

OPTIONS

- **Integral Tube Fitting Connections**
- Versa-Mount Brackets
- Bonnet Handle Lock-Out
- Bonnet Lock Plates



See Options/Accessories Pages 61-62.

OPTION CODE	OPTION DESCRIPTION
AU7	½" Integral Tube Fitting - Parker® A-LOK Dual Ferrules (Process Ports)
AV7	½" Integral Tube Fitting - Swagelok® Dual Ferrules (Process Ports)
GA	Anti-Tamper Bonnet (All Positions)
GC	Anti-Tamper Bonnet (Isolate Valves Only)
GE	Anti-Tamper Bonnet (Vent Valve Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided)
GK	Bonnet Lock-Out (Isolate Valve(s) Only - Lock Not Provided)
GM	Bonnet Lock-Out (Vent Valve(s) Only - Lock Not Provided)
MH	Viton® O-Ring Flange Seals
TH	Hydrostatic Testing
VC	CS Versa-Mount Bracket
VS	316 SS Versa-Mount Bracket
VCH	CS Heavy-Duty Versa-Mount Bracket
VSH	316 SS Heavy-Duty Versa-Mount Bracket
W	Safety Bonnet Lock Plate
WA	CS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW3	300 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW9	316 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)

PRESSURE & TEMPERATURE

BODY MATERIAL	SOFT SEAT (Delrin) Teflon Pressure-Core	SOFT SEAT (Peek) Teflon Pressure-Core
Carbon Steel	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
316 SS	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
See Page 5:	Chart B	Chart B

Three-Valve Miniature Manifolds

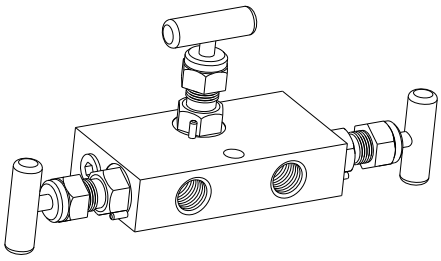
.136" ORIFICE

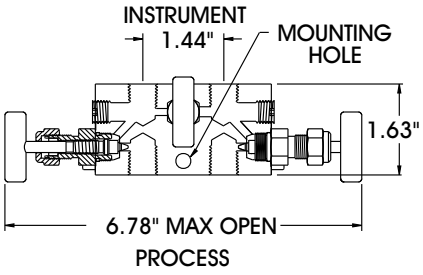
Description

¼" FNPT x ¼" FNPT

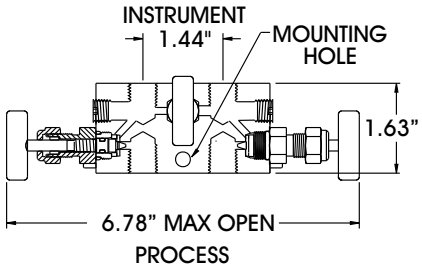
Body Style

M-506 Hard Seat

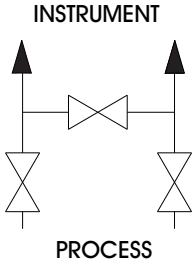




M-506 Soft Seat



SEAT	MAX Cv RATINGS
Integral Metal	.25
Soft Washer	.22
Approx. Manifold Weight:	**1.8 lbs each [M-506]**



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A479-316	Manifold not available in Monel®.	Manifold not available in Hastelloy-C®.
Bonnet	ASTM A108-1215	ASTM A479-316		
Stem	ASTM A582-303	ASTM A479-316		
Seal Retainer	ASTM A479-316	ASTM A479-316		
Handle Assembly	ASTM A108	ASTM A582 (18-8)		
Plug(s)	ASTM A108	ASTM A182-F (18-8)		

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested

Three-Valve Miniature Manifolds

.136" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
M - 5 0 6				-						
Soft Seat										
M - 5 0 6				-						

BODY CODE	
[Std.] Carbon Steel	C
[Std.] 316 SS	S

HARD SEAT CODE	
[Std.] Integral Metal	M

SOFT SEAT CODE	
D	Delrin® Washer [Std.]
K	Kel-F® Washer
P	Peek® Washer
T	Teflon® Washer
Z	Tefzel Washer

STEM SEAL CODE	
[Std.] Teflon® Packed	T
Grafoil® Packed	G
Viton® O-Ring	V

OPTION CODE	OPTION DESCRIPTION
H5	CS Mini Round Handle
H6	SS Mini Round Handle
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
XL	Clean for Critical Service (Oxygen or Chlorine)

PRESSURE & TEMPERATURE

BODY MATERIAL	METAL SEAT Teflon Packed or Viton O-ring	METAL SEAT Grafoil Packed
Carbon Steel	6,000 PSI @ 200° F Max.	2,000 PSI @ 450° F Max.
316 SS	6,000 PSI @ 200° F Max.	2,000 PSI @ 450° F Max.
See Page 5:	Chart F	Chart F
BODY MATERIAL	**SOFT SEAT (Delrin) Teflon Packed or Viton O-ring**	**SOFT SEAT (Peek) Teflon Packed or Viton O-ring**
Carbon Steel	3,000 PSI @ 200° F Max.	6,000 PSI @ 200° F 3,000 PSI @ 400° F
316 SS	3,000 PSI @ 200° F Max.	6,000 PSI @ 200° F 3,000 PSI @ 400° F
See Page 5:	Chart C	Chart C

Three-Valve Fugitive Emissions Manifold

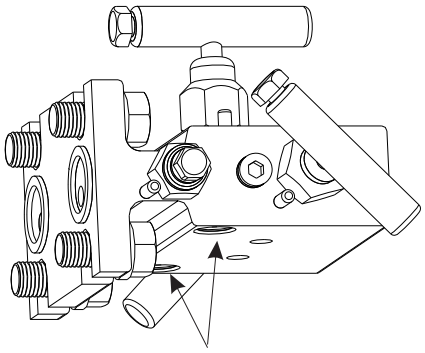
.187" ORIFICE

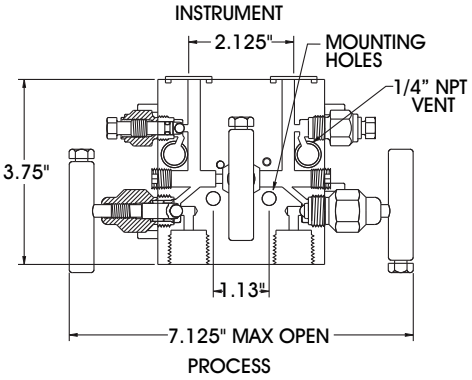
Description

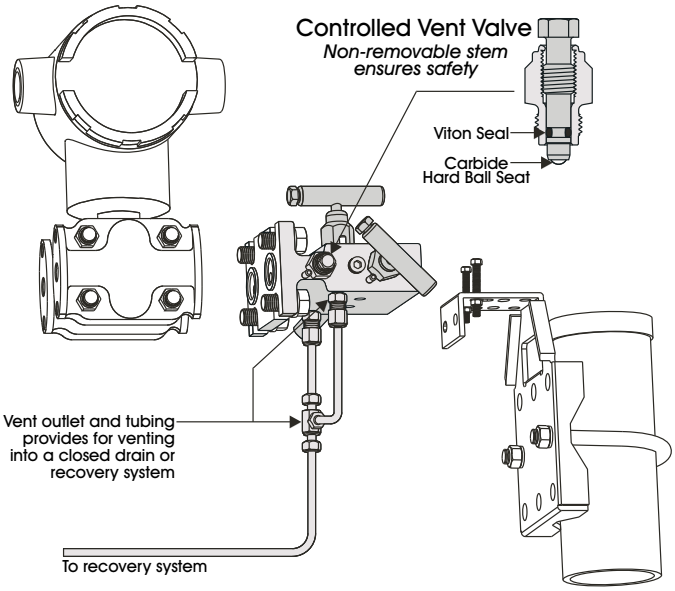
½" FNPT x Flange

Body Style

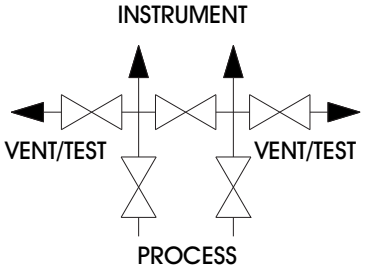
M-694 Hard Seat







SEAT	MAX Cv RATINGS
Hard Ball / Cone	.53
Approx. Manifold Weight:	**5.2 lbs each [M-694]**



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	A105 CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A105-CF	ASTM A479-316	ASTM B164-N04400	ASTM B575-N10276 or ASTM A494 CW-12MW
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108	ASTM F593 (18.8)	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
Mounting Bolts	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM F593 (18-8)	ASTM F593 (18-8)

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Three-Valve Fugitive Emissions Manifolds

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
M - 6 9 4				-						

BODY CODE	
[Std.] Carbon Steel	C
A105 Carbon Steel	P
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

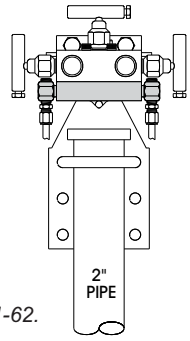
HARD SEAT CODE	
C	Carbide Ball [Std.]
R	Ceramic Ball
6	316 SS Ball
H	Hastelloy-C®
N	K-Monel®

STEM SEAL CODE		
Block Valve(s)	Vent Valve(s)	
[Std.] Teflon® Pressure-Core™	Viton® O-Ring [Std.]	T
Grafoil® Packed	Grafoil® Packed	G
Viton® O-Ring	Viton® O-Ring	V
Teflon® Packed	Teflon® Packed	P
Low-Temp Pressure-Core™	Fluorosilicone O-Ring	J

OPTION CODE	OPTION DESCRIPTION
AU7	½" Integral Tube Fitting - Parker® A-LOK Dual Ferrules (Process Ports)
AV7	½" Integral Tube Fitting - Swagelok® Dual Ferrules (Process Ports)
CVSCF	Vent Valve Seal Material: Fluorosilicone O-Ring
GC	Anti-Tamper Bonnet (Isolate Valves Only)
GD	Anti-Tamper Bonnet (Equalizer Valve Only)
GK	Bonnet Lock-Out (Isolate Valves Only - Lock Not Provided)
GL	Bonnet Lock-Out (Equalizer Valve Only - Lock Not Provided)
MH	Viton® O-Ring Flange Seals
MU	Dielectric Isolation (Flange Manifolds Only)
TC	Steam Trace Block - Carbon Steel
TH	Hydrostatic Testing
TS	Steam Trace Block - 316 SS
VC	CS Versa-Mount Bracket
VS	316 SS Versa-Mount Bracket
VCH	CS Heavy-Duty Versa-Mount Bracket
VSH	316 SS Heavy-Duty Versa-Mount Bracket
W	Safety Bonnet Lock Plate
WA	CS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™(Flange Manifolds Only)
WAW3	300 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™(Flange Manifolds Only)
WAW9	316 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™(Flange Manifolds Only)
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)

OPTIONS

- **Steam Trace Block**
- Versa-Mount Brackets
- Bonnet Handle Lock-Out
- Bonnet Lock Plates
- Integral Tube Fitting Connections



See Options/Accessories Pages 61-62.

PRESSURE & TEMPERATURE

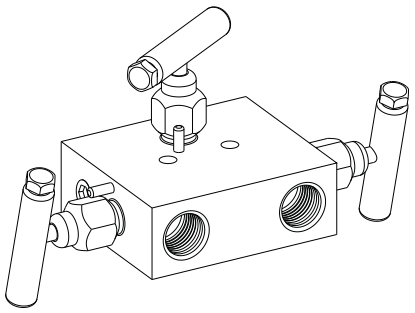
BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
Carbon Steel Code C	10,000 PSI @ 200° F 8,000 PSI @ 450° F	Not Available.
A105 Carbon Steel Code P	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 800° F
316 SS Code S	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart F

Three-Valve Manifolds

.187" ORIFICE

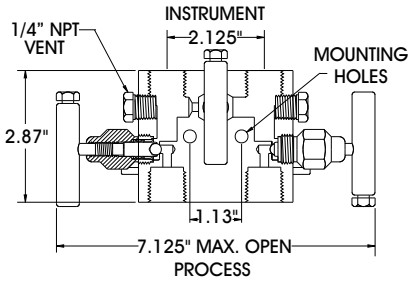
Description

½" FNPT x ½" FNPT

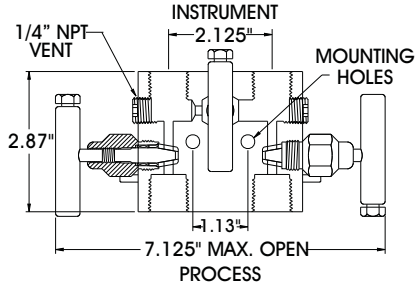


Body Style

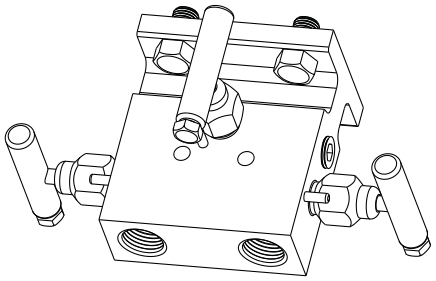
M-500 Hard Seat



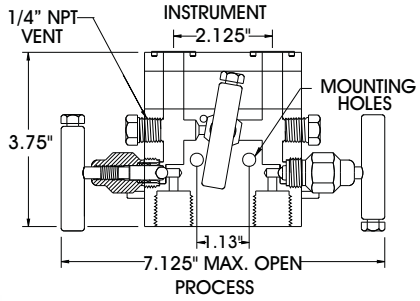
M-501 Soft Seat



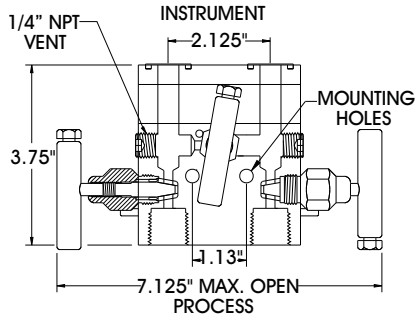
½" FNPT x Flange



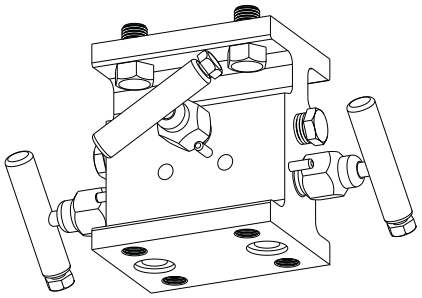
M-650 Hard Seat



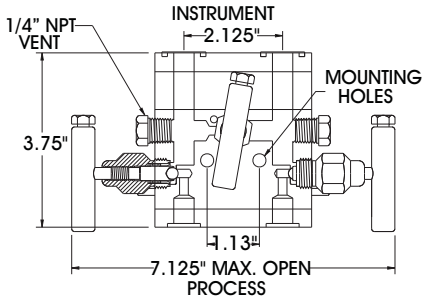
M-651 Soft Seat



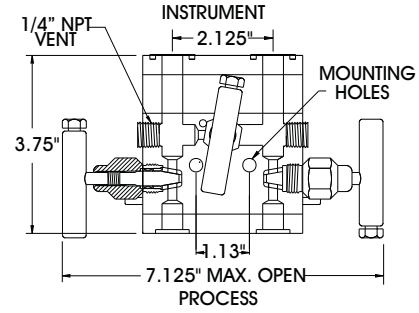
Flange x Flange



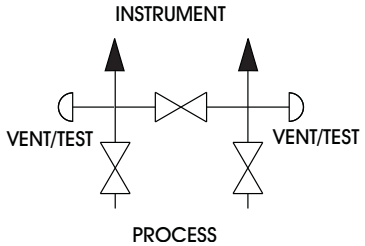
M-750 Hard Seat



M-751 Soft Seat



SEAT	MAX Cv RATINGS
Hard Ball	.53
Soft Cone	.83
Approx. Manifold Weight:	4.2 lbs each [M-500 / 501] 5.2 lbs each [M-650 / 651] 5.7 lbs each [M-750 / 751]



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	A105 CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A105 CF	ASTM A479-316	ASTM B164-N04405 or ASTM B164-N04400	ASTM B575-N10276 or ASTM A494 CW-12MW
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM A479-316	ASTM B165-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108	ASTM F593 (18.8)	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
Mounting Bolts	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM F593 (18-8)	ASTM F593 (18-8)

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Three-Valve Manifolds

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
M-500				-						
M-650				-						
M-750				-						
Soft Seat										
M-501				-						
M-651				-						
M-751				-						

BODY CODE	
[Std.] Carbon Steel	C
A105 Carbon Steel	P
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

HARD SEAT CODE	
[Std.] Carbide Ball	C
Ceramic Ball	R
316 SS Ball	6
K-Monel® Ball	N
Hastelloy-C® Ball	H

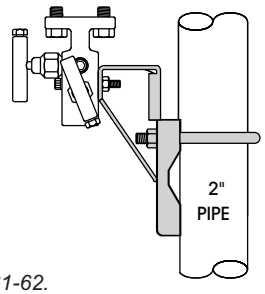
SOFT SEAT CODE	
D	Delrin® Cone [Std.]
K	Kel-F® Cone
P	PEEK® Cone
T	Teflon® Cone
Z	Tefzel Cone

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Teflon® Pressure-Core™ Back-up	K
Grafoil® Packed	G
Viton® O-Ring	V
Low-Temp Pressure-Core™	J
Teflon® Packed [Hard Seat Only]	P

OPTION CODE	OPTION DESCRIPTION
AU7	½" Integral Tube Fitting - Parker® A-LOK Dual Ferrules (Process Ports)
AV7	½" Integral Tube Fitting - Swagelok® Dual Ferrules (Process Ports)
GA	Anti-Tamper Bonnet (All Positions)
GC	Anti-Tamper Bonnet (Isolate Valve(s) Only)
GD	Anti-Tamper Bonnet (Equalizer Valve(s) Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided)
GK	Bonnet Lock-Out (Isolate Valve(s) Only - Lock Not Provided)
GL	Bonnet Lock-Out (Equalizer Valve(s) Only - Lock Not Provided)
ME	Slotted Instrument Flange Using Bolts over 3"
MH	Viton® O-Ring Flange Seals
MU	Dielectric Isolation (Flange Manifolds Only)
M7	Required Slotting for Rosemount® 1151 Transmitters Series 6 & Above (Flange Manifolds Only)
PB	(2) ¼" Constant Purge Ports (Bottom) *See pg. 61 for port locations.*
PT	(2) ¼" Constant Purge Ports (Top) *See pg. 61 for port locations.*
P1	Purge or Test Connections
TC	Steam Trace Block - Carbon Steel
TH	Hydrostatic Testing
TS	Steam Trace Block - 316 SS
VA	Bracket Spacer for Flange to Flange Manifolds
VC	CS Versa-Mount Bracket
VS	316 SS Versa-Mount Bracket
VCH	CS Heavy-Duty Versa-Mount Bracket
VSH	316 SS Heavy-Duty Versa-Mount Bracket
W	Safety Bonnet Lock Plate
WA	CS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW3	300 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW9	316 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)
X3	(2) ¼" Test Ports on Instrument Flange (Flange Manifolds Only) *See pg. 61 for port locations.*

OPTIONS

- **Versa-Mount Brackets**
- Bonnet Handle Lock-Out
- Bonnet Lock Plates
- Steam Trace Block
- Integral Tube Fitting Connections



See Options/Accessories Pages 61-62.

PRESSURE & TEMPERATURE

BODY MATERIAL	HARD SEAT Teflon Pressure-Core CODE T	HARD SEAT Teflon Pressure-Core CODE K	HARD SEAT Grafoil
Carbon Steel Code C	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 400° F	Not Available.
A105 Carbon Steel Code P	10,000 PSI @ 200° F 8,000 PSI @ 450° F	Not Available	6,000 PSI @ 200° F 1,500 PSI @ 800° F
316 SS Code S	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 400° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart D	Chart F

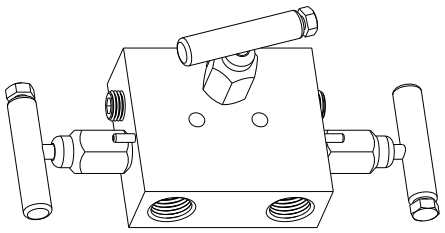
BODY MATERIAL	SOFT SEAT (Delrin) Teflon Pressure-Core CODE T	SOFT SEAT (Peek) Teflon Pressure-Core CODE T
Carbon Steel Code C	6,000 PSI @ 200° F	10,000 PSI @ 200° F 3,000 PSI @ 400° F
316 SS Code S	6,000 PSI @ 200° F	10,000 PSI @ 200° F 3,000 PSI @ 400° F
See Page 5:	Chart A	Chart B

Three-Valve Manifolds

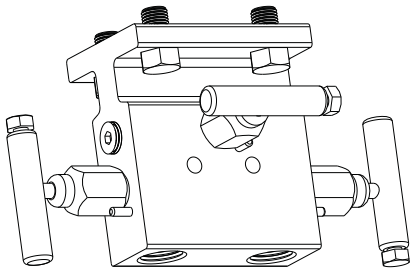
.250" ORIFICE

Description

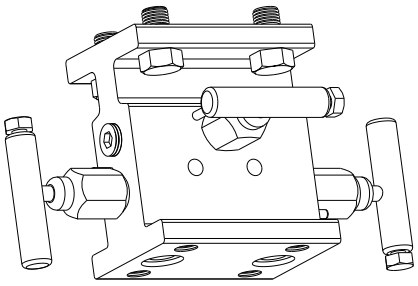
½" FNPT x ½" FNPT



½" FNPT x Flange

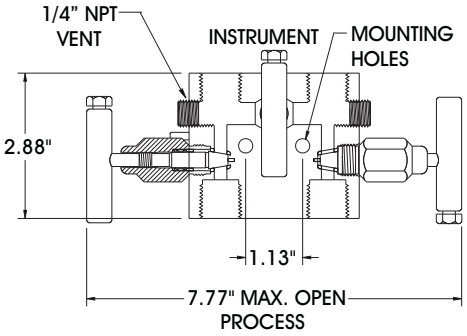


Flange x Flange

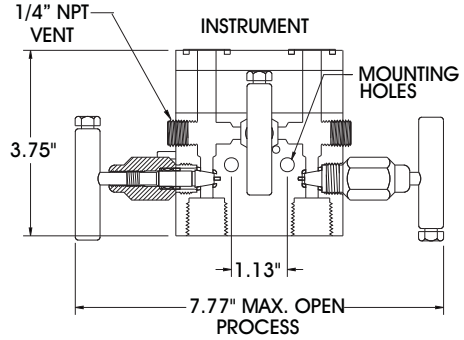


Body Style

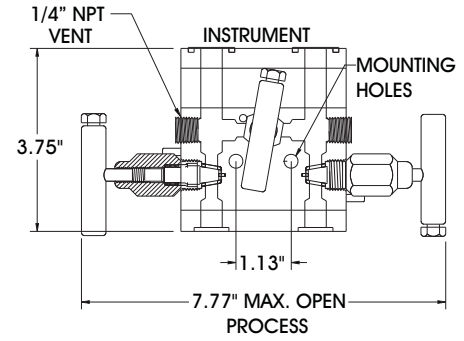
M2-501 Soft Seat



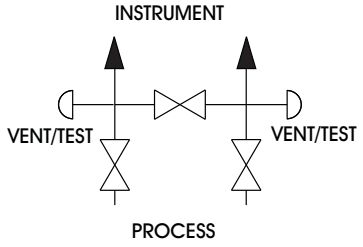
M2-651 Soft Seat



M2-751 Soft Seat



SEAT	MAX Cv RATINGS
Soft Cone	1.4
Approx. Manifold Weight:	4.2 lbs each [M2-501] 5.2 lbs each [M2-651] 5.7 lbs each [M2-751]



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A479-316	ASTM B164-N04405 or ASTM B164-N04400	ASTM B575-N10276 or ASTM A494 CW-12MW
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM B165-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
Mounting Bolts	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM F593 (18-8)	ASTM F593 (18-8)

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Three-Valve Manifolds

.250" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Soft Seat										
M2-501				-						
M2-651				-						
M2-751				-						

BODY CODE	
[Std.] Carbon Steel	C
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

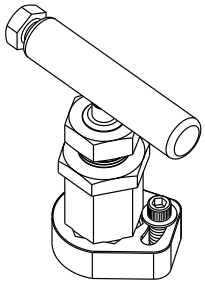
SOFT SEAT CODE	
D	Delrin® Cone [Std.]
K	Kel-F® Cone
P	PEEK® Cone
T	Teflon® Cone
Z	Tefzel Cone

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Viton® O-Ring	V
Low-Temp Pressure-Core™	J

OPTION CODE	OPTION DESCRIPTION
AU7	½" Integral Tube Fitting - Parker® A-LOK Dual Ferrules (Process Ports)
AV7	½" Integral Tube Fitting - Swagelok® Dual Ferrules (Process Ports)
GA	Anti-Tamper Bonnet (All Positions)
GC	Anti-Tamper Bonnet (Isolate Valve(S) Only)
GD	Anti-Tamper Bonnet (Equalizer Valve(s) Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided)
GK	Bonnet Lock-Out (Isolate Valve(s) Only - Lock Not Provided)
GL	Bonnet Lock-Out (Equalizer Valve(s) Only - Lock Not Provided)
ME	Slotted Instrument Flange Using Bolts over 3"
MH	Viton® O-Ring Flange Seals
MU	Dielectric Isolation (Flange Manifolds Only)
M7	Required Slotting for Rosemount® 1151 Transmitters Series 6 & Above (Flange Manifolds Only)
PB	(2) ¼" Constant Purge Ports (Bottom) *See pg. 61 for port locations.*
PT	(2) ¼" Constant Purge Ports (Top) *See pg. 61 for port locations.*
P1	Purge or Test Connections
TC	Steam Trace Block - Carbon Steel
TH	Hydrostatic Testing
TS	Steam Trace Block - 316 SS
VA	Bracket Spacer for Flange to Flange Manifolds
VC	CS Versa-Mount Bracket
VS	316 SS Versa-Mount Bracket
VCH	CS Heavy-Duty Versa-Mount Bracket
VSH	316 SS Heavy-Duty Versa-Mount Bracket
W	Safety Bonnet Lock Plate
WA	CS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW3	300 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW9	316 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)
X3	(2) ¼" Test Ports on Instrument Flange (Flange Manifolds Only) *See pg. 61 for port locations.*

OPTIONS

- **Bonnet Lock Plates**
- Versa-Mount Brackets
- Bonnet Handle Lock-Out
- Steam Trace Block
- Integral Tube Fitting



See Options/Accessories Pages 61-62.

PRESSURE & TEMPERATURE

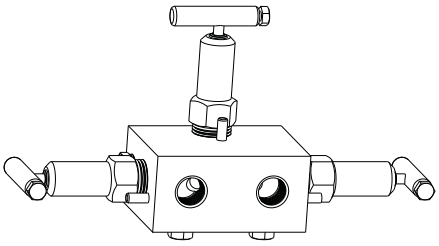
BODY MATERIAL	SOFT SEAT (Delrin) Teflon Pressure-Core	SOFT SEAT (Peek) Teflon Pressure-Core
Carbon Steel	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
316 SS	6,000 PSI @ 200° F Max.	10,000 PSI @ 200° F 3,000 PSI @ 400° F
See Page 5:	**Chart B**	**Chart B**

Three-Valve Manifolds

.375" ORIFICE

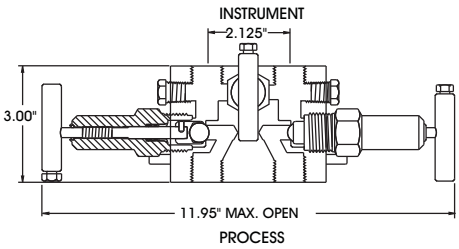
Description

½" FNPT x ½" FNPT

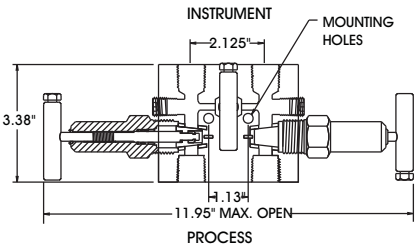


Body Style

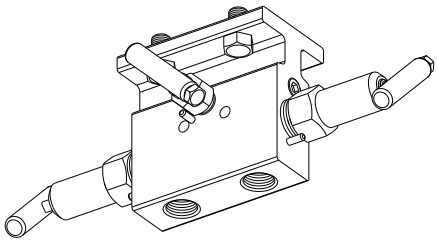
M3-500 Hard Seat



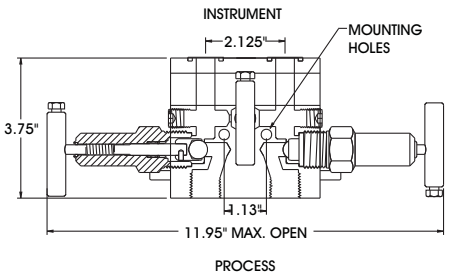
M3-551 Soft Seat



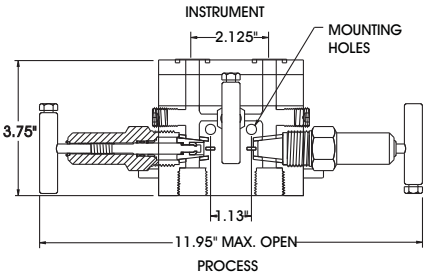
½" FNPT x Flange



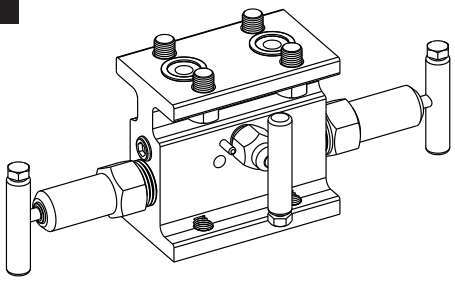
M3-650 Hard Seat



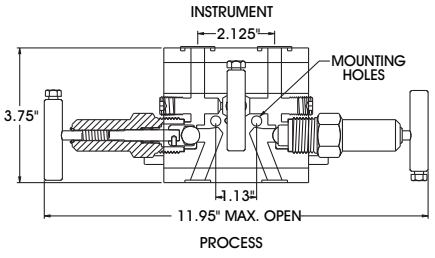
M3-651 Soft Seat



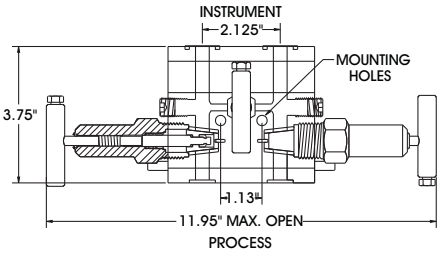
Flange x Flange



M3-750 Hard Seat

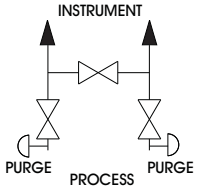


M3-751 Soft Seat

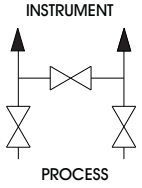


SEAT	MAX Cv RATINGS
Hard Ball	2.4
Hard Cone	3.0
Soft Cone	3.0
Approx. Manifold Weight:	9.0 lbs each [M3-500] 6.5 lbs each [M3-551] 7.0 lbs each [M3-650 / 651] 7.6 lbs each [M3-750 / 751]

M3-500



M3-551/650/651/750/751



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	A105 CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A105 CF	ASTM A479-316	ASTM B164-N04405 or ASTM B164-N04400	ASTM B575-N10276 or ASTM A494 CW-12MW
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM A479-316	ASTM B165-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108	ASTM F593 (18-8)	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
Mounting Bolts	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM F593 (18-8)	ASTM F593 (18-8)

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Three-Valve Manifolds

.375" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
M3-500				-						
M3-650				-						
M3-750				-						
Soft Seat										
M3-551				-						
M3-651				-						
M3-751				-						

BODY CODE	
[Std.] Carbon Steel	C
A105 Carbon Steel	P
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

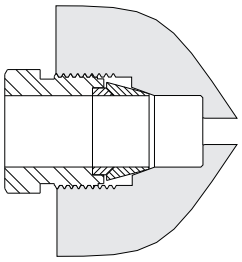
HARD SEAT CODE	
[Std.] Carbide Ball	C
Ceramic Ball	R
316 SS Ball	6
K-Monel® Ball	N
Hastelloy-C® Ball	H

SOFT SEAT CODE	
L	Rylon® Cone [Std.]
D	Delrin® Cone
K	Kel-F® Cone
P	PEEK® Cone
T	Teflon® Cone
6	316 SS Cone

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Viton® O-Ring	V
Low-Temp Pressure-Core™	J
Teflon® Packed	P

OPTIONS

- **Integral Tube Fitting Connections**
- Versa-Mount Brackets
- Bonnet Handle Lock-Out
- Bonnet Lock Plates
- Steam Trace Block



See Options/Accessories Pages 61-62.

OPTION CODE	OPTION DESCRIPTION
AU7	½" Integral Tube Fitting - Parker® A-LOK Dual Ferrules (Process Ports)
AV7	½" Integral Tube Fitting - Swagelok® Dual Ferrules (Process Ports)
GA	Anti-Tamper Bonnet (All Positions)
GC	Anti-Tamper Bonnet (Isolate Valves Only)
GD	Anti-Tamper Bonnet (Equalizer Valve(s) Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided)
GK	Bonnet Lock-Out (Isolate Valve(s) Only - Lock Not Provided)
GL	Bonnet Lock-Out (Equalizer Valve(s) Only - Lock Not Provided)
MA	Versa-Mount Bracket Holes (M3-500 Only)
ME	Slotted Instrument Flange Using Bolts over 3"
MH	Viton® O-Ring Flange Seals
MU	Dielectric Isolation (Flange Manifolds Only)
M7	Required Slotting for Rosemount® 1151 Transmitters Series 6 & Above (Flange Manifolds Only)
PB	(2) ¼" Constant Purge Ports (Bottom) *See pg. 61 for port locations.*
PT	(2) ¼" Constant Purge Ports (Top) *See pg. 61 for port locations.*
P1	Purge or Test Connections
TC	Steam Trace Block - Carbon Steel
TH	Hydrostatic Testing
TS	Steam Trace Block - 316 SS
VA	Bracket Spacer for Flange to Flange Manifolds
VC	CS Versa-Mount Bracket
VS	316 SS Versa-Mount Bracket
VCH	CS Heavy-Duty Versa-Mount Bracket
VSH	316 SS Heavy-Duty Versa-Mount Bracket
W	Safety Bonnet Lock Plate
WA	CS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW3	300 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW9	316 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)
X3	(2) ¼" Test Ports on Instrument Flange (Flange Manifolds Only) *See pg. 61 for port locations.*

PRESSURE & TEMPERATURE

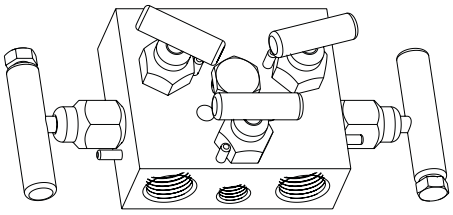
BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
Carbon Steel Code C	10,000 PSI @ 200° F 8,000 PSI @ 450° F	Not Available.
A105 Carbon Steel Code P	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 800° F
316 SS Code S	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart F
BODY MATERIAL	**SOFT SEAT (Delrin)**	**SOFT SEAT (Rylon)**
Carbon Steel Code C	6,000 PSI @ 200° F Max.	1,500 PSI @ 200° F Max.
316 SS Code S	6,000 PSI @ 200° F Max.	1,500 PSI @ 200° F Max.
See Page 5:	Chart E	Chart E

Five-Valve Manifolds

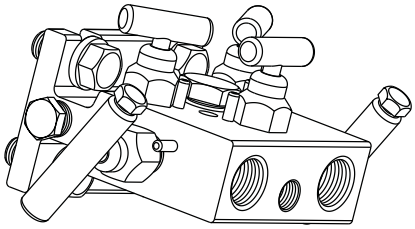
.187" ORIFICE

Description

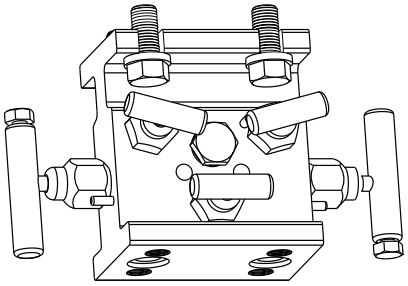
½" FNPT x ½" FNPT



½" FNPT x Flange

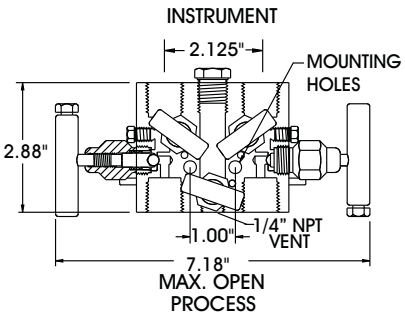


Flange x Flange

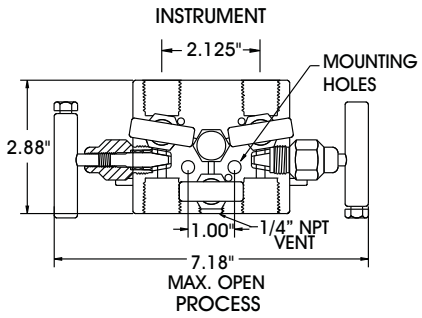


Body Style

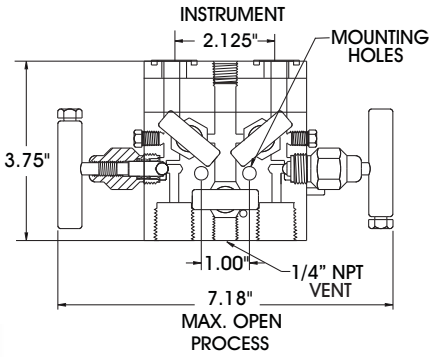
M-502 Hard Seat



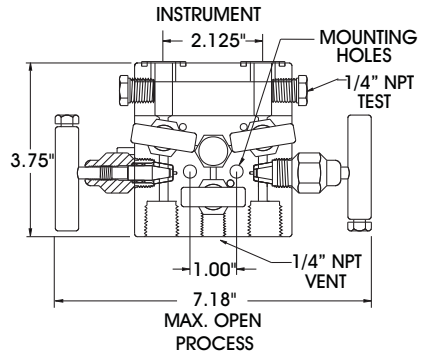
M-573 Soft Seat



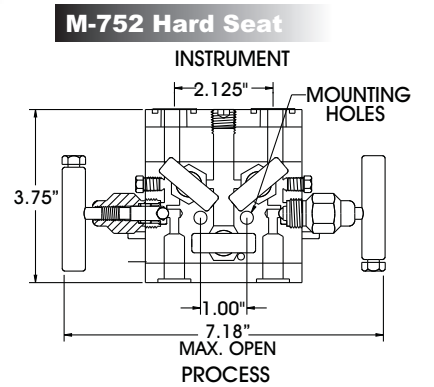
M-652 Hard Seat



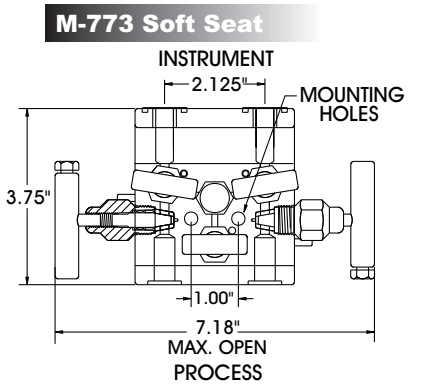
M-673 Soft Seat



M-752 Hard Seat

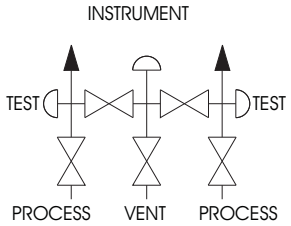


M-773 Soft Seat



SEAT	MAX Cv RATINGS
Hard Ball / Cone	.53
Soft Cone	.83
Approx. Manifold Weight:	4.7 lbs each [M-502 / 573] 5.7 lbs each [M-652 / 673] 6.2 lbs each [M-752 / 773]

NOTE: ***M-502 / 573 / 652 / 752 / 773:*** *TEST PORTS LOCATED ON BOTTOM SIDE OF MANIFOLD.*



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	A105 CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A105 CF	ASTM A479-316	ASTM B164-N04405 or ASTM B164-N04400	ASTM B575-N10276 or ASTM A494 CW-12MW
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108	ASTM F593 (18-8)	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
Mounting Bolts	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM F593 (18-8)	ASTM F593 (18-8)

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Five-Valve Manifolds

.187" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
M - 5 0 2				-						
M - 6 5 2				-						
M - 7 5 2				-						
Soft Seat										
M - 5 7 3				-						
M - 6 7 3				-						
M - 7 7 3				-						

BODY CODE	
[Std.] Carbon Steel	C
A105 Carbon Steel	P
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

HARD SEAT CODE	
[Std.] Carbide Ball	C
Ceramic Ball	R
316 SS Ball	6
K-Monel®	N
Hastelloy-C®	H

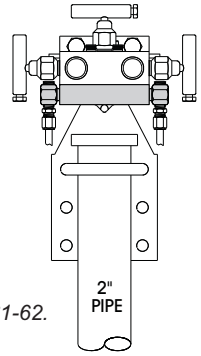
SOFT SEAT CODE	
D	Delrin® Cone / Washer [Std.]
K	Kel-F® Cone / Washer
P	PEEK® Cone / Washer
T	Teflon® Cone / Washer
Z	Tefzel Cone / Washer

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Viton® O-Ring	V
Low-Temp Pressure-Core™	J
Teflon® Packed [Hard Seat Only]	P

OPTIONS

- **Steam Trace Block**
- Versa-Mount Brackets
- Bonnet Handle Lock-Out
- Bonnet Lock Plates
- Integral Tube Fitting Connections

See Options/Accessories Pages 61-62.



OPTION CODE	OPTION DESCRIPTION
AU7	½" Integral Tube Fitting - Parker® A-LOK Dual Ferrules (Process Ports)
AV7	½" Integral Tube Fitting - Swagelok® Dual Ferrules (Process Ports)
GC	Anti-Tamper Bonnet (Isolate Valve(s) Only)
GK	Bonnet Lock-Out (Isolate Valve(s) Only - Lock Not Provided)
MH	Viton® O-Ring Flange Seals
MU	Dielectric Isolation (Flange Manifolds Only)
M7	Required Slotting for Rosemount® 1151 Transmitters Series 6 & Above (Flange Manifolds Only)
PB	(2) ¼" Constant Purge Ports (Bottom) *See pg. 61 for port locations.*
PS	(2) ¼" Side Purge with Plugs (M-773 and M-752 Only) *See pg. 61 for port locations.*
TC	Steam Trace Block - Carbon Steel
TH	Hydrostatic Testing
TS	Steam Trace Block - 316 SS (Not available with M-773)
VC	CS Versa-Mount Bracket
VS	316 SS Versa-Mount Bracket
VCH	CS Heavy-Duty Versa-Mount Bracket
VSH	316 SS Heavy-Duty Versa-Mount Bracket
W	Safety Bonnet Lock Plate
WA	CS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW3	300 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW9	316 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)
X3	(2) ¼" Test Ports on Instrument Flange (Available on M-652, M-752 and M-773) *See pg. 61 for port locations.*

PRESSURE & TEMPERATURE

BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
Carbon Steel Code C	10,000 PSI @ 200° F 8,000 PSI @ 450° F	Not Available.
A105 Carbon Steel Code P	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 800° F
316 SS Code S	10,000 PSI @ 200° F 8,000 PSI @ 450° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart F

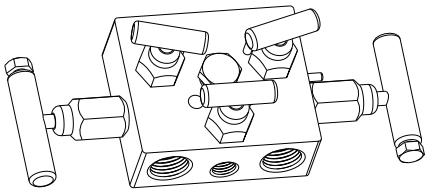
BODY MATERIAL	SOFT SEAT (Delrin) Teflon Pressure-Core	SOFT SEAT (Peek) Teflon Pressure-Core
Carbon Steel Code C	6,000 PSI @ 200° F Max.	6,000 PSI @ 200° F 3,000 PSI @ 400° F
316 SS Code S	6,000 PSI @ 200° F Max.	6,000 PSI @ 200° F 3,000 PSI @ 400° F
See Page 5:	Chart A	Chart A

Five-Valve Manifolds

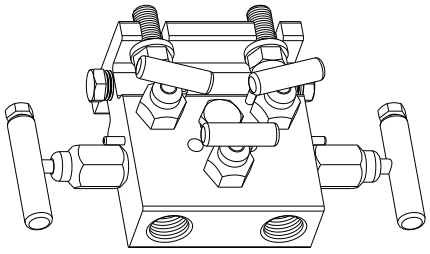
.250" ORIFICE

Description

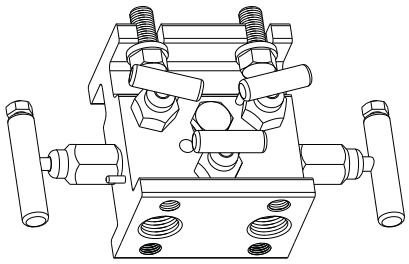
½" FNPT x ½" FNPT



½" FNPT x Flange

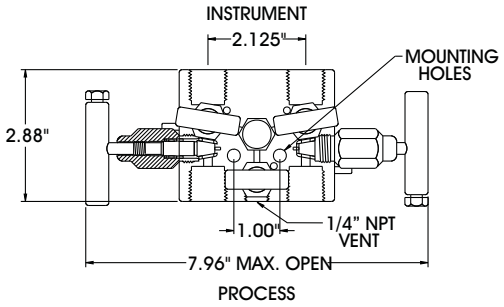


Flange x Flange

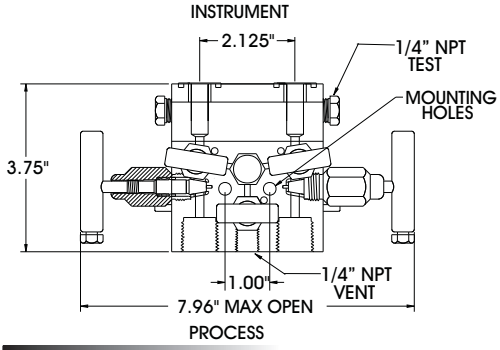


Body Style

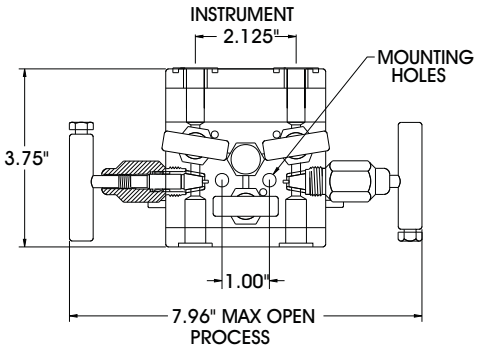
M2-573 Soft Seat



M2-673 Soft Seat

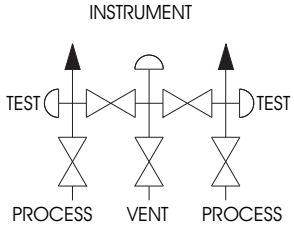


M2-773 Soft Seat



SEAT	MAX Cv RATINGS
Soft Cone	1.4
Approx. Manifold Weight:	4.7 lbs each [M2-573] 5.7 lbs each [M2-673] 6.2 lbs each [M2-773]

NOTE: ***M2-573 / 773:*** *TEST PORTS LOCATED ON BOTTOM SIDE OF MANIFOLD.*



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A479-316	ASTM B164-N04405 or ASTM B164-N04400	ASTM B575-N10276 or ASTM A494 CW-12MW
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
Mounting Bolts	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM F593 (18-8)	ASTM F593 (18-8)

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Five-Valve Manifolds

.250" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Soft Seat										
M 2 - 5 7 3				-						
M 2 - 6 7 3				-						
M 2 - 7 7 3				-						

BODY CODE	
[Std.] Carbon Steel	C
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

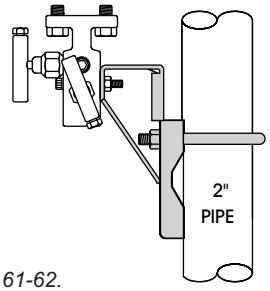
	SOFT SEAT CODE
D	Delrin® Cone [Std.]
K	Kel-F® Cone
P	PEEK® Cone
T	Teflon® Cone
Z	Tefzel Cone

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Viton® O-Ring	V
Low-Temp Pressure-Core™	J

OPTION CODE	OPTION DESCRIPTION
AU7	½" Integral Tube Fitting - Parker® A-LOK Dual Ferrules (Process Ports)
AV7	½" Integral Tube Fitting - Swagelok® Dual Ferrules (Process Ports)
GC	Anti-Tamper Bonnet (Isolate Valves Only)
GK	Bonnet Lock-Out (Isolate Valve(s) Only - Lock Not Provided)
MH	Viton® O-Ring Flange Seals
MU	Dielectric Isolation (Flange Manifolds Only)
M7	Required Slotting for Rosemount® 1151 Transmitters Series 6 & Above (Flange Manifolds Only)
PB	(2) ¼" Constant Purge Ports (Bottom) *See pg. 61 for port locations.*
PT	(2) ¼" Constant Purge Ports (Top - M2-673/773 Only) *See pg. 61 for port locations.*
P1	Purge or Test Connections
TC	Steam Trace Block - Carbon Steel
TH	Hydrostatic Testing
TS	Steam Trace Block - 316 SS
VC	CS Versa-Mount Bracket
VS	316 SS Versa-Mount Bracket
VCH	CS Heavy-Duty Versa-Mount Bracket
VSH	316 SS Heavy-Duty Versa-Mount Bracket
W	Safety Bonnet Lock Plate
WA	CS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW3	300 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WAW9	316 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only)
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)
X3	(2) ¼" Test Ports on Instrument Flange (Available on M2-773 Only) *See pg. 61 for port locations.*

OPTIONS

- **Versa-Mount Brackets**
- Bonnet Handle Lock-Out
- Bonnet Lock Plates
- Steam Trace Block
- Integral Tube Fitting Connections



See Options/Accessories Pages 61-62.

PRESSURE & TEMPERATURE

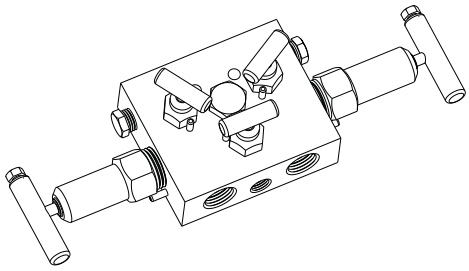
BODY MATERIAL	SOFT SEAT (Delrin) Teflon Pressure-Core	SOFT SEAT (Peek) Teflon Pressure-Core
Carbon Steel	6,000 PSI @ 200° F Max.	6,000 PSI @ 200° F 3,000 PSI @ 400° F
316 SS	6,000 PSI @ 200° F Max.	6,000 PSI @ 200° F 3,000 PSI @ 400° F
See Page 5:	**Chart A**	**Chart A**

Five-Valve Manifolds

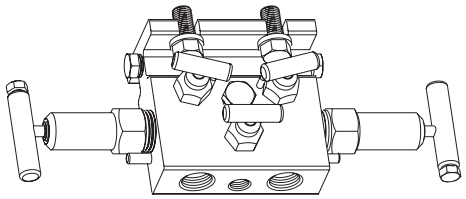
.375" ORIFICE

Description

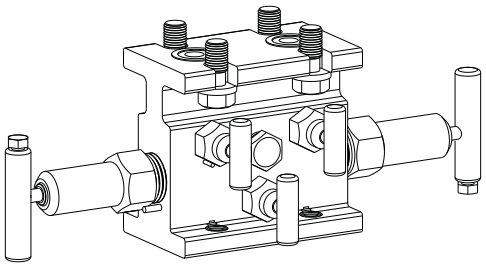
½" FNPT x ½" FNPT



½" FNPT x Flange

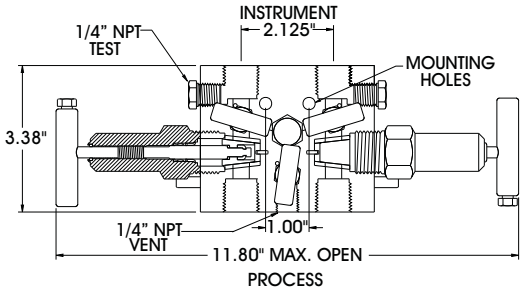


Flange x Flange

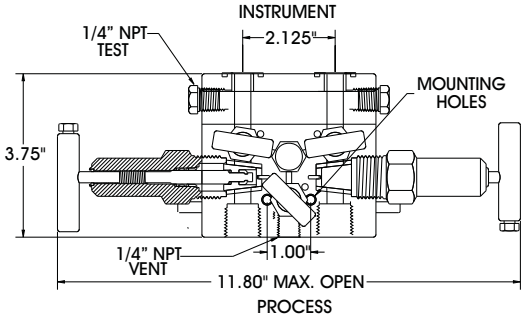


Body Style

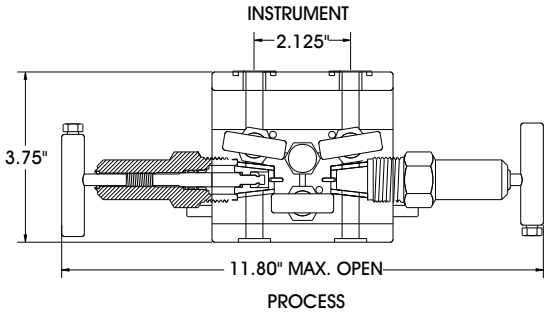
M3-573 Soft Seat



M3-673 Soft Seat

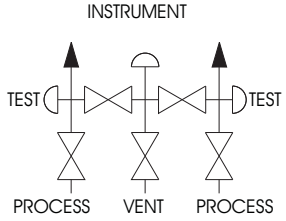


M3-773 Soft Seat



SEAT	MAX Cv RATINGS
Soft Cone	3.0
Approx. Manifold Weight:	7.1 lbs each [M3-573] 7.7 lbs each [M3-673] 8.3 lbs each [M3-773]

NOTE: ***M3-773:*** *TEST PORTS LOCATED ON BOTTOM SIDE OF MANIFOLD.*



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	ASTM A108-1215	ASTM A479-316	ASTM B164-N04405 or ASTM B164-N04400	ASTM B575-N10276 ASTM A494 CW-12MW
Bonnet	ASTM A108-1215	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Stem	ASTM A582-303	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer	ASTM A479-316	ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly	ASTM A108	ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)	ASTM A108	ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
Mounting Bolts	ASTM A449-TYPE 1	ASTM A449-TYPE 1	ASTM F593 (18-8)	ASTM F593 (18-8)

- Carbon Steel Manifolds are Zinc Cobalt Plated with Dichromate Dip
- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Carbon Steel Weld End Connection Bodies are AISI 1018

Five-Valve Manifolds

.375" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Soft Seat										
M3-573				-						
M3-673				-						
M3-773				-						

BODY CODE	
[Std.] Carbon Steel	C
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

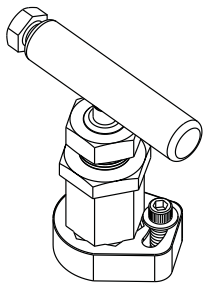
SOFT SEAT CODE	
L	Rylon® Cone [Std.]
K	Kel-F® Cone
P	PEEK® Cone
T	Teflon® Cone
D	Delrin® Cone
6	316 SS Cone

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Viton® O-Ring	V
Low-Temp Pressure-Core™	J

OPTION CODE	OPTION DESCRIPTION
AU7	½" Integral Tube Fitting - Parker® A-LOK Dual Ferrules (Process Ports)
AV7	½" Integral Tube Fitting - Swagelok® Dual Ferrules (Process Ports)
GC	Anti-Tamper Bonnet (Isolate Valve(s) Only)
GK	Bonnet Lock-Out (Isolate Valve(s) Only - Lock Not Provided)
MD	Versa-Mount Bracket Holes (M3-673 Only)
MH	Viton® O-Ring Flange Seals
MU	Dielectric Isolation (Flange Manifolds Only)
M7	Required Slotting for Rosemount® 1151 Transmitters Series 6 & Above (Flange Manifolds Only)
PB	(2) 1/8" Constant Purge Ports (Bottom - M3-573 / 773 Only) *See pg. 61 for port locations.*
PS	(2) ¼" Side Purge with Plugs (M3-773 Only) *See pg. 61 for port locations.*
P1	Purge or Test Connections
TC	Steam Trace Block - Carbon Steel
TH	Hydrostatic Testing
TS	Steam Trace Block - 316 SS
VC	CS Versa-Mount Bracket
VS	316 SS Versa-Mount Bracket
VCH	CS Heavy-Duty Versa-Mount Bracket
VSH	316 SS Heavy-Duty Versa-Mount Bracket
W	Safety Bonnet Lock Plate
WA	CS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 Coplanar Flange
WAW3	300 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 Coplanar Flange
WAW9	316 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 Coplanar Flange
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)
X3	(2) ¼" Test Ports on Instrument Flange (Available on M3-773) *See pg. 61 for port locations.*

OPTIONS

- **Bonnet Lock Plates**
- Versa-Mount Brackets
- Bonnet Handle Lock-Out
- Steam Trace Block
- Integral Tube Fitting Connections



See Options/Accessories Pages 61-62.

PRESSURE & TEMPERATURE

BODY MATERIAL	SOFT SEAT (Delrin)	SOFT SEAT (Rylon)
Carbon Steel	6,000 PSI @ 200° F Max.	1,500 PSI @ 200° F Max.
316 SS	6,000 PSI @ 200° F Max.	1,500 PSI @ 200° F Max.
See Page 5:	**Chart A**	**Chart A**

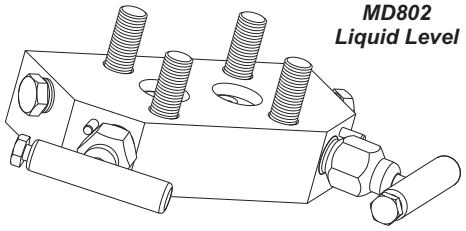
Two, Three & Five-Valve Integral Coplanar™ Manifolds

For Rosemount® 3051, 3095 and 2024 without Coplanar™

.125" ORIFICE

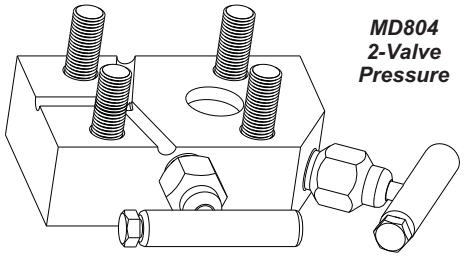
Description

½" FNPT x Flange



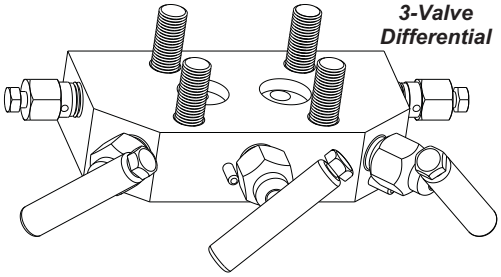
MD802
Liquid Level

½" FNPT x Flange



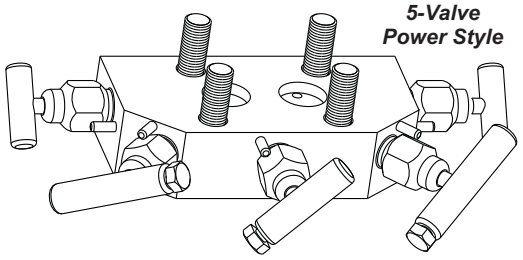
MD804
2-Valve
Pressure

½" FNPT x Flange



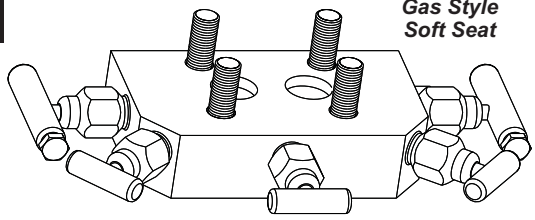
MD808
3-Valve
Differential

½" FNPT x Flange



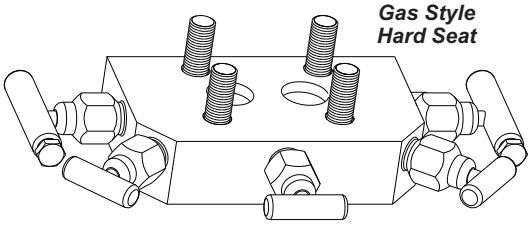
MD810
5-Valve
Power Style

½" FNPT x Flange



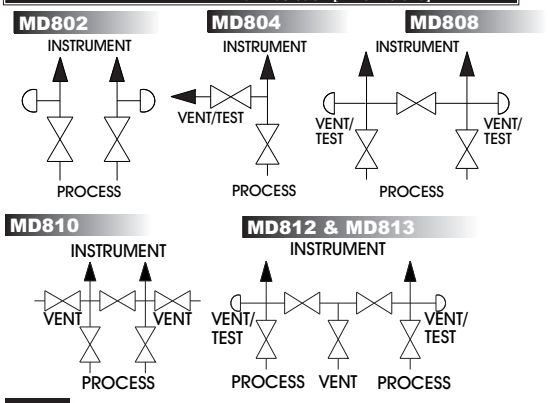
MD813
5-Valve
Gas Style
Soft Seat

½" FNPT x Flange



MD812
5-Valve
Gas Style
Hard Seat

SEAT	MAX Cv RATINGS
Hard Ball	.25
Soft Cone / Washer	.25
Approx. Manifold Weight:	5.0 lbs each [MD802] 4.3 lbs each [MD804] 5.1 lbs each [MD808] 5.9 lbs each [MD810] 6.4 lbs each [MD812 / 813]



MATERIALS OF CONSTRUCTION

PART DESCRIPTION	CARBON STEEL	316 SS	MONEL®	HASTELLOY-C®
Body	Manifold not available in Carbon Steel.	ASTM A479-316 or ASTM A240-316	ASTM B164-N04405	ASTM B575-N10276 or ASTM A494 CW-12MW
Bonnet		ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Stem		ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Seal Retainer		ASTM A479-316	ASTM B164-N04405	ASTM B574-N10276
Handle Assembly		ASTM A582 (18-8)	ASTM A582 (18-8)	ASTM A582 (18-8)
Plug(s)		ASTM A182-F (18-8)	ASTM B164-N04405	ASTM B574-N10276
Mounting Bolts		ASTM A574	ASTM F593 (18-8)	ASTM F593 (18-8)

- 316 SS Manifolds Meet NACE MR0175 Requirements (Latest Revision)
- 100% Pressure Tested
- Coplanar™ is a trademark of Rosemount®, Inc.
- Rosemount® is a registered trademark of Rosemount®, Inc.

Two, Three & Five-Valve Integral Coplanar™ Manifolds

.125" ORIFICE

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
MD802										
MD804										
MD808										
MD810				-						
MD812				-						
Soft Seat										
MD813				-						

BODY CODE	
[Std.] 316 SS	S
Monel®	M
Hastelloy-C®	H

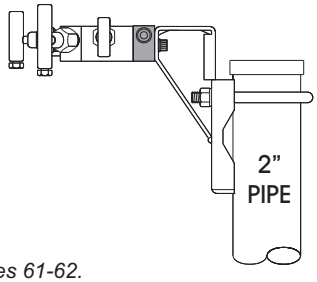
HARD SEAT CODE	
[Std.] Carbide Ball	C
Ceramic Ball	R
316 SS Ball	6
K-Monel® Ball	N
Hastelloy-C® Ball	H

SOFT SEAT CODE	
D	Delrin® Cone / Washer [Std.]
K	Kel-F® Cone / Washer
P	PEEK® Cone / Washer
T	Teflon® Cone / Washer
Z	Tefzel Cone / Washer

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Low-Temp Pressure-Core™	J

OPTIONS

- **Steam Trace Block**
- Versa-Mount Brackets
- Bonnet Lock Plates
- Bonnet Handle Lock-Out



See Options/Accessories Pages 61-62.

OPTION CODE	OPTION DESCRIPTION
GA	Anti-Tamper Bonnet (All Positions)
GC	Anti-Tamper Bonnet (Isolate Valves Only)
GD	Anti-Tamper Bonnet (Equalizer Valve Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided)
GK	Bonnet Lock-Out (Isolate Valves Only - Lock Not Provided)
GL	Bonnet Lock-Out (Equalizer Valve Only - Lock Not Provided)
TH	Hydrostatic Testing
TS	Steam Trace Block - 316 SS
VCH	CS Heavy-Duty Versa-Mount Bracket
VSH	316 SS Heavy-Duty Versa-Mount Bracket
W	Safety Bonnet Lock Plate
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)

PRESSURE & TEMPERATURE

BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
316 SS	6,000 PSI @ 450° F Max.	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F

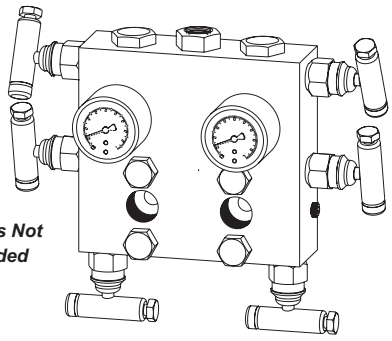
BODY MATERIAL	SOFT SEAT (Delrin) Teflon Pressure-Core
316 SS	6,000 PSI @ 200° F Max.

Purge Adapters

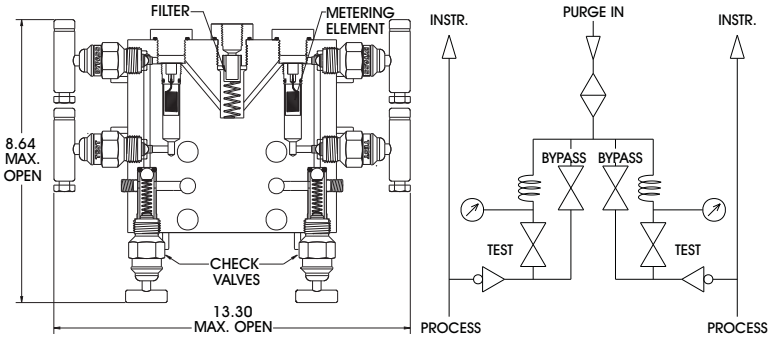
PATENT PENDING

Description

AK-062SCT *Flow & Level*

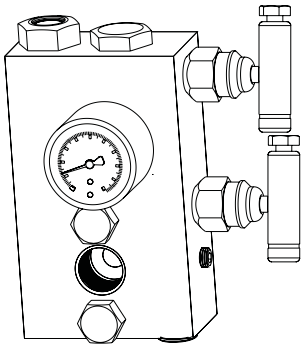


Gauges Not Included

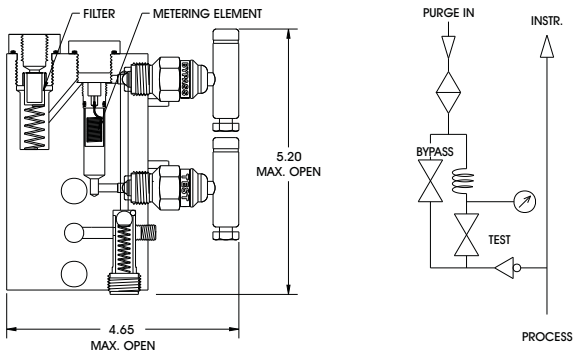


Adjustable Check Valve Option Shown

AK-064SCT *Gauge Pressure*



Gauges Not Included



Fixed Check Valve Option Shown

FEATURES

- Fixed constant purge for gases or liquids
- A variety of flow rates available
- Built-in test valves to test purge flows
- Built-in by-pass valves to by-pass purge metering elements in order to allow for a high flow purge into the process
- Built-in filter element to protect purge metering elements
- Optional check valves to prevent back flow of process into the purge adapter in case of purge failure or process surge
- 316 SS Body
- Tungsten Carbide® ball seats
- Teflon® Pressure-Core® Stem Seal
- ½" FNPT x Flange connections

METERING ELEMENT FLOW RATE DATA

SCFH	GPH
Capillary Flow Rates	
0.1 SCFH @ 10 PSI Air	N/A
0.4 SCFH @ 10 PSI Air	0.3 GPH @ 25 PSI H_20
N/A	1.0 GPH @ 25 PSI H_20

Orifice Size	Orifice Flow Rates	
.016"	4 SCFH @ 10 PSI Air	2 GPH @ 25 PSI H_20
.031"	19 SCFH @ 10 PSI Air	6 GPH @ 25 PSI H_20
.047"	36 SCFH @ 10 PSI Air	16 GPH @ 25 PSI H_20
.063"	55 SCFH @ 10 PSI Air	28 GPH @ 25 PSI H_20
.078"	85 SCFH @ 10 PSI Air	42 GPH @ 25 PSI H_20
.094"	110 SCFH @ 10 PSI Air	48 GPH @ 25 PSI H_20

MATERIALS OF CONSTRUCTION

PART DESCRIPTION	
Body	ASTM A479-316
Bonnet	ASTM A479-316
Stem	ASTM A479-316
Seal Retainer	ASTM A479-316
Handle Assembly	ASTM A582 (18.8)
Pipe Plugs	ASTM A182-F (18.8)
Caps/Plugs	ASTM A479-316
Capillary Assembly	300 Series SS
Check Valve Assembly	300 Series SS
Filter	5 Micron Phenolic Impregnated Rayon
O-Ring Seals	Viton®

Purge Adapters

ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES						DESCRIPTION
Hard Seat											
AK-062				-							Differential Pressure Purge Adapter Only
AK-064				-							Static Pressure Purge Adapter Only
AK-084				-							Differential Purge Adapter, M-750SCT 3-Valve Manifold and Mounting Bracket Assembly
AK-088				-							Static Pressure Purge Adapter, M-716SCT 2-Valve Manifold and Mounting Bracket Assembly
AK-090				-							Liquid Level Purge Adapter, M-758SCT 2-Valve Liquid Level Manifold and Mounting Bracket Assembly

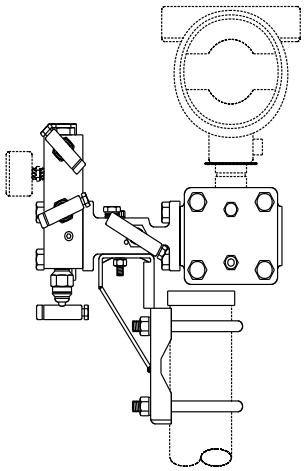
BODY CODE	
[Std.] 316 SS	S

HARD SEAT CODE	
C	Carbide Ball [Std.]
R	Ceramic Ball
6	316 SS Ball
N	K-Monel® Ball
H	Hastelloy-C® Ball

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Viton® O-Ring	V
Low-Temp Pressure-Core™	J
Teflon® Packed	P

OPTION CODE	OPTION DESCRIPTION
C3	EPDM O-Rings
CC	Adjustable Check Valve(s)
CD	Non-Adjustable Check Valve(s)
CF	0.1 SCFH Capillary Assembly
CG	1.0 GPH Capillary Assembly
CK	0.4 SCFH / .3 GPH Capillary Assembly
CHXXX	Orifice Assembly XXX = Orifice Size (Choose .016", .031", .047", .063", .078" or .094" as referenced on page 51)
CJ	7 Micron Filter, Sintered 316 SS
CE	Anit-Tamper Device on all Vent/Test Bonnets

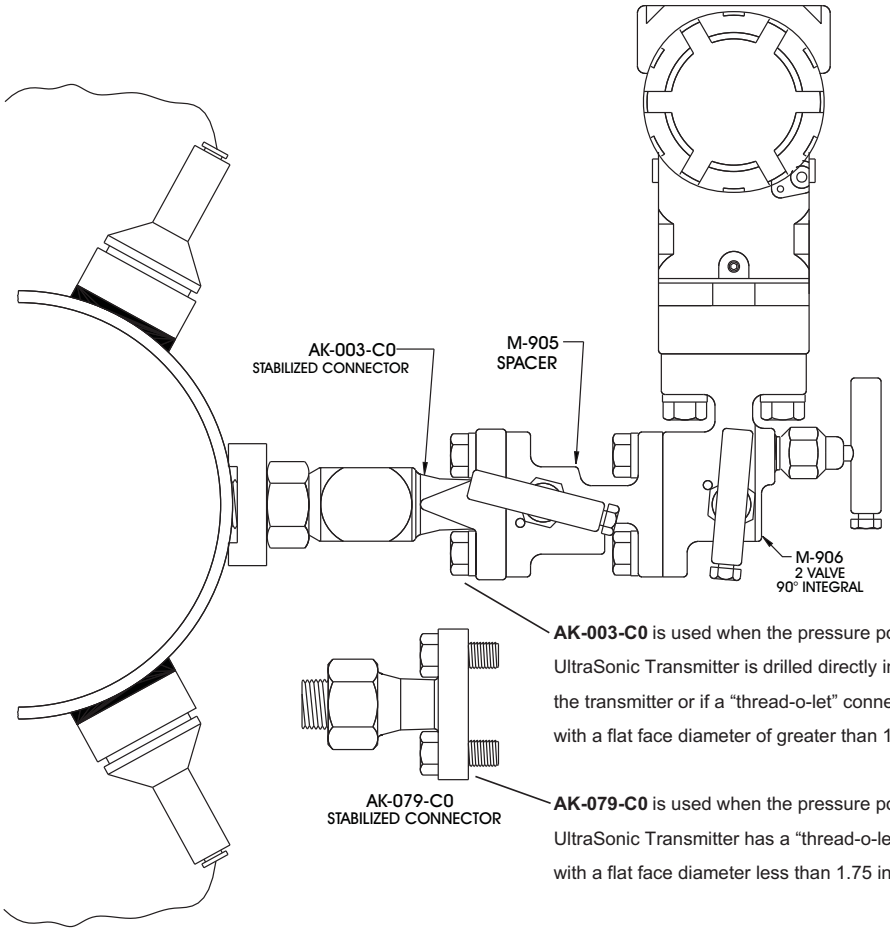
AK-084SCT
AK-088SCT
AK-090SCT
Assemblies



PRESSURE & TEMPERATURE

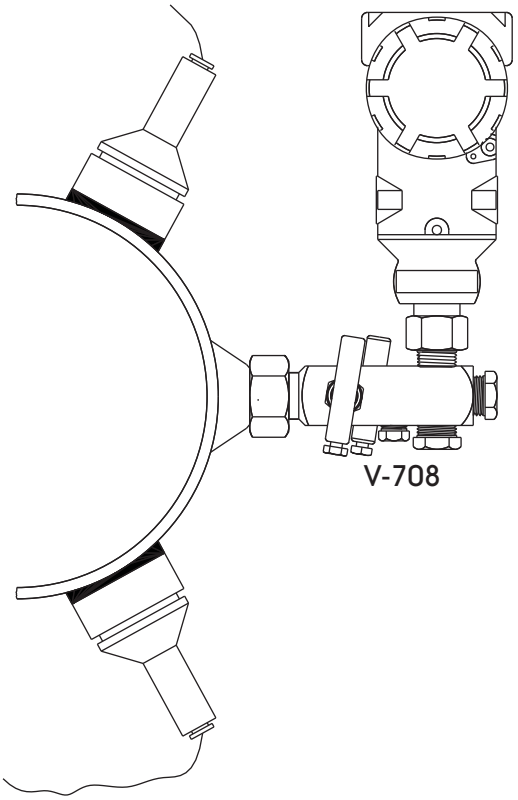
BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
316 SS	6,000 PSI @ 400° F	6,000 PSI @ 400° F

Direct-Mount™ Systems for UltraSonic Flow Meters



AK-003-C0 is used when the pressure port on the UltraSonic Transmitter is drilled directly into the body of the transmitter or if a "thread-o-let" connection is used with a flat face diameter of greater than 1.75 inches.

AK-079-C0 is used when the pressure port on the UltraSonic Transmitter has a "thread-o-let" connection with a flat face diameter less than 1.75 inches.



ORDERING INFORMATION

BODY STYLE	BODY CODE	SEAT CODE	STEM SEAL CODE		OPTION CODES					
Hard Seat										
M-905				-						
M-906				-						
V-708				-						
Stabilized Connectors ~ 75 ft./lbs. with CS Bolts										
AK-003-C0				-						
AK-079-C0										

BODY CODE	
[Std.] 316 SS	S

HARD SEAT CODE	
C	Carbide Ball [Std.]
R	Ceramic Ball
6	316 SS Ball

STEM SEAL CODE	
[Std.] Teflon® Pressure-Core™	T
Grafoil® Packed	G
Low-Temp Pressure-Core™	J

OPTION CODE	OPTION DESCRIPTION
GA	Anti-Tamper Bonnet (All Positions)
GC	Anti-Tamper Bonnet (Isolate Valve(s) Only)
GE	Anti-Tamper Bonnet (Vent Valve Only - M-906 & V-708 Only)
GJ	Bonnet Lock-Out (All Positions - Lock Not Provided)
GK	Bonnet Lock-Out (Isolate Valve(s) Only - Lock Not Provided)
GM	Bonnet Lock-Out (Vent Valve Only - Lock Not Provided - M-906 & V-708 Only)
MH	Viton® O-Ring Flange Seals (M-905/906 Only)
•MJ	Viton® O-Ring Flange Seal (AK-003/079-CO Only)
•MN	Dielectric Isolation (AK-003/079-CO Only)
MU	Dielectric Isolation (M-905/906 Only)
M7	Required Slotting for Rosemount® 1151 Transmitters Series 6 & Above (M-906 Only)
TH	Hydrostatic Testing
TS	Steam Trace Block - 316 SS (M-905 & M-906 Only)
W	Safety Bonnet Lock Plate
WA	CS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only - M-906 Only)
WAW3	300 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only - M-906 Only)
WAW9	316 SS — 2-¼" Bolts for Rosemount® 3051C, 3095, or 2024 with Coplanar™ (Flange Manifolds Only - M-906 Only)
WK	Paper Tag
W1	316 SS Tag (20 Characters ~ See page 61)
W3	300 SS Standard Length Flange Bolts (CS Standard)
W9	316 SS Standard Length Flange Bolts (CS Standard)
XL	Clean for Critical Service (Oxygen or Chlorine)
• AK-003-C0 or AK-079-C0 Can Only Use These Designated Options.	

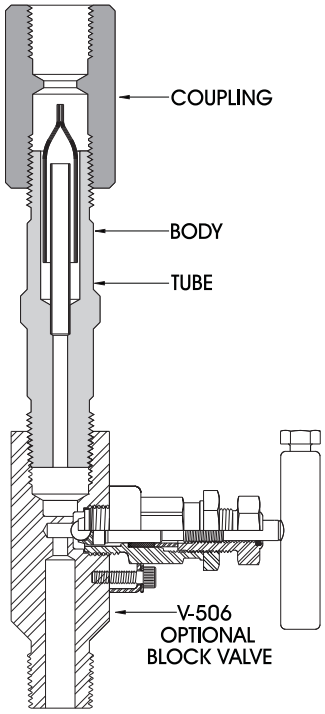
PRESSURE & TEMPERATURE

BODY MATERIAL	HARD SEAT Teflon Pressure-Core	HARD SEAT Grafoil
316 SS	10,000 PSI @ 200° F 8,000 PSI @ 400° F	6,000 PSI @ 200° F 1,500 PSI @ 1,000° F
See Page 5:	Chart D	Chart F

Gauge Siphons and Swivels

The PGI Gauge Siphon replaces the old style “Pigtail” siphon. The siphon provides a thermal barrier, protecting your instruments from harmful vapors. The siphon also reduces gauge whip, allowing closer process installation. The siphon can be used as either a freeze or steam protector when used with the proper fill fluids.

When very high heat is present, the siphon, used in conjunction with the PGI V-506 Grafoil Packed Hand Valve, reduces temperatures seen at the instrument by lengthening the condensate leg.



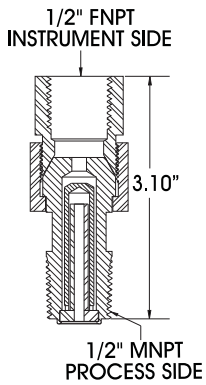
Gauge Siphons

PART NO.	CONNECTIONS INLET	CONNECTIONS OUTLET	BODY	COUPLING	TUBE
Gauge Siphons					
A7-524-C0	1/2" MNPT	1/2" FNPT	316 SS	CS	316 SS
A7-524-C0S	1/2" MNPT	1/2" FNPT	316 SS	316 SS	316 SS
A7-508-C0	3/4" MNPT	3/4" FNPT	316 SS	CS	316 SS
A7-508-C0S	3/4" MNPT	3/4" FNPT	316 SS	316 SS	316 SS
Gauge Siphons with Excess Flow Check					
A7-509-C0	1/2" MNPT	1/2" FNPT	316 SS		
Gauge Siphons with Excess Flow Check and Swivels					
A7-507-C0	1/2" MNPT	1/2" FNPT	316 SS		
Gauge Swivel					
A7-530-C0	1/2" MNPT	1/2" FNP	316 SS		
A7-530-K0	1/2" MNPT	1/2" FNP	Monel		

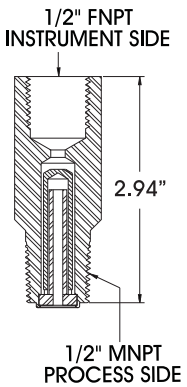
Hand Block Valve

PART NO.	CONNECTIONS INLET	CONNECTIONS OUTLET	BODY & BONNET	PACKING	SEAT
V-506CCG	1/2" MNPT	1/2" FNPT	ASTM A105 CF	Grafoil®	Carbide Ball
V-506SCG	1/2" MNPT	1/2" FNPT	ASTM A479-316 SS	Grafoil®	Carbide Ball

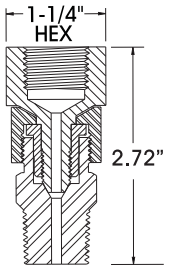
A7-507



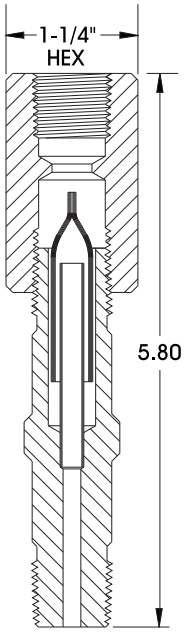
A7-509



A7-530



A7-524

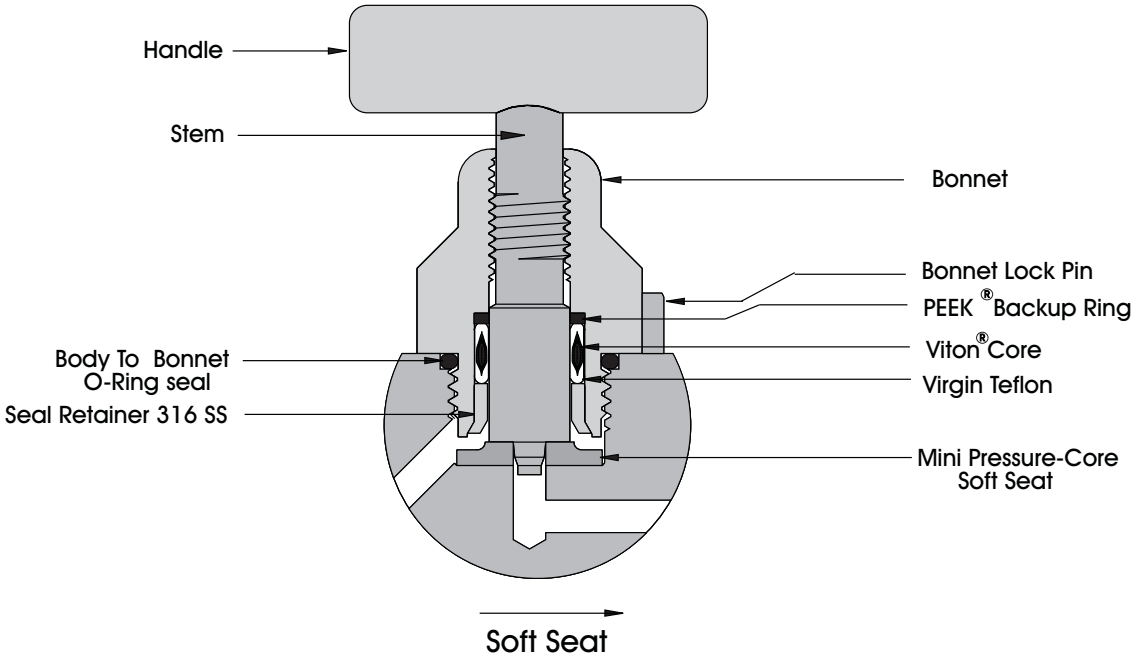


Teflon® Mini Pressure-Core™ Stem Seal Bonnet and Packing Design

.136" ORIFICE

P A T E N T E D

.136" Orifice



Mini Teflon Pressure-Core vs. Conventional "Packed" Teflon®

Conventional mini packed bonnet designs are prone to stem leaks due to Teflon® seal extrusion. The packing is located above the stem threads, thus allowing the possibility of critical stem thread contamination by the process. Additionally, the soft seat area is so small that technicians can easily force the stem through the seat washer as they try to get a “firm feel” on the shut-off. Over the long run, stem and seat leaks will cause calibration and recording difficulties, as well as loss of sample product.

Mini Pressure-Core Advantages:

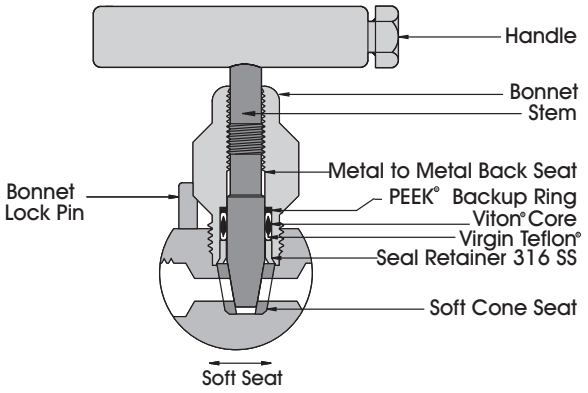
- HIGHLY RELIABLE Patented Pressure-Core™ Stem Seal with 5 YEAR WARRANTY
- Seal BELOW the Stem Threads
- Soft Seat Washer with FOUR TIMES the Sealing Area of a Standard Mini Seat that Provides a Seat that Can’t Be Damaged with Excessive Shutoff Force
- SAME Cv RATING (.22 Max) as the Conventional Mini Bonnet

Teflon® Pressure-Core™ Stem Seal Bonnet and Packing Design

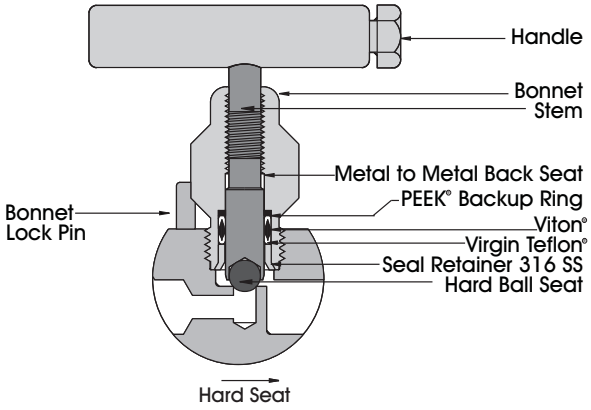
.187" .250" .375" ORIFICE

PATENTED

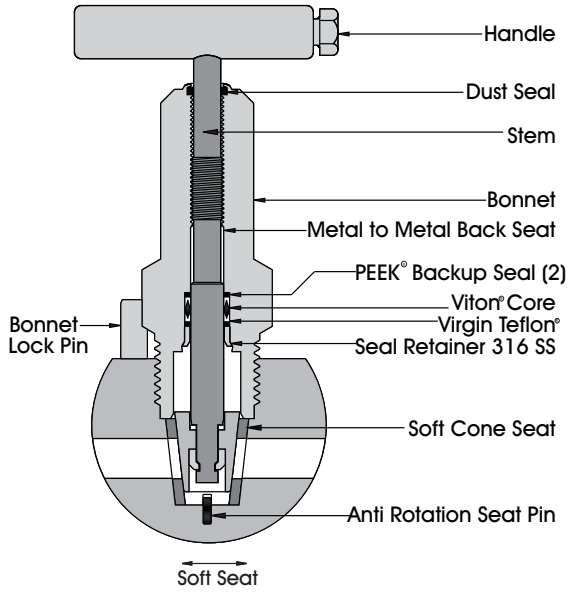
.187" .250" Orifice



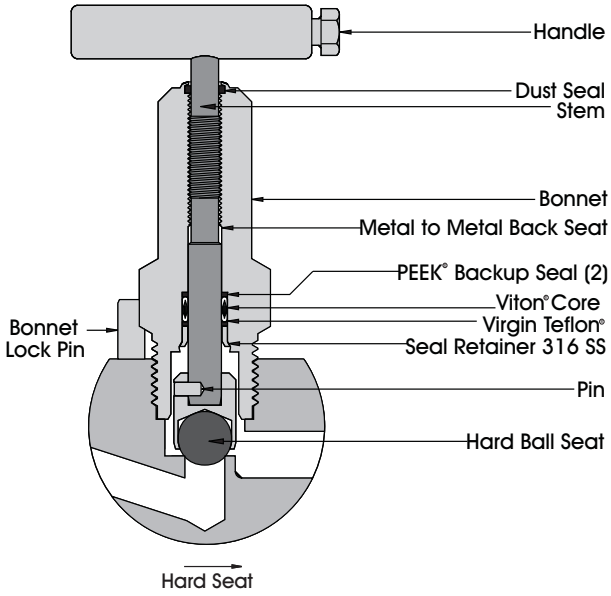
.187" Orifice Only



.375" Orifice



.375" Orifice

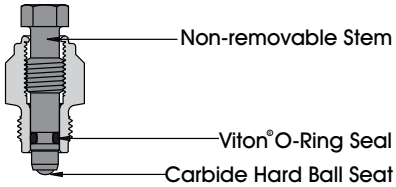


Viton® O-Ring Bonnet Design

.125" 136" .187" .250" .375" ORIFICE

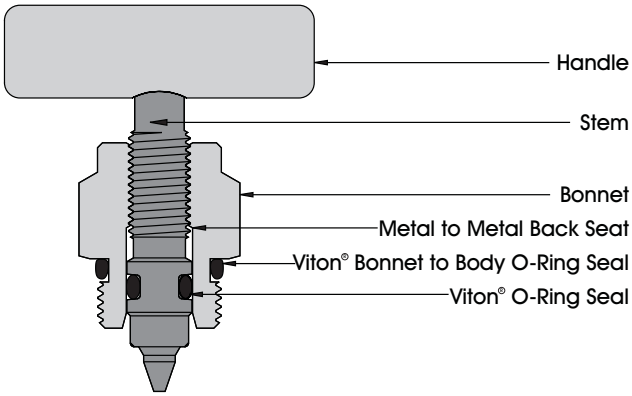
CODE "V"

.125" Orifice

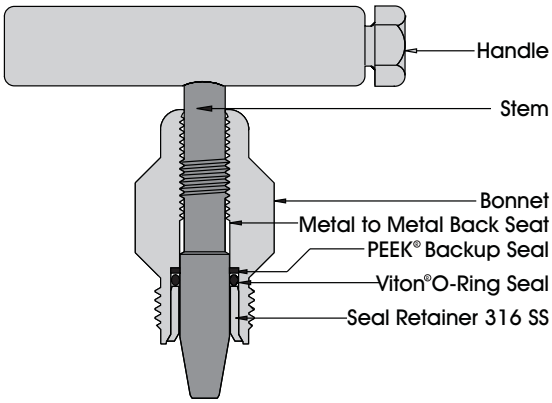


CONTROLLED
VENT VALVE

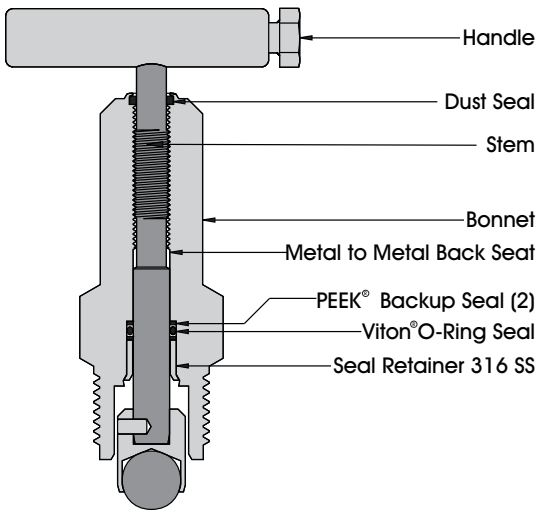
.136" Orifice



.187" .250" Orifice



.375" Orifice



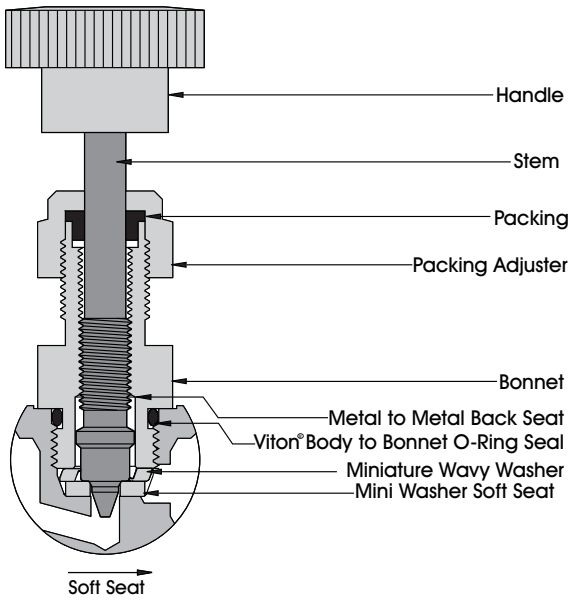
Adjustable Packed Bonnet Designs ~ Bonnet and Packing Design

.136" .187" .375" ORIFICE

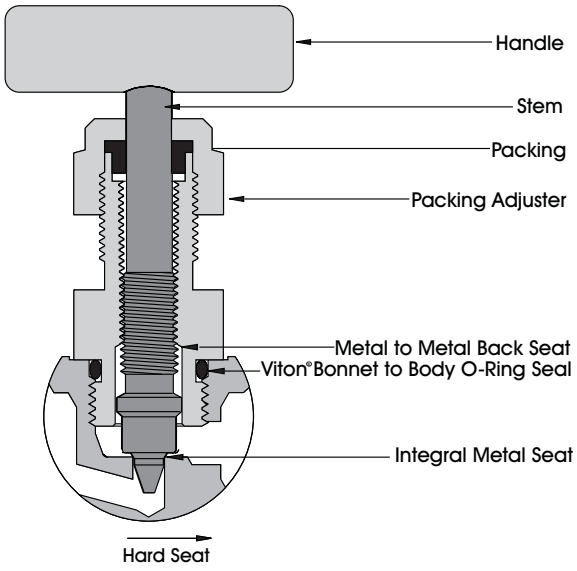
Packed Mini Valves

Teflon® Code "T"

.136" Orifice



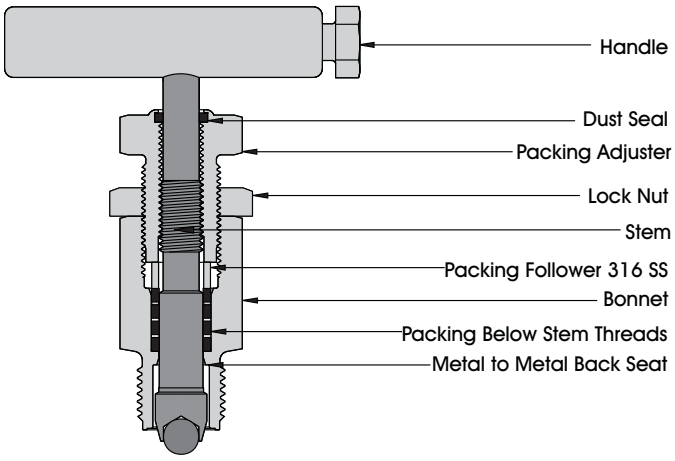
.136" Orifice



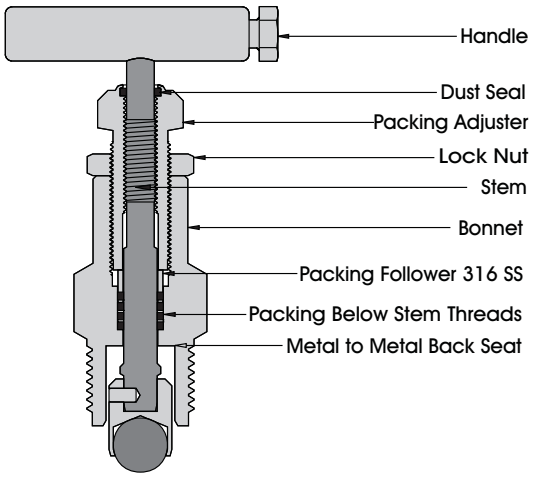
Packed Valves

Teflon® Code "P" Grafoil® Code "G"

.187" Orifice



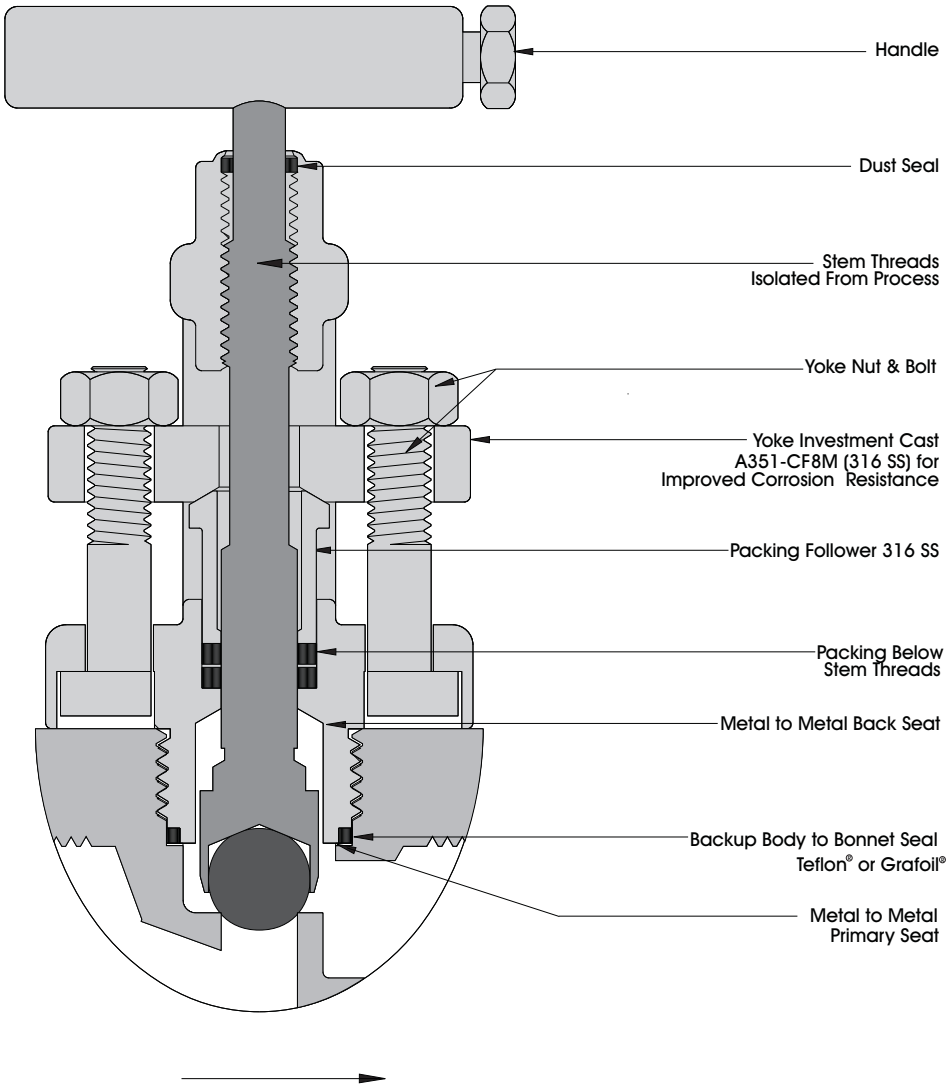
.375" Orifice



OS & Y Bonnet Code "Y"

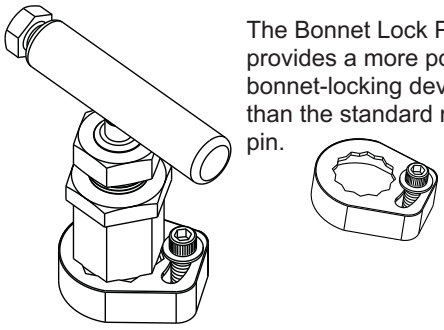
Packings

Teflon® Code "P" Grafoil® Code "G"



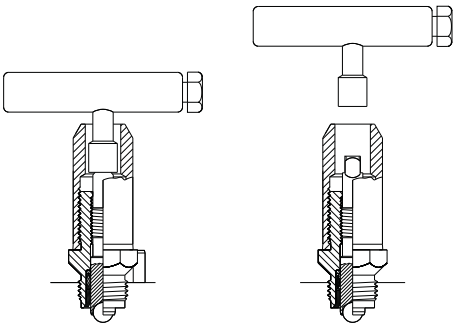
Options

Bonnet Lock Plate



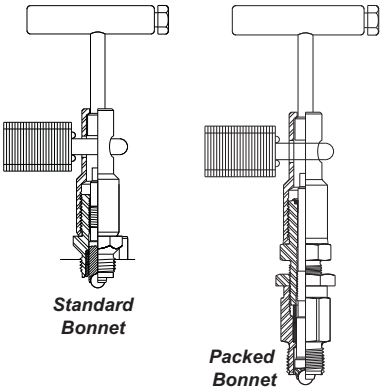
The Bonnet Lock Plate provides a more positive bonnet-locking device than the standard roll pin.

Anti-Tamper Bonnet



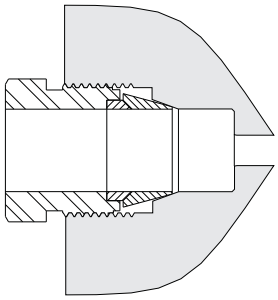
The Anti-Tamper Bonnet Handle allows the bonnet stem to be placed in any position, including open or close, before removing the handle. Without the handle, it is virtually impossible to operate the valve.

Bonnet Handle Lock-out



The Bonnet Handle Lock-out is similar to the Anti-Tamper Bonnet Handle. The bonnet stem is placed in its desired position, the handle is then raised, and the lock installed. The handle cannot be removed, and therefore cannot be lost.

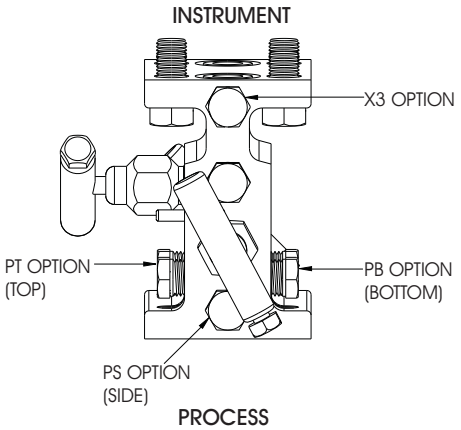
Integral Tube Fitting Connection



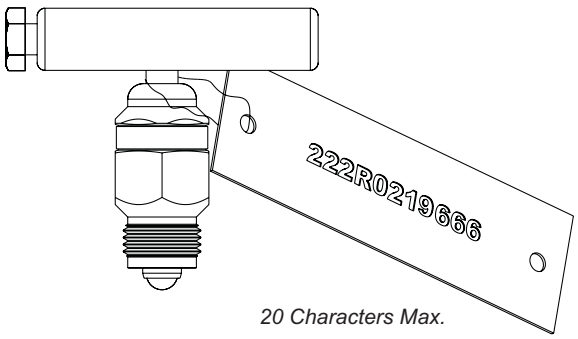
The Integral Tube Fitting Connection is available in ½" tube only. It is optional on most manifolds and needle valves. Specify the Integral Tube Fitting Connection option to select a system which eliminates pipe threads. A variety of ferrules are available.

PART NUMBER	DESCRIPTION	BONNET MATERIAL	SEAT	STEM SEAL
.187" Orifice				
SAV161SCT	Anti-Tamper Bonnet	316 SS	Carbide Ball	Teflon® Pressure-Core™
SAV166S-T	Anti-Tamper Bonnet	316 SS	Soft Cone	Teflon® Pressure-Core™
AK-123-C0	Anti-Tamper Handle Only	316 SS	- - -	- - -
SAV164SCT	Bonnet Handle Lock-out	316 SS	Carbide Ball	Teflon® Pressure-Core™
SAV165S-T	Bonnet Handle Lock-out	316 SS	Soft Cone	Teflon® Pressure-Core™
.375" Orifice				
SAV305SCT	Bonnet Handle Lock-out	316 SS	Carbide Ball	Teflon® Pressure-Core™
SAV305S-T	Bonnet Handle Lock-out	316 SS	Soft Cone	Teflon® Pressure-Core™

Purge Port Locations



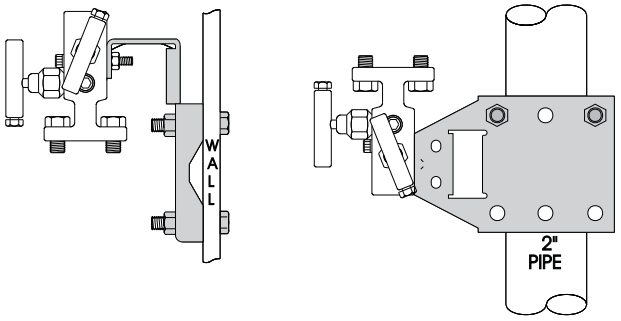
316 Stainless Steel Tag ~ Option Code W1



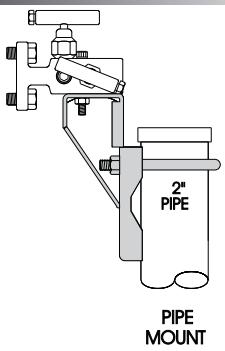
20 Characters Max.

Accessories and Kits

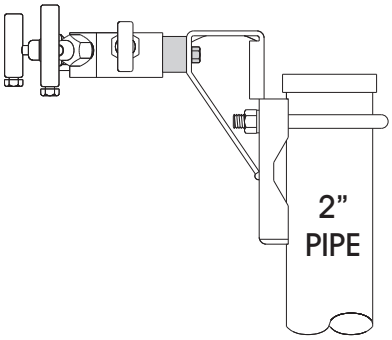
AK-002-_ _: Versa-Mount Manifold Brackets



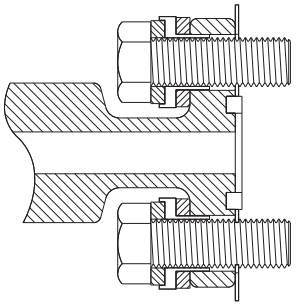
AK-002-_ _ - HD: Heavy-Duty Versa-Mount Manifold Brackets



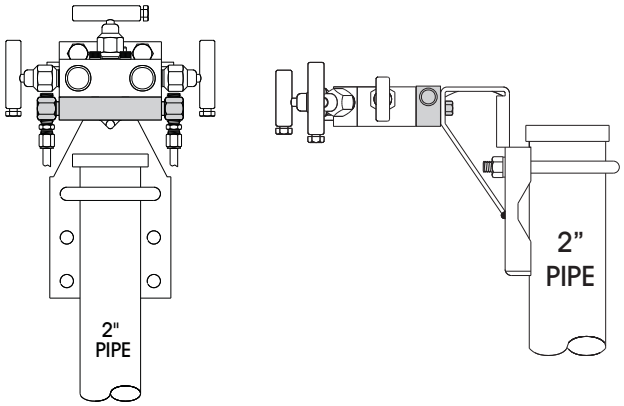
AK-085-C0: Coplanar™ Mounting Adapter Plate



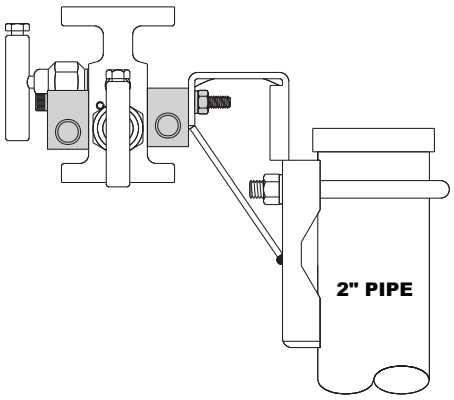
AK-032-_ _ - _ _: Manifold Dielectric Kits



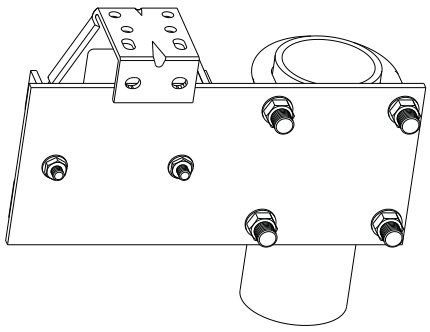
AK-_ _ _: Steam Trace Block



AK-_ _ _: Dual Steam Trace Block

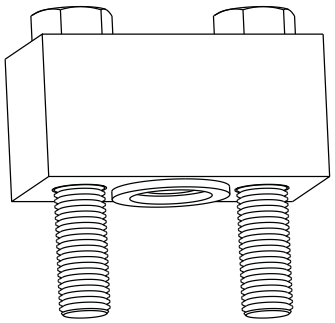


AK-099-10: Versa-Mount Side Adapter



This bracket allows the transmitter to be mounted off set to the mounting post.

AK-010-_ _: Flange Adapters



These adapters can be mounted on the process side of our flange to flange manifolds.

Accessories and Kits

Accessories

PART NUMBER	DESCRIPTION	MATERIAL
Flange Adapters, Brackets and Hex Nipples		
AK-010-10	Flange Adapter - Includes (2) ½" NPT Flange Adapters, (4) Bolts, (2) Teflon® Seals	Carbon Steel
AK-010-C0	Flange Adapter - Includes (2) ½" NPT Flange Adapters, (4) Bolts, (2) Teflon® Seals	316 SS
AK-034-10	Conduit / Purge Meter Bracket	Carbon Steel
AK-035-10	Dual Conduit / Purge Meter Bracket	Carbon Steel
AK-099-10	Versa-Mount with Side Adapter Kit	Carbon Steel
C4-008-10	½" NPT Concentric Hex Nipple - 3" Long	Carbon Steel
C4-008-C0	½" NPT Concentric Hex Nipple - 3" Long	316 SS
C4-009-10	½" NPT Eccentric Hex Nipple - 3" Long	Carbon Steel
C4-009-C0	½" NPT Eccentric Hex Nipple - 3" Long	316 SS
Manifold Mounting Brackets & Accessories		
AK-002-10	Versa-Mount Manifold Mounting Bracket **[VC Option Code]**	Carbon Steel
AK-002-C0	Versa-Mount Manifold Mounting Bracket **[VS Option Code]**	316 SS
AK-002-10-HD	Versa-Mount Manifold Mounting Bracket (Heavy-Duty) **[VCH Option Code]**	Carbon Steel
AK-002-C0-HD	Versa-Mount Manifold Mounting Bracket (Heavy-Duty) **[VSH Option Code]**	316 SS
AK-002-10-HDWL	Versa-Mount Manifold Mounting Bracket (Heavy-Duty) w/ 2 Mounting U-Bolts **[VCHWL Option Code]**	Carbon Steel
AK-085-C0	Coplanar™ Mounting Adapter Plate	316 SS
Steam Trace Block		
AK-006-10	Steam Trace Block for Conventional 3 Valve Manifolds **[TC Option Code]**	Carbon Steel
AK-006-C0	Steam Trace Block for Conventional 3 Valve Manifolds **[TS Option Code]**	316 SS
AK-007-10	Steam Trace Block for Conventional 2 and 5 Valve Manifolds **[TC Option Code]**	Carbon Steel
AK-007-C0	Steam Trace Block for Conventional 2 and 5 Valve Manifolds **[TS Option Code]**	316 SS
AK-110-C0	Steam Trace Block for M-616 Slim Body 2 Valve Pressure Manifold **[TS Option Code]**	316 SS
AK-111-C0	Steam Trace Block for MD804, MD808, MD810, MD812 & MD813 Coplanar™ Manifolds **[TS Option Code]**	316 SS
Pipe Plugs		
P6-024-10	½" NPT Allen Head	Carbon Steel
P6-024-C0	½" NPT Allen Head	316 SS
P6-024-K0	½" NPT Allen Head	Monel®
P6-036-10	¼" NPT Hex Head	Carbon Steel
P6-036-C0	¼" NPT Hex Head	316 SS
P6-062-10	½" NPT Hex Head	Carbon Steel
P6-062-C0	½" NPT Hex Head	316 SS

Kits

PART NUMBER	DESCRIPTION	MATERIAL
Manifold Flange Seal Kits		
P5-018-R0	Manifold Flange Seal	Teflon®
P5-018-R1	Manifold Flange Seal	Grafoil®
P5-027-R0	Manifold Flange Seal for M-660 Manifold	Teflon®
P5-027-R1	Manifold Flange Seal for M-660 Manifold	Grafoil®
P5-046-R0	Manifold Flange Seal when used with Dielectric Isolators	Teflon®
P5-075-R0	Viton® O-Ring Flange Seal	Viton®
Manifold Dielectric Kits (1 kit per Manifold)		
AK-032-C0	Dielectric Gasket / CS Bolts / 316 SS Washers / Bolt Sleeves	
AK-032-C0-W3	Dielectric Gasket / 300 SS Bolts / 316 SS Washers / Bolt Sleeves	
AK-032-C0-W9	Dielectric Gasket / 316 SS Bolts / 316 SS Washers / Bolt Sleeves	

.136" ORIFICE SEATS

PART NO.	DESCRIPTION
SP5-020-R0	Mini Teflon® Seat
SP5-020-R1	Mini Kel-F® Seat
SP5-020-R2	Mini Delrin® Seat
SP5-020-R3	Mini PEEK® Seat
SP7-024-C0	Wavey Washer
SP3-010-R3	Mini Pressure-Core™ Delrin® Seat
SP3-010-R2	Mini Pressure-Core™ Teflon® Seat
SP3-010-R4	Mini Pressure-Core™ PEEK® Seat
SP3-010-R9	Mini Pressure-Core™ Tefzel Seat

.136" ORIFICE HANDLES

PART NO.	DESCRIPTION
SAV-001-10	Round Handle - Carbon Steel
SAV-002-10	Bar Handle - Carbon Steel
SAV-002-A0	Bar Handle - Stainless Steel
SAV-003-R0	Round Handle - Plastic

.136" ORIFICE BONNET PACKING

PART NO.	DESCRIPTION
SP5-019-R0	Mini Packed Teflon® Seal
SP5-047-R0	Mini Packed Grafoil® Seal
SP7-025-C0	Stainless Steel Backup Washer

.136" ORIFICE BONNET ASSEMBLIES

PART NO.	DESCRIPTION
SAV106C-V	Carbon Steel with Viton® Packing
SAV106S-V	Stainless Steel with Viton® Packing
SAV107C-T	Carbon Steel with Packed Teflon®
SAV107S-T	Stainless Steel with Packed Teflon®
SAV117C-T-H3	Carbon Steel w/ Teflon® Mini Pressure-Core™
SAV117S-T-H4	Stainless Steel w/ Teflon® Mini Pressure-Core™
SAV117C-J-H3	Carbon Steel w/ Low-Temp Teflon® Mini Pressure-Core™
SAV117S-J-H4	Stainless Steel w/ Low-TempTeflon® Mini Pressure-Core™
SAV119C-V-H3	Carbon Steel w/ Viton® O-Ring
SAV119S-V-H4	Stainless Steel w/ Viton® O-Ring

.187" ORIFICE SEATS

PART NO.	DESCRIPTION
SP3-003-R1	Kel-F® Cone Seat
SP3-003-R2	PEEK® Cone Seat
SP3-003-R3	Teflon® Cone Seat
SP3-003-R4	Delrin® Cone Seat
SP3-003-R9	Tefzel Cone Seat

.187" ORIFICE BONNET ASSEMBLIES

PART NO.	STEM SEAL	SEAT	BONNET MATERIAL
SAV100CCV	Viton®	Carbide Ball	Carbon Steel
SAV100CCT	Teflon® Pressure-Core™		
SAV100CCJ	Low-Temp Teflon® Pressure-Core™		
SAV100SCV	Viton®	Carbide Ball	316 SS
SAV100SCT	Teflon® Pressure-Core™		
SAV100SCJ	Low-Temp Teflon® Pressure-Core™		
SAV144SCG-HH	Grafoil®		
SAV101C-V	Viton®	Soft Cone	Carbon Steel
SAV101C-T	Teflon® Pressure-Core™		
SAV101C-J	Low-Temp Teflon® Pressure-Core™		
SAV101S-V	Viton®	Soft Cone	316 SS
SAV101S-T	Teflon® Pressure-Core™		

.187" ORIFICE OS & Y BONNET ASSEMBLIES

PART NO.	STEM SEAL	SEAT	BONNET MATERIAL
SAV202SCG-HH	Grafoil® Packed	Carbide Ball	316 SS

.250" ORIFICE SEATS

PART NO.	DESCRIPTION
SP3-012-R4	Delrin® Cone Seat
SP3-012-R1	Kel-F® Cone Seat
SP3-012-R2	PEEK® Cone Seat

.250" ORIFICE PRESSURE-CORE™ BONNET ASSEMBLIES

PART NO.	STEM SEAL	SEAT	BONNET MATERIAL
SAV123C-T-HH	Teflon® Pressure-Core™	Soft Cone	Carbon Steel
SAV123C-J-HH	Low-Temp Teflon® Pressure-Core™		
SAV123S-T-HH	Teflon® Pressure-Core™	Soft Cone	316 SS
SAV123S-J-HH	Low-Temp Teflon® Pressure-Core™		

.375" ORIFICE SEATS

PART NO.	DESCRIPTION
SP3-007-R1	Kel-F® Cone Seat
SP3-007-R2	PEEK® Cone Seat
SP3-007-R3	Teflon® Cone Seat
SP3-007-R4	Delrin® Cone Seat
SP3-007-R8	Rylon® Cone Seat

.375" ORIFICE PRESSURE-CORE™ BONNET ASSEMBLIES

PART NO.	STEM SEAL	SEAT	BONNET MATERIAL
SAV300CCT-HH	Teflon® Pressure-Core™	Carbide Ball	Carbon Steel
SAV300CCJ-HH	Low-Temp Teflon® Pressure-Core™		
SAV300SCT-HH	Teflon® Pressure-Core™		316 SS
SAV300SCJ-HH	Low-Temp Teflon® Pressure-Core™		
SAV300C-T-HH	Teflon® Pressure-Core™	Soft Cone	Carbon Steel
SAV300C-J-HH	Low-Temp Teflon® Pressure-Core™		
SAV300S-T-HH	Teflon® Pressure-Core™		316 SS
SAV300S-J-HH	Low-Temp Teflon® Pressure-Core™		

.375" ORIFICE OS & Y BONNET ASSEMBLIES

PART NO.	STEM SEAL	SEAT	BONNET MATERIAL
SAV200SCG-HH	Grafoil® Packed	Carbide Ball	316 SS
SAV200S-G-HH	Grafoil® Packed	Cone Seat	316 SS

.375" ORIFICE PACKED STYLE BONNET ASSEMBLIES

PART NO.	STEM SEAL	SEAT	BONNET MATERIAL
SAV301SCG-HH	Grafoil® Packed	Carbide Ball	316 SS
SAV301S-G-HH	Grafoil® Packed	Cone Seat	316 SS

Note: Handle included in all Bonnet Assemblies.

Individual Bolt Chart

Individual Hex Head Bolt Part Number Chart

PART NUMBER	BOLT LENGTH	MATERIAL 7/16-20 THREAD	OPTION CODE	PART NUMBER	BOLT LENGTH	MATERIAL 7/16-20 THREAD	OPTION CODE
P6-057-10	3/4"	CS	WV	P6-086-10	3"	CS	WF
P6-057-A0		300 SS		P6-086-A0		300 SS	
P6-057-C0		316 SS		P6-086-C0		316 SS	
P6-067-10	1"	CS	WG	P6-089-10	3-1/4"	CS	WJ
P6-067-A0		300 SS		P6-089-A0		300 SS	
P6-067-C0		316 SS		P6-089-C0		316 SS	
P6-073-10	1-1/4"	CS	W7	P6-107-10	3-1/2"	CS	WQ
P6-073-A0		300 SS		P6-107-A0		300 SS	
P6-073-C0		316 SS		P6-107-C0		316 SS	
P6-058-10	1-1/2"	CS	WB	P6-149-10	3-3/4"	CS	WS
P6-058-A0		300 SS		P6-149-A0		300 SS	
P6-058-C0		316 SS		P6-149-C0		316 SS	
P6-028-10	1-3/4"	CS	WH	P6-108-10	4"	CS	WN
P6-028-A0		300 SS		P6-108-A0		300 SS	
P6-028-C0		316 SS		P6-108-C0		316 SS	
P6-061-10	2"	CS	WC	P6-102-10	4-1/4"	CS	WP
P6-061-A0		300 SS		P6-102-A0		300 SS	
P6-061-C0		316 SS		P6-102-C0		316 SS	
P6-029-10	2-1/4"	CS	WA	P6-109-10	4-1/2"	CS	WR
P6-029-A0		300 SS		P6-109-A0		300 SS	
P6-029-C0		316 SS		P6-109-C0		316 SS	
P6-080-10	2-1/2"	CS	WE	P6-197-10	4-3/4"	CS	WT
P6-080-A0		300 SS		P6-197-A0		300 SS	
P6-080-C0		316 SS		P6-197-C0		316 SS	
P6-038-10	2-3/4"	CS	WD	P6-002-10	5-1/4"	CS	WU
P6-038-A0		300 SS		P6-002-A0		300 SS	
P6-038-C0		316 SS		P6-002-C0		316 SS	

Hex Head Bolt Washers

PART NUMBER	DESCRIPTION
P6-090-A0	316 SS Bolt Washer (For Slotted Flange Manifolds)
P6-090-10	Carbon Steel Bolt Washer (For Slotted Flange Manifolds)

"MD" Coplanar™ Manifolds Individual Allen Head Bolt Part Number

PART NUMBER	DESCRIPTION
P6-145-10	7/16-20 x 1-3/4" MD Manifolds (1.3 Centers) - Carbon Steel
P6-145-A0	7/16-20 x 1-3/4" MD Manifolds (1.3 Centers) - 300 SS
P6-145-C0	7/16-20 x 1-3/4" MD Manifolds (1.3 Centers) - 316 SS

Warranty, Sales Policy, Special Orders and Oxygen & Chlorine Service

Product Warranty

PGI International warrants its products to be free from defects in material and/or workmanship for a period of one year from date of shipment. This guarantee is valid only if such products have been used in normal applications consistent with our recommendations. Our liability is limited to repair or replacement and no responsibility is assumed for consequential damage or expense. Any controversy arising out of the sale of PGI International products shall be determined in accordance with laws of the State of Texas.

PGI International reserves the right to change materials, specifications or designs without notice. PGI International will not be obligated to install or furnish such changes on products previously or subsequently sold.

Teflon® Pressure-Core® Stem Seal Warranty

After years of field experience and over one million valves in service, PGI International takes great pride in extending a five year limited warranty on our patented Teflon® Pressure-Core® Stem Seal System. The warranty period starts at date of purchase and extends for five full years. If within this period the Pressure-Core® Stem Seal develops a leak, PGI will provide a new bonnet and stem assembly at no cost.

PGI International will assume no consequential damages or liabilities connected with this warranty. The warranty is void if the valves have not been used in accordance with the stamped pressure / temperature ratings or if the bonnet assembly has been disassembled. The Teflon® Pressure-Core® Stem Seal is factory assembled and cannot be disassembled or inspected without damaging the seal.

Sales Policy

Our products are sold through authorized manufacturer representatives or direct from our factory sales office. All orders are subject to acceptance by PGI International, headquarters located in Houston, Texas (U.S.A.). Prices are subject to change without notice and any errors in published prices are subject to correction. No materials may be returned for credit without written authorization from our Houston office. In issuing credit for returned material, we reserve the right to direct deduct a reconditioning and handling charge. Special items, not conforming to our standard line, will not be accepted for credit.

Special Orders

PGI International has been a custom manufacturer of valve components since 1941. PGI invites inquiries for special variations on our line of valves and will work with you to solve your specific application problems.

Oxygen & Chlorine Service

To insure the quality, safety and cleanliness levels of our products, PGI International has a verifiable, environmentally controlled system of precision cleaning for Oxygen and Chlorine Service.

- Parts are cleaned with an approved liquid cleaner in an ultrasonic vibrator.
- Inspection of parts is done with an Ultraviolet light to detect contaminants such as hydrocarbons and minute particles that are not visible to the naked eye.
- Each part is tagged and heat-sealed in a double bag to prevent contamination in transit.
- **Upon completion of cleaning process, Carbon Steel Manifolds discolor to a silver-greenish sheen. This does not affect manifold performance in any way.**

INSTRUMENTATION PRODUCTS

- Instrument Valves & Manifolds
- Power and Steam Plant Valves & Manifolds
- Purge Adapters for the Process Industry

SPECIALIZED SYSTEMS

- Gas & Liquid Sampling Systems
- Natural Gas Sampling System Heated Enclosures
- Sample Cylinders and Accessories

MEASUREMENT ACCURACY PRODUCTS

- ThermoSync® Thermowells & Temperature Probes
- Direct-Mount® Systems
- Square Root Error (SRE) & Gauge Line Error (GLE) Indicators

ZEUS® POWER SYSTEMS

- TEC™ ThermoElectric Battery Chargers
- DB1™ Differential Pressure Battery Chargers

ADDITIONAL PGI DIVISION PRODUCTS & SERVICES

- Valve Fittings & Wellhead Components
- Propane and Anhydrous Ammonia Valves
- Contract Machining



QUALITY SYSTEM CERTIFICATION ISO 9001:2008 DNV

Parker

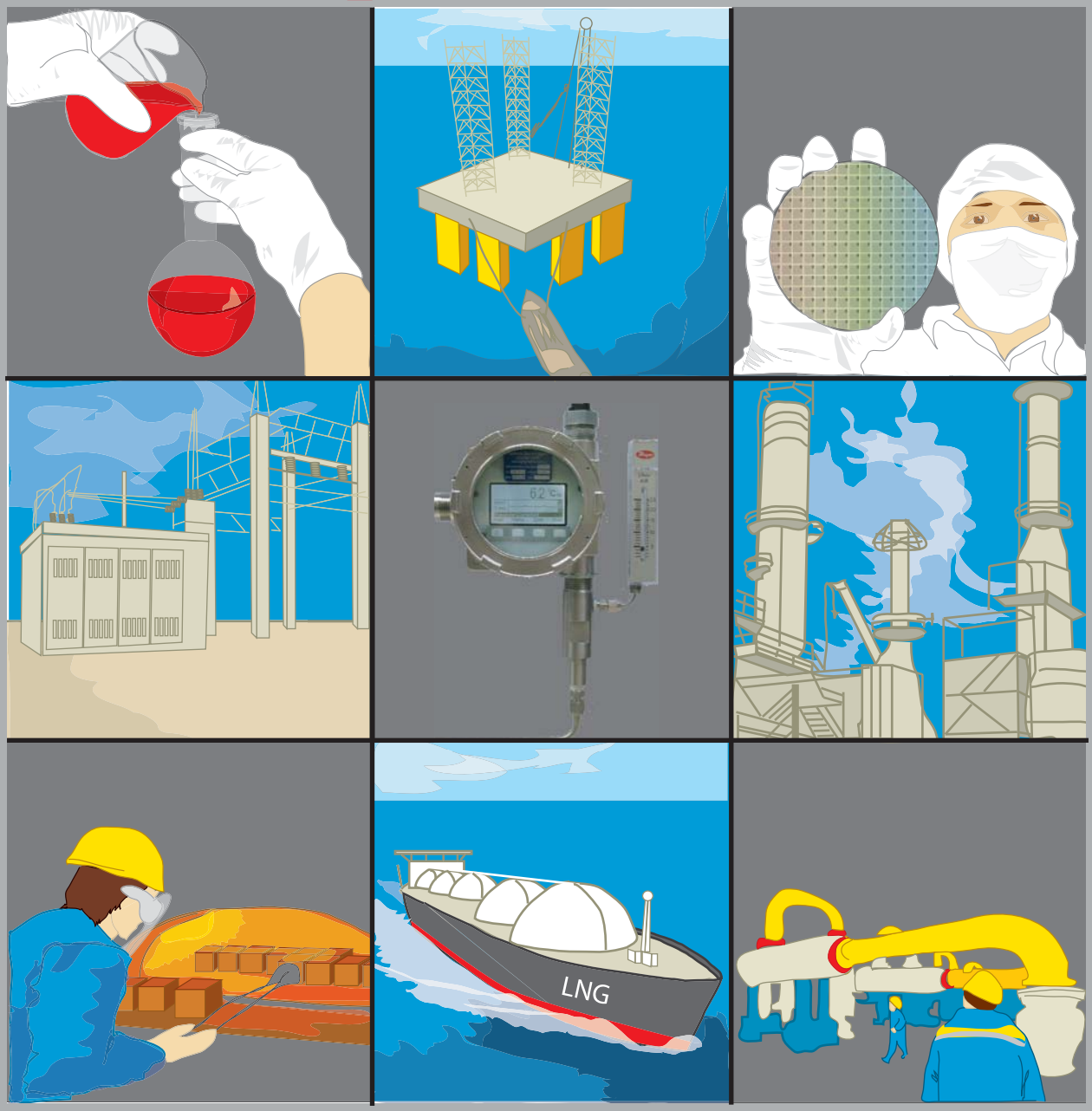
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PhyMetrix®



PhyMetrix Explosion proof Moisture analyzer Model ExMa User's Manual

www.Phymetrix.com

Read this manual before using the analyzer. For personal and system safety, and for optimum product performance, make sure you thoroughly understand the contents before installing, using, or maintaining this analyzer.

Please visit our website at www.phymetrix.com for other products that may be applicable to your needs.

Every effort has been made to ensure accuracy in the contents of this manual. Should there be any doubts to the accuracy of the content please contact the manufacturer.
The contents of this manual are subject to change without notice.

The instructions, procedures, drawings, specifications and concepts contained in this manual are the property of Phymetrix Inc., and shall not be used as the basis for the manufacture or sale of apparatus or services, or reproduced or copied or transmitted in any form or by any means without written permission.

Warranty

This instrument is warranted, to the original end-user purchaser, against defects in materials and workmanship. Liability under this warranty is limited to restoring the instrument to normal operation or replacing the analyzer, at the sole discretion of the manufacturer. Batteries are specifically excluded from any liability. This warranty is effective from the date of delivery to the original purchaser. If Phymetrix determines that the equipment was defective, the warranty period is:

- one year from delivery for electronic or mechanical failures
- one year from delivery for sensor shelf life

If Phymetrix determines that the equipment was damaged by misuse, improper installation, the use of unauthorized replacement parts, or operating conditions outside the guidelines specified, the repairs are not covered under this warranty.

Normal wear and tear, parts damaged by abuse, misuse, negligence or accidents are specifically excluded from the warranty.

Purchaser acknowledges that in accepting and using this analyzer, notwithstanding any contrary term or provision in the purchaser's purchase order or otherwise, the only warranty extended by Phymetrix is the express warranty contained herein. Purchaser further acknowledges that there are no other warranties expressed or implied, including without limitation, the warranty of merchantability or fitness for a particular purpose; that there are no warranties which extend beyond the description of the face hereof; that no oral warranties, representations, or guarantees of any kind have been made by Phymetrix, its distributors or the agents of either of them, that in any way alter the terms of this warranty; that Phymetrix and its distributors shall in no event be liable for any consequential or incidental damages, including but not limited to injury to the person or property of the purchaser or others, and from other losses or expenses incurred by the purchaser arising from the use, operation, storage or maintenance of the product covered by the warranty; that Phymetrix’s liability under this warranty is restricted to repair or replacement of defective parts at Phymetrix sole option; and that Phymetrix neither assumes nor authorizes any other person to assume for it any other warranty. The warranty shall be void if serial numbers affixed to the products are removed, obliterated or defaced.

Return Policy / Procedures
If equipment malfunction is suspected or it is determined that the analyzer needs recalibration, please contact Phymetrix.
Communicate the instrument model number, serial number, application including dewpoint range being measured, and the details of the problem.
If the analyzer needs factory service you will be issued a RMA and shipping instructions.

The factory will diagnose the equipment and upon determining the problem will notify you whether the terms of the warranty cover the required repair. If the costs are not covered you will need to approve the estimated cost in order to proceed with the repair.

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1 Introduction

Thank you for purchasing the state-of-the-art Phymetrix Explosion proof Moisture Analyzer model *ExMa*. This User's Manual describes the functions of this analyzer as well as the operating methods and handling precautions. There are also some sections that review general knowledge and concepts of water vapor science. Read this manual thoroughly before using the analyzer. There is a Quick Setup Manual describing the main functions and basic procedures for performing measuring operations. Check our website "www.phymetrix.com" for latest versions of documentation regarding these analyzers.
After reading this manual, keep it easily accessible for future reference. It may come in handy when there are some challenging measurements to be performed.
Conventions used in this manual:

- When using the word "*system*" in this manual we are referring to the user's system in which the moisture content is being measured. This could be a simple configuration of a pressurized gas bottle with a pressure regulator, or a complex system of dryers, filters, regulators, long tubing, valves etc.
- When referring to text that is displayed on the analyzer screen, it is presented in this manual using a font that makes it **stand out**.

The analyzer part number is displayed upon power-up and in the *About* screen, the dash numbers following the main part number signify options as follows:
-I for Explosion Proof certification, **-P** for internal pressure sensor,
-A for analog output 4/20mA, **-R** for Alarm Relays.

Check to see that your analyzer has arrived intact with all accessories that were ordered.



Model: ExMa shown with *optional* filter pressure regulator and exhaust flow meter

Save the packing materials until you have verified that there is no concealed damage, it may also be useful for future transportation.

2 Important Principles of Operation

2.1 Sensor Operating Principle

The nanopore sensor utilized in this analyzer measures the amount of water vapor molecules that have entered its pores. This amount is directly proportional to the partial water vapor pressure in the gas surrounding the sensor, and the partial water vapor pressure is dependant on the water vapor content of the gas and the total pressure of the gas. Thus to compute the water vapor content of the gas under measurement the analyzer has to “know” the total pressure of the gas. If the analyzer was purchased with the pressure sensor option then the total pressure is measured and utilized by the analyzer, if there is no built-in pressure sensor then the user should enter the total pressure into the analyzer, this can be easily done by entering atmospheric pressure (the analyzer default setting) and measuring at atmospheric pressure by allowing the outlet (exhaust) port to vent without restrictions.

2.2 Sampling Mechanism Operating Principle

The analyzer is equipped with a built-in sampling system which has the required tight seals to measure low moisture content; it consists of a stainless steel 100 micron filter and a flow control orifice, which may be placed at either the inlet(factory default) or outlet of the sampling cell or removed. The gas under measurement is exposed only to the stainless steel walls of the sampling system.

3 ⚠ Precautions ⚠

- Observe the appropriate electrical safety codes and regulations. Consult with National Electrical Code, and/or other nationally or locally recognized procedures relevant to your location.
- When measuring flammable, explosive or toxic gasses; vent the sample outlet to a safe and appropriate location.
- When measuring high pressure samples (do not exceed 5000 psia); be sure that the system is depressurized before connecting or disconnecting the sample tubing.
- Corrosives such as Ammonia, HCl and Chlorine should be avoided; H_2S and SO_2 can be present if the moisture content is below 10 PPMv.
- Avoid extreme temperatures, pressures and mechanical vibration, refer to specifications.
- Do not disassemble the analyzer.
- Do not use with contaminants and liquids, refer to section 5.2 for sample conditioning.
- Avoid exposing the sensor to ambient air as it may slowdown your next measurement.
- The ExMa is weatherproof as long as the cover is tightly closed, and the conduit ports are appropriately sealed.
- Designs with circuitry activated by relay contacts should consider noise from contact bounce, an option for debouncing is placing an appropriately rated capacitor across the relay contacts.

4 Moisture System Considerations

This section is offered as background information. There are several considerations in keeping your system at a stable and pure moisture level, free of contamination from ambient air moisture:

- The integrity of the materials isolating the pure gas from the external air, including leaks from poorly secured fittings.
- The back diffusion of moisture through the exhaust outlet, the exhausts of both the analyzer and the user system under measurement should be considered.
- The effects of temperature on the equilibrium of moisture and the surrounding materials, often observed as diurnal cycles in the measurement.

4.1 Integrity of the Materials of the User's System

Before considering the materials of a system where a specified dewpoint level must be maintained, one should review two concepts.

- Compared to the structure of solids the water molecule is much smaller. This is true compared to even the crystalline structure of metals but especially important in the polymer structure of plastics.
- Water vapor pressure in gasses obeys Dalton's law of partial pressures, which states that the overall pressure of a gas is the sum of its constituent gases. And each gas seeks to equilibrate its pressure across gradients of only its own gas pressure.

Let's consider air in a pipe at a total pressure of 100 psia, which has been dried down to -40°C dewpoint. The partial water vapor pressure in the pipe is 0.13mB. If the ambient temperature is 22°C with relative humidity of 30%, then the partial water vapor pressure in the surrounding atmosphere is 7.9mB or approximately 60 times greater than the partial water vapor pressure in the pipe. Thus even though the total pressure in the pipe is much greater that the pressure outside, the reverse is true for the water vapor pressure, and as we discussed earlier the water vapor seeks to equilibrate its pressure thus it "wants" to flow from the outside to the inside and will do so through the cracks in the joints (such as poorly tightened fittings, or NPT threads even if they are properly taped), as well as through the walls of pipes tubes and other vessels. The integrity of the system is extremely important in maintaining a stable low dewpoint; for dewpoints below -60°C always use stainless steel or PTFE, while for higher dewpoints you can use copper or galvanized steel; but never use rubber, Tygon, Nylon or other plastic tubing. Pressure regulators often use rubber diaphragms, check and if necessary replace with a stainless steel diaphragm regulator. Filter bowls should be stainless steel or glass, plastic bowls should be avoided. If a flow meter is placed at the inlet of the analyzer it should have a glass tube and be rated for the expected pressure levels, however in general it is best to place flow meters at the analyzer exhaust. Another material consideration relates to materials sealed in the system such as paper filters; these may not contribute to leaks but will greatly slow down the measurement because they will adsorb and desorb water molecules as the system dewpoint is changing.

4.2 Moisture Back Diffusion (backflow) Along the Walls of the Exhaust Tubing

The linear velocity of gas flowing in a tube is close to zero immediately along the wall of the tube. This coupled with the previously discussed "need" for the moisture to flow from the higher water vapor pressure to the lower one, allows for water molecules to flow against the total flow through the exhaust outlet into the sampling chamber of the analyzer. The fact that water

molecules are highly polar further enhances their ability to migrate against the gas flow at the sampling chamber outlet. To prevent this backflow of moisture from influencing the measurement, the analyzer should have at least 12” in length of 1/8” dia. stainless steel tubing at its exhaust port, and a minimum flow of 2 SCFH (1 SLPM) should be maintained; higher flows will produce faster equilibrium time and thus are desirable for quick measuring. A small pigtail (coiled 1/8” dia. ss. tubing 12” long) can be connected to the exhaust port of the analyzer. The short tube with attached flow meter also provides protection from back diffusion of moisture.

4.3 Temperature Dependant Equilibrium

The effect of ambient temperature on the gas partial water vapor pressure of a system can change the moisture content of the gas. This is not the temperature sensitivity of the measuring analyzer, rather the actual change of partial water vapor pressure in the user’s system due to increase in ambient temperature and thus the increase of energy of the water molecules on and in the walls of the system (tubing, vessels etc…). A typical example would be the observation of a daily cycling of the measurement in a system with tubing or other components exposed to direct sunlight. During the day as the sun transfers energy into the system, the dewpoint will appear to increase, while at night the dewpoint will appear to decrease. There may be other reasons for this daily dewpoint cycling such as the effect of sun/temperature on the efficiency of gas dryers etc. It is possible to minimize this effect using sun shields and tubing insulators. Alternatively one may study the response of the particular system to ambient temperature, by logging data over several days during different seasons, and compensating the measurements for this effect. The temperature effect will vary greatly depending on the size and materials of the system, for example stainless steel walls will have a much smaller effect than brass or copper walls.

5 Sampling Techniques

The amount of moisture measured will be influenced by the system moisture content as well as leaks in the system and transient effects of adsorption / desorption from materials in the system (as described in the previous sections).

5.1 Choosing a Measurement Site

The ExMa has been designed to perform extractive measurements. It is important to choose an appropriate sampling location that is representative of the moisture content of the system of interest.

5.2 Sample Conditioning

Particulate and liquid contaminants can effect the measurement, especially the response time. Sample conditioning may be necessary to remove contaminants and improve the measurement and the longevity of the sensor. Make sure that sample conditioning components are made of suitable materials. Avoid paper or other fiber filter elements, use stainless steel instead. For expected dewpoints below -50°Cdp (39 PPMv), avoid plastic filter bowls, use stainless steel or glass instead. Drain trapped liquids from filter bowls.

If the application is suspect of possible presence of liquids for example:
• Compressed air with possible oil and/or water,
• Gas Insulated Switchgear or Transformer, SF_6 or N_2 blanket with suspected oil carryover,
• Natural Gas with possible Triethylene Glycol carryover,
Consult with Phymetrix for specialized sampling systems.

5.3 Tubing and Fittings

Make sure all tubing is constructed of materials suitable for low dewpoint measurement, i.e. stainless steel or Teflon, do not use rubber or plastic tubing (refer to section 4.1 for more details). Check for leaks after connecting.
Flow meters can be a source of moisture ingress especially if they have a plastic flow tube; ensure flow meters are connected at the analyzer exhaust, not at inlet. However metering valves should be at the inlet in order to maintain constant atmospheric pressure in the sampling chamber.

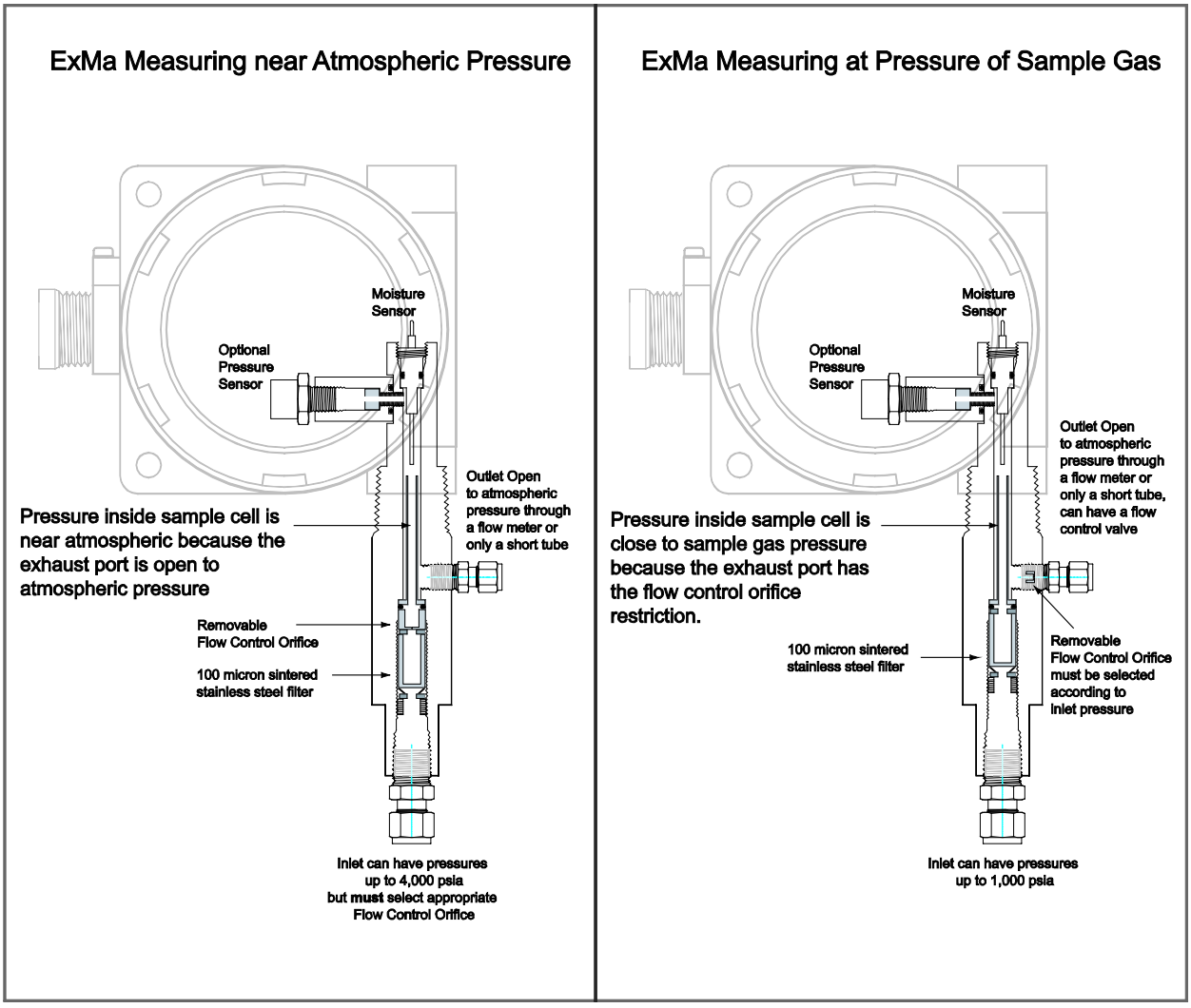
5.4 Sample Pressure

Pressure variations will effect the measurement. Higher pressure is more likely to produce condensation and thus erroneous readings or even damage the sensor. If the sample pressure needs to be reduced use a suitable pressure dropping device such as a stainless steel needle valve or pressure regulator with a stainless steel diaphragm or a flow control orifice. Make sure Joule-Thomson effects do not cool the gas below hydrocarbon and water dewpoints.

5.5 Pressure Considerations

When sampling gases from sources above 50 psia the user needs to exercise some caution.

The model **ExMa** has a built-in orifice. This orifice can be used to regulate the flow from various pressures.



• The sample cell has a built-in filter and flow control orifice at the inlet.
• On Request the orifice can be moved to the outlet to perform measurements at pressure.

The inlet orifice eliminates the need for any pressure regulators while maintaining sufficient but not excessive flows throughout the pressure rating of the analyzer.

For example 0.004” to 0.016” dia. orifices, produces flows described in the following table.

source pressure psia - (Bar)	flow SLPM 0.016” orifice	flow SLPM 0.012” orifice)	flow SLPM 0.008” orifice	flow SLPM 0.006” orifice	flow SLPM 0.004” orifice
15 - (1.03)	0.7	0.4	0.17	0.08	0.04
25 - (1.72)	2	1.3	0.6	0.3	0.1
35 - (2.4)	3	1.9	0.8	0.5	0.2
55 - (3.8)	4.8	3.0	1.4	0.7	0.3
75 - (5.2)	6.6	4.1	1.9	1.0	0.4
100 - (6.9)	8.9	5.5	2.6	1.4	0.6
150 - (10.3)	13.4	8.3	3.8	2.1	0.9
200 - (13.8)	17.9	11.0	5.1	2.7	1.1
300 - (20.7)	26.8	16.6	7.7	4.1	1.7
400 - (27.6)	35.7	22.1	10.3	5.5	2.3
500 - (34.5)	44.7	27.6	12.8	6.9	2.9
600 - (41.4)	53.6	33.1	15.4	8.2	3.4
700 - (48.3)	62.5	38.7	18.0	9.6	4.0
800 - (55.1)	71.5	44.2	20.5	11.0	4.6
900 - (62)	80.4	49.7	23.1	12.4	5.1
1000 - (68.9)	89.3	55.2	25.7	13.7	5.7
1500 - (103.4)	134.0	82.8	38.5	20.6	8.6
2000 - (137.9)	178.7	110.5	51.3	27.5	11.4

The grayed boxes are preferred operating points. Other orifices can be provided to accommodate different pressures and flows. Consult PhyMetrix support for its proper sizing.

Measuring with the ExMa, Near Atmospheric Pressure

It is recommended for most applications to perform the measurement at near atmospheric pressure. Placing the flow control orifice at the inlet and allowing the outlet to be unrestricted (other than the exhaust pigtail and flow meter), assures that the analyzer has sufficient but not excessive flow and the pressure inside the sampling chamber is near atmospheric. This approach guarantees safe conditions and eliminates the need for the optional pressure sensor. If there is no pressure sensor the analyzer can be set with atmospheric pressure 14.7psia for the **Mea. at** setting of the pressure correction (refer to section 8.3), the orifice and unrestricted outlet will guarantee repeatable conditions for all pressures within the rating of the orifice.

Measuring with the ExMa, at Pressure of Sample

If it is desired to perform the measurement at the same pressure as the sample, up to the rating of the analyzer (5000 psia standard), then place the orifice at the outlet.

The analyzer is now setup with the orifice at the outlet, thus the measuring chamber will be pressurized to the same pressure as your sample. To perform accurate measurements, you must know the pressure and enter it into the analyzer, or order the optional built-in pressure sensor which will perform the measurement and correction automatically.

6 Installation

6.1 Mechanical Installation

The ExMa can be mounted directly on the pipe or can be mounted on a panel surface and connected with tubing. Refer to Appendix A ExMa Installation Drawing.
Connections for inlet and outlet of the gas being measured are made through a variety of available options e.g. ⅛" or ¼" Swagelok® tubing compression fittings.
Refer to Mechanical Installation Drawing Appendix A.

6.2 Electrical Connections: Power, 4/20mA Analog Output, Serial I/O

6.2.1 Powering the ExMa

The ExMa has two (2) standard modes of being powered.

1) **AC powered** from 90-260 VAC 47-440 Hz
2) **DC powered** from a 12 – 24 VDC 10VA power supply

Optionally the ExMa can be ordered to also operate in **4/20mA Loop Powered** mode.

Refer to the **ExMa Electrical Connection** diagram in Appendix B for the various power modes and the specific wiring for each mode.

6.2.2 Analog Output 4/20mA

The ExMa has an isolated 4/20mA output, which may be connected as a sink in configurations where the power is provided externally, or if the ExMa is actively powered (modes 1&2) the 4/20mA can be configured to source the current.
Refer to the **ExMa Electrical Connection** diagram in Appendix B for the 4/20mA configurations and specific wiring for each.
The ExMa status bar will have an **Analog Output Loop Open** message if the 4/20mA output is not connected. The user menus allow the user to force the 4/20mA output to known values for purposes of testing and calibrating the 4/20mA interface, refer to section 8.5.

6.2.3 ExMa HART interface

The ExMa is equipped with a HART interface which overlays digital signals on the 4-20mA loop current. Thus the ExMa can be used in any 4-20mA loop and can simultaneously communicate digitally on the same two wires.
The ExMa responds to all of the HART Universal (Common Practice) Commands as well as some important setup and configuration commands.

When wiring the ExMa for use with HART make sure that there is sufficient resistance between the power supply and the ExMa 4/20 interface. Usually there is a 250 Ohm resistor used for sensing the current this is adequate to provide the proper impedance isolation for HART modems to operate properly.

HART Commands Implemented in the ExMa

HART Command		Description	
#	**Name**		
0	Read Unique Identifier	Read Device identification such as address, manufacturer, revision level etc.	
1	Read Primary Variable	Read the measurement of the Primary Variable (P.V.)	
2	Read Current and % of range	Read the current that is produced by the Primary Variable and the percent of range it represents. These depend on the command #51 measurement assigned to the P.V., the value of that measurement and the assignments of command #35.	
3	Read Dynamic Variables and P.V. current	Read the measurements of up to 4 measurement variables as assigned by command # 51.	
6	Write Polling Address	Assign a polling address to a device. An address (1-15) puts the device in fixed 4mA mode for multidrop connectivity. Address 0 puts the device in 4/20mA mode.	
11	Read Unique Identifier Associated with Tag	Find device that has the desired textual Tag assigned by command # 18.	
12	Read Message	Read information written by command # 17.	
13	Read Tag, Descriptor and Date	Read information written by command # 18.	
14	Read P.V. Sensor Information	Information on primary sensor Serial Number, range etc.	
15	Read P.V. Output Setup	Analog output range, alarms etc.	
16	Read Final Assembly Number	Read number written by command # 19.	
17	Write Message	For use by owner/operator to identify the device and its use.	
18	Write Tag, Descriptor and Date	For use by owner/operator to identify the device and its use. Can search for the Tag, with command # 11, on multidrop connections.	
19	Write Final Assembly Number	For use by owner/operator to identify the device and its use.	
35	Write Primary Variable Range Values	Setup the measurement units and values that correspond to 4mA and 20mA output of the loop.	
40	Analog Out Fixed	Forces the Analog Output DAC to a specified value.	
44	Write Primary Variable Units	Select the units of measure for the Primary Variable.	
45	Trim DAC Zero	Trims the DAC Zero by difference of Cmnd. #40 and observed value.	
46	Trim DAC Gain	Trims the DAC Gain by ratio of Cmnd. #40 and observed value.	
50	Read Dynamic Variable Assignments	Read the assignments of command # 51.	Measurement Variables and [available units]: 00 – Moisture Measurement °C & °F dewpoint, ppmV, mB H_2O vapor pressure, grams of H_2O / m^3 and Lbs H_2O /10^6 standard cubic feet in Natural Gas 01 – Temperature of Gas [°C, °F] 02 – Temperature of Board [°C, °F] 03 – Pressure [psi, bar, mbar, kg/sqcm, pascal …] 08 – Loop Voltage [mV] 09 – Status Bits
51	Write Dynamic Variable Assignments	Assign Measurement Variables to each of the four primary variables reported by the analyzer by command # 3.	
53	Write Transmitter Variable Units	Select Units of measure for each of the Variables.	
108	Write Burst Command Number	Select command number to burst.	
109	Burst Mode Control	Enable/Disable burst (continuous) transmissions.	

A free of charge program may be downloaded from our website www.phymetrix.com that allows communicating with the ExMa HART interface.

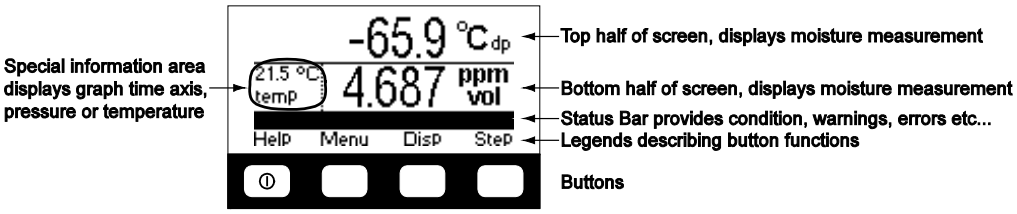
The ExMa HART interface Address is the Instrument Serial Number which can be seen in the About menu. The ExMa can be set up to operate in HART polling mode by selecting a polling address 1-15 in the **HART** user interface menu, in this mode multiple (up to 15) ExMa's or other HART devices can communicate on the same loop but each device consumes only 4mA.

6.2.4 Serial I/O RS485/RS-422

The ExMa can optionally provide a RS-485/422 interface in power modes 1 and 2. Refer to the ExMa Electrical Connection diagram in Appendix B for connections. The default communication port settings are 19200, E, 7, 2; however they can be modified in the **COMs** user interface menu.

7 User Interface Overview

The analyzer user interface consists of a backlit graphic LCD display, an audio sounder and four touch areas on the glass cover of the explosion proof enclosure. These touch areas provide the button functions which are dependant on the required selection choices, thus appropriate legends appear on the display immediately above the touch areas. For ease of discussion we will refer to these touch areas as "buttons" in the rest of the user's manual. To "press" a button, the user must touch the appropriate ***metal colored oval area*** on the glass with a finger. It may be necessary to press the finger firmly on the glass to get a wide contact area. When a button is activated a small light will be illuminated immediately above the touch area.



Note: A personal computer Virtual Analyzer program is available on our website (www.phymetrix.com) allowing the user to familiarize themselves with the user interface and train on its operation.

Note that the analyzer distinguishes between long and short presses of the glass touch areas (buttons). Normally to operate the analyzer one must perform short presses (less than 1 second), the button must be released after the beep.

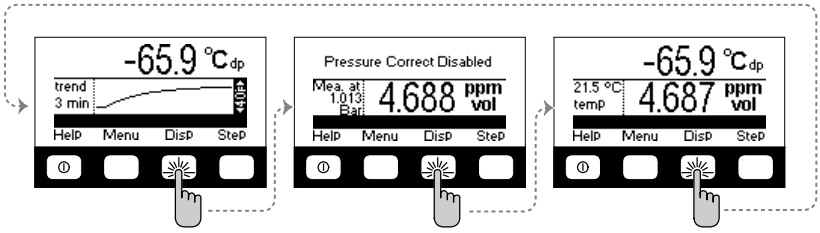
8 Operating the Analyzer

Performing measurements with the analyzer is a simple process:

- Connect the sample gas to the analyzer (refer to section 5.2 and section 6.1)
- Connect Power and Signals to the analyzer (refer to section 6.2)
- If possible adjust the flow of the gas to be greater than 1 LPM (2 SCFH)
- Select the graphing display mode
- Observe the reading once the graph is stable
- Change the display mode if desired

8.1 The Display Mode

Once powered, the analyzer will enter one of three display modes (whichever was last used) that show the measurements performed by the analyzer. Pressing the **Disp** button will change the display mode. Use the mode best suited for your application.



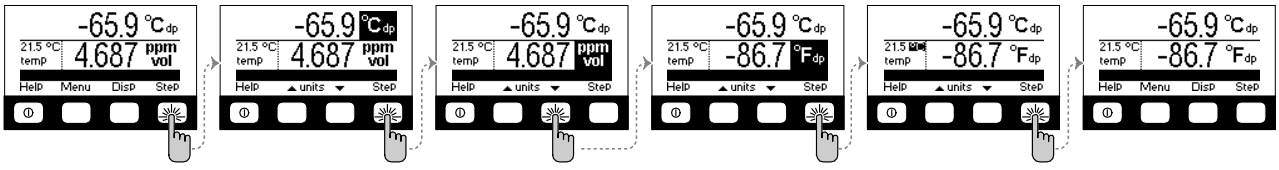
- Dewpoint Units and Graph of the measured dewpoint in the last 90 minutes is displayed. The graph span (Y-axis above shown 40°Fdp) will automatically resize to accommodate the minimum and maximum measurements in the last 90 minutes. Select between 90 or 3 minute time axis by choosing *Continuous* or *Spot* measurement modes in the **Mode Of Use** option available in **MENU-2**.
- Pressure corrected and at pressure measurements, as well as the gas pressure in the sampling chamber is displayed. The pressure correction selection in this display mode will be also utilized in the other two display modes. If pressure correction is enabled, then the status bar will provide an indication in all three display modes, so that the user is made aware that the displayed measurement is pressure corrected. In the example shown above, the pressure correction is disabled.
- Dual Dewpoint Units and Temperature of gas under measurement is displayed. Allows the user to view the measurement in two different units as well as the temperature in the sampling chamber. In the right most screen in the example above the moisture content is being viewed in °C and in ppm by volume, while the temperature is displayed to be 21.5°C.

8.2 Units to Display the Measurement

Measuring water vapor content in gasses presents many challenges not the least of which is understanding the units of measuring. Different industries require different units of measure for various reasons some technical some historical. The units typically used are in several categories:

a) The ratio of the volume occupied by the water vapor to the volume occupied by the other gasses in the mixture. These measurements are expressed in Parts Per Million by volume **PPMv**, or Parts Per Billion by volume **PPBv**, or Volume Concentration %.
b) The ratio of the weight of the water vapor to the weight of the other gasses in the mixture. These measurements are usually expressed in Parts Per Million by weight **PPMw**.
c) The density of water vapor in the mixture of gasses, is the ratio of the weight of the water vapor to the volume occupied (at atmospheric pressure) by the total mixture of gasses. These measurements are expressed in grams per cubic meter (**g/m^3**), or pounds of water per million standard cubic feet (**$LbsH_2O/MMSCF$**).
d) The partial vapor pressure of water vapor – the pressure exerted by the water vapor only, without considering the other gasses in the mixture. These measurements are expressed in units of pressure such a **microBar**, mmHg, or any other pressure units that may be convenient.
e) The dewpoint of the gas mixture - the temperature at which the water vapor in the gas is saturated. This means that if the gas temperature was above the dewpoint temperature and contained water only in vapor form, then if the gas is cooled, when it reaches the dewpoint temperature the water vapor will just start to form condensation. Dewpoint measurements are expressed in units of temperature such as **°C** or **°F**.
There are other measurement categories for expressing water vapor content in gasses however they are not central in the context of this analyzer, and are listed for completeness: Relative Humidity, Mixing Ratio, Absolute Humidity, Humid Volume of Air, Weight concentration %, Delta Dewpoint. Freeware programs compatible with Microsoft® Windows, as well as with Apple and Android smart-phones, are available for downloading at www.phymetrix.com facilitating easy conversions between the above categories of units of measure.
In this analyzer, moisture content of the gas being measured can be displayed in a variety of units: °C & °F dewpoint, ppmV, ppmW, µB H_2O vapor pressure, grams of H_2O / m^3, and Lbs H_2O /10^6 standard cubic feet in Natural Gas. Use the **Step** button (right most) to highlight the units of the measurement and use the ▲ and ▼ buttons to change the units to the desired values. If the instrument is unlocked then the unit changes will be permanent even after the analyzer is powered OFF.

The following diagram depicts the button presses required to change the units in which the measurement is displayed on the bottom half of the screen from ppmV to °F.



Similarly the units for the top half of the screen or the temperature can be changed.
If the instrument is locked then the change will last for 5 seconds so the newly selected units can be viewed, then the selection will revert to the original units. The status bar will indicate **Locked-change is temporary** and will produce beeping sounds.

8.3 Pressure Correction

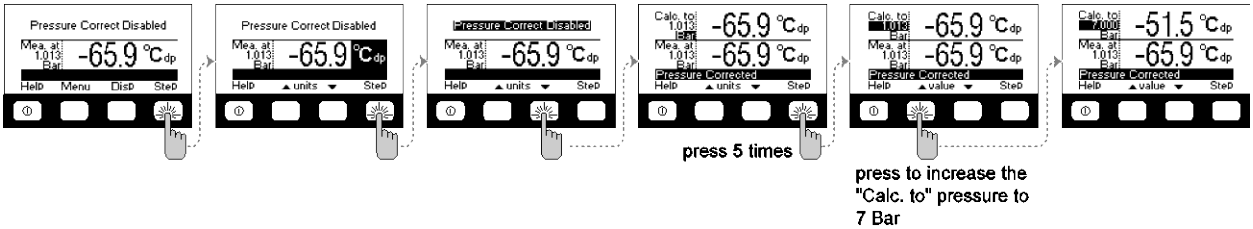
In the previous section the summary of the units of measure for water vapor content reveals that the units can be organized in three groups:

1) Proportion of water vapor in the gas is measured in several different categories such as PPMv, PPMw, or LbsH_2O/MMSCF.
2) Pressure exerted by the water vapor.
3) Temperature at which the water vapor is saturated in the gas.

The measurements of group 1 are most intuitive as they can be visualized as a proportion of water in a gas mixture. These units are independent of the pressure of the gas that is being described. For example if we say that the gas has seven pounds of water per million standard cubic feet, we are describing the water content irrelevant of the pressure at which the gas may be. The measurements in group 2 are in units of pressure and may at first seem an unusual way of measuring content but if we recall Dalton's Law of gases it becomes evident of the usefulness of this means of expressing water vapor content in gasses. Note however that if the total gas pressure is increased the partial water vapor pressure will also increase, thus the content of water vapor in a gas is not fully described by the partial water vapor pressure – we would also need to specify the total pressure of the gas mixture.
The measurements in group 3 are units of temperature, describing the water vapor saturation temperature in the gas mixture. This method of expressing water vapor content is also affected by the total pressure; if the total pressure is increased the gas will become saturated at a higher temperature. Thus we would also need to know the total pressure of the gas mixture in order to describe its water vapor content with dewpoint units.

As we discussed earlier this analyzer measures the partial water vapor pressure in the gas and computes the water vapor content in the chosen measurement units to display on its screen. To make this computation the analyzer software needs to "know" the total gas pressure. This pressure can be automatically measured by the optional internal pressure sensor, or if the analyzer was not purchased with that option then the pressure can be entered by the user. To simplify operation the user can enter atmospheric pressure and measure at atmospheric pressure by allowing the exhaust of the analyzer to be unobstructed.

Lets consider an example where the gas under test is measured at atmospheric pressure, however the gas is in a pipeline at much higher pressure, and the user wants to know if there could be water condensation in the pipe. Reading the dewpoint at atmospheric pressure does not allow us to compare it to the expected low ambient temperature in order to determine if condensation will occur; we would need to know the dewpoint at the same pressure as is present in the pipeline. The analyzer can compute this dewpoint by having its Pressure Correction feature enabled, and having the user enter the pressure in the pipeline. This can be done by pressing the **Disp** button until the analyzer displays the Pressure correct mode. By factory default the pressure correction is disabled.



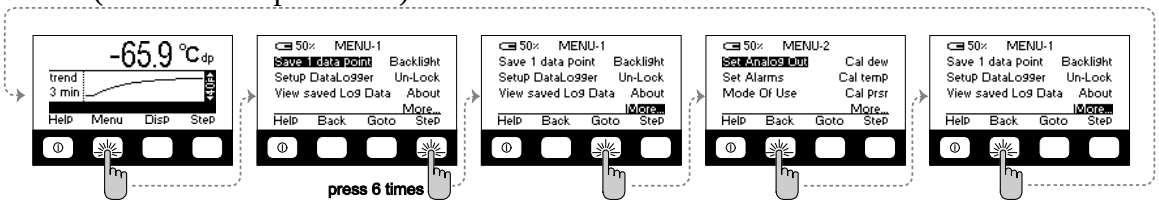
The above diagram depicts the steps required to enable the pressure correction and set up the "Calculated to" pressure to 7 Bar (about 100 psia). This example shows the analyzer measuring

the gas at atmospheric pressure (1.013 Bar) to have a dewpoint of -69.5°C, and calculating that the same gas when at 7 Bar will have a dewpoint of -51.5°C.
If the user switches to the Graphing or Dual Units display mode, the displayed measurements will be -51.5°C; there will be a reminder that the computation is being performed with the status bar message **Pressure Corrected**.

To disable the pressure correction computation; while in the Pressure Correct display mode, press the **Step** button until the **Calc.to** pressure *units* are highlighted, and then press the ▲ or ▼ button until the **Pressure Correct Disabled** message appears on the top half of the screen.

8.4 Navigating Through the Menus

While in any of the three display mode screens, press the **Menu** button to go to the **MENU-1** screen. This screen contains seven options; the last one is labeled **More…** press the **Step** button six times until the **More…** option is highlighted, then press the **Goto** button to go to the **MENU-2** screen (refer to example below).



Similarly by accessing the **More…** option of **MENU-2** will navigate to **MENU-3**.
While in **MENU-3** to go back to **MENU-2** press the **Back** button. Similarly navigate back to the **MENU-1** screen and back to the display screen.
If the analyzer is left in any of the MENU modes and the buttons are not pressed for 3 minutes then it will revert back to the display screen.
While in any of the MENU screens press the **Step** button until the desired option is highlighted, then press the **Goto** button to enter the edit / view mode for that option.

8.5 The Functions Available in the Menus

MENU-1

Save 1 Data Point or Start-Stop Log

If Data Logging is setup for *Single Point* logging then this menu choice allows the user to save a single point in the log. If the setup is for *Continuous* logging then this menu choice allows the user to start or stop the logging. In both cases the user can choose the id tag associated with the measurement. *Refer to Data Logging section for more details.*

Setup DataLogger

This menu choice allows the user to select the logging mode to be either *Single Point* or *Continuous*, in addition in the continuous mode it allows selecting the sampling period and the total number of samples to be saved.

View saved Log Data

This menu choice allows viewing the logged data on the analyzer.

Backlight

This menu choice is provided for commonality with portable analyzers that have the ability of selecting the intensity of the backlight, it serves no purpose in the on-line analyzer.

Un-Lock

This menu choice allows the user to lock or unlock the analyzer. The user can setup the analyzer, using the PhyAI.exe program, to require a password in order to unlock it or can allow unlocking without a password. A locked analyzer will prevent the operator from making permanent changes.

About

This menu choice provides information regarding the software version and copyright, as well as the analyzer and sensor serial numbers. In addition the date when the analyzer was last calibrated is displayed.

MENU-2

Set Analog Out

For analyzers equipped with the analog 4/20mA output option this menu choice allows setting the measured dewpoint that will correspond to the 4mA and the 20mA values, as well as testing the analog output interface.

Set Alarms

For analyzers equipped with Alarm Relays this menu choice allows setting the alarm relays.

Mode Of Use

This menu choice allows selecting either *SpotCheck* or *Continuous* modes of operation. Use the **Sel** button to switch between modes of operation. In the *SpotCheck* mode the measurement graph spans 3 minutes to indicate if the reading is stable. When the line seems flattened the reading can be taken. In the *Continuous* mode the measurement graph spans 90 minutes to indicate the recent history of the measurement.

Cal Dew

This menu choice allows the user to enter a single calibration point, by exposing the analyzer to a gas with a known dewpoint and enter that dewpoint value to create a single point calibration. For Analyzers equipped with a Self Calibrating Solenoid Valve, this menu choice allows the user to setup the self calibrating schedule.

Cal Temp

This menu choice allows setting the slope and offset for calibrating the two temperature sensors in the analyzer. ‘Td’ is the temperature sensor located at the dewpoint sampling chamber and measures the temperature of the gas being sampled. ‘Tb’ is the temperature sensor located on the circuit board.

Cal Prsr

This menu choice allows setting the slope and offset for calibrating the optional pressure sensor which measures the pressure of the gas in the sampling chamber.

MENU-3

Lockable Items

This menu choice allows selecting which items can be locked.

Status Bar

This menu choice allows selecting the items that will be displayed on the status bar.

Time-Date

This menu option allows setting the battery-backed clock calendar.

Autoshutoff

This menu choice is provided for commonality with portable analyzers that have battery saver shutoff.

PPMw factors

This menu choice allows the user to select the method of PPMw computations. The user can select measurement in gas and the molecular weight of the gas, or measurement in liquid and Henry's constant associated with the liquid.

Language de fr es

This menu choice allows the user the select the language in which the analyzer menus appear. Available languages are English, German, French and Spanish.

MENU-4

COMs

This menu choice allows setting the communications port for analyzers that have serial communications RS-485/422 output options.

Dig. Out PWM

This menu choice is provided for controlling the pulse width modulation of digital outputs such as relays or solenoids in order to facilitate power savings.

Set Thermostat

This menu choice is provided for on-line analyzers equipped with sample heating for controlling the temperature of an enclosure.

HART

This menu choice allows selecting the HART polling address.

9 Data Logging

The analyzer has a built-in memory capable of storing data. The data can be stored in one of two modes, *Single Point* or *Continuous*.

Single Point data can be viewed on the analyzer screen. A personal computer Microsoft Windows® compatible program PhyAI.exe is available, which allows the user to view and/or erase the *Single Point* or *Continuous* data in the analyzer's memory.

The user can choose the mode (*Single Point* or *Continuous*) of how data should be logged from the **Setup DataLogger** option available on **MENU-1**.

In addition the analyzer can be connected via its serial port or HART interface to a personal computer. By using the PhyAI.exe program, the analyzer can continuously transmit its real-time measurements to an MS Excel® spreadsheet to log the data directly to the PC disk drive as well as plot it in real time. This method of data logging may be useful in stationary measurement installations, or portable uses (with a laptop computer) requiring very large amounts of data logging.

Continuous data logging is useful in studying the moisture content, temperature and pressure of the gas being measured over a long period of time. The analyzer can store over 4000 points of

data, at a user selectable period (5 seconds to 1275 seconds), thus data can be gathered with very fine resolution or with coarser resolution that can record data for approximately 2 months. The total number of points to be logged can be limited to be less that the total free memory as to conserve it for other use. When deciding on the choice of sampling period and total number of data points to capture; consider the response time of the system in which the moisture content is being measured as well as what is the desired total time for which data has to be logged.
The **Setup DataLogger** option available on **MENU-1** allows the user to choose the Log type to be *Continuous* and then to choose the period (in 5 second increments up to 1275 seconds). As the period is modified the analyzer will compute and display the total free records in the memory and the amount of time that the data can be logged for using the currently selected period. The user can also set a limit for the total number of points to be logged depending on the requirements of the application.
Once the analyzer is setup for *Continuous* data logging, the logging can be started from the **Start-Stop Log** option available on **MENU-1**. While *Continuous* data logging is running there will be an indication on the status bar "Logging Data".

9.1 Retrieving the Data / Clearing the Memory

To retrieve the data from the analyzer memory, it is required to install the PhyAI.exe program on a Microsoft Windows® compatible personal computer with a serial port. Single point data log can be viewed on the analyzer screen from the **View saved Log Data** option available on the **MENU-1**.

9.2 Logging Data Directly into a Personal Computer

The PhyAI.exe program allows the user to log data in real time directly into Excel 2003 via the OLE interface and plot the data in an excel graph. Excel 2007 will also perform data logging however when prompted from the PhyAI program to automatically plot dual axis graphs it will plot only single axis graphs, all other functions will operate properly, dual axis graphs can be plotted manually.

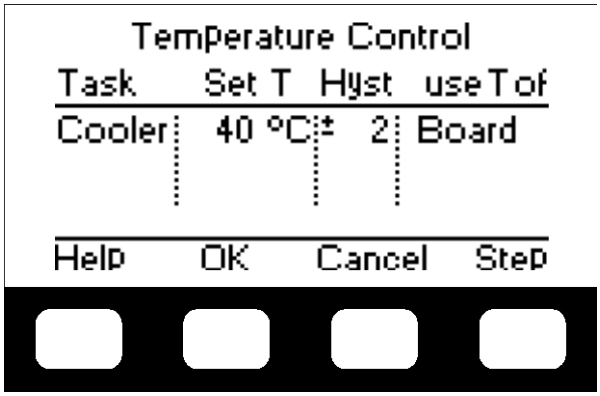
10 Single Point Calibration

If necessary to adjust the measurement without having to send the analyzer for recalibration, the user can expose the analyzer to a gas with a known moisture content. The known value can be entered into the program and the analyzer can be set to adjust the measured value such that the reported value is equal to the known moisture content of the gas. Once the single Point Calibration is performed, this adjustment will be applied as a constant offset on the full range of the measurement as long as the Single Point Calibration is enabled; the user can at any time disable or enable this calibration point or perform a new single point calibration (changes can be made only when unlocked.) In order to alert the user that the measured value is being adjusted, the status bar will provide an indication when the Single Point Calibration is being applied. When the single Point Calibration is disabled the analyzer will compute the measurements per original factory settings.
Caution! Before a calibration is performed the user should be absolutely certain of the moisture content of the gas that the analyzer is being exposed to. It is also very important that the analyzer is allowed sufficient time to equilibrate with the gas of known moisture content, which can be determined by observing a flat graph line in the continuous mode of measurement.

11 Using the ExMa for temperature control

When the ExMa is installed in an enclosure (for example in a sample system) it can be equipped such that it can control an enclosure heater and or cooler. These functions are controlled through the **Set Thermostat** menu choice in **MENU-4**.

If either a cooler or heater or both are installed, the appropriate fields in this menu will allow the user to select the temperature for each item and hysteresis for cooler, as well as which temperature sensor to use for controlling the temperature (sample gas or circuit board).
The cooler is controlled as a thermostat, while the Heater control is PID.
This menu has up to two rows of data, one for cooler and one for heater, if installed.
For each there are four columns of parameters that may be modified. The *temperature*, the *units* of the temperature, *hysteresis* (for cooler only) and which *temperature sensor* to use.
For example if in the Cooler row the selections are **40 °C +/-2 Board**, this means that when the board temperature sensor exceeds 42°C the cooler solenoid will be energized, and when the board temperature is below 38°C the cooler solenoid will be de-energized.
Use the **Step** key to move the highlight over the parameter that needs to be changed, and then use ▲ or ▼ to change the parameter. To finish, press the **Step** key until there are no highlights. Press the **OK** key so that the analyzer saves the selection or press the **Cancel** key if you are not sure about the selections and would like to leave the menu without making any changes.



12 Troubleshooting and Maintenance

This analyzer is designed to be maintenance and trouble free. However should problems occur due to process conditions or other factors, use this chapter for troubleshooting purposes. If the encountered circumstances are not discussed in this manual please contact Phymetrix. Spare parts may be ordered through Phymetrix.

12.1 Cleaning

The analyzer enclosure may be cleaned using a moist cloth.
The flow control orifice of the ExMa can be removed and cleaned with solvents.
The sensor is not user serviceable and should not be cleaned by the user. If it is contaminated please acquire an RMA and send the analyzer for repair.

12.2 Self Diagnostics

The analyzer constantly performs self diagnostics to determine if all parts are operating properly. The results of the diagnostics are displayed on the status bar.

Table 1 Status Bar Messages

Status bar Message	Meaning
Pressure Corrected	The analyzer is computing the moisture measurement using pressure correction
AO frozen	The Analog output (4/20mA) is being kept frozen (unchanging) by some part of the program.
Single Point Cal Enabled	Single point calibrations are being performed. Can be disabled from the Cal dew function in MENU-2
Logging Data	The continuous data logging is enabled and running.
Calibration Past Due	The analyzer compared the date since the last calibration to the date in the battery backed clock/calendar and computed that the time exceeded the settings of the number of months between recalibrations.
Max Pressure Exceeded	The pressure sensor inside the sampling chamber is measuring more than rated pressure of the pressure sensor.
Temperature Sensor Error	One or both of the temperature sensors are not operating properly, cable unplugged etc.
Pressure Sensor Error	The pressure sensor is not operating properly, cable unplugged etc.
Analog Output Loop Open	The analog output is not connected to a proper source.
Battery Low	The battery needs to be recharged.
Temp Range Exceeded	The temperature exceeds +70°C
Sensor Range Exceeded	The moisture sensor measurement exceeds the preprogrammed parameters.
Sensor Msr Err=x	The moisture sensor measuring circuit has detected an error.

12.3 Suspected Erroneous Measurements

Some of the most common suspected erroneous conditions are listed in the following table included are common reasons and suggested remedies.

If the measurement is suspected to be erroneous, before calling for support, it may be helpful to have the following information:

- Type of gas being measured.
- Expected dewpoint.
- Nominal pressure (consider back pressure).
- Nominal temperature.
- Nominal flow rate though the analyzer.
- Flow diagram or description of system, showing items and their materials of construction. Include materials of filer elements, regulator diaphragms, and valve seats.
- Possible contaminants (particulates, liquids, oil, glycol, cleaning solutions, etc.).
- Are the pipes and analyzer purged before measuring? How long? Flow rate? With the same gas that will be measured?
- If other equipment was used to verify the dewpoint, what is the equipment (include model number)? What is its specified measuring range? When was it last calibrated/certified?
- If using bottled gas for reference: Manufacturer? Content and accuracy markings? What is the pressure in the bottle at time of comparison? What is the ambient temperature where the bottle is stored? What are the materials of construction of the pressure regulator, especially the diaphragm?

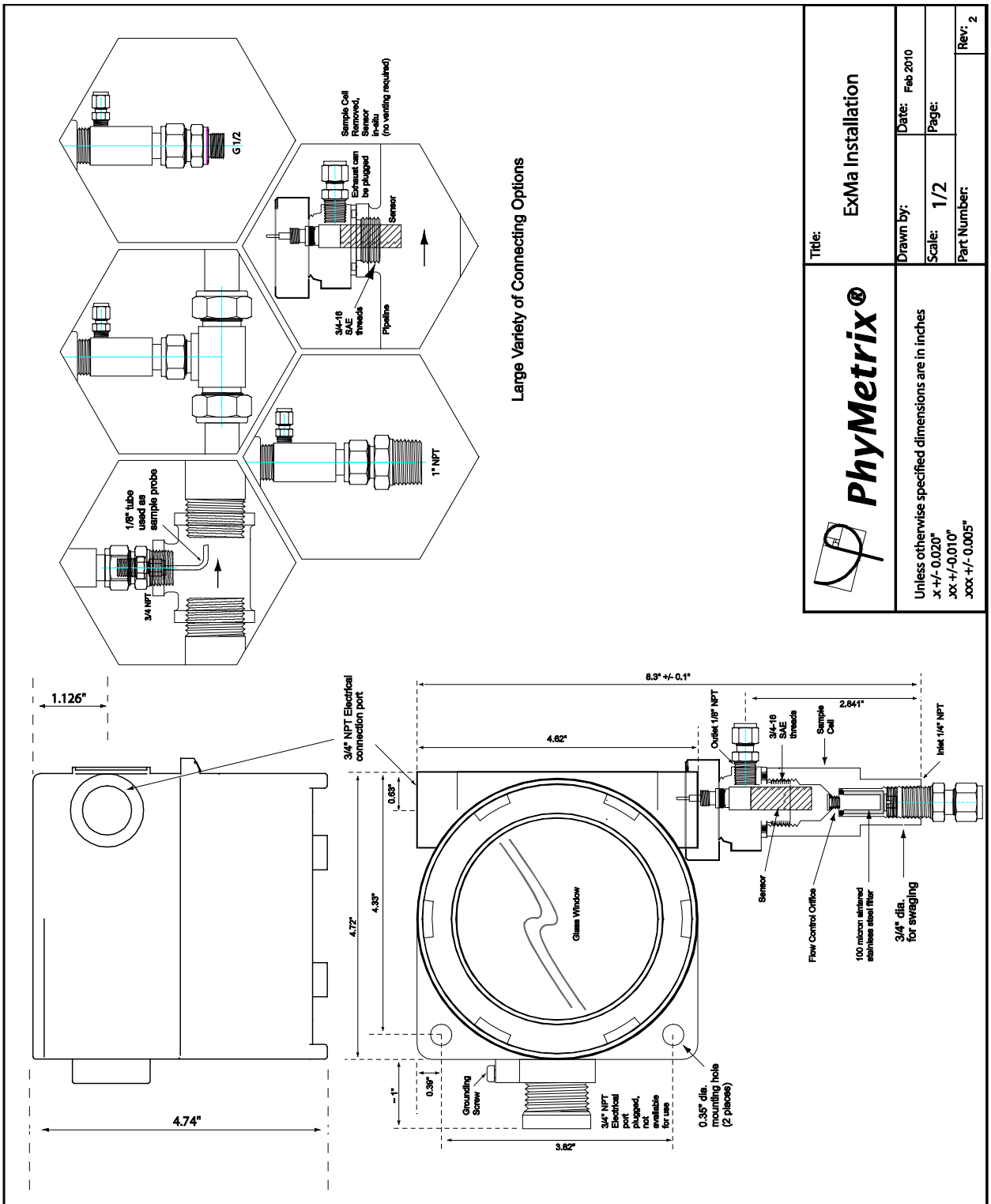
Table 2 Guide to Troubleshooting Measurements

Problem or Unexpected Observation Behavior	Likely Source of Problem	Analysis	Remedy
Measurement is **dryer** than is expected.	Equilibrium	Before concluding that there is an incorrect measurement, make sure that the system is at equilibrium.	Use the graph display and wait for equilibrium.
	Sampling point	Consider if the sampling point could be dryer than the rest of the system.	If necessary find a more appropriate sample point
	Damage Corrosion, abrasion	Contaminants can damage the sensor.	Refer to sections: 3 Precautions and 5.2 Sample conditioning.
	Needs recalibration	Depending on the application recalibration may be yearly or in 5 years.	Consult with factory.
Measurement is **wetter** than is expected.	Equilibrium	Before concluding that there is an incorrect measurement, make sure that the system is at equilibrium.	Use the graph display and wait for equilibrium.
	Sampling point	Consider if the sampling point could be wetter than the rest of the system.	If necessary find a more appropriate sample point
	Condensation	Refer to the "Measurement is **not changing**" observation below	
	Damage Corrosion, abrasion	Contaminants can damage the sensor.	Refer to sections: 3 Precautions and 5.2 Sample conditioning.
	Incompatible materials in system with low dewpoint.	Refer to section 4.1 Integrity of the materials of the system.	Replace inappropriate materials.
	Leaks	Check for leaks around all interconnections.	Tighten fittings. Repair the leaks.
	Needs recalibration	Depending on the application recalibration may be yearly or in 5 years.	Consult with factory.
Measurement is changing **slower** than expected.	Equilibrium	The rate at which the system will reach equilibrium depends on the system particulars, such at ambient temperature, internal pressure, flow rates, system materials of construction, surface area of system internals.	Previous experience may be indicative of the system response time. It is common for systems to take hours to equilibrate.
	Sampling point	Is the sampling point in the direct flow of the system gas, or is it at a dead end of the distribution system?	Sample in the direct flow.
	Contamination	Are there hygroscopic contaminants?	Clean the sensor and install filters.
	Out-gassing	Are there materials in the system that could be out-gassing?	Replace the hygroscopic materials.
	Leaks	Check for leaks around all interconnections.	Tighten fittings. Repair the leaks.
	Large diameter sampling tubing	Larger diameter tubing have larger surfaces.	Use smallest practical tubing diameter, 1/8" recommended
	Low flow rate	Response time is normally greatly influenced by flow rate, but if the measurement value is influenced by flow rate there may be a leak.	Flow rate should be greater than 1 LPM.
Measurement is **not changing**, always shows a dewpoint close to ambient temperature.	Condensation	Condensation may have occurred from a slug of water or from previous conditions where the gas dewpoint was greater than the ambient temperature. Condensation typically accumulates in filter bowls or other low points in the system. Then evaporates and produces a high dewpoint.	Drain the condensate and allow the system to dry down.
Measurement has a **daily cycle**	Thermally induced water vapor pressure change.	Refer to section 4.3 Temperature dependant equilibrium	

13 Specifications for Model ExMa

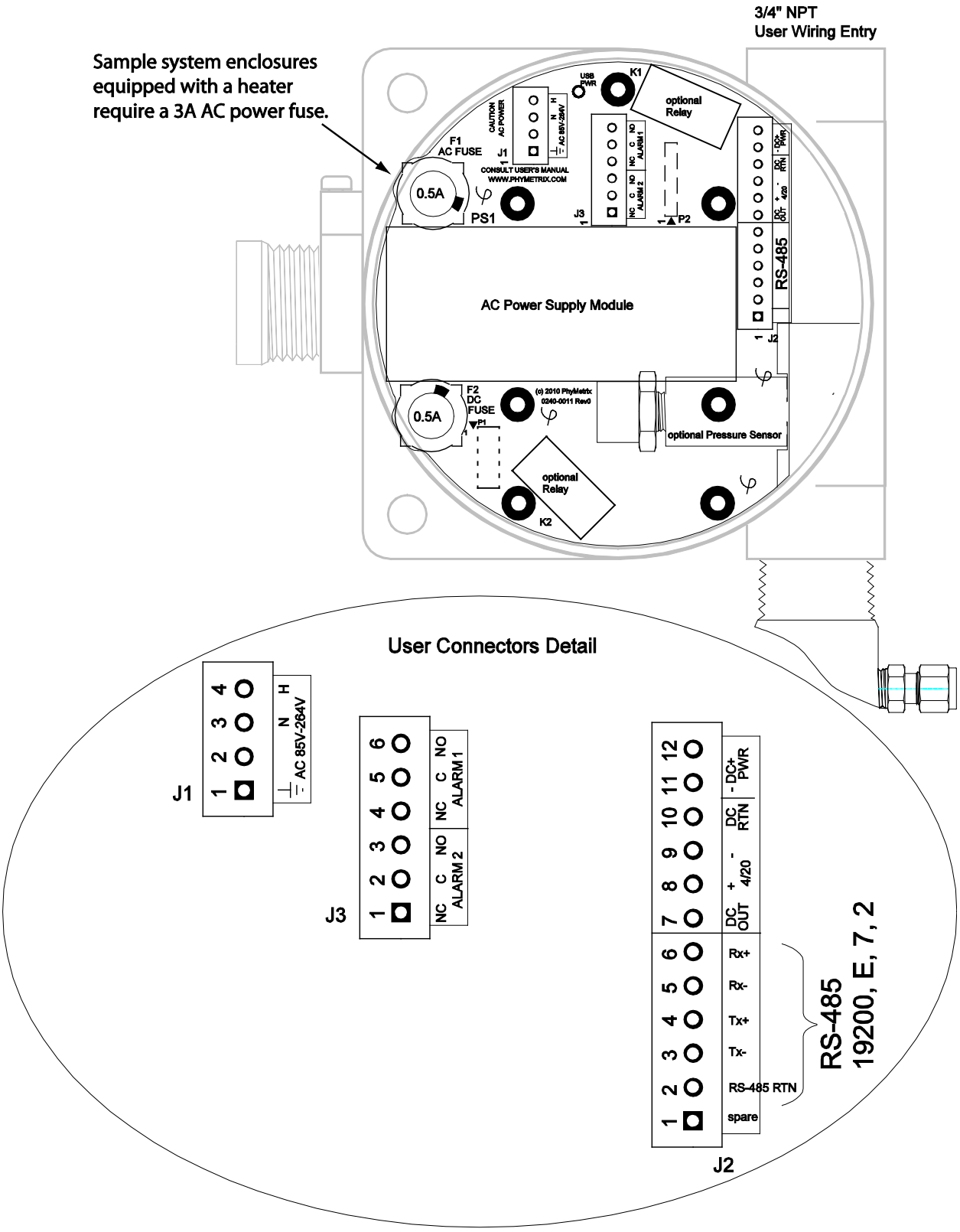
Temperature Range	ExMa Analyzer: -20°C to +60°C Electronics: -40°C to +85°C Moisture Sensor: -20°C to +60°C Pressure Sensor: -20°C to +85°C LCD operating: -20°C to +70°C storage: -30°C to +80°C
Moisture Sensor	Range -110°C to +20°C Accuracy: ±2°C temperature corrected Repeatability: 0.8°C Response time: 95% of step change in 3 min. Sample flow: >1 LPM
Temperature Sensors	-40°C to +70°C ±2°C
Pressure Sensor	2 to 1000 PSIA ±1%, 316L stainless steel wetted parts (higher pressures can be ordered)
Electrical	3 automatic detection - self configuring power modes: 1) 90-260VAC 47-440Hz or 2) 12-24VDC 10VA or 3) 4/20mA Loop Powered Power modes 1 or 2 have the following optional I/O: a) RS-422/485 isolated b) 4/20mA sink or source; isolated; with HART® c) 3 Alarm Relays - 3A, 250VAC / 30VDC contacts
Mechanical	3/4" OD tube and 1/4" NPTF Inlet, 1/8" NPTF Outlet All 316 Stainless Steel wetted parts, small surface area stainless steel sampling chamber for fast response time. Enclosure Aluminum or optional 316 Stainless Steel, Glass lens, IP66 & IP68 FM/CSA Explosion Proof Certified Class I, Div I, Groups B, C And D Class II, III, Div 1, Groups E, F And G ATEX Explosion Proof Certified ATEX 2 GD, Exd I & IIC; IECEx, Exd I & IIC Dimensions SS enclosure- L: 8.7" (221mm) W: 5.8" (147mm) H: 4.8" (122mm) Weight Total: 8.4 Lbs (3.8 Kg) Pressure: 5000 PSIA (345 Bar) Flow Control Orifice can be placed at Inlet(default) or Outlet; Built in serviceable/cleanable 100 micron Filter
Miscellaneous Features	Through the glass user interface buttons, allow operation while enclosure is closed NIST traceable calibrations Units of measure: °C & °F dewpoint, ppmV, ppmW, µB H_2O vapor pressure, grams of H_2O / m^3 and Lbs H_2O /10^6 standard cubic feet in Natural Gas Virtual Analyzer PC software for training and evaluation, allows the user to experience the exact interface on their own PC with voice explanations

Appendix A ExMa Installation Drawing

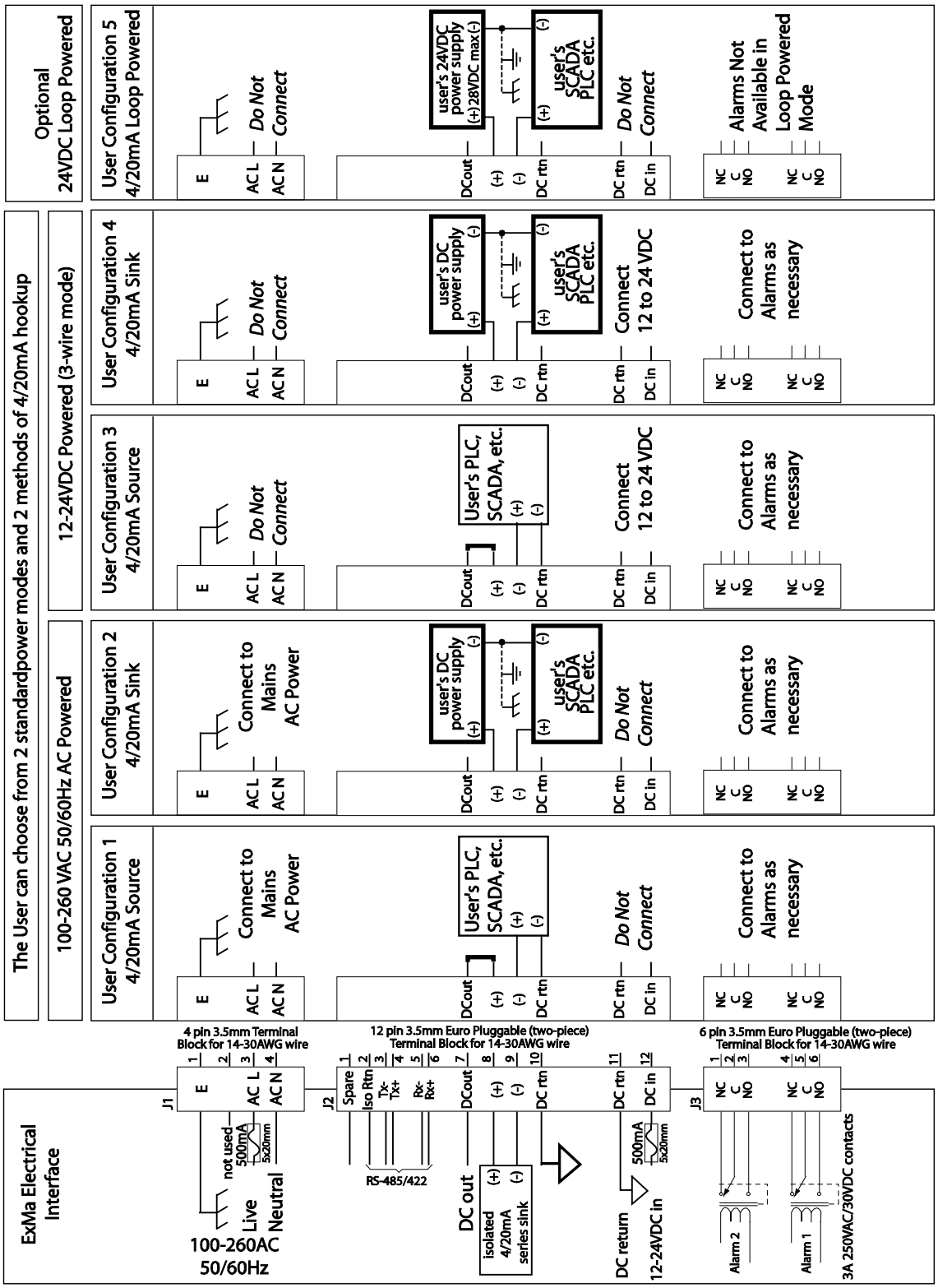


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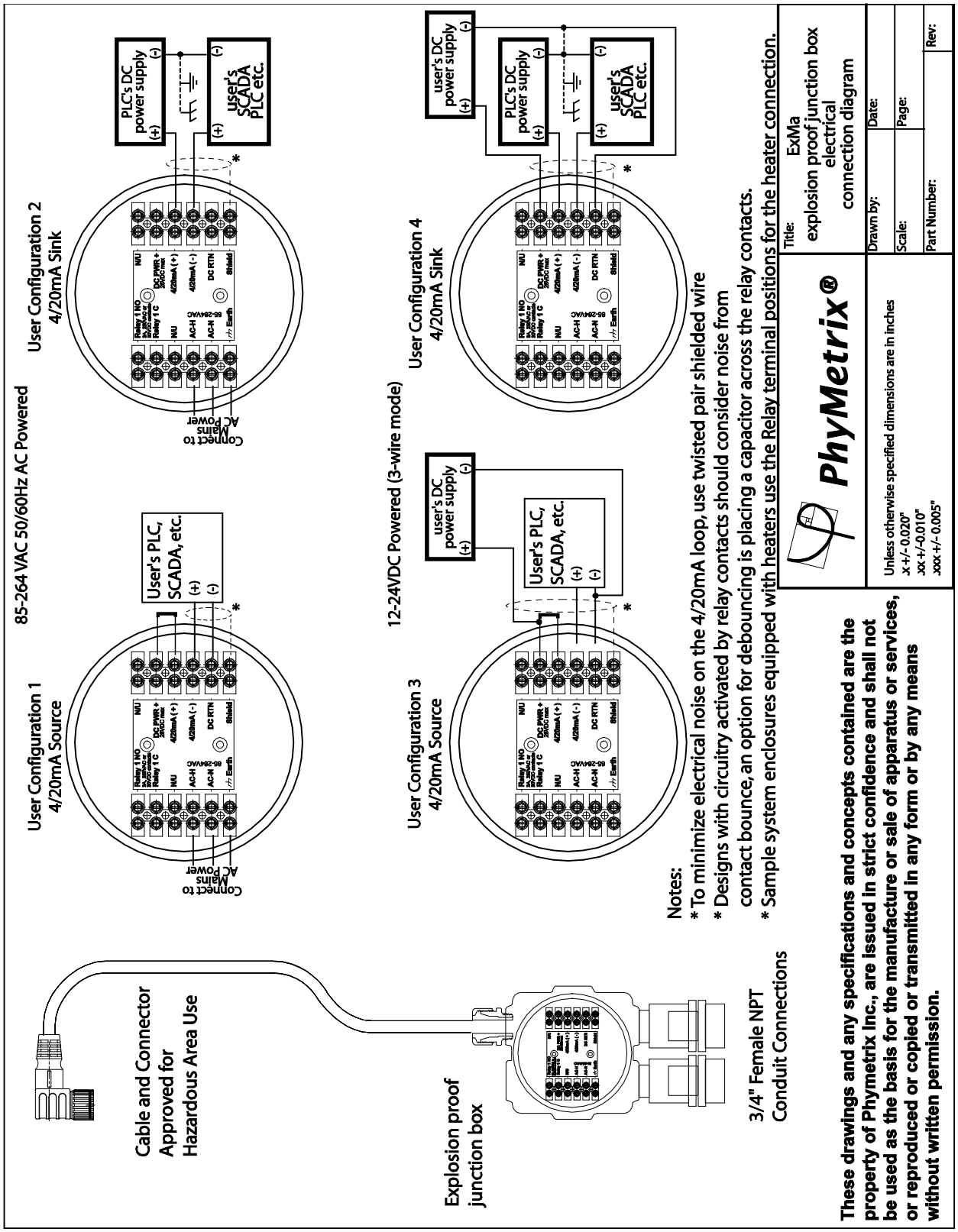
Appendix B ExMa Electrical Connections



Appendix B ExMa Electrical Connections



Appendix B ExMa Electrical Connections



Appendix C Notes on ExMa use in low power applications e.g. solar power

For all power consumption calculations it is assumed that the ExMa will be powered by 12VDC, unless otherwise noted.
Power connections:
+12VDC to J2 pin 12
RETURN (Gnd) (-) to J2 pin 11

Analyzer Power Consumption
The ExMa (with the display backlight OFF) will draw about 13 mA from 12VDC power.
The display backlight will draw an additional 2.5 mA at 100% and proportionally lower on the other settings, which can be user selected. The backlight can be turned OFF, but each time the user presses a button on the screen the backlight will turn on to a low setting (~ 0.5 mA) for a few seconds.

Analog Output Power Consumption
The Analog output will use 4 to 20 mA depending on the measurement. It is also possible to order the ExMa with voltage output 1-5V, which will further reduce current consumption by avoiding the 4-20 mA.

Relay Power Consumption
It is better not to have Alarm Relays for solar Powered Application, but if they are needed, in order to conserve current there is a pulse width modulator for the Alarm Relay drive. The Relays will each draw about 37 mA at 100% PWM, and proportionally less e.g. at 55% about 21 mA. The Relay PWM percentage can be user selected. (go to MENU-4)
Be sure to configure the relay polarities in such a way that power consumption is minimized. For example if only one Relay will be used then configure the other to a very high dewpoint and select the polarity such that the relay is not energized. For the Relay that is used select the polarity such that current draw is minimized, but also consider that having the Relay energized while conditions are “GOOD” provides a fail safe operation in that if the analyzer looses power the relay will signal an alarm condition.

Appendix D Analyzer Calibration Log

Analyzer Serial Number: _____

Sensor Serial Number: _____

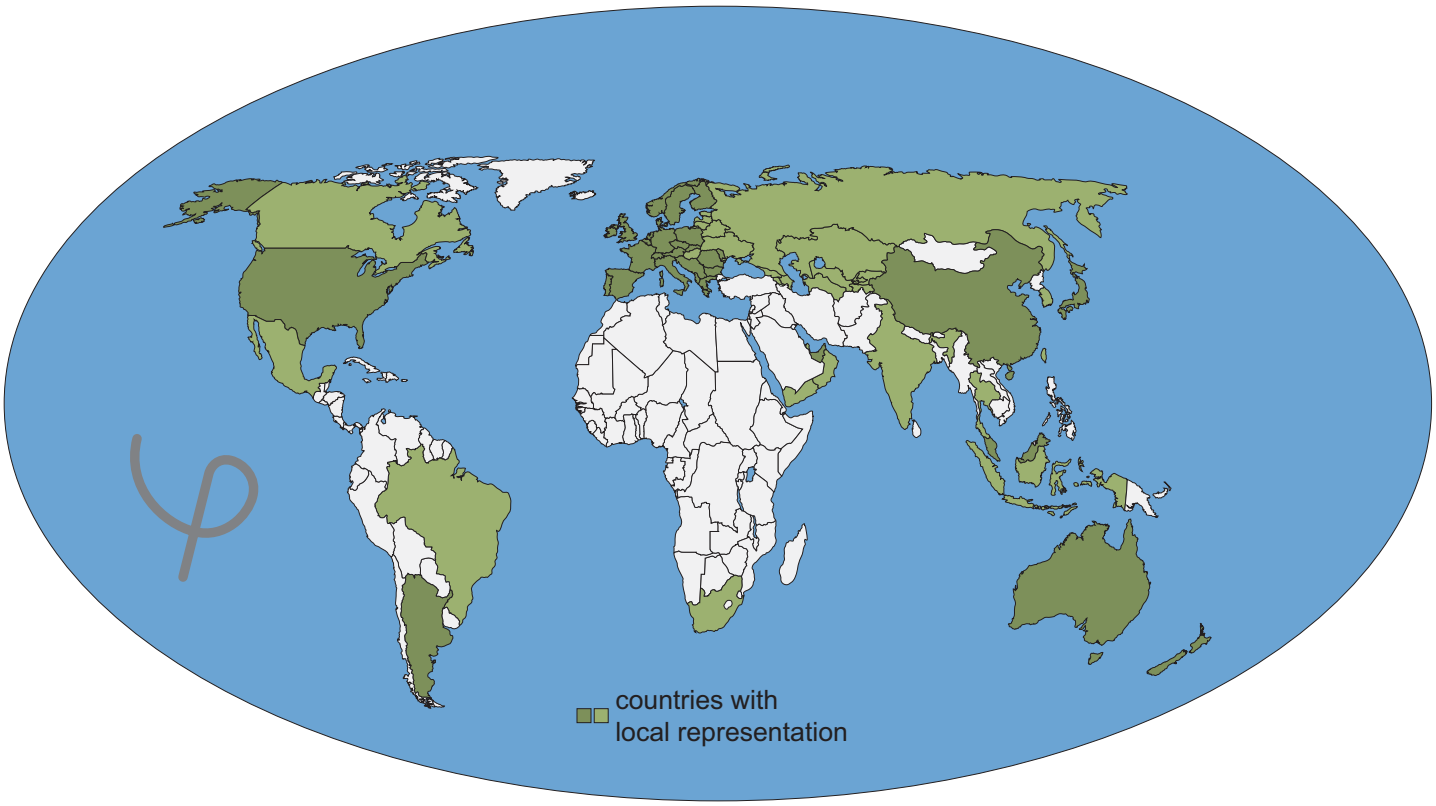
Date	Performed by	Comments

Notes:

Moisture Measurement Innovation at Work

Integrating nanotechnology into moisture measurement

PhyMetrix®



PhyMetrix Inc., 28C Industrial Blvd. Medford, NY 11763, USA, Tel:1-631-627-3950 Fax:1-631-627-3949

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2 Year Warranty PhyMetrix

MADE IN USA

MAG-GAGE®
THE SUPERIOR MAGNETIC LEVEL GAUGE

- Patented Wide-Flag®
  Solid Design Magnet
  -350° / 1100° F rating
- Standard 2 to 4 week delivery
  Expedited delivery available
- Constructed to meet ANSI/ASME
  codes B31.1/B31.3 Min. Sch 40
- No Pressurized Floats
- All Welds are GTAW/TIG
  No MIG or T-Drilling
- Replaces Sightglasses



ISO 9001 Certified 1410004

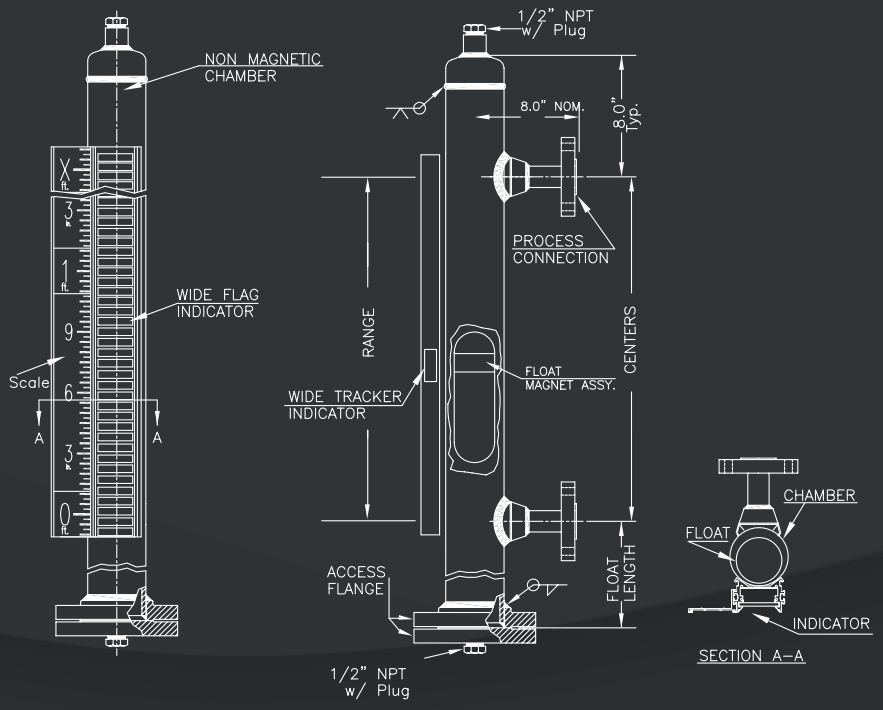
PROCESS LEVEL TECHNOLOGY, LTD.

The Process Level Technology Mag-Gage® is a proven method to measure liquid levels. The Mag-Gage® is one of the safest and most economical ways to measure and control your level requirements. It can be installed on almost any shape, size or type of vessel in the industry. In applications of extreme pressure, temperature, vibration and highly corrosive or hazardous material the Mag-Gage® will perform where others fail.

Principles of Operation

The Chamber is constructed of non-magnetic materials, and process connections to mate with those of the tank, vessel or other equipment where the level is to be measured.

The Float is engineered and located inside the Chamber. It is sized and weighed to the specific gravity of the process fluid to be measured. The float contains a 360° Magnetic Assembly which generates a strong uniform magnetic circuit. The magnetic Flux Lines generated by the float interlocks with the indicator. The hermetically sealed Indicator, the Wide Flag® or Wide Tracker® Style, contains its own magnetic assemblies which interlock with the float through the Chamber, providing a strong and reliable design. As the Float moves with the changes in the liquid level, the magnetic attraction between the Indicator and Float will ensure that the Indicator will track the position of the float exactly and the liquid level is measured precisely.



INDICATORS



Wide Tracker®



Wide Flag® (Patented)

Wide Tracker®

- Extra Large Rectangular Indicator
- 1.40" Wide X 1.5 Long
- Bright Yellow (other colors available)
- Dual Magnetic Coupling

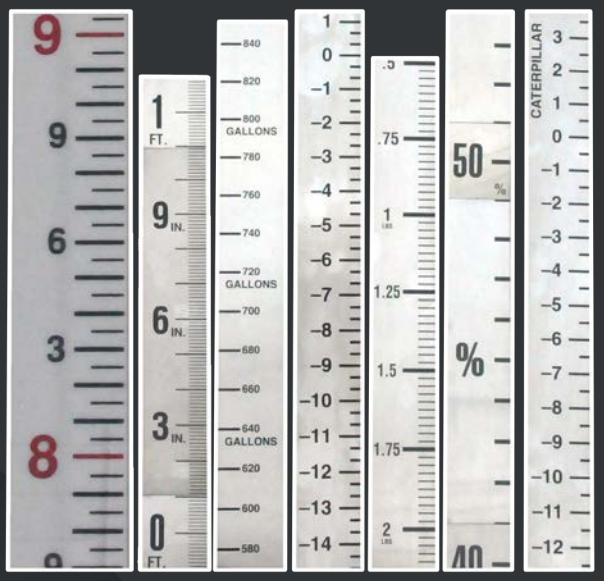
Wide Flag®

- Easy to read 1.40" Wide-Flag (Visible from 200+ ft.)
- Patented solid one piece ceramic magnetic flag
- 180 degree rotation
- Temperatures from -350°F to 1100°F
- High contrast Yellow (liquid) and Black (vapor)
- Other color combinations available

Available Enclosures:
Anodized Aluminum or 316 Stainless Steel

Scales

- Scale can be customized to any increments (ft./in., gallons, percent, metric, etc.)
- All scales are photo etched into Stainless Steel - No rusting, fading or stickers falling off
- Large, easy to read markings that allow measurement to be taken from a safe distance



Scales Available In:

- Feet/Inch Standard
- Metric
- % Scale
- 10ths Scale
- Wide Acrylic Scale
- Gallon Scale
- +/- Scale
- Inch only Scale

POINT LEVEL SWITCHES







MGS-200EX & MGS-200EX/2

Type	Electrical
Volts	150 VAC / VDC
Current	1.0 AMPS
Power	25 Watts
Contacts	SPDT or DPDT
Deadband	½ inch
MAWT	-40°F to +800°F
Enclosure	NEMA 4X
Connection	¾" FNPT

MGS-700EX & MGS-700EX/2

Type	Electrical
Volts	125/250 VAC
Current	10.0 Amps
Power	2500 Watts
Contacts	SPDT or DPDT
Deadband	½ inch
MAWT	-40°F to +600°F
Enclosure	NEMA 4X
Connection	¾" FNPT

MGS-500EX & MGS-500EX/2

Type	Electrical
Volts	500 VAC/VDC
Current	3.0 AMPS
Power	100 Watts
Contacts	SPDT or DPDT
Deadband	½ inch
MAWT	-40°F to +600°F
Enclosure	NEMA 4X
Connection	¾" FNPT

MGS-900EX & MGS-900EX/2

Type	Electrical
Volts	125/250 VAC
Current	15.0 Amps
Power	3750 Watts
Contacts	SPDT or DPDT
Deadband	½ inch
MAWT	-40°F to +600°F
Enclosure	NEMA 4X
Connection	¾" FNPT

Electrical Area Classification: Class I, Division I, Groups B, C, D



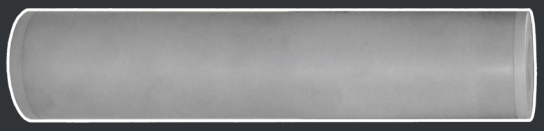
MGS-100: NON-BLEED PNEUMATIC SWITCH

Type	Non-Bleed Pneumatic
Supply Pressure	30-200 PSIG
Deadband	½ inch
MAWT	0°F to 200°F
Enclosure	0°F to 200°F
Connection	¼" FNPT

FM US C APPROVED

A SUPERIOR MAGNETIC CIRCUIT

When designing the magnetic circuit between the float and indicator there are many considerations other than just how strong the magnets are in the float. The Mag-Gage® level gages have undergone extensive testing to produce a rigid and high performance design. With a unique construction the indication performs under the most demanding conditions such as high/low temperatures, vibrations, even schedule 160 chambers. Our patented solid magnet Wide Flag® design not only provides highly visible indication but provides a powerful connection with the float. The reliability and repeatability of the Mag-Gage® float and indicator combination is unmatched.



CPVC Float



Kynar Float



Titanium High Pressure Float



High Pressure Interface Float with Field Adjustable Weight

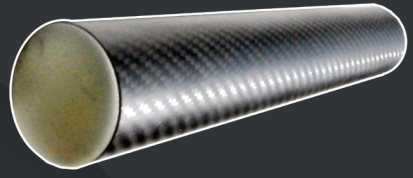


Coated Float for Corrosive Process

- All floats are engineered to the specific operating conditions of each application.
- Shell is constructed of stainless steel, titanium, hasteloy, monel, CPVC, PVDF (Kynar), or any other non-magnetic material.
- Magnetic circuit is made of a series of Alnico magnets to provide a light yet effective connection.
- We can handle the highest pressures in the industry with no oversized, pressurized or vented floats. Pressurized floats can be a safety concern and can leak over time.
- PLT uses solid engineering to conquer the demands of high pressures and low gravities.



Standard Stainless Steel Float



The Carbon Fiber Float® (Patented)

MAG-GAGE® LIQUID LEVEL ORDERING GUIDE

Standard Specifications

- Non-Magnetic Chamber material
- All Flanges, Fittings and Pipe meet ASME/ANSI Standards
- Fabricated/Welded to B31.1/B31.3 code

Scale

- Feet and Inches, ¼" divisions
- Photo etched and backfilled on stainless steel
- Metric, Percentage, or Volumetric available
- Optional 3½" Acrylic scales

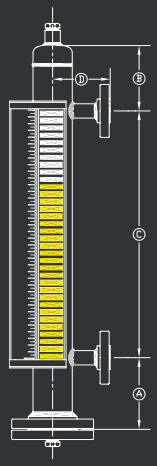
Float Chamber

- 2" to 3" pipe W/RF Flanges - Sch 40
- ½" FNPT vent and drain connections
- All flanges and fittings rated for process conditions
- Connections: ½" through 8" plus
- Pressure ratings vacuum to 5000 PSIG
- Temperature Rating: -350°F to +1100°F
- Specific gravity range: 0.28 and up
- Lengths from 4.0" to 50 feet

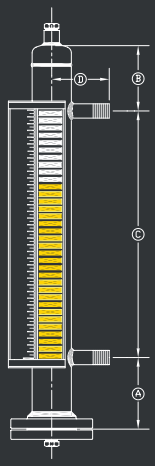
Indicator

- Bright colored
- Can be seen from 200 ft. or more
- 1.4" wide
- Hermetically Sealed

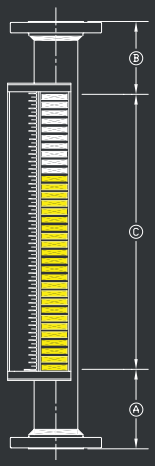
Chamber Styles



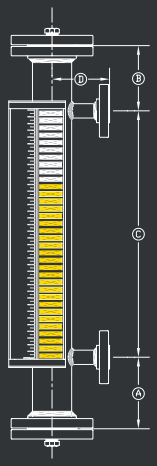
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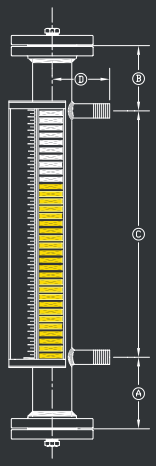
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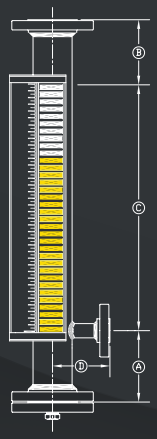
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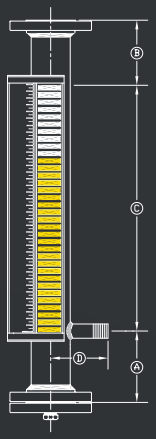
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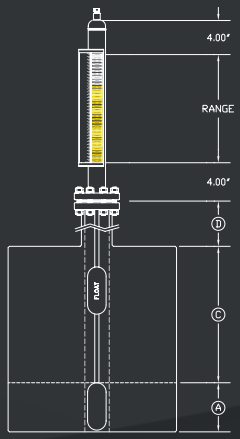
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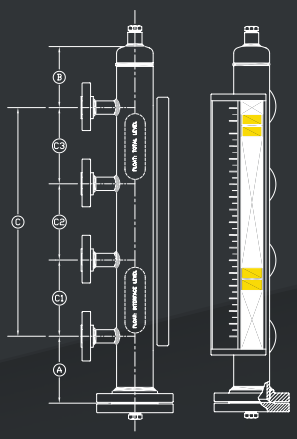
Style F



Style G



Style H



Style X (Other Configurations)

MG										
1	2	3	4	5	6	7	8	9	10	11

1 Model

MG: Mag-Gage®

2 Material

4S: 304/304L SS
4C: 304 SS/CS
6S: 316/316L SS
6C: 316 SS/CS
2S: 321 SS
4T: Teflon Lined 304 SS
4H: Halar Coated 304 SS
NS: Non-Stick Coating
AL: Aluminum
A2: Alloy 20
MO: Monel
TT: Titanium
HB: Hastelloy B
HC: Hastelloy C
ZR: Zirconium
CP: CPVC
PV: PVC
KY: Kynar (PVDF)
PP: Polypropylene
CM: Other material

3 Style

Specify Options

4 Process Connection

Specify Size

5 Flange Rating

01: 150#
03: 300#
06: 660#
09: 900#
15: 1500#
25: 2500#
50: 5000#

6 Specific Gravity

Specify

7 Pressure

Unit in PSIG

8 Temperature

Unit in Fahrenheit

9 Length

Specify

10 Indicator

WF: Wide Flag
SWF: SS Wide Flag
WT: Wide Tracker
SWT: Single Wide Tracker

11 Options

Chamber

WN: Weld Neck Flanges
LJ: Lap Joint Flanges
RJ: Ring Joint Flanges
BW: All Butt Weld Construction
NM: NACE MR0175/MRO103

Temperature Controls

CI: Low Temp. Cryogenic Insulation
IB: High Temp. Insulation Blanket
EH: Electrical Heat Tracing
FP: Freeze Protection
ST: Steam Tracing
FE: Frost Extension

Valves

GV: Gate Valves
VD: Vent & Drain Valves

Indication and Scale

MS: Metric Scale
PS: Percent Scale
VS: Volumetric Scale
AS: 3 ½ " Acrylic Scale
FE: Non Frost Extension
DI: Dual Indication
IF: Interface Indication
AR: Level Arrow Indicators
IL: Illuma-Mag™
IG: Indicator Guard
HDC: Heavy Duty Mounting Clamps

Testing

HY: Hydrostatic
NDE: 100% Non-destructive Testing (Die Penetration, X-Ray)
PMI: Positive Material Identification

MAG-TRANS® PREMIER LEVEL TRANSMITTER

The Mag-Trans® 2523 Series Level Transmitter is the next generation in Magnetostrictive Level Sensing Technology. It contains a dual compartment enclosure attached to the piezomagnetic wave guide sensor. The output is reliable, repeatable, fast and accurate.

- Standardized Dual Compartment
- Stainless Steel Enclosure Option
- Two Wire: Loop Powered
  - 10-30 Vdc (24 Vdc Nominal)
- Graphic Display:
  - Inch-Metric-Percent
  - Scroll-Tile
- HART – Protocol
- PACTware
- Local Programming
- Repeatable
- Reliable
- Variable Range
- Process Temperatures: -50°F to +800°F
- Class 1, DIV 1, GRP B, C, D



Specifications

Accuracy	+/- 0.015
Repeatability	.001% Full Span
Linearity	.020% Full Span
Refresh Rate	25x per second
Damping	1.0-25.0 Seconds
Electrical Classfication	Class 1, Div 1, Grp B, C, D

Input	10-30 Vdc (24 Vdc Nominal)
Output	4-20mA, HART
Software	HART/PACTware
Display	LCD-Graphic
Process Temperature	800°F
Ambient Temperature	-25°F to 175°F

FieldComm Group
Connecting the World of Process Automation

HART COMMUNICATION PROTOCOL

FM US C APPROVED

PACTware™

ISA

MAG-TRANS® ORDERING GUIDE

MT 2523						
1	2	3	4	5	6	7

1 Model
MT 2523

2 Length
Unit in Inches

3 Mounting Location
BML: Bottom Left
TML: Top Left
BMR: Bottom Right
TMR: Top Right

4 Dual Compartment Housing Materal
ALE: Epoxy Coated Aluminum
SSE: All 316 Stainless Steel

5 Probe Material
6S: 316 Stainless Steel

6 Temperature
Unit in Fahrenheit

7 Options
HT: High Temp
RD: Remote Display
FM: FM Approved US/Canada
FRD: Field Mounted Loop Powered Indicator
FRDS: All Stainless Steel FRD

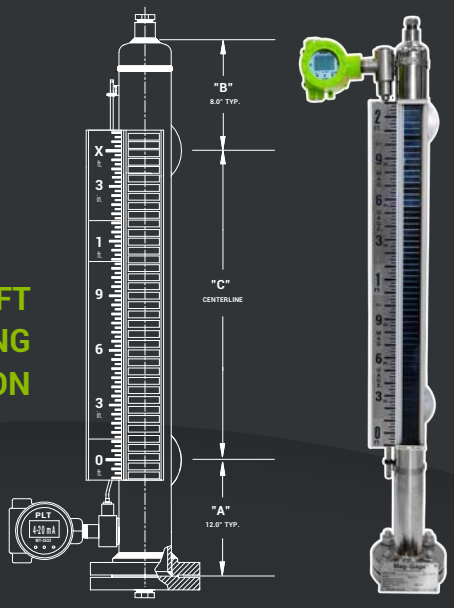


FRD: Field Mounted, Loop Powered Indicator - Can be externally mounted anywhere within power loop. Epoxy Coated Aluminum or 316 SS Class1, Div1, Group B, C, D

FRDS: All 316 Stainless Steel

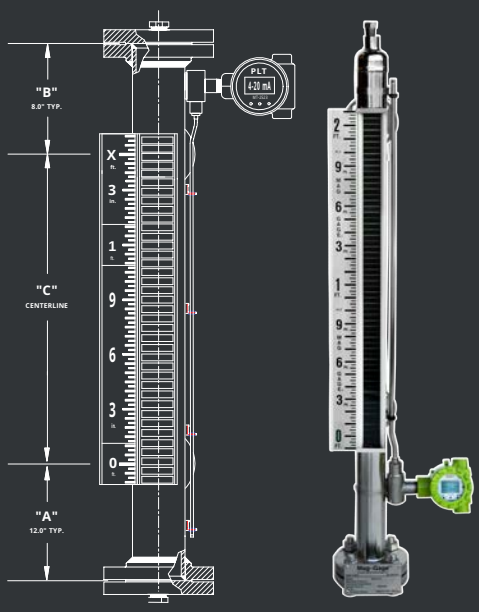
Installation Options

LEFT MOUNTING POSITION



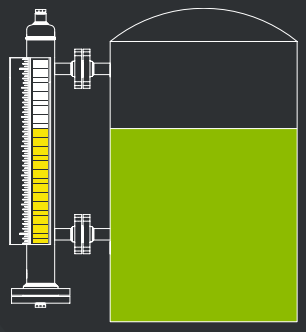
BML *TML*

RIGHT MOUNTING POSITION

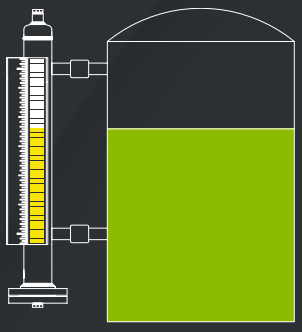


TMR *BMR*

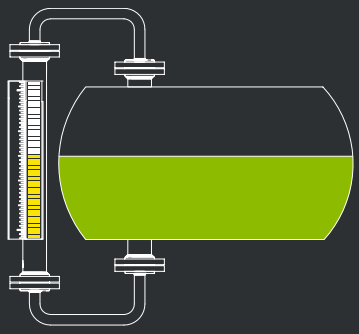
GENERAL INSTALLATIONS



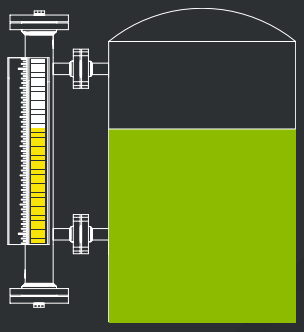
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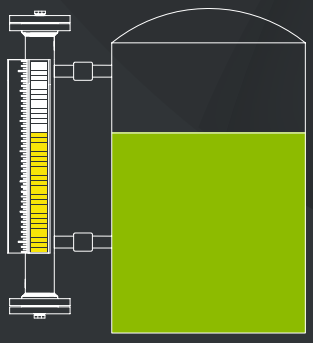
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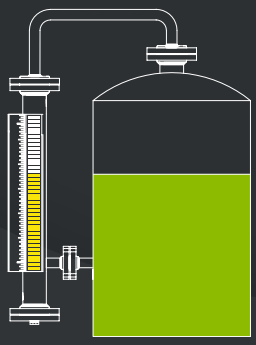
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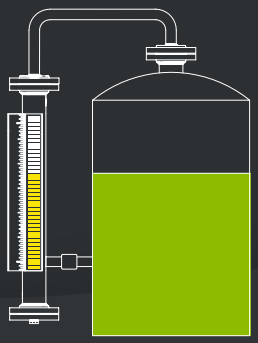
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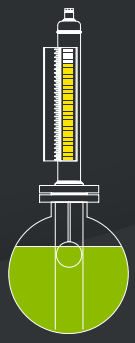
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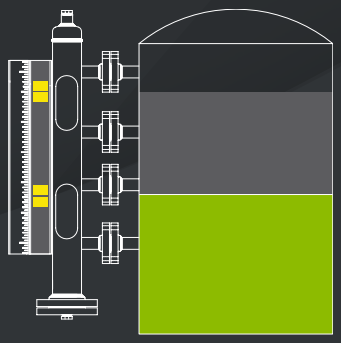
Style F



Style G



Style H



Style X

Applications

- Acetic Acid
- Ammonia
- Asphalt Settler
- Benzene
- Blow case
- Boiler Steam Drum
- Butane
- Caustics
- Cooling Towers
- Deionized Water
- Dow Therm
- Drip Pot
- Feedwater Heaters
- Flare Drums
- Freon
- Glycol
- Hydraulic Oil
- Hydrazine
- Hydrochloric Acid
- Hydrofluoric Acid
- Hydrogen Sulfide
- Interface (i.e. oil/water)
- Jet Fuel
- LPG
- Liquid Carbon Dioxide
- Liquid Ethylene
- Molten Sulfur
- Phosgene
- Propylene
- Propane
- Seal Oil Pots
- Slop Oil
- Sour Oil
- Sump Tank
- Underground Storage
- and more...

Other Products



Bypass



IT2523



Seal Pot



Day Tanks

OPTIONS AND CUSTOMIZATIONS



SANITARY MAG-GAGE®
Tri-colored flags



DUAL CHAMBER
Options: MAG-TRANS®, Guided Wave Radar



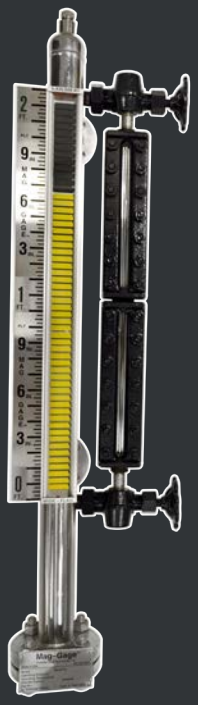
PLASTICS
Options: CPVC, KYNAR, Others



HIGH TEMPERATURE INSULATION



CRYOGENIC INSULATION



INTEGRAL SIGHTGLASS

INQUIRIES

Upon product inquiry, a thorough analysis of the customer's application and product specifications is performed. Promptly after the initial inquiry, PLT issues a quotation in complete compliance with the application/specifications previously submitted.

DELIVERABLES

After purchase date, a standard shipping term between 2 to 4 weeks will be issued with all standard orders. Requests for a faster delivery, or immediate (24 hour) delivery can be accommodated. Any delivery requirements are to be given with initial inquiry in order to ensure on time delivery.



Process Level Technology, Ltd.
MAG-GAGE®

888 Clear Creek Ave.
League City, TX 77573
Phone 281 332 6241
Fax 281 332 0232
www.mag-gage.com

MADE IN USA

© 2016

Process Level Technology, Ltd.



MAG-GAGE® IOM

INSTALLATION, OPERATION AND MAINTENANCE MANUAL

888 CLEAR CREEK AVE LEAGUE CITY, TEXAS 77573
Phone # (281) 332-MAG1(6241)
Fax # (281) 332-0232
WWW.MAG-GAGE.COM

PLT MAG-GAGE Revision 05

Process Level Technology, Ltd.
Installation, Operation and Maintenance Instructions

Contents

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"MAG-GAGE®"

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2.1.2. Components
2.1.3. Chamber Material
2.1.4. Internal Float
2.1.5. Float Submergence
2.1.6. Gage ratings
2.1.7. Hydrostatic Testing

2.2.0. Level Indication
2.2.1. Introduction
2.2.2. Single Indication (SI)
2.2.3. Single Indication - Reference Guide
2.2.4. Flag/Flipper Indication (FL)
2.2.5. Flag/Flipper Indication - Reference Guide
2.2.6. Flag /Flipper Indication - Retrofit

2.3.0. Installation
2.3.1. Inspection
2.3.2. Chamber Orientation
2.3.3. Connection Valves
2.3.4. Float Orientation
2.3.5. Chamber Gaskets
2.3.6. Flanges and Connections
2.3.7. Interface Applications

2.4.0. Operation
2.4.1. Introduction
2.4.2. Procedures/Storage

2.5.0. Removal From Service
2.5.1. Introduction
2.5.2. Procedures

Process Level Technology, Ltd.
Installation, Operation and Maintenance Instructions

Contents

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2.6.1. Introduction
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2.7.0. Troubleshooting
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2.7.2. Float & Indicator Detachment
2.7.3. Differential Level
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2.7.5. Switch Malfunctioning

2.8.0. Parts List
2.8.1. Introduction
2.8.2. Chamber
2.8.3. Indicator & Scale Assembly

2.9.0. Warranty
2.9.1. Introduction
2.9.2. Conditions
2.9.3. Provisions

2.10.0. Terms and Condition of Sale
2.10.1. Introduction
2.10.2. Terms
2.10.3. Shipment
2.10.4. Restocking
2.10.5. Cancellation

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Section 3.0.0. Pneumatic Level Control

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3.1.1. Introduction
3.1.2. Operating Specifications
3.1.3. Installation Procedures
3.1.4. Operation & Maintenance

3.2.0. Pneumatic Level Controller - LCP
3.2.1. Introduction
3.3.2. Operation

Section 4.0.0. Electronic Level Control

4.1.0. Electric Switches – MGS200EX (/2)
4.1.1. Introduction
4.1.2. Specifications
4.1.3. Mounting
4.1.4. Operation
4.1.5. Electrical Wiring - Rising Level
4.1.6. Electrical Wiring - Falling Level

4.2.0. Electric Switches - MGS500EX (/2)
4.2.1. Introduction
4.2.2. Specifications
4.2.3. Mounting
4.2.4. Operation
4.2.5. Electrical Wiring-Raising Level
4.2.6. Electrical wiring-Falling Level

4.3.0. Electric Switches – MGS700EX(/2) MGS-900EX(/2)
4.3.1. Introduction
4.3.2. Specification
4.3.3. Mounting
4.3.4. Operation
4.3.5. Electrical Wiring-Rising Level
4.3.6. Electrical Wiring-Falling Level

Section 2.1.0. - Description

2.1.1. INTRODUCTION

Process Level Technology, Ltd magnetic level gages (**MAG-GAGE®**) are an indirect reading liquid level indicator. The magnetic level gage series utilize non-magnetic 2.00-inch, schedule 40 chambers (standard) manufactured to length specifications with process connections that match those of the vessel or tank. For some high pressure, low gravity applications, a 3.00-inch schedule 40 chamber is available. The process connections may be:

1. Side mounted, threaded, flanged or socket welded
2. Top and bottom flanged mounted
3. Tank top mounted
4. Combination

A variety of mounting styles is available to suit any vessel or piping requirements. Refer to the drawing depicting magnetic level gage mounting configurations.

2.1.2. COMPONENTS

The gage chamber contains a magnetic float and is completely isolated from the indicator housing attached to the outside of the gage chamber. External indicators consist of a single yellow or continuous flag/flipper models. The magnetic float maintains a magnetic bond with the external level indicator. As the level of the process medium fluctuates within the tank and gage chamber, the float reacts accordingly with the indicator recording the level of the fluid within the chamber.

2.1.3. CHAMBER MATERIAL

Gages are manufactured to meet exact specifications of the process media such as operating pressure, temperature, specific gravity, etc. Standard chamber materials are 316/304 stainless steel however any non-magnetic material may be used. Other chamber materials that are available include CPVC, Kynar, Hastelloy, Alloy 20, Zirconium, Monel, Etc.

Section 2.1.0. – Description

2.1.4. INTERNAL FLOAT

A magnetized float is contained inside the float chamber and is designed to the requirements of the process conditions. For this reason floats are not interchangeable unless the process conditions and gage chambers are identical. The float moves freely inside the chamber reacting to fluctuating level changes within the adjoining vessel.

2.1.5. FLOAT SUBMERGENCE

Under normal operating conditions, the float should be submerged about 80% or more in the process fluid. It is important to note, however, that the position of the float in the media will vary with different process conditions. Float magnets are located in the upper portion of the float.

2.1.6. GAGE RATINGS

Magnetic level gages can be designed for operating conditions from full vacuum service up to 5000 PSIG, 1100 degrees F, and a minimum gravities of 0.20. All magnetic gages with alloy chambers will have full ANSI ratings based on flange classifications. Gages with CPVC, Kynar (PVDF) or Fiberglass shields will have 150 PSIG ratings only.

2.1.7. HYDROSTATIC TESTING

Gage chambers are hydrostatically tested to 150% of indicated gage rating without floats installed. Floats are tested individually. Gages can be field hydrostatically tested after installation at the operator's discretion. ***CAUTION: Do not conduct hydrostatic testing of the magnetic gage chamber attached to a process vessel with the float installed. If a gage is field tested with the float installed, the float may crush and chamber may become damaged. This procedure will void the warranty.***

Section 2.2.0. - Level Indication

2.2.1. INTRODUCTION

There are two types of external level indication options offered by Process Level Technology, Ltd. for magnetic level gages. The single indicator (ST)/(SST) is recommended for stagnant storage level applications with little or no level fluctuations. The wide flag indicator (WF)(SWF) is recommended for turbulent or high vibration level conditions.

2.2.2. SINGLE TRACKER INDICATION (ST or SST)

The single follower assembly used for indicating level consists of a rectangular yellow magnetic follower sealed in a channel with a 316 stainless steel calibration scale marked in feet and inches, total inches or in centimeters. The indicator is mounted parallel and immediately adjacent to the gage chamber to allow maximum magnetic coupling between the float and the follower within the indicator channel. The indicator is sealed to prevent dirt and moisture accumulation. A red bumper is positioned at the bottom of the channel to cushion the impact of the follower against the cover. Although the yellow follower provides maximum visibility even at nighttime, retrofit kits for illuminating gages are available.

2.2.3. SINGLE TRACKER INDICATION - REFERENCE GUIDE

A black reference guide in the center of the yellow follower allows the operator to match the graduated scale with the level of the process fluid. A nameplate at the lower end of the scale provides zero level indication. If the yellow follower is decoupled from the internal float's magnetic field, the follower will descend below the zero point on the scale. Thus, when the vessel is empty, the level gage will read zero and the yellow follower will remain visible. To prevent the float from losing magnetic coupling with the follower, a spring is mounted inside the top and bottom of the gage chamber. This cushion the impact of the float against the chamber ends when the vessel is completely full or empty. The float and the follower are magnetically coupled when the follower remains visible. If the magnetic coupling is lost between the float and follower, use a hand magnet to attract the follower until it is contained within the float's magnetic field. Refer to the Troubleshooting portion of the manual, Section, 2.7.2.

Section 2.2.0. - Level Indication (cont.)

2.2.4. WIDE FLAG/FLIPPER INDICTION (WF),(SWF)

Process Level Technology offers a continuous Wide Flag or Flipper style indicator as an option to the Single Yellow Follower indicator. Flag indications are industrial grade level indicators which consist of a series of ceramic flags, black on one side, yellow on the other. As the magnetic float reacts to level fluctuations, each flag or flipper will rotate 180 degrees to reveal the opposite color.
Process Level Technology, Ltd. a flipper is housed in a rugged sealed housing with a recessed glass window and rotates on a ceramic and stainless steel surface. This eliminates the flippers from sticking or hanging up. The unique design prevents all flippers from rotating in excess of 180 degrees and each flag is magnetically locked to the next. Wide Flag indicators are recommended where surging or turbulent level conditions exist. Each flag indicator is 1.40 inches wide and is more visible than the standard single indicator. These are available with or without scales up to 20 ft.

2.2.5. WIDE FLAG/FLIPPER INDICATION - REFERENCE GUIDE

Yellow represents liquid column, **Black** represents vapor space.

2.2.6. WIDE FLAG/FLIPPER INDICATION - RETROFIT

When flipper style indicators are purchased with a Process Level Technology, Ltd. magnetic level gage, no installation is necessary. If the indicator is removed or a retrofit kit is purchased for a gage already in service, however, the following steps should be noted:

1. The mounting clamps connecting the flipper assembly to the gage chamber are adjustable to most manufacturers' standard, (i.e. 1.50 inch to 2.50-inch pipe). If the gage is in service and there is liquid in the tank, only the flippers adjacent to the float will rotate to yellow when the indicator assembly is clamped on.
2. Run a magnet along the window of the indicator from zero to where yellow is showing as noted, or
3. Drain the gage to zero on the indicator, and then fill again. As the float rises, the level indicator will react accordingly and will be reset properly.

Section 2.3.0. - Installation

2.3.1. INSPECTION

All magnetic level indicators are securely packed in crates to provide maximum protection of the equipment during shipment. It is important to unpack and inspect each gage upon receipt to insure the indicator and chamber were not damaged in shipment. If you should find damaged parts, contact Process Level Technology, Ltd. immediately. All Process Level Technology, Ltd. magnetic gages are fully insured against damage or loss unless specified by the customer otherwise. Claims must be filed within 15 days from the date of receipt of shipment.

2.3.2. CHAMBER ORIENTATION

The **magnetic float is packaged separately for shipment**; the Float is strapped externally to the outside of chamber which should be removed before installation. The float chamber should always be leveled vertically. If it is not leveled correctly, the float may be magnetically uncoupled from the level indicator during operations.

2.3.3. CONNECTION VALVES

Valves should be installed between the process vessel and level gage to allow for isolation, draining, and cleaning purposes. (See section 2.6.2. on Maintenance for more details on cleaning and maintenance procedures). Standard block valves can be ordered with the gage or separately from Process Level Technology. Ball check valves are not necessary for magnetic level gages. If certain valve specifications are required, please advise Process Level Technology, Ltd. accordingly.

2.3.4. FLOAT ORIENTATION

The internal magnetic float has a preferred orientation vertically which is inscribed at the top of the float. Install the float properly by taking note of the correct orientation through the chamber flange connection. If the float is installed into the chamber inverted, it will not couple with the external indicator correctly, resulting in improper level indication. Floats that are installed in gages with inverted chamber construction will contain a loop at the top of the float for installation and removal purposes. **Internal floats should be installed after any hydrostatic field tests of the chamber and connecting vessel are complete.**

Section 2.3.0. - Installation (cont.)

2.3.5. CHAMBER GASKETS

Standard magnetic level gages are supplied with 0.125-inch composition gaskets. If this type of gasket is not compatible with the process media, appropriate gaskets should be used in replacement of those shipped with the gage.

2.3.6. FLANGES AND CONNECTIONS

Process connections and vent/drain flanges are designed to meet each customer's specifications. All flange boltholes straddle the centerline unless otherwise specified. Both male and female threaded connections and socket weld connections are available. ***DO NOT WELD ON MAG-GAGE OR ON THE VESSEL WITH INDICATOR AND FLOAT INSTALLED, THIS WILL DESTROY THE MAGETIC CIRCUIT.***

2.3.7. INTERFACE APPLICATIONS

Magnetic level gages can be used to identify fluid interfaces only if the proper specific gravities have been identified at the maximum operating conditions. The float can designed to float in one media while sinking in the other. Immiscible oil over water levels is an example. Care should exercised, however, when using magnetic level gages in interface applications because *rag layers* may exist which are difficult to identify.

Do not install a gage with two floats and two single indicators on one chamber for an interface**.** In this case the two floats may *collide* causing incorrect readings. Chambers can be manufactured with multiple connections for maximum process influx. The proper method is to install one gage per process phase, not a combination.

Section 2.4.0. - Operation

2.4.1. INTRODUCTION

It is important that all instructions pertaining to entering magnetic level gages into service be read thoroughly first before commencing with service operations. Failure to do so may void the warranty by subjecting the gage to a potential safety hazard.

2.4.2. PROCEDURES

1. Check that the operating conditions, (temperature, pressure and specific gravity) are within that maximum rating of the gage. Each gage has a permanent nameplate indicating process specifications, serial number, tag number, etc. It is critically important to check that the specific gravity of the process media is specified at the maximum operating conditions.

2. The gage chamber should be leveled vertically, empty, blocked in and isolated. Check to see that all drain and vent plugs are in place. Close all vent and drain valves if plugs are not used.

3. For *standard* gages, install the float by removing the bottom drain flange located at the base of the gage. The float is marked TOP to insure proper orientation. A spring is attached to the inside of the drain flange to cushion the float when the vessel is empty. Reinstall the bottom drain blind flange with a new flange gasket after the float is in place.

4. For *inverted* gages, remove the top vent blind flange from the gage chamber. Install the float by inserting a string through the float loop and lower the float into position slowly. Remove the string from the float and chamber after the float is resting on the bottom of the gage. An auxiliary magnet may be required to recouple the indicator, (either single follower or flipper indicator), to the internal float.

5. Reinstall the blind flange with a new gasket. The gage chamber should be isolated with no opening to atmosphere. Check to see that all drain and vent plugs are securely in place and that any vent and drain connections are closed.

Section 2.4.0. - Operation

2.4.2. PROCEDURES (cont.)

6. When the gage is mounted and ready for placement into service, PARTIALLY OPEN THE **TOP** PROCESS CONNECTION VALVE FIRST and very **slowly** to allow initial pressure and temperature equalization between the vessel and the level gage. This allows the process conditions of the vessel to equalize with the gage slowly and reach operating conditions at a slow, even, and reasonable rate.

7. **CAUTION.** DO NOT OPEN THE **BOTTOM** PROCESS CONNECTION VALVE FIRST. IF THE BOTTOM VALVE IS OPENED FIRST WITH THE TOP VALVE CLOSED AND THE VESSEL IS UNDER PRESSURE, THE INTERNAL FLOAT WILL RISE INSTANTLY AND LODGE ITSELF INTO THE TOP OF THE CHAMBER CAUSING SEVERE DAMAGE TO THE FLOAT AND CHAMBER.

8. After the float chamber has reached process conditions, continue to open the **TOP** process connection valve slowly, allowing any liquid or condensate to enter the gage slowly. This procedure is critically important for high pressure and temperature applications. The float and indicator may react or rise to condensate accumulation migrating through the top valve with the bottom valve closed.

9. When the gage chamber has attained normal operating conditions, open the **BOTTOM** process valve connection slowly. This will allow proper fluid entry into the gage chamber under normal operating conditions. The level indicator should rise vertically, thus rendering a fluid level. Flag or flipper indication will result in black to yellow rotation of the flippers as the fluid rises. At this point, installation should be complete. Allow at least 30 minutes for both top and bottom valve procedures.

10. Please note, under elevated operating conditions, the indicator may record a significant level from condensate influx through the top valve *before* the bottom valve is opened. If this is the condition, it is possible the indicator (and float) may readjust and fall slightly from the effects of final process equalization after the bottom valve is completely opened.

11. Extended Storage: All MAG-GAGE® magnetic level gages and gage accessories not put in service shall be stored inside in the original creates

Section 2.5.0. - Removal from Service

2.5.1. INTRODUCTION

To remove the gage from service, the next steps should be followed to prevent danger to personnel and damage to the gage when the vessel is pressurized.

2.5.2. PROCEDURES

1. Close the bottom process connection valve first to prevent further process influx to the gage.

2. Completely close the top process connection valve to isolate the gage from the process conditions.

3. Attach proper vapor collection equipment to the gage vent connection if required.

4. Open the vent valve slowly to relieve gage pressure and allow ambient air influx.

5. Attach the proper liquid collection equipment to the drain connection is required.

6. Open the drain valve slowly to remove remaining gage liquid.

7. **CAUTION**: Never use the vent or drain on a gage as a pressure relief mechanism for the process system. Doing so may permanently damage parts of the gage as well as inducing a safety hazard.

Section 2.6.0. - Maintenance

2.6.1. INTRODUCTION

Process Level Technology, Ltd. magnetic level gages contain a standard 0.50 inch vent and drain plug in the top and bottom of the gage chamber to allow cleaning and removal of the process fluid if required. Socket weld vent and drain valve connections are available. Some gages are connected to a solvent or steam line that allows **empty gages without floats** to be decontaminated or *blown down* periodically without removing the gage from the vessel location. Process Level Technology, Ltd. magnetic gages should be maintained and inspected on at least an annual basis, or more frequently depending on the process system.

2.6.2. PROCEDURES

1. Block in the gage chamber with the process connection valves or wait until the vessel is empty and out of service.

2. Close the bottom valve first and the top valve second.

3. Open the vent valve slowly or remove vent plug carefully to depressurize the gage especially if the gage has been under pressure.

4. Open the drain valve slowly or remove the drain plug carefully to allow any remaining fluid to drain from the chamber.

5. When all of the gage fluid has been drained, carefully remove the drain flange and float from the gage chamber. Be sure to examine the float for excessive wear and clean as required.

6. Clean the inside wall of the chamber with a "bottle brush" or similar scrubbing tool. Some processes may dictate the use of a suitable solvent for cleaning.

7. After cleaning of the chamber, replace the float and drain flange. A new flange gasket should be installed. Use gaskets compatible with the process media if replaced.

Section 2.6.0. - Maintenance

2.6.2. PROCEDURES (cont.)

8. Check the stainless steel pipe clamps to insure they are tight and adjust the scale channel. Correctly match the zero point to process connection elevations.

9. If necessary, use a permanent magnet to attract the yellow indicator until it is coupled to the float inside the chamber.

Section 2.7.0. - Troubleshooting

2.7.1. INTRODUCTION

Process Level Technology, Ltd. magnetic level gages are simple to install and operate. The following troubleshooting tips may be of assistance during installation and startup. Complete reading of this is required.

2.7.2. FLOAT & INDICATOR DETACHMENT

1. If detachment is a frequent problem, it could be caused by several factors, most of them resulting from improper installation of the gage, particularly the float.

2. Check to ensure that the scale and channel assembly is fastened tight against the gage chamber so that magnetic coupling is maintained from top to bottom of the indicator.

3. Check to ensure the internal magnetic float within the chamber is right side up. If the float was installed inverted, the single yellow indicator will magnetically couple, but the actual process level will be higher that what the indicator records. All floats are clearly marked TOP. Floats designed for *inverted* gages will have a loop welded at the top of the float for installation and removal purposes.

4. If the float springs mounted in the top and bottom of the gage chamber have been removed, the float could rise past the top of the indicator and lose magnetic coupling with the indicator.

5. If the process connection dimension has been miscalculated and the gage length is too long, do not attempt installation because it will warp the chamber. A warped chamber will prohibit the float to move freely. This can cause float and indicator detachment.

2.7.3. DIFFERENTIAL LEVEL

This can occur during startup and is easily corrected. Under normal operating conditions, most floats are about 80% submerged in the process media. It is important to note that the position of the float in the fluid will vary with different process conditions. To attain a true level elevation, adjust the scale vertically to get an exact reading.

Section 2.7.0. - Troubleshooting (cont.)

2.7.4. DEFECTIVE INDICATOR

If the glass indicator cover is cracked or broken, a replacement cover can be shipped within 24 hours after receipt of order. One advantage of the magnetic level gage is the indicator assembly can be serviced without removing the gage chamber from service. To replace the indicator cover, remove the four screws from cover plate at the top and bottom of the indicator channel. There are two red gaskets beneath each cover that require removal. Remove the two red seal strips and slide the glass plate cover out of the channel. Clean any debris or fragments. Replace the glass cover with the new glass plate by sliding into the channel again. Replace each red side and top gaskets with the top and bottom covers. If the gage is inexcess of 6 feet in length, it may be easier to remove the indicator from the channel.

2.7.5. SWITCH MALFUNCTIONING

All level switches may be wired to trip on rising or falling level. After the switch is connected to the desired alarm function, it is necessary to set the switch. This is accomplished by passing the float either manually or by filling the gage chamber until it passes the highest switch. This will trip the switch to the desired setting so it will alarm properly with rising or falling level.

Section 2.8.0. - Parts List

2.8.1. INTRODUCTION

When ordering spare parts for the MAG-GAGE® series magnetic level gage, the following information will be required.

1. Serial number of the gage or accessory item.
2. Description of parts to be ordered.
3. Model number of the parts to be ordered, if known.
4. Original purchase order, if known.

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2.8.2. CHAMBER

1. Vent plug.
2. Float chamber
3. Chamber blind flange, spring, and gasket.
4. Drain plug.
5. Internal magnetic float.

2.8.3. INDICATOR & SCALE ASSEMBLY

1. Channel assembly
2. Anodized Alum. Indicator track with single tracker follower or wide flag indication
3. Stainless Steel Indicator track with single tracker follower or wide flag indication
4. Top and bottom seals
5. Calibration scale (total inches, feet & inches, centimeters)
6. Chamber clamps
7. Identification Tag.

Section 2.9.0. - Warranty

2.9.1. INTRODUCTION

All Process Level Technology, Ltd. products are warranted against defects in material and workmanship for one year (365 days) from the date of shipment. Process Level Technology, Ltd. will repair or replace those products that fail to perform as specified with the following exceptions. This warranty does not apply to glass breakage or any other liability other than materials and workmanship.

2.9.2. CONDITIONS

1. Products repaired or modified by persons that are unauthorized by Process Level Technology, Ltd

2. Products subject to misuse, negligence or accidents

3. Products that are connected installed or otherwise used in such a way not in accordance with the manufacturer's instructions.

2.9.3. PROVISIONS

This warranty is in lieu of any other warranty expressed or implied by any party other than Process Level Technology, Ltd. Repairs and/or replacements shall be at the sole discretion of Process Level Technology, Ltd. based on the terms and conditions.

Section 2.10.0. - Terms and Condition of Sale

2.10.1. INTRODUCTION

All orders should be entered to the following address:

Process Level Technology, Ltd.
888 Clear Creek Ave.
League City, Texas 77573
PH# (281) 332-MAG1(6241), Fax# (281) 332-0232

2.10.2. TERMS

The payment terms are **Net 30 days** to approved customers. Sales representatives may assume collection responsibility for new accounts at their discretion. Late charges will be added at the rate of 1.50% per month.

2.10.3. SHIPMENT

All shipments will be **F.O.B. factory location, Houston, Texas**, via motorfreight insured. Freight charges are normally prepaid and added to invoice unless specified otherwise.

2.10.4. RESTOCKING

Every magnetic level gage is designed and manufactured to exact customer specifications. As a result, there will be **no restocking option** after shipment is made.

2.10.5. CANCELLATION

Cancellation charges after order placement will be at the discretion of Process Level Technology, Ltd. and dependent upon production phase of the product.

Section 3.1.0. - Non Bleed, Block & Bleed Switches (MGS-100)

3.1.1. INTRODUCTION

MGS-100 pneumatic switches are designed for use on magnetic MAG-GAGE® series gages only. The MGS-100 is a non-bleed, block and bleed pneumatic switch operates when the magnetic field of a Process Level Technology, Ltd. magnetic float passes by it, either on a rising or falling level condition. Since there is no physical interaction or connection between the switch and float, it is very important that all installation instructions be followed properly for the switch to function reliably. Please read all installation and operation instructions before beginning installation.

3.1.2. OPERATING SPECIFICATIONS

Medium:	Filtered Air or Gas
Supply Pressure:	VAC to 200 PSIG
Max. Temp:	200 degrees F (93C)
Air Flow:	29 SCFM @ 100 PSIG
Air Consumption:	Zero SCFM

3.1.3. INSTALLATION

1. Loosen the included hose clamps completely and install them so they surround the gage chamber. Reattach the clamp to itself, make 2 or 3 turns of the clamp's screw but do not reattach completely.

2. Insert the top "L" shaped bracket under the top hose clamp and tighten the clamp to the gage chamber. The top bracket is the bracket above the front label if the writing is right side up. Before tightening, you may adjust the height at which you would like the alarm to trigger. The trigger point is at the midpoint of the enclosure.

3. Since the switch should be securely fastened to the gage chamber by the top clamp, slide the bottom hose clamp over the bottom bracket and tighten the clamp to the gage chamber.

Section 3.1.0. - Non Bleed, Block & Bleed Switches MGS-100

3.1.4. INSTALLATION - (cont.)

4. The alarm switch should be mounted so that it is level with the ground. If it is not level, loosen the hose clamps, adjust the switch's alignment, and when the switch is level, retighten the hose clamps. Improper alignment may cause the switch to malfunction.

5. The switch must also be flush and tighten against the chamber. Failure to do this results in vibration and rattling of the switch, which may in extreme circumstances cause the switch to fail.

6. No material should be present between the switch housing and the gage chamber. Any material present can interfere with the magnetic field of the internal float and prevent proper activation of the switch.

3.1.6. OPERATION & MAINTENANCE

1. The pneumatic supply line must be connected to the connection labeled 1 OR 2 The output to the alarm or other signaling device must be connected to the connection labeled **PORT 3**.
2. **PORT 1** is the supply port that will activate the output when the float passes above the switch. Port 2 is the vent It is to be used as a *HIGH LEVEL* indicator.
3. **PORT 2** activates the output when the float passes below the switch. Port 1 is the vent IT is to be used as a *LOW LEVEL* indicator.
4. All input and output connections are 1/4-inch NPT connections.
5. The muffler must remain uncovered and clean for proper non-bleeding functioning of the switch. If covered, the interior of the switch may pressurize and explode.
6. Pneumatic connections must provide air or gas that is free of particulate matter or debris. Dirty supply gas may cause the valve inside to clog and lead the switch to failure.
7. When the switch is first installed, **it is necessary to set the switch for normal operation**. This is accomplished by passing the float pass the switch, the chamber can be filled with liquid so the float will pass the highest switch and then drained, or by manually sliding the switch pass the float in both directions. If the switch is being positioned above the float, the float must pass in the down direction before installation and conversely if the switch is positioned below the float.

Section 3.2.0. - Pneumatic Level Controller (LCP)

3.2.1. INTRODUCTION

The LCP Pneumatic Level Switch Controller provides supply and vent air control for two pneumatic switches used in a high and low point level application. The LCP is designed to be used with pneumatic switches on magnetic MAG-GAGE® series gages only.

3.2.2. OPERATION

1. As the float rises past the high pneumatic switch level, it will supply air to the port P4 of the controller.

2. When port P4 has air supplied to it there will be a pneumatic signal out of port 2 of the controller. The pneumatic signal will continue until the float passes the low pneumatic switch.

3. The low switch will supply a signal to port P2 on the controller therefore shutting the pneumatic signal off. The output signal will stay off until the float rises past the high pneumatic switch.

4. The cycle will then repeat.

5. To reverse the output on the controller, connect the high pneumatic switch to port P2, and the low pneumatic switch to P4 on the controller.

Section 4.1.0. – Electric Level Switches (MGS-200EX/MGS-200EX2)

4.1.1 INTRODUCTION

The MGS-200EX and MGS-200EX2 are hermetically sealed bistable-latching switches designed for magnetic MAG-GAGE® series gages only. The MGS-200EX has single pole double throw contacts (SPDT) and the MGS-200EX2 has double pole, double throw contacts (DPDT). The switch will change state when the float passes by it in a rising or falling level condition. The switch remains in a latched position until the float passes the switch in the opposite direction. The MGS-200EX and MGS-200EX2 does not require any routine maintenance

4.1.2 SPECIFICATIONS

Maximum switching voltage:	150 VDC/VAC
Maximum switching current amps:	1.0 amps (VDC/VAC)
Maximum switching wattage:	25 watts (VDC/VAC)
Minimum breakdown volts:	250 VDC
Maximum Temperature (standard):	350 degrees F
Maximum Temperature (HT option):	800 degrees F
Ambient Temperature Range	-25C to +85C
Dead Band:	0.35 inch
Electrical Area Classification:	Class I Div I Grp. B,C,D

4.1.3 MOUNTING

The MGS-200EX/EX2 is mounted to the MAG-GAGE® chamber with all 316 Stainless Steel worm gear pipe clamps. Rod mounted switch assemblies are available as a factory installed option. Switch points can be changed at any time by loosening the clamps and sliding the switch vertically to the desired set point.

4.1.4 OPERATION

When the switch is first installed, it is necessary to set the switch for normal operation. This is accomplished by passing the float pass the switch, the chamber can be filled with liquid so the float will pass the highest switch and then drained, or by manually sliding the switch pass the float in both directions. If the switch is being positioned above the float, the float must pass in the down direction before installation and conversely if the switch is positioned below the float.

Section 4.3.0. – Electric Level Switches (MGS-200EX/MGS-200EX2)

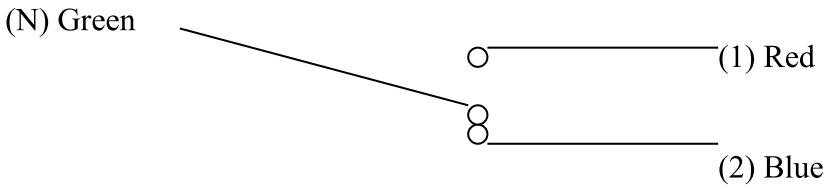
Caution: If there is a need to take the switch out of service or disconnect it for any reason, then make the sure the circuit is de-energized.
Note: Keep cover tightly closed when in operation. To prevent ignition of GRP. B atmospheres a approved sealing fitting must be installed

4.1.5 ELECTRICAL WIRING – RISING LEVEL

N/O	Red	Terminal 1	Closes on rising level.
C	Green	Terminal N	
N/C	Blue	Terminal 2	Opens on rising level.

4.1.6 ELECTRICAL WIRING – FALLING LEVEL

N/C	Red	Terminal 1	Opens on falling level.
C	Green	Terminal N	
N/O	Blue	Terminal 2	Closes on falling level.



Section 4.2.0. – Electric Level Switches (MGS-500EX/MGS-500EX2)

4.2.1 INTRODUCTION

The MGS-500EX and MGS-500EX2 are hermetically sealed bistable-latching switches designed for magnetic MAG-GAGE® series gages only. The MGS-500EX has single pole double throw contacts (SPDT) and the MGS-500EX2 has double pole, double throw contacts (DPDT). The switch will change state when the float passes by it in a rising or falling level condition. The switch remains in a latched position until the float passes the switch in the opposite direction.
The MGS-500EX and MGS-500EX2 does not require any routine maintenance

4.2.2 SPECIFICATIONS

Maximum switching voltage:	300 VDC/VAC
Maximum switching current amps:	3.0 amps (VDC/VAC)
Maximum switching wattage:	100 watts (VDC/VAC)
Minimum breakdown volts:	1000 VDC
Maximum Temperature (standard):	350 degrees F
Maximum Temperature (HT option):	650 degrees F
Ambient Temperature Range	-25C to +85C
Dead Band:	0.35 inch
Electrical Area Classification:	Class I Div I Grp. B,C,D

4.2.3 MOUNTING

The MGS-500EX/EX2 is mounted to the MAG-GAGE® chamber with all 316 Stainless Steel worm gear pipe clamps. Rod mounted switch assemblies are available as a factory installed option. Switch points can be changed at any time by loosening the clamps and sliding the switch vertically to the desired set point.

4.2.4 OPERATION

When the switch is first installed, it is necessary to set the switch for normal operation. This is accomplished by passing the float pass the switch, the chamber can be filled with liquid so the float will pass the highest switch and then drained, or by manually sliding the switch pass the float in both directions. If the switch is being positioned above the float, the float must pass in the down direction before installation and conversely if the switch is positioned below the float.

Section 4.2.0. – Electric Level Switches (MGS-500EX/MGS-500EX2)

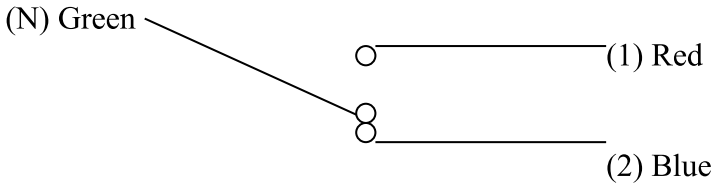
Caution: If there is a need to take the switch out of service or disconnect it for any reason, then make the sure the circuit is de-energized.
Note: Keep cover tightly closed when in operation. To prevent ignition of GRP. B atmospheres a approved sealing fitting must be installed

4.2.5 ELECTRICAL WIRING – RISING LEVEL

N/O	Red	Terminal 1	Closes on rising level.
C	Green	Terminal N	
N/C	Blue	Terminal 2	Opens on rising level.

4.2.6 ELECTRICAL WIRING – FALLING LEVEL

N/C	Red	Terminal 1	Opens on falling level.
C	Green	Terminal N	
N/O	Blue	Terminal 2	Closes on falling level.



Section 4.3.0. – Electric Level Switches (MGS-700EX(/2),MGS-900EX2(/2))

4.3.1 INTRODUCTION

The MGS-700/900EX and MGS-700/900EX2 are bistable-latching switches designed for Process Level Technology, Ltd. MAG-GAGE® series gages only. The MGS-700/900EX has single pole double throw contacts (SPDT) and the MGS-700/900EX2 has double pole, double throw contacts (DPDT). The switch will change state when the float passes by it in a rising or falling level condition. The switch remains in a latched position until the float passes the switch in the opposite direction.

4.3.2 SPECIFICATIONS

	MGS-700EX(/2)	MGS-900EX(/2)
Maximum switching voltage:	250 VAC	250 VAC
Maximum switching current amps:	10.0 amps VAC	15.0amps VAC
Maximum switching wattage:	2500 watts VAC	3250 watts VAC
Maximum Temperature (standard):	350 degrees F	350 degree F
Maximum Temperature (HT option):	650 degrees F	650 degree F
Dead Band:	0.35 inch	0.35 inch
Electrical Area Classification:	Class I Div I Grp. B,C,D	

4.3.3 MOUNTING

The MGS-700EX/900EX,(/2) is mounted to the MAG-GAGE® chamber with all 316 Stainless Steel worm gear pipe clamps. The switch must be mounted with TOP facing up. Rod mounted switch assemblies are available as a factory installed option. Switch points can be changed at any time by loosening the clamps and sliding the switch vertically to the desired set point.

4.3.4 OPERATION

When the switch is first installed, it is necessary to set the switch for normal operation. This is accomplished by passing the float pass the switch, the chamber can be filled with liquid so the float will pass the highest switch and then drained, or by manually sliding the switch pass the float in both directions. If the switch is being positioned above the float, the float must pass in the down direction before installation and conversely if the switch is positioned below the float.

Section 4.3.0. – Electric Level Switches (MGS-700EX(/2), MGS-900EX2(/2))

Caution: If there is a need to take the switch out of service or disconnect it for any reason, then make the sure the circuit is de-energized.
Note: Keep cover tightly closed when in operation. To prevent ignition of GRP. B atmospheres a approved sealing fitting must be installed

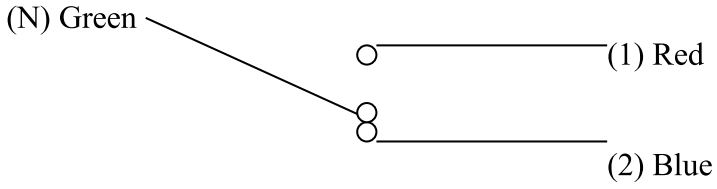
4.3.5 ELECTRICAL WIRING – RISING LEVEL

N/O	Red	Terminal 1(4)	Closes on rising level.
C	Green	Terminal 2(5)	
N/C	Blue	Terminal 3(6)	Opens on rising level.

4.3.6 ELECTRICAL WIRING – FALLING LEVEL

N/C	Red	Terminal 1(4)	Opens on falling level.
C	Green	Terminal 2(5)	
N/O	Blue	Terminal 3(6)	Closes on falling level.

*(#) DPDT



Quality Products & Sales Inc
Orifice Metering Division
PO Box 7
Broken Arrow Ok 74013
Local #(918) 251-0115 * Watts #(800) 444-4634 * Fax #(918) 455-1982

ORIFICE PLATE INSTALLATION INSTRUCTIONS

1. Make certain the pipeline is not under pressure and has been properly drained or purged as required.

2. Loosen all Studs

3. Remove the studs in one half of the flange union.

4. Spread flange union by turning jackscrews clockwise.

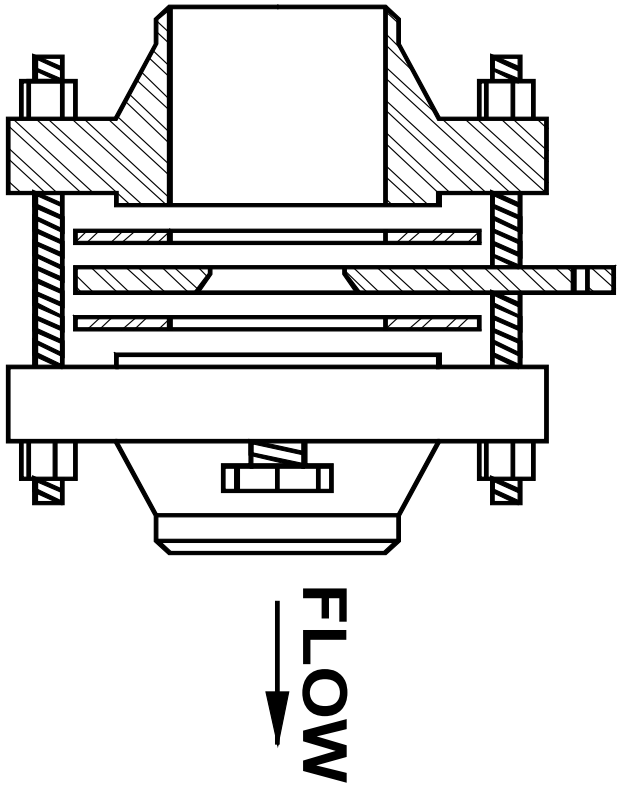
5. Install new plate or removed existing replacement or inspection.
(Be Sure the Beveled Side is toward the downstream)

6. Install new gaskets when installing plate. We recommend installing new gaskets each time the flange union is seperated.

7. Release the flange union by turning jackscrews counter clockwise.

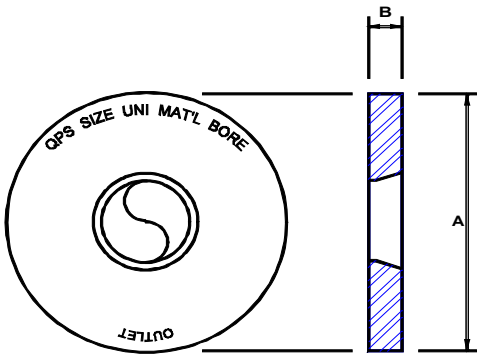
8. Replace studs.

9. Tighten studs starting with two studs opposite each other.



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Universal Fitting Orifice Plates



LINE SIZE	PLATE OUTER DIAMETER	SPECIAL OUTER DIAMETER	STANDARD PLATE THICKNESS	LINE SIZE	PLATE OUTER DIAMETER	SPECIAL OUTER DIAMETER	STANDARD PLATE THICKNESS
	A	A+	B		A	A+	B
3/4	1.125	1.125	.125	14	14.563	14.000	.250
1	1.312	1.312	.125	16	16.563	16.000	.375
1-1/2	2.000	2.000	.125	18	18.563	18.000	.375
2	2.437	2.437	.125	20	20.563	20.000	.375
2-1/2	2.812	2.812	.125	24	24.500	24.000	.375
3	3.437	3.437	.125	26	26.750	26.000	.375
4	4.406	4.406	.125	30	30.750	30.000	.500
6	6.437	6.437	.125	34	35.228	*	.500
8	8.437	8.437	.125	36	38.000	*	.500
10	10.687	10.687	.250	42	44.000	*	.750
12	13.079	12.593	.250				

MATERIALS: 304 SS., 316 SS., MONEL, HASTELLOY, TITANIUM, TANTALUM, INCONEL, ALLOY 20

Other materials available upon request

Manufactured to meet
A.G.A. REPORT #3
A.P.I. 14.3.2
ASME SPECIFICATIONS
I.S.O. 9001 SPECIFICATIONS

Calculations available using equations
A.G.A. REPORT #3
API-2530
ASME MFC-3M
ISO-5167

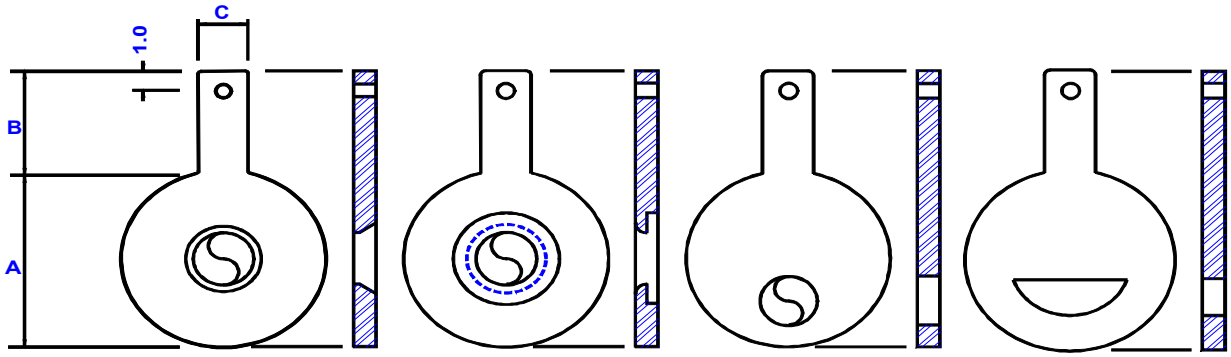
NOTE 1: (A) Outer diameters are for use with bonded Seal rings .
NOTE 2: (A+) Outer diameters are for use in RTJ holders, slip dual and Teflon Seal rings.

Seal Rings
Available in all sizes, styles and materials

Dual and Single Chamber fittings sold separate

Quality Products & Sales Inc
Orifice Metering Division
PO Box 7
Broken Arrow Ok 74013
Local #(918) 251-0115 * Watts #(800) 444-4634 * Fax #(918) 455-1982

Paddle Type Orifice Plate



BORE & BEVEL | QUADRANT BORE | ECCENTRIC BORE | SEGMENTAL BORE

LINE SIZE	150# FLANGE RATING	300# FLANGE RATING	400# FLANGE RATING	600# FLANGE RATING	900# FLANGE RATING	1500# FLANGE RATING	2500# FLANGE RATING	HANDLE LENGTH	HANDLE WIDTH
	A	A	A	A	A	A	A	B	C
1/2	1.875	2.125	2.125	2.125	2.500	2.500	2.750	4.0	1.0
3/4	2.250	2.625	2.625	2.625	2.750	2.750	3.000	4.0	1.0
1	2.625	2.875	2.875	2.875	3.125	3.125	3.375	4.0	1.0
1-1/2	3.375	3.750	3.750	3.750	3.875	3.875	4.625	4.0	1.0
2	4.125	4.375	4.375	4.375	5.625	5.625	5.750	4.0	1.0
2-1/2	4.875	5.125	5.125	5.125	6.500	6.500	6.625	4.0	1.0
3	5.375	5.875	5.875	5.875	6.625	6.875	7.750	4.0	1.0
4	6.875	7.125	7.000	7.625	8.125	8.250	9.250	4.0	1.0
6	8.750	9.875	9.750	10.500	11.375	11.125	12.500	6.0	1.0
8	11.000	12.125	12.000	12.625	14.125	13.875	15.250	6.0	1.0
10	13.375	14.250	14.125	15.750	17.125	17.125	18.750	6.0	1.0
12	16.125	16.625	16.500	18.000	19.625	20.500	21.625	6.0	1.0
14	17.750	19.125	19.000	19.375	20.500	22.750	*	6.0	1.0
16	20.250	21.250	21.125	22.250	22.625	25.250	*	6.0	1.0
18	21.500	23.375	23.250	24.000	25.000	27.625	*	6.0	1.0
20	23.750	25.625	25.375	26.750	27.375	29.625	*	6.0	1.0
24	28.125	30.375	30.125	31.000	32.875	35.500	*	6.0	1.0

MATERIALS: 304 SS., 316 SS., MONEL, HASTELLOY, TITANIUM, TANTALUM, INCONEL, ALLOY 2(

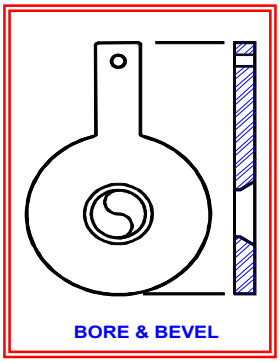
Other materials available upon request

Manufactured to meet
A.G.A Report #3
A.P.I 14.3.2
ASME SPECIFICATIONS
I.S.O. SPECIFICATIONS

Calculations available using equations
A.G.A. REPORT #3
API-2530
ASME MFC-3M
ISO-5167
Orifice Flanges sold seperate

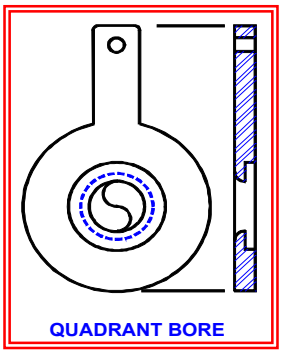
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Orifice Metering Division
PO Box 7
Broken Arrow Ok 74013
Local #(918) 251-0115 * Watts #(800) 444-4634 * Fax #(918) 455-1982

Paddle Type Orifice Plate



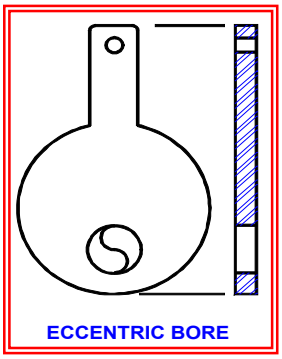
The Concentric Bore & Bevel is the most widely accepted style of Orifice Plate. The bevel is machined on the downstream side to narrow the bore edge to the appropriate edge thickness.

*** Bore & Bevels are designed for clean gases/vapors and liquids.**



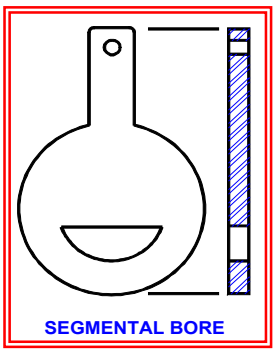
The Quadrant bored Orifice Plate is machined with a rounded inlet edge. The thickness of the plate must be at least equal to the radius. Any excess material is removed with a counter-bore on the downstream side of the plate.

*** Quadrant bores are designed for dirty, viscous and corrosive liquid**



The Eccentric bored Orifice Plate is machined off center. With the bottom of the bore setting inscribed within a circle equal to 98% of the pipe diameter.

*** Eccentric bores are designed for dirty gases/vapors and liquids with solids or slurries entrapped in the line.**

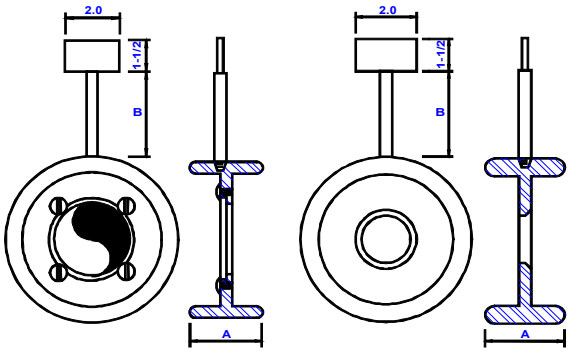


The Segmental bored Orifice Plate is machined by removing a segment of a circle. With the bottom of the bore setting inscribed within a circle equal to 98% of the pipe diameter.

*** Segmental bores are designed for dirty gases/vapors and liquids**

Quality Products & Sales Inc
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RTJ ORIFICE PLATES AND HOLDERS



MODEL 590 MODEL 560

PIPE SIZE	300-600# RATING				900# RATING			
	API RING NUMBER	OVERALL THICKNESS	HANDLE LENGTH	APPROXIMATE GAP	API RING NUMBER	OVERALL THICKNESS	HANDLE LENGTH	APPROXIMATE GAP
		A	B	*		A	B	*
1/2	R-11	.906	4.50	.593	R-12	1.00	4.50	.593
3/4	R-13	1.00	4.50	.593	R-14	1.00	4.50	.593
1	R-16	1.00	4.50	.593	R-16	1.00	4.50	.593
1-1/2	R-20	1.00	4.50	.593	R-20	1.00	4.50	.593
2	R-23	1.062	4.50	.593	R-24	1.062	5.50	.531
2-1/2	R-26	1.062	5.50	.593	R-27	1.062	5.50	.531
3	R-31	1.062	5.50	.593	R-31	1.062	5.50	.531
4	R-37	1.062	5.50	.593	R-37	1.062	5.50	.531
6	R-45	1.062	6.50	.593	R-45	1.062	6.50	.531
8	R-49	1.062	6.50	.593	R-49	1.062	6.50	.531
10	R-53	1.187	7.50	.718	R-53	1.187	7.50	.565
12	R-57	1.187	7.50	.718	R-57	1.187	7.50	.565
14	R-61	1.187	7.50	.718	R-62	1.437	7.50	.718
16	R-65	1.312	7.50	.843	R-66	1.562	7.50	.843
18	R-69	1.312	7.50	.843	R-70	1.687	7.50	.875
20	R-73	1.250	7.50	.718	R-74	1.562	7.50	.750
24	R-77	1.437	7.50	.812	R-78	1.875	9.50	.781

MATERIALS: Carbon Steel, Stainless Steel, Chromoly, Monel, Hastelloy

Other materials and schedules available

Style 590 available in sizes 3" and larger.

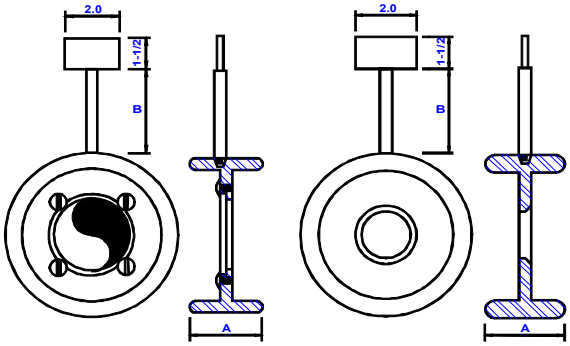
Style 560 available in sizes 1/2" and larger.
2" through 8" sizes have a 1/4"
standard plate thickness. Add
1/8" to the "A" and Gap dimensions

Manufactured to meet
A.G.A Report #3
A.P.I 14.3
ASME SPECIFICATIONS

Seal rings sold seperately

Quality Products & Sales Inc
Orifice Metering Division
PO Box 7
Broken Arrow Ok 74013
Local #(918) 251-0115 * Watts #(800) 444-4634 * Fax #(918) 455-1982

RTJ ORIFICE PLATES AND HOLDERS



MODEL 590 **MODEL 560**

PIPE SIZE	1500# RATING				2500# RATING			
	API RING NUMBER	OVERALL THICKNESS	HANDLE LENGTH	APPROXIMATE GAP	API RING NUMBER	OVERALL THICKNESS	HANDLE LENGTH	APPROXIMATE GAP
		A	B	*		A	B	*
1/2	R-12	1.00	4.50	.593	R-13	1.00	4.50	.593
3/4	R-14	1.00	4.50	.593	R-16	1.00	4.50	.593
1	R-16	1.00	4.50	.593	R-18	1.00	4.50	.593
1-1/2	R-20	1.00	4.50	.593	R-23	1.062	5.50	.500
2	R-24	1.062	5.50	.500	R-26	1.602	5.50	.500
2-1/2	R-27	1.062	5.50	.500	R-28	1.187	5.50	.562
3	R-35	1.062	5.50	.500	R-32	1.187	6.50	.562
4	R-39	1.062	5.50	.500	R-38	1.312	6.50	.593
6	R-46	1.187	6.50	.562	R-47	1.437	7.50	.593
8	R-50	1.312	6.50	.593	R-51	1.562	8.50	.625
10	R-54	1.437	7.50	.718	R-55	2.00	8.50	.812
12	R-58	1.687	8.50	.750	R-60	2.125	9.50	.875
14	R-63	1.875	8.50	.781				
16	R-67	2.125	9.50	1.00				
18	R-71	2.125	9.50	1.00				
20	R-75	2.125	10.50	.875				
24	R-79	2.312	11.50	1.00				

MATERIALS: Carbon Steel, Stainless Steel, Chromoly, Monel, Hastelloy

Other materials and schedules available

Style 590 available in sizes 3" and larger.

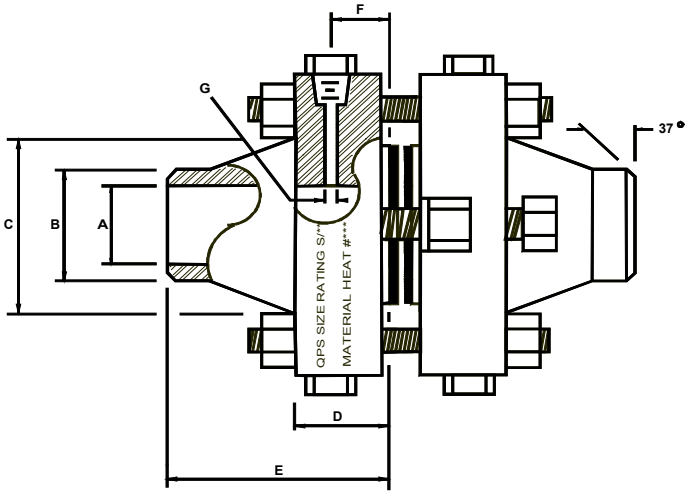
Style 560 available in sizes 1/2" and larger. 2" through 8" sizes have a 1/4" standard plate thickness. Add 1/8" to the "A" and Gap dimensions

Manufactured to meet
A.G.A Report #3
A.P.I 14.3
ASME SPECIFICATIONS

Seal rings sold seperately

Quality Products & Sales Inc
Orifice Metering Division
PO Box 7
Broken Arrow Ok 74013
Local #(918) 251-0115 * Watts #(800) 444-4634 * Fax #(918) 455-1982

300# RFWN ORIFICE FLANGE UNION



PIPE SIZE	(A) BORE	(B) POINT OF WELD	(C) HUB AT BASE	(D) MINIMUM FLANGE THICKNESS	(E) OVERALL LENGTH	(F) CENTER OF TAP	(G) PRESSURE TAP HOLE SIZE	DIAMETER OF RAISED FACE	DIAMETER OF BOLT CIRCLE	DIAMETER OF HOLES	NUMBER OF HOLES	SIZE OF STUDS	SIZE OF JACKSCREWS	APPROXIMATE WEIGHT
	A	B	C	D	E	F	G							
1/2	.622	.84	1.50	1.5	3.00	.937	.25	1.37	2.62	.562	4	1/2 X 4-3/4	1/2 X 4	10
3/4	.824	1.05	1.87	1.5	3.12	.937	.25	1.68	3.25	.687	4	5/8 X 5-1/4	1/2 X 4	10
1	1.049	1.32	2.12	1.5	3.25	.937	.25	2.00	3.50	.687	4	5/8 X 5-1/4	5/8 X 4	18
1-1/2	1.610	1.90	2.75	1.5	3.37	.937	.25	2.87	4.50	.812	4	3/4 X 5-1/4	5/8 X 4	25
2	2.067	2.38	3.31	1.5	3.37	.937	.375	3.62	5.00	.687	8	5/8 X 5-1/4	5/8 X 4	27
2-1/2	2.469	2.88	3.93	1.5	3.50	.937	.375	4.12	5.87	.812	8	3/4 X 5-1/4	5/8 X 4	35
3	3.068	3.50	4.62	1.5	3.50	.937	.375	5.00	6.62	.812	8	3/4 X 5-1/4	3/4 X 4	43
4	4.026	4.50	5.75	1.5	3.62	.937	.500	6.18	7.87	.812	8	3/4 X 5-1/4	3/4 X 4	66
6	6.065	6.63	8.12	1.5	3.93	.937	.500	8.50	10.62	.875	12	3/4 X 5-1/4	3/4 X 4	106
8	7.981	8.63	10.25	1.62	4.37	.937	.500	10.62	13.00	1.00	12	7/8 X 5-3/4	3/4 X 4	152
10	10.020	10.75	12.62	1.87	4.62	.937	.500	12.75	15.25	1.125	16	1 X 6-1/2	3/4 X 4	216
12	12.000	12.75	14.75	2.0	5.12	.937	.500	15.00	17.75	1.250	16	1-1/8 X 7	3/4 X 4	327
14	13.250	14.00	16.75	2.12	5.62	.937	.500	16.25	20.25	1.250	20	1-1/8 X 7-1/2	1 X 5-1/2	448
16	15.250	16.00	19.0	2.25	5.75	.937	.500	18.50	22.50	1.375	20	1-1/4 X 8	1 X 5-1/2	596
18	17.250	18.00	21.0	2.37	6.25	.937	.500	21.00	24.75	1.375	24	1-1/4 X 8-1/4	1 X 5-1/2	741
20	19.250	20.00	23.12	2.50	6.37	.937	.500	23.00	27.00	1.375	24	1-1/4 X 8-1/2	1 X 5-1/2	887
24	23.250	24.00	27.62	2.75	6.62	.937	.500	27.25	32.00	1.625	24	1-1/2 X 9-1/2	1 X 5-1/2	1311

MATERIALS: A105 (C.S.) AND A182 (S.S.)

Other materials and schedules available

HARDWARE:

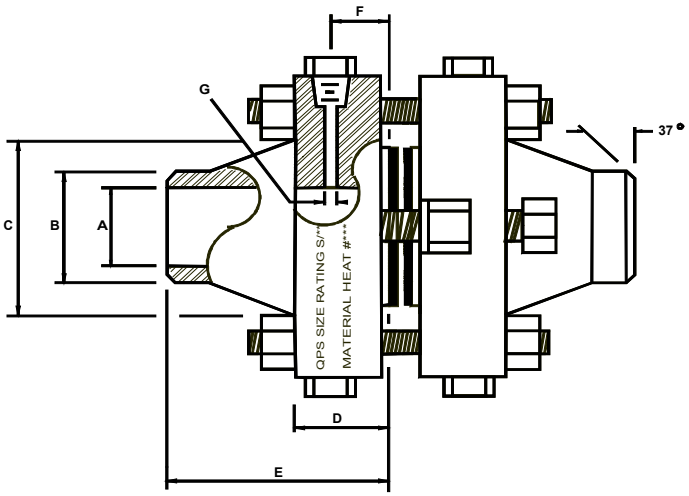
Stud Bolts: A193 Gr. B7 Steel
Hex Nuts: A194 Gr. 2H Steel
Jackscrew: C1018 Hardened Square Head Screws
Pipe Plugs: Hex Head, Forged Steel
Ring Gaskets: C4430 Non-Asbestos

Manufactured to meet
A.G.A Report #3-2
A.P.I 14.3
ASME SPECIFICATIONS

Orifice Plates sold seperate

Quality Products & Sales Inc
Orifice Metering Division
PO Box 7
Broken Arrow Ok 74013
Local #(918) 251-0115 * Watts #(800) 444-4634 * Fax #(918) 455-1982

600# RFWN ORIFICE FLANGE UNION



PIPE SIZE	(A) BORE	OUTER DIAMETER	(B) POINT OF WELD	(C) HUB AT BASE	(D) MINIMUM FLANGE THICKNESS	(E) OVERALL LENGTH	(F) CENTER OF TAP	(G) PRESSURE TAP HOLE SIZE	DIAMETER OF RAISED FACE	DIAMETER OF BOLT CIRCLE	DIAMETER OF HOLES	NUMBER OF HOLES	SIZE OF STUDS	SIZE OF JACKSCREWS	APPROXIMATE WEIGHT
	A	O.D.	B	C	D	E	F	G							
1/2	.622	3.75	.84	1.50	1.5	3.00	.937	.25	1.37	2.62	.562	4	1/2 X 4-3/4	1/2 X 4	10
3/4	.824	4.62	1.05	1.87	1.5	3.12	.937	.25	1.68	3.25	.687	4	5/8 X 5-1/4	1/2 X 4	10
1	1.049	4.87	1.32	2.12	1.5	3.25	.937	.25	2.00	3.50	.687	4	5/8 X 5-1/4	5/8 X 4	18
1-1/2	1.610	6.12	1.90	2.75	1.5	3.75	.937	.25	2.87	4.50	.812	4	3/4 X 5-1/4	5/8 X 4	25
2	2.067	6.50	2.38	3.31	1.5	3.37	.937	.375	3.62	5.00	.687	8	5/8 X 5-1/4	5/8 X 4	27
2-1/2	2.469	7.50	2.88	3.93	1.5	3.50	.937	.375	4.12	5.87	.812	8	3/4 X 5-1/4	5/8 X 4	35
3	3.068	8.25	3.50	4.62	1.5	3.50	.937	.375	5.00	6.62	.812	8	3/4 X 5-1/4	3/4 X 4	43
4	4.026	10.75	4.50	6.00	1.75	4.25	.937	.500	6.18	8.50	1.00	8	7/8 X 6	3/4 X 4	103
6	6.065	14.00	6.62	8.75	2.12	4.87	.937	.500	8.50	11.50	1.12	12	1 X 7	3/4 X 4	195
8	7.981	16.50	8.62	10.75	2.43	5.50	.937	.500	10.62	13.75	1.25	12	1-1/8 X 8	3/4 X 4	278
10	10.020	20.00	10.75	13.50	2.75	6.25	.937	.500	12.75	17.00	1.37	16	1-1/4 X 8-3/4	1 X 5-1/2	454
12	12.000	22.00	12.75	15.75	2.87	6.37	.937	.500	15.00	19.25	1.37	20	1-1/4 X 9	1 X 5-1/2	553
14	13.250	23.75	14.00	17.00	3.00	6.75	.937	.500	16.25	20.75	1.50	20	1-3/8 X 9-3/4	1 X 5-1/2	815
16	15.250	27.00	16.00	19.50	3.25	7.25	.937	.500	18.50	23.75	1.62	20	1-1/2 X 10-1/2	1 X 5-1/2	1113
18	17.250	29.25	18.00	21.50	3.50	7.50	.937	.500	21.00	25.75	1.75	20	1-5/8 X 11-1/4	1 X 6-1/2	1306
20	19.250	32.00	20.00	24.00	3.75	7.75	.937	.500	23.00	28.50	1.75	24	1-5/8 X 11-3/4	1 X 6-1/2	1622
24	23.250	37.00	24.00	28.25	4.25	8.25	.937	.500	27.25	33.00	2.00	24	1-7/8 X 13-1/4	1 X 7-1/2	2320

MATERIALS: Domestic A105 (C.S.) AND A182 (S.S.)

Other materials and schedules available

HARDWARE:

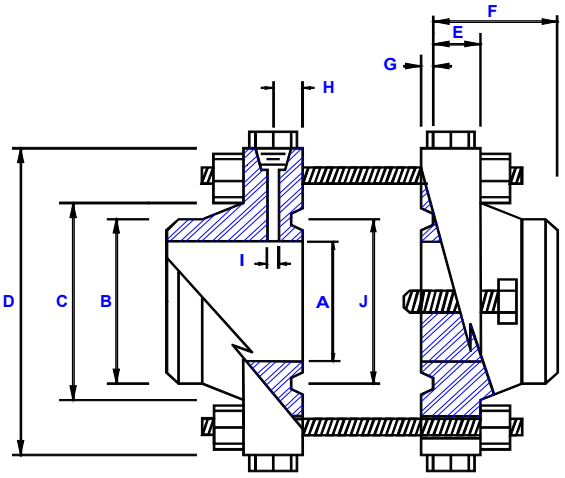
Stud Bolts: A193 Gr. B7 Steel
Hex Nuts: A194 Gr. 2H Steel
Jackscrew: C1018 Hardened Square Head Screws
Pipe Plugs: Hex Head, Forged Steel
Ring Gaskets: C4430 Non-Asbestos

Manufactured to meet
A.G.A Report #3
A.P.I 14.3
ASME SPECIFICATIONS

Orifice Plates sold seperate

Quality Products & Sales Inc
Orifice Metering Division
PO Box 7
Broken Arrow Ok 74013
Local #(918) 251-0115 * Watts #(800) 444-4634 * Fax #(918) 455-1982

900# RTJWN ORIFICE FLANGE UNION



PIPE SIZE	(A) BORE	POINT OF WELD	HUB AT BASE	OUTER DIAMETER	MINIMUM FLANGE THICKNESS	OVERALL LENGTH NOTE#1	DEPTH OF RING GROOVE	TAP CENTER TO PLATE FACE	PRESSURE TAP HOLE SIZE	PITCH DIAMETER OF GROOVE	DIAMETER OF BOLT CIRCLE	DIAMETER OF HOLES	NUMBER OF HOLES	SIZE OF STUDS	SIZE OF JACKSCREWS	APPROXIMATE WEIGHT
	A	B	C	D	E	F	G	H	I	J						
1	*	1.31	2.06	5.87	1.25	3.00	.250	1.00	.250	2.00	4.00	1.00	4	7/8X6	5/8 X 4	27
1-1/2	*	1.87	2.75	7.00	1.25	3.25	.250	1.00	.250	2.687	4.87	1.12	4	1X6-1/4	5/8 X 4	41
2	*	2.37	4.12	8.50	1.50	4.00	.312	1.00	.375	3.750	6.50	1.00	8	7/8X6-1/2	5/8 X 4	71
2-1/2	*	2.87	4.87	9.62	1.62	4.12	.312	1.00	.375	4.250	7.50	1.12	8	1X6-3/4	5/8 X 4	85
3	*	3.50	5.00	9.50	1.50	4.00	.312	1.00	.375	4.875	7.50	1.00	8	7/8X6-1/2	3/4X5-1/2	100
4	*	4.50	6.25	11.50	1.75	4.50	.312	1.00	.500	5.875	9.25	1.25	8	1-1/8X7-1/2	3/4X5-1/2	140
6	*	6.62	9.25	15.00	2.18	5.50	.312	1.00	.500	8.312	12.50	1.25	12	1-1/8X8-1/2	3/4X5-1/2	280
8	*	8.62	11.75	18.50	2.50	6.37	.312	1.00	.500	10.625	15.50	1.50	12	1-3/8X9-1/2	1 X 6-1/2	475
10	*	10.75	14.50	21.50	2.75	7.25	.312	1.00	.500	12.750	18.50	1.50	16	1-3/8X10	1 X 6-1/2	675
12	*	12.75	16.50	24.00	3.12	7.87	.312	1.00	.500	15.00	21.00	1.50	20	1-3/8X10-3/4	1 X 6-1/2	930

NOTE #1 ***Overall length does not include depth of Ring Groove***

* ***To be determined by customer***

** ***Due to the depth of the Ring Groove the tap hole location exceeds AGA AND API Specifications***

MATERIALS: Domestic A105 (C.S.) AND A182 (S.S.)

Other materials and schedules available

HARDWARE:

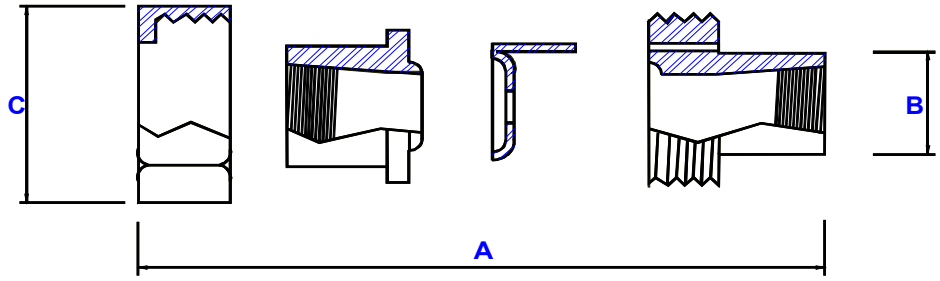
Stud Bolts: A193 Gr. B7 Steel
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Jackscrew: C1018 Hardened Square Head Screws
Pipe Plugs: Hex Head, Forged Steel

Manufactured to meet
A.G.A Report #3
A.P.I 14.3
ASME SPECIFICATIONS

RTJ Orifice Plates sold seperate

Quality Products & Sales Inc
Orifice Metering Division
PO Box 7
Broken Arrow Ok 74013
Local #(918) 251-0115 * Watts #(800) 444-4634 * Fax #(918) 455-1982

3000# THREADED RESTRICTION UNIONS



PIPE SIZE	OVER ALL LENGTH WHEN ASSEMBLED	HUB DIMENSION	HEX NUT DIMENSION (NOTE #1)	APPROXIMATE WEIGHT
	A	B	C	
1/4"	1.71	.92	1.73	.46
3/8"	1.88	1.08	2.02	.66
1/2"	2.04	1.26	2.03	.66
3/4"	2.35	1.50	2.38	1.24
1"	2.57	1.80	2.77	1.65
1-1/4"	2.84	2.18	3.31	2.60
1-1/2"	3.09	2.46	3.70	3.10
2"	3.46	3.04	4.39	5.00

NOTE #1: Across Corners

NOTE #2: Stainless Steel units may have flat plates with (2) C4430 gaskets or cupped plates without tabs.

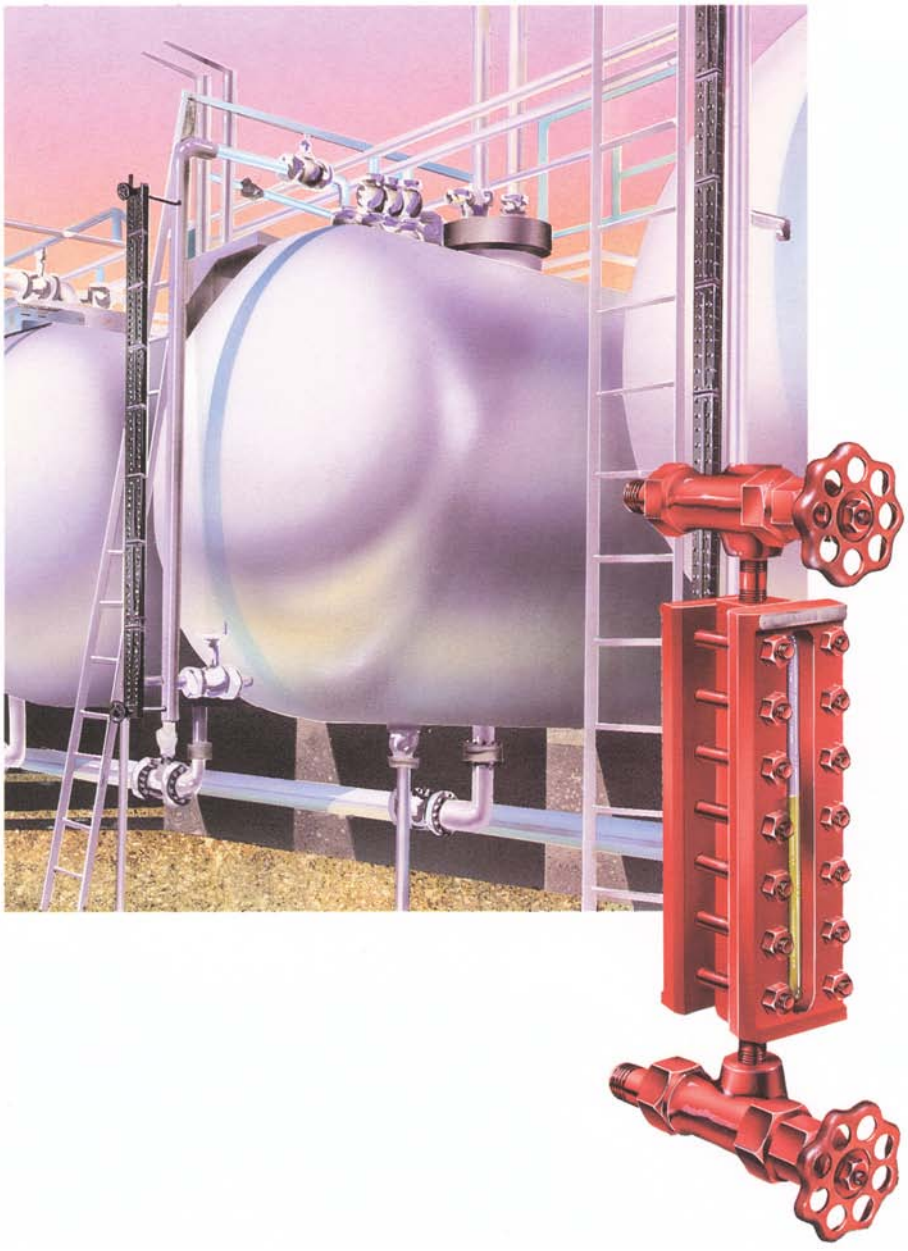
FORGING MATERIALS: Domestic A105 (C.S.) AND A182 (S.S.)

PLATE MATERIAL: A240-316 SS.

Quest-Tec Solutions

The New Standard of Level

Glass-Trac | Steam-Trac | Level-Trac | Mag-Trac



Liquid Level Gages and Valves

Forty years of product knowledge brings you the best the market has to offer: Quest Tec Solutions is a young company with a long lineage of quality, experience and care. The development and engineering of the liquid level gage and valve product lines began more than forty years ago.

These products have been consistently refined and improved to remain one of the industry leaders in liquid level measurement. One of the leading liquid measurement companies, Daniel Measurement and Control, directed this product development and engineering.

New management means a fresh dedication to bring you solutions: On September 27, 2001, the Daniel liquid level gage and valve product lines were purchased by Quest Tec Solutions. Quest-Tec, a wholly owned subsidiary of Baro Holdings, Inc., is managed by people that have been involved with liquid level products for over 15 years. The management and staff at Quest Tec have collective hands-on experience with all aspects of the liquid level gage and valve product line of over 150 years.

New facilities means flexibility to better meet your needs: Quest Tec relocated its manufacturing facility for better growth and flexibility across Houston to 4003-D Greenbriar, Stafford, TX 77477 with a new phone number of (281) 240-0440. This new facility has also allowed for the expansion into new product offerings such as Magnetic Level gages, High Pressure Steam gages and Electronic Boiler trim.

When choosing your liquid level measurement solution provider, why not choose the best? The symmetry of a market tried-and-true product coupled with the energy of new management, has positioned Quest Tec to be best suited to assist you solve your liquid level measurement challenges.

GLASS-TRAC LIQUID LEVEL GAGES and VALVES

ORDERING INFORMATION

Please Specify:

- Gage Size Number
- Type of Service
- Temperature Limits
- Pressure Limits
- Type of Connections
- Special Functions
- Vessel Centers if Close Hook-up

GAGE NUMBERING SYSTEM

Example: 71-RL:

7 is #7 Glass (#1 through #9)
1 is One-Section Gage (1, 2, 3, 4, . . .)
R is Reflex (T-Transparent)
L is Low Pressure Series (M = Mid, H = High, WP = Weld Pad)

(Add appropriate digits or letters to indicate special purpose gage or accessory)

HC Externally Heating/Cooling Gages
FP Frost Preventive Extensions
LC Large Chamber Gage
EP Explosion Proof Illuminator
CH Close Hook-up Connections

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Carbon steel is the standard material for all Glass-Trac low, mid and high pressure liquid level gages. The percentages of carbon steel pressure ratings for optional gage materials are listed below.

GAGES

Stainless Steel 300 & 400 Types 100%
Monel, Hastelloy B & C 90%
Brass 50%

GASKETS

Special Acid Sheet Gasketing 75%
Teflon®, KEL-F® 50%
Glass Filled Teflon 100%

Teflon is a registered trademark of DuPont.
KEL-F Is a registered trademark of 3M.

All specification are subject to change without notice as part of a continuing program of product improvement.

REFLEX GAGES

Glass-Trac Reflex Gages use prism glass to provide an excellent indication of the liquid level. All liquids appear black in high contrast to the mirror-like surface above. This clean line of separation can be sighted from many yards away. Reflex Gages are made in three pressures series (maximum 4000 psig @ 100ºF) and are tapped for ½" or ¾" NPT connections. The standard Glass-Trac level gages are designed for minimum -20ºF service.

On Glass-Trac Reflex Close Hook-up Gages with ½" NPT connections, the center-to-center dimensions is the same as the overall length on standard gages. On Close Hook-up Gages with ¾" NPT connections, the center-to-center dimensions is the same as the overall length on standard gages plus ⅜".

MATERIALS

BODY (LIQUID CHAMBER): Accurately machined from square tubes to provide perfect seating for gage glasses. Glass is recessed for protection. Body materials include 316 stainless steel and carbon steel.

COVER: Glass-Trac gage covers are made of carbon steel or 316 stainless steel in all their sizes and pressure ratings for higher strength and dependable service. All covers are machined to provide recessed seating protection for the glass.

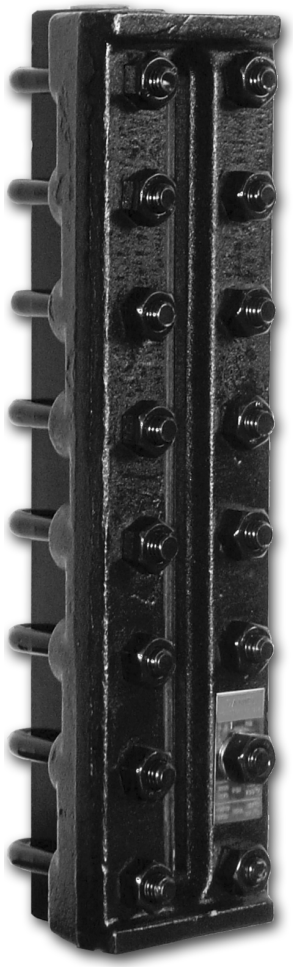
GLASS: All standard Glass-Trac Reflex Gages use tempered borosilicate glass in nine standard lengths. Each glass has expertly molded reflecting prisms.

GASKETS & CUSHONS: High grade non-asbestos is used in gaskets and cushions for Glass-Trac gages. The machined recess in the gage body and cover protects the gasket and cushion as well as the glass.

BOLTS: Glass-Trac gage bolts are made of alloy steel, ASTM A-193 Grade B7.

NUTS: Gage nuts are made of steel, ASTM A-194 Grade 2H.

(Torque instructions for gage bolts are on the back cover.)



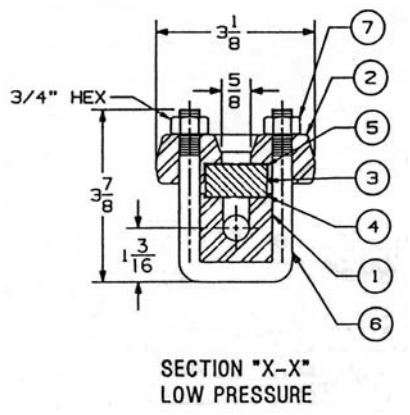
TYPICAL REFLEX TOP/BOTTOM



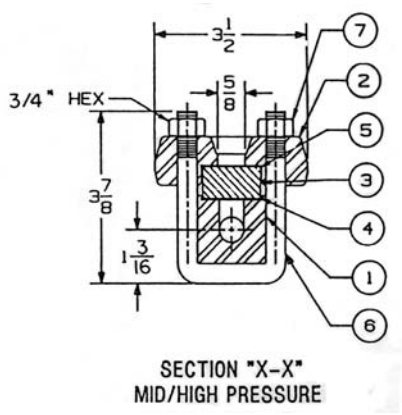
TYPICAL-REFLEX CLOSE HOOK-UP

PRESSSURE RATINGS & DIMENSIONS

Reflex Gages
(With Straight-Thru Connections)



SECTION "X-X"
LOW PRESSURE



SECTION "X-X"
MID/HIGH PRESSURE

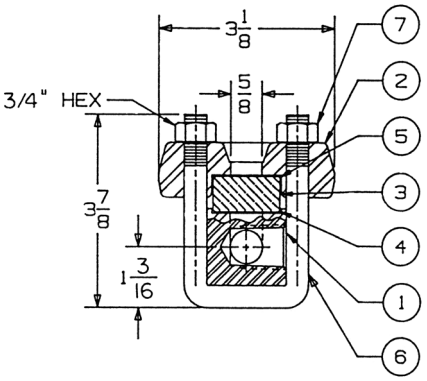
SIZES AND WEIGHTS											
SIZE NUMBERS			OVER-ALL LENGTH (IN.)			VISIBLE GLASS (IN.) B	GLASS SIZE C	CLOSE HOOK-UP CENTER-TO-CENTER (IN.)		APPROX. WT. (LBS.)	
LOW PRESS.	MID-PRESS.	HIGH PRESS.	A (STD)* 1/2" or 3/4" NPT	A (CH) 1/2" NPT	A (CH) 3/4" NPT			D 1/2" NPT	D 3/4" NPT	LOW PRESS.	MID-HIGH PRESS.
SINGLE-SECTION GAGE											
11 RL	11 RM	11 RH	5 1/4	8 7/8	9 1/4	3 3/4	3 3/4	5 1/4	5 5/8	7	8
21 RL	21 RM	21 RH	6 1/4	9 7/8	10 1/4	4 3/4	4 3/4	6 1/4	6 5/8	8	9
31 RL	31 RM	31 RH	7 1/4	10 7/8	11 1/4	5 3/4	5 3/4	7 1/4	7 5/8	9	11
41 RL	41 RM	41 RH	8 1/4	11 7/8	12 1/4	6 3/4	6 3/4	8 1/4	8 5/8	10	12
51 RL	51 RM	51 RH	9 3/8	13	13 3/8	7 7/8	7 7/8	9 3/8	9 3/4	12	14
61 RL	61 RM	61 RH	10 5/8	14 1/4	14 5/8	9 1/8	9 1/8	10 5/8	11	14	16
71 RL	71 RM	71 RH	11 3/4	15 3/8	15 3/4	10 1/4	10 1/4	11 3/4	12 1/8	15	18
81 RL	81 RM	81 RH	13 3/8	17	17 3/8	11 7/8	11 7/8	13 3/8	13 3/4	17	20
91 RL	91 RM	91 RH	14 1/8	17 3/4	18 1/8	12 5/8	12 5/8	14 1/8	14 1/2	18	21
TWO-SECTION GAGE											
32 RL	32 RM	32 RH	14 1/2	18 1/8	18 1/2	13	5 3/4	14 1/2	14 7/8	19	22
42 RL	42 RM	42 RH	16 1/2	20 1/8	20 1/2	15	6 3/4	16 1/2	16 7/8	22	25
52 RL	52 RM	52 RH	18 3/4	22 3/8	22 3/4	17 1/4	7 7/8	18 3/4	19 1/8	24	28
62 RL	62 RM	62 RH	21 1/4	24 7/8	25 1/4	19 3/4	9 1/8	21 1/4	21 5/8	27	32
72 RL	72 RM	72 RH	23 1/2	27 1/4	27 1/2	22	10 1/4	23 1/2	23 7/8	29	35
82 RL	82 RM	82 RH	26 3/4	30 3/8	30 3/4	25 1/4	11 7/8	26 3/4	27 1/8	34	40
92 RL	92 RM	92 RH	28 1/4	31 7/8	32 1/4	26 3/4	12 5/8	28 1/4	28 5/8	37	43
THREE-SECTION GAGE											
63 RL	63 RM	63 RH	31 7/8	35 1/2	35 7/8	30 3/8	9 1/8	31 7/8	32 1/4	41	48
73 RL	73 RM	73 RH	35 1/4	38 7/8	39 1/4	33 3/4	10 1/4	35 1/4	35 5/8	45	53
83RL	83 RM	83 RH	40 1/8	43 3/4	44 1/8	38 5/8	11 7/8	40 1/8	40 1/2	52	60
93 RL	93 RM	93 RH	42 3/8	46	46 3/8	40 7/8	12 5/8	42 3/8	42 3/4	55	64
FOUR-SECTION GAGE											
74 RL	63 RM	63 RH	47	50 5/8	51	45 1/2	10 1/4	47	47 3/8	60	71
84 RL	73 RM	73 RH	53 1/2	57 1/8	57 1/2	52	11 7/8	53 1/2	53 7/8	69	80
94 RL	83 RM	83 RH	56 1/2	60 1/8	60 1/2	55	12 5/8	56 1/2	56 7/8	72	85
FIVE-SECTION GAGE											
75 RL	75 RM	75 RH	58 3/4	62 3/8	62 3/4	57 1/4	10 1/4	58 3/4	59 1/8	74	88
85 RL	85 RM	85 RH	66 7/8	70 1/2	70 7/8	65 3/8	11 7/8	66 7/8	67 1/4	86	100
95 RL	95 RM	95 RH	70 5/8	74 1/4	74 5/8	69 1/8	12 5/8	70 5/8	71	90	106

*3/4" NPT Tapped High Pressure Gages Add "1 ½" to 'A' Dimension.

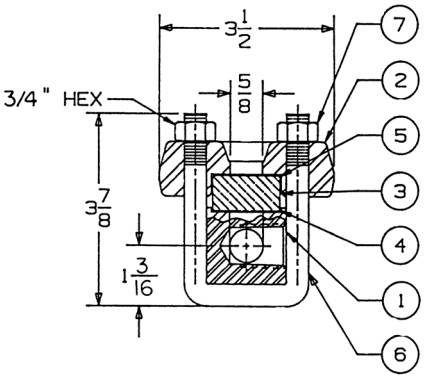
Reflex Gages
(With Close Hook-Up Connections)

PARTS

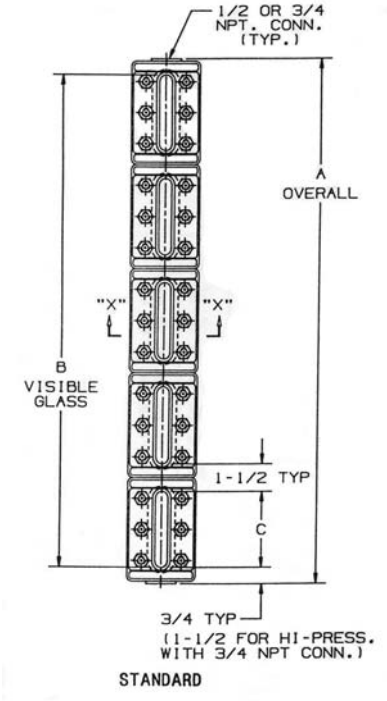
ITEM NO.	NAME	MATERIAL
1	CHAMBER	CARBON STEEL
2	COVER	CARBON STEEL
3	GLASS	TEMPERED
4	GASKET	NON-ASBESTOS
5	CUSHION	NON-ASBESTOS
6	BOLT	ASTM A193 B7
7	NUT	ASTM A194 2H



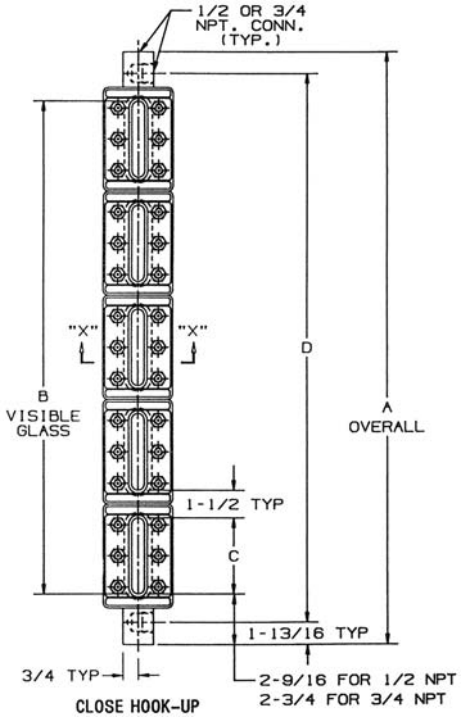
SECTION "X-X"
LOW PRESSURE



SECTION "X-X"
MID/HIGH PRESSURE



STANDARD



CLOSE HOOK-UP

PRESSURE RATINGS AT ° F*							
LOW PRESSURE GAGE**							
Glass Size	**100°**	**200°**	**300°**	**400°**	**500°**	**600°**	**700°**
1	2400	2320	2240	2150	2000	1780	1520
2	2325	2250	2170	2090	1940	1720	1470
3	2250	2180	2100	2020	1880	1670	1420
4	2175	2100	2020	1940	1820	1600	1370
5	2100	2030	1960	1880	1750	1550	1320
6	2025	1950	1890	1810	1680	1500	1280
7	1950	1890	1820	1750	1630	1440	1230
8	1875	1820	1750	1680	1560	1390	1180
9	1800	1740	1680	1620	1510	1340	1140
MID-PRESSURE GAGE**							
Glass Size	**100°**	**200°**	**300°**	**400°**	**500°**	**600°**	**700°**
1	3000	2900	2800	2690	2500	2220	1890
2	2910	2820	2720	2600	2420	2150	1840
3	2820	2720	2625	2530	2350	2080	1780
4	2725	2640	2560	2460	2270	2040	1740
5	2630	2540	2460	2360	2190	1950	1660
6	2535	2450	2360	2270	2110	1875	1600
7	2440	2360	2280	2190	2030	1805	1540
8	2345	2270	2190	2110	1960	1740	1480
9	2250	2180	2100	2020	1880	1670	1420
HIGH PRESSURE GAGE**							
Glass Size	**100°**	**200°**	**300°**	**400°**	**500°**	**600°**	**700°**
ALL	4000	3890	3790	3700	3470	3080	2530

*Gages for service to 800º F are available. Consult the factory for the application and ratings.
** Saturated steam to 300 WSP. Above 300 WSP, use transparent gage with mica shields.

TRANSPARENT GAGES

Glass-Trac Transparent Gages use clear, see-through glass on both sides so that both the color and the interface of liquids can be viewed. Electric lighted gage illuminators are available for use on Transparent Gages and provide easy viewing of liquid levels in dimly lighted areas. Transparent Gages are made in three pressure series (maximum 3000 psig @ 100ºF) and are tapped for ½" or ¾" NPT connections. The standard Glass-Trac level gages are designed for -20ºF service.

On Glass-Trac Transparent Close Hook-up Gages with ½" NPT connections, the center-to-center dimension is the same as the overall length on standard gages. On Close Hook-up Gages with ¾" NPT connections the center-to-center dimensions is the same as the overall length on standard gages plus ⅜".

MATERIALS

BODY (LIQUID CHAMBER): Accurately machined from square tubes to provide perfect seating for gasket, and gage glasses. Both glasses are recessed for protection. Body materials include Type 316 stainless steel and carbon steel.

COVERS: Both covers on transparent gages are carefully machined to provide perfect seating for cushions and gage glasses. This machining also provides deep recessed seating in the cover for added glass protection. Covers are available in Type 316 stainless steel and in carbon steel.

GLASS: All standard Glass-Trac Transparent Gages use tempered borosilicate glass in nine standard lengths. Each transparent glass is crystal clear and has the highest strength possible.

GASKET & CUSHIONS: High grade non-asbestos is used in gaskets and cushions for Glass-Trac gages. The machined recess in the gage body and cover protects the gasket and cushion as well as the glass.

BOLTS: Glass-Trac gage bolts are made of alloy steel, ASTM
A-193 Grade B7.

NUTS: Gage nuts are made of steel, ASTM A-194 Grade 2H.

(Torque instructions for gage bolts are on Back Cover.)



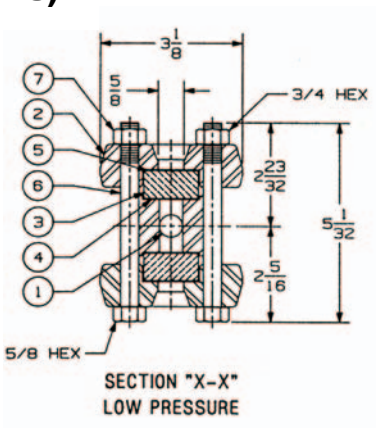
TYPICAL TRANSPARENT TOP/BOTTOM



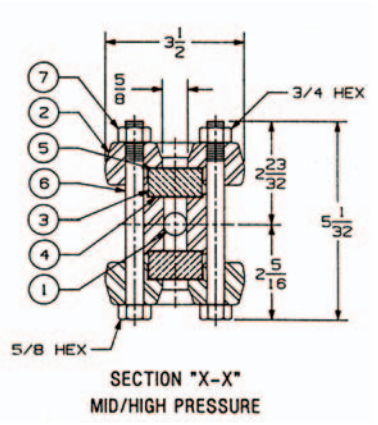
TYPICAL TRANSPARENT CLOSE HOOK-UP

PRESSURE RATINGS & DIMENSIONS:

Transparent Gages
(With Straight-thru Connections)



SECTION "X-X"
LOW PRESSURE



SECTION "X-X"
MID/HIGH PRESSURE

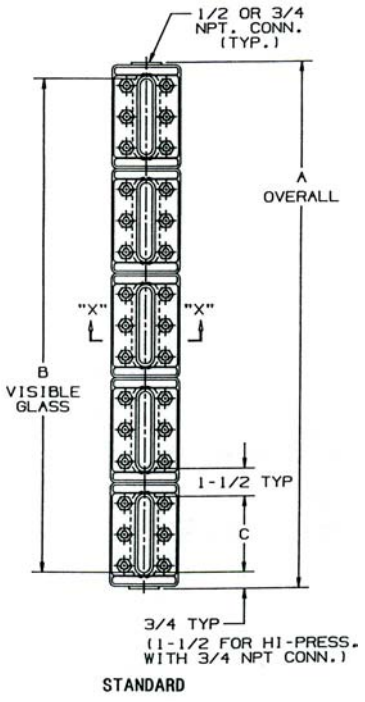
SIZES AND WEIGHTS											
SIZE NUMBERS			OVER-ALL LENGTH (IN.)			VISIBLE GLASS (IN.) B	GLASS SIZE C	CLOSE HOOK-UP CENTER-TO-CENTER (IN.)		APPROX. WT. (LBS)	
LOW PRESS.	MID-PRESS.	HIGH PRESS.	A(STD)* 1/2 OR 3/4 NPT	A(CH) 1/2 NPT	A(CH) 3/4 NPT			D 1/2" NPT	D 3/4" NPT	LOW PRESS.	MID-HIGH PRESS.
SINGLE SECTION GAGE											
11 TL	11 TM	11 TH	5 1/4	8 7/8	9 1/4	3 3/4	3 3/4	5 1/4	5 5/8	10	12
21 TL	21 TM	21 TH	6 1/4	9 7/8	10 1/4	4 3/4	4 3/4	6 1/4	6 5/8	11	14
31 TL	31 TM	31 TH	7 1/4	10 7/8	11 1/4	5 3/4	5 3/4	7 1/4	7 5/8	14	17
41 TL	41 TM	41 TH	8 1/4	11 7/8	12 1/4	6 3/4	6 3/4	8 1/4	8 5/8	16	19
51 TL	51 TM	51 TH	9 3/8	13	13 3/8	7 7/8	7 7/8	9 3/8	9 3/4	17	21
61 TL	61 TM	61 TH	10 5/8	14 1/4	14 5/8	9 1/8	9 1/8	10 5/8	11	19	24
71 TL	71 TM	71 TH	11 3/4	15 3/8	15 3/4	10 1/4	10 1/4	11 3/4	12 1/8	21	27
81 TL	81 TM	81 TH	13 3/8	17	17 3/8	11 7/8	11 7/8	13 3/8	13 3/4	24	30
91 TL	91 TM	91 TH	14 1/8	17 3/4	18 1/8	12 5/8	12 5/8	14 1/8	14 1/2	26	32
TWO-SECTION GAGE											
32 TL	32 TM	32 TH	14 1/2	18 1/8	18 1/2	13	5 3/4	14 1/2	14 7/8	27	33
42 TL	42 TM	42 TH	16 1/2	20 1/8	20 1/2	15	6 3/4	16 1/2	16 7/8	32	38
52 TL	52 TM	52 TH	18 3/4	22 3/8	22 3/4	17 1/4	7 7/8	18 3/4	19 1/8	36	43
62 TL	62 TM	62 TH	21 1/4	24 7/8	25 1/4	19 3/4	9 1/8	21 1/4	21 5/8	40	49
72 TL	72 TM	72 TH	23 1/2	27 1/4	27 1/2	22	10 1/4	23 1/2	23 7/8	43	54
82 TL	82 TM	82 TH	26 3/4	30 3/8	30 3/4	25 1/4	11 7/8	26 3/4	27 1/8	50	61
92 TL	92 TM	92 TH	28 1/4	31 7/8	32 1/4	26 3/4	12 5/8	28 1/4	28 5/8	51	64
THREE-SECTION GAGE											
63 TL	63 TM	63 TH	31 7/8	35 1/2	35 7/8	30 3/8	9 1/8	31 7/8	32 1/4	59	73
73 TL	73 TM	73 TH	35 1/4	38 7/8	39 1/4	33 3/4	10 1/4	35 1/4	35 5/8	63	80
83 TL	83 TM	83 TH	40 1/8	43 3/4	44 1/8	38 5/8	11 7/8	40 1/8	40 1/2	75	92
93 TL	93 TM	93 TH	42 3/8	46	46 3/8	40 7/8	12 5/8	42 3/8	42 3/4	78	97
FOUR-SECTION GAGE											
74 TL	74 TM	74 TH	47	50 5/8	51	45 1/2	10 1/4	47	47 3/8	85	107
84 TL	84 TM	84 TH	53 1/2	57 1/8	57 1/2	52	11 7/8	53 1/2	53 7/8	100	122
94 TL	94 TM	94 TH	56 1/2	60 1/8	60 1/2	55	12 5/8	56 1/2	56 7/8	104	129
FIVE-SECTION GAGE											
75 TL	75 TM	75 TH	58 3/4	62 3/8	62 3/4	57 1/4	10 1/4	58 3/4	59 1/8	106	134
85 TL	85 TM	85 TH	66 7/8	70 1/2	70 7/8	65 3/8	11 7/8	66 7/8	67 1/4	124	152
95 TL	95 TM	95 TH	70 5/8	74 1/4	74 5/8	69 1/8	12 5/8	70 5/8	71	129	161

***3/4 "NPT Tapped High Pressure Gages Add 1 ½" to 'A' Dimensions.**

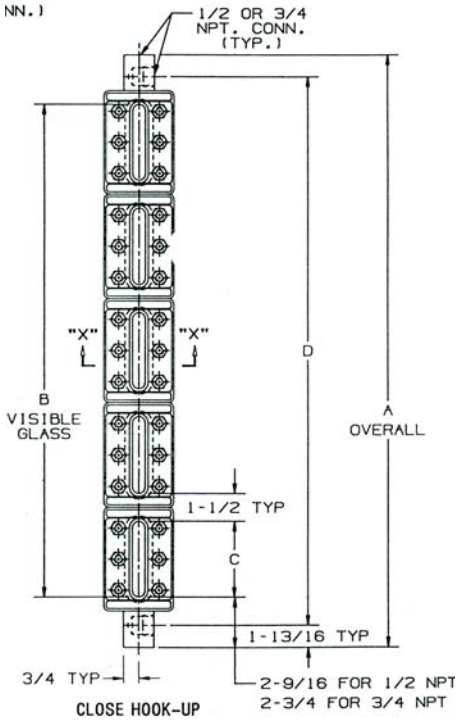
Transparent Gages
(With Close Hook-up Connections)

PARTS

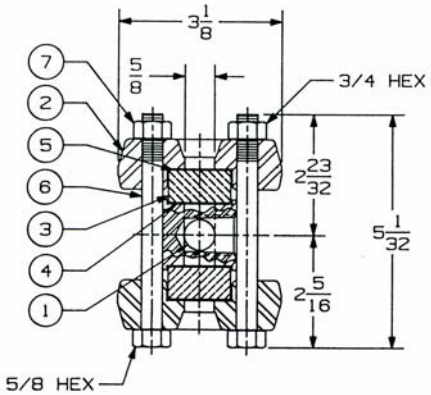
ITEM NO.	NAME	MATERIAL
1	CHAMBER	CARBON STEEL
2	COVER	CARBON STEEL
3	GLASS	TEMPERED
4	GASKET	NON-ASBESTOS
5	CUSHION	NON-ASBESTOS
6	BOLT	ASTM A193 B7
7	NUT	ASTM A194 2H



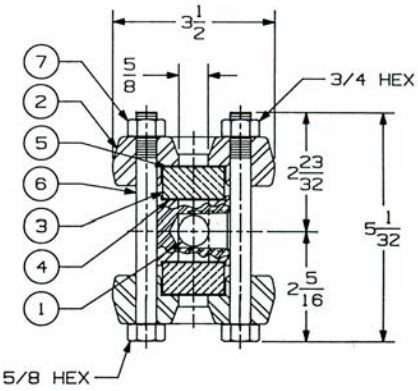
STANDARD



CLOSE HOOK-UP



SECTION "X-X"
LOW PRESSURE



SECTION "X-X"
MID/HIGH PRESSURE

PRESSURE RATINGS AT ° F*							
LOW PRESSURE GAGE**							
GLASS SIZE	**100°**	**200°**	**300°**	**400°**	**500°**	**600°**	**700°**
1	2000	1935	1870	1790	1660	1480	1260
2	1815	1750	1690	1620	1510	1340	1150
3	1630	1580	1520	1460	1360	1210	1050
4	1440	1390	1340	1290	1200	1060	900
5	1250	1210	1170	1120	1040	920	790
6	1065	1030	995	950	890	790	680
7	875	845	815	785	730	645	550
8	690	665	645	620	575	510	440
9	500	480	465	445	415	370	320
Maximum Saturated Steam 350 WSP							
MID-PRESSURE GAGE**							
GLASS SIZE	**100°**	**200°**	**300°**	**400°**	**500°**	**600°**	**700°**
1	2500	2420	2340	2240	2080	1850	1580
2	2315	2250	2170	2090	1940	1720	1470
3	2130	2060	1990	1910	1770	1575	1340
4	1940	1875	1810	1740	1620	1435	1230
5	1750	1690	1630	1570	1460	1295	1100
6	1565	1510	1460	1400	1305	1160	990
7	1375	1330	1280	1230	1145	1015	870
8	1190	1150	1110	1065	990	880	750
9	1000	970	935	895	835	740	630
Maximum Satrated Steam 750 WSP with Mica Shield							
HIGH PRESSURE GAGE**							
GLASS SIZE	**100°**	**200°**	**300°**	**400°**	**500°**	**600°**	**700°**
ALL	3000	2920	2850	2780	2600	2310	1890

*Gages for service up to 800ºF are available. Consult the factory for application and ratings.

OFFSET VALVES

TYPE 1S & 1U

SCREWED BONNET

TYPE 2S & 2U

UNION REPLACEABLE SEAT

4000 psig CWP 6000 psig Test
¾" NPT Male Union Tank Connection
½" NPT Female Gage Connection
½" NPT Female Drain Connection

PRESSURE - TEMPERATURE RATING			
Teflon Packing		Wire-Graphite Packing	
4000 psi	100º F	2950 psi	500º F
3730 psi	200º F	2700 psi	600º F
3470 psi	300º F	2430 psi	700º F
3200 psi	400º F		

Glass-Trac Type 1 & 2 Offset Gage Valves are available with screwed (S), union (U), (illustrated below) and tubular (T) gage connections (Page 15). Both 1 and 2 Valves are used with Reflex and Transparent Gages in working pressures up to 4000 psi and with Tubular Gages to their maximum rating. The Teflon packing ring is standard and used in services up to 450º F. For temperatures to 700º F, valves are fitted with special wire graphite packing. Both valves have stainless steel ball checks to shut off the flow automatically in case of gage glass breakage.

The "offset" feature permits easy cleaning of gages. A floating tailpiece on Type 1 valves permits an overall vertical adjustment of 1/8" if the gage center-to-centers are not precisely located. Installation is quicker and gage strain is eliminated.

Type 2 Valves have an optional backseating stem allowing the packing to be changed without shutting down the vessel.

PARTS

ITEM NO	NAME	STANDARD MATERIAL	316 SS WETTED PARTS MATERIAL
1	BODY	CARBON STEEL	316 SS
2	UNION NUT	CARBON STEEL	CARBON STEEL
3	PACKING NUT	CARBON STEEL	CARBON STEEL
4	PACKING FOLLOWER	316 SS	316 SS
5	PACKING RING	TEFLON	TEFLON
6	PACKING WASHER	17-4 PH SS	17-4 PH SS
7	STEM	416 SS	316 SS
8	STEM NUT	CARBON STEEL	CARBON STEEL
9	NAME PLATE	304 SS	304 SS
10	HAND WHEEL	IRON	IRON

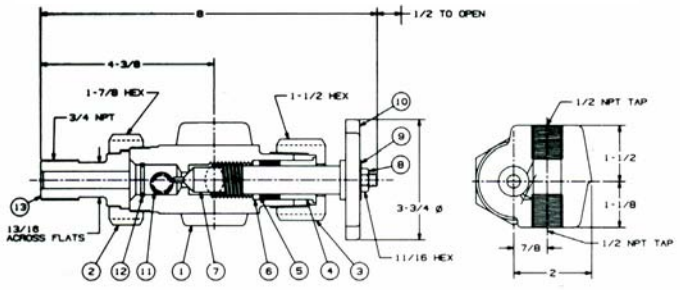
ITEM NO	NAME	STANDARD MATERIAL	316 SS WETTED PARTS MATERIAL
11	BALL	440 SS	316 SS
12	BALL RETAINER	316 SS	316 SS
13	MALE CONNECTOR	CARBON STEEL	316 SS
14	BONNET	416 SS	316 SS
15	SEAT	416 SS	316 SS
17	FEMALE CONNECTOR	CARBON STEEL	316 SS

*Item No. 13 has hole with 1/16 eccentricity for ± 1/8 maximum misalignment on the overall center-to-center.
Note: Valve shown is for bottom left hand (or top right hand) location. Opposite hand is reversed. Valves are furnished in pairs of one bottom left hand and one top left hand.

Note: 316 SS wetted parts not available in Type 1 valves.

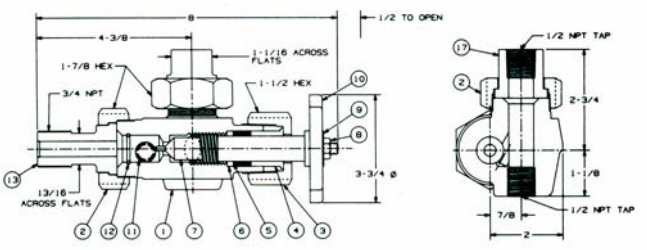
Type 1S

Weight per set approximately 10 lbs. 6ozs.



Type 1U

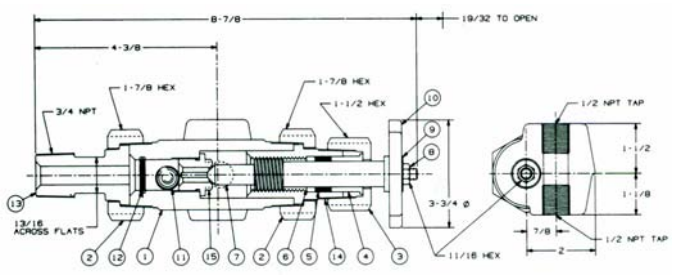
Weight per set approximately 11 lbs. 6 ozs.



Type 1T Tubular Gage Valve shown on page 15. Optional Gage Connections shown on page 25. Optional Tank Connections shown on pages 26 and 27.

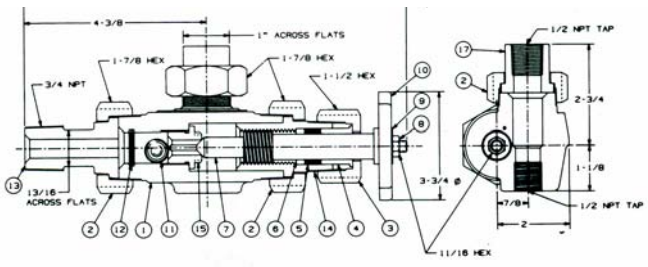
Type 2S

Weight per set approximately 11 lbs. 6 ozs.



Type 2U

Weight per set approximately 12 lbs. 6 ozs.



Type 2T Tubular Gage Valve shown on page 15. Optional Gage Connections shown on page 25. Optional Tank Connections shown on pages 26 and 27. Optional Quick Opening Valve shown on page 24.

OFFSET OS&Y VALVES

TYPE 3S & 3U

HEAVY DUTY OUTSIDE SCREW &YOKE

4000 psig CWP 6000 psig Test
½", ¾" (Std.) or 1" NPT or IPS Solid Shank Tank Connection or Flanged Tank Connection
½" NPT Female Gage Connection
½" NPT Female Drain Connection

PRESSURE - TEMPERATURE RATING			
Teflon Packing		Wire-Graphite Packing	
4000 psi	100º F	2950 psi	500º F
3730 psi	200º F	2700 psi	600º F
3470 psi	300º F	2430 psi	700º F
3200 psi	400º F		

The Glass-Trac Type 3 Offset Gage Valve has the Outside Screw & Yoke design which prevents excessively hot and corrosive fluids from contracting stem threads, causing possible malfunction. The stem backs directly off the regrindable valve seat using the positive, non-rotating stem principle. The valve is offset for ease in gage cleaning and comes in both screwed (S) and a union (U) gage as standard. On special order, tubular (T) gage or other type connection can be supplied. Type 3 valves are used with Reflex and Transparent Gages in working pressures up to 4000 psi.

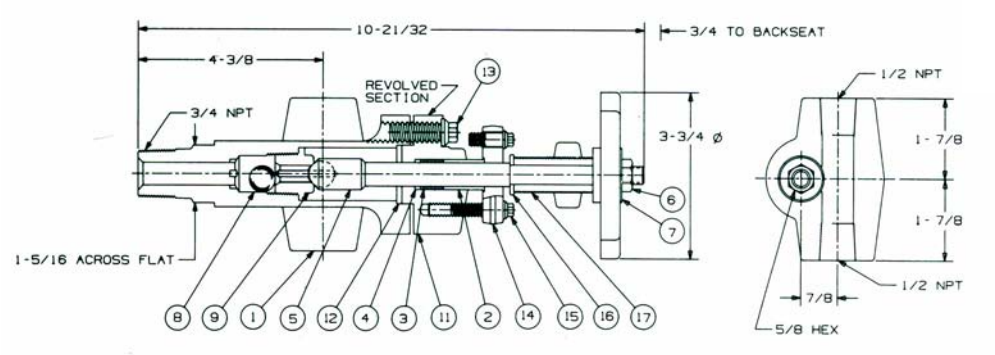
The standard tank connection for Type 3 OS&Y Offset Gage valves is a ¾" NPT solid shank, with optional ½" and 1" NPT sizes. Ends beveled for welding also are available. Valve materials include forged carbon steel and 316 stainless steel. A molded Teflon packing ring is standard at no extra cost in valves for services up to 450º F. For temperatures to 700º F, valves have wire-graphite packing. The Type 3 valve has stainless steel safety ball checks to shut off the flow automatically in case of gage glass breakage.

PARTS

ITEM NO	NAME	STANDARD MATERIAL	316 SS WETTED PARTS MATERIAL
1	BODY	CARBON STEEL	316 SS
2	PACKING FOLLOWER	316 SS	316 SS
*3	PACKING RING	TEFLON	TEFLON
4	PACKING WASHER	17-4 PH SS	17-4 PH SS
5	STEM	416 SS	316 SS
6	STEM NUT	CARBON STEEL	CARBON STEEL
7	NAME PLATE	304 SS	304 SS
8	BALL	440 SS	316 SS
9	SEAT	416 SS	316 SS
10	FEMALE CONNECTOR	CARBON STEEL	316 SS

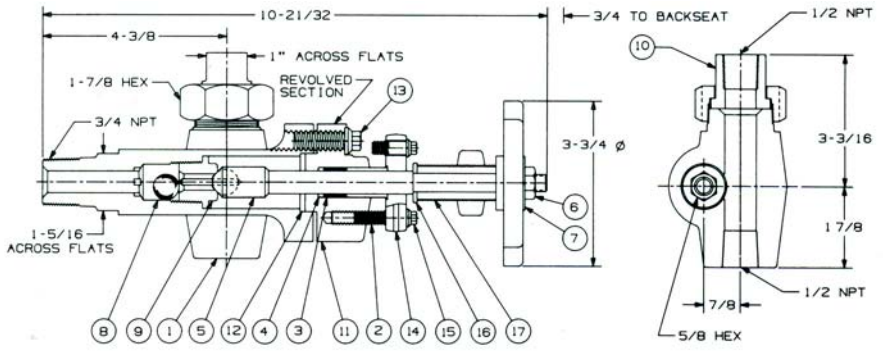
ITEM NO	NAME	STANDARD MATERIAL	316 SS WETTED PARTS MATERIAL
11	YOKE	FORGED STEEL	316 SS
12	YOKE GASKET	ASB-304 SS	ASB-304 SS
*13	YOKE SCREW	CARBON STEEL	CARBON STEEL
14	PRESSURE BAR	FORGED STEEL	FORGED STEEL
**15	PRESS BAR SCREW	ALLOY STEEL	ALLOY STEEL
16	INNER THRUST WASHER	17-4 PH SS	17-4 PH SS
17	HANDWHEEL ASSY.	IRON	IRON
18	OUTER THRUST WASHER	17-4 PH SS	17-4 PH SS

* 4 REQUIRED
** 2 REQUIRED



TYPE 3S

Weight per set approximately 17 lbs. 8 ozs.



TYPE 3U

Weight per set approximately 17 lbs. 8ozs.

A Tubular Gage Connection is available on request. Optional Tank Connections shown on pages 26 and 27. Optional Gage Connections shown on page 25.

OFFSET OS&Y VALVES

TYPE 7S & 7U

STANDARD OUTSIDE SCREW &YOKE

1440 psig CWP, 2160 psig Test (600 Ibs. Class)
¾" NPT Male Tank Connection
½" NPT Female Union Gage Connection

PRESSURE - TEMPERATURE RATING			
Teflon Packing		Wire-Graphite Packing	
1440 psi	100º F	1250 psi	500º F
1400 psi	200º F	1110 psi	600º F
1365 psi	300º F	1065 psi	700º F
1330 psi	400º F		

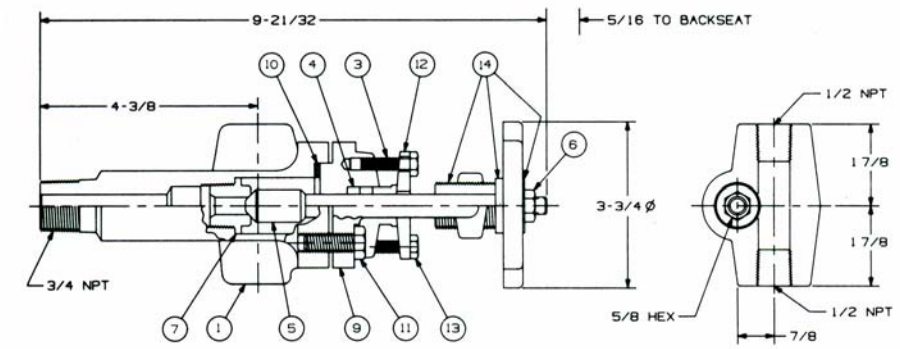
The Glass-Trac Type 7 Offset Gage Valve features the Outside Screw & Yoke (OS&Y) design which prevents excessively hot and corrosive fluids from contacting stem threads. The stem uses the positive non-rotating stem principle and backs directly off the regrindable seat. This valve is offset for ease in gage cleaning and is available in screwed (S) and union (U) gage connections. The Type 7 Valve also has a backseating stem as a standard feature. Stainless steel ball checks are available upon request.

PARTS

ITEM NO	NAME	MATERIAL
1	BODY	CARBON STEEL
2	UNION NUT	CARBON STEEL
3	PACKING FOLLOWER	STEEL
4	PACKING RING	TEFLON
5	STEM	416 SS
6	STEM NUT	CARBON STEEL
7	SEAT	416 SS
8	FEMALE CONNECTOR	CARBON STEEL
9	YOKE	FORGED STEEL

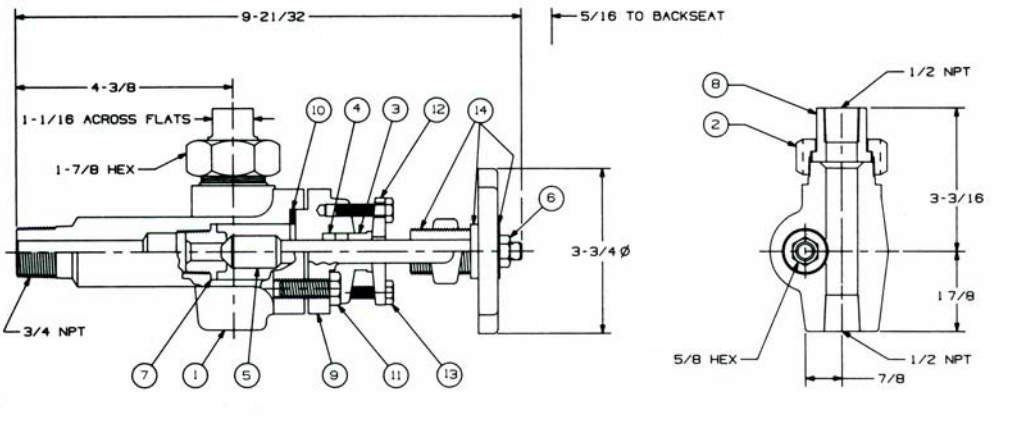
ITEM NO	NAME	MATERIAL
10	YOKE GASKET	SPIRAL ASB-304 SS
11	YOKE BOLT	ALLOY STEEL
12	PRESSURE BAR	FORGED STEEL
13	PRESSURE BAR SCREW	ALLOY STEEL
14	STEM-SCREW-HANDLE NAME PLATE ASSEMBLY	304 SS IRON/304 SS
15	OUTER THRUST WASHER	STEEL

NOTE: Valve shown is for bottom left hand (or top right hand) location. Opposite and is reversed. Valves are furnished in pairs of one bottom left hand and one top left hand.



TYPE 7S

Weight per set approximately 12 Ibs



TYPE 7U

Weight per set approximately 12 Ibs.

A Tubular Gage Connection is available on request. Optional Gage Connections shown on page 25. Optional Tank Connections shown on pages 26 and 27. A Ball Check Valve is available on request.

STRAIGHT-THRU VALVES

Type 4S & 4U

RENEWABLE INTERNAL STEM BONNET

4000 psig CWP 6000 psig Test
¾" NPT Male Union Tank Connection
½" NPT Female Gage Connection
½" NPT Female Drain Connection

PRESSURE - TEMPERATURE RATING			
Teflon Packing		Wire-Graphite Packing	
4000 psi	100º F	2950 psi	500º F
3730 psi	200º F	2700 psi	600º F
3470 psi	300º F	2430 psi	700º F
3200 psi	400º F		

The Glass-Trac Type 4 Straight-Thru Gage Valve is available with screwed (S) and Union (U) gage connections and used with Reflex and Transparent Gages in working pressures up to 4000 psi. The "straight-thru" valve body design is popularly used with close hook-up (side connection) gages because the gage side connection centers and vessel centers can be identical. (With offset valves, vessel centers must be inside or outside side connection centers.) Type 4 Valves have a ¾" NPT Male Tank Connection as standard, with other connections available on order.

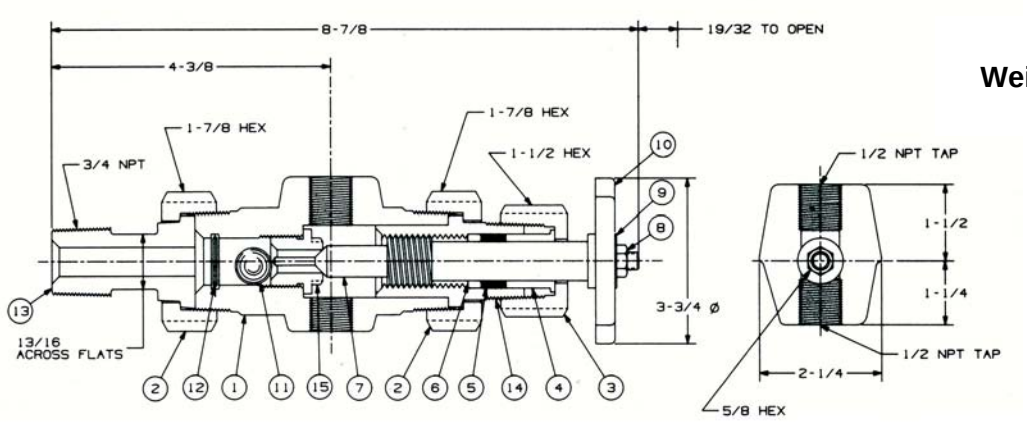
Type 4 Straight-Thru Gage Valves are stocked in carbon steel with stainless steel trims. A molded Teflon packing ring is standard at no extra cost in valves for services to 450ºF. For temperatures to 700º F, valves have wire-graphite packing. The Type 4 Valve has stainless steel ball checks to shut off the flow automatically in case of gage glass breakage. An optional back seating stem is available on request.

PARTS

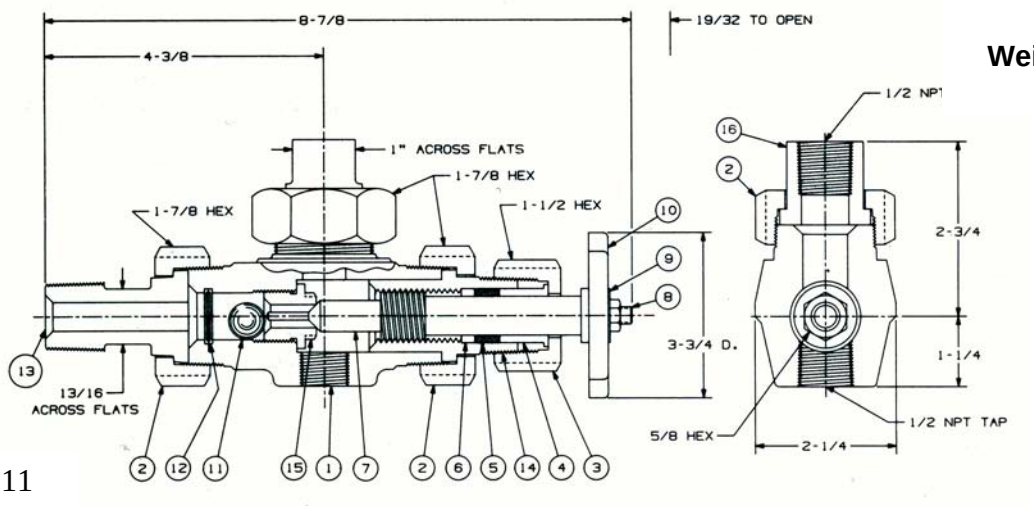
ITEM NO	NAME	STANDARD MATERIAL	316 SS WETTED PARTS MATERIAL
1	BODY	CARBON STEEL	316 SS
2	UNION NUT	CARBON STEEL	CARBON STEEL
3	PACKING NUT	CARBON STEEL	CARBON STEEL
4	PACKING FOLLOWER	316 SS	316 SS
5	PACKING RING	TEFLON	TEFLON
6	PACKING WASHER	17-4 PH SS	17-4 PH SS
7	STEM	416 SS	316 SS
8	STEM NUT	CARBON STEEL	CARBON STEEL
9	NAME PLATE	304 SS	304 SS
10	HAND WHEEL	IRON	IRON

ITEM NO	NAME	STANDARD MATERIAL	316 SS WETTED PARTS MATERIAL
11	BALL	440 SS	316 SS
12	BALL RETAINER	316SS	316 SS
*13	MALE CONNECTOR	CARBON STEEL	316 SS
14	BONNET	416 SS	316 SS
15	SEAT	416 SS	316 SS
16	FEMALE CONNECTOR	CARBON STEEL	316 SS

* Item No. 13 has hole with 1/16 eccentricity for ± 1/8 maximum misalignment on the overall center-to-center.
Note: Valve shown is for bottom left-hand (or top right-hand) location. Opposite hand is reversed. Valves are furnished in pairs of one bottom left hand and one top left hand.



TYPE 4S
Weight per set approximately 12 lbs.



TYPE 4U
Weight per set approximately 12 lbs.

A Tubular Gage Connection is available on request. Optional Tank Connections shown on pages 26 and 27. Optional Gage Connections shown on page 25. Quick Opening Valve model shown on page 24.

STRAIGHT-THRU OS&Y VALVES

Type 5S & 5U

STANDARD OUTSIDE SCREW & YOKE

1440 psig CWP, 2160 psig Test (600 lbs. Class)
¾" NPT Male Tank Connection
½" NPT Female Gage Connection
½" NPT Female Drain Connection only

PRESSURE - TEMPERATURE RATING			
Teflon Packing		Wire-Graphite Packing	
1440 psi	100º F	1250 psi	500º F
1400 psi	200º F	1110 psi	600º F
1365 psi	300º F	1065 psi	700º F
1330 psi	400º F		

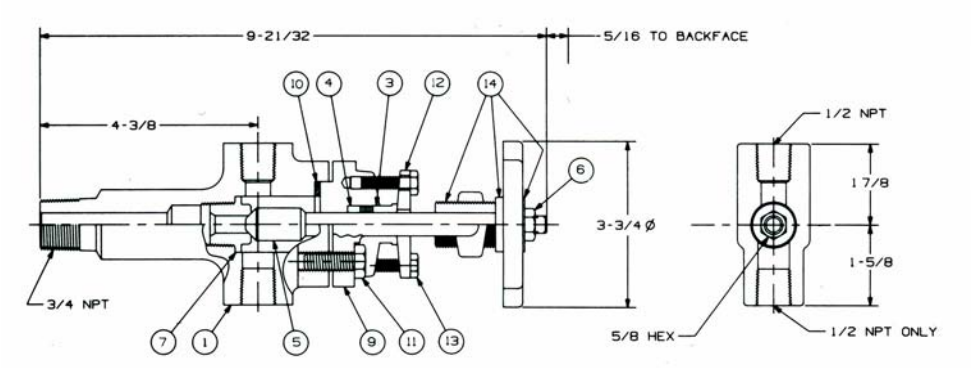
The Glass-Trac Type 5 Gage Valve has the Outside Screw & Yoke design which prevents excessively hot and corrosive fluids from contacting stem threads, causing possible malfunction. The stem backs directly off the regrindable valve seat using the positive, non-rotating stem principle. The valve has a "straight-thru" body design and, with an optional bleed valve, can be used in a block and bleed application. Standard gage connections are screwed (S) and union (U) but any other type connection can be supplied on special order.

The standard tank connection for Type 5 OS&Y Straight-Thru Gage Valves is a ¾' NPT solid shank, with optional ½" and 1" NPT sizes. Ends beveled for welding also are available. Valve materials include forged carbon steel with stainless steel trims. A molded Teflon packing ring is standard at no extra cost in valves for services up to 450ºF. For temperatures to 700ºF, valves have wire-graphite packing. The standard Type 5 Valve has a back seating stem that allows the packing to be changed without shutting down the vessel. Stainless steel ball checks are available upon request.

PARTS

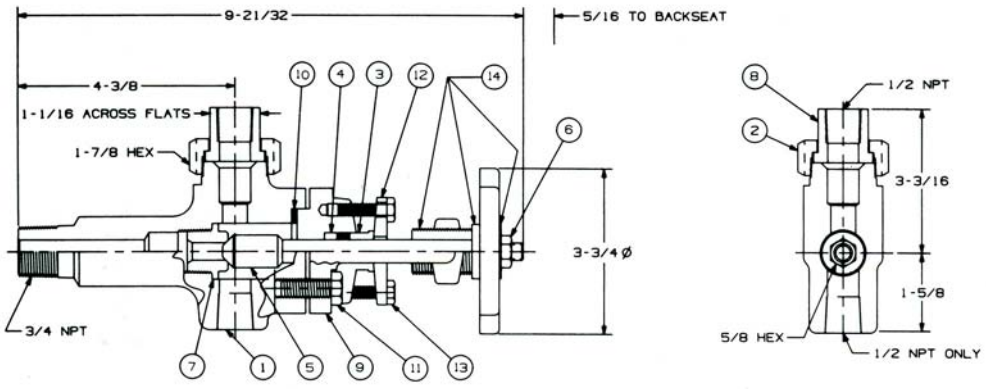
ITEM NO	NAME	MATERIAL
1	BODY	CARBON STEEL
2	UNION NUT	CARBON STEEL
3	PACKING FOLLOWER	STEEL
4	PACKING RING	TEFLON
5	STEM	416 SS
6	STEM NUT	CARBON STEEL
7	SEAT	416 SS
8	FEMALE CONNECTOR	CARBON STEEL

ITEM NO	NAME	MATERIAL
9	YOKE	FORGED STEEL
10	YOKE GASKET	SPIRAL ASB-304 SS
11	YOKE BOLT	ALLOY STEEL
12	PRESSURE BAR	FORGED STEEL
13	PRESSURE BAR SCREW	ALLOY STEEL
14	STEM-SCREW-HANDLE NAME PLATE ASSEMBLY	304 SS IRON/304 SS
15	OUTER THRUST WASHER	STEEL



TYPE 5S

Weight per set approximately 12 lbs.



TYPE 5U

Weight per set approximately 12 lbs.

½" NPT & 1" NPT OPTIONAL.
½" IPS & 1" IPS BEVELED ENDS OPTIONAL.

A Tubular Gage Connection is available on request. Optional Tank Connections shown on pages 26 and 27. Optional Gage Connection shown on page 25. A Ball Check Valve is available on request.

TUBULAR GAGES AND VALVES

⅝” O.D. Glass Standard, ¾” O.D. Glass Optional



Shown with Type 2T valves

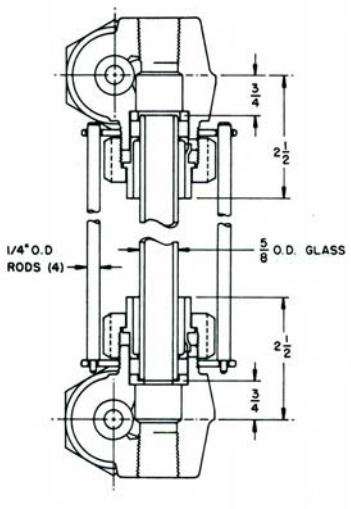
Glass-Trac Tubular Glass Gages are available in any length desired and can be fitted with Type 1T or 2T Gage Valves (see Page 18). These gages provide 360º visibility of the liquid level through strong, clear glass. Tubular glass is used in three types: Red Line, High Pressure and Heavy Wall. Pressure ratings are different for each type and also depend upon glass length (see next page). If glass breakage occurs, a stainless steel ball check shuts off each valve. Glass tubes should be cut 1½” shorter than valve center-to-center. The resulting visible glass length is 5” less than the valve center-to-center.

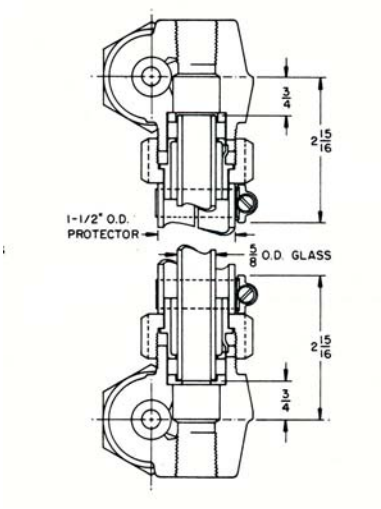
Red Line glass provides a bright crimson stripe against a narrow white strip throughout the length of the tube. Liquid levels are easy to see against this special optical effect. The glass is heat-resistant and ends are fire polished. Red Line is available in both ⅝” and ¾” O.D.

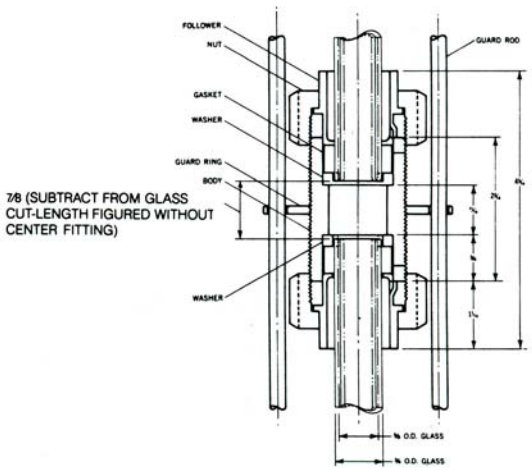
High Pressure glass is a versatile, medium-strong type of tube used in many applications. It is crystal clear and ends are fire polished.

Heavy Wall glass has the highest pressure rating of all tubular glass. It is extremely clear, corrosion resistant, will not scratch easily and is extra resistant to heat shock. Ends are ground.

Four carbon steel guard rods and two guard rod rings are used to protect tubular glass gages. The rods are anchored in each ring which is fastened to the valve behind the union nut. Rods should be cut 1¾” shorter than valve center-to-center. A transparent plastic sheath also is available to clamp around the glass tube. Sheath length should be 4 ⅜” shorter than valve center-to-center. Also available is an expanded metal gage glass protector for additional protection of the glass. Specify gage valve center-to-center for proper sizing of this assembly.







CENTER FITTING
(Recommended when valve centers exceed maximum recommended service length)

NOTE: ***Type 1T 4000 psi Tubular Valve and Type 2T 4000 psi Tubular Valve shown on page 15.***

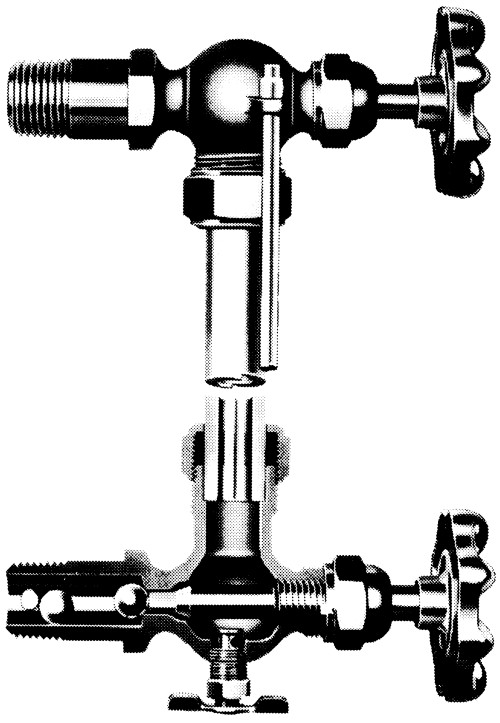
MAXIMUM RECOMMENDED WORKING PRESSURE, PSIG

GLASS LENGTH	5/8" O.D. RED LINE		3/4" O.D. RED LINE		5/8" O.D. HIGH PRESSURE	
	TO 150° F*	TO 425° F**	TO 150° F*	TO 425° F**	TO 150° F*	TO 425 °F**
8"	370	285	360	280	435	320
10"	345	280	340	275	420	315
12"	335	280	330	275	410	305
14"	325	275	320	270	390	295
15"	320	275	315	270	380	290
16"	315	270	310	265	375	285
18"	305	265	300	260	360	280
20"	290	265	285	260	350	270
22"	280	260	275	255	335	265
24"	265	255	260	250	320	255
30"	235	†	230	†	280	†
36"	205	†	200	†	245	†
48"	165	†	160	†	195	†
60"	125	†	125	†	150	†
72"	90	†	90	†	100	†

GLASS LENGTH	3/4" O.D. HIGH PRESSURE		5/8" O.D. HEAVY WALL		3/4" O.D. HEAVY WALL	
	TO 150° F*	TO 425° F**	TO 150° F*	TO 425° F**	TO 150° F*	TO 425° F**
8"	425	315	600	350	600	350
10"	410	310	600	345	600	345
12"	400	300	600	340	600	340
14"	385	290	600	335	600	335
15"	375	285	600	330	600	330
16"	370	280	600	325	600	325
18"	355	275	600	320	600	320
20"	345	265	600	315	600	315
22"	330	260	590	310	590	310
24"	315	250	580	300	580	300
30"	275	†	550	†	550	†
36"	240	†	500	†	500	†
48"	190	†	340	†	340	†
60"	145	†	‡	†	‡	†
72"	100	†	‡	†	‡	†

*To 150ºF and/or CORROSIVE SERVICES **For 150-425º and/or CORROSIVE SERVICES
†Maximum recommended length in this service is 24".
‡ Maximum recommended length in this service is 48".

TUBULAR VALVES (Brass)



½" NPT Male Tank Connection
⅝" O.D. Tubular Glass Gage Connection

For low pressure water vessels, storage tanks, containers, etc., Glass-Trac provides Type OT Brass Valves for Tubular Gages. The valves are made up with 5/8" O.D. Pyrex Red Line, High Pressure or Heavy Wall Glass from stock. Each valve contains a brass ball check which closes the valve in the event of glass breakage. Two guard rods are used. The lower valve also is fitted with a threaded drain cock. Type OT Brass Valves are suitable for working pressures up to 200 psig at or under 400ºF.

Tubular glasses are available in any length and should be cut 1½" shorter than valve center-to-center. Guard rods should be ¾" longer than the valve center-to-centers.

Visible length is 3" less than the valve centers.

TUBULAR VALVES

Type 1T & 2T

4000 psig CWP 6000 psig Test
¾" NPT Male Union Tank Connection
⅝"O.D. Tubular Glass Gage Connection
½" NPT Female Drain Connection

Glass-Trac Offset Tubular Gage Valves are identical to Type 1 and 2 S and U Valves except they are fitted with the ⅝" O.D. tubular glass connection. The Type 2T Valve also can be furnished in the coarse thread design and with quick-operating lever for remote operation by chain. Both valves have a molded Teflon packing ring and rubber glass gaskets as standard for services up to 250º F. For temperatures to 425º F, valves have wire-graphite packing and Viton® glass gaskets. In the event of tubular glass breakage, a stainless steel ball check closes the valve to prevent further loss of fluid.

PRESSURE - TEMPERATURE RATING			
Teflon Packing		Wire-Graphite Packing	
4000 psi	100 F	3470 psi	300 F
3730 psi	200 F	3200 psi	* 400 F
3600 psi	250 F	3150 psi	425 F

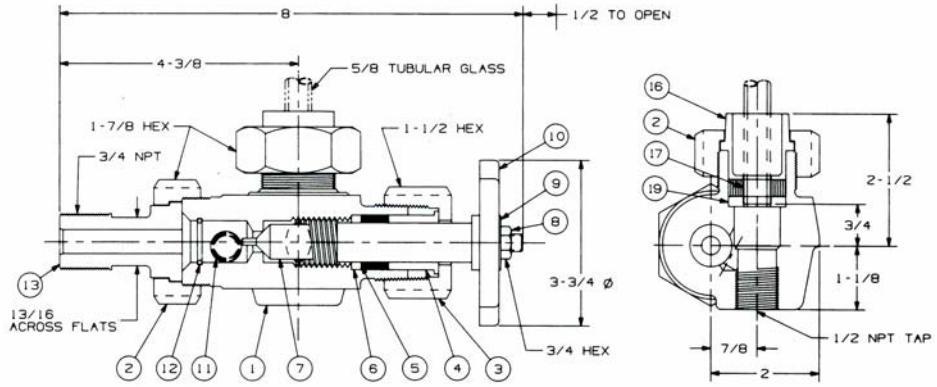
NOTES: ***These ratings are for the valves only and not the tubular glass gages. See glass gage ratings on page 14.***

PARTS

ITEM NO	NAME	STANDARD MATERIAL	316 SS WETTED PARTS MATERIAL
1	BODY	CARBON STEEL	316 SS
2	UNION NUT	CARBON STEEL	CARBON STEEL
3	PACKING NUT	CARBON STEEL	CARBON STEEL
4	PACKING FOLLOWER	316 SS	316 SS
5	PACKING RING	TEFLON	TEFLON
6	PACKING WASHER	17-4 PH SS	17-4 PH SS
7	STEM	416 SS ①	316 SS
8	STEM NUT	CARBON STEEL	CARBON STEEL
9	NAME PLATE	4165	304 SS
10	HAND WHEEL	ALLOY ZINC	ALLOY ZINC
11	BALL	440 SS	440 SS
12	BALL RETAINER	316 SS	316 SS

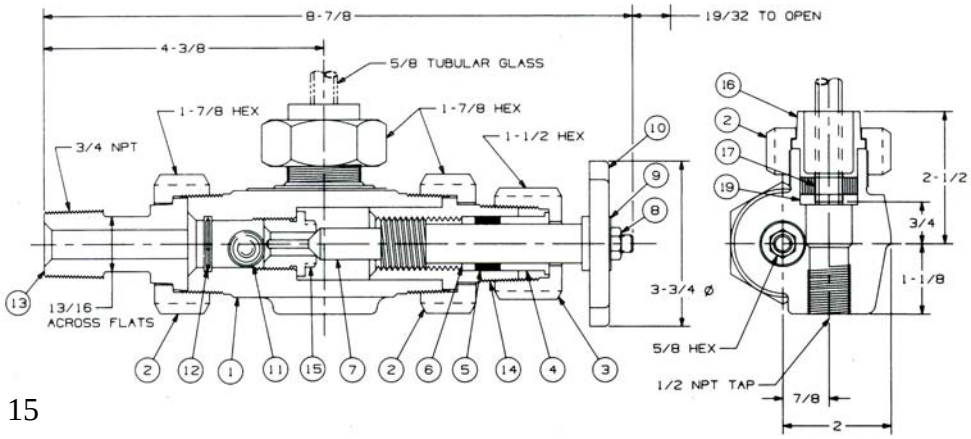
ITEM NO	NAME	STANDARD MATERIAL	316 SS WETTED PARTS MATERIAL ②
*13	MALE CONNECTOR	CARBON STEEL	316 SS
14	BONNET ②	416 SS	316 SS
15	SEAT ②	416 SS	316 SS
16	GLASS FOLLOWER	CARBON STEEL	CARBON STEEL
17	GLASS GASKET	RUBBER	RUBBER
**18 OR 19	LOWER GLASS SUPPORT	CARBON STEEL	316 SS

* ITEM NO.13 HAS HOLE WITH 1/16 ECCENTRICITY FOR ± 1/8 MAXIMUM MISALIGNMENT ON THE OVERALL CENTER-TO-CENTER.
**ITEM NO.21 IS USED IN LOWER VALVE ; ITEM NO.20 IN UPPER VALVE.
NOTE: Valve shown is for bottom left hand (or top right hand) location. Opposite hand is reversed. Valves are furnished in pairs of one bottom left hand and one top left hand.
① For Type 1 – 416 SS
② Available in Type 2 Valve only.



TYPE 1T

Weight per set approximately 10 lbs. 12ozs.



TYPE 2T

Weight per set approximately 11 lbs. 12ozs.

Optional Tank Connections shown on pages 26 and 27. Optional Gage Connections shown on page 25.

SPECIALTY GAGES:

Welding Pad

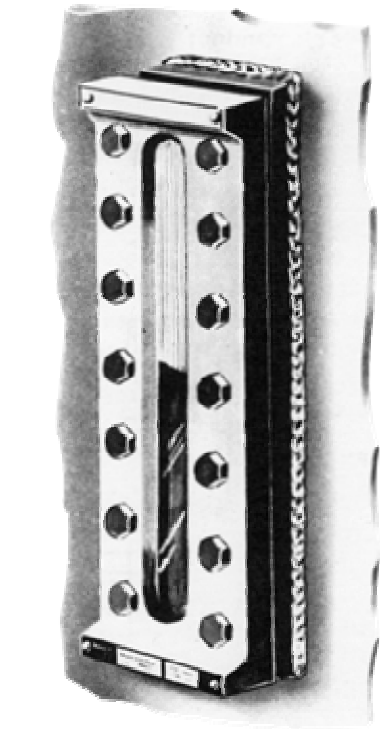
Glass-Trac Welding Pad Gages are used when standard tank connections cannot be used or when the liquid has solids in suspension. The gage becomes an integral part of the vessel because it is welded right onto the outer wall. Reflex or Transparent glass is used in any of nine standard lengths. Standard covers are 3⅛" wide. **NOTES:** Welding pad gages to be used on vessels less than 36" in diameter must be special ordered. The welding pad body must be machined to allow proper fit up.

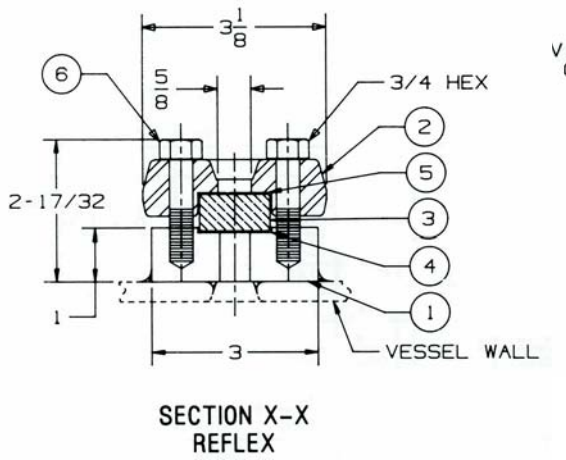
Method of Installation:

1. Assemble complete gage with spacer plate (available on request) in place of gage glass.
2. Place gage in exact location desired on empty vessel and weld around circumference of the pad.
3. Allow gage to cool, then remove cover and spacer. Drill or burn top and bottom holes in vessel wall at the top and bottom of each gage slot. Slot is ⅝" wide.
4. Replace gage glass, gasket, cushion and cover. Torque bolts to prescribed foot/pounds.

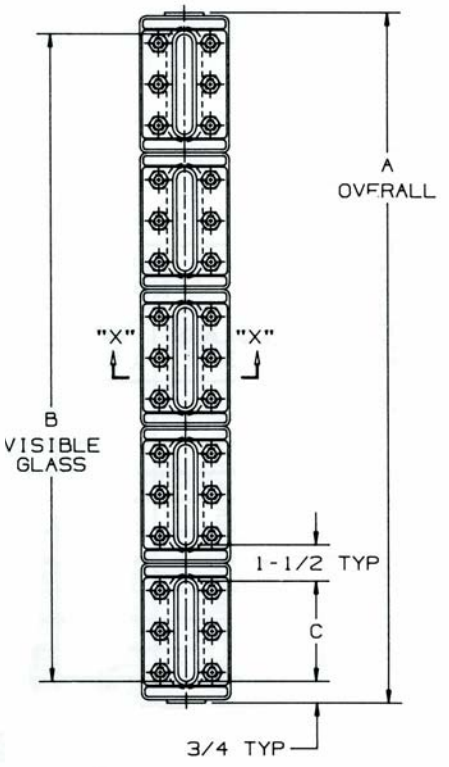
NOTES: While the gage itself can be designed to withstand certain pressures. Glass-Trac cannot control the installation of each gage or the load applied to the gage by the vessel. Because of this, Glass-Trac cannot rate Weld Pad Gages.

When ordering, add WP to gage size number.





SECTION X-X
REFLEX



PARTS

ITEM NO.	NAME	MATERIAL
1	WELDING PAD	AISI 1020 HR
2	COVER	CARBON STEEL
3	GLASS	TEMPERED
4	GASKET	NON-ASBESTOS
5	CUSHION	NON-ASBESTOS
6	BOLT	ASTM A193 B7

DIMENSIONS

SIZE NO.		DIMENSIONS (IN INCHES)		
GLASS SIZE	NO. SECT.	A	B	C
1	1	5 1/4	3 3/4	3 3/4
2	1	6 1/4	4 3/4	4 3/4
3	1	7 1/4	5 3/4	5 3/4
4	1	8 1/4	6 3/4	6 3/4
5	1	9 3/8	7 7/8	7 7/8
6	1	10 5/8	9 1/8	9 1/8
7	1	11 3/4	10 1/4	10 1/4
8	1	13 3/8	11 7/8	11 7/8
9	1	14 1/8	12 5/8	12 5/8
3	2	14 1/2	13	5 3/4
4	2	16 1/2	15	6 3/4
5	2	18 3/4	17 1/4	7 7/8
6	2	21 1/4	19 3/4	9 1/8
7	2	23 1/2	22	10 1/4
8	2	26 3/4	25 1/4	11 7/8
9	2	28 1/4	26 3/4	12 5/8
6	3	31 7/8	30 3/8	9 1/8
7	3	35 1/4	33 3/4	10 1/4
8	3	40 1/8	38 5/8	11 7/8
9	3	42 3/8	40 7/8	12 5/8
7	4	47	45 1/2	10 1/4
8	4	53 1/2	52	11 7/8
9	4	56 1/2	55	12 5/8
7	5	58 3/4	57 1/4	10 1/4
8	5	66 7/8	65 3/8	11 7/8
9	5	70 5/8	69 1/8	12 5/8

SPECIALTY GAGES:

Large-Chamber

Example: 71 RL-LC (No.7 glass, 1-section, Reflex, Low Pressure, Large Chamber)



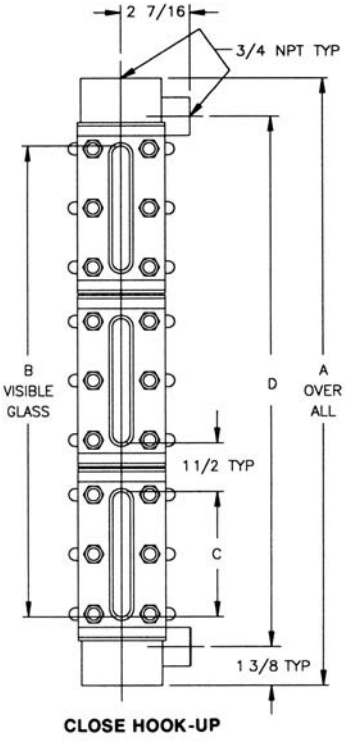
Glass-Trac Large Chamber Gages are made in a special low pressure series of both Reflex and Transparent Gages. The large diameter chamber makes accurate liquid level readings possible under unusual conditions such as boiling, flashing, or foaming of the liquid. The chamber is manufactured from heavy duty seamless steel pipe with an inside diameter of 2⅛". Each end of the pipe is closed off with a welded plug which is drilled and tapped for ¾" NPT connections. For close hook-ups, ¾" NPT side connections are made and ends may be drilled, tapped and plugged for cleaning as required.

Recessed seats are machined into the liquid chamber and gage covers for protection of glass, gasket and cushion. Special bolts are used. Large Chamber Gages are made in lengths for standard flat glasses and multiple section gages are available.

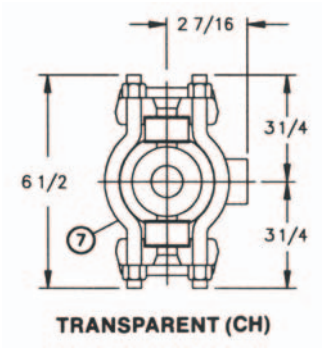
When ordering, add LC for large chamber to gage size number and CH for close hook-up.

DIMENSIONS

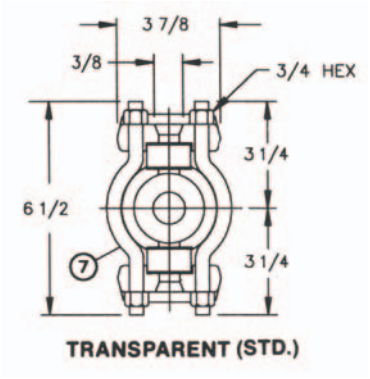
SIZE NO.		DIMENSIONS (IN INCHES)						
GLASS SIZE	NO. SECT.	STANDARD			CLOSE HOOK-UP			
		A	B	C	A	B	C	D
1	1	6 1/4	3 3/4	3 3/4	8 3/8	3 3/4	3 3/4	5 5/8
2	1	7 1/4	4 3/4	4 3/4	9 3/8	4 3/4	4 3/4	6 5/8
3	1	8 1/4	5 3/4	5 3/4	10 3/8	5 3/4	5 3/4	7 5/8
4	1	9 1/4	6 3/4	6 3/4	11 3/8	6 3/4	6 3/4	8 5/8
5	1	10 3/8	7 7/8	7 7/8	12 1/2	7 7/8	7 7/8	9 3/4
6	1	11 5/8	9 1/8	9 1/8	13 3/4	9 1/8	9 1/8	11
7	1	12 3/4	10 1/4	10 1/4	14 7/8	10 1/4	10 1/4	12 1/8
8	1	14 3/8	11 7/8	11 7/8	16 1/2	11 7/8	11 7/8	13 3/4
9	1	15 1/8	12 5/8	12 5/8	17 1/4	12 5/8	12 5/8	14 1/2
3	2	15 1/2	13	5 3/4	17 5/8	13	5 3/4	14 7/8
4	2	17 1/2	15	6 3/4	19 5/8	15	6 3/4	16 7/8
5	2	19 3/4	17 1/4	7 7/8	21 7/8	17 1/4	7 7/8	19 1/8
6	2	22 1/4	19 3/4	9 1/8	24 3/8	19 3/4	9 1/8	21 5/8
7	2	24 1/2	22	10 1/4	26 5/8	22	10 1/4	23 7/8
8	2	27 3/4	25 1/4	11 7/8	29 7/8	25 1/4	11 7/8	27 1/8
9	2	29 1/4	26 3/4	12 5/8	31 3/8	26 3/4	12 5/8	28 5/8
6	3	32 7/8	30 3/8	9 1/8	35	30 3/8	9 1/8	32 1/4
7	3	36 1/4	33 3/4	10 1/4	38 3/8	33 3/4	10 1/4	35 5/8
8	3	41 1/8	38 5/8	11 7/8	43 1/4	38 5/8	11 7/8	40 1/2
9	3	43 3/8	40 7/8	12 5/8	45 1/2	40 7/8	12 5/8	42 3/4
7	4	48	45 1/2	10 1/4	50 1/8	45 1/2	10 1/4	47 3/8
8	4	54 1/2	52	11 7/8	56 5/8	52	11 7/8	53 7/8
9	4	57 1/2	55	12 5/8	59 5/8	55	12 5/8	56 7/8
7	5	59 3/4	57 1/4	10 1/4	61 7/8	57 1/4	10 1/4	59 1/8
8	5	67 7/8	65 3/8	11 7/8	70	65 3/8	11 7/8	67 1/4
9	5	71 5/8	69 1/8	12 5/8	73 3/4	69 1/8	12 5/8	71



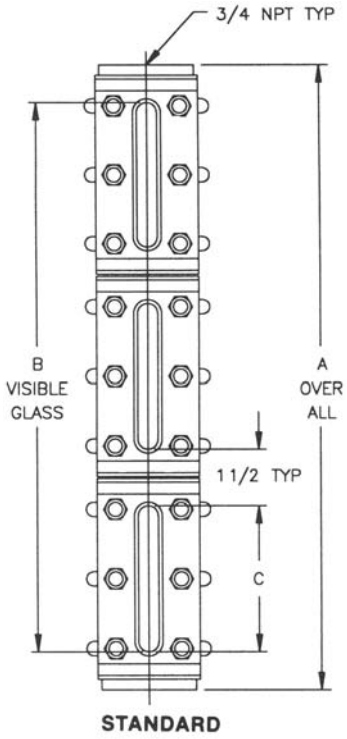
CLOSE HOOK-UP



TRANSPARENT (CH)

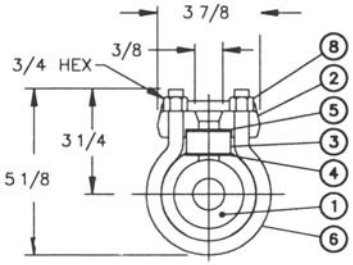


TRANSPARENT (STD.)

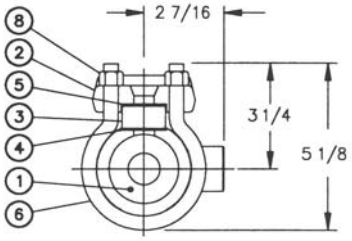


STANDARD

ITEM NO.	NAME	MATERIAL
1	CHAMBER	ASTM A106 GRB
2	COVER	CARBON STEEL
3	GLASS	TEMPERED
4	GASKET	NON - ASBESTOS
5	CUSHION	NON - ASBESTOS
6	U-BOLT	ASTM A193 B7
7	BOLT	ASTM A193 B7
8	NUT	ASTM A194 2H



REFLEX (STD.)



REFLEX (CH)

PRESSURES-TEMPERATURE RATINGS (psig)

REFLEX - LARGE CHAMBER							
GLASS SIZE	100° F	200° F	300° F	400° F	500° F	600° F	700° F
1	1020	990	950	910	850	755	620
2	980	950	915	875	815	725	600
3	940	910	880	840	780	695	590
4	900	870	840	805	750	665	560
5	860	830	800	770	715	635	540
6	830	805	775	745	690	610	530
7	790	765	735	710	660	585	510
8	750	725	700	670	625	555	500
9	695	695	670	645	600	530	480
TRANSPARENT - LARGE CHAMBER							
GLASS SIZE	100° F	200° F	300° F	400° F	500° F	600° F	700° F
1	790	765	740	705	660	585	390
2	750	725	700	670	625	555	380
3	720	695	670	645	600	530	360
4	680	655	635	610	565	500	340
5	650	630	605	580	540	480	330
6	610	590	570	545	510	450	310
7	580	560	540	520	485	430	300
8	540	520	505	480	450	400	280
9	500	485	465	445	415	370	260

SPECIALTY GAGES:

Heated/Cooled Externally

Example: 71 TL-HC (No. 7 glass, 1-section, Transparent, Low Pressure, Externally Heated/Cooled Gage)

Also available in close hook-up (CH) and internally heated/cooled type.



Glass-Trac Externally Heated/Cooled Gages may be either low Pressure or Mid Pressure or Mid Pressure, Reflex or Transparent and have ½" or ¾" NPT Connections. Pressure-temperature ratings and sizes remain the same as standard flat gages.

On externally heated/cooled gages a metal tube is employed to transmit heating or cooling fluid. The tubing starts from an adaptor nut on one valve, passes along a machined groove in the gage body wall and connects to the adaptor nut in the opposite valve. Fluid piped through the tubing serves as the heating or cooling media. Gage bodies (liquid chambers) are made extra long to accommodate the groove and tubing.

Most common heating fluids are steam and hot water. To cool gages, methane, propane, freon and ammonia refrigerants are used.

The adaptor nut on the gage valves can be fitted with either a ½" NPT Female Tank connections or a ¾" NPT Male Tank connection. Valve Types 1,2 and 4 may be used.

When ordering Glass-Trac Externally Heated/ Cooled Gages, add HC to the gage size number.

Tank Connections
(Also see pages 26 and 27)

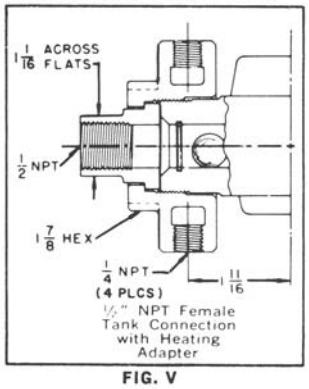


FIG. V

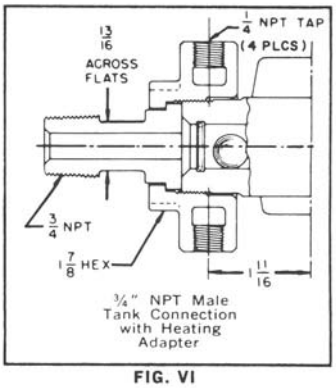
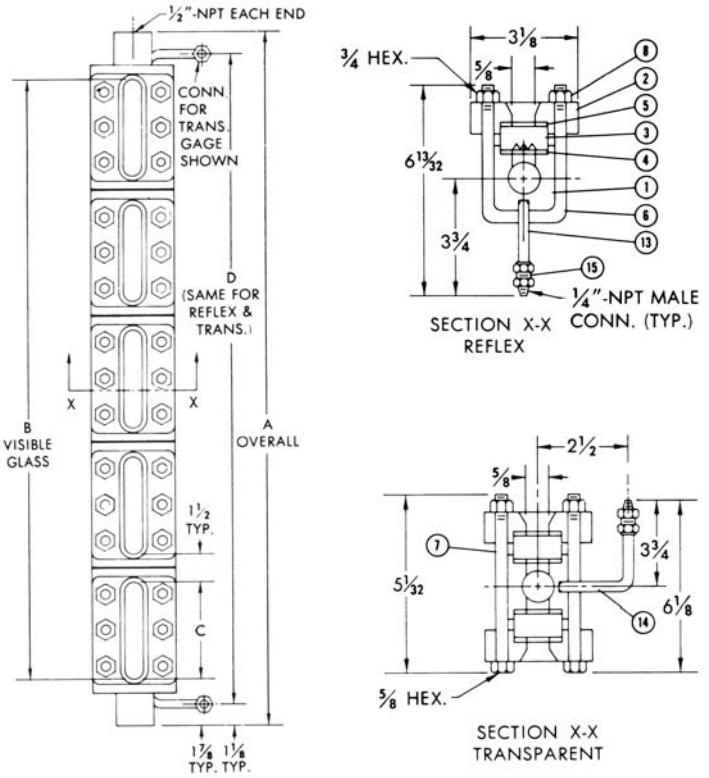


FIG. VI



PARTS

ITEM NO.	NAME	MATERIAL
1	CHAMBER	CARBON STEEL
2	COVER	CARBON STEEL
3	GLASS	TEMPERED
4	GASKET	NON-ASBESTOS
5	CUSHION	NON-ASBESTOS
6	U-BOLT	ASTM A193 B7
7	BOLT	ASTM A193 B7
8	NUT	ASTM A194 2H
13	TUBING	COPPER
14	TUBING	COPPER
15	FITTING	STEEL

DIMENSIONS AND PRESSURE RATINGS

SIZE NO.		DIMENSIONS (IN INCHES)				LOW PRESSURE				MID-PRESSURE			
						REFLEX MAX. PSIG @ TEMP.*		TRANSPARENT MAX. PSIG @ TEMP.*		REFLEX MAX. PSIG @ TEMP.*		TRANSPARENT MAX. PSIG @ TEMP.*	
GLASS SIZE	NO. SECT.	A	B	C	D	100° F	700° F	100° F	700° F	100° F	700° F	100° F	700° F
1	1	7 1/2	3 3/4	3 3/4	5 1/4	2400	1520	2000	1260	3000	1890	2500	1580
2	1	8 1/2	4 3/4	4 3/4	6 1/4	2325	1470	1815	1150	2910	1840	2315	1470
3	1	9 1/2	5 3/4	5 3/4	7 1/4	2250	1420	1630	1050	2820	1780	2130	1340
4	1	10 1/2	6 3/4	6 3/4	8 1/4	2175	1370	1440	900	2725	1740	1940	1230
5	1	11 5/8	7 7/8	7 7/8	9 3/8	2100	1320	1250	790	2630	1660	1750	1100
6	1	12 7/8	9 1/8	9 1/8	10 5/8	2025	1280	1065	680	2535	1600	1565	990
7	1	14	10 1/4	10 1/4	11 3/4	1950	1230	875	550	2440	1540	1375	870
8	1	15 5/8	11 7/8	11 7/8	13 3/8	1875	1180	690	440	2345	1480	1190	750
9	1	16 3/8	12 5/8	12 5/8	14 1/8	1800	1140	500	320	2250	1420	1000	630
3	2	16 3/4	13	5 3/4	14 1/2	2250	1420	1630	1050	2820	1780	2130	1340
4	2	18 3/4	15	6 3/4	16 1/2	2175	1370	1440	900	2725	1740	1940	1230
5	2	21	17 1/4	7 7/8	18 3/4	2100	1320	1250	790	2630	1660	1750	1100
6	2	23 1/2	19 3/4	9 1/8	21 1/4	2025	1280	1065	680	2535	1600	1565	990
7	2	25 3/4	22	10 1/4	23 1/2	1950	1230	875	550	2440	1540	1375	870
8	2	29	25 1/4	11 7/8	26 3/4	1875	1180	690	440	2345	1480	1190	750
9	2	30 1/2	26 3/4	12 5/8	28 1/4	1800	1140	500	320	2250	1420	1000	630
6	3	34 1/8	30 3/8	9 1/8	31 7/8	2025	1280	1065	680	2535	1600	1565	990
7	3	37 1/2	33 3/4	10 1/4	35 1/4	1950	1230	875	550	2440	1540	1375	870
8	3	42 3/8	38 5/8	11 7/8	40 1/8	1875	1180	690	440	2345	1480	1190	750
9	3	44 5/8	40 7/8	12 5/8	42 3/8	1800	1140	500	320	2250	1420	1000	630
7	4	49 1/4	45 1/2	10 1/4	47	1950	1230	875	550	2440	1540	1375	870
8	4	55 3/4	52	11 7/8	53 1/2	1875	1180	690	440	2345	1480	1190	750
9	4	58 3/4	55	12 5/8	56 1/2	1800	1140	500	320	2250	1420	1000	630
7	5	61	57 1/4	10 1/4	58 3/4	1950	1230	875	550	2440	1540	1375	870
8	5	69 1/8	65 3/8	11 7/8	66 7/8	1875	1180	690	440	2345	1480	1190	750
9	5	72 7/8	69 1/8	12 5/8	70 5/8	1800	1140	500	320	2250	1420	1000	630

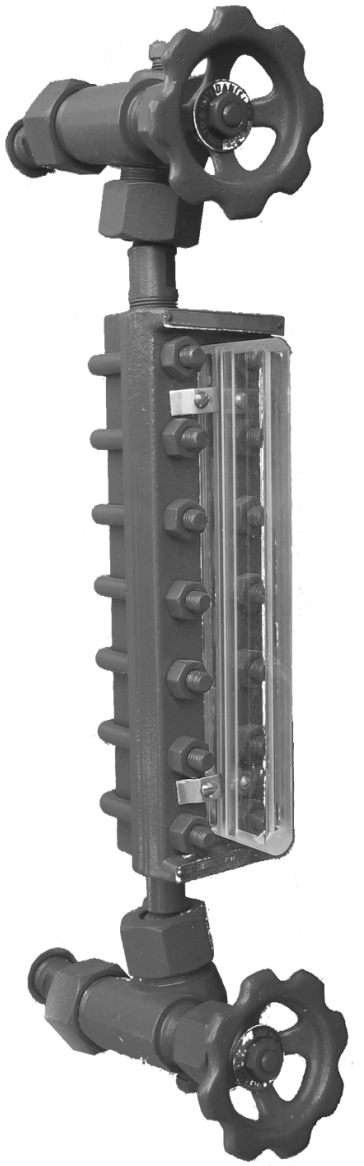
* Saturated steam to 350 WSP

**Maximum saturated steam 600 WSP with mica shields

SPECIALTY GAGE:

Frost-Prevention Extensions

Example: 81 RL-FP w/ 3⅝" extensions (No.8 glass, 1-section, Reflex, Low Pressure, Frost Preventive Gage with 3⅝" extensions).

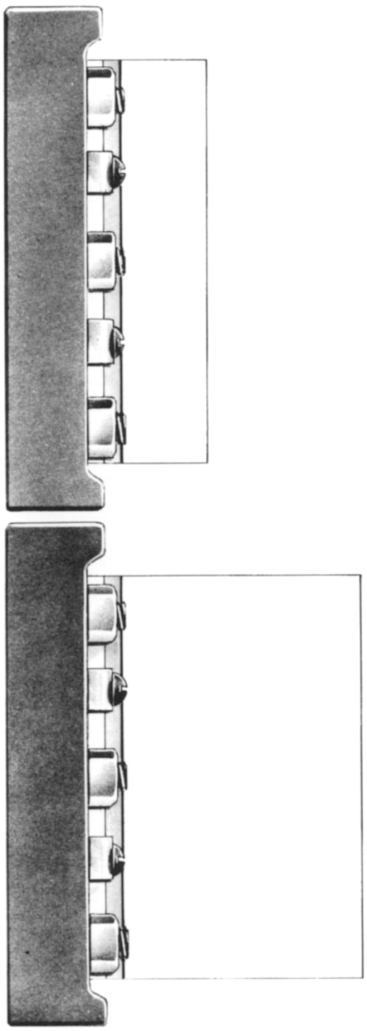


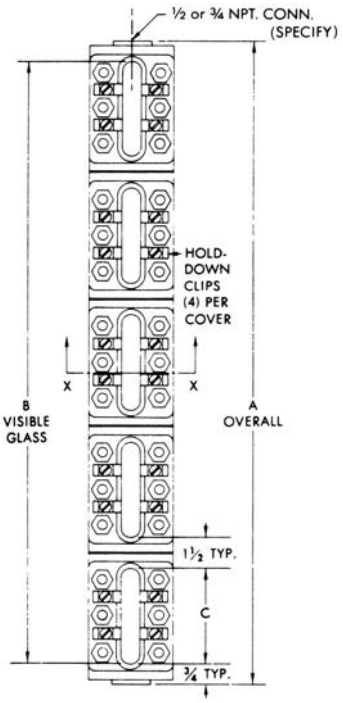
Glass-Trac plastic extensions for flat gage glasses prevent frost from forming in the liquid level view slot in low temperature services. Reflex and Transparent Gages in all pressure ratings can be fitted with plastic extensions.

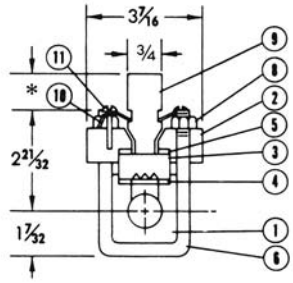
Projecting from the view slot, the clear plastic extensions keeps the liquid level indication clearly visible. Stocked extensions are 1⅝" and 3⅝" in length. If the gage is thickly insulated, longer extensions are available. The extension is held in place by stainless steel clamps fastened to the gage cover. For extra low temperature services, Glass-Trac gages can be made of special metals.

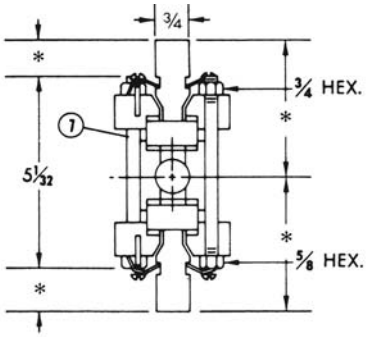
Recommended length for Frost Preventive Extensions: 1⅝" extension is standard from 80ºF ambient to 0ºF temperature. Add 1" extension length for each 100º F below 0º F.

When ordering, specify length and add FP to gage size number.









*Depends on Extension Length

PARTS

ITEM NO.	NAME	MATERIAL
1	CHAMBER	CARBON STEEL
2	COVER	CARBON STEEL
3	GLASS	TEMPERED
4	GASKET	NON-ASBESTOS
5	CUSHION	NON-ASBESTOS
6	U-BOLT	ASTM A193 B7
7	BOLT	ASTM A193 B7
8	NUT	ASTM A192 2H
9	EXTENSION	PLASTIC
10	CLIP	303 SS
11	SCREW	303 SS

DIMENSIONS AND PRESSURE RATINGS

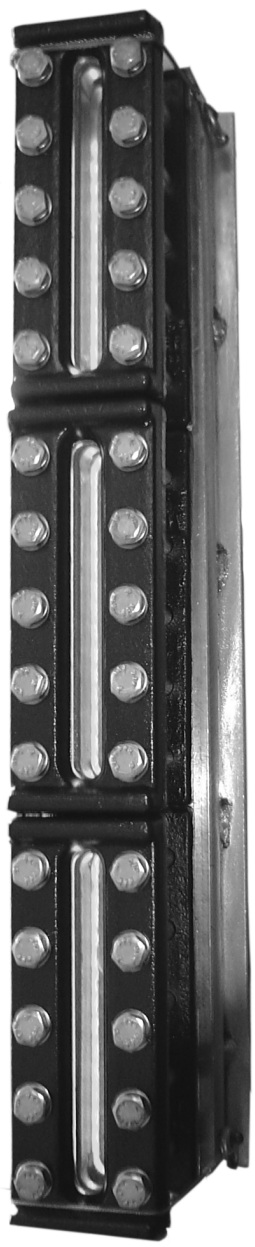
SIZE NO.		DIMENSIONS (IN INCHES)			LOW PRESSURE				MID-PRESSURE			
					REFLEX MAX. PSIG @ TEMP.*		TRANSPARENT MAX. PSIG @ TEMP.*		REFLEX MAX. PSIG @ TEMP.*		TRANSPARENT MAX. PSIG @ TEMP.*	
GLASS SIZE	NO. SECT.	A	B	C	100° F	700° F	100° F	700° F	100° F	700° F	100° F	700° F
1	1	5 1/4	3 3/4	3 3/4	2400	1520	2000	1260	3000	1890	2500	1580
2	1	6 1/4	4 3/4	4 3/4	2325	1470	1815	1150	2910	1840	2315	1470
3	1	7 1/4	5 3/4	5 3/4	2250	1420	1630	1050	2820	1780	2130	1340
4	1	8 1/4	6 3/4	6 3/4	2175	1370	1440	900	2725	1740	1940	1230
5	1	9 3/8	7 7/8	7 7/8	2100	1320	1250	790	2630	1660	1750	1100
6	1	10 5/8	9 1/8	9 1/8	2025	1280	1065	680	2535	1600	1565	990
7	1	11 3/4	10 1/4	10 1/4	1950	1230	875	550	2440	1540	1375	870
8	1	13 3/8	11 7/8	11 7/8	1875	1180	690	440	2345	1480	1190	750
9	1	14 1/8	12 5/8	12 5/8	1800	1140	500	320	2250	1420	1000	630
3	2	14 1/2	13	5 3/4	2250	1420	1630	1050	2820	1780	2130	1340
4	2	16 1/2	15	6 3/4	2175	1370	1440	900	2725	1740	1940	1230
5	2	18 3/4	17 1/4	7 7/8	2100	1320	1250	790	2630	1660	1750	1100
6	2	21 1/4	19 3/4	9 1/8	2025	1280	1065	680	2535	1600	1565	990
7	2	23 1/2	22	10 1/4	1950	1230	875	550	2440	1540	1375	870
8	2	26 3/4	25 1/4	11 7/8	1875	1180	690	440	2345	1480	1190	750
9	2	28 1/4	26 3/4	12 5/8	1800	1140	500	320	2250	1420	1000	630
6	3	31 7/8	30 3/8	9 1/8	2025	1280	1065	680	2535	1600	1565	990
7	3	35 1/4	33 3/4	10 1/4	1950	1230	875	550	2440	1540	1375	870
8	3	40 1/8	38 5/8	11 7/8	1875	1180	690	440	2345	1480	1190	750
9	3	42 3/8	40 7/8	12 5/8	1800	1140	500	320	2250	1420	1000	630
7	4	47	45 1/2	10 1/4	1950	1230	875	550	2440	1540	1375	870
8	4	53 1/2	52	11 7/8	1875	1180	690	440	2345	1480	1190	750
9	4	56 1/2	55	12 5/8	1800	1140	500	320	2250	1420	1000	630
7	5	58 3/4	57 1/4	10 1/4	1950	1230	875	550	2440	1540	1375	870
8	5	66 7/8	65 3/8	11 7/8	1875	1180	690	440	2345	1480	1190	750
9	5	70 5/8	69 1/8	12 5/8	1800	1140	500	320	2250	1420	1000	630

*Saturated steam to 300 WSP

**Maximum saturated steam 600 WSP with mica shields

GAGE ACCESSORY:

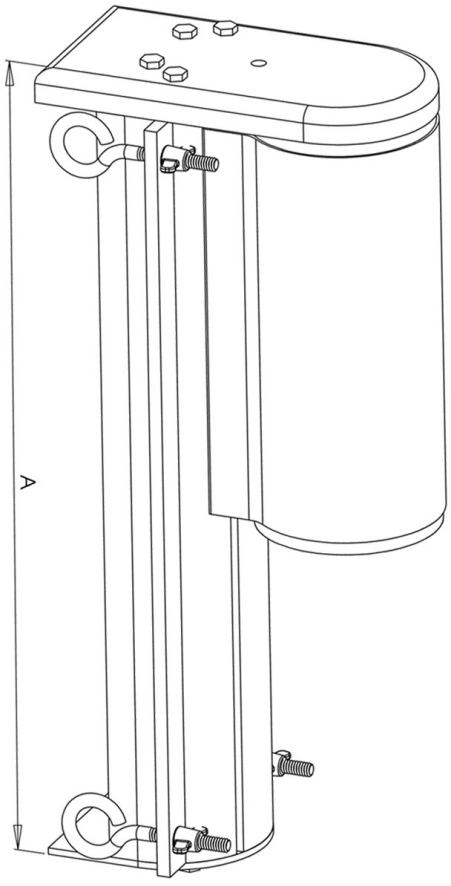
Illuminators (Explosion-Proof)



The Quest-Tec Solutions ***See-Level™*** LED Illuminator for hazardous locations utilizes the latest technology to provide brilliant green back lighting to any process gage. Innovative circuitry allows for the use of an individual light source every ½" along the length of any gage. With a life span of over 100,000 hours each, light source is likely to never need replacing. Even in the event of an individual lamp failure, the design provides lighting overlap ensuring that the fluid level is always illuminated. All of this is accomplished with a meager 5 watts of power usage.

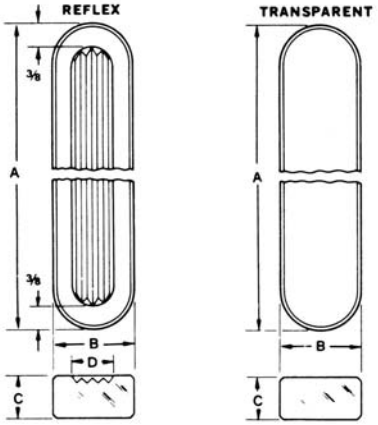
Through the use of new attachment techniques, the ***See-Level™*** Illuminator readily mounts to any brand of existing or new process gages in a matter of minutes without the loosening of any cover bolting. Mounting requires no special tools or modifications to the existing structure. Set it up, attach the power and go! It's that easy.

The modular design allows for a single illuminator to be manufactured to your specific visible length eliminating the labor involved in mounting and wiring multiple illuminators.



DIMENSIONAL DATA

Flat Gage Glasses



GLASS SIZE NO.	A
1	4 1/2"
2	5 1/2"
3	6 1/2"
4	7 1/2"
5	8 5/8"
6	9 7/8"
7	11"
8	12 5/8"
9	13 3/8"

B	C	D
1 5/16"	11/16"	11/16"

TOLERANCE FOR DIMENSIONS ABOVE

A	B	C
+0 -1/32"	+1/32" -0	+0 1/32"

Glass-Trac standard gage glass is made of borosilicate glass. For higher temperature service or requirements, aluminosilicate glass can be supplied.

Mica shields are available for use with Transparent Gages in steam boiler service enabling glass to be used in higher pressures. They are placed between gasket and glass. KEL-F® shields are available for use with Transparent Gages in corrosive service.

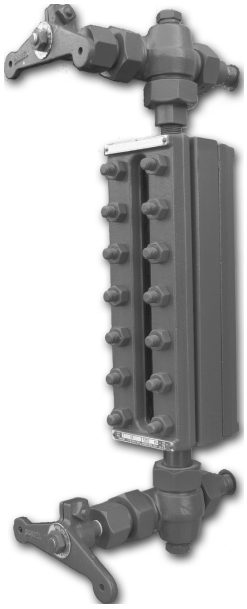
NOTE: For cyclic temperature applications, or to aid in torque retention, spring washers are available upon request.

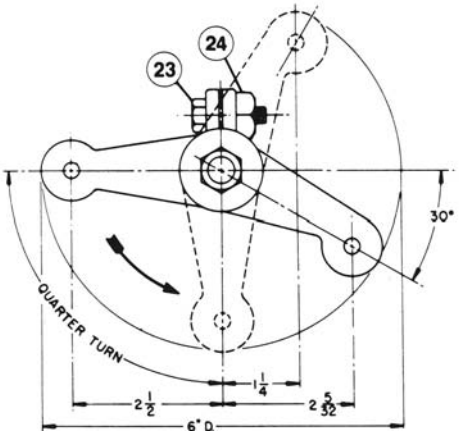
LIQUID LEVEL GAGE VOLUMES

STANDARD GAGE VOLUMES (APPROXIMATE)						LARGE CHAMBER GAGE VOLUMES (APPROXIMATE)			
GLASS SIZE NO.	VISIBLE LENGTH (INCHES)	REFLEX		TRANSPARENT		REFLEX		TRANSPARENT	
		CU. IN.	CU. CM	CU. IN.	CU. CM.	CU. IN.	CU. CM	CU. IN.	CU. CM.
1	3 3/4	2.07	34	3.17	52	15.49	254	15.92	261
2	4 3/4	2.61	43	3.99	65	19.16	314	19.70	323
3	5 3/4	3.21	53	4.82	79	22.82	374	23.48	385
4	6 3/4	3.68	60	5.63	92	26.49	434	27.26	447
5	7 7/8	4.28	70	6.55	107	30.61	501	31.51	516
6	9 1/8	4.94	81	7.58	124	35.19	577	36.24	594
7	10 1/4	5.55	91	8.50	139	39.31	644	40.49	664
8	11 7/8	6.42	105	9.83	161	45.26	742	46.64	764
9	12 5/8	6.82	112	10.45	171	48.01	787	49.47	811

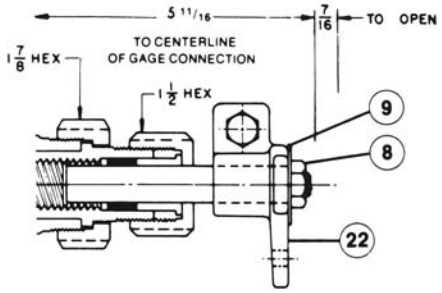
NOTE: For multiple section level gages, add "C" volume for each additional section. "C" is volume between gage sections.

QUICK-OPENING LEVERS





Glass-Trac Gage Valves are available with a coarse thread stem design and levers for fast, remote operation by chain. Only ¼ turn of the lever opens or closes the valves, which may be mounted in hard-to-reach areas. A ¼" hole is drilled in the end of each lever for connecting the chain.



PARTS

ITEM NO.	PART	MATERIAL
8	STEM NUT	CARBON STEEL
9	NAME PLATE	304 SS
22	LEVER	DUCTILE IRON
23	BOLT	CARBON STEEL
24	NUT	CARBON STEEL

GAGE CONNECTIONS

All Glass-Trac gage valves, types 1 thru 7, can be fitted with any gage connection shown here.

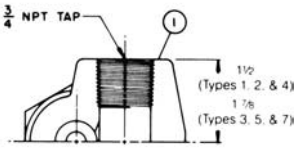


FIG. VII

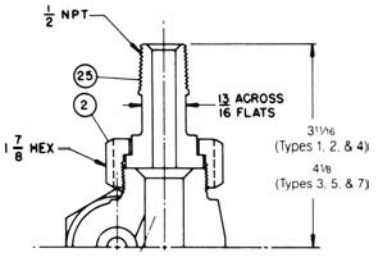


FIG. VIII

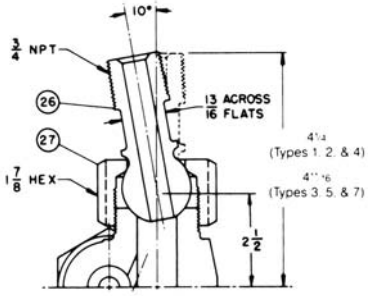


FIG. X

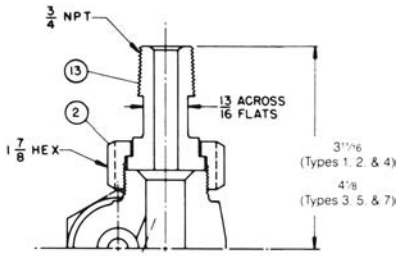


FIG. XI

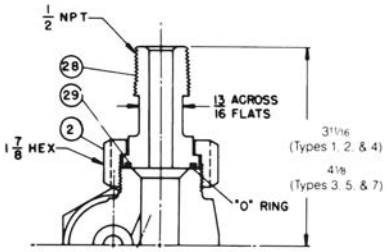


FIG. XIII

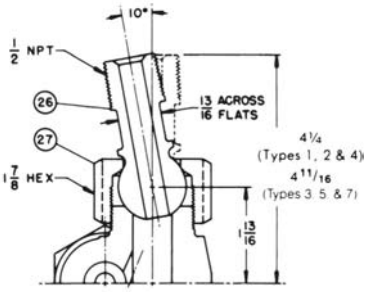


FIG. XIV

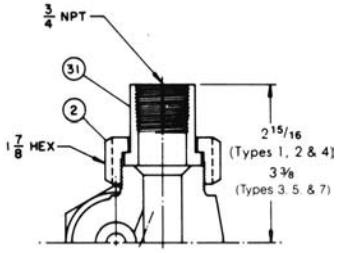


FIG. XV

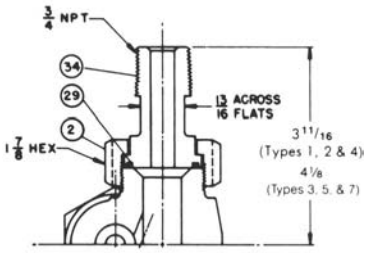


FIG. XVI

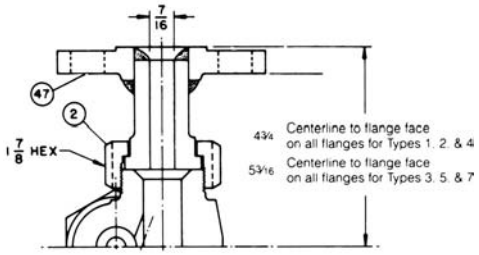


FIG. XVII

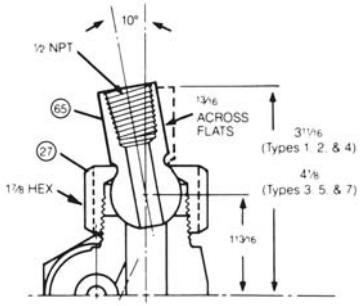


FIG. XXIX

PARTS

ITEM NO.	NAME	STANDARD MATERIAL	316 SS WETTED PARTS MATERIAL
1	BODY	FORGED STEEL	316 SS
2	UNION NUT	CARBON STEEL	CARBON STEEL
25	MALE CONNECTOR - 1/2"	CARBON STEEL	316 SS
26	MALE SPHERICAL CONN. - 3/4"	CARBON STEEL	316 SS
26	MALE SPHERICAL CONN. - 1/2"	CARBON STEEL	316 SS
27	SPHERICAL NUT	CARBON STEEL	CARBON STEEL
28	MALE "O" RING CONN. - 1/2"	CARBON STEEL	316 SS
*29	"O" RING	BUNA-N	BUNA-NN
31	FEMALE UNION - 3/4"	ALLOY STEEL	-
34	MALE "O" RING CONN. - 3/4"	CARBON STEEL	316 SS
47	ANSI RF SLIP-ON FLG'D ASSY.	CARBON STEEL	316 SS
**65	FEMALE SPER. CONN. - 1/2"	CARBON STEEL	316 SS

*O-Ring of Teflon® or Viton® on request.
**3/4" NPT female spherical connections are not available.
Note: Valve shown is for bottom left hand (or top right hand) location. Opposite hand is reversed. Valve are furnished in pairs of one bottom left hand and one top left hand.

TANK CONNECTIONS

All Tank Connections for Glass-Trac Gage Valves are shown here including the standard connections illustrated on the valves. For Types 1, 2 and 4 Valves, Fig. II through XXVII are available.

For Types 3, 5, and 7 Valves, Fig. XXV through Fig. XXVIII are available.

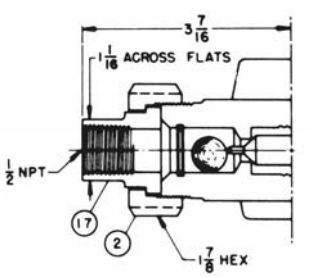


FIG. II

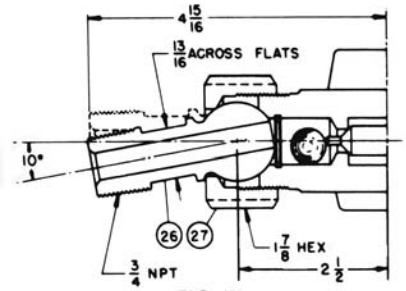


FIG. III

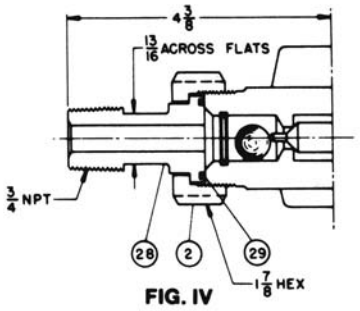


FIG. IV

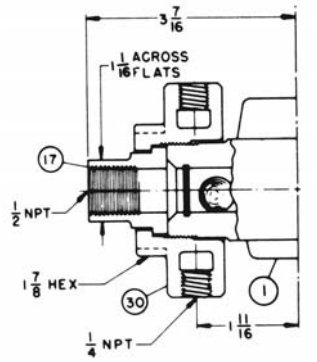


FIG. V

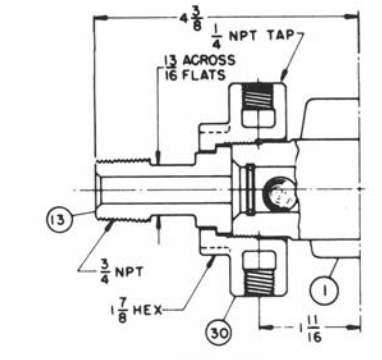


FIG. VI

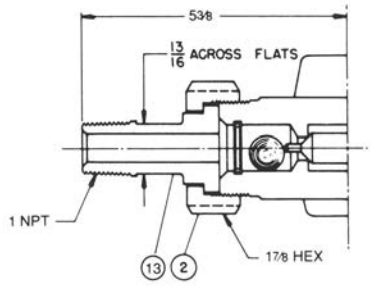


FIG. XII

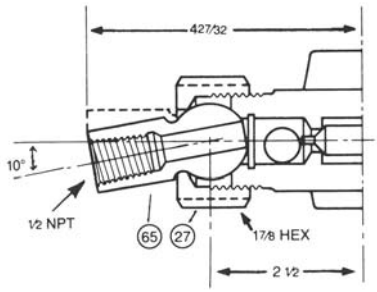


FIG. XVIII

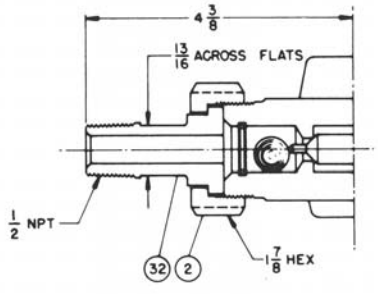


FIG. XIX

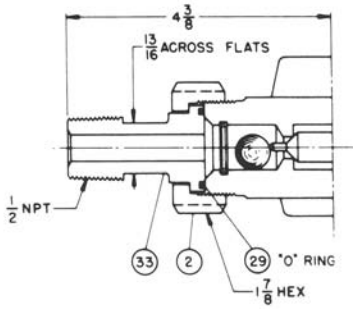


FIG. XX

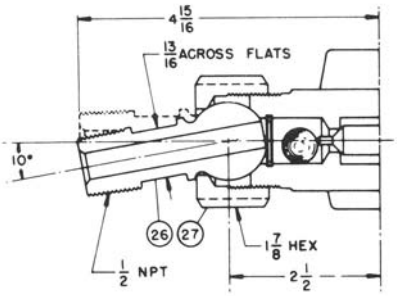


FIG. XXI

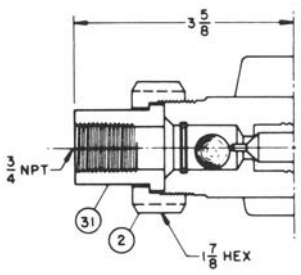


FIG. XXII

TANK CONNECTIONS (CONTINUED)

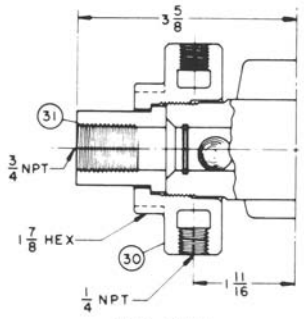
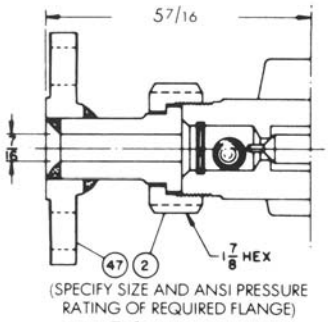


FIG. XXIII



(SPECIFY SIZE AND ANSI PRESSURE RATING OF REQUIRED FLANGE)
FIG. XXIV

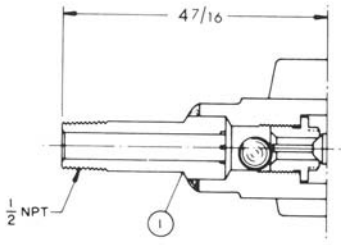


FIG. XXV

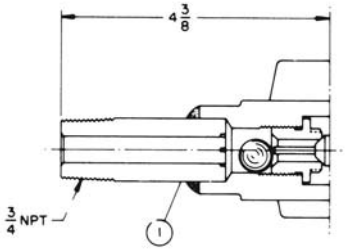


FIG. XXVI

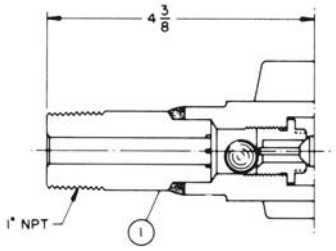
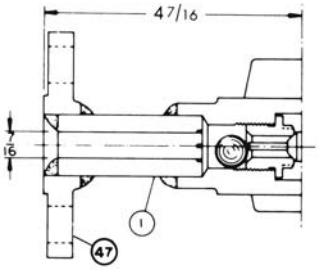


FIG. XXVII



(SPECIFY SIZE AND ANSI PRESSURE RATING OF REQUIRED FLANGE)
FIG. XXVIII

PARTS

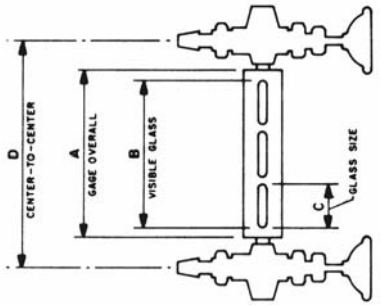
ITEM NO	NAME	STANDARD MATERIAL	316 SS WETTED PARTS MATERIAL
1	BODY	FORGED STEEL	316 SS
1	BODY - 1/2" NPT SHANK	FORGED STEEL	316 SS
1	BODY - 3/4" NPT SHANK	FORGED STEEL	316 SS
1	BODY - 1" NPT SHANK	FORGED STEEL	316 SS
1	BODY - RF FLG'D SHANK	FORGED STEEL	316 SS
2	UNION NUT	CARBON STEEL	CARBON STEEL
*13	MALE CONNECTOR	CARBON STEEL	316 SS
17	FEMALE CONNECTOR - 1/2"	CARBON STEEL	316 SS
26	MALE SPHERICAL CONN.	CARBON STEEL	316 SS
27	SPHERICAL NUT	CARBON STEEL	CARBON STEEL
*28	MALE "O" RING CONN. - 3/4"	CARBON STEEL	316 SS
**29	"O" RING	BUNA-N	BUNA-N
30	HEATED/COOLED NUT	CARBON STEEL	CARBON STEEL
31	FEMALE CONNECTION - 3/4"	ALLOY STEEL	-
*32	MALE CONNECTOR - 1/2"	CARBON STEEL	316 SS
*33	MALE "O" RING CONN. - 1/2"	CARBON STEEL	316 SS
47	ANSI RF SLIP-ONFLG'D ASSY.	CARBON STEEL	316 SS
***65	FEMALE SPHER. CONN. - 1/2"	CARBON STEEL	316 SS

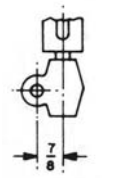
* Has floating tailpiece for ± 1/8" maximum misalignment on the overall center-to-center.
**O-Ring of Teflon® or Viton® on request.
***3/4" NPT female connection is not available.

Note: Valve is for bottom left hand (or top right hand) location. Opposite hand is reversed. Valves are furnished in pairs of one bottom left hand and one top left hand.

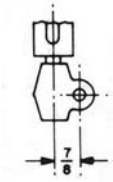
Viton® is a registered trademark of DuPont.

INSTALLATION: STANDARD GAGES





BOTTOM LEFT HAND OFFSET GAGE VALVE



TOP LEFT HAND OFFSET GAGE VALVE

NOTE: A. B. C. D Dimensions are in inches

SIZE NO.		A GAGE OVERALL	B VISIBLE GLASS	C VISIBLE GLASS	D* MINIMUM VALVE CENTER-TO-CENTER WITH GAGE CONNECTION							
					FOR GAGES TAPPED 1/2" NPT				FOR GAGES TAPPED 3/4" NPT			
GLASS NO.	NO. SECT.				** 1/2"-NPT FEMALE SCREWED CAT. 1S, 2S. 4S	** 1/2"-NPT FEMALE SCREWED CAT. 1U, 2U. 4U	1/2"-NPT MALE UNION FIG. VIII	1/2"-NPT MALE SPHERICAL FIG. XIV	**3/4"-NPT FEMALE SCREWED CAT. 1S, 2S, 4S	3/4"-NPT FEMALE SCREWED CAT. 1U, 2U, 4U	3/4"-NPT MALE UNION FIG. XI	3/4"-NPT MALE SPHERICAL FIG. X
1	1	5 1/4	3 3/4	3 3/4	8 1/2	11	11 5/8	12 3/4	8 3/4	11 5/8	11 1/2	12 5/8
2	1	6 1/4	4 3/4	4 3/4	9 1/2	12	12 5/8	13 3/4	9 3/4	12 5/8	12 1/2	13 5/8
3	1	7 1/4	5 3/4	5 3/4	10 1/2	13	13 5/8	14 3/4	10 3/4	13 5/8	13 1/2	14 5/8
4	1	8 1/4	6 3/4	6 3/4	11 1/2	14	14 5/8	15 3/4	11 3/4	14 5/8	14 1/2	15 5/8
5	1	9 3/8	7 7/8	7 7/8	12 5/8	15 1/8	15 3/4	16 7/8	12 7/8	15 3/4	15 5/8	16 3/4
6	1	10 5/8	9 1/8	9 1/8	13 7/8	16 3/8	17	18 1/8	14 1/8	17	16 7/8	18
7	1	11 3/4	10 1/4	10 1/4	15	17 1/2	18 1/8	19 1/4	15 1/4	18 1/8	18	19 1/8
8	1	13 3/8	11 7/8	11 7/8	16 5/8	19 1/8	19 3/4	20 7/8	16 7/8	19 3/4	19 5/8	20 3/4
9	1	14 1/8	12 5/8	12 5/8	17 3/8	19 7/8	20 1/2	21 5/8	17 5/8	20 1/2	20 3/8	21 1/2
3	2	14 1/2	13	5 3/4	17 3/4	20 1/4	20 7/8	22	18	20 7/8	20 3/4	21 7/8
4	2	16 1/2	15	6 3/4	19 3/4	22 1/4	22 7/8	24	20	22 7/8	22 3/4	23 7/8
5	2	18 3/4	17 1/4	7 7/8	22	24 1/2	25 1/8	26 1/4	22 1/4	25 1/8	25	26 1/8
6	2	21 1/4	19 3/4	9 1/8	24 1/2	27	27 5/8	28 3/4	24 3/4	27 5/8	27 1/2	28 5/8
7	2	23 1/2	22	10 1/4	26 3/4	29 1/4	29 7/8	31	27	29 7/8	29 3/4	30 7/8
8	2	26 3/4	25 1/4	11 7/8	30	32 1/2	33 1/8	34 1/4	30 1/4	33 1/8	33	34 1/8
9	2	28 1/4	26 3/4	12 5/8	31 1/2	34	34 5/8	35 3/4	31 3/4	34 5/8	34 1/2	35 5/8
6	3	31 7/8	30 3/8	9 1/8	35 1/8	37 5/8	38 1/4	39 3/8	35 5/8	38 1/4	38 1/8	39 1/4
7	3	35 1/4	33 3/4	10 1/4	38 1/2	41	41 5/8	42 3/4	38 3/4	41 5/8	41 1/2	42 5/8
8	3	40 1/8	38 5/8	11 7/8	43 3/8	45 7/8	46 1/2	47 5/8	43 5/8	46 1/2	46 3/8	47 1/2
9	3	42 3/8	40 7/8	12 5/8	45 5/8	48 1/8	48 3/4	49 7/8	45 7/8	48 3/4	48 5/8	49 3/4
7	4	47	45 1/2	10 1/4	50 1/4	52 3/4	53 3/8	54 1/2	50 1/2	53 5/8	53 1/4	54 3/8
8	4	53 1/2	52	11 7/8	56 3/4	59 1/4	59 7/8	61	57	59 7/8	59 3/4	60 7/8
9	4	56 1/2	55	12 5/8	59 3/4	62 1/4	62 7/8	64	60	62 7/8	62 3/4	63 7/8
7	5	58 3/4	57 1/4	10 1/4	62	64 1/2	65 1/8	66 1/4	62 1/4	65 1/8	65	66 1/8
8	5	66 7/8	65 3/8	11 7/8	70 1/8	12 5/8	73 1/4	74 3/8	70 3/8	73 1/4	73 1/8	74 1/4
9	5	70 5/8	69 1/8	12 5/8	73 7/8	76 3/8	77	78 1/8	74 1/8	77	76 7/8	78
8	6	80 1/4	78 3/4	11 7/8	83 1/2	86	86 5/8	87 3/4	83 3/4	86 5/8	86 1/2	87 5/8
9	6	84 3/4	83 1/4	12 5/8	88	90 1/2	91 1/8	92 1/4	88 1/4	91 1/8	91	92 1/8
8	7	93 5/8	92 1/8	11 7/8	96 7/8	99 3/8	100	101 1/8	97 1/8	100	99 7/8	101
9	7	98 7/8	97 3/8	12 5/8	102 1/8	104 5/8	105 1/4	106 3/8	102 3/8	105 1/4	105 1/8	106 1/4
8	8	107	105 1/2	11 7/8	110 1/4	112 3/4	113 3/8	114 1/2	110 1/2	113 3/8	113 1/4	114 3/8
9	8	113	111 1/2	12 5/8	116 1/4	118 3/4	119 3/8	120 1/2	116 1/2	119 3/8	119 1/4	120 3/8
8	9	120 3/8	118 7/8	11 7/8	123 5/8	126 1/8	126 3/4	127 7/8	123 7/8	126 3/4	126 5/8	127 3/4
9	9	127 1/8	125 5/8	12 5/8	130 3/8	132 7/8	133 1/2	134 5/8	130 5/8	133 1/2	133 3/8	134 1/2

*Dimensions in column "D" apply to low-pressure (series "L"), mid-pressure (series "M"), ½" NPT high-pressure (series "H"), frost-free (all series), and internally heated/cooled reflex and transparent level gages tapped ½" NPT or ¾" NPT. For installation dimensions on other level gages see footnote.

**These dimensions use close pipe nipples. For short ½" nipple add ¾"; for short ¾" nipple add 11/4".

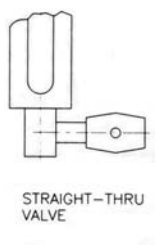
Note: Use the following constants for other level gages.

1. Low pressure (series "L") large chamber, add 1" to above "A" and "D" dimensions.
2. Low-pressure (series "L"), mid-pressure (series "M") externally heated/cooled, add 2¼" to above "D" dimensions.
3. For valve Types 3, 5, or 7, add ⅞" to Column "D" to obtain minimum centers.
4. For High Pressure (series "H") with ¾" NPT, add 1½" to dimensions "A" and"D".
5. For a ½" NPT Female Spherical Gage connection (Figure XXIX), add 1⅞".

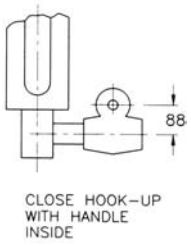
INSTALLATION: CLOSE HOOK-UP GAGES

(GAGE CONNECTIONS)

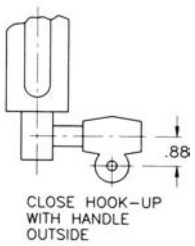
SIZE NO.	MINIMUM CENTER-TO-CENTER TANK CONNECTIONS					
	STRAIGHT-THRU 1/2" VALVE 3/4"		OFFSET VALVE HANDLES		OFFSET VALVE HANDLES	
11	5 1/4"	5 5/8"	3 1/2"	3 7/8"	7"	7 3/8"
21	6 1/4"	6 5/8"	4 1/2"	4 7/8"	8"	8 3/8"
31	7 1/4"	7 5/8"	5 1/2"	5 7/8"	9"	9 3/8"
41	8 1/4"	8 5/8"	6 1/2"	6 7/8"	10"	10 3/8"
51	9 3/8"	9 3/4"	7 5/8"	8"	11 1/8"	11 1/2"
61	10 5/8"	11"	8 7/8"	9 1/4"	12 3/8"	12 3/4"
71	11 3/4"	12 1/8"	10"	10 3/8"	13 1/2"	13 7/8"
81	13 3/8"	13 3/4"	11 5/8"	12"	15 1/8"	15 1/2"
91	14 1/8"	14 1/2"	12 3/8"	12 3/4"	15 7/8"	16 1/4"
32	14 1/2"	14 7/8"	12 3/4"	13 1/8"	16 1/4"	16 5/8"
42	16 1/2"	16 7/8"	14 3/4"	15 1/8"	18 1/4"	18 5/8"
52	18 3/4"	19 1/8"	17"	17 3/8"	20 1/2"	20 7/8"
62	21 1/4"	21 5/8"	19 1/2"	19 7/8"	23"	23 3/8"
72	23 1/2"	23 7/8"	21 3/4"	22 1/8"	25 1/4"	25 5/8"
82	26 3/4"	27 1/8"	25"	25 3/8"	28 1/2"	28 7/8"
92	28 1/4"	28 5/8"	26 1/2"	26 7/8"	30"	30 3/8"
63	31 7/8"	32 1/4"	30 1/8"	30 1/2"	33 5/8"	34"
73	35 1/4"	35 5/8"	33 1/2"	33 7/8"	37"	37 3/8"
83	40 1/8"	40 1/2"	38 3/8"	38 3/4"	41 7/8"	42 1/4"
93	42 3/8"	42 3/4"	40 5/8"	41"	44 1/8"	44 1/2"
74	47"	47 3/8"	45 1/4"	45 5/8"	48 3/4"	49 1/8"
84	53 1/2"	53 7/8"	51 3/4"	52 1/8"	55 1/4"	55 5/8"
94	56 1/2"	56 7/8"	54 3/4"	55 1/8"	58 1/4"	58 5/8"
75	58 3/4"	59 1/8"	57"	57 3/8"	60 1/2"	60 7/8"
85	66 7/8"	67 1/4"	65 1/8"	65 1/2"	68 5/8"	69"
95	70 5/8"	71"	68 7/8"	69 1/8"	72 3/8"	72 3/4"
86	80 1/4"	80 5/8"	78 1/2"	78 7/8"	82"	82 3/8"
96	84 3/4"	85 1/8"	83"	83 3/8"	86 1/2"	86 7/8"
87	93 5/8"	94"	91 7/8"	92 1/4"	95 3/8"	95 3/4"
97	98 7/8"	99 1/4"	97 1/8"	97 1/2"	100 5/8"	101"
88	107"	107 3/8"	105 1/4"	105 5/8"	108 3/4"	109 1/8"
98	113"	113 3/8"	111 1/4"	111 5/8"	114 3/4"	115 1/8"
89	120 3/8"	120 3/4"	118 5/8"	119"	122 1/8"	122 1/2"
99	127 1/8"	127 1/2"	125 3/8"	125 3/4"	128 7/8"	129 1/4"



STRAIGHT–THRU VALVE



CLOSE HOOK–UP WITH HANDLE INSIDE



CLOSE HOOK–UP WITH HANDLE OUTSIDE

CAUTION

Gage glasses may fail from improper external mechanical stress or accident rather than from internal pressure, but both factors should be considered. Four basic precautions when heeded will assure the gage glass user of safe, satisfactory performance:

1. Proper glass selection
2. Correct installation.
3. Periodic inspection and cleaning.
4. Replacement as necessary.

Proper glass selection involves size, pressure rating and quality of glass. Flat and tubular glasses should fit perfectly without stress; glass should be crystal clear and without blemish; length determines pressure rating; if longer glass results in breakage, a multiple-section gage with shorter glasses should be considered.

Installation involves proper seating on gaskets and cushions; glass-to-metal contact should not occur; do not install any glass with scratches or chipped edges; do not tighten gage bolts when gage is in use; use torque instructions provided with gage; use gage valves with ball checks that shut-off automatically if breakage occurs; make sure vessel center-to-centers are correct and vertical.

Proper tightening of bolts with torque wrench is extremely important, so that no unusual stress is introduced into the glass.

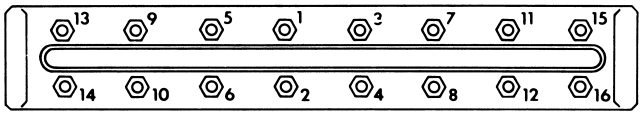
Clean outside of glasses with ordinary glass cleaners, not harsh chemicals; check for scratches, chipped edges on glass; inspect glass for clarity.

Glass should be replaced if any blemish mars surface. If gage is taken apart, glass, gaskets and cushions should be automatically replaced to reduce risk; make sure gage or tubular valves surfaces are clean and dry before installing glasses.

For safety purposes, glasses in high temperature service should be replaced more often than similar glasses used in low temperature services.

GLASS-TRAC GAGE ASSEMBLY

(Numbers Indicate Proper Bolt Torquing Sequence.)



Gage Series	Torque (Tighten in 4-5 Ft.-Lb. Steps)
Low Press. Large Chamber	20 Ft.-Lb.
Mid-Press	32 Ft.-Lb.
High-Press	40 FT.-Lb.

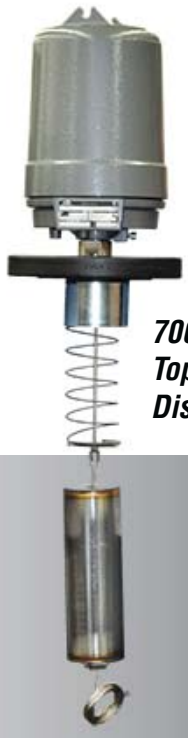
Mailing Address: P.O. Box 2127 • Stafford, TX • 77497-2127
Toll Free Tel: 866.240.9906 • Tel: 281.240.0440 • Fax: 281.240.2440
www.questtecsolutions.com

Level Switches

General Instructions

Level Switches are available for a range of industrial applications. ATEX/IECEx-certified options for potentially explosive atmospheres are available for both flameproof and intrinsically safe protection.

NOTE: If you suspect that a product is defective, contact the factory or the SOR® Representative in your area for a return authorization number (RMA). This product should only be installed by trained and competent personnel.



700 Series Top-Mounted Displacer



100 Series Flanged Chamber



200 Series Sealed Chamber



Design and specifications are subject to change without notice.

For latest revision, go to ***SORInc.com***

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Float-Operated Level Switches - Vertical

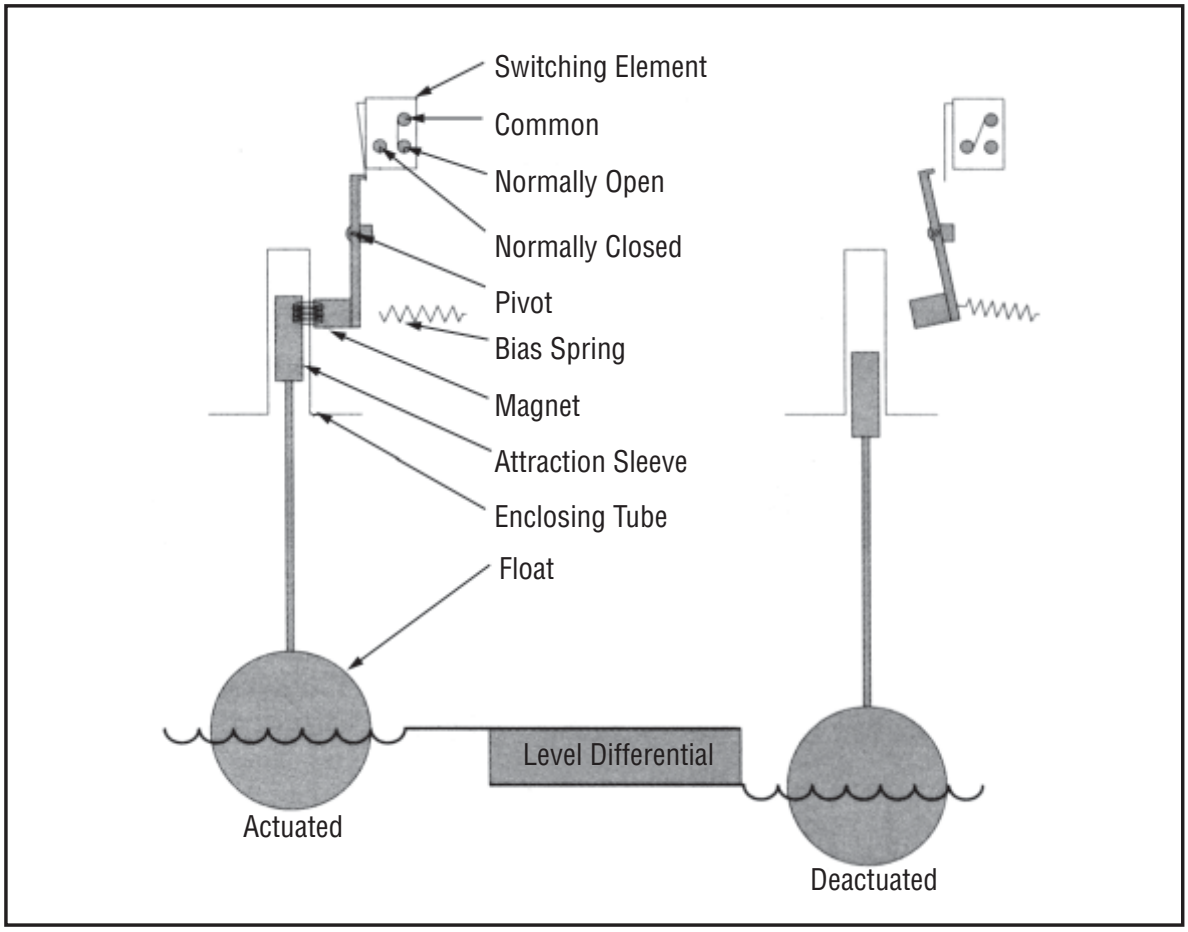
Operation

- The float rides on the process liquid surface, precisely tracking liquid surface motion.
- Floats are attached to a mechanical linkage. When rising liquid level meets the float, buoyancy lifts the linkage and positions the attraction sleeve up in the enclosing tube. Upward movement of the attraction sleeve positions it within the magnetic field generated by the external magnet.
- Magnetism pulls the external magnet in toward the attraction sleeve, and the external magnet is tightly engaged against the enclosing tube actuating the switching element.
- When liquid level falls, the attraction sleeve drops out of the magnetic field allowing the float to pull the magnet away from the enclosing tube, deactuating the switch.

NOTE: Float-type level switches are generally able to be used in high-temperature applications, and sometimes prove useful for close interface detection.

NOTE: Floats are able to operate up to three switching elements. Independent switching levels can be obtained with tandem floats. Consult the factory for special float switching arrangements.

Float-Operated Level Switches - Vertical



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Displacer-Operated Level Switches - Vertical

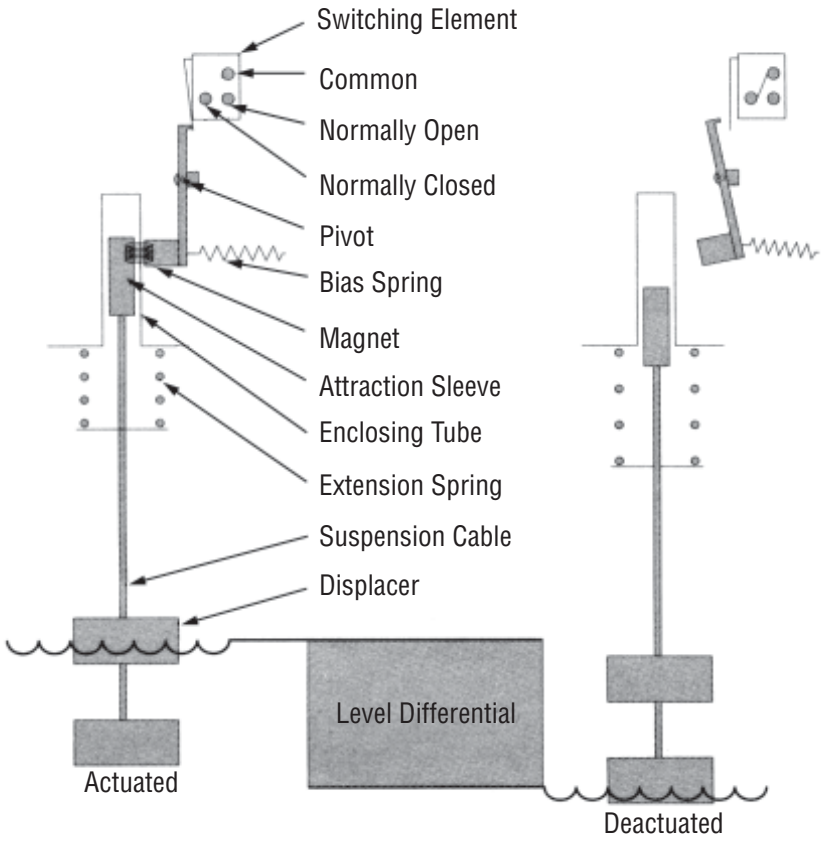
Operation

- Displacer controls offer alternate features to the float-operated control. The sensor is a weight (displacer), heavier than the liquid, which is suspended by a spring.
- When liquid contacts the displacer, a buoyancy force is produced, which causes the effective weight of the displacer to change. This causes the spring to retract slightly to a new equilibrium position.
- When the spring retracts, the attraction sleeve also moves upward into the field of the external magnet, thus overcoming the force of the bias spring and actuating the switching element. The switching mechanism operates the same as with vertical float-operated level switches.

NOTE: This principle provides for narrow or wide switching differential, and allows switching point alteration by moving the displacer(s) up or down the suspension cables.

NOTE: Displacers can be arranged in combinations of narrow and wide differential to operate up to three switching stages. Displacer controls operate under higher pressure conditions than float-operated switches.

Displacer-Operated Level Switches - Vertical

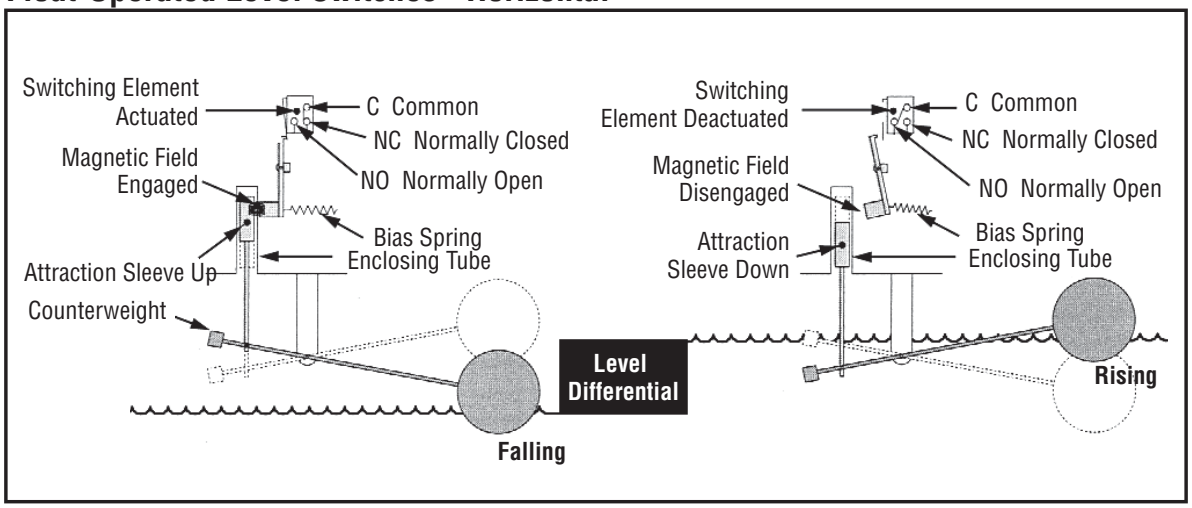


Float-Operated Level Switches - Horizontal

Operation

The float rides on the process liquid surface, precisely tracking liquid surface motion. Rising liquid level lifts the float via a pivot mechanism, sliding the attraction sleeve down inside the enclosing tube and out of the magnetic field to deactuate the electrical or pneumatic switch (signaling liquid presence).

Float-Operated Level Switches - Horizontal



Falling Level

- The float is connected to a mechanical linkage which positions the attraction sleeve up in the enclosing tube when the float is not supported by liquid.
- Positioned at the top of the enclosing tube, the attraction sleeve is within the magnetic field generated by the external magnet.
- Magnetism pulls the external magnet in toward the attraction sleeve, and the external magnet is tightly engaged against the enclosing tube.
- While the external magnet is held against the enclosing tube, the switching element is actuated.
- Subsequently, falling liquid level lowers the float, drawing the attraction sleeve into the magnetic field to activate the electrical or pneumatic switch (signaling liquid absence).

Rising Level

- When the float is supported by liquid, the float and the mechanical linkage position the attraction sleeve down in the enclosing tube.
- Positioned at the bottom of the enclosing tube, the attraction sleeve is outside of the magnetic field generated by the external magnet.
- When the attraction sleeve is removed from the magnetic field, the magnetic field is disengaged. The bias spring snaps the external magnet away from the attraction sleeve. The switching element is deactuated.

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Switch and Switch Chamber Installation

- Verify that obstructions are not present in the application which would prevent free float or diaplacer movement throughout the entire range of motion.
- Assure that mounting provides vertical alignment of the switch. For proper operation, the unit must be mounted with the electrical housing and enclosing tube centerline within 3º of vertical. The conduit connection centerline must be within 3º of horizontal.
- Controls operating in liquids which tend to leave deposits in the piping should incorporate tee or cross type fitting to allow periodic cleaning of the process piping. A drain or blow-down valve will assist in cleaning the control chamber and piping.

External Chamber Installation

- Pipe support hangers or stands should be used where necessary.
- All isolation valves must be fully open during service, as restricted valves may cause erroneous level switching.

Single Switch Chamber

- External chamber piping should be short, straight and unrestricted.
- Pipe must be of a diameter equal to or greater than the process connection diameter.
- Valves and other equipment between the chamber and process must be of the same diameter or larger than the process connection diameter to allow adequate liquid flow into the chamber.

Multiple Switch Chambers

In addition to the Single Switch installation instructions, multiple chamber installations have the following requirements:

- Headers connecting multiple chambers to the process connection must be larger than the chamber process connection diameter to allow adequate liquid flow to all chambers. Multiple chamber diameters are listed below:
  - two chambers should be 1.5 times larger
  - three or four chamber installations should be 2 times larger
  - five or more chamber installations should be at least 2.5 times larger.
- Valves, tees, elbows and other pipe fittings in a header must be the same diameter as the recommended header diameter.



Not following these installation instructions, including pipe and valve diameter and pipe lengths can affect operation of the switch, including differential. See Single Switch Chamber Installation (A) and Multiple Switch Chamber Installation (B).



Insulation of the control chamber is acceptable, but temperature extensions, finned extensions and switch housing and cover must not be insulated.

Single Switch Chamber Installation

❶ Locate switch chamber process connection 12” to 24” (300mm to 600mm) away from the process pipe or tank.

❷ Locate the switch chamber so that the switch actuates or deactuates at the desired level. Refer to catalog for set point information.

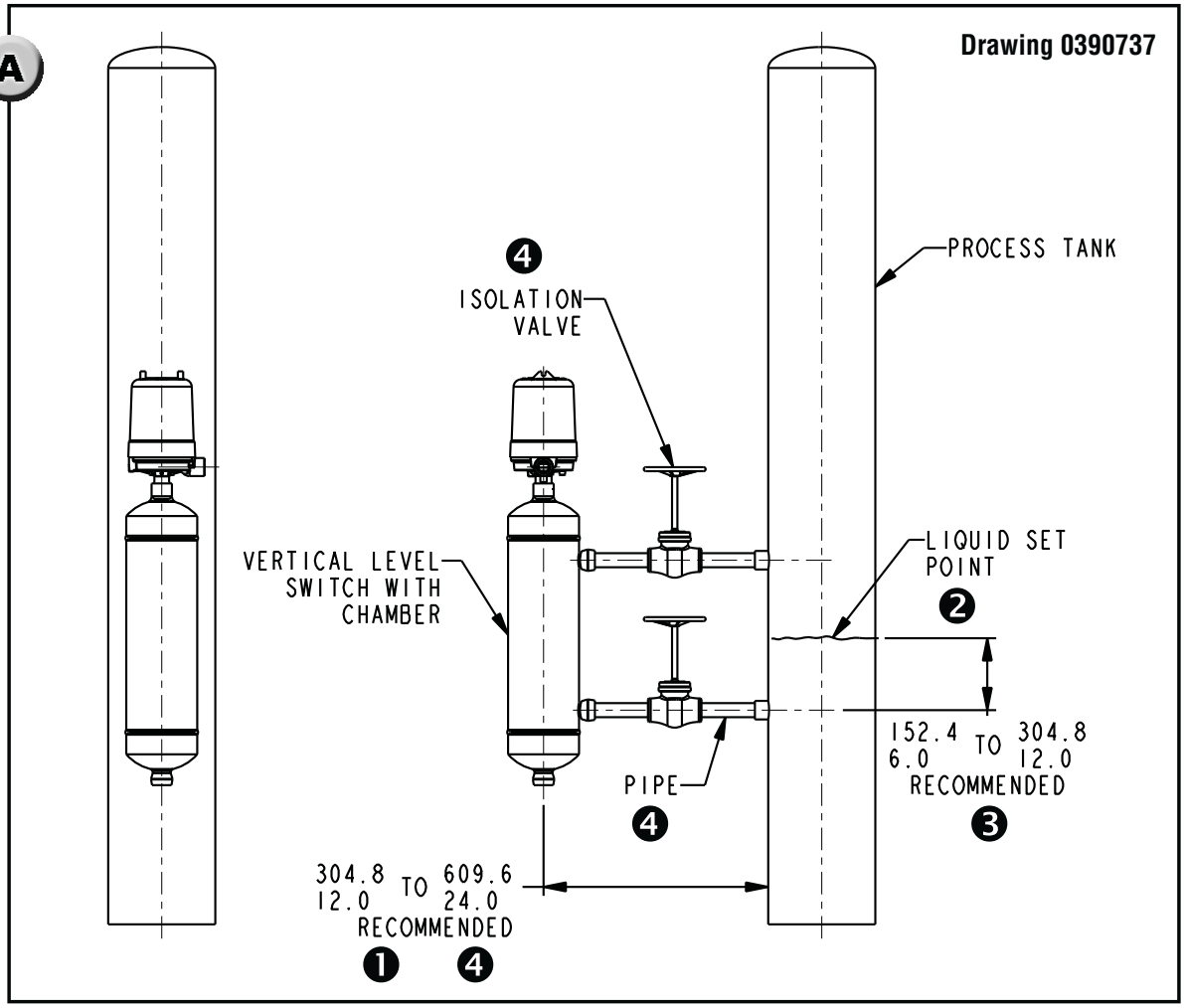
❸ For bottom chamber connections, connect the bottom chamber process connection to the process pipe or tank 6” to 12” (150mm to 300mm) below the centerline of the chamber. For side chamber connections, pipe directly to the process pipe or tank. This will ensure liquid level in the switch chamber is as close as possible to process liquid level.

❹ Inside diameter of piping, including elbows, tees and valves, must be equal to or greater than process connection diameter.

❺ One elbow is recommended to connect the level switch chamber with the process pipe or tank (if required).

A

Drawing 0390737



IMPORTANT

Deviating from any of these instructions may adversely affect operation of the level switch by restricting liquid flow into the switch chamber. The recommended dimensions allow adequate space for isolation valves, pipe fittings and insulation. Structural support (not shown) must be provided for level switch chambers.

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Multiple Switch Chamber Installation

❶ The header pipe diameter for three (3) or four (4) chambers needs to be two times the process connection diameter. For 1" (25mm) process connections, the pipe header must be 2" (50mm) in diameter. This includes pipe connecting the header to the process, fittings, valves and other pipe equipment installed as part of the header piping. Headers should be arranged to use one elbow or tee to connect to the process pipe or tank.

❷ Pipe connecting the header to individual chambers can be the same size as the process connection on the switch chamber. Fittings and valve diameters must also be equal to or greater than the process connection diameter. One elbow is recommended to connect the level switch chamber to the header pipe.

❸ Install each chamber so that the actuate or deactuate point is at the desired process liquid level. Refer to catalog for set point locations.

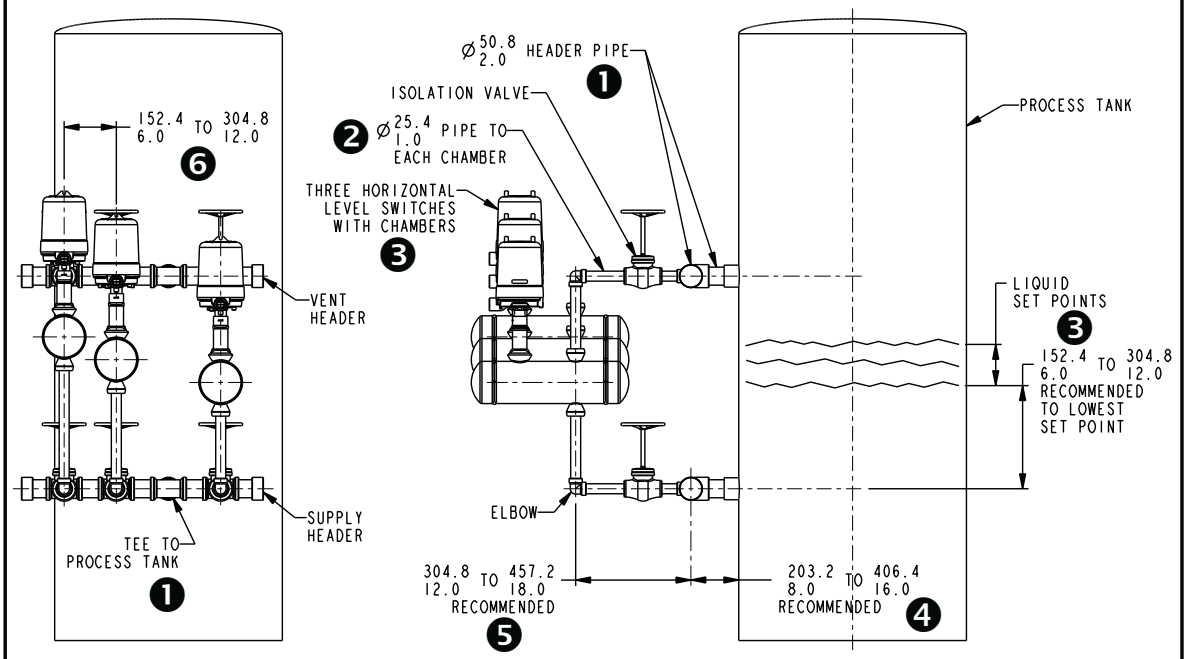
❹ Locate the header 8" to 16" (200mm to 400mm) away from the process tank.

❺ Locate switch chamber process connection 12" to 18" (300mm to 450mm) away from the header pipe.

❻ Horizontal spacing of level switch chambers should be 6" to 12" (150mm to 300mm).

B

Drawing 0390737

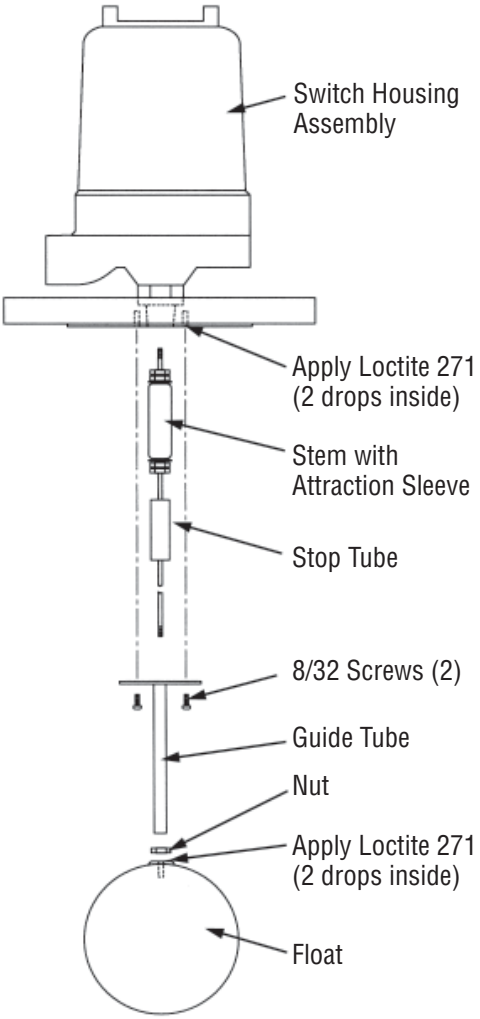


IMPORTANT

Deviating from any of these recommendations may adversely affect operation of the level switch by restricting liquid flow into the switch chamber. The recommended dimensions leave adequate space for isolation valves, fittings and insulation. Structural support (not shown) must be provided for level switch chambers.

Float Attachment

Flanged Process Connection



❶ Place the Stem with Attraction Sleeve inside the flange of the Switch Housing Assembly.

❷ Place the Stop Tube over the Stem.

❸ Place two drops of Loctite 271 inside each small threaded hole in the flange bottom.

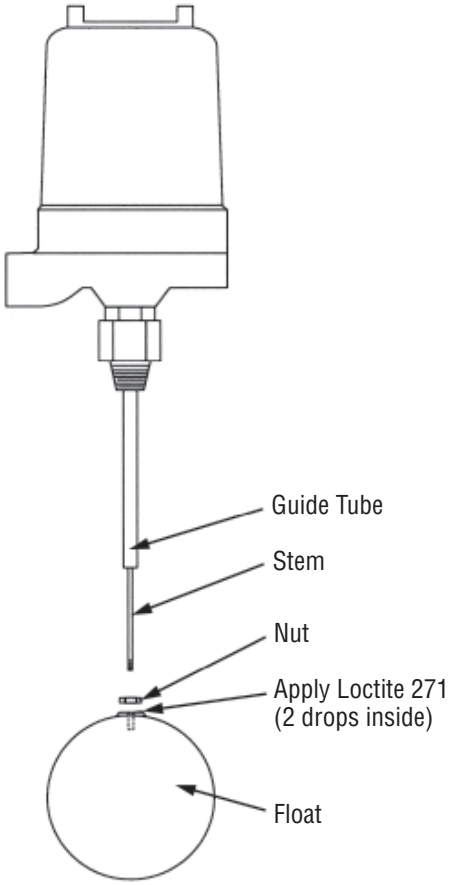
❹ Slide the guide tube into place so that the stem goes inside.

❺ Attach the Guide Tube to the flange using the 8/32 screws (qty 2). Do not over-tighten.

❻ Thread the nut onto the exposed end of the stem.

❼ Place two drops of Loctite 271 inside the threaded hole of the float.

❽ Holding the stem with pliers, thread the float onto the stem and hand-tighten. Thread the nut down against the float and tighten securely.



Threaded Process Connection

❶ Remove the protective rubber plug from the end of the Guide Tube and Stem.

❷ Thread the nut onto the exposed end of the stem.

❸ Place two drops of Loctite 271 inside the threaded hole of the float.

❹ Holding the stem with pliers, thread the float onto the stem and hand-tighten. Thread the nut down against the float and tighten securely.

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Electrical Wiring Instructions



Electrical power must be disconnected from explosion proof models before the cover is removed. Failure to do so could result in severe personal injury and/or substantial property damage.

- Ensure that the wiring conforms to all applicable local and national electrical codes and install unit(s) according to relevant national and local safety codes.
- Switch housing conduit connections may be rotated 360° by loosening the set screw located under the housing base. Do not attempt to rotate without following this instruction and loosening the set screw. Retighten the set screw after adjusting the housing. Care must be taken in positioning the incoming wiring to ensure clearance between the wiring and the switch housing.
- Switch wiring should be brought through the conduit connection, under the baffle plate, wrapped around the sealing tube and brought up to the proper terminal. All excess wire should be cut off prior to stripping the wire to avoid interference with the action of the switch mechanism or housing cover.
- All housings must be properly "sealed" at the conduit connection to maintain the NEMA classification.
- Check the housing cover-to-base fit to ensure the gaskets are sealed properly.

NOTE: For ATEX or IEC Certified T6 and S3 Enclosures: Electrical conduit connection threads may be of non-ISO thread form. Check the product certification nameplate for relevant thread form information before attempting to connect to the electrical conduit connection. In the event a fitting or adaptor is used, check the adaptor body for thread form information. The cable entry device shall be certified under explosion protection type "d" for flameproof enclosures, suitable for the conditions of use if correctly installed.

NOTE: For Product Utilizing a Hermetically Sealed Switch. If the unit is installed in a Class I, Div. 2 location, a conduit seal is not required per the National Electric Code (NEC) 501.5B.

NOTE: For Intrinsic Safety Certified T6 and S3 Enclosures, the parameters are as follows:
Ui = 30V Ii = 1A Ci = 0 Li = 0

NOTE: See Specific Condition of Use on page 14 regarding the marking of nameplates for installation.

Safety Integrity Level (SIL) Installation Requirements

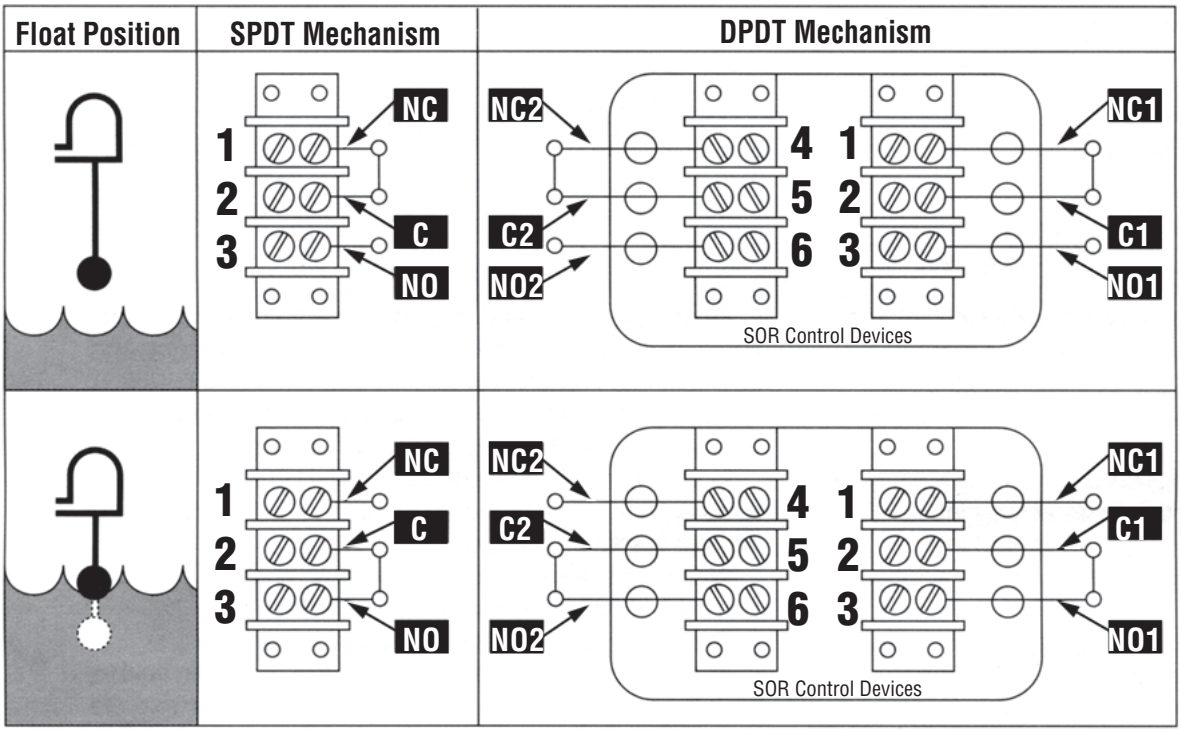
The SOR pressure switches have been evaluated as Type-A safety related hardware. To meet the necessary installation requirements for the SIL system, the following information must be utilized:

- Proof Test Interval shall be one year.
- Units may only be installed for use in Low Demand Mode.
- Products have a HFT (Hardware Fault Tolerance) of 0, and were evaluated in a 1oo1 (one out of one) configuration.

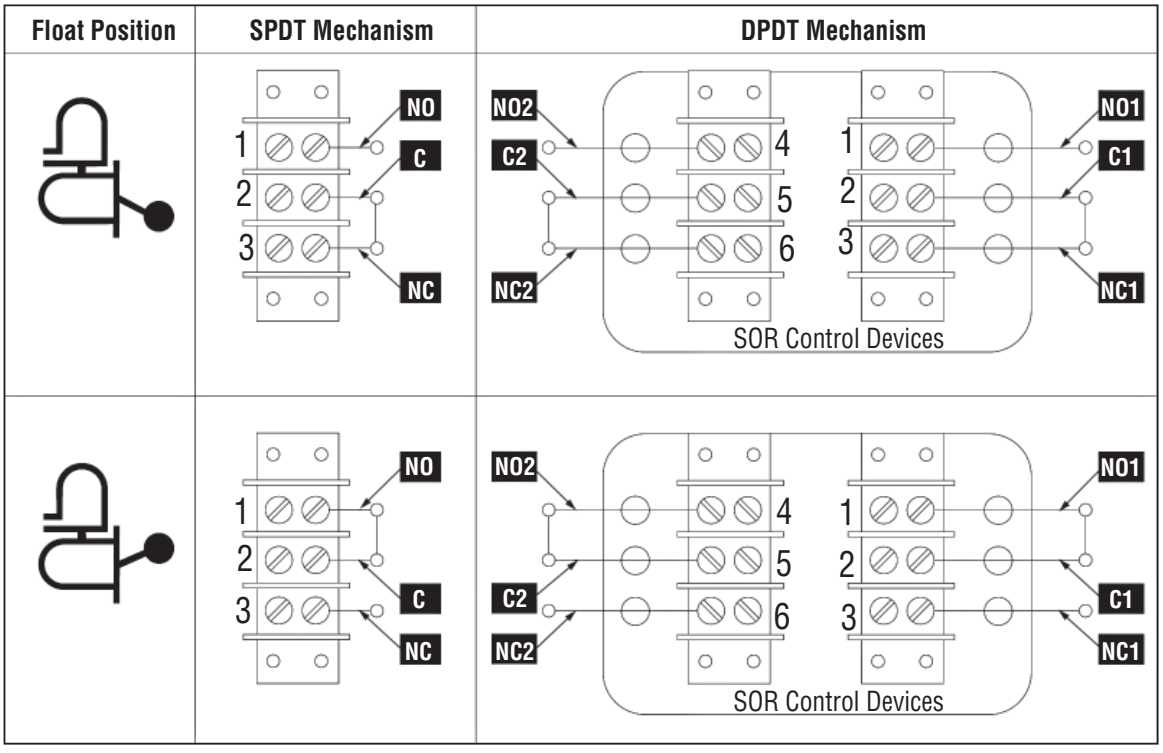
Form 1538 (03.12) ©2012 SOR Inc.

Wiring Mechanism

Vertical



Horizontal



NOTE: For C, G, R, S & Y Switch Assemblies, customer is to wire to the outside terminals.

Set Point

Rising level set point is the level at which actuation occurs. Falling level set point is the level at which deactuation occurs. Do not adjust the switch mechanism or the attraction sleeve position without factory instruction.

- **Float Type –** Set points are factory set (non-adjustable).
- **Displacer Type except for Top Mount –** Set points are factory set (non-adjustable).
- **Top Mount Displacer Type –** Set points may be adjusted by moving displacers up or down on the suspension cable.

Multi-stage controls are factory set for a specific switching sequence. Each control is tagged with a diagram showing the switching sequence.

Differential

Differential is the difference in liquid level between the actuation and deactuation points of a switching element.

- **Float Type –** Differential is factory-set (non-adjustable).
- **Displacer Type except for Top Mount –** Differential is factory-set (non-adjustable).
- **Top Mount Narrow Differential Displacer Type –** Differential is factory-set (non-adjustable).
- **Top Mount Wide Differential Displacer Type –** Differential may be adjusted by moving displacers up or down on the suspension cable. Set points are factory adjusted for the centerline of each displacer.



Do not change factory-set switching element positions during installation.

Pneumatic Piping

Pneumatic switches may be piped according to the charts below so that an air signal (outlet) is generated at either a high- or low-level condition.

	Liquid Level Condition	Output	Required Porting		
			Inlet	Output	Exhaust
Vertical	Low	Pressurized	B	C	A
	Low	Vented	A	C	B
	High	Pressurized	A	C	B
	High	Vented	B	C	A
	Liquid Level Condition	**Output**	**Required Porting**		
			Inlet	**Output**	**Exhaust**
Horizontal	High	Pressurized	B	C	A
	High	Vented	A	C	B
	Low	Pressurized	A	C	B
	Low	Vented	B	C	A

Switch Ratings

Switch Type		Resistive Amperage					Inductive Amperage				
		110-130 VAC	210-250 VAC	20-30 VDC	110-130 VDC	210-250 VDC	110-130 VAC	210-250 VAC	20-30 VDC	110-130 VDC	210-250 VDC
Standard Dry Contact		15	15	5	.5	.25	15	15	5	.4	.13
Hi-Temperature Dry Contact		5	5	1.5	.5	-	5	5	1	.25	-
Gold Contact		1	-	1	-	-	1	-	.5	-	-
Anti-Vibration		15	15	5	.5	.25	15	15	5	.4	.13
High-Amp DC		-	-	10	10	3	-	-	10	10	3
Hermetically Sealed		11	11	5	.5	.25	11	11	.25	.25	.13
Gold Contact Hermetically Sealed		1	-	1	-	-	1	-	.5	-	-
Hi-Temperature Hermetically Sealed		5	5	1.5	.3	-	5	5	1	.25	-
Mini Hermetically Sealed	DPDT	5	5	5	.5	-	5	5	2.5	.25	-
	SPDT	11	11	5	.5	.25	11	11	2.5	.25	.13
Anti-Vibration Gold Contact		1	-	1	-	-	1	-	.5	-	-
Gold Contact Mini-Hermet		1	-	1	-	-	1	-	.5	-	-
Anti-Vibration Mini-Hermet	DPDT	5	5	5	.5	-	5	5	2.5	2.5	-
	SPDT	11	11	5	.25	.25	11	11	2.5	.5	.13
Hi-Temperature Mini-Hermet		5	5	1.5	.5	-	5	5	1	.25	-
Extra Hi-Temperature (Ceramic)		1	1	1	.4	-	1	1	.4	-	-
Standard Pneumatic 316SS Fittings		Non-bleed 3-way aluminum valve body. Buna-N O-Rings 150 psig maximum supply, 24 CFM @ 100 psig									

NOTE: Pneumatic switches must be used with clean, dry air or gas. All switches include a pre-wired terminal block. These switches have higher current ratings for SPDT than DPDT.

Preventive Maintenance

Periodic inspections are necessary to keep the switch in good working order. SOR recommends a systematic program of preventive maintenance be implemented at the time of installation. The following precautions are important and will help keep your switch in top operating condition.

- Keep the switching mechanism clean. Never leave the cover off longer than absolutely necessary. There is no need to lubricate any part of the switch.
- Inspect switches and wiring monthly. Dry contact switches should be inspected for excessive wear and misalignment. Pneumatic switch connections and tubing should be inspected for cracks and air leakage. Repair or replace as required.

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Troubleshooting

SOR switches are designed for long life and trouble-free operation. However, should you suspect a malfunction, conduct the following inspection.



Do not open when an explosive gas atmosphere may be present.



If required, this product must be installed with an explosion proof breather vent or drain per Agency requirements and the National Electric Code – Article 501, Section F, paragraph 3.

- Is the control being operated within the nameplate limitations?
- Is power connected to the control? Is the power "On"?
- Is the controlled equipment functional and wired properly? Is the level control wired properly? (See wiring continuity diagrams on Page 11 for proper wiring arrangement.)
- Is the control piped properly? The control must be piped so that it is within:
  a. - 3° of the horizontal centerline for horizontal mount units.
  b. - 3° of the vertical centerline for vertical mount units.
  c. Ensure that all process piping is free of foreign material and that isolation valves are fully open.
  d. Pneumatic lines must be free of liquid and foreign matter.
- Has the factory-set position of the switching element(s) changed?
- Is the control damaged? Inspect for cracks, terminal corrosion or lead wire damage. Replace the control if any damage is discovered.
- Does the control function when manually operated? Dry Contact Switches: Be certain the dry contact switch actuation lever is not bent, and the calibration set screw is positioned in the center of the lever. Manually move the magnet carriage. The carriage must not bind as it is moved. This manual movement of the carriage should cause switch actuation.
- * Make sure that the interior of the switch is free of dirt, corrosion and scale. Check the:
  a. Inside of the enclosing tube.
  b. Attraction sleeve and stem.
  c. Float or displacer.
  d. Interior of the chamber and process connections.
- * Ensure the factory-calibrated jam nut settings have not been moved and are carrying the attraction sleeve in and out of the magnetic field.
- Call the factory or the SOR representative in your area if inspection doesn't reveal the problem.

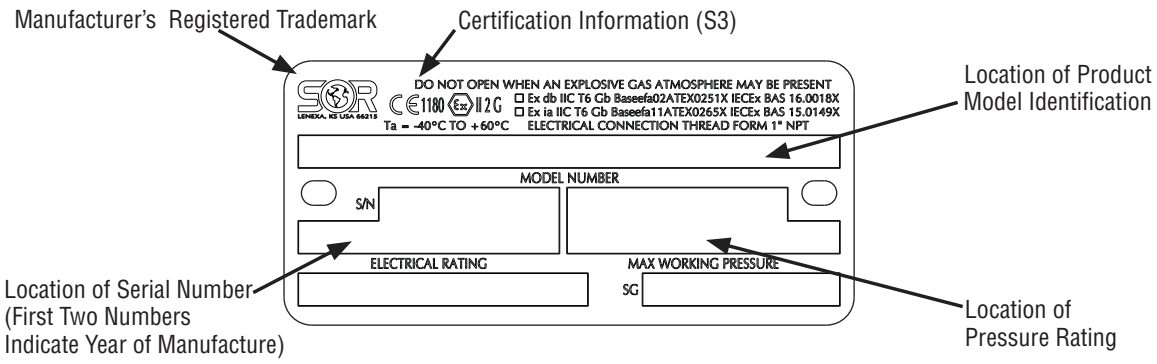
****NOTE: The enclosing tube gasket must be replaced each time the seal is broken. Standard gasket P/N 3070-015, spiral wound gasket P/N 3070-014 (for high pressure, high temperature and NACE units).***

General Information for ATEX/IECEx Certified Models

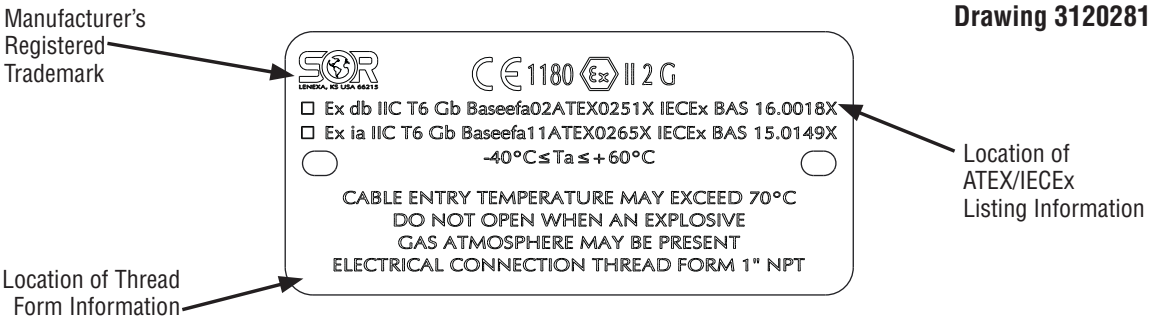
See the ratings nameplate for individual product ratings.

Sample Nameplates

Drawing 3120280



Drawing 3120281



Special Conditions for Safe Use

- This apparatus may have a combined nameplate which carries multiple approvals (Intrinsic Safety & Flameproof). The equipment should be marked as to which protection method it is installed as and shall not be changed or utilized in any other manner than was originally marked by the end user.
- To minimize the risk of electrostatic discharge, clean only with a damp cloth.
- The operating rod and bushing gap shall not exceed from 0.1 mm.

Relevant IEC Standard

IEC 60079-0: 2004
IEC 60079-1: 2003
IEC 60529: 2001
IEC 61241-0: 2004
IEC 61241-1: 2004
EN 60079-0: 2009
EN 60079-11: 2007

Form 425 (09.16) ©SOR Inc.

Declaration of Conformity

For ATEX Certified Models

EC Declaration of Conformity

CE

Product	**S3 & T6 Mechanical Level Switches**
Manufacturer	SOR Inc. 14685 West 105th Street Lenexa, Kansas 66215-2003 United States of America
Date of Issue	**August 11, 2016**
We declare that the above products conform to the following specifications and directives	ATEX Directive (2014/34/EU) Equipment Intended for use in Potentially Explosive Atmospheres EN 60079-0:2012 EN 60079-1:2014 EN 60079-11:2012
Carries the marking	Ex **II 2 G Ex db IIC T6 Gb (-40°C ≤ Ta ≤ +60°C)** Ex **II 2 G Ex ia IIC T6 Gb (-40°C ≤ Ta ≤ +60°C)**
Reference document	**EC-Type Examination Certificate** **Baseefa02ATEX0251** Issued June 4, 2003 **Baseefa11ATEX0265X** Issued February 8, 2012
ATEX Notified Body	**SGS Baseefa** (Notified Body No. 1180) Rockhead Business Park, Staden Lane, Buxton, Derbyshire SK17 9RZ United Kingdom Baseefa Customer Reference No. 1021
Person responsible	Michael J. Bequette (VP of Engineering)

Michael J. Bequette

Engineered to Order with Off-the-Shelf Speed

14685 West 105th Street, Lenexa, KS 66215-2003
913-888-2630 • 800-676-6794 USA • 913-888-0767 FAX

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Service Policy

- In order to expedite the repair or replacement of returned goods, the following information must be provided:
  a Serial Number and complete Model Number.
  b. Customer Purchase Order Number.
  c. Installation site.
  d. Reason for return.
  e. A Material Safety Data Sheet must be provided.
- If the returned goods are defective as defined in the warranty, and returned within the warranty period, SOR will promptly repair or replace the returned goods at our option, without cost to the customer.
- If the returned goods are returned after the warranty period, or without a warranty claim, the customer must approve the repair or replacement.
- All shipments returned to the factory will be prepaid by the customer. All product warranty shipments shall be prepaid by the factory.

Limited Warranty

SOR® agrees to repair or replace any switch found to be defective in material or workmanship within five years from date of shipment. The warranty is valid only if the switch was installed in accordance with published factory installation instructions, operated within the design limitations stated on the nameplate, and returned to the factory for inspection, freight prepaid, within the warranty period. No claim for labor or consequential damages will be allowed.

SORInc.com

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Form 425 (09.16) ©SOR Inc.

DXP - GO Switch

The DXP combines position sensors, internal mount pilot device and an on-board spool valve into a single enclosure.

- Intrinsically Safe Class I, Div.1, Groups A, B, C, D (EEx ia IIC, II 1 G)
- Explosion-proof Class I, Div.1, Groups C & D (EEx d IIB, II 2 G)
- SPDT contact switches
- Integral Solenoid Pilot Valve (24Vdc, 110Vac and Intrinsically Safe)

0539

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2	Indicator Assembly
3	DXP Enclosure Assembly
5	Spool Valve Assembly
5	Pilot Device Assembly
6	GO Switch Assembly
6	Shaft / Cam Assembly
7	Approvals & Warranty



3300 Fern Valley Road, Louisville, Kentucky 40213 USA **www.topworx.com**
502.969.8000 phone 502.969.5911 fax info@topworx.com

TOPWORX

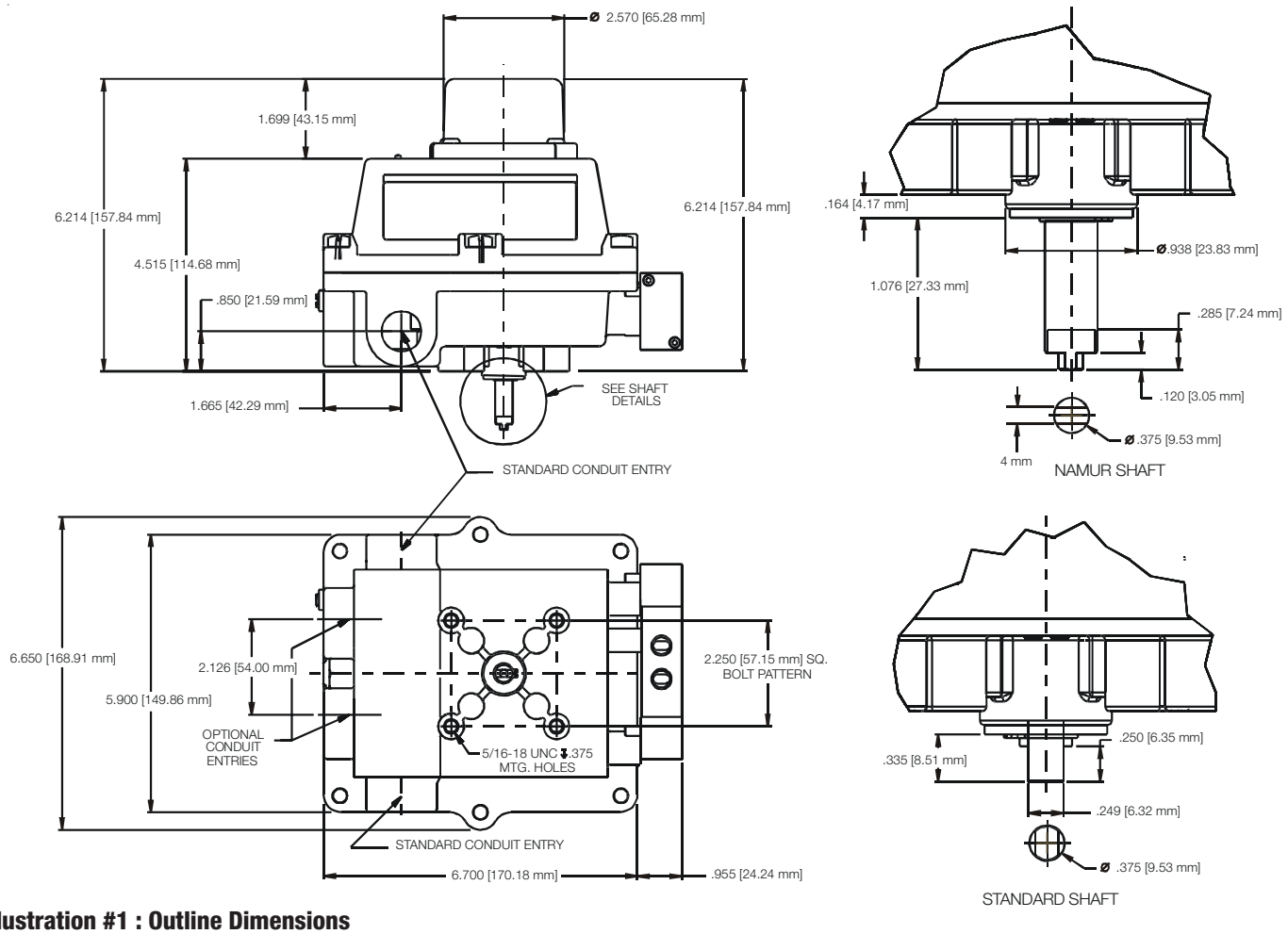


Illustration #1 : Outline Dimensions

Installation Notes

1. Be cautious not to allow undue axial (thrust) load on the DXP shaft.

2. Cycle the valve a couple of times prior to final tightening of the mounting kit hardware. This allows the shaft to self-center in the pinion slot, or coupler.

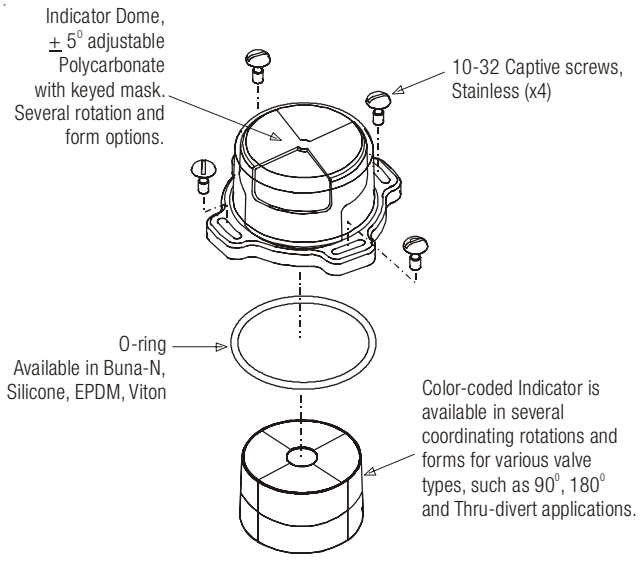
3. Always use sound mechanical practices when torquing down any hardware or making pneumatic connections.

4. This product comes shipped with plastic plugs in the conduit entries in an effort to protect the internal components from debris during shipment and handling. **It is the responsibility of the receiving and/or installing personnel to provide appropriate permanent sealing devices to prevent the intrusion of debris, or moisture, when stored outdoors or when installed.**

5. **It is the responsibility of the installer, or end user, to install this product in accordance with the National Electrical Code (NFPA 70), or any other national or regional code defining proper practices.**

Indicator / Dome Replacement Kits	
AV-GB002	90^0, Green/Open, Red/Closed, Buna oring
AV-YB002	90^0, Yellow/Open, Blk/Closed, Buna oring
AV-TB002	90^0, Green/Thru, Red/Divert, Buna oring
AV-4B002	45^0, Green/Open, Red/Closed, Buna oring

Illustration #2 : Indicator Assembly



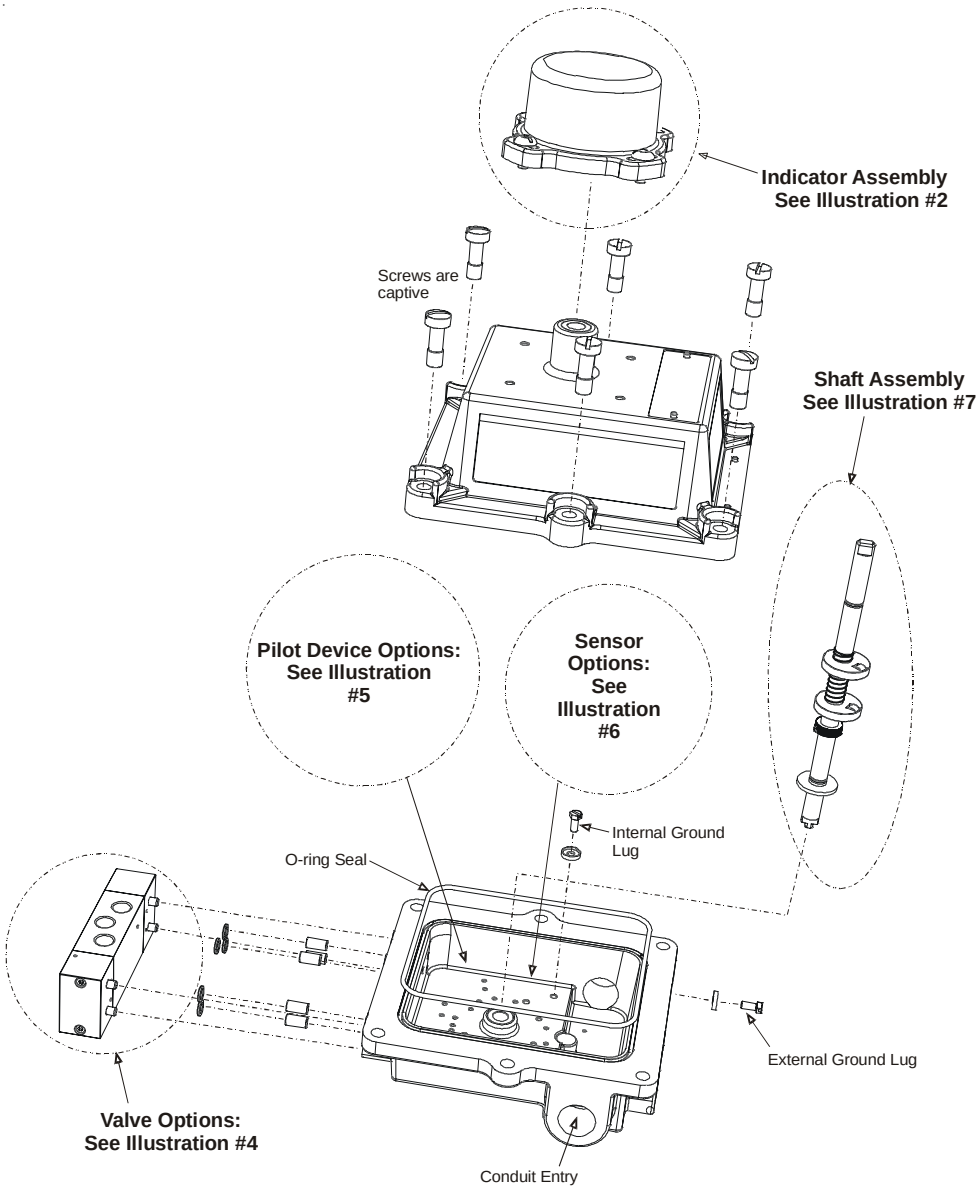


Illustration #3 : DXP Enclosure Assembly

Enclosure Specifications / Materials of Construction	
Enclosure	Die-cast A360 aluminum with dichromate conversion coating inside and out & epoxy coated exterior
Fasteners	Qty 6: M8 socket head bolt - stainless steel (6mm wrench)
Shaft Bushings	Cast-in Oilite bronze
Seals	O-ring seals available in: Buna-N, Silicone, EPDM & Viton
Conduit Entries	Quantity 2-4 available in: 3/4 NPT, 1/2 NPT, M20 & M16
Mounting Holes	(4X) 5/16-18 UNC tapped holes on 2.25"(57.15mm) Square Pattern, Optional F05 Pattern

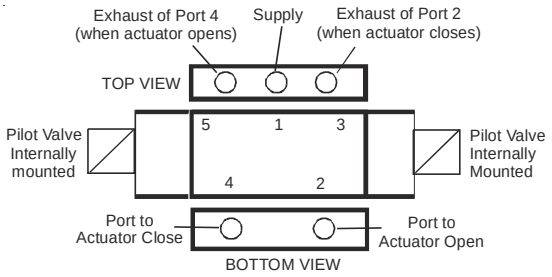
Maximum Torque Values for Fasteners		
Description	*Type*	*Max. Torque*
Enclosure Lid Screws	See spec Table	8 ft.lbs.
Indicator Dome Screws	10-32 UNF	20 in.oz.
Bottom Mounting Holes	5/16-18 UNF	10 ft.lbs.

Pneumatic Hookup Procedures

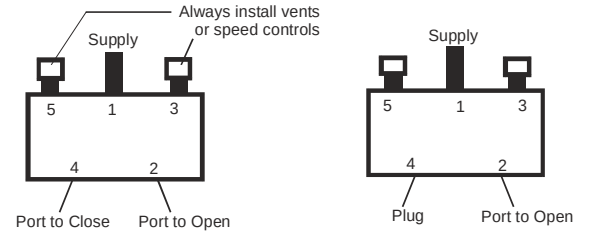
Prior to connecting the supply air to the spool valve, flush the system to remove any debris or contaminates. Galvanized pipe can easily flake and contaminate the system and therefore is not recommended.

4-Way Spool Valves

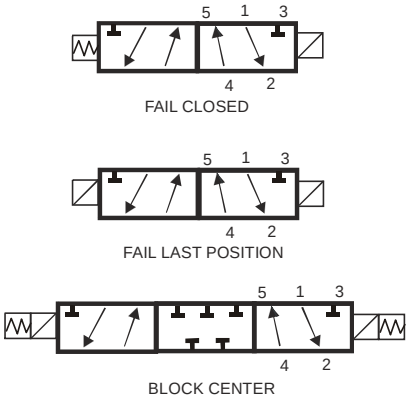
The TopWorx spool valve is a 5 port, 4-way valve driven by an internally mounted pilot valve. The spool valve supply port and work ports are 1/4" NPT. The exhaust ports are 1/8" NPT, marked as follows for the DXP:



NEVER PLUG, OR BLOCK, PORT 5



Spool Valve Specifications	
Medium	Dried, filtered air (40 micron)
Max Operating Pressure	100psi (0.7MPa) (6.89Bar)
Min Operating Pressure	30psi (0.28MPa) (2.76Bar)
Ambient Temperature Range	Refer to Product Nameplate Marking
Flow Coefficient	1.2Cv / 1.0Cv for Cold Temp
Environment Rating	Type 4, 4X, IP67
Port Size	1/4" NPT
Manual Override	Available in: Latching/non-latching Push Type & Palm Actuator Type
Valve Body	Available in: Hardcoat Anodized Aluminum, 304 & 316 Stainless
Valve Seals	Spool seals: Buna-N Valve Body Seals available in: Buna-N, Silicone, EPDM & Viton. Cold Temp Spools are lap-joint technology containing no seals.



Don't forget!

TopWorx has a complete line of breathers, flow controls, regulators and filters.

Check out **www.topworx.com** or call us at **502.969.8000** for more details

DID YOU KNOW? TopWorx manufactures the globally-known GO Switch Leverless Limit Switch, which comprises a full line of harsh environment sensors. If your application is very cold, very hot, under water or in a caustic atmosphere, then GO Switch has the answer.

Highly Recommended

TopWorx highly recommends Locktite 567 brand thread sealant. Do not use a hard setting pipe compound. If Teflon thread seal tape is used, start the wrap on the second thread from the leading thread of the fitting. This will prevent tape shreds from contaminating the spool valve seals.

Flow controls (AL-M21) or Breathers (AL-M31) should be installed in the exhaust ports to keep debris from falling into the spool valve and damaging the seals. This must be addressed prior to installation, or storage.

Fail Closed Spool Valve Replacement Assemblies	
AV-BFCVA20	Std Alum Spool Va Assy w/Buna seals
AV-BFCVS20	Std 304ss Spool Va Assy w/Buna seals
AV-BFCV620	Std 316ss Spool Va Assy w/Buna seals

Fail Last Position Spool Valve Replacement Assemblies	
AV-BFLPVA20	Std Alum Spool Va Assy w/Buna seals
AV-BFLPVS20	Std 304ss Spool Va Assy w/Buna seals
AV-BFLPV620	Std 316ss Spool Va Assy w/Buna seals

Block-Center Spool Valve Replacement Assemblies	
AV-BBCVA20	Std Alum Spool Va Assy w/Buna seals
AV-BBCVS20	Std 304ss Spool Va Assy w/Buna seals
AV-BBCV620	Std 316ss Spool Va Assy w/Buna seals

Consult factory for more options.

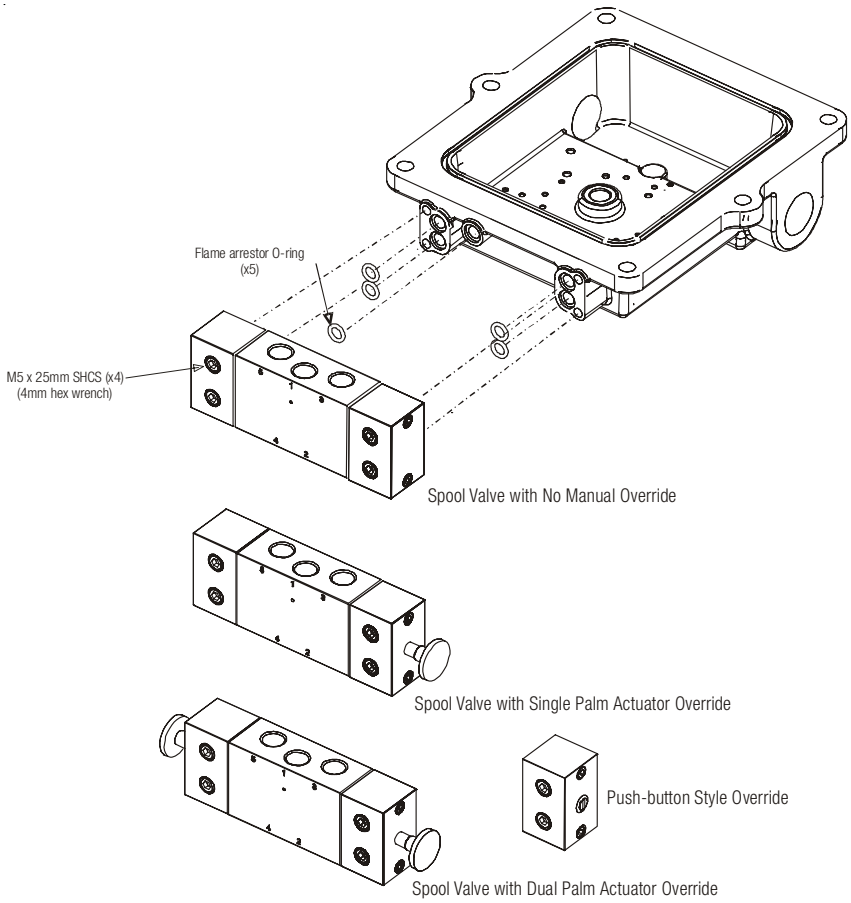


Illustration #4 : Spool Valve Assembly

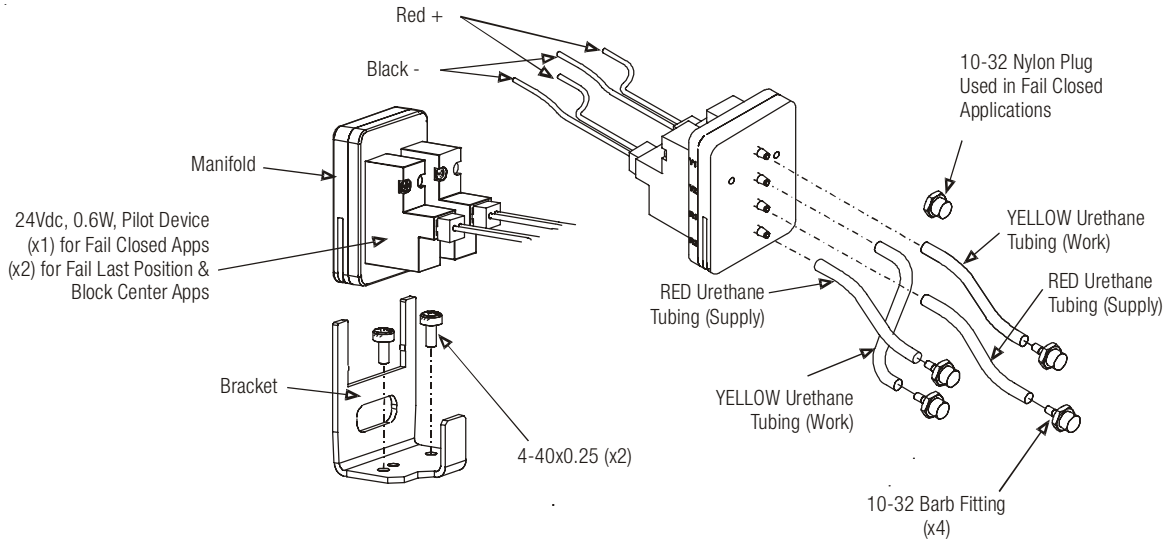


Illustration #5 : Pilot Device Assembly

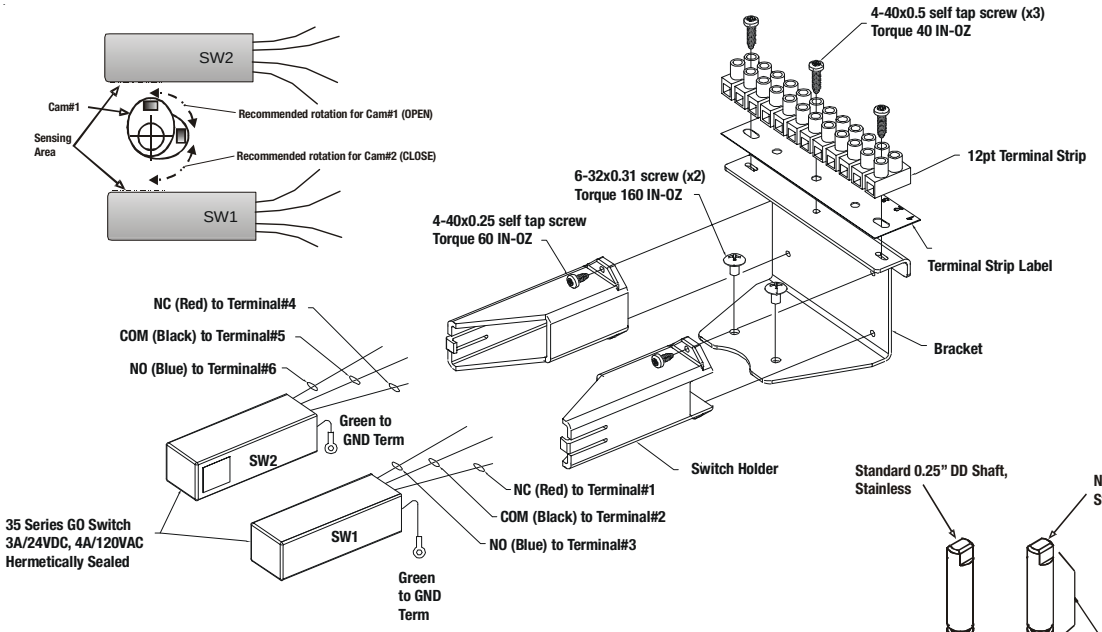


Illustration #6 : GO Switch Assembly

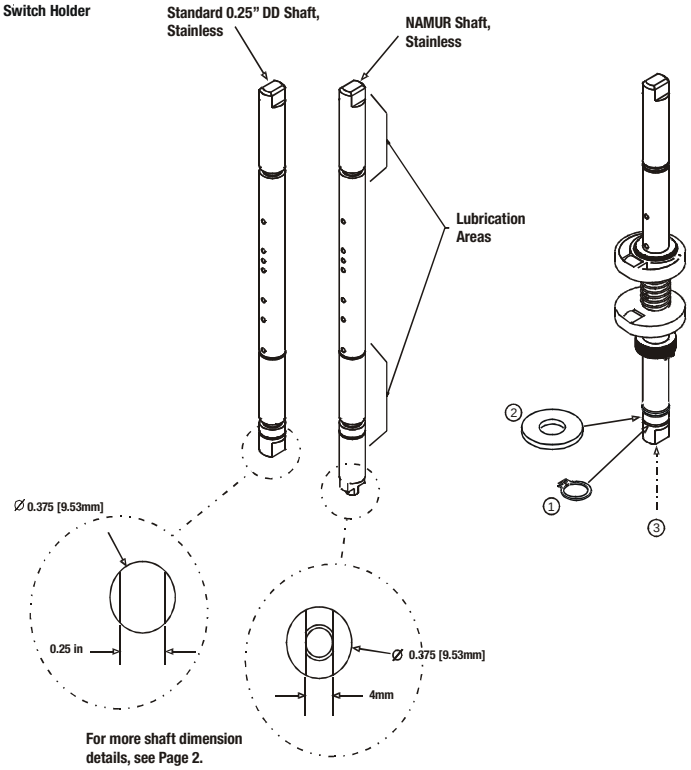


Illustration #7 : Shaft / Cam Assembly (2 GO Switches)

Switch Calibration Procedure

Never perform switch calibration procedure while area is known to be hazardous.

For Intrinsically Safe models, unit must be wired in accordance to Control Drawing S-K094/094A. Or, for standard explosion-proof models:
Calibration may be performed using a Volt-Ohm meter by using the Ohm setting across COM and NO. When switch is active, the meter will read ≤0.5 Ohms, or the Diode setting may used simply to indicate continuity.

If a 120Vac source is used, an appropriately sized resistor must be used in series to limit current to a maximum of 15 Amperes when circuit rating is unknown, or permanent damage may occur.

Step 1: With valve in the CLOSED position, disengage the BOTTOM Cam from the splined Hub and rotate Clockwise until SW1 activates. Release Cam to re-engage splined Hub.

Step 2: Rotate valve to the OPEN position. Disengage the TOP Cam from the splined Hub and rotate Counter-clockwise until SW2 activates. Release Cam to re-engage the splined Hub.

Step 3: Cycle valve CLOSED and OPEN several times to insure switches will maintain calibration.

For Reverse Acting actuators:

Step 1: With valve in the CLOSED position, disengage the TOP Cam from the splined Hub and rotate Counter-clockwise until SW2 activates. Release Cam to re-engage the splined Hub.

Step 2: Rotate valve to the OPEN position. Disengage the BOTTOM Cam from the splined Hub and rotate Clockwise until SW1 activates. Release Cam to re-engage the splined Hub.

Repeat Step 3 above.

Warranty

TopWorx warrants that each item of new equipment manufactured by it will be free from defects in material and workmanship under normal use and service; its obligation under this Warranty, being limited to making good, at its factory, and part of parts thereof, which shall be returned to it with transportation charges prepaid, within one year after the date of the purchase of such equipment by the original purchaser, and which its examination shall disclose to its satisfaction to have been thus defective. TopWorx however, assumes no risk or liability for results of the use of the products purchased from it.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, WHETHER OF MERCHANTABILITY FITNESS, OR OTHERWISE EXPRESSED OR IMPLIED, AND ALL OTHER OBLIGATIONS OR LIABILITIES AND TOPWORX NEITHER ASSUMES , NOR AUTHORIZES ANY PERSON TO ASSUME FOR IT ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OF THIS EQUIPMENT.

No claims for labor in replacing defective parts and equipment and consequential damages will be allowed by the Company.

This Warranty shall not apply to equipment which has been subjected to misuse, negligence or accident.

This Warranty shall not apply to any equipment which shall have been repaired or altered, outside the Company's factory so as to affect such equipment's stability or reliability in the judgement of the Company.

Illustration #6 : (4) GO Switch Assembly

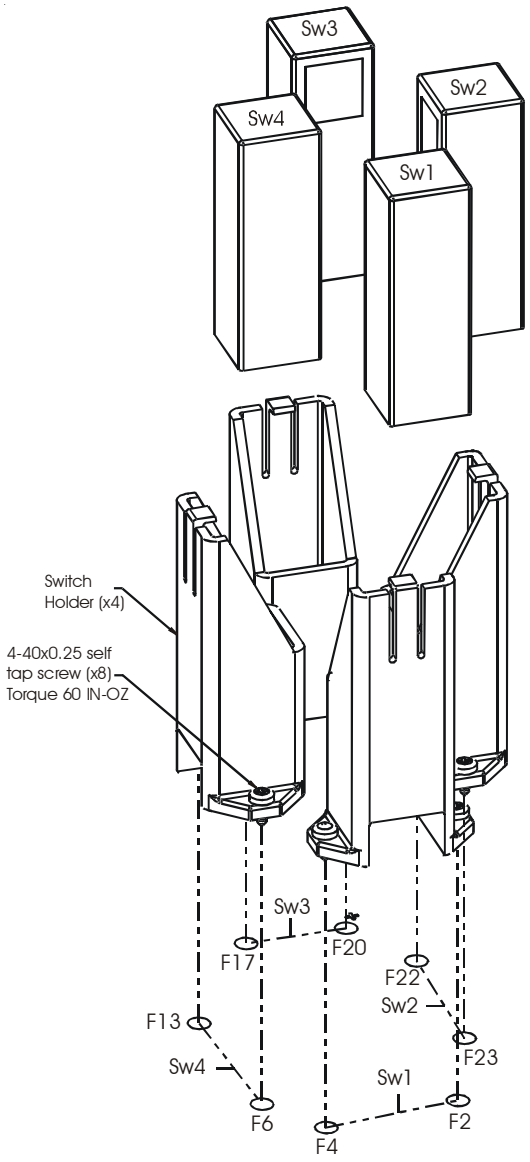
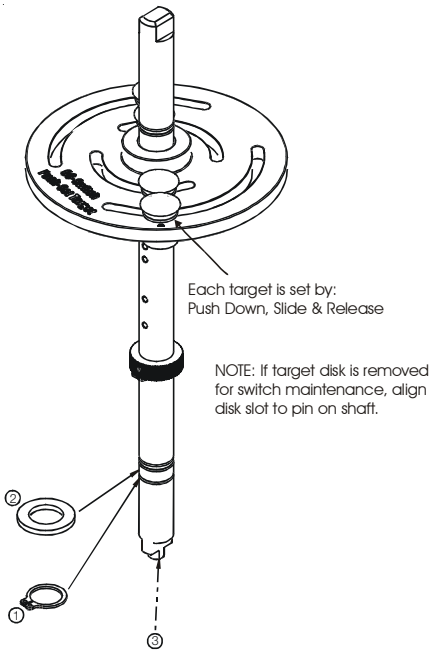


Illustration #7 : Push Set Target Assembly (4 GO Switches)



Telemetering Equipment for use in Hazardous Locations

CE 0539 Ex II 1 G c UL us LISTED

Zone 0 EEx ia IIC T4 -40^{0}C≤Tamb≤60^{0}C; IP67
DEMKO 04ATEX130958X
Class I, Div.1 & 2, Groups A, B, C, D, T4; Type 4, 4X
Intrinsically Safe / Securite Intrinseque
Install per Control Drawing: S-K094/094A

CE 0539 Ex II 2 G c UL us LISTED

Zone 1 EEx d IIB T6 -40^{0}C≤Tamb≤60^{0}C; IP67
DEMKO 04ATEX0320446X
Class I, Div.1, Groups C & D, T6; Div.2, Groups A,B,C,D, T3
Type 4, 4X, 7
Max Current: 3A/24Vdc; 4A/120Vac (switches)
Pilot Coil: 24Vdc or 110Vac

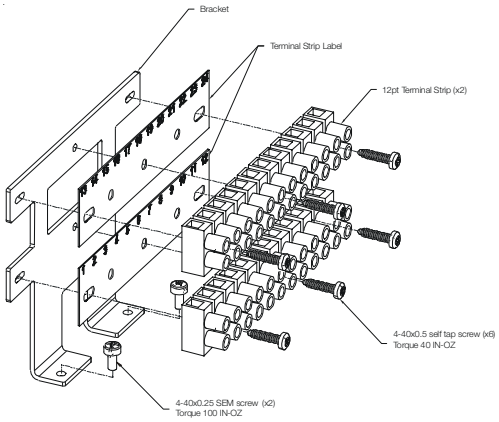
Special Conditions of Safe Use (All installations)

Clean only with a damp cloth to prevent possibility of electrostatic discharge.

For Explosion Proof installations, the internal ground connection shall be used and the external ground connection, if supplied in addition, is supplemental bonding allowed where local authorities permit, or is required.

When installing with a third party listed nipple-mount solenoid, it is the responsibility of the installer to provide fittings, and apparatus, suitable for the area classification in accordance with the National Electrical Code.

All cable entry devices or conduit stopping boxes shall be certified in type of explosion protection 'd', suitable for the conditions of use and correctly installed.



Switch 1		Switch 2	
Green to GND	Ground	Green to GND	Ground
COM (Black)	Terminal 2	COM (Black)	Terminal 5
NO (Blue)	Terminal 3	NO (Blue)	Terminal 6
NC (Red)	Terminal 1	NC (Red)	Terminal 4
Switch 3		**Switch 4**	
Green to GND	Ground	Green to GND	Ground
COM (Black)	Terminal 8	COM (Black)	Terminal 11
NO (Blue)	Terminal 9	NO (Blue)	Terminal 12
NC (Red)	Terminal 7	NC (Red)	Terminal 10

About Valvetop™

Valvetop valve networking and control devices link on/off valves to process control systems via a variety of fieldbus protocols. Valvetop valve controllers and monitors support multiple bus protocols, operate in the most demanding plant conditions, and carry a variety of global approvals. Whether your application is rotary or linear, fieldbus or conventional, hazardous or general purpose, we have a suitable solution for you.

For inquiries, contact TopWorx at: 502.969.8000
www.topworx.com
info@topworx.com

About TopWorx

TopWorx is the leader in field networking, valve control, and position sensing solutions for the process industries. Our products and services help plants, mills, and pipelines improve their performance by making it easy to implement modern automation technologies.



Field Networking Solutions

Networx™ field networking products and services make it easy for plant personnel to understand, implement, and enjoy the benefits of modern bus networking technologies.



Valve Control Solutions

Valvetop™ valve networking and control solutions support multiple bus protocols, operate in the most demanding plant conditions, and carry a variety of global approvals.



Position Sensing Solutions

GO® Switch leverless limit switches provide reliable position sensing in extremely hot, cold, wet, dirty, corrosive, abusive, and explosive plant conditions.

TOPWORX

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Louisville, Kentucky 40213 USA

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SOLENOID VALVES FOR VALVE AUTOMATION

BULLETIN
VAC-2015

VERSA

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THE COMMITMENT CONTINUES

Fluid Power is our business. It is our only business, so we have to be good at it. Since its beginning in 1949, Versa has maintained its commitment to quality products and satisfied customers.

Versa has succeeded in serving industry's needs with a broad line of directional control devices. Our focus on product variety, technical expertise and company support remains constant. It all begins with a responsiveness to industry needs and ends with delivery of the valve or system you need–when you need it.

We view ourselves as problem solvers and that role requires more than making good products. It is what we do before and after that is equally important From drawing board to user satisfaction, our commitment is continuous.

QUALITY IS ABSOLUTE

Quality has no degrees at Versa. There is no such thing as "pretty good" or "almost right". Every product is designed and manufactured to conform to uniformly high standards.

These standards are assured by a quality management system which includes ISO 9001 certification and testing of all products prior to shipment.

No matter how tough the application or environmental demands, Versa offers you a choice of valves to meet the challenge. Advanced design, durable construction materials and rigid manufacturing standards provide valves you can rely on for years of trouble-free performance.

Be it a single valve or a pneumatic system, Versa's commitment to quality is uncompromising. Count on it.



WORLDWIDE ACCESSIBILITY

More than 500 fluid power representatives and over 100 stocking locations comprise Versa's worldwide distribution system. They are supported by manufacturing and technical centers in the United States and The Netherlands.

The distributor network is the key to customer service and the source of continuous application feedback. Versa uses this input as part of its research and development program in an effort to respond to individual and industry needs.

Versa makes certain that our distributors' sales and service personnel receive factory training on an ongoing basis. This includes basic theory, product indoctrination and seminars.

Our distributor family is a source of pride to Versa–but more important—it is a source of support and service to all of our customers.

Contact Versa for the distributor servicing your specific area.



HOW WE PUT IT TOGETHER IS WHAT SETS US APART

Versa is not the biggest manufacturer of directional control valves, so we try to be the best.

Design, manufacture, quality control, pricing, delivery – whatever the function – it must be geared to customer needs.

Many companies sell valves. At Versa, that is not enough. We sell satisfaction.

Versa exercises diligence to assure that information contained in this catalog is correct, but does not accept responsibility for any errors or omissions. Versa also reserves the right to change or delete data or products at any time without prior notification. To be sure the data you require is correct, consult factory.

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Technical Information:

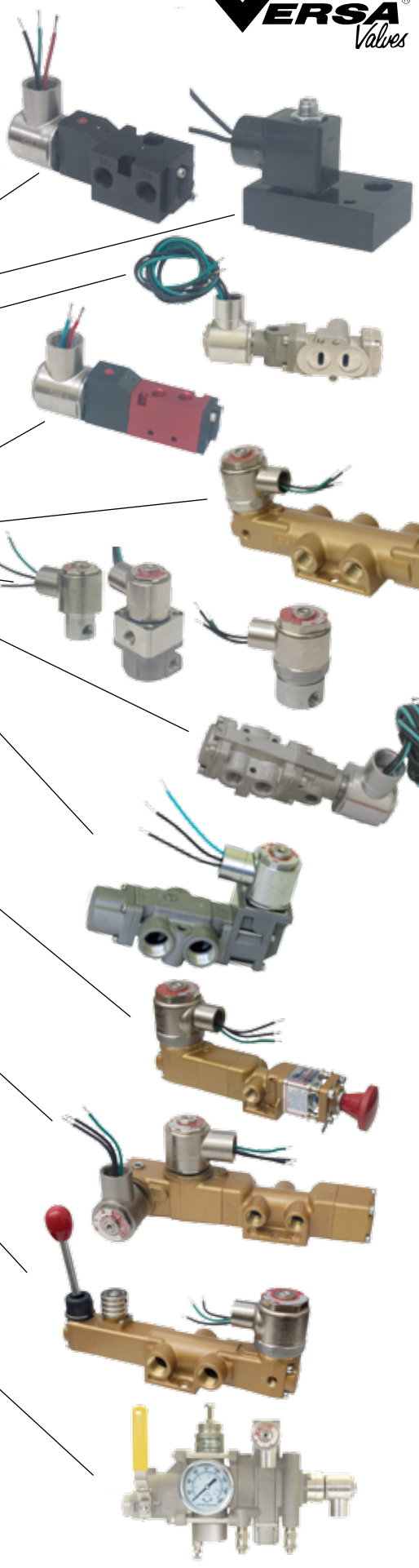
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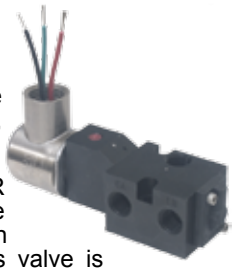
DIRECT MOUNT ACTUATOR VALVES

ALUMINUM CONSTRUCTION

SERIES C5 NAMUR

3-Way/4-Way Field Convertible Solenoid Valves

General Description



The Versa C5 NAMUR mount control valve is a high flow, 5-port, solenoid/pilot valve. It is designed to mount directly to any NAMUR actuator, thus reducing actuator response time and cost of tubing, fittings, brackets, and labor.

The 5-port design allows the C5 NAMUR to be ordered as either 4-way (for double acting actuators) or 3-way (for spring return or fail-safe actuators). The function of this valve is field convertible utilizing no special tools, gaskets, or sealants. Relocation of a port plug converts a 3-way to a 4-way, or a 4-way to a 3-way. When the 4-way valve is converted to 3-way function, the unused exhaust port becomes an actuator vent into which a filter/muffler can be installed to prevent contaminants from entering either the valve or the actuator.

Single solenoid models (for 2-position control), or double solenoid models (for 2 or 3-position control) are available. Actuator positioning is possible with the use of 3-position valves since all Versa C5 NAMUR valves are bubbletight. A complete selection of electrical connections, area classifications, and power requirements makes the most exacting and demanding specifications or applications easy to satisfy. Manual overrides (guarded-push to operate) are standard on all C5 NAMUR valves. Consult factory for other manual overrides available as an option.

Materials

Valve Body and Plunger: anodized aluminum (for stainless steel direct mount valve, See page 8)
Actuating Caps: solenoid – anodized aluminum
spring cap – synthetic resin
Valve Seals: plunger and body – FKM (fluorocarbon)
pilot piston – NBR (nitrile)
valve/actuator mounting O rings – NBR (nitrile)
Pilot Piston: synthetic resin
Screws: stainless steel (except valve to actuator = carbon steel)
Port Plug: brass
Solenoid Parts: sleeve, plunger & spring – 304 & 430F stainless steel
coils–epoxy encapsulated with 3 spade terminals (std) or 2 or 3 wire lead (opt)
coil cover– (when applicable) option: –C50 = carbon steel, painted;
–LB–XN, –LB–XX,–PC, –PC–XN, –PC–XX, –XN, –XX= carbon steel, electroless nickel plated

Operating Pressures and Weights

Valve Type	Operating Pressure Range†† Pneumatic	Approximate Weights	
		Ordinary Service	Hazardous Service
Single Solenoid/Spring Return (2-position)	15-115 psi (1-8 bar)	0.8 lbs. (363 g)	1.1 lbs. (500 g)
Double Solenoid/Detented (2-position)	10-115 psi (0.7-8 bar)	1.2 lbs. (545 g)	1.8 lbs. (816 g)
Double Solenoid/Spring Centered (3-position)	15-115 psi (1-8 bar)	1.2 lbs. (545 g)	1.8 lbs. (816 g)

†† Pressure ranges may change based on solenoid option. See page 6.
MPa = $\frac{\text{bar}}{10}$
For higher pressure applications, consult factory.

Porting Size

Inlet and exhaust – 1/4 NPT or G1/4
Cylinder ports – O ring seal per NAMUR standard

Flow Rates

Cv = 0.75 (Kv = 11) average for all ports (48 SCFM at 100 psi; 82 $Nm^3/_h$ at 7 bar).
For actuator speed rates see page 6.

Installation, Filtration and Lubrication

Valves have no limitations on mounting orientation.
40 to 50 micron filtration and general purpose lubricating oil ISO, ASTM viscosity grade 32 recommended.
Ambient temperature range 5°F (15°C) to 125°F (50°C).

Options Suffix

Manual Override: none Standard on basic valves, guarded-push to operate.
For other solenoid options see page 6.

C5 NAMUR Valve
Product Number Selector

FUNCTION	PORT SIZE	Cv (Kv)	Basic Valve Number*			
			SINGLE SOLENOID/SPRING RETURN, 2 POSITION	DOUBLE SOLENOID/ DETENT, 2 POSITION	DOUBLE SOLENOID/SPRING CENTERED, 3 POSITION	
					Blocked Center	Exhaust Ports Open
4-way 5/2 & 5/3	1/4 NPT G1/4	.75 (11) .75 (11)	CGS-4232-NB1 -†- (coil code) CGS-4292-NB1 -†- (coil code)	CGG-4232-NB1 -†- (coil code) CGG-4292-NB1 -†- (coil code)	CXX-4233-NB1 -†- (coil code) CXX-4293-NB1 -†- (coil code)	CXX-4234-NB1-†- (coil code) CXX-4294-NB1 -†- (coil code)
3-way** 3/2 & 3/3	1/4 NPT G1/4	.75 (11) .75 (11)	CGS-3232-NB1 -†- (coil code) CGS-3292-NB1 -†- (coil code)	CGG-3232-NB1 -†- (coil code) CGG-3292-NB1 -†- (coil code)	CXX-3233-NB1 -†- (coil code) CXX-3293-NB1 -†- (coil code)	CXX-3234-NB1 -†- (coil code) CXX-3294-NB1 -†- (coil code)

* All valves include O ring interface seals and #10-24 mounting screws.
For #10-32 screws change NB1 to NB2. For M5 screws change NB1 to NB3.
** 3-way is the same valve as 4-way, but is provided with a relocated cylinder port plug. See note on page 7

For coil code see page 6.
†Add suffix option here, if required.

SERIES E5 NAMUR
3-Way Solenoid Valves

General Description

The Versa E5 NAMUR mount control valve is an inexpensive, simple and effective 3-way direct-acting solenoid valve. It is designed to mount directly to any actuator with NAMUR footprint thus reducing cost of tubing, fittings, brackets and labor.

It is most effective on spring return or fail-safe actuators where high speed open or close is not important, but where cost is a factor. A threaded actuator vent port is standard.

Available as a 3-way, 2-position, direct solenoid, spring return only, and with most of the Versa solenoid options. See page 6.

Materials

Valve Body: anodized aluminum
Valve Seals: body/plunger –NBR (nitrile)
valve/actuator mounting O rings –NBR (nitrile)

Screws: (valve to actuator) = stainless steel)

Solenoid Parts: sleeve, plunger & spring – 304 & 430F stainless steel
coils–epoxy encapsulated with 3 spade terminals (std) or 2 or 3 wire lead (opt)
coil cover– (when applicable) option:–C50 = carbon steel, painted;
–LB–XN, –LB–XX, –PC, –PC–XN, –PC–XX, –XN, –XX= carbon steel, electroless nickel plated

Operating Pressures and Weights

Valve Type	Operating Pressure Range Pneumatic	Approximate Weights	
		Ordinary Service	Hazardous Service
Single Solenoid/Spring Return (2-position)	0-150 psi (0-10.3 bar)	0.6 lbs (272 g)	0.9 lbs (408 g)

Porting Size

Inlet and Vent: 1/4 NPT or G1/4
Exhaust: #10-32 (1/8 NPT or G1/8 available)
Cylinder ports: O ring seal for NAMUR standard
(For non-NAMUR actuators, consult fatory)

Flow Rates

Cv = 0.08 (Kv = 1.2) average for all ports
(5 SCFM at 100 psi; 8.5 Nm3/h at 7 bar).
For actuator speed rates see page 6.

Options

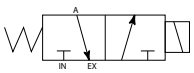
See page 6.

Installation, Filtration and Lubrication

Valves have no limitations on mounting orientation.
40 to 50 micron filtration and general purpose lubricating oil
ISO, ASTM viscosity grade 32 recommended.
Ambient temperature range 5°F (15°C) to 125°F (50°C).



E5 NAMUR Valve
Product Number Selector

FUNCTION	PORT SIZE	Cv Kv	Basic Valve Number* SINGLE SOLENOID/SPRING RETURN 2-POSITION
3-Way 3/2	1/4 NPT G1/4	.08 (1.2) .08 (1.2)	E5SM-3011-34-NB1 -†- (coil code) E5SM-3071-34-NB1 -†- (coil code) 

For coil code see page 6.
†Add suffix option here, if required.

* All valves include O ring interface seals and #10-24 mounting screws.
For #10-32 screws change NB1 to NB2.
For M5 screws change NB1 to NB3.

SERIES C5 & E5 NAMUR Solenoid Options

	NAMUR OPTIONS		VOLTAGES & COIL CODES** VALVE TYPE		NOMINAL COIL POWER
	DESCRIPTION	SUFFIX DETAIL*	C5	E5	
NON HAZARDOUS SERVICE	Spade Terminals (standard)	None	110V50 (**E110**) 24V60 (**A024**) 120V60 (**A120**) 12VDC (**D012**) 24VDC (**D024**)		AC=8.5W DC=10.5W
	Strain Relief mini-DIN type connector, cord grip PG9	-HC			
	1/2 NPT conduit mini-DIN type connector	-HCC			
	1/2 NPT conduit, watertight, NEMA 4	-228L			
	1/2 NPT conduit, general purpose, NEMA 1,2,3	-C50	220V50 (**E220**) 240V60 (**A240**) 48VDC (**D048**) 240V50 (**E240**)		AC=6W DC=7W
	1/2 NPT conduit, watertight, NEMA 4 & 4X	-PC			
HAZARDOUS SERVICE	**Hazardous Locations**, UL listed, CSA approved 1/2 NPT conduit, NEMA 7 & 9,	-XX	110V50 (**E110**) 24V60 (**A024**) 120V60 (**A120**) 12VDC (**D012**) 24VDC (**D024**) 220V50 (**E220**) 240V60 (**A240**) 48VDC (**D048**) 240V50 (**E240**)		AC = 5.6W DC = 7.2W
	-watertight, dusttight, NEMA 4, 4X, 7 & 9,	-PC-XX			
	Flameproof (d) - ATEX IECEx EEx II 2 G IIB + H_2 T3 T6* Ex d Ex d IIB T3 to T6 Gb				
	M20 x 1.5 conduit entry, Basic standard	-XN			
	with Flameproof Junction Box	-AJB-PS-XN			
	Hazardous Locations, UL listed, CSA approved low power, 1/2 NPT conduit, NEMA, 7 & 9, **Flameproof (d)** - ATEX IECEx EEx II 2 G IIB + H_2 T3 T6 Ex d Ex d IIB T3 to T6 Gb	-LB-XX	12V60 (**A012**) 6VDC (**D006**) 24V60 (**A024**) 12VDC (**D012**) 48V60 (**A048**) 24VDC (**D024**) 120V60 (**A120**) 48VDC (**D048**) 240V60 (**A240**) 120VDC (**D120**)		AC or DC =1.8W
	M20 x 1.5 conduit entry with Low power 1.8W coil	-LB-XN			
	Intrinsic Safe, Factory Mutual/CSA approved mini DIN connector with strain relief PG9 cord grip	-HC-XISC	24VDC (**D024**) SYSTEM VOLTAGE	NOT AVAILBLE	DC=1.6 W MAX
	with 1/2 NPT conduit entry	-HCC-XISC			
	Intrinsic Safe (ia) - ATEX II 2 G EEx ia IIC T4, to T6**				
	With PG9 cable gland, mini -DIN type connector	-HC-XISX6			
	with 1/2 NPT conduit entry	-HCC-XISX6			
MISC	Silencer/Dust Excluder For Solenoid Exhaust (Not Available For -XISC)	L14			

* Add option number to basic valve number as suffix

** Add coil code # to end of valve number

* Add option number to basic valve number as suffix.
See pages 26/27, 28/29 and 31 for complete description.

** The coil code is shown within the parenthesis following the voltage. Add desired coil code to end of valve number

NAMUR Actuator Speed Chart

This chart represents approximate actuator operation times under average load conditions at 80 psi (5.5 bar). Due to differing designs of quarter-turn actuators, breakaway friction, loading, internal airflow, inlet piping, fittings and exhaust port options, the values shown are intended as an estimate. Faster or slower times may actually be achieved.

		Actuator Volume in^3 (cm^3)									
	Valve Type	5 (82)	10 (164)	25 (410)	50 (820)	100 (1640)	150 (2460)	200 (3280)	400 (6560)	600 (9840)	1000 (16400)
ACTUATOR CYCLE TIME IN SECONDS	C5	.32	.36	.47	.63	.98	1.3	1.7	3.1	4.5	7.2
	E5	.46	.64	1.1	2.0	3.9	5.7	7.5	-	-	-
	C316	.19	.21	.25	.35	.55	.65	1.0	1.5	2.2	3.5

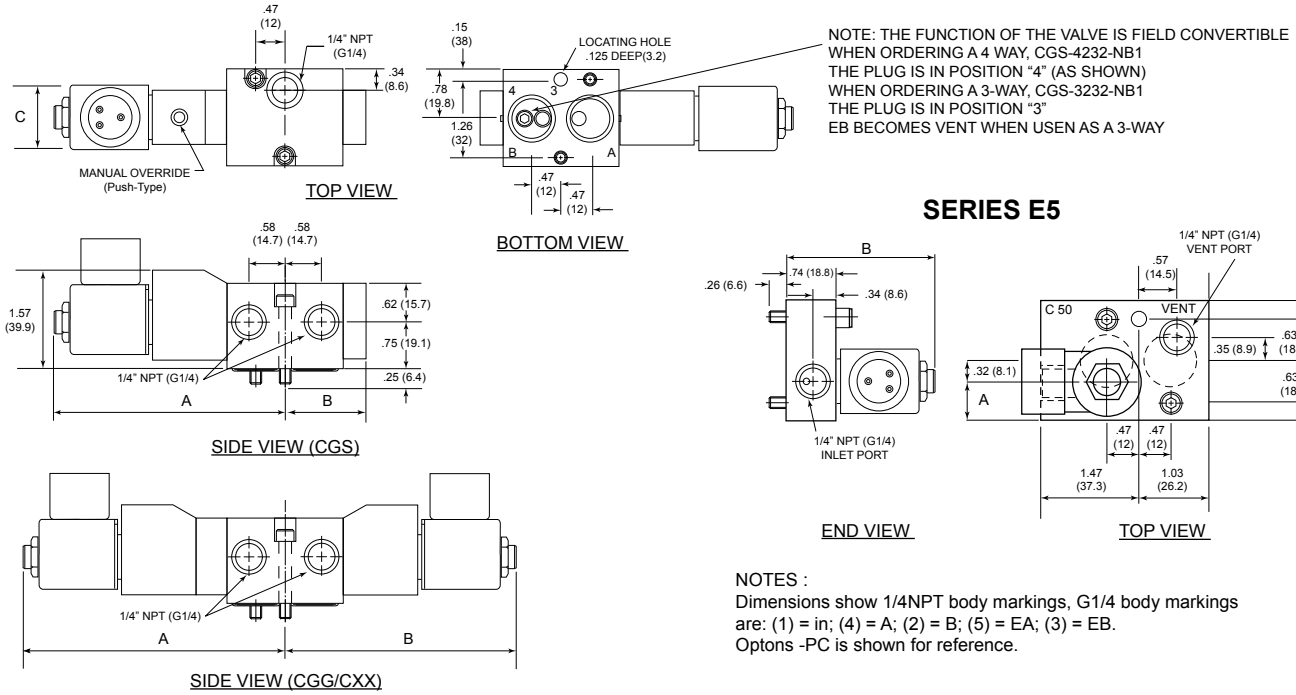
For double-acting actuators (open & close), use volume from selected actuator specifications and the chart for estimated speed. The times indicated are per shift. For spring return actuators, use open volume to obtain time from chart. Actuator spring loading may affect shift time. Slower speeds (adjustable) can always be accomplished by using Versa's Bleed Control Valves in the control valve exhaust port.

SERIES C5 & E5 NAMUR Dimensions

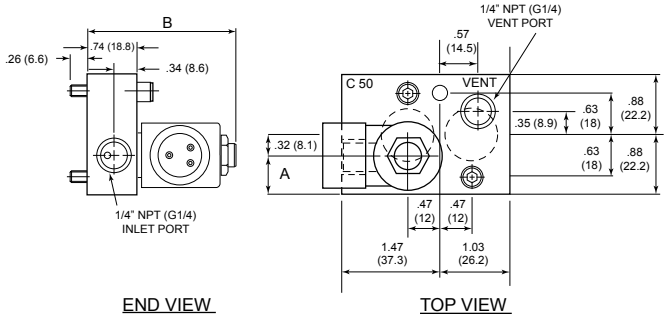
Shown as inch (mm)

Port markings shown are for valves with NPT threads. Port markings for valves with G threads are: (1) = IN; (2) = B; (3) = EB; (4) = A; (5) = EA. Option -PC is shown for reference.

SERIES C5



SERIES E5



NOTES :
Dimensions show 1/4NPT body markings, G1/4 body markings are: (1) = in; (4) = A; (2) = B; (5) = EA; (3) = EB.
Optons -PC is shown for reference.

E5 NAMUR DIMENSIONS: INCHES (mm)

Valve Type	Solenoid Option					
	STANDARD, -228L		-C50, -PC		-XX, -XN	
	A	B	A	B	A	B
E5	0.44 (11.2)	2.31 (58.7)	0.52 (13.2)	2.31 (58.7)	.73 (18.4)	2.39 (60.7)

C5 NAMUR DIMENSIONS: INCHES (mm)

Valve Type	Solenoid Options											
	Standard, -228L			C50, -PC			-XX, -XN			-XISC, -XISX6		
	A	B	C	A	B	C	A	B	C	A	B	C
CSG	3.71 (94.2)	1.31 (38.3)	.885 (22.5)	3.71 (94.2)	1.31 (33.3)	1.04 (26.4)	3.79 (96.3)	1.31 (33.3)	1.45 (36.8)	3.53 (89.7)	1.31 (33.3)	1.15 (29.2)
CGG/CXX	4.21 (106.9)	3.71 (94.2)	.885 (22.5)	4.21 (106.9)	3.71 (94.2)	1.04 (26.4)	4.29 (109.0)	3.79 (96.3)	1.45 (36.8)	4.03 (102.4)	3.53 (89.7)	1.15 (29.2)

DIRECT MOUNT ACTUATOR VALVES

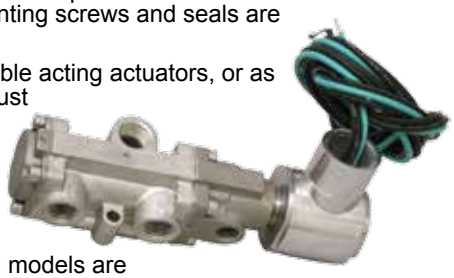
STAINLESS STEEL CONSTRUCTION

SERIES C316 NAMUR

Stainless Steel 3 or 4-Way Solenoid Valves

General Description

The Versa C316 Series stainless steel NAMUR mount actuator control valve is a high flow, bubbletight, 5 port solenoid valve. It is designed to mount directly to any NAMUR actuator, thus reducing actuator response time and space. Installed costs are also lower as the need for tubing, fittings, brackets and assembly labor are greatly reduced. All mounting screws and seals are included with the valve.



The 5-port design allows the C316 NAMUR valve to be ordered as either a 4-way for double acting actuators, or as a 3-way for spring return actuators. When the 3-way function is utilized, the unused exhaust port becomes an actuator vent where a filter/muffler can be installed to prevent contaminants from entering either the valve or the actuator. The 5-port design allows the user to independently control actuator speed in either open or close direction by utilizing speed or bleed controls. Single or double solenoid 2-position models are available. Single solenoid spring return models utilize an air assisted spring return feature, assuring a positive return. Double solenoid valves may be used in applications where a momentary signal is required or in a “fail in last shifted position” actuator application. Double solenoid models are equipped with a detent that maintains the valve in the last shifted position, even in high vibration applications. All solenoid actuators are solenoid/pilot type, which allows the use of smaller solenoids resulting in lower power consumption. This design assures a positive shift when the valve is energized and reduces the chance of coil burnout. Manual override for single or double solenoid valves is available as an option.

Materials

Valve Body, Actuating Caps & Internal Parts: 316L stainless steel
Valve Seals: FKM (fluorocarbon)
Screws: stainless steel
Solenoid Parts: 304, 430F & 302 stainless steel internal parts; coil/solenoid housing per solenoid option selected

Operating Pressure and Weights

Valve Type	*Operating Pressure Range Pneumatic	Approximate Weights		
		General Service	Hazardous Service	
			(-XX, -XN, -XIS_)	(-XMA_, -XIF_)
Single Solenoid-Spring Return	25 to 150 psi (1.8 to 10.3 bar)	1.3 lbs (590 gms)	1.6 lbs (725 gms)	2.5 lbs (1130 gms)
Double Solenoid	15 to 150 psi (1 to 10.3 bar)	1.9 lbs (860 gms)	2.6 lbs (1180 gms)	4.3 lbs (1950 gms)

* For applications above 125 psi (8.6 bar) exhaust flow controls or mufflers are recommended.

Porting Size

Inlet and Exhaust: 1/4 NPT
Cylinder Ports: O ring mount per NAMUR standard

Flow Rate

Cv = 1.6 (Kv = 23.5)

Actuator Speed

See chart on page 6 for approximate operation times under load conditions at 80 psi (5.5 bar).

Installation, Filtration and Lubrication

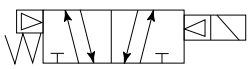
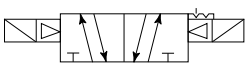
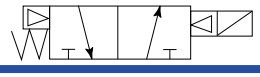
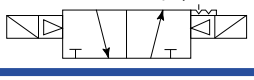
Valves have no limitation on mounting orientation.
40 to 50 micron filtration is recommended
Lubrication not required.
Ambient and media temperature range -5°F to 200°F (-20° to 93°C)
Low Temperature available consult factory.

Solenoid Options

See page 9

C316 NAMUR Valve

Product Number Selector

	Basic Valve Number*	
FUNCTION	SINGLE SOLENOID/SPRING RETURN, 2 POSITION	DOUBLE SOLENOID DETENT, 2 POSITION
4-way 5/2	CGS-4332-316-NE1 -†- (coil code) 	CGG-4332-316-NE1 -†- (coil code) 
3-way 3/2	CGS-3331-316-NE1 -†- (coil code) 	CGG-3331--316NE1 -†- (coil code) 

*All valves include O ring interface seals and #10-24 mounting screws. For #10-32 screws change NE1 to NE2. For M5 screws change NE1 to NE3.
† Add suffix option here if required.
See coil code page 9.

SERIES C316 NAMUR Solenoid Options

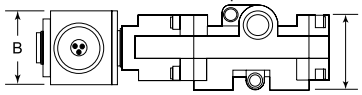
	Area Classification	Suffix Detail	Solenoid Housing Material	Common voltages (Coil Codes) All options available in all voltages, except where noted. Consult factory for other voltages.	NOMINAL COIL POWER AC/DC (watts)
GENERAL	**General Purpose**				
	1/2" NPT conduit, NEMA 1, 2, & 3*	None	Carbon Steel, Painted		6.0/7.0
	1/2" NPT conduit, watertight, NEMA 4 & 4X**	-PC	Carbon Steel, Electroless nickel plated		6.0/7.0
	Cord grip PG9 mini-DIN type connector, NEMA 4	-HC	Engineered polymer		6.5/10.5
	1/2" NPT conduit, mini-DIN type connector, NEMA 4	-HCC	Engineered polymer		6.5/10.5
	* For high temperature coil include -HT				
HAZARDOUS LOCATION	**Hazardous Location UL/CSA (NEMA 7& 9)**				
	Class I, Div 2 (A & B); Class I Div 1 (C & D); Class II Div 1 (E, F & G)				5.6/7.2
	1/2" NPT conduit entry, Basic standard	-XX	Carbon Steel, Electroless nickel plated		1.8/1/8
	with Low power 1.8W coil	-LB-XX	Carbon Steel, Electroless nickel plated		5.6/7.2
	with potted coil	-PC-XX	Carbon Steel, Electroless nickel plated		5.6/7.2
	with Stainless housing coil housing	-ST-XX	Stainless Steel		
	Flameproof (d) - ATEX IECEx EEx II 2 G IIB + H_2 T3 T6* Ex d Ex d IIB T3 to T6 Gb			12VDC **(D012)**	
	M20 x 1.5 conduit entry, Basic standard	-XN	Carbon Steel, Electroless nickel plated	24VDC **(D024)**	5.6/7.2
	with Low power 1.8W coil, T6	-LB-XN	Carbon Steel, Electroless nickel plated	48VDC **(D048)**	1.8/1/8
	with potted coil	-PC-XN	Carbon Steel, Electroless nickel plated	120V60 **(A120)** 110V50 **(E110)**	5.6/7.2
	with Stainless steel coil housing	-ST-XN	Stainless Steel	240V60 **(A240)** 220V50 **(E220)**	5.6/7.2
	with Flamproof Junction Box	-AJB-XN	-XN w/Aluminum Epoxy Coated Box		
	Flameproof (d) Increased Safety (e) - ATEX IECEx, CSA, INMETRO EX II 2 G D Ex d e IIC T* Gb EX tb IIIC T* °C Db EXd IIC DIP A21 T6 T4 Class I Div I Grp B, C & D Class I Div II Grp E, F & G				
	with M20 x 1.5 conduit entry	-XDBS †	Stainless Steel w/ Junction Box		0.85,1.8 & 4
	with 1/2" NPT conduit entry	-XDBT †	Stainless Steel w/ Junction Box		0.85,1.8 & 4
	Encapsulated (m), Increased Safety (e) Tight Dust (tD) - ATEX IECEx EEX II 2 G Ex e mb II T5 & T6 EEX II 2 D Ex tD A21 IP66/IP67 T100ºC,T85ºC Ex e mb II T5, T6 Gb Ex tD A21 IP66/IP67 T100ºC,T85ºC Db				
	M20 x 1.5 Conduit entry†	-XMAA	Engineered polymer		NA/4.0
	with 6-12mm ø cable gland†	-XMFA	Engineered polymer		NA/4.0
	1/2" NPT conduit entry†	-XMAF	Engineered polymer		NA/4.0
	with 9-16mm ø cable gland†	-XMFF	Engineered polymer		NA/4.0
	Intrinsically Safe FM/CSA Class I (Group A, B, C, D); Class II (Group E, F, G), CLASS III, DIV 1 **				NA/1.6
	With PG9 cable gland, mini -DIN type connector	-HC-XISC	Engineered polymer		NA/1.6
	with 1/2" NPT conduit entry	-HCC-XISC	Engineered polymer		
	Intrinsically Safe (ia) - ATEX II 2 G EEx ia IIC T4, to T6**				
	With PG9 cable gland, mini -DIN type connector	-HC-XISX6	Engineered polymer		NA/1.6
	with 1/2" NPT conduit entry	-HCC-XISX6	Engineered polymer		NA/1.6
	Intrinsically Safe (ia) - ATEX II 2 G EEx ia IIC T4, to T6				
	with M20 x 1.5 conduit entry	-XIFA	Engineered polymer		NA/0.8
	with 1/2" NPT conduit entry	-XIFF	Engineered polymer		NA/0.8
MISC	Manual Override, un-guarded push and hold (not available with all solenoid options)	-ME			
	Solenoid exhaust adapter, 1/8 NPT	-H2			
	Silencer/Dust Excluder for Solenoid Exhaust (not available -XISC or -XISX6)	-L14			

Notes
* For high temperature coil add , -HT (included in XMA_, XIF_)

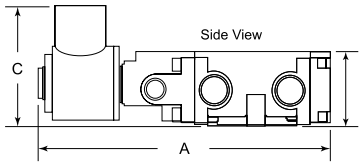
** 24 Volt DC Only

†For ordering information see "Miscellaneous" column page 27.

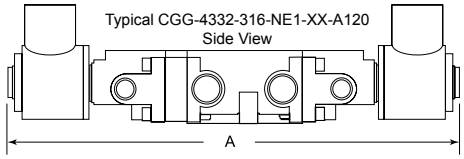
Typical CSG-4332-316-NE1-XMA-A120
Top View



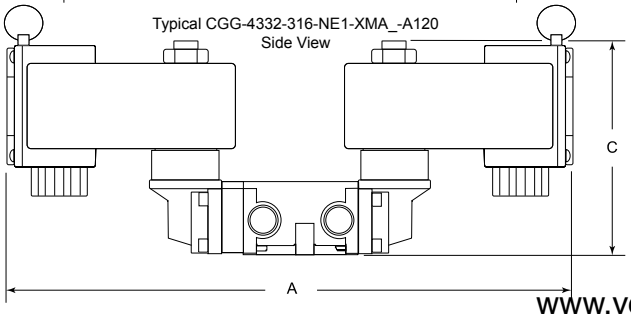
Side View



Typical CGG-4332-316-NE1-XX-A120
Side View



Typical CGG-4332-316-NE1-XMA_-A120
Side View



Dimensions

C316 NAMUR DIMENSIONS Valve Type		SOLENOID OPTIONS								
		GENERAL SERVICE			HAZARDOUS SERVICE (-XX, -XN, -XISC, -XISX6)			HAZARDOUS SERVICE (-XMA, -XIF)		
		A	B	C	A	B	C	A	B	C
Single solenoid, spring return 3-Way or 4-Way	Inches (mm)	5.62 (142.7)	1.44 (36.6)	2.33 (59.1)	5.67 (144)	1.44 (36.6)	2.33 (59.1)	6.59 (167.3)	2.56 (65)	4.27 (108.5)
Double solenoid 3-Way or 4-Way	Inches (mm)	8.70 (221)	1.44 (36.6)	2.33 (59.1)	8.79 (233.2)	1.44 (36.6)	2.33 (59.1)	10.6 (269.2)	2.56 (65)	4.27 (108.5)

For warranty information and/or any additional information with regards to installation, operation and service warnings, please consult factory.

BODYPORTED VALVES

ALUMINUM CONSTRUCTION

SERIES C5/C7 Bodyported
3-Way*/4-Way Solenoid Valves

General Description



Versa C5 and C7 valves are 5 port/2-position or 5 port/3-position, high flow, bodyported, solenoid/pilot valves. They can be provided with single or double solenoid actuators. Manual override (guarded-push to operate, turn to lock) is standard on all models. Other options are available. Actuator positioning is possible with the use of 3-position valves since all C5 and C7 valves are leak free/bubbletight.

The standard valve is supplied with DIN style coil, but other options are available making the most exacting and demanding specifications or applications easy to satisfy.

Materials

Valve Body and Plunger: anodized aluminum
Actuating Caps: solenoid – anodized aluminum
spring cap – synthetic resin
Pilot Piston: synthetic resin
Valve Seals: plunger and body – FKM (fluorocarbon)
pilot piston – NBR (nitrile)
Screws: Stainless steel
Solenoid Parts: sleeve, plunger & spring – 304 & 430F stainless steel
coils epoxy molded with 3 spade terminals (std) or 2 or 3 wire leads (opt)
coil cover (opt.-when applicable) zinc chromate plated steel

Valve Type	Size Series	Operating Pressure Range† Pneumatic	Approximate Weights	
			Ordinary Service	Hazardous Service
Single Solenoid/spring return (2-position)	C5	15-115 psi (1-8 bar)	0.5 lbs. (235 g)	0.8 lbs. (363 g)
	C7	25-115 psi (1.7-8 bar)	0.7 lbs. (300 g)	1.0 lbs. (454 g)
Double Solenoid/detented (2-position)	C5	10-115 psi (0.7-8 bar)	0.87 lbs. (395 g)	1.2 lbs. (545 g)
	C7	15-115 psi (1-8 bar)	1.0 lbs. (454 g)	1.3 lbs. (590 g)
Double Solenoid/spring centered (3-position)	C5	15-115 psi (1-8 bar)	0.87 lbs. (395 g)	1.2 lbs. (545 g)
	C7	25-115 psi (1.7-8 bar)	1.0 lbs. (454 g)	1.3 lbs. (590 g)

† Pressure ranges may change based on solenoid option. See page 6.

MPa = $\frac{\text{bar}}{10}$

For higher pressure applications, consult factory.

Porting Size

Inlet, outlet and exhaust – 1/8 NPT or G1/8-Series C5
1/4 NPT or G1/4-Series C7

Flow Rates (average for all ports)

Cv = 0.75 (Kv = 11) for 1/8 NPT (G1/8)-Series C5
Cv = 1.6 (Kv = 23) for 1/4 NPT (G1/4)-Series C7

Installation, Filtration and Lubrication

Valves have no limitations on mounting orientation.
40 to 50 micron filtration and general purpose lubricating oil ISO, ASTM viscosity grade 32 recommended.
Ambient temperature range 5°F (15°C) to 125°F (50°C).

Options Suffix

Manual Override: none Standard on basic valves, guarded-push to operate, turn to lock -
-CML unguarded-push to operate, twist to lock

For solenoid options see page 6 (same options utilized as Direct Mount Valves).

C5/C7 Bodyported Valve
Product Number Selector

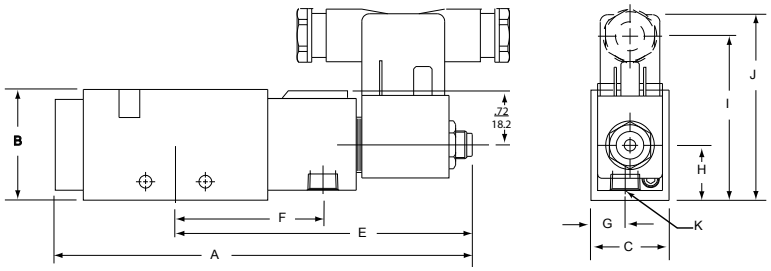
For coil code see page 6.

FUNCTION*	SIZE SERIES	PORT SIZE	Cv (Kv)	Basic Valve Number*			
				SINGLE SOLENOID/SPRING RETURN, 2 POSITION	DOUBLE SOLENOID/ DETENT, 2 POSITION	DOUBLE SOLENOID/SPRING CENTERED, 3 POSITION	
						Blocked Center	Exhaust Ports open
4-WAY 5/2 & 5/3	C5	1/8 NPT G1/8"	0.75 (11) 0.75 (11)	CSG-4222-†-(coil code) CSG-4282-†-(coil code)	CGG-4222-†-(coil code) CGG-4282-†-(coil code)	CXX-4223-†-(coil code) CXX-4283-†-(coil code)	CXX-4224-†-(coil code) CXX-4284-†-(coil code)
	C7	1/4" NPT G1/4	1.6 (23) 1.6 (23)	CSG-4322-†-(coil code) CSG-4382-†-(coil code)	CGG-4322-†-(coil code) CGG-4382-†-(coil code)	CXX-4323-†-(coil code) CXX-4383-†-(coil code)	CXX-4324-†-(coil code) CXX-4384-†-(coil code)

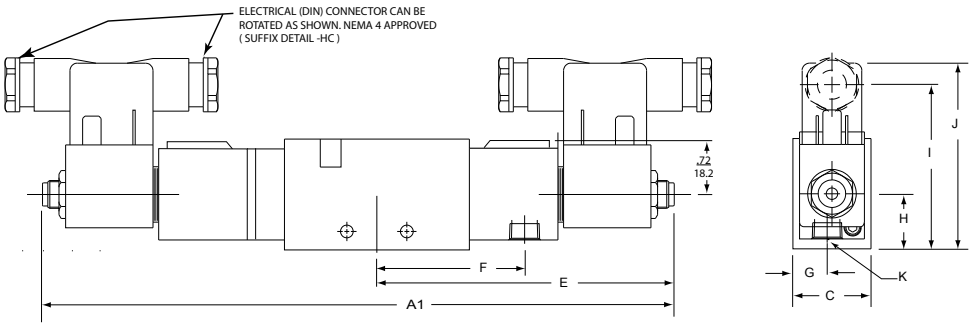
* 3-Way valve can be obtained by plugging one port of a 4-way. For 3-way NC plug port B (4); for 3-way NO plug port A (2).

† Add suffix here, if required.

Bodyported Series C5 & C7 Dimensions



5/2 SINGLE SOLENOID



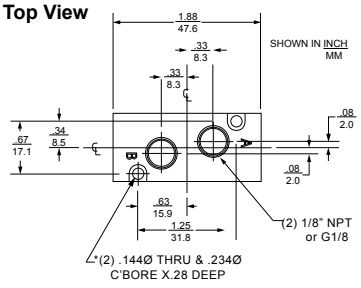
5/2 & 5/3 DOUBLE SOLENOID

Basic Valve Dimensions		A	A1	B	C	E	F	G	H	J	K	L
C5	inch	5.03	7.92	1.25	0.88	3.71	1.69	0.38	0.63	2.11	1/8" NPT	2.47
	mm	127.7	201.2	31.8	22.4	94.2	42.8	9.5	15.9	53.5	G1/8	62.8
C7	inch	5.65	8.55	1.50	1.06	4.02	2.00	0.47	0.75	2.23	1/4" NPT	2.52
	mm	143.6	217.1	38.1	27.0	102.2	50.8	11.8	19.1	56.7	G1/4	64.2

Four Way C5
Port and Mounting Holes Dimensions

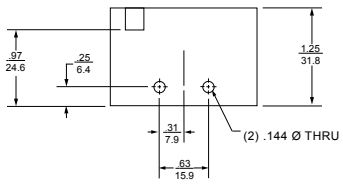
Valve body less right & left actuating caps shown.

Top View

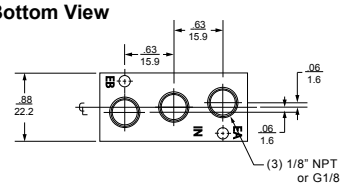


* (6-32SCREWS 1-1/4" LONG RECOMMENDED, PAS-0632-20)

Side View



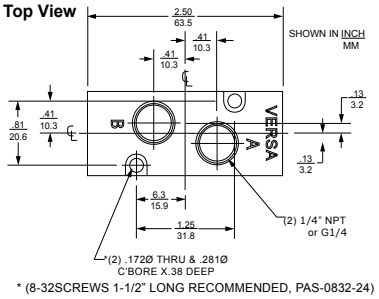
Bottom View



Four Way C7
Port and Mounting Holes Dimensions

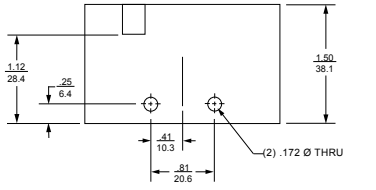
Valve body less right & left actuating caps shown.

Top View

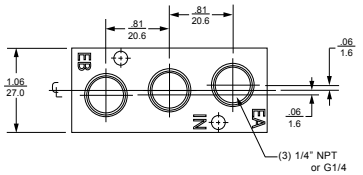


* (8-32SCREWS 1-1/2" LONG RECOMMENDED, PAS-0832-24)

Side View



Bottom View



NOTE: VALVES SUPPLIED WITH G THREADS HAVE PORTS MARKED AS FOLLOWS: IN=1, A=2, EA=3, B=4, EB=5

SERIES V Bodyported

3-Way & 4-Way Solenoid Valves

General Description



Versa Series V valves are full flow valves, available in 1/8, 1/4, 3/8, 1/2, 3/4 and 1" NPT port sizes. Ports of 1/8 to 1/2 ISO 228 "G" threads are also available. Three-way designs are provided with 3 ports; four-way designs have 5 ports. Each is available for 2-position or 3-position service. Standard size O ring seals provide bubbletight sealing and ease of service.

Each valve is solenoid/pilot actuated, which enables the use of physically small solenoids providing low power consumption, and also assures a strong positive shifting force without fear of coil burn-out. A complete selection of electrical connections, area classifications, and power requirements makes the most exacting and demanding specifications or applications easy to satisfy.

Materials

Valve body: forged brass
Actuating Caps: solenoid – forged brass
spring cap – diecast aluminum
Internal parts (wetted): rod brass
Valve seals: NBR (nitrile), standard size O rings
Screws: zinc plated steel
Solenoid parts: sleeve, plunger & spring – 304 & 430F and 302 stainless steel
coils epoxy molded with 2 or 3 wire leads (Std.)
coil cover (Std) – zinc chromate plated steel

Operating Pressures and Weights

Valve Type	Port Size	Operating Pressure Range† Pneumatic	Approximate Weights							
			Ordinary Service				Hazardous Service††			
			3-way		4-way		3-way		4-way	
			lbs.	kg	lbs.	kg	lbs.	kg	lbs.	kg
Single Solenoid/spring return (2-position)	1/8 or 1/4 3/8 or 1/2	40-175 psi (2.8-12 bar)	3.5 5.3	1.6 2.4	4.1 6.6	1.9 3.0	3.9 5.7	1.8 2.6	4.5 7.0	2.0 3.2
	3/4 or 1	50-175 psi (3.5-12 bar)	11.3	5.1	15.0	6.8	11.7	5.3	15.4	7.0
Double Solenoid/momentary contact (2-position)	1/8 or 1/4 3/8 or 1/2 3/4 or 1	20-175 psi (1.4-12 bar)	4.9 6.7 13.7	2.2 3.1 6.2	5.5 8.1 17.4	2.5 3.7 8.0	5.8 7.6 14.6	2.6 3.5 6.6	6.3 8.9 18.2	2.9 4.0 8.3
Double Solenoid/spring centered (3-position)	1/8 or 1/4 3/8 or 1/2	40-175 psi (2.8-12 bar)	5.8 7.6	2.7 5.0	6.3 8.9	2.9 4.0	6.7 8.5	3.1 5.4	7.1 9.7	3.2 4.4
	3/4 or 1	50-175 psi (3.5-12 bar)	17.5	7.9	21.2	9.6	18.3	8.3	22.0	10.0

†Pressure ranges may change based on solenoid option. See page 27. MPa = $\frac{\text{bar}}{10}$

†† Weights shown for hazardous service are for type -XX. For other suffix options consult factory.

Porting Size

Inlet, outlet and exhaust — 1/8" NPT, 1/4" NPT, 3/8" NPT, 1/2" NPT, 3/4" NPT, or 1" NPT. Or G1/8, G1/4, G3/8, G1/2 ISO 228.

Installation, Filtration and Lubrication

Valves have no limitations on mounting orientation.
40 to 50 micron filtration and general purpose lubricating oil ISO, ASTM viscosity grade 32 recommended.
Ambient temperature range -10°F (-23°C) to 200°F (95°C).

Flow Rates

Port Size	Average		Flow*	
	Cv Factor (all ports)	Kv Factor (all ports)	SCFM	Nm3/h
1/8" NPT or G1/8	1.4	20.3	80	145
1/4" NPT or G1/4	1.8	26.1	100	185
3/8" NPT or G3/8	3.4	49.3	200	345
1/2" NPT or G1/2	4.0	58.0	240	405
3/4" NPT	9.7	140.6	580	980
1" NPT	11.1	161.0	640	1125

* Assumptions:

Media = air
Inlet pressure = 100 psi (7 bar)
△P = 40 psi (3 bar)
Outlet abs = 74.7 psi (5 bar)
Temp = 68°F (20°C)
SG = 1.0

Series V Bodyported Valve **Product Number Selector**

Function	Port Size (NPT)*	Flow C_v	Flow (Kv)	Single Solenoid/Spring Return 2-position	Double Solenoid/ Momentary Contact 2-position	Double Solenoid/Spring Centered 3-position	
				BASIC VALVE NUMBER		Blocked Center	Exhaust Ports Open
3-way, 3/2 Normally Closed 3-way, 3/3 Three Position	1/8” 1/4” 3/8” 1/2” 3/4” 1”	1.4 1.8 3.4 4.0 9.7 11.1	(20.3) (26.1) (49.3) (58.0) (140.6) (161.0)	VSG-3221-U-(coil code) VSG-3321-U-(coil code) VSG-3421-U-(coil code) VSG-3521-U-(coil code) VSG-3621-U-(coil code) VSG-3721-U-(coil code)	VGG-3221-U-(coil code) VGG-3321-U-(coil code) VGG-3421-U-(coil code) VGG-3521-U-(coil code) VGG-3621-U-(coil code) VGG-3721-U-(coil code)	VXX-3223-U-(coil code) VXX-3323-U-(coil code) VXX-3423-U-(coil code) VXX-3523-U-(coil code) VXX-3623-U-(coil code) VXX-3723-U-(coil code)	---------
3-way, 3/2 Normally Open 3-way, 3/3 Three Position	1/8” 1/4” 3/8” 1/2” 3/4” 1”	1.4 1.8 3.4 4.0 9.7 11.1	(20.3) (26.1) (49.3) (58.0) (140.6) (161.0)	VGS-3222-U-(coil code) VGS-3322-U-(coil code) VGS-3422-U-(coil code) VGS-3522-U-(coil code) VGS-3622-U-(coil code) VGS-3722-U-(coil code)	SEE ABOVE	SEE ABOVE	---------
4-way, 5/2 & 5/3	1/8” 1/4” 3/8” 1/2” 3/4” 1”	1.4 1.8 3.4 4.0 9.7 11.1	(20.3) (26.1) (49.3) (58.0) (140.6) (161.0)	VSG-4222-U-(coil code) VSG-4322-U-(coil code) VSG-4422-U-(coil code) VSG-4522-U-(coil code) VSG-4622-U-(coil code) VSG-4722-U-(coil code)	VGG-4222-U-(coil code) VGG-4322-U-(coil code) VGG-4422-U-(coil code) VGG-4522-U-(coil code) VGG-4622-U-(coil code) VGG-4722-U-(coil code)	VXX-4223-U-(coil code) VXX-4323-U-(coil code) VXX-4423-U-(coil code) VXX-4523-U-(coil code) VXX-4623-U-(coil code) VXX-4723-U-(coil code)	VXX-4224-U-(coil code) VXX-4324-U-(coil code) VXX-4424-U-(coil code) VXX-4524-U-(coil code) VXX-4624-U-(coil code) VXX-4724-U-(coil code)

For coil code see page 27.

* Valves with ISO 228 “G” threads have same Cv (Kv) flow factors as corresponding NPT port sizes. To indicate model number of valves with “G” thread, add suffix “-2B” to basic valve number shown. For example: VSG-3221-U becomes VSG-3221-U-2B.

SERIES V BODYPORTED **SOLENOID OPTIONS**

(Consult page number indicated for complete description of desired option.)

Coil & Coil Housing - nonhazardous location

Suffix

none: Std coil & housing, (page 26/28)
-HT: Class H coil, (page 27, 30)
-HC or -HCC: DIN style coil & connector, (page 28, 30)
-PC: Potted coil, (page 28, 30)

Manual Override

Suffix

-G,-M or -M5R: (page 29)

Seals

Suffix

-155: FKM (fluorocarbon)

Voltage (coil code) -(page 27).

For other coil voltages consult factory.

Solenoid Operator - nonhazardous location

Suffix

none: Std coil & housing, (page 26-27, 28)
-HC or -HCC: DIN style coil and connector, (page 26-27, 28)

Solenoid Operator - hazardous location

Suffix

-LB: Low power (1.8 W) operator, (page 26/30)
-PC
-XX
-XN
-AJB-PS-XN
-XDAS, T
-XIFA, E, F
-HC-XISC, -HCC-XISC
-HC-XISX6, -HCC-XISX6
-XMAA, E, F, G
-XMFA, E, F, G

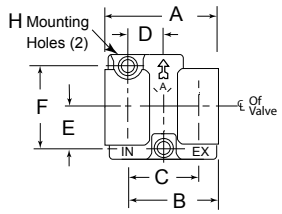
(page 26/30)

Misc - nonhazardous & hazardous

Suffix: -E14 Silencer/Dust Excluder For Solenoid Exhaust
-D14 Water & Dust Excluder / Silencer
(not available for -XISC or -XISX6)

BODYPORTED SERIES V Dimensions†

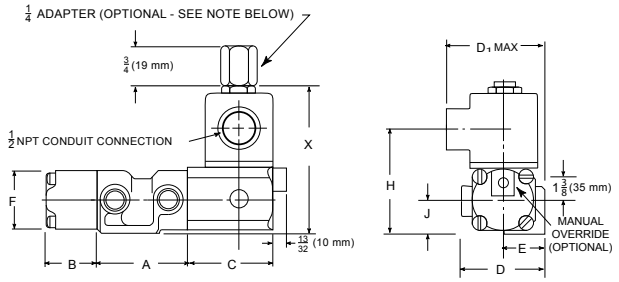
THREE-WAY



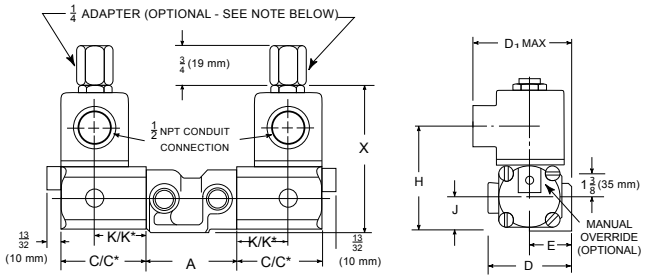
BODY DETAIL

Basic Valve Dimensions	A		B		C		D		E		F		HØ	
NPT or G	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
1/8 -1/4	2 3/16	56	1 3/4	44	1 5/16	33	21/32	17	51/64	20	1 19/32	40	.256	6.5
3/8 -1/2	3 3/4	95	2 7/8	73	2	51	1	25	1 1/8	29	2 1/4	57	.328	8
3/4 -1	5 1/2	140	4 1/4	108	3	76	1 1/2	38	1 9/16	40	3 1/8	79	.390	10

SINGLE SOLENOID



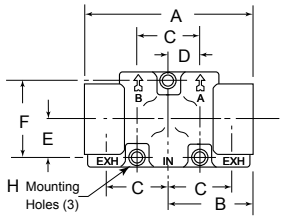
DOUBLE SOLENOID



Basic Valve Dimensions	A		B		C		C*		D1		D		E		F		H		J		K		K*		X	
NPT or G	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
1/8 - 1/4	2 3/16	56	1 7/32	31	2 3/32	53	3	76	2 1/2	64	2	51	1	25	1 1/2	38	2 19/32	66	13/16	21	1 9/32	33	2 3/16	56	3 13/16	97
3/8 - 1/2	3 3/4	95	1 7/32	31	2 3/32	53	3	76	2 7/8	73	2 3/4	70	1 3/8	35	1 11/16	43	2 21/32	67	7/8	22	1 9/32	33	2 3/16	56	3 7/8	98
3/4 - 1	5 1/2	140	2 1/16	52	2	51	3 15/32	88	3 3/8	86	3 3/4	95	1 7/8	48	2 7/16	62	3 29/32	99	1 1/4	32	1	25	2 1/2	64	5 5/32	131

*Dimensions for Spring-Centering Valves. NOTE: Adapter is supplied when specified by adding suffix "-H" to product number

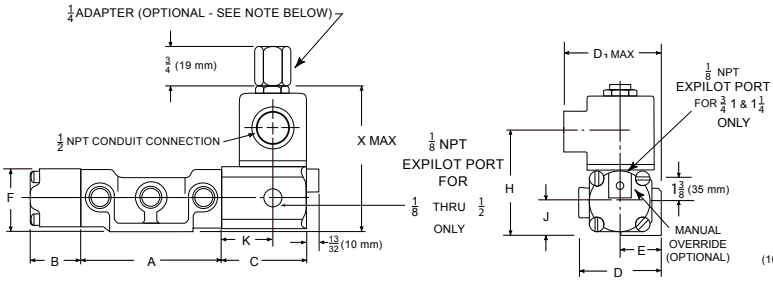
FOUR-WAY



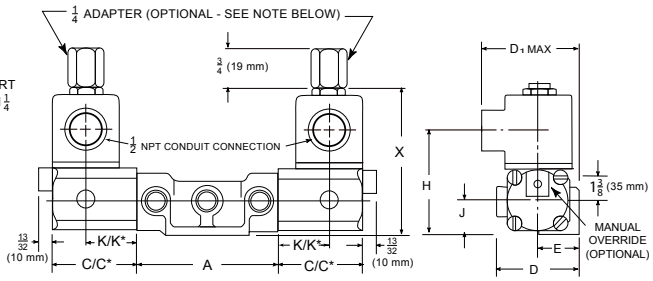
BODY DETAIL

Basic Valve Dimensions	A		B		C		D		E		F		HØ	
NPT or G	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
1/8 - 1/4	3 1/2	89	1 3/4	44	1 5/16	33	21/32	17	51/64	20	1 19/32	40	.256	6.5
3/8 - 1/2	5 3/4	146	2 7/8	73	2	51	1	25	1 1/8	29	2 1/4	57	.328	8
3/4 - 1	8 1/2	216	4 1/4	108	3	76	1 1/2	38	1 9/16	40	3 1/8	79	.390	10

SINGLE SOLENOID



DOUBLE SOLENOID



Basic Valve Dimensions	A		B		C		C*		D1		D		E		F		H		J		K		K*		X	
NPT or G	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
1/8 - 1/4	3 1/2	89	1 7/32	31	2 3/32	53	3	76	2 1/2	64	2	51	1	25	1 1/2	38	2 19/32	66	13/16	21	1 9/32	33	2 3/16	56	3 13/16	97
3/8 - 1/2	5 3/4	146	1 7/32	31	2 3/32	53	3	76	2 7/8	73	2 3/4	70	1 3/8	35	1 11/16	43	2 21/32	67	7/8	22	1 9/32	33	2 3/16	56	3 7/8	98
3/4 - 1	8 1/2	216	2 1/16	52	2	51	3 15/32	88	3 3/8	86	3 3/4	95	1 7/8	48	2 7/16	62	3 29/32	99	1 1/4	32	1	25	2 1/2	64	5 5/32	131

*Dimensions for Spring-Centering Valves. NOTE: Adapter is supplied when specified by adding suffix "-H" to product number

†Dimensions shown are for basic valve as listed on previous page. Some options may change the dimensions, for which consult factory.

3-WAY DIRECT SOLENOID VALVES

General Description

Two valve series, Series E and Series E5, comprise the direct actuated, 3 port/2 position valves. The main difference between the two series is physical size and weight, Series E being the greater of the two. Both series offer high reliability at low cost. Stainless steel construction provides the compatibility for use with many aggressive media and environments.

A variation of the valve type provides electrical quick exhaust valves. These valves function the same as a 3-way valve, but a larger capacity exhaust and rapid response to slight pressure differential during the de-energized portion of the cycle, results in a more rapid evacuation of the controlled device than would be expected with a standard 3-way valve.

Materials

Valve body, 430F stainless steel
Valve seals: Nitrile (Buna N)
Solenoid parts: sleeve, plunger & spring— 304, 430F and 302 stainless steel
coils—epoxy molded
coil cover (when applicable)—zinc chromate coated steel

Installation, Filtration and Lubrication

Valves have no limitations on mounting orientation.
40 to 50 micron filtration and general purpose lubricating oil ISO, ASTM viscosity grade 32 recommended.
Ambient temperature range 0°F (-18°C) to 180°F (82°C).

3-WAY DIRECT SOLENOID VALVE PRODUCT NUMBER SELECTOR

BASIC VALVE NUMBER
Single Solenoid/Spring Return, 2 Position

Function	Maximum Operating Pressure Differential†	Series E 1/8" NPT	Series E 1/4" NPT	Series E5 1/8" NPT	Flow Cv (Kv) Inlet	Flow Cv (Kv) Exhaust
3-Way, 3/2 Normally Closed Exhaust to Atmosphere (For Piped Exhaust add -H to ESM and -H2 to E5SM valve number)	150 psi (10.0 bar) 100 psi (6.9 bar) 75 psi (5.2 bar) 60 psi (4.1 bar) 50 psi (3.4 bar) 30 psi (2.1 bar) 20 psi (1.4 bar) Vacuum (AC only)	ESM-3201-34-* ESM-3201-44-* ESM-3201-66-* ---------- ESM-3201-86-* ---------- ESM-3201-126-* ESM-3201-166-*	ESM-3301-34-* ESM-3301-44-* ESM-3301-66-* ---------- ESM-3301-86-* ---------- ESM-3301-126-* ESM-3301-166-*	E5SM-3201-34-* E5SM-3201-44-* ---------- E5SM-3201-64 ---------- E5SM-3201-84-* ---------- ----------	.06 (.87) .106 (1.5) .21 (3.1) .21 (3.1) .26 (3.8) .26 (3.8) .56 (8.1) .79 (11.5)	.106 (1.5) .106 (1.5) .21 (3.1) .106 (1.5) .21 (3.1) .106 (1.5) .21 (3.1) .21 (3.1)
3-Way, 3/2 Normally Open Piped Exhaust	150 psi (10.0 bar) 125 psi (8.6 bar) 100 psi (6.9 bar) 100 psi (6.9 bar) 100 psi AC only (6.9 bar) 75 psi (5.2 bar) 75 psi (5.2 bar) 75 psi DC only (5.2 bar)	ESM-3202-43-H-* ---------- ESM-3202-44-H-* ESM-3202-84-H-* ---------- ESM-3202-66-H-* ESM-3202-86-H-* ----------	ESM-3302-43-H-* ---------- ESM-3302-44-H-* ESM-3302-84-H-* ---------- ESM-3302-66-H-* ESM-3302-86-H-* ----------	---------- E5SM-3202-33-H2-* ---------- ---------- E5SM-3202-44-H2-* ---------- ---------- E5SM-3202-44-H2-*	06 (.87) 06 (.87 .106 (1.5) .106 (1.5) .106 (1.5) .21 (3.1) .21 (3.1) 106 (1.5)	.106 (1.5) .06 (8.7) .106 (1.5) .26 (3.8) .106 (1.5) .21 (3.1) .26 (3.8) .106 (1.5)
3-Way, 3/2 Normally Closed QUICK EXHAUST	Operating Pressure† 5-150 psi (0.3-10 bar) 5-150 psi (0.3-10 bar) 5-100 psi (0.3-6.9 bar) 5-100 psi (0.3-6.9 bar)		1/4"NPT Inlet & Outlet 3/4"NPT Exhaust EQE-50403-316-* ---------- EQE-50604-316-* ----------	1/4"NPT Inlet & Outlet 3/8"NPT Exhaust ---------- E5QE-30303-316-* ---------- E5QE-30404-316-*	.06 (.87) .055 (.80) .106 (1.5) .075 (1.1)	8.8 (128) 3.3 (48) 8.8 (128) 3.3 (48)

† MPa = bar / 10 * Add coil code to valve number (page 27).

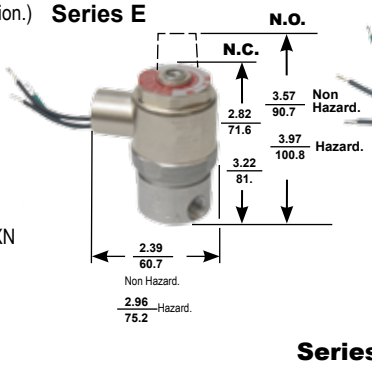
3-WAY DIRECT SOLENOID OPTIONS (Consult page number indicated for complete description of desired option.)

Series E Suffix	SOLENOID OPERATOR (nonhazardous location)	Series E5 Suffix
-HC or _HCC	DIN style coil & connector, (page 26/27, 28)	-HC or -HCC
-PC	Potted coil, (page 26/27, 28)	-PC
	SOLENOID OPERATOR - (hazardous location)	
----------		-LB-XX; -LB-XN
-XDBS* or T*		----------
-XX -XX	Flameproof (page 26/27 & 29)	-XX
----------		-XN
-PS-XX		-AJB-PS-XN
		-PC-XX
-XMAA, E, F or G	Encapsulation (page 26/27 & 29)	----------
-XMFA, E, F or G		----------
-XIFA, F	Intrinsically Safe (page 26/27,29)	-HC-XISC, -HCC-XISC -HC-XISX6, -HCC-XISX6
	MISCELLANEOUS	
-3	FKM (fluorocarbon) seals	-3
-HT	Class H coil (page 29, 30)	-HT
-M,-M5R,-MAE	Manual Override (page 29)	----------
-E14	Silencer/Dust Excluder for Solenoid Exhaust	-L14

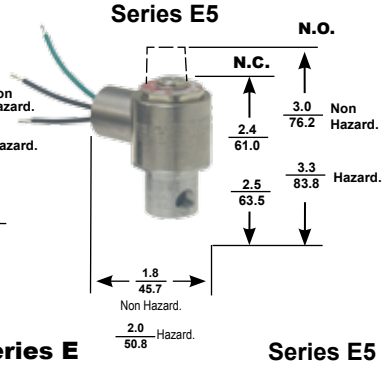
*For ordering information See "Miscellaneous" column page 27.

DIMENSIONS inches FOR BASIC VALVE
mm

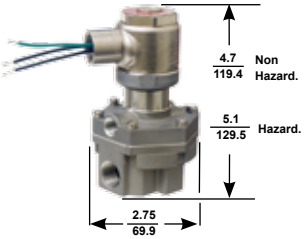
Series E



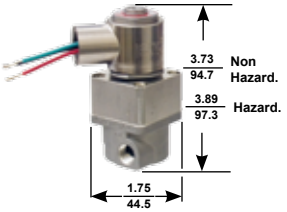
Series E5



Series E Quick Exhaust



Series E5 Quick Exhaust



SERIES C316 Bodyported
3-Way & 4-Way Solenoid Valves

General Description

Versa Series C316 stainless steel valve is a high flow, 3 or 5 port solenoid valve that utilizes a fluorocarbon elastomer seal packed plunger that provides bubbletight performance with long, trouble-free product life. The design also provides the highest flow in the smallest package. Stainless steel bodies, actuating caps and internal parts allow use in the most aggressive environments.

The C316 Series is available as 4-Way, for double acting devices, or 3-Way for spring return devices. The 3-Way function can be specified as either normally open or normally closed. All solenoid actuators are solenoid/pilot type, which allows the use of small solenoids resulting in low power consumption. Solenoid/pilots also provide a positive shifting force that assures the valve shifts, thus reducing the chance of coil burnout. Single solenoid-spring return models utilize an air assisted return feature assuring a positive return. Double solenoid models are equipped with a detent that maintains the valve in the last shifted position, even in high vibration environments. A complete selection of electrical connections, power requirements and area classifications makes the Versa C316 the valve of choice for demanding applications.

A Latching Reset option for single solenoid-spring return 3-Way & 4-Way valves is available for the C316 Series. With the loss of solenoid signal or pressure, the valve shifts closed and latches. The valve cannot be re-shifted until manually reset.

Materials

Valve body, actuating caps & internal parts: 316L stainless steel
Valve seals: FKM (fluorocarbon)
Screws: stainless steel
Solenoid internal parts: 304, 430F & 302 stainless steel
Coil/solenoid housing: per solenoid option selected



Operating Pressures & Weights

Valve Type	Operating Pressure Range Pneumatic	General Service	Hazardous Service (-XX, -XN, -XIS)	Hazardous Service (-XMA, -XIF)
Single Solenoid-Spring Return	25 to 150 psi (1.8 to 10.3 bar)	1.3 lbs (590 gms)*	1.6 lbs (725 gms)*	2.5 lbs (1130 gms)*
Single Solenoid-Latching 3-Way	25 to 150 psi (1.8 to 10.3 bar)	1.6 lbs (725 gms)*	1.9 lbs (860 gms)*	2.8 lbs (1270 gms)*
Double Solenoid-Detented	15 to 150 psi (1.0 to 10.3 bar)	1.9 lbs (860 gms)*	2.6 lbs (1180 gms)*	4.3 lbs (1950 gms)*

*Weights shown are for 3-Way valves. For 4-Way add 0.1 lbs (45 gms).

Porting Sizes
Inlet cylinder & exhaust: 1/4 NPT

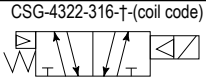
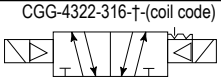
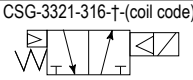
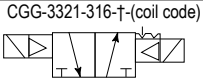
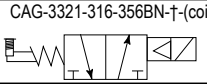
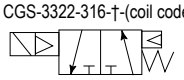
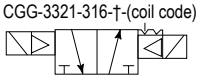
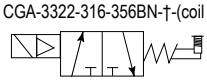
Flow Rate
Cv = 2.0 (Kv = 29.3)

Installation, Filtration and Lubrication
Valves have no limit on mounting orientation.
40 to 50 micron filtration is recommended
Lubrication not required
Ambient & media temperature range -5°F to 200°F (-20°to 93°C)

Options
See page 17

Series C316 BODYPORTED VALVE
Product Number Selector

Basic Valve Number

FUNCTION	SINGLE SOLENOID/SPRING RETURN, 2 POSITION	DOUBLE SOLENOID DETENT, 2 POSITION	LATCHING, SINGLE SOLENOID SPRING RETURN
4-Way 5/2	CSG-4322-316-†-(coil code) 	CGG-4322-316-†-(coil code) 	CAG-4322-316-356BN-†-(coil code) 
3-Way NC 3/2	CSG-3321-316-†-(coil code) 	CGG-3321-316-†-(coil code) 	CAG-3321-316-356BN-†-(coil code) 
3-Way NO 3/2	CGS-3322-316-†-(coil code) 	CGG-3321-316-†-(coil code) 	CGA-3322-316-356BN-†-(coil code) 

† Add suffix option here as required. See coil code below.

Series C316 Bodyported Solenoid Options

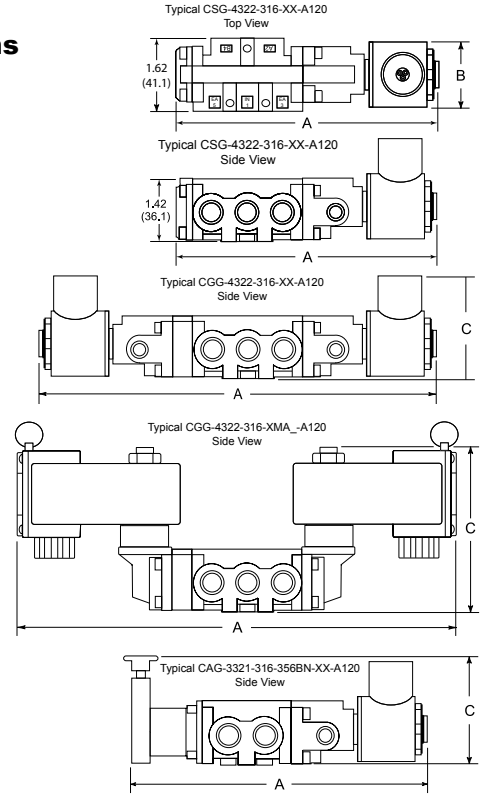
		Suffix Detail	Solenoid Housing Material	Voltages (Coil Codes) All options available in all voltages, except where noted. Consult factory for other voltages.	NOMINAL COIL POWER AC/DC (watts)
GENERAL	**General Purpose** 1/2" NPT conduit, NEMA 1, 2, & 3* 1/2" NPT conduit, watertight, NEMA 4 & 4X** Cord grip PG9 mini-DIN type connector, NEMA 4 1/2" NPT conduit, mini-DIN type connector, NEMA 4 * For high temperature coil include -HT	None -PC -HC -HCC	Carbon Steel, Painted Carbon Steel, Electroless nickel plated Engineered polymer Engineered polymer		6.0/7.0 6.0/7.0 6.5/10.5 6.5/10.5
HAZARDOUS LOCATION	Hazardous Location UL/CSA (NEMA 7& 9) Class I, Div 2 (A & B); Class I Div 1 (C & D); Class II Div 1 (E, F & G) 1/2" NPT conduit entry, Basic standard with Low power 1.8W coil with potted coil with Stainless housing coil housing	 -XX -LB-XX -PC-XX -ST-XX	 Carbon Steel, Electroless nickel plated Carbon Steel, Electroless nickel plated Carbon Steel, Electroless nickel plated Stainless Steel		 5.6/7.2 1.8/1/8 5.6/7.2 5.6/7.2
	Flameproof (d) - ATEX IECEx EEx II 2 G IIB + H_2 T3 T6* Ex d Ex d IIB T3 to T6 Gb M20 x 1.5 conduit entry, Basic standard with Low power 1.8W coil, T6 with potted coil with Stainless steel coil housing with Flamproof Junction Box	 -XN -LB-XN -PC-XN -ST-XN -AJB-XN	 Carbon Steel, Electroless nickel plated Carbon Steel, Electroless nickel plated Carbon Steel, Electroless nickel plated Stainless Steel -XN w/Aluminum Epoxy Coated Box	12VDC **(D012)** 24VDC **(D024)** 48VDC **(D048)** 120V60 **(A120)** 110V50 **(E110)** 220V50 **(E220)** 240V60 **(A240)**	 5.6/7.2 1.8/1/8 5.6/7.2 5.6/7.2
	Flameproof (d) Increased Safety (e) - ATEX IECEx, CSA, INMETRO EX II 2 G D Ex d e IIC T* Gb EX tb IIIC T* ºC Db EXd IIC DIP A21 T6 T4 Class I Div I Grp B, C & D Class I Div II Grp E, F & G with M20 x 1.5 conduit entry with 1/2" NPT conduit entry	 -XDBS† -XDBT†	 Stainless Steel w/ Junction Box Stainless Steel w/ Junction Box		 0.85,1.8 & 4 0.85,1.8 & 4
	Encapsulated (m), Increased Safety (e) Tight Dust (tD) - ATEX IECEx EEX II 2 G Ex e mb II T5 & T6 EEX II 2 D Ex tD A21 IP66/IP67 T100ºC,T85ºC Ex e mb II T5, T6 Gb Ex tD A21 IP66/IP67 T100ºC,T85ºC Db M20 x 1.5 Conduit entry† with 6-12mm ø cable gland† 1/2" NPT conduit entry† with 9-16mm ø cable gland†	 -XMAA -XMFA -XMAF -XMFF	 Engineered polymer Engineered polymer Engineered polymer Engineered polymer		 NA/4.0 NA/4.0 NA/4.0 NA/4.0
	Intrinsically Safe FM/CSA Class I (Group A, B, C, D); Class II (Group E, F, G), CLASS III, DIV 1 ** With PG9 cable gland, mini -DIN type connector with 1/2" NPT conduit entry	 -HC-XISC -HCC-XISC	 Engineered polymer Engineered polymer		 NA/1.6 NA/1.6
	Intrinsically Safe (ia) - ATEX II 2 G EEx ia IIC T4, to T6** With PG9 cable gland, mini -DIN type connector with 1/2" NPT conduit entry	 -HC-XISX6 -HCC-XISX6	 Engineered polymer Engineered polymer		 NA/1.6 NA/1.6
	Intrinsically Safe (ia) - ATEX II 2 G EEx ia IIC T4, to T6 with M20 x 1.5 conduit entry with 1/2" NPT conduit entry	 -XIFA -XIFF	 Engineered polymer Engineered polymer		 NA/0.8 NA/0.8
MISC	Manual Override, un-guarded push and hold (not available with all solenoid options) Solenoid exhaust adapter, 1/8 NPT Silencer/Dust Excluder for Solenoid Exhaust (not available -XISC or -XISX6)	-ME -H2 -L14			

Notes
* For high temperature coil add , -HT (included in XMA_, XIF_)
** 24 Volt DC Only
†For ordering information see "Miscellaneous" column page 27.

Dimensions

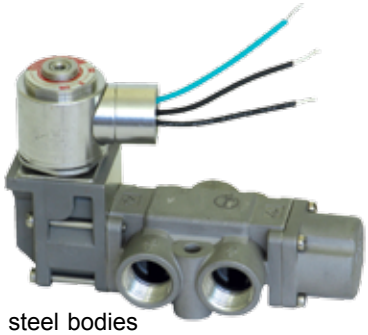
Dimensions		SOLENOID OPTIONS								
VALVE TYPE		GENERAL SERVICE			HAZARDOUS SERVICE (-XX, -XN, -XISC, -XISX6)			HAZARDOUS SERVICE (-XMA_, -XIF_)		
		A	B	C	A	B	C	A	B	C
3-Way Single Solenoid, Spring Return †	Inches (mm)	5.31 (135.0)	1.04 (26.4)	2.13 (54.2)	5.41 (137.5)	1.44 (36.6)	2.30 (58.5)	6.31 (160.3)	2.56 (65)	4.13 (104.8)
4-Way Single Solenoid, Spring Return †	Inches (mm)	5.81 (147.7)	1.04 (26.4)	2.13 (54.2)	5.91 (150.2)	1.44 (36.6)	2.30 (58.5)	6.81 (173.0)	2.56 (65)	4.13 (104.8)
3-Way Double Solenoid, Detented †	Inches (mm)	8.33 (211.6)	1.04 (26.4)	2.13 (54.2)	8.53 (216.8)	1.44 (36.6)	2.30 (58.5)	10.33 (262.4)	2.56 (65)	4.13 (104.8)
4-Way Double Solenoid, Detented †	Inches (mm)	8.83 (221.3)	1.04 (26.4)	2.13 (54.2)	9.03 (229.5)	1.44 (36.6)	2.30 (58.5)	10.83 (275.0)	2.56 (65)	4.13 (104.8)
3-Way Double Solenoid, Latching*	Inches (mm)	6.41 (162.9)	1.04 (26.4)	2.34 (59.4)	6.51 (165.5)	1.44 (36.6)	2.34 (59.4)	7.41 (188.2)	2.56 (65)	4.13 (104.8)

* Add 0.5" (12.7 mm) to "A" dimension for 4-Way Latch Valve. † For dimensions –XDA_ & XDB_ consult factory



SERIES V316 Bodyported
3-Way and 4-Way Solenoid Valves

General Description



Versa Series V316 valves are available in 1/4", 3/8", or 1/2" and 1" NPT port sizes. Three-way designs are provided with 3 ports; four-way valve 5 ports. Each is available for 2-position or 3- position service.

Investment cast 316 stainless steel bodies and actuating caps, coupled with 316 stainless steel internals makes this valve series compatible for use with aggressive media and environments.

Each valve is solenoid/pilot actuated, which enables the use of physically small solenoids and resultant low power consumption, and also assures a large positive shifting force without fear of coil burnout. A complete selection of electrical connections, area classifications, and power requirements makes the most exacting and demanding specifications or applications easy to satisfy

Materials

Valve Body, actuating caps, internal parts: 316 stainless steel
Valve Seals: FKM (fluorocarbon)
Screws: stainless steel
Solenoid Parts: sleeve, plunger & spring – 304, 430F and 302 stainless steel
coils—epoxy molded
coil cover (when applicable) – electroless nickel plated steel

Porting Sizes

Inlet, outlet, & exhaust: 1/4" NPT, 3/8" NPT, 1/2" or 1" NPT

Flow Rates (average for all ports)

1/4" NPT: C_V = 1.8 (K_V = 26)
3/8" NPT: C_V = 2.0 (K_V = 29)
1/2" NPT: C_V = 5.5 (K_V = 80)
1" NPT: C_V = 11.1 (K_V = 161)

Operating Pressures and Weights

Valve Type	Port Size	Operating Pressure Range† Pneumatic	Approximate Weights							
			Ordinary Service				Hazardous Service††			
			3-way		4-way		3-way		4-way	
			lbs.	kg	lbs.	kg	lbs.	kg	lbs.	kg
Single Solenoid/spring return (2-position)	1/4" & 3/8" & 1/2" NPT	40 - 175 psi (2.8 - 12 bar)	2.5 3.4	1.2 1.6	2.8 3.2	1.3 1.5	2.7 3.6	1.2 1.6	3.2 3.6	1.5 1.6
	1" NPT	50 - 175 psi (3.5 - 12 bar)	8.4	3.8	—	—	8.6	3.9	—	—
Double Solenoid/momentary contact (2-position)	1/4" & 3/8" & 1/2" NPT	20 - 175 psi (1.4-12 bar)	3.4 4.3	1.6 2.0	3.9 4.3	1.8 2.0	3.8 4.7	1.7 2.1	4.3 4.7	2.0 2.1
	1" NPT	20 - 175 psi (1.4 - 12 bar)	9.2	4.2	—	—	9.6	4.4	—	—
Double Solenoid/spring centered (3-position)	1/4" & 3/8" NPT 1/2" NPT	40-175 psi (2.8-12 bar)	3.5 5.0	1.6 2.3	4.0 5.0	1.8 2.3	3.9 5.4	1.8 2.5	4.4 5.4	2.0 2.5

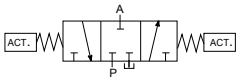
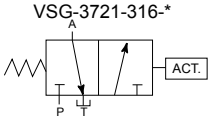
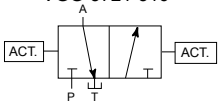
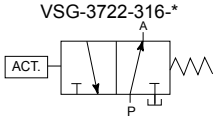
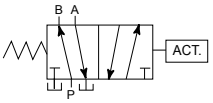
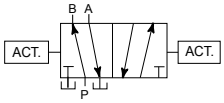
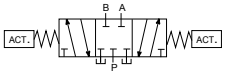
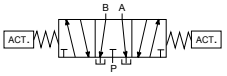
† Pressure range may change based on solenoid options. See page 27.
MPa = bar / 10

†† Weights shown for hazardous service are for -XX type. For other suffix options consult factory.

Installation, Filtration and Lubrication

Valves have no limitations on mounting orientation.
40 to 50 micron filtration and general purpose lubricating oil ISO, ASTM viscosity grade 32 recommended.
Ambient temperature range -10°F (-23°C) to 200°F (95°C).

Series V316 Bodyported Valve
Product Number Selector

Function	Port Size (NPT)*	Flow Cv	Flow (Kv)	BASIC VALVE NUMBER: Single Solenoid/Spring Return, 2-position	Double Solenoid/ Momentary Contact 2-position	Double Solenoid/Spring Centered 3-position: Blocked Center	Double Solenoid/Spring Centered 3-position: Exhaust Ports Open
3-Way, 3/2 Normally Closed	1/4"	1.8	(26)	VSG-3321-316-*	VGG-3321-316-*		----------
	3/8"	2.0	(29)	VSG-3421-316-*	VGG-3421-316-*		
	1/2"	5.5	(80)	VSG-3521-316-*	VGG-3521-316-*		
	1"	11.1	(161)	VSG-3721-316-*	VGG-3721-316-*		
3-Way, 3/3 Three Position	1/4"	1.8	(26)			VXX-3323-316-*	----------
	3/8"	2.0	(29)			VXX-3423-316-*	
	1/2"	5.5	(80)			VXX-3523-316-*	
3-Way, 3/2 Normally Open	1/4"	1.8	(26)	VGS-3322-316-*			
	3/8"	2.0	(29)	VGS-3422-316-*			
	1/2"	5.5	(80)	VGS-3522-316-*	SEE ABOVE	----------	----------
	1"	11.1	(161)	VGS-3722-316-*			
3-Way, 3/3 Three Position	1/4"	1.8	(26)		----------	SEE ABOVE	----------
	3/8"	2.0	(29)				
	1/2"	5.5	(80)				
4-Way, 5/2 & 5/3	1/4"	1.8	(26)	VSG-4322-316)-*	VGG-4322-316-*	VXX-4323-316-*	VXX-4324-316-*
	3/8"	2.0	(29)	VSG-4422-316)-*	VGG-4422-316-*	VXX-4423-316-*	VXX-4424-316-*
	1/2"	5.5	(80)	VSG-4522-316-*	VGG-4522-316-*	VXX-4523-316-*	VXX-4524-316-*
							

* Add coil code to valve number (page 27).

SERIES V316 BODYPORTED SOLENOID OPTIONS

(Consult page number indicated for complete description of desired option)

Coil & Coil Housing nonhazardous location

Suffix

none: Std coil & housing, (page 26/27, 28)
-HT: Class H coil, (page 29, 30)
-HC or -HCC: DIN style coil & connector, (page 26/27, 30)
-PC: Potted coil, (Page 30)

Manual Override

Suffix

-ME: Manual override (page 29)

Misc

Suffix

-L14: Silencer/Dust Excluder for Solenoid Exhaust (not available for -XISC or -XISX6)
D14: Water & Dust Excluder / Silencer

Solenoid Operator nonhazardous location

Suffix

none: Std coil & housing, (page 26/27, 28)
-HC or -HCC: DIN style coil and connector, (page 26/28)

Solenoid Operator - hazardous location

Suffix

-ST: Stainless steel coil cover (Page 30)
-LB-XX;-LB-XN Low power (1.8 W) operator, (page 26/30)
-XX
-PC-XX; -PC-XN
-XN
-AJB-PS-XN
-XDAS,T
-XIFA, F
-HC-XISC, -HCC-XISC
-HC-XISX6, -HCC-XISX6
-XMAA, E, F, G
-XMFA, E, F, G

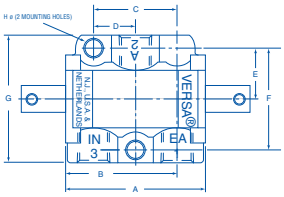
} (page 26/30)

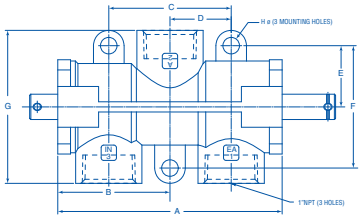
Voltage (coil code) - Nonhazardous location operators - (page 27)
Hazardous Location operators - (Page 26/29)
For other coil voltages consult factor.

STAINLESS STEEL CONSTRUCTION

BODYPORTED SERIES V316 Dimensions†

THREE-WAY

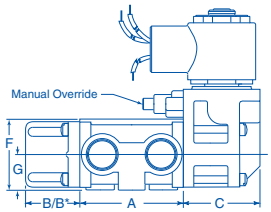


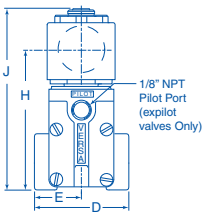


BODY DETAIL

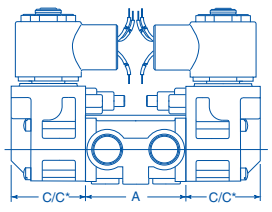
SIZE	A		B		C		D		E		F		G		H Ø	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
1/4" - 3/8"	2.19	56	1.75	45	1.31	33	0.66	17	.80	20	1.59	40	2	51	0.27	6.7
1/2"	2.84	95	2.08	52.8	1.31	33	0.66	17	.80	20	1.59	40	2.5	63.5	0.27	6.7
1"	5.5	140	3.25	82.6	3.0	76	1.5	38.1	1.5	40	3.0	6.2	3.38	85.7	0.4	1.2

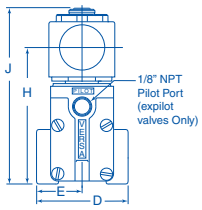
SINGLE SOLENOID





DOUBLE SOLENOID



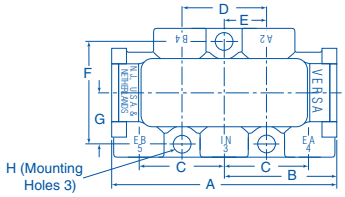


SIZE	A		B		B*		C		C*		D		E		F		G		H		J	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
1/4" - 3/8"	2.19	55.6	1.15	29.2	1.76	45.1	1.62	41.3	2.54	64.6	2	51	1.0	25.4	3.89	97.4	0.75	19.1	3.83	97.4	2.98	75.7
1/2"	2.84	72.1	1.15	29.2	1.76	45.1	1.62	41.3	2.54	64.6	2.5	63.5	1.25	31.8	3.89	97.4	0.75	19.1	3.83	97.4	2.98	75.7
1"	5.5	139.7	2.01	151	—	—	2.01	151	—	—	3.75	95.3	1.88	47.6	5.17	131.3	4.29	109	5.17	131.3	4.29	109

BASIC VALVE DIMENSIONS

*Dimensions for Spring-Centering Valves. NOTE: Adapter is supplied when specified by adding suffix "-H2" to product number.

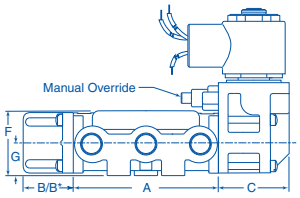
FOUR-WAY

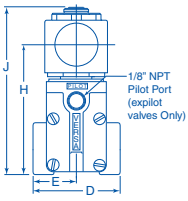


BODY DETAIL

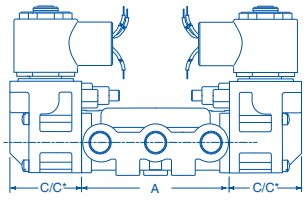
SIZE	A		B		C		D		E		F		G	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
1/4" - 3/8"	3.5	89	1.75	44.5	1.31	33.3	1.32	33.5	0.66	16.7	1.56	39.6	0.80	20.2
1/2"	4.0	101.6	2.0	51	1.31	33.3	1.32	33.5	0.66	16.7	1.56	39.6	0.80	20.2

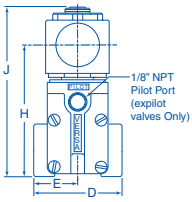
SINGLE SOLENOID





DOUBLE SOLENOID

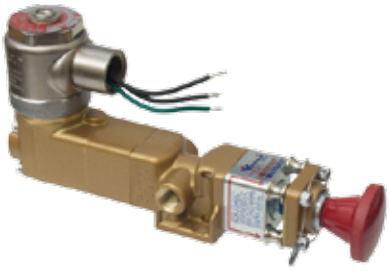




SIZE	A		B		B*		C		C*		D		E		F		G		H		J	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
1/4"- 3/8"	3.50	88.9	1.15	29.2	1.84	47	1.62	41.3	2.54	64.6	2	51	1.0	25.4	1.56	39.6	0.75	19	2.98	75.7	3.83	97.4
1/2"	4.0	101.6	1.15	29.2	1.84	47	1.62	41.3	2.54	64.6	2.5	63.5	1.25	31.8	1.56	39.6	0.75	19	2.98	75.7	3.83	97.4

*Dimensions for Spring-Centering Valves. NOTE: Adapter is supplied when specified by adding suffix "-H2" to product number.
†Dimensions shown are for basic valve as listed on previous page. Some options may change the dimensions, for which consult factory.

3-Way NC
Solenoid Operated/Spring Return
Lockout Valves



General Description

Versa 3-way normally closed Lockout Valves function the same as a solenoid operated-spring return valve, except that a means is provided to allow the valve to be physically locked with a padlock or hasp with padlock in order to prevent accidental actuation. Two types of lockout are available: one provides the ability for locking the valve in the de-energized position whereby the inlet is blocked and the exhaust is open; the other type provides the ability for locking in either the de-energized or energized position.

Types Available

	Series V	Series V316
Media:	Pneumatic Service	Pneumatic Service
Pressure: (minimum depends on valve size)	40 or 50 to 175 psi (2.8 or 3.5 - 12 bar)	40 to 175 psi (2.8 - 12 bar)
Construction Materials:	Forged & machined brass; NBR (nitrile) O ring seals	Investment cast & machined 316 stainless steel; FKM (fluorocarbon) seals
Functional Type:	3-way normally closed	3-way normally closed
Body Style:	Bodyported	Bodyported
Port Sizes & Flow:	1/8"NPT or G1/8 (C_V = 1.4, K_V =20.3) 1/4"NPT or G1/4 (C_V = 1.8, K_V =26.1) 3/8"NPT or G3/8 (C_V = 3.4, K_V =49.3) 1/2"NPT or G1/2 (C_V = 4.0, K_V =58.0) 3/4"NPT (C_V = 9.7, K_V =140.6) 1"NPT (C_V = 11.1, K_V =161.0)	1/4"NPT (C_V = 1.8, K_V = 26) 3/8"NPT (C_V = 2.0, K_V = 29) 1/2"NPT (C_V = 5.5, K_V = 80)
Actuation:	Solenoid/pilot-spring return for either Ordinary Service or Hazardous Service	Solenoid/pilot-spring return for either Ordinary Service or Hazardous Service.

Lockout Valves
Product Number Selector

FUNCTION	PORT SIZE	FLOW Cv	FLOW (kv)	Series V: LOCKOUT IN EXHAUST POSITION	Series V: LOCKOUT IN EITHER POSITION	Series V316: LOCKOUT IN EXHAUST POSITION	Series V316: LOCKOUT IN EITHER POSITION	OPERATING PRESSURE
3-Way NC	1/8" NPT**	1.4	(20.3)	VIA-3221-138-LOVB-*	VIA-3221-138-LOVE-*	----------	----------	40-175 psi (2.8-12 bar)
	1/4" NPT**	1.8	(26.1)	VIA-3321-138-LOVB-*	VIA-3321-138-LOVE-*			
	1/4" NPT	1.8	(26)			VIA-3321-316-138-LOVB-*	VIA-3321-316-138-LOVE-*	
	3/8" NPT**	3.4	(49.3)	VIA-3421-138-LOVB-*	VIA-3421-138-LOVE-*			
	3/8" NPT	2.0	(29)			VIA-3421-316-138-LOVB-*	VIA-3421-316-138-LOVE-*	
	1/2" NPT**	4.0	(58)	VIA-3521-138-LOVB-*	VIA-3521-138-LOVE-*			
	1/2" NPT	5.5	(80)			VIA-3521-316-138-LOVB-*	VIA-3521-316-138-LOVE-*	
	3/4" NPT	9.7	(140.6)	VIA-3621-138-LOVB-*	VIA-3621-138-LOVE-*	----------	----------	50-175 psi (3.5-12 bar)
	1" NPT	11.1	(161)	VIA-3721-138-LOVB-*	VIA-3721-138-LOVE-*	----------	----------	

* Add coil code to valve number (ordinary page 27; hazardous page 26/29).
** Valves with ISO 228 "G" threads are designated by utilizing Suffix "-2B" in model number

Options

Options available for Series V Lockout Valve are the same as listed on page 13.
Options available for Series V316 Lockout Valve are the same as listed on page 19.

Installation, Filtration and Lubrication

Valves have no limitations on mounting orientation.
40 to 50 micron filtration and general purpose lubricating oil ISO, ASTM viscosity grade 32 recommended.
Ambient temperature range -10°F (-23°C) to 200°F (95°C).

SPECIAL PURPOSE DUAL SOLENOID VALVES

BRASS OR **STAINLESS STEEL** **CONSTRUCTION**

Push Pull Solenoid Suffix-PPG



General Description

A dual solenoid valve with a hand lever. The design concept is to provide the functionality of a, dual coil, 2-position valve with the addition of manual control or any other actuator. The valve operates as standard 2-position requiring only momentary electrical contact to shift valve. Various manual actuators are available. The lever shown is a -"L" type which can be manually set in either offset position when the solenoid valve is de-energized.

Redundant Solenoid 2oo2, Suffix -RS



General Description

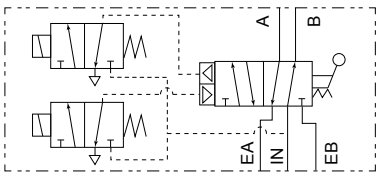
When parallel electronic control circuits are utilized in a system, if a complete control circuit fails or requires maintenance, the parallel circuit will keep the system running. In a parallel circuit Versa's Redundant Valve functions the same as a solenoid operated-spring return valve, except that it has two solenoids (one for each of the parallel circuits) rather than one solenoid. Either or both of these solenoids will shift and maintain the controlled device in the shifted position. Both solenoids must be de-energized to return the controlled device to the un-shifted position. The use of one Redundant Valve can replace multiple valves and components to accomplish the same function. This function can be considered as a (2oo2).

Shut off Valve 1oo2, Suffix -SOV

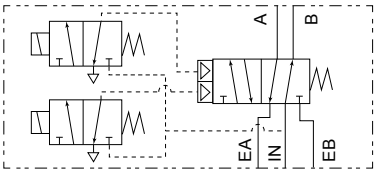


General Description

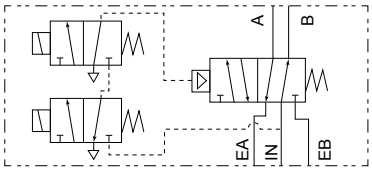
While the *Shut off Valve* looks similar to the *Redundant Solenoid Valve* (shown above) the internal pilot circuit is different. The -SOV option provides a series pilot control circuit that requires both coils, a primary and a secondary, to be energized in order for the valve to shift. Conversely if the electrical signal to either coil is removed the valve will return to the de-energized position. This function can be considered as a (1oo2). Where various control devices (e.g., temperature, pressure switches) could be wired in series with each coil. The actuation of any one of these devices, attached to either coil, would interrupt the signal to the coil and cause the valve to shift to the de-energized position.



-PPG Flow Schematic



-RS Flow Schematic



-SOV Flow Schematic

Types Available	SERIES V	SERIES 316
Media:	Pneumatic Service	Pneumatic Service
Pressure:	50 to 175 psi (3.5 to 12 bar)†	40 to 175 psi (2.8 to 12 bar)†
Construction Material:	Forged & machined brass; NBR (nitrile) O ring seals	Investment cast & machined 316 stainless steel, FKM (fluorocarbon) seals
Functional Types:	3-way, normally closed 4-way, 2 position	3-way, normally closed 4-way, 2 position
Port Sizes & Flow:	1/8" NPT or G1/8 (Cv=1.4,Kv=20.3) 1/4" NPT or G1/4 (Cv=1.8,Kv=26.1) 3/8" NPT or G3/8 (Cv=3.4,Kv=49.3) 1/2" NPT or G1/2 (Cv=4.0,Kv=58.0)	1/4" NPT (Cv=1.8,Kv=26 3/8" NPT (Cv=2.0,Kv=29) 1/2" NPT (Cv=5.5,Kv=80)
Actuation:	Solenoid/pilot-spring return (2 solenoids per valve), for either ordinary or hazardous service.	Solenoid/pilot-spring return (2 solenoids per valve), for either ordinary or hazardous service.

SPECIAL PURPOSE DUAL SOLENOID VALVES
How to specify SPECIAL PURPOSE DUAL SOLENOID VALVES

V SA - 3 5 2 1 - 316 - RS (OPTIONS)

V = V Series brass or stainless steel. See page 12 for Series V, page 18 for Series V316.

LA = -PPG with Lever
IA = -PPG with Button
AA = -PPG with Latch, see page 25

SA = -RS -SOV with Spring Return
AA = -RS -SOV with Latch, see page 25

3 = Three-way
4 = Four-way

2 = 1/8"NPT (Series V**)
3 = 1/4"NPT (Series V**) or V316)
4 = 3/8"NPT (Series V**) or V316)
5 = 1/2"NPT (Series V**) or V316)

2 = Threaded sideports-INPilot solenoid: no auxiliary pilot required.

1 = 3-way NC
2 = 3-way NO, 4-way/2-position
3 = 4-way/3-position (blocked center)
4 = 4-way/3-position (exhaust ports open in center)

Add "316" for stainless steel valves. Leave blank for brass

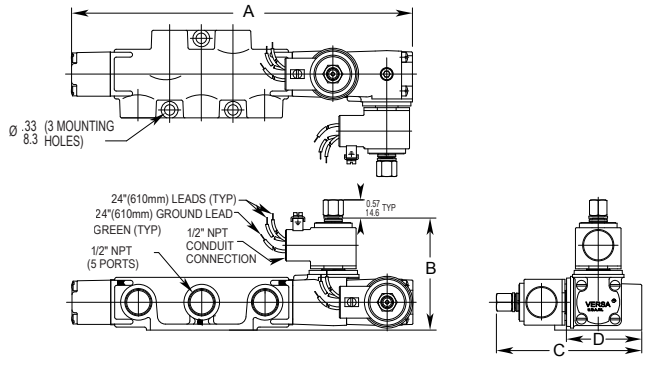
SPECIAL PURPOSE DUAL SOLENOID VALVES SUFFIX -RS -SOV -PPG

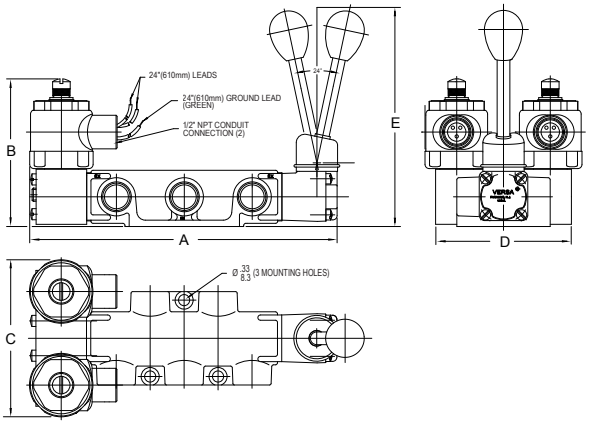
OPTIONS (Refer to pages 26 -29, 31 for specific certifications, standards & classifications, approvals, protective codes and voltage codes.)

** Valves with ISO 228 "G" Threads are designated by utilizing suffix "-2B" in model number.

Installation, Filtration And Lubrication Valves have no limitations on mounting orientation. 40 to 50 micron filtration and general purpose lubricating oil ISO, ASTM viscosity grade 32 recommended. Ambient temperature range -10°F (-23°C) to 200°F (95°C).

Dimensions





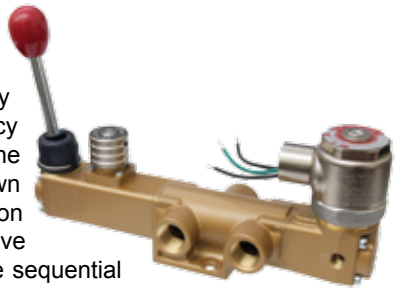
		SIZE		A	B†	C†	D
RS or SOV	3 WAY	1/8 & 1/4	in	7.2	3.45	3.66	2
			mm	183	88	93	51
		3/8 & 1/2	in	8.78	3.43	4.18	2.76
			mm	223	87.2	106.1	70
	4 WAY	1/8 & 1/4	in	8.50	3.45	3.66	2
			mm	216	88	93	51
		3/8 & 1/2	in	10.75	3.50	4.02	2.76
			mm	273	89	102	70

		SIZE	A	B†	C†	D	E
PPG	3 WAY	1/8 &	5.49	3.80	1.30	2.0	6.37
		1/4	139	96.6	96.6	50.8	162
		3/8 &	7.05	4.35	4.62	2.75	6.45
		1/2	179	110.4	117.4	69.9	163.9
	4 WAY	1/8 &	6.81	3.80	4.62	2.0	6.37
		1/4	173	96.6	117.4	50.8	161.9
		3/8 &	9.05	4.35	4.62	2.75	6.45
		1/2	230	110.4	117.4	69.9	163.9

† Dimensions listed are for -XX type hazardous service solenoids. For dimensions with other hazardous service solenoids that can be applied, consult factory. Dimensions for standard non-hazardous service solenoids will be slightly less than those listed.

LATCHING/MANUAL RESET VALVES

BRASS OR **STAINLESS STEEL** **CONSTRUCTION**



General Description

Latching valves are particularly suited to applications where it is desirable or mandatory to manually reset or restart a system. A typical application could involve the emergency shutdown of automatically monitored process operations. Loss or interruption of the control signal to the valve actuator causes the valve to shift, latch and shut-down a process step. When the signal is restored the valve remains in the latched position until the operator manually unlatches it and allows the process step to resume. Positive latching in such an application is vitally important since many process operations are sequential and one step must not be started until the one ahead of it has started.

This example is only one of many which can be accommodated through the use of Versa's Latching Valves. A wide range of functional types, port sizes, actuators, and latching arrangements provide the engineer with a complete choice of valving to suit his particular needs.

Types Available	Series V	Series V316
Media	Pneumatic; others, consult factory.	Pneumatic and various other gases, including corrosives.
Pressure: (minimum depends on size and type)	20 or 55 to 175 psi (1.4 or 3.8 to 12 bar)	20 or 55 to 175 psi (1.4 or 3.8 to 12 bar)
Construction Materials	Forged & machined brass; NBR (nitrile) O ring seals	Investment cast & machined 316 stainless steel; FKM (fluorocarbon) seals
Functional Type	3-way normally closed 3-way normally open 3-way 3-position 4-way 2 & 3 position	3-way normally closed 3-way normally open 3-way 3-position 4-way 2 & 3 position
Body Style	Bodyported	Bodyported
Port Sizes & Flow	1/8" NPT or G1/8 (Cv = 1.4, Kv = 20.3) 1/4" NPT or G1/4 (Cv = 1.8, Kv = 26.1) 3/8" NPT or G3/8 (Cv = 3.4, Kv = 49.3) 1/2" NPT or G1/2 (Cv = 4.0, Kv = 58.0) 3/4" NPT (Cv = 9.7, Kv = 140.6) 1" NPT (Cv =11.1, Kv = 161.0)	1/4" NPT (Cv = 1.8, Kv = 26) 3/8" NPT (Cv = 2.0, Kv = 29) 1/2" NPT (Cv = 5.5, Kv = 80)
Actuation	Solenoid/pilot for either ordinary service or hazardous service.	Solenoid/pilot for either ordinary service or hazardous service.

Latching/Reset Devices For Series V or V316 Valves

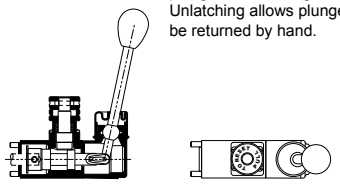
The Latching Device actuator consists of the latch, with or without an integral spring for returning the valve plunger, and an inline hand operator where needed to manually shift the valve.

The specific Latching Device may be attached to any Series "V" valve body size or style up to 1" NPT or any Series V316 valve body up to 1/2" NPT, as indicated for the type of latching/reset device required. The actuator on the opposite end of the valve body would be a solenoid/pilot device.

LATCHES IN ACTUATED POSITION

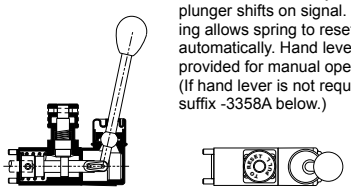
Suffix "-181B"

Latches automatically when plunger shifts on signal. Unlatching allows plunger to be returned by hand.



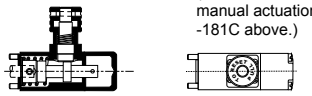
Suffix "-181C"

Latches automatically when plunger shifts on signal. Unlatching allows spring to reset plunger automatically. Hand lever provided for manual operation. (If hand lever is not required see suffix -3358A below.)



Suffix "-3358A"

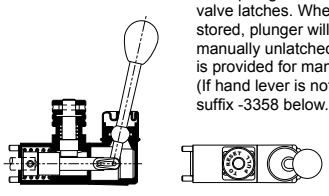
Latches automatically when plunger shifts on signal. Unlatching allows spring to reset plunger automatically. (If hand lever is required for manual actuation see suffix -181C above.)



LATCHES IN UN-ACTUATED POSITION

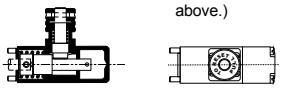
Suffix "-181D"

Unlatching allows plunger to shift on signal. If signal is lost, spring shifts plunger automatically and valve latches. When signal is re-stored, plunger will not shift until manually unlatched. Hand lever is provided for manual operation. (If hand lever is not required see suffix -3358 below.)



Suffix "-3358"

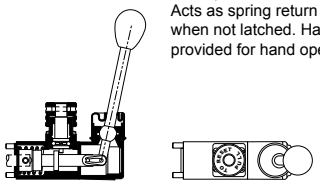
Unlatching allows plunger to shift on signal. Spring returns plunger automatically and valve latches. (If hand lever is required for manual actuation see suffix -181D above.)



LATCHES IN EITHER POSITION

Suffix "-181AA"

(2 position latch) Valve may be manually latched in either offset position or left unlatched. Acts as spring return valve when not latched. Hand lever is provided for hand operation.



How to specify LATCHING/RESET VALVES

V AG - 3 5 2 1 - 181B - (OPTIONS)

V = Pneumatic service: nominal 20 to 175 psi (1.4 - 12 bar); pressure range may vary depending upon specific valve type. See page 12 for Series V, page 18 for Series V316.

AG=Solenoid/pilot operated for 3-way NC or 4-way
GA=Solenoid/pilot operated for 3-way NO

3 = Three-way
4 = Four-way

2 = 1/8"NPT (Series V*)
3 = 1/4"NPT (Series V* or V316)
4 = 3/8"NPT (Series V* or V316)
5 = 1/2"NPT (Series V* or V316)
6 = 3/4"NPT (Series V)
7 = 1"NPT (Series V)

2 = Threaded sideports-INPilot solenoid: no auxiliary pilot required.

1 = 3-way NC
2 = 3-way NO, 4-way/2-position
3 = 4-way/3-position (blocked center)
4 = 4-way/3-position (exhaust ports open in center)

Locking Reset Device (refer to page 22 for specific device required)	Series V	Series V316
	181AA	316-181AAE
	181AB	316-181ABE
	181B	316-181B
	181C	316-181C
	181D	316-181D
	3358	316-3358
	3358A	316-3358A

OPTIONS	Series V	Series V316	
Electrical Connection/Coil Cover	-HC	-HC	
	-HCC	-HCC	
Seals	-11		
	-155		
Solenoids for Hazardous Service	-XX	-XX	
	-3567	-LB,XX	
	-XN	-XN	Flameproof
	-AJB-PS-XN	-AJB-PS-XN	
	-XDAS, T	-XDAS, T	
	-LB,-XN	-LB,XN	
	-XMAA, E, F, G	-XMAA, E, F, G	Encapsulation
	-XMFA, E, F, G	-XMFA, E, F, G	
	-HC-XISC	-HC-XISC	Intrinsically safe
	-HCC-XISC	-HCC-XISC	
	-HC-XISX6	-HC-XISX6	
	-HCC-XISX6	-HCC-XISX6	
	-XIFA, F	-XIFA, F	
Options for Special Conditions	-3	-----	Florocarbon
	-PS	-PC	NEMA 4
	-HT	-HT	High Temperature
	-G,-M,-M5R	-ME	Overrides
	-TR50-ST	-ST	Stainless Steel
	-E14	-L14	Dust Excluders

OPTIONS (Refer to pages 26 to 31 for specific certifications, standards & classifications, approvals, and protective codes.)
Voltage (coil code) See page 27
*Valves with ISO 228 "G" Threads are designated by utilizing suffix "-2B" in model number.
Installation, Filtration And Lubrication Valves have no limitations on mounting orientation. 40 to 50 micron filtration and general purpose lubricating oil ISO, ASTM viscosity grade 32 recommended. Ambient temperature range -10°F (-23°C) to 200°F (95°C).

SOLENOID PILOT – ELECTRICAL OPERATOR SPECIFICATIONS

Solenoid/Pilot actuated valves are available with a variety of different solenoids for both nonhazardous and hazardous locations. Basic details of actuators for hazardous locations are listed below. Details for nonhazardous location actuators are listed on pages 26-27. For additional data consult factory. Product numbers and other details may be found on the appropriate pages for each specific valve type and series

NONHAZARDOUS LOCATION SOLENOIDS (Inline or upright style)

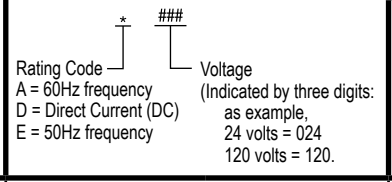
	Suffix Identification	Protection Classification	Area Classification and (Gas Grouping)	Certification- (Conformance)	Ingress Protection	
	None or -U	General Purpose	Indoor & Outdoor	CSA	NEMA 1,2,3	
	-HC -HCC (Shown)	General Purpose	Indoor & Outdoor	CSA	NEMA 4; IP65	

HAZARDOUS LOCATION SOLENOIDS

	Suffix Identification	Protection Classification	Area Classification and (Gas Grouping)	Certification- (Conformance)	Ingress Protection	
	-XX -LB-XX	Hazardous Locations	CLASS I, DIV. 1 (C & D) CLASS I, DIV. 2 (A & B) CLASS II, DIV. 1 (E, F & G)	UL - CSA	NEMA 7 & 9	
	-XN -LB-XN	(d) Flameproof	Ex d IIB+H2 T3 to T6 Gb II 2 G Ex d IIB+H2 T3 to T6	IECEx ATEX	P66 & IP68	
	-XDBS* -XDBT*	(d) Flameproof (e) Increased Safety	EX II 2 G D Ex d e IIC T* Gb EX tb IIIC T* ºC Db Class I Div I Grp B, C & D Class I Div II Grp E, F & G EX d IIC DIP A21 T6 T4	ATEX ATEX - IECEx -INMETRO CSA	IP66, IP67, & IP68 NEMA 4, 4X 6P	
***For ordering information see "Miscellaneous" column page 27**						
	-XMAA -XMAE -XMAF -XMFA -XMFE -XMFF	(mb) Encapsulation (e) Increased Safety (tD) Tight Dust	Ex e mb II T5, T6 Gb Ex tD A21 T100ºC, T85ºC Db II 2 G Ex e mb II T5, T6 II 2D Ex tD A21 T100ºC, T85ºC	IECEx ATEX	IP66 & IP67	
	-XIFA -XIFE -XIFF	(ia) Intrinsic Safe	Ex (ia) IIC T4...T6 Gb Ex (ia) IIIC T130ºC, T80ºC Db II 2 G Ex ia IIC T4...T6 II 2 D Ex iaD 21 T130ºC, T80ºC	IECEx ATEX	IP66 & IP67	
	-XISX6		II 2 G EEx ia IIC T6	ATEX	IP65	
	-XISC	Intrinsic Safe	Class I, Groups (A, B, C & D) Class II, Groups (E, F, &G) Class III	Factory Mutual CSA		

*For XDAS or XDAT consult factory

PRODUCT NUMBER COIL CODES: Complete product numbers require, when applicable, a coil code that represents the desired coil current, frequency and voltage. The coil code takes the form shown below, with ratings and voltage substituted as required.



Voltage (Power)	Electrical Characteristics	Miscellaneous
All usual 50 Hz & 60 Hz AC (7.3W) All usual DC (9.5W)	Class F epoxy molded coil (155ºC). Continuous duty, 2 leads 24" (60 cm).	Steel cover with 1/2 NPT conduit entry.
24V60, 120V60, 240V60 (8.5W) 24V50, 110V50, 220V50 (8.5W) 12VDC, 24VDC, 48VDC (10.5W)	Class F epoxy molded coil (155ºC), with 3 spade terminals and mini DIN socket with PG9 cable gland. Continuous duty.	

Voltage (Power)	Electrical Characteristics	Miscellaneous
All usual 50 Hz & 60 Hz AC (5.6W) All usual DC (7.2W)	Class F epoxy molded coil (155ºC). continuous duty. 3 leads 24" (60 cm).	Plated steel coil housing with 1/2 NPT conduit entry. For stainless steel (182FM) coil housing add: (-ST)
12V60, 24V60, 48V60, 120V60, 240V60 (1.8W) 6VDC, 12VDC, 24VDC, 48VDC (1.8W)		Plated steel coil housing with 1/2 NPT conduit entry. For stainless steel (182FM) coil housing add: (-ST) Maximum pilot pressure 120 psi (8 bar). 1.8W nominal power.
All usual 50 Hz & 60 Hz AC (5.6W) All usual DC (7.2W)		Plated steel coil housing with M20 x 1.5 conduit entry. Ground terminal on cover. For stainless steel (182FM) coil housing add: (-ST)
12V60, 24V60, 48V60, 120V60, 240V60 (1.8W) 6VDC, 12VDC, 24VDC, 48VDC (1.8W)		Steel chromate coated coil housing with M20 x 1.5 conduit entry. Ground terminal on cover. For stainless steel (182FM) coil housing add: (-ST) Maximum pilot pressure 120 psi (8 bar) 1.8W nominal power.
24VDC (D024) 120V60 (A120) 110V50 (E110) 230V50 (E230) 1.8 Watt standard, for lower watt contact factory.	Epoxy molded coils rated for continuous duty, Class H – 180°C.	Stainless steel coil housing with internal Junction Box. Internal and external ground screw.
24VDC (4W) (Consult factory for other voltage options)	Continuous duty coil & rectifier, including surge suppression, potted within housing.	Thick wall epoxy coil housing with integral junction box. Internal ground terminal. M20 x 1.5 conduit entry: (-XMAA), (-XMFA), Cable gland for 6-12 mm ø cable: (-XMAE), (-XMFE) 1/2 NPT conduit entry with adapter: (-XMAF), (-XMFF)
24VDC (10W inrush, 2.6W holding) (Consult factory for other voltages)	Continuous duty coil & power controller potted within housing.	
24VDC (0.8W) (Consult factory for other voltages)	Continuous duty Coil and power controller potted within housing.	Requires the use of an approved safety barrier or isolator. Thick wall epoxy coil housing and integral junction box. Internal ground terminal. M20 x 1.5 conduit entry: (-XIFA) Cable gland for 6-12 mm ø cable: (-XIFE) 1/2 NPT conduit entry with adapter: (-XIFF)
24VDC system voltage prior to barrier (1.6 watt max.)	Class F epoxy molded coil (155ºC). Continuous duty.	Requires the use of an approved barrier or isolator. Maximum operating system voltage before barrier 28VDC. Maximum pilot pressure 115 psi (8 bar). 3 spade terminals & DIN connector with PG9 cable gland: (-HC) 1/2 NPT conduit entry: (-HCC)

Stainless steel coil housing with internal Junction Box. Internal and external ground screw.	Suffix Detail Ordering Code			
	M 20 Connection		½" Connection	
	No Diode	Diode	No Diode	Diode
Standard (vent to atmosphere)	XDBS1	XDBS5	XDBT1	XDBT5
1/8" Adapter (-H2E)	XDBS2	XDBS6	XDBT2	XDBT6
1/4" Adapter (-H2)	XDBS3	XDBS7	XDBT3	XDBT7
Dust Nut (-L14)	XDBS4	XDBS8	XDBT4	XDBT8

OPTIONS AVAILABILITY CHART

Solenoid Options - Nonhazardous Location

		VALVE SERIES								
		NAMUR C5	NAMUR E5	NAMUR C316	C5/C7	E	E5	V	C316	V316
	1/2" NPT Conduit entry, NEMA 1,2,3	-C50	-C50	std	-C50	std	std	std	std	std
	1/2" NPT Conduit entry, Potted coil NEMA 4 & 4X, 11, 12, 13.	-PC	-PC	-PC	-PC	-PC	-PC	-PC	-PC	-PC
	1/2" NPT Conduit Integrally Molded Coil & Conduit Entry, NEMA 4/IP65.	-228L	-228L	n/a	-228L	n/a	n/a	n/a	n/a	n/a
	3 Spade Terminals, for use with mini DIN connector	std	std	n/a	std	n/a	n/a	n/a	n/a	n/a
	Mini DIN Connector with PG9 cord grip, NEMA 4.	-HC	-HC	-HC	-HC	-HC	-HC	-HC	-HC	-HC
	Mini DIN Connector with 1/2" NPT conduit entry, NEMA 4.	-HCC	-HCC	-HCC	-HCC	-HCC	-HCC	-HCC	-HCC	-HCC

Solenoid Options - hazardous Location

	VALVE SERIES								
	NAMUR C5	NAMUR E5	NAMUR 316	C5/C7	E	E5	V	C316	V316
1/2" NPT Conduit entry, NEMA 7 & 9, UL & CSA.	-XX	-XX	-XX	-XX	-XX	-XX	-XX	-XX	-XX
M20 x 1.5 Conduit entry, (d) Flameproof, IP66, T4, ATEX	-XN	-XN	-XN	-XN	n/a	-XN	-XN	-XN	-XN
Stainless steel (182 FM) coil cover for Hazardous Location Options: -XX -XN	-ST -ST	-ST -ST	-ST -ST	--ST -ST	n/a n/a	-ST -ST	-TR50-ST -ST	-ST -ST	--ST -ST
 Potted Coil (female threaded conduit connection) for Hazardous Location options, NEMA 4X, 11, 12, 13: -XX -XN	-PC -PC	-PC -PC	-PC -PC	-PC -PC	n/a n/a	-PC -PC	-TR50-PC -PC	-PC -PC	-PC -PC
Potted Coil (male threaded conduit connection) for-XX Hazardous Location options, NEMA 4X, 11, 12, 13.	n/a	n/a	n/a	n/a	-PS	n/a	-PS	n/a	n/a
LOW WATT (1.8W) Solenoid: For -XX Hazardous Location option; NEMA 7 & 9, UL & CSA. For -XN Hazardous Location option; T6, ATEX.	LB-XX -LB-XN	-LB-XX -LB-XN	-LB-XX -LB-XN	-LB-XX -LB-XN	n/a n/a	-LB-XX -LB-XN	3567 -LB-XN	-LB-XX -LB-XN	-LB-XX -LB-XN

Solenoid Options - Hazardous Location Cont.

		VALVES SERIES								
		NAMUR		NAMUR	C5/C7	E	E5	V	C316	V316
		C5	E5	C316						
	(e) Increased Safety (d) Flameproof **ATEX:** EX II 2 G D Ex d e IIC T* Gb	n/a	n/a	-XDBS*	n/a	-XDBS*	n/a	-XDBS*	-XDBS*	-XDBS*
	IEC/EX: EX tb IIIC T* °C Db EXd IIC DIP A21 T6 T4	n/a	n/a	-XDBT*	n/a	-XDBT*	n/a	-XDBT*	-XDBT*	-XDBT*
	CSA: CI Div I Grp B, C & D CI Div II Grp E, F & G									
	(e) Increased Safety	n/a	n/a	-XMAA	n/a	-XMAA	n/a	n/a	-XMAA	-XMAA
	(m) Encapsulated	n/a	n/a		n/a	-XMAE	n/a	-XMAE	--	-XMAE
	(tD) Dust Tight	n/a	n/a	-XMAF	n/a	-XMAF	n/a	-XMAF	-XMAF	-XMAF
	IECEx Ex e Ex mb, Ex tD	n/a	n/a	--	n/a	-XMAG	n/a	-XMAG	--	-XMAG
	Ex e mb II T5, T6 Gb Ex tD A21 T100ºC, 85ºC	n/a	n/a	-XMFA	n/a	- XMFA	n/a	-XMFA	-XMFA	-XMFA
	ATEX EEX	n/a	n/a	--	n/a	-XMFE	n/a	-XMFE		-XMFE
	II 2 G Ex e mb II T5, T6	n/a	n/a	-XMFF	n/a	-XMFF	n/a	-XMFF	-XMFF	-XMFF
	Ex tD A21 T100ºC, 85ºC	n/a	n/a	--	n/a	-XMFG	n/a	-XMFG	--	-XMFG
	(ia) Intrinsic Safe	n/a	n/a	-XIFA	n/a	-XIFA	n/a	-XIFA	-XIFA	-XIFA
	ATEX EEx	n/a	n/a	--	n/a	-XIFE	n/a	-XIFE	--	-XIFE
	II 2 G EEx ia IIC T4, T5	n/a	n/a	-XIFF	n/a	-XIFF	n/a	-XIFF	-XIFF	-XIFF
	Factory Mutual & CSA Class I, Groups (A, B, C, D) Class II, Groups (E, F & G) Class III, Division 1	-HC-XISC -HCC-XISC	n/a n/a	-HC-XISC -HCC-XISC	-HC-XISC -HCC-XISC	n/a n/a	-HC-XISC -HCC-XISC	-HC-XISC -HCC-XISC	-HC-XISC -HCC-XISC	-HC-XISC -HCC-XISC
	(ia) Intrinsic Safe **ATEX** EEx II 2 G EEx ia IIC T4, T5	n/a n/a	n/a n/a	-HC-XISX6 -HCC-XISX6	-HC-XISX6 -HCC-XISX6	n/a n/a	-HC-XISX6 -HCC-XISX6	-HC-XISX6 -HCC-XISX6	-HC-XISX6 -HCC-XISX6	-HC-XISX6 -HCC-XISX6

* For ordering information see "Miscellaneous" column page 27.
For -XDAS and -XDAT consult factory for specifications.

Miscellaneous Options

		VALVE SERIES								
		NAMUR C5	NAMUR E5	NAMUR C316	C5/C7	E	E5	V	C316	V316
Manual Override	(Manually pressurizes pilot of solenoid/ pilot actuator)									
	-CML: Unguarded locking type; push to operate and turn to lock.	—	—	-ME	—	-MAE	—	-M	-ME	-ME
	-G: Guarded manual override -MAE: Unguarded, manual override -ME: Unguarded type; push & hold to operate.	-CML	—	—	-CML	-M5R	—	-M5R	—	—
	-M5R: Unguarded locking manual override with a knurled knob, push to actuate and turn to lock.	G	—	—	G	-M	—	-G	—	—
Low Temperature Service	-EP: Ethylene-Propylene Seals	—	-EP	—	—	-EP	-EP	-EP	—	-EP
	-44: Low Temperature.	-44	-44	-44	-44	-44	-44	-44	-44	-44
Coil Options	-L14: Silencer/Dust Excluder	-L14	-L14	-L14	-L14	-E14	-L14	-E14	-L14	-L14
	-D14: Water & Dust Excluder / Silencer	-D14	-D14	-D14	-D14	D14	-D14	-D14	-D14	-D14
Natural Gas Service	–NGS: The standard V-316 Series product is rated for air and gas service including natural gas. Versa recommends suffix detail –NGS for enhanced performance	—	—	std	–NGS	std	std	–NGS	std	–NGS
	-NGST: For low temperature applications.			-NGST	-NGST			-NGST	-NGST	-NGST
Stainless Steel Tag	P- 2002-16-NV28A: Stainless Steel Tag part number Two configrations: 1) Two lines of text, up to 20 characters.	Yes	Yes	Yes	Yes	—	—	Yes	Yes	Yes
	2) Two lines, one line is text, the sencond is squental numbering. 20 characters per line. Consult factory for ordering details.									

MISCELLANEOUS INFORMATION

Hazardous Location Combination Suffix Details

Cross Reference Chart

Suffix Reference	
Suffix	Description
-XX	North American solenoid
-XN	ATEX solenoid
-XDB	World Solenoid
-HT	Class H coil
-ST	Stainless solenoid housing
-PC	Potted coil
-LB	1.8 watt solenoid
-LA	0.85 watt solenoid
-VJBT	Add on Junction Box
-D14	Solenoid vent, water proof nut
-PS	Potted coil, male conduit
-CD	72” wire leads
-LX	1.8 watt solenoid
-H2E	1/8” npt solenoid vent
-HE	¼” npt solenoid vent
-L14	solenoid vent dust nut
-303D	Integral diode

North American (-XX)	
Combination Suffix	Included Suffix
-XXA	-XX, -HT
-XXA4	-XX, -D14, -HT
-XXB	-XX, -PS
-XXB4	-XX, -D14, -PS
-XXC	-XX, -HT, -PS
-XXC4	-XX, -D14, -HT, -PS
-XXD	-XX, -ST
-XXD4	-XX, -D14, -ST
-XXE	-XX, -PC, -ST
-XXE4	-XX, -D14, -PC, -ST
-XXF	-XX, -HT, -ST
-XXF4	-XX, -D14, -HT, -ST
-XXG	-XX, -LB, -ST
-XXG4	-XX, -D14, -LB, -ST
-XXH	-XX, -HT, -PC, -ST

North American (-XX) (Cont.)	
Combination Suffix	Included Suffix
-XXH4	-XX, -D14, -HT, -PC, -ST
-XXJ	-XX, -LB, -PC, -ST
-XXJ4	-XX, -D14, -LB, -PC, -ST
-XXK	-XX, -HT, -LB, -PC, -ST
-XXK4	-XX, -D14, -HT, -LB, -PC, -ST
-XXL	-XX, -PC
-XXL4	-XX, -D14, -PC
-XXM	-XX, -HT, -PC
-XXM4	-XX, -D14, -HT, -PC
-XXN	-XX, -LB, -PC
-XXN4	-XX, -D14, -LB, -PC
-XXP	-XX, -HT, -LB, -PC
-XXP4	-XX, -D14, -HT, -LB, -PC
-XXQ	-XX, -HT, -LB
-XXQ4	-XX, -D14, -HT, -LB
-XXR	-XX, -LB
-XXR4	-XX, -D14, -LB
-XXS	-XX, -LA, -ST
-XXS4	-XX, -D14, -LA, -ST
-XXU	-XX, -HT, -LB, -ST
-XXU4	-XX, -D14, -HT, -LB, -ST
-XXV	-XX, -LA
-XXV4	-XX, -D14, -LA
-XXW	-XX, -CD, -HT, -H2, -PC, -ST
-XXW4	-XX, -D14, -CD, -HT, -PC, -ST

ATEX (XN)	
Combination Suffix	Included Suffix
-XNA	-XN, -HT
-XND	-XN, -ST
-XNE	-XN, -PC, -ST
-XNF	-XN, -HT, -ST
-XNG	-XN, -LB, -ST
-XNH	-XN-HT, -PC, -ST
-XNJ	-XN, -LB, -PC, -ST
-XNK	-XN, -HT, -LB, -PC, -ST

ATEX (XN) (Cont.)	
Combination Suffix	Included Suffix
-XNL	-XN, -PC
-XNM	-XN, -HT, -PC
-XNN	-XN, -LB, -PC
-XNP	-XN, -HT, -LB, -PC
-XNQ	-XN, -HT, -LB
-XNR	-XN, -LB
-XNS	-XN, -LA, -ST
-XNU	-XN, -HT, -LB, -ST
-XNV	-XN, -LA
-XNX	-XN, -LB, -PS
-XNWS	-XN, -VJBT, -LB, -PS
-XXK4	-XX, -D14, -HT, -LB, -PC, -ST

World Solenoid (XDB)	
Combination Suffix	Included Suffix
-XDBS1	-XDBS, -HT, -LX
-XDBS2	-XDBS, -HT, -LX, -H2E
-XDBS3	-XDBS, -HT, -LX, -HE
-XDBS4	-XDBS, -HT, -LX, -L14
-XDBS5	-XDBS, -HT, -LX, -303D
-XDBS6	-XDBS, -HT, -LX, -H2E, -303D
-XDBS7	-XDBS, -HT, -LX, -HE, -303D
-XDBS8	-XDBS, -HT, -LX, -L14, -303D
-XDBS9	-XDBS, -HT, -LX, -D14
-XDBS10	-XDBS,-HT,-LX,-D14, -303D
-XDBT1	-XDBT, -HT, -LX
-XDBT2	-XDBT, -HT, -LX, -H2E
-XDBT3	-XDBT, -HT, -LX, -HE
-XDBT4	-XDBT, -HT, -LX, -L14
-XDBT5	-XDBT, -HT, -LX, -303D
-XDBT6	-XDBT, -HT, -LX, -H2E, -303D
-XDBT7	-XDBT, -HT, -LX, -HE, -303D
-XDBT8	-XDBT, -HT, -LX, -L14, -303D
-XDBT9	-XDBT, -HT, -LX, -D14
-XDBT10	-XDBT, -HT, -LX, -D14, -303D

Modular Air Package

Based on the V316 Series

General Description

The Versa Modular Air Package is a compact air management system, based on V316 Series components, that will provide a full range of pneumatic accessories and functions to meet the needs of most control systems in the actuator control industry. Major components are shutoff and check valves, filter/regulators, speed controls and directional control valves.

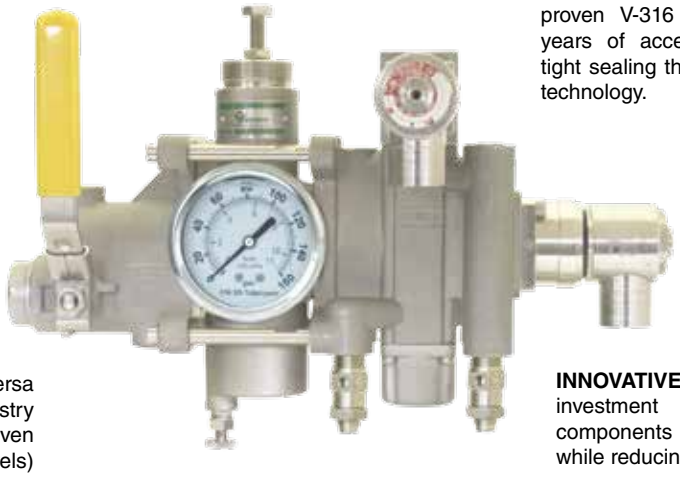
Design Benefits

Versa's VMAP simplifies the design process by combining all the components of a common circuit into one integrated assembly. Whether a standard shutoff circuit or an intricate control system, VMAP has the features to meet the requirements of any control project. VMAP will reduce engineering, components, vendors, costs, weight and save time.

TROUBLE FREE. Designed with integral assembly flanges combined with all O ring interface sealing and standard fasteners. Long leak free service life is accomplished. No custom or flat gaskets to leak or brackets to fail.

EFFICIENCY. VMAP's modular design effectively groups common automation and controls components together in user approved groupings to combine features and reduce size and weight.

TECHNOLOGY. Utilizing the latest in computer aided design and finite element software flow is maximized yielding the highest flow in the smallest of packages.



PROVEN. VMAP is based on Versa's field proven V-316 Series product. Over 30 years of acceptance in providing bubble tight sealing though Versa's packed plunger technology.

CUSTOM CIRCUITRY is achieved through modular design by simply combining various components to create the desired circuit

FLEXIBILITY. Many standard and custom circuits are easily created using the VMAP modular concept.

RELIABILITY. The reliability of the Versa V-316 Series combined with industry approved materials yields a proven product. SIL (Safety Integral Levels) exceeding most application requirements.

INNOVATIVE. Through the use of investment casting technology main components are integrated saving space while reducing potential leakage points.

ENGINEERING BENEFITS

- Standard or custom circuits available utilizing VMAP's modular components.
- Convenience of one purchase order and one vender.
- No need for developing Bill or Materials for fittings, tubing and bracketing.
- No need for designing complete layout of many different system components.
- No need for designing brackets for many individual components.

FIELD BENEFITS

- Repairability ease; by removing a few screws and the various modules can be disassembled and inspected, no tubing or fittings to remove
- Field configurability of function after installation; add more valves as the requirements of the process change.
- 10 year warranty

INSTALLATION BENEFITS

- Reducing fittings, tubing and related labor costs
- Reduction in size and weight
- One component to mount.



See VMAP Bulletin online at Versa Website

NEW



VMAP and Panel shown at scale

Current Technology



WARNINGS REGARDING THE DESIGN APPLICATION, INSTALLATION AND SERVICE OF VERSA PRODUCTS

The warnings below must be read and reviewed before designing a system utilizing, installing, servicing, or removing a Versa product. Improper use, installation or servicing of a Versa product could create a hazard to personnel and property.

DESIGN APPLICATION WARNINGS

Versa products are intended for use where compressed air or industrial hydraulic fluids are present. For use with media other than specified or for non-industrial applications or other applications not within published specifications, consult Versa.

Versa products are not inherently dangerous. They are only a component of a larger system. The system in which a Versa product is used must include adequate safeguards to prevent injury or damage in the event of system or product failure, whether this failure be of switches, regulators, cylinders, valves or any other system component. System designers must provide adequate warnings for each system in which a Versa product is utilized. These warnings, including those set forth herein, should be provided by the designer to those who will come in contact with the system.

Where questions exist regarding the applicability of a Versa product to a given use, inquiries should be addressed directly to the manufacturer. Confirmation should be obtained directly from the manufacturer regarding any questioned application prior to proceeding.

INSTALLATION, OPERATION AND SERVICE WARNINGS

Do not install or service any Versa product on a system or machine without first depressurizing the system and turning off any air, fluid, or electricity to the system or machine. All applicable electrical, mechanical, and safety codes, as well as applicable governmental regulations and laws must be complied with when installing or servicing a Versa product.

Versa products should only be installed or serviced by qualified, knowledgeable personnel who understand how these specific products are to be installed and operated. The individual must be familiar with the particular specifications, including specifications for temperature, pressure, lubrication, environment and filtration for the Versa product which is being installed or serviced. Specifications may be obtained upon request directly from Versa. If damages should occur to a Versa product, do not operate the system containing the Versa product. Consult Versa for technical information.

LIMITED WARRANTY DISCLAIMER AND
LIMITATION OF REMEDIES

Products sold by Versa are warranted to be free from defective material and workmanship for a period of ten years from the date of manufacture, provided said items are used in accordance with Versa specifications. Versa's liability pursuant to that warranty is limited to the replacement of the Versa product proved to be defective provided the allegedly defective product is returned to Versa or its authorized distributor.

Versa provides no other warranties, expressed or implied, except as stated above. There are no implied warranties of merchantability or fitness for a particular purpose. Versa's liability for breach of warranty as herein stated is the only and exclusive remedy and in no event shall Versa be responsible or liable for incidental or consequential damages.











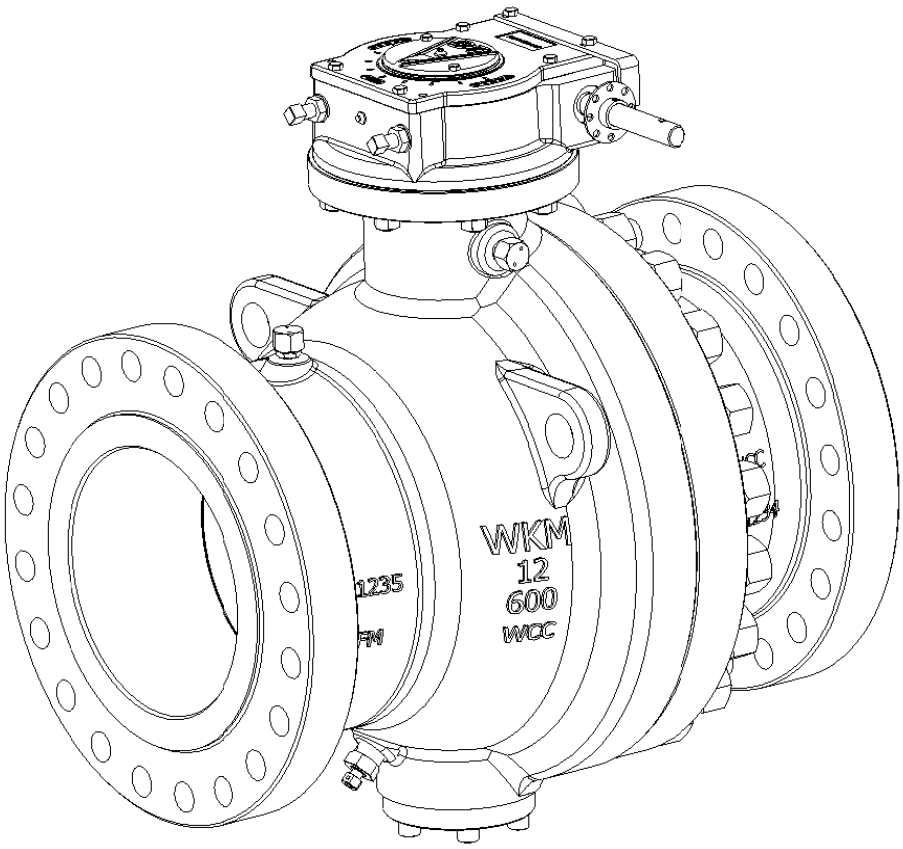
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CAMERON

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WKM® 370D6 Ball Valve

Installation, Operation, and Maintenance Manual



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The procedures included in this book are to be performed in conjunction with the requirements and recommendations outlined in API Specifications. Any repairs to the equipment covered by this book should be done by an authorized Cameron service representative. Cameron will not be responsible for loss or expense resulting from any failure of equipment or any damage to any property or death or injury to any person resulting in whole or in part from repairs performed by other than authorized Cameron personnel. Such unauthorized repairs shall also serve to terminate any contractual or other warranty, if any, on the equipment and may also result in equipment no longer meeting applicable requirements.

File copies of this manual are maintained. Revisions and/or additions will be made as deemed necessary by Cameron. The drawings in this book are not drawn to scale, but the dimensions shown are accurate.

BILL OF MATERIALS

370D6 Series Standard Gearless Valve (see parts list in Table 1)

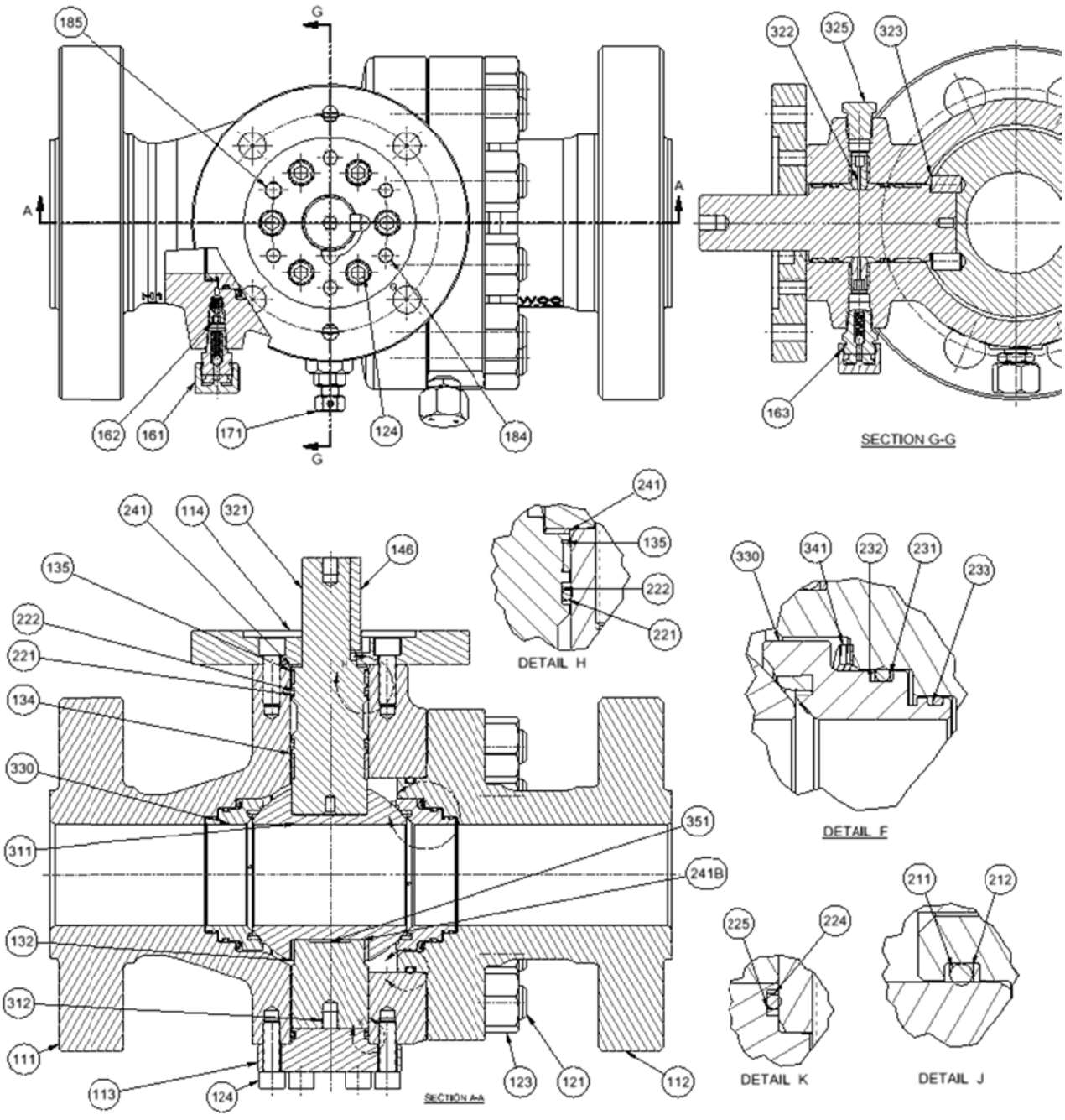


Figure 1 – 370D6 Series Standard Less Gear Valve

Table 1 – Parts List for Standard Gearless Valve

Item	Qty	Description
111	1	Body
112	1	Tailpiece
113	1	Lower Cover Plate
114	1	Adapter Plate
121	*	Body Studs
123	*	Body Nuts
124	*	Cap Screws – Lower Cover Plate/ Adapter Plate
132	1	Trunnion Bearing
134	1	Lower Stem Bearing
135	1	Upper Stem Bearing
146	1	Stem Key
151	1	Nameplate (Not Shown)
153	2	Caution Tag (Not Shown)
161	2	Grease Fitting
162	2	Check Valve
163	1	Stem Grease Fitting
171	1	Bleed Fitting
184	3	Torque Pin
185	1	Locating Torque Pin
211	1	O-Ring, Tailpiece
212	1	BACK-UP RING, TAILPIECE (Only For Class 1500 & 2500)
221	2	O-Ring, Stem
222	2	Back-Up Ring, Stem
224	1	O-Ring, Lower Cover Plate
225	1	BACK-UP RING, LOWER COVER PLATE (Only For Class 1500 & 2500)
231	2	O-Ring, Seat, Outer
232	2	Back-Up Ring, Seat, Outer
233	2	O-Ring, Seat, Inner
241	1	Stem Thrust Washer
241b	1	BALL THRUST WASHER (Only For 6” 900/1500 And All 8”Through 16”)
311	1	Ball
312	1	Trunnion
321	1	Stem
322	*	Stem Retaining Screw
323	2	Ball Drive Pin
325	*	Pipe Plug
330	2	Seat Assembly
341	2	Seat Spring
351	1	Ground Spring

*Quantities depend on valve size and class. Customer assembly drawings available upon request shall specify quantities.

370D6 Standard Wrench Head Valve (see parts list in Table 2)

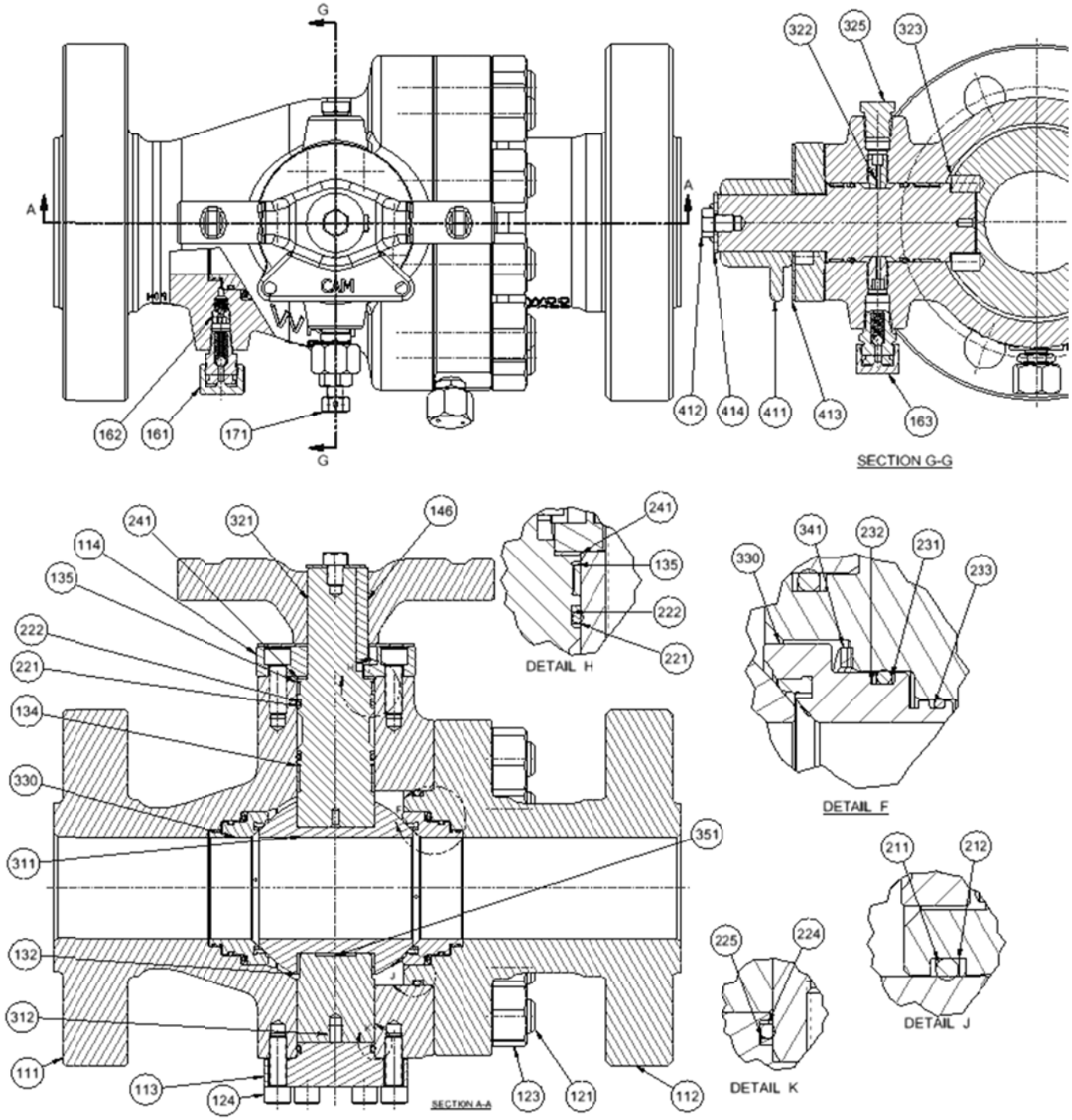


Figure 2 – 370D6 Series Standard Wrench Head Valve

Table 2 – Parts List for Standard Wrench Head Valve

Item	Qty	Description
111	1	Body
112	1	Tailpiece
113	1	Lower Cover Plate
114	1	Wrench Plate
121	*	Body Studs
123	*	Body Nuts
124	*	Cap Screws – Lower Cover Plate / Wrench Plate
132	1	Trunnion Bearing
134	1	Lower Stem Bearing
135	1	Upper Stem Bearing
146	1	Stem Key
151	1	Nameplate (Not Shown)
153	2	Caution Tag (Not Shown)
161	2	Grease Fitting
162	2	Check Valve
163	1	Stem Grease Fitting
171	1	Bleed Fitting
185	1	Locating Torque Pin (Not Shown)
211	1	O-Ring, Tailpiece
212	1	BACK-UP RING, TAILPIECE (Only For Class 1500 & 2500)
221	2	O-Ring, Stem
222	2	Back-Up Ring, Stem
224	1	O-Ring, Lower Cover Plate
225	1	BACK-UP RING, LOWER COVER PLATE (Only For Class 1500 & 2500)
231	2	O-Ring, Seat Outer
232	2	Back-Up Ring, Seat, Outer
233	2	O-Ring, Seat, Inner
241	1	Stem Thrust Washer
311	1	Ball
312	1	Trunnion
321	1	Stem
322	*	Stem Retaining Screw
323	2	Ball Drive Pin
325	*	Pipe Plug
330	2	Seat Assembly
341	2	Seat Spring
351	1	Ground Spring
411	1	Wrench Head
412	1	Wrench Screw
413	1	Weather Protector
414	1	Wrench Washer

*Quantities depend on valve size and class. Customer assembly drawings available upon request shall specify quantities.

SCOPE

370D6 ball valves 2” FP to 16” FP are full bore, through conduit, bi-directional, anti-blowout stem, double block and bleed in closed and open position, with trunnion mounted ball for easy operation. These valves can be equipped with plastic seat inserts made of RTFE, NYLON, or PEEK as the customer requires. All the seats are self-relieve type seats to eliminate cavity pressure lock. All valves have a built-in sealant injection system for emergency seat seal and also a stem sealant fitting for stem seal recovery. The valve uses backed self-lubricating PTFE sleeve bearings and thrust washers for low torque operation.

The 370D6 valves are available in the sizes and classes as per Table 3.

Unless otherwise specified on the purchase order, all the small sizes of valves are equipped with a wrench head (noted W in Table 3) as standard; all other valves are equipped with a gear operator (noted G in Table 3). The hand wheel can be removed from the gear shaft by taking out the roll pin.

Table 3 – 370D6 Series Ball Valve Availability

Valve Availability						
Valve Class/Size	150	300	600	900	1500	2500
2FP	W	W	W	W	W	W
3RP			W	W		
3FP	W	W	W	W	W	W
4RP			W	W		
4FP	W	W	W	W	G	G
6RP	W	W	W	W	G	G
6FP	W	W	G	G	G	
8RP	W	W	G	G	G	
8FP	G	G	G	G	G	
10RP	G	G	G	G	G	
10FP	G	G	G	G		
12RP	G	G	G	G		
12FP	G	G	G			
14FP	G	G	G			
16FP	G	G	G			

All valves are built with trim selection and seals as the customer requires. Contact a WKM representative for proper trim selection for the required application.

NAMEPLATE INFORMATION

The valve information, including trim, is clearly identified on the valve nameplate that is permanently affixed on the valve. Figure 3 shows a standard valve nameplate and Table 4 details the information stamped on the nameplate.

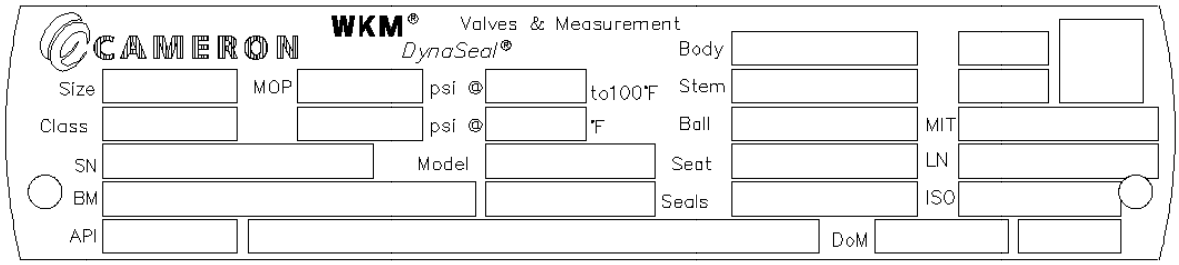


Figure 3 – 370D6 Ball Valve Standard Nameplate

Table 4 – Nameplate Information

Item	Preprint	Stamp
1	Size	If full bore, size is the nominal bore size If reduced bore, size is end size x bore through ball x end size
2	Class	Valve Class Designation as defined per API 6D
3	SN*	Valve's unique Serial Number
4	BM	Valve Bill of Material part number
5	MOP	Maximum Operating Pressure; the working pressure of the valve @ 100°F and at maximum temperature
6	API	API Number the valve is in compliance with
7	Body**	Body Material Symbol
8	Temp	Operating Temperature Range
9	Model	Valve's Model Designation
10	Stem**	Stem Material Symbol
11	Ball**	Ball Material Symbol
12	Seat**	Seat Material Symbol
13	Seals**	Seals Material Symbol
14	DOM	Date of Manufacture
15	MIT	Maximum Impact Temperature
16	LN	API License Number

*- Most important data for obtaining replacement parts

**- Consult a WKM Representative for material's symbol correspondence

STORAGE

VALVES DELIVERED BY WKM

Following testing and prior to shipment, valves are drained of water and through bores and flange faces are coated with grease and covered by protectors. This will protect the valves for a minimum of six months in covered storage from the date of shipment. For long periods of storage and particularly harsh environments (i.e. as found in an uncovered marine atmosphere) additional precautions must be taken.

All 370D6 valves should be stored in the full open position as received, with the flange seal surfaces and the bore greased, and the protectors installed on the flanges. If long term storage is necessary, the valve should be conditioned according to standard engineering practices; contact a WKM representative for long term storage procedures.

INSTALLATION AND OPERATION INSTRUCTIONS

BEFORE INSTALLATION SAFTEY INFORMATION

Valves shall be operated and maintained strictly in accordance with these procedures. Operation or maintenance outside of these procedures constitutes abuse of the product and voids all warranty and claims.

When special operation is required, a formal written request to the company must be made for approval to operate in this manner if warranty and product liability is to be maintained.

Before any work is performed on a valve, personnel working on the valve must obtain the proper work permits required by his employer. Personnel shall always use safety precautions set forth by the law and regulations required by his employer. Personnel shall also be aware that any venting or draining of fluids from the valve shall be done in accordance with safety and environmental procedures enforced at the particular location.

The maintenance personnel doing the repairs shall be well trained and familiar with all of the information contained in this manual.

The valves shall be appropriately used for the intended purpose. Any safety or protection devices on the valve shall not be permanently removed or altered unless written approval is received from a WKM representative.

Transport, unpacking, lifting, and connections to the different types of systems (electric, pneumatic, hydraulic systems, etc.) shall be made by expert and qualified personnel.

Should any difficulties or abnormalities arise that cannot be solved by the technician, contact a WKM representative.

Any servicing not covered by these instructions must be made by an authorized service center, after preliminary approval has been given by a WKM representative.

INSTALLATION

Before installation, ensure the grease fittings and sealing surfaces of connection flanges were not damaged during transportation. Clearly identify the valve through its nameplate, check its weight with the packing list or relevant documents, and then place it on a horizontal surface using suitable handling equipment.

Handling equipment must be provided which is appropriate for the total weight of the package. Pay particular attention that slings do not damage the gear or actuator.

For 370D6 valves 8FP to 16FP use the lifting lugs or eyes on the valve for slinging. Do not use lifting lugs or eyes provided on the gear or actuator, if present.

To avoid the ingress of debris or sand into the ball and seat area, the protective covers should not be removed until the valve is ready to be installed in the line. When the valve is ready to be installed in the line, remove the protective plastic or wooden flange protectors.

During installation the valve must be fully open and the line sections, between which the valve will be installed, must be aligned, cleaned, and correctly spaced. Should the valve be closed, the exposed face of the ball must be protected with grease or other anti-adhesive product.

When the valve has butt welding ends, welding on the line must be performed using the proper welding procedure. After welding, clean and check the weld bead and repair as required.

WKM 370D6 valves are bidirectional and may be installed with either end facing upstream. The valve should be installed in such a way as to facilitate maintenance, easy access to the valve fittings, and actuating operations.

370D6 valve standard position is with the stem in the vertical, upwards position and gear/wrench on the top side of valve. In this position the drain/bleed fittings are located in the lowest part of the body which allows for the most effective drainage. However, the valve may be installed in any position as far as stem location, but the drain fitting will not be in the lowest part of body and the drainage may not be as effective.

CAUTION: If the valve cannot be properly drained (see Section 6.1) and the line's foreign particles removed, the seats may wear out, get damaged, or accumulate particles and water that may prevent easy operation and affect the valve performance. It is the responsibility of the user to determine if the application may include abrasive particles and the valve may be need to be installed in a different position than the standard stem-upwards position.

When installing the valve, allow for possible deformations caused by the expansion of the line. The valve must not support the line. Avoid any strain in the valve body.

CAUTION: Do not overload the valve beyond the design piping loads stated on the requirements.

Use studs, nuts, and raised face gaskets or ring joints as per size and class conforming to ASME B16.5. Alternately tighten the studs using a cross pattern method, several times, following the procedure recommended by ASME PCC-1-2010 "Guidelines for Pressure Boundary Bolted Flange Joint Assembly" or gasket manufacturer specification.

CAUTION: While all 370D6 trunnion ball valves have self-relieving seats as standard equipment, it is recommended that appropriate safeguards be put into place to prevent exceeding the pressure/temperature limits given by the manufacturer.

FIELD TESTING

When field testing is required, the following procedures are recommended:

1. Ensure that the test fluids are compatible with the valve seat and seal material
2. Flush the system to remove foreign material that may be in the line as a result from installation procedures to avoid damaging the ball and seats
3. If performing line shell testing, the valve shall be in half open position. The maximum line pressure can be 1-1/2 times the valve maximum cold working pressure
4. If performing seat testing, make sure the valve is fully closed. The maximum pressure for seat testing is the maximum cold working pressure
5. After completion of testing, purge all test fluids from the valve

CAUTION: If the seats are tested to a higher pressure than the maximum cold working pressure, the seats can be permanently damaged. If a higher test pressure is desired contact a WKM representative for details.

OPERATION

370D6 series ball valves only work in the fully closed or fully open position; these valves work for on/off service only.

WARNING: These valves shall never be operated partially open or partially closed. Throttling (partial opening) or "pinching" flow may cause non-uniform wear on seats and ball over the sealing surfaces where it is exposed to the flow line, preventing tight shut-off.

To close the valve, turn gear hand wheel clockwise until it stops; to open the valve turn the gear hand wheel counter-clockwise until it stops.

All the wrench operated valves have the wrench levers aligned along with valve through bore when opened and perpendicular with the through bore when closed.

All gear operated valves have the gear indicator aligned with the valve through bore when opened and perpendicular with the through bore when closed. The gear also has "OPEN" and "CLOSE" markings.

While opening or closing, the ball must reseat; this reseating torque is higher than the run torque. Turn the hand wheel until the gear has a positive stop.

If the valve is operated by a power actuator, carefully read the actuator operation manual.

CAUTION: The end stops have been shop set to assure the correct 90 degree rotation from the fully open to fully closed position. Do not change their adjustment. If the valve is not correctly reseated at the end of opening or closing, the ball and the seats can quickly be damaged when exposed to flow pressure, preventing tight shut-off.

These valves can be operated by one person. It is recommended that no extensions be used for operating the valve. Using an extension or power tool to operate the valve voids all warranty and claims, and may result in failure.

MAINTENANCE PROCEDURES

Under normal working conditions, 370D6 ball valves are designed for lengthy, reliable service. The following recommended practices and procedures will ensure optimum performance.

DRAINAGE PROCEDURE

All valves can be drained and lubricated depending on application conditions, or anytime if desired. Valves may accumulate water, scale, deposits, and other foreign matter during their service. These materials may damage the valve in the following ways:

1. At low temperature, ice may form inside the valve and hinder its normal operation
2. Foreign matter may prevent the valve from fully closing and the ensuing throttling may damage the ball or the seat seals
3. Foreign matter may get caught between the ball and the seat and damage their surfaces

A drainage schedule is the best way to prevent damage caused by foreign matter. However, it is recommended that drainage should be carried out in the following cases:

1. Whenever the valve does not close
2. Before and during the cold season
3. After washing the line
4. After hydraulic test
5. Periodically to remove the accumulation of body debris. The frequency may be established based on the contaminants in the application

For a drainage procedure, the following procedure is recommended:

1. 370D6 valves are double block and bleed in closed and also open position. The drainage can be done in either the closed or open position. Make sure the valve is fully closed or fully open.

   NOTE: The time to drain the valve depends on the size of the valve and the fluid in the line; significant time may be required if the line contains a gas fluid. If the valve is drained in the open position, the time will be shorter compared to if drained in the valve in the closed position due to the smaller body cavity to drain when the valve is fully open.

2. Slowly open the bleed fitting (171) located on the lower side of the body.

CAUTION: Open the drain fitting slowly until the pressure in the body cavity has been discharged. Make sure the fitting body does not unscrew while loosening the fitting stem. If necessary, use another wrench to prevent the fitting body from unscrewing.

LUBRICATION – GREASE INJECTION

The implementation of a regular lubrication program extends the service life of the valve before carrying out maintenance operations and improves its performance. It is recommended to schedule a regular lubrication program based on the frequency of operations and the severity of service. All 370D6 series ball valves have two grease injection fittings located on the body seat area with the exception of the 2", 3", and 4" Class 150 & 300 that have one grease fitting located in the center of the body.

Lubrication also may be necessary for a temporary seal restoration in the event of slight damage to the seats caused by debris in the line; before operating the valve if the valve has been left in its position for a long period of time; or as soon as an increase in stem torque is noticed.

CAUTION: Grease fittings should not be removed if there is pressure in the line. Grease fittings should never be painted.

The gear operators are factory lubricated for life. If desired, the gear can be lubricated using the lube fitting located on the side of the gear operator.

WKM 103 is an effective sealant; it is viscous grease with a thick consistency. It consists of synthetic oils, a suspending agent, friction-reducing filler, plastic, and an antioxidant. WKM 103 Sealant may be used in valves with a temperature range of -50° F through 250° F. This sealant is suitable in lines transporting hydrocarbon liquids and gases where water, dilute acids, alkalis, or salt solutions may be present; as well as where sweet or sour produced gas with water or organic condensate, LPG, and aqueous solutions are being transported. The gallon containers are for use with bucket-type high-pressure grease guns. Gun cartridges are poly bags sized to fit screw/prime high pressure handguns.

WKM 103 Sealant part numbers:

- K155812 Gun Cartridge
- K155849 1 gal – 10 lbs.
- K155853 3 gal – 30 lbs.
- K155857 5 gal – 50 lbs.
- K155866 16 gal – 150 lbs.
- K155869 55 gal – 551 lbs.

WKM Lubricant 58G part number – K154208 – Gun Cartridge

For Lubrication and temporary seat or stem seal restoration with the valve under line pressure, follow the instructions below:

1. Fill the WKM high pressure grease gun with valve sealant

2. Make sure the valve is in the fully open or fully closed position. For 2", 3", and 4" Class 150 & 300 valves, lubrication is recommended in the fully open position

Warning: Back up the seat grease fitting so only the safety vent cap will be removed from the fitting. Carefully remove the safety cap from the seat grease fitting. NEVER remove the grease fitting when the valve is under pressure.

3. Remove safety vent cap from grease fitting. Attach grease gun connection onto grease fitting and inject sealant. If injection of the sealant is difficult, flush the valve seats and attempt to inject sealant again.

4. Repeat process for the second seat grease fitting as applicable, or the stem fitting. Replace safety caps on all grease fittings.

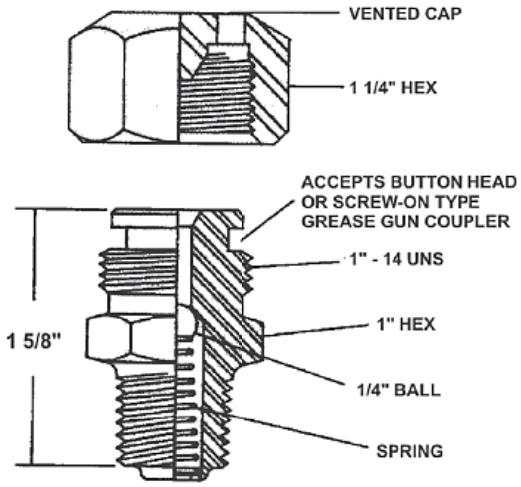


Figure 4 – Typical Injection Fitting

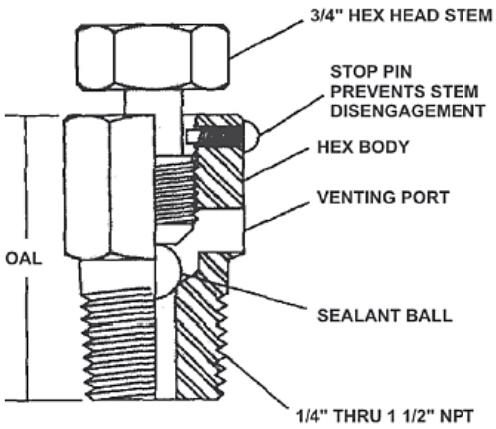


Figure 5 – Vent or Bleed Fitting

Table 5 shows a list of recommended lubricants by the cleaner/sealant manufacturer for the indicated service and conditions. Use of other lubricants without WKM approval voids all warranty and claims. Contact WKM representatives for availability.

Table 5 – Manufacturer Recommended Lubricants

Flush/Sealant Recommendations				
Service Condition	Product	Cleaner/Sealant Manufacturer		The valve Cleaner/Sealant Manufacturer's contact information can be found below:
		WKM	VAL-TEX	
Natural Gas	Flush		Valve flush	**Headquarters** Cameron Valves & Measurement 3250 Brairpark Drive, Suite 300 Houston, TX 77042 Tel. (281) 499-8511 Order 1-800 323-9160 Fax (281) 261-3588
	Standard valve lubricant	WKM 58G	2000 light lube	
	Standard sealant	WKM 103	80 bulk/ 80-HS stick	
	Standard low Temp.		50 bulk / stick	
	Severe leak sealant		80+PTFE bulk / stick	
Sour Gas	Flush		Valve flush	
	Standard valve lubricant	WKM 58G	2065 light lube	
	Standard sealant	WKM 103	65 bulk / stick	

	Standard low Temp.		65 bulk / stick	www.c-a-m.com
	Severe leak sealant		80+PTFE bulk / stick	
Dry CO2	Flush		Valve flush	
	Standard valve lubricant	WKM 58G	2300 light lube	
	Standard sealant	WKM 103	302 bulk / stick	
	Standard low Temp.		65 bulk / stick	**VAL-TEX**
	Severe leak sealant		80+PTFE bulk / stick	Valves Inc. of Texas
Crude Oil	Flush		Valve flush	10600 Fallston Rd.
	Standard valve lubricant	WKM 58G	2000 light lube	Houston, TX 77099
	Standard sealant	WKM 103	80 bulk/ 80-HS stick	Tel. (281) 530-4848
	Standard low Temp.		50 bulk / stick	Order 1-800-627-9771
	Severe leak sealant		80+PTFE bulk / stick	www.valtex.com

Table 6 lists the recommended quantity of lubricant per valve size and class.

Table 6 – Recommended Lubricant Quantities

Lubricant and Flush Volume (per valve size and class)			
Valve size	Valve class	Lubricant per seat (ounces)	Valve Flush per seat (ounces)
2”	150-300	12	-
2”	600-2500	3	5
3”	150-300	16	-
3”	600-2500	4	7
4”	150-300	20	-
4”	600-2500	5	9
6”	150-1500	7	13
8”	150-900	9	17
10”	150-900	12	21
12”	150-900	14	26
14”	150-600	16	30
16”	150-600	20	36

Several high pressure guns can be used for lubrication:

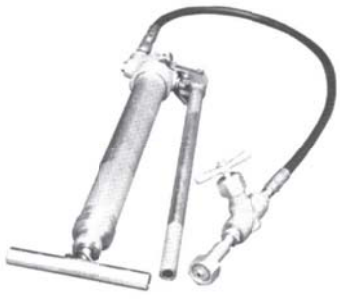


Figure 6 – Screw/Prime Hand Gun
Part No. 2122495-01



Figure 7 – Bucket-type Gun
Part No. K065189



Figure 8 – Air Over Hydraulic Foot Pump
Part No. 2330398-01

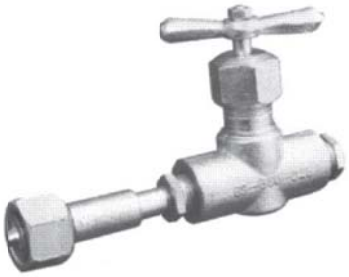


Figure 9 – Adapter Fitting
Part No. K296434

370D6 VALVE RECONDITIONING

The 370D6 valves can be rebuilt if necessary. The disassembly and reassembly of the valve requires proper lifting equipment and normal maintenance tools.

Spare parts are determined by the individual customer specification; however the following list is suggested as a minimum for typical maintenance operations:

- Stem and ball radial bearings
- Stem thrust washers and ball thrust washer (if applicable)
- All O-rings and applicable back-up rings
- Seat springs
- Seat subassemblies
- Drain fitting
- Grease injection fittings

CAUTION: Prior to disassembly, the valve must first be isolated from system pressure and flow. Operate the valve at least two times and drain the valve to make sure there is no residual pressure left in the body.

After observing the above precautions, remove the valve from the pipe line system. Set the valve in a clean place free of dust and/or metallic chips.

DISASSEMBLY

1. Operate the Valve to the closed position.

CAUTION: Prior to disassembly, verify that there is no pressure in the body cavity. Operate the valve at least two times to bleed any residual pressure.

2. Stand the valve on the body flange end. Care should be taken to avoid damaging the sealing surface of the raised face or ring groove (if applicable).
3. If wrench operated – remove the wrench screw on top of the stem, the washer, and the wrench.
4. If actuated valve – check the actuator operation manual and remove the actuator.
5. If gear operated – loosen the gear mounting hardware while lifting the gear until it comes off of the stem.

6. Remove stem key. Unscrew the adapter plate or lever plate cap screws and remove the adapter plate paying attention not to damage the torque pins.
7. Unscrew the stem grease fitting and the plug (if applicable), unscrew the stem retainer screw(s) and remove it.

CAUTION: Failure to remove the stem retainer screw (one or two as applicable) will prevent the stem removal from the body and may cause severe stem and screw damage during the following step.

8. Carefully pull the stem out of the body. To remove the stem, install a cap screw through the gear plate into the threaded hole located on the top of the stem. Use a rubber mallet to hit against the gear plate and gently pull the stem out. Remove the O-rings, back-up rings, and stem thrust washer and use a screwdriver to also remove the stem bearings.
9. Remove the cap screw from the stem, and again utilize the gear plate to remove the trunnion from the body.
10. Remove the lower cover plate O-ring and back-up ring (if applicable). Carefully remove the ground spring located between the trunnion and ball.
11. Loosen and remove the body nuts.
12. Lift the tailpiece off of the body paying attention not to damage the body O-ring.
13. Remove the tailpiece O-ring and back-up ring if applicable.
14. Using a strap, lift the ball out of the body and lower it onto wood blocks. Take out the drive pins and inspect the trunnion bearing and thrust bearing (if applicable). Remove bearings as necessary.
15. Remove the seat ring from the tailpiece, taking care not to damage the seals.
16. Remove the O-rings and the back-up ring from the seat assembly.
17. Remove the seat spring from the tailpiece pocket.
18. Repeat steps 15-17 for removal of the body seat assembly.
19. Remove the drain fitting and grease fittings.

CLEANING

CHEMICAL RESISTANT VINYL OR RUBBER GLOVES SHOULD BE WORN DURING CLEANING OPERATIONS

- Remove any foreign and corrosive products within the body.

CAUTION: Abrasive cleaning products should never be used, especially on sealing area. If water jetting is used, dry with compressed air.

- Clean all metallic parts with a soft cloth saturated with a solvent. Observe all sealing surfaces.
- Clean the grease fittings and, if present, the grease channels.

Clean the sealing rings and the gaskets with a soft cloth. If necessary, wash them with soap and rinse them with clean water.

INSPECTION

After cleaning, all valve components should be inspected for damage, dents, scoring, wear, or corrosion. If any damage is found, proceed with the repair where possible or with replacement of the parts.

For a complete inspection procedure, the following operations should be carried out:

1. Check the metallic parts for damage along the sealing surfaces and on moving surfaces. Particular attention should be paid to surface nicks and corner damage.

2. Make sure that the sealing rings and gaskets are not slashed, extruded and/or otherwise damaged.

3. Check for scratches and plating defects on the surfaces of the bearings, the thrust washers, the O-ring grooves, the ball, and the seat components.

4. Inspect all replacement components that are going to be used to ensure damage has not occurred in storage or transportation.

5. If any damage is found, the minor repairs should be carried out by trained personnel, otherwise contact WKM representative.

The minor repairs that may be carried out on site by maintenance personnel shall be in accordance with the following points:

1. Use standard engineering practices to repair the damaged metallic surfaces.

2. Remove surface nicks on ball and stem by using a mild abrasive such as Scotch Brite pads.

3. Remove all corner damages by using a mild abrasive or with a bearing scraper.

4. Replace all faulty parts and components.

5. Flush lube and sealant while the valve is disassembled.

REASSEMBLY

After inspecting the parts and getting the replacement parts as required, use the following procedure to assemble the 370D6 ball valve:

1. Place the body, on the ANSI flange, on a clean and solid surface that will hold the weight of the assembled valve securely. Place the tailpiece on the ANSI flange. Take care not to damage the sealing surfaces.

2. If studs have been removed, install the studs in the body with the ID stamping up and the short end threaded into the body and screw them down completely. Remove any particles which may have flaked off the studs.

3. Inspect the seats, paying careful attention to the insert sealing surfaces. Reject and replace all seats with dings, scratches, or any other physical defects. Install the O-rings and the backup ring. The back-up ring should be on the head side of the seat as shown in Fig. 10. Apply lubricant until completely covering the O-rings and back-up ring.

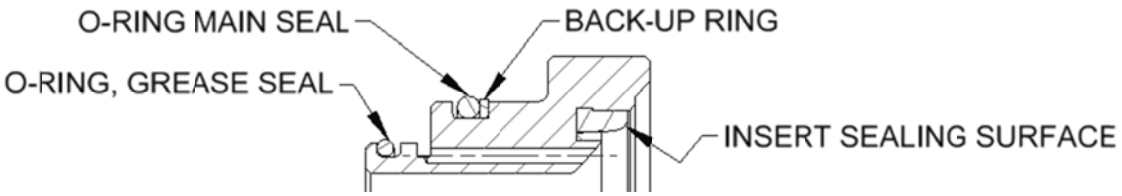


Figure 10 – 370D6 Seat Assembly

4. Install the O-rings and back-up ring (as applicable) to the tailpiece and cover. If the valve size and class require back-up rings, those shall be positions above the O-ring towards the flange of the part as shown in detail J and detail K of Fig. 1 and Fig. 2.

5. Install the radial bearings on the stem using a bearing tool shown in Fig. 11. The lower bearing is wider than the upper bearing. Both bearings shall fit into the designated grooves.

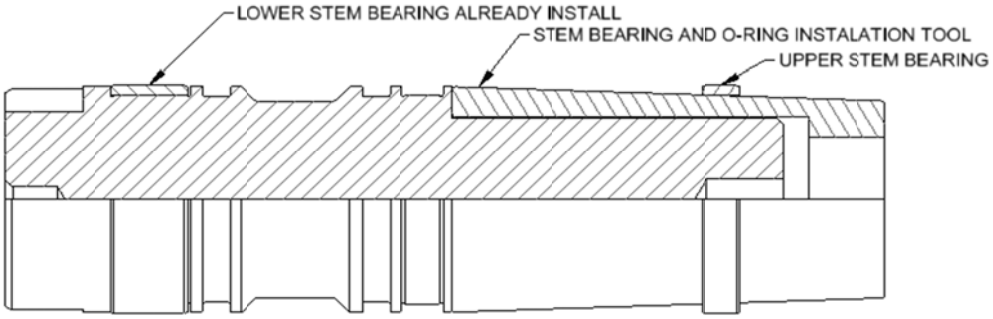


Figure 11 – Stem Bearing Installation

Using the same tool, install the O-rings. Install the back-up rings above the O-rings on the stem gear side, as shown in Fig. 12.

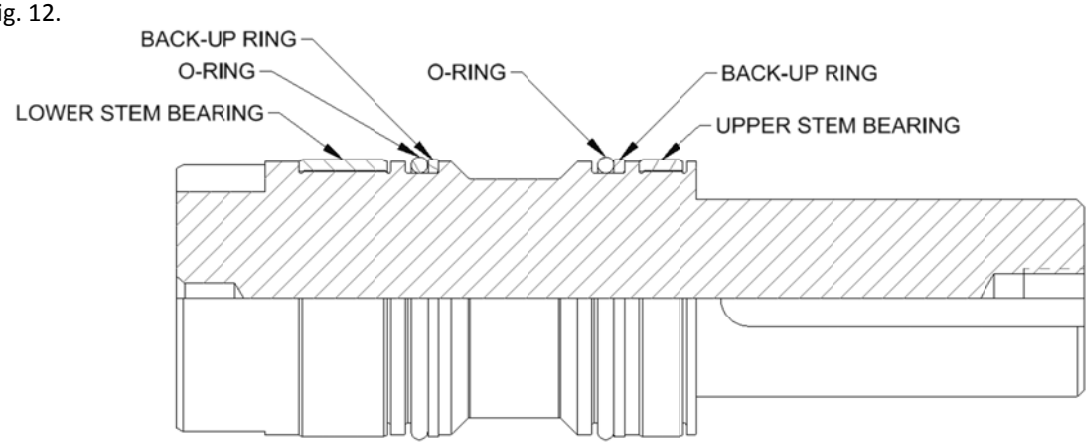


Figure 12 – Stem O-ring Installation

6. Install the ball thrust washer (if applicable) and the trunnion radial bearing in the ball trunnion bore.

7. Grease the ball drive pin holes and install the drive pins. Make sure the drive pins are placed correctly in the holes and do not stick above the ball.

8. Apply a coat of lubricant on the entire surface of body and tailpiece seat pockets and install the seat springs into the seat pockets.

9. Lower one seat assembly, with the insert facing up, into the body pocket. Press the seat using a proper tool until the O-rings and back-up rings are completely engaged in the pocket. Take care to avoid damaging the seat insert.

10. Repeat the procedure with the other seat into the tailpiece seat pocket.

11. Lift the ball and slightly lower into the body until it rests on the body seat, then orient the ball trunnion hole with the body trunnion hole. The ball should be in the closed position and symmetrically oriented over the body seat. There should be an equal amount of the body seat visible on both sides of the ball.

12. Grease the body trunnion hole and stem hole.

13. Set the ground spring on top of the trunnion with a generous amount of grease, and push the trunnion into the body bore hole until the trunnion engages the ball. Use a rubber mallet if necessary. Install the lower cover plate over the trunnion and thread at least two cap screws until the cover plate back face contacts the body trunnion boss face.

14. Flip the tailpiece over using the proper lifting equipment. Lift the tailpiece and start lowering it onto the body. Before the tailpiece engages the studs, orient it such that the grease fittings of the tailpiece are on the same side as the grease fittings of the body, towards the front of the valve or aligned with the stem bore (if applicable). At the same time, the tailpiece end flange bolt holes must be aligned with the body end flange bolt holes. After these two alignments are completed, slowly lower the tailpiece onto the body until it rests on the ball.

15. Install two nuts, 180°apart, and tighten sequentially until the tailpiece is contacting the body around the entire flange. Install the remainder of the nuts.

16. The stem should be installed at this time.

NOTE: The ball was installed in the closed position and the drive pins should be aligned with the valve bore. Check to make sure the drive pins are in the correct place on the ball holes. Orient the stem (as shown in Fig. 13) with the key groove toward the valve body markings and the drive pin holes matching the drive pins in the ball. Orient the bearing splits towards the stem key groove and drive the stem into the body using a rubber mallet until the stem completely engages the ball and drive pins.

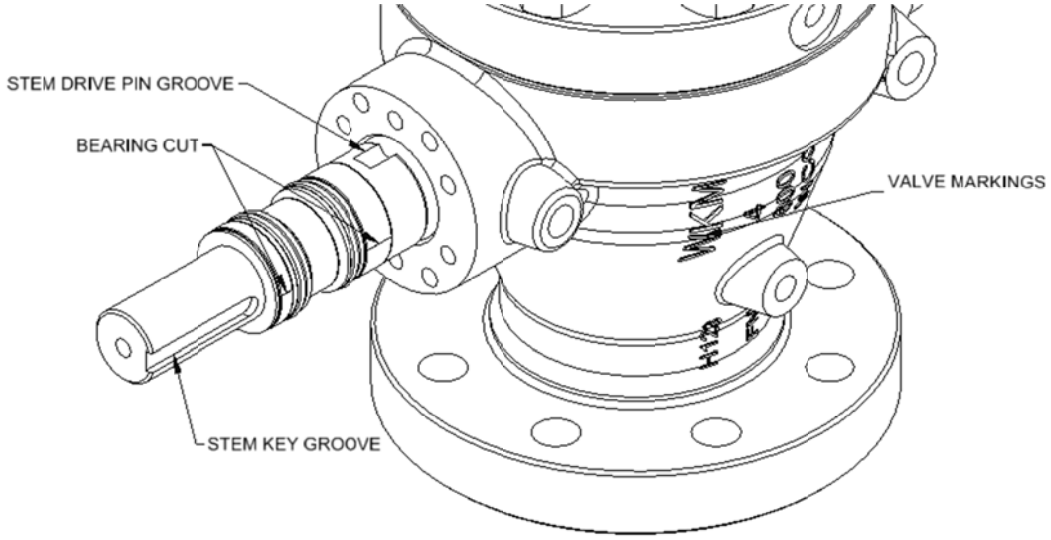


Figure 13 – Stem Orientation for Installation

17. If a wrench operated valve, use the following procedure to install the wrench (as detailed in Fig. 14):
    a. Install the stem thrust washer over the stem with the Teflon backing oriented towards the ball.
    b. Install the locating pin into the correctly sized hole.
    c. Install the lever plate over the stem. The lever plate should fit over the locating pin with the key grooves oriented towards the valve body markings and the tailpiece.
    d. Install all cap screws and torque as required per Table 7.
    e. Install the key. The key should not stick above the stem.
    f. Install the weather protector.
    g. Install the wrench head and secure the washer and screw on top of the stem.

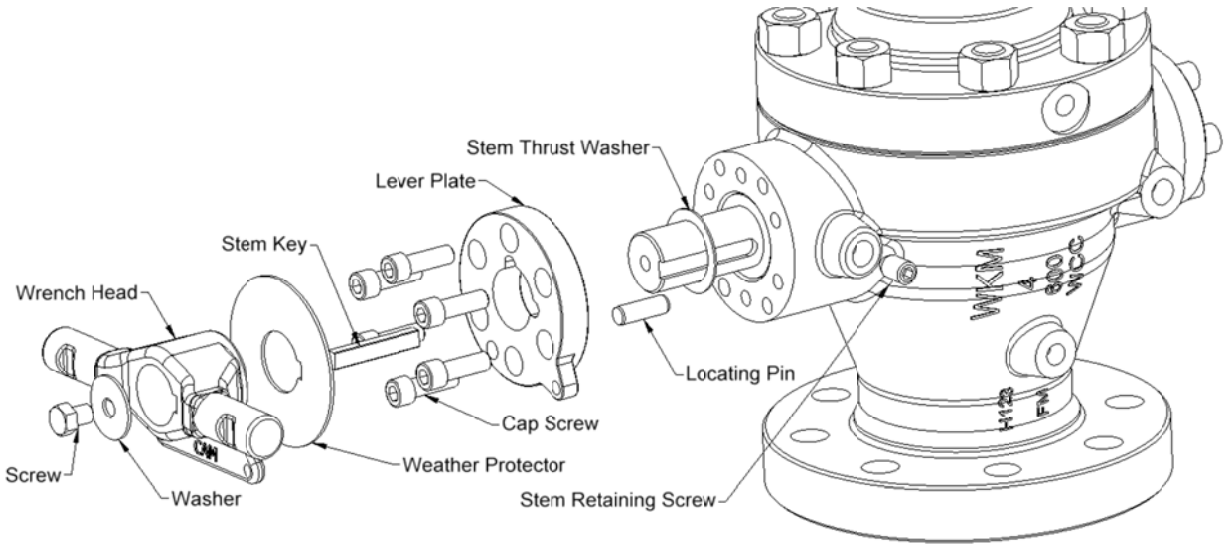


Figure 14 – Wrench Operated Valve Assembly

18. If a bare stem valve, use the following procedure to install the adapter plate (as detailed in Fig. 15):
    h. Install the stem thrust washer over the stem with the Teflon backing oriented towards the ball.

i. Install the torque pins and the locating pin into the correctly sized holes.
j. Install the gear adapter plate over the stem. The plate should fit over all the pins including the locating pin, with the key grooves oriented towards the valve body markings and the tailpiece.
k. Install all the cap screws and torque as required per Table 7.
l. Install the key. The key should not stick above the stem.

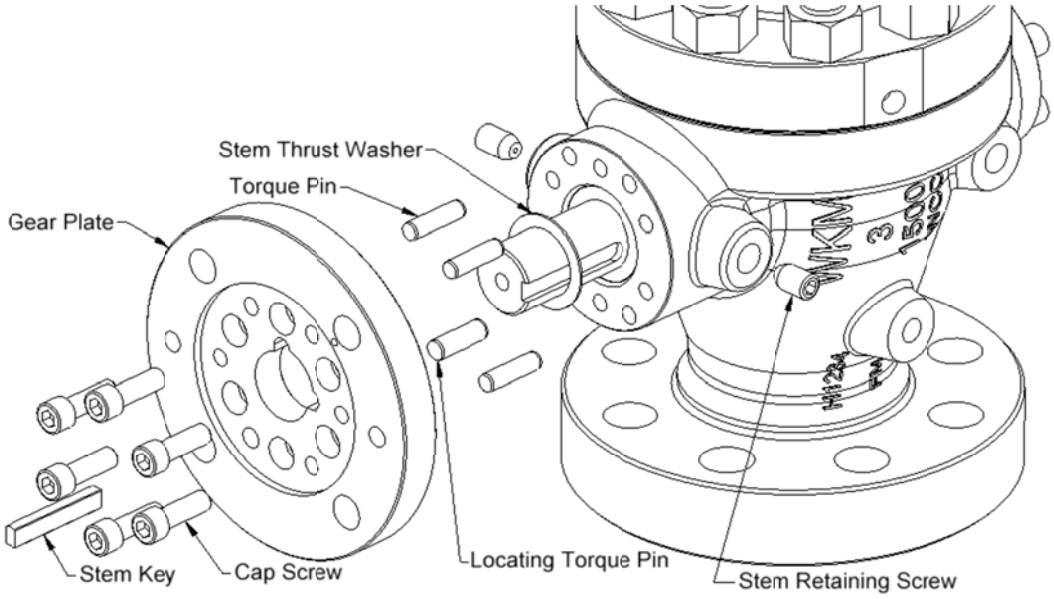


Figure 15 – Gear Adapter Plate Assembly

19. Install the stem retaining screw(s). Thread the screws until contacting the stem and turn back a half turn.

CAUTION: If the stem retaining screw is not backed off and remains in contact with the stem, the valve torque may increase and affect actuator performance.

20. If removed, tape all check valves and external fittings with Teflon tape and install them at this time. Use the installation torques noted in Table 8.

21. The body stud nuts and cap screws should be torqued as required per Table 7, in a cross pattern sequence. Check each at least twice to make sure they have been tightened correctly.

22. If the valve requires a gear operator, see Gear Operator Assembly. If otherwise actuated, carefully read the actuator operation manual before installation.

GEAR OPERATOR ASSEMBLY

Contact a WKM Representative for part numbers and other relevant information to select the proper gear operator. The gear can be installed in two positions, with the gear shaft on either side of the valve so the valve can be operated from either side of the pipeline. However, unless otherwise specified by the customer, the gear is installed with the gear shaft on the front of the valve (valve body markings) and the procedure below shows the steps for this installation (detailed in Fig. 16).

1. With the gear positioned with the indicator cap down, install the mounting studs provided with the order.

2. Before sliding the gear completely against the adapter plate, check the position of the hand wheel gear shaft. On all 370D6 series valves the shaft will be oriented to the top right. The shaft will always be at 90° from the centerline of the valve and never at an angle.

3. After correctly positioning the hand wheel gear shaft, slide the gear operator towards the adapter plate. Start all nuts onto the studs and tighten them with the proper open end wrench.

4. Remove the indicator cap. Using the hand wheel, turn the hand wheel gear shaft so that the key slot on the stem and operator are aligned with each other.

5. Using a rubber mallet, tap the key gently into the key slot until it is below the top of the stem. **Do not use excessive force to drive the key**. If the key does not fit properly, recheck the alignment of the key slots. If the key sticks out above the end of the stem slightly rotate the gear shaft to make sure the key is engaging the adapter plate groove. Another key or punch should be used to drive in the key to prevent damaging the gear operator key slot.

6. Loosen the locknuts and rotate both stop screws on the gear operator counter clockwise.

7. To set the closed stop, turn the hand wheel gear shaft clockwise until the key stops on the adapter plate groove. Back off a quarter turn, then turn the close position stop screw clockwise until it stops and tighten approximately 1 Ft-lb. for each inch of valve bore. Retighten the locknut. **The hand wheel gear shaft should always be turned in the closed direction to set the closed stop, so that all slack will be taken out of the gearing. This ensures a more accurate stop setting.**

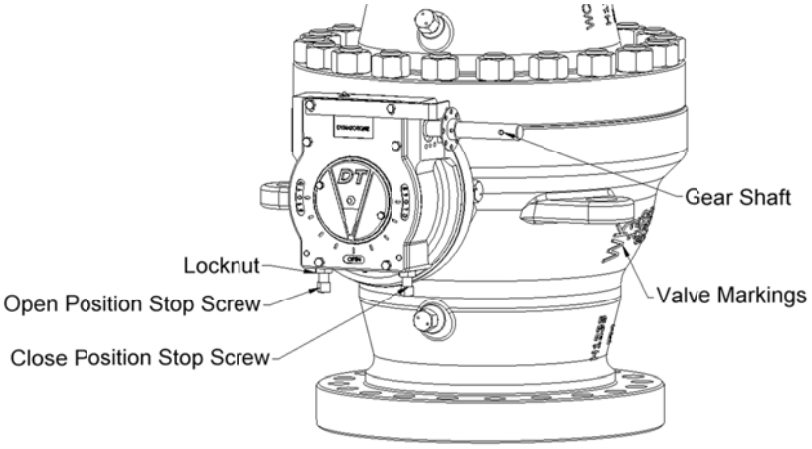


Figure 16 – Gear Operator Assembly

8. After setting the closed stop a quick check can verify that is has been correctly set. Turn the hand wheel gear shaft towards the open position, and then return the valve to the closed position until contacting the closed stop. After fully closing the gear, mark the ball with a circle tangent to the adapter flow bore (or body flow bore) in a plane 90° with the stem axis. Open the ball halfway and measure the minimum distance from the ball corner (ball flow bore to sphere corner) to the mark. The distance should meet the dimension L detailed in Table 9.

Table 9 – Dimension L

Distance from Ball Corner to Mark		
Valve Size	Valve Class	Dimension L (+/- 0.04")
2" FP & 3" RP	150-900	0.67"
2”FP	1500	0.96"
2”FP	2500	1.28"
3”FP & 4”RP	150-900	0.87"
3”FP	1500	1.19"
3”FP	2500	1.81"
4”FP & 6”RP	150-900	1.03"
4”FP & 6”RP	1500	1.24"
4”FP & 6”RP	2500	1.87"
6”FP & 8”RP	150-600	1.05"
6”FP & 8”RP	900-1500	1.37"
8”FP & 10”RP	150-600	1.19"
8”FP & 10”RP	900	1.40"
10”FP & 12”RP	150-900	1.35"
12”FP & 14”RP	150-600	1.50"
12”FP & 14”RP	900	1.74"
14”FP	150-600	1.56"
16”FP	150-600	1.87"

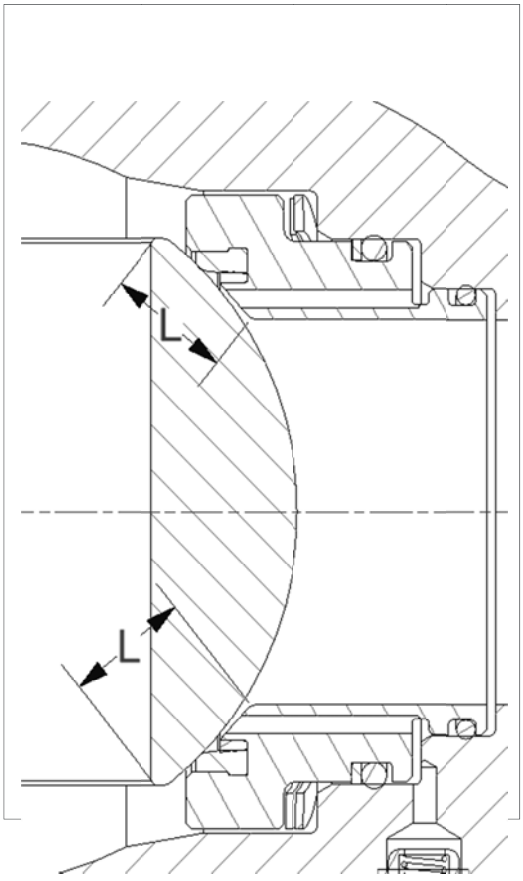


Figure 17 – Dimension L

9. To set the open stop, turn the hand wheel gear shaft counter clockwise until the key stops on the adapter plate groove. Look into the bore of the valve, the flow bore of the ball should be aligned with the flow bore of the seat assembles with not more than 1/16” of the ball radius protruding into the flow bore. Turn the open position stop screw clockwise until it stops and tighten approximately 1 Ft-lb. for each inch of valve bore. Retighten the locknut. **The hand wheel gear shaft should always be turned in the open direction to set the open stop, so that all slack will be taken out of the gearing. This ensures a more accurate stop setting.**

10. After setting the open stop a quick check can verify that it has been set correctly. Turn the hand wheel gear shaft several turns towards the closed direction, and then return the valve to the open position until the key hits the stop. There should be no more than 1/16” of the ball radius exposed into the flow bore after the stop if properly set.

11. Reinstall the indicator cap and tighten the indicator cap screws.

12. Install the hand wheel and secure it with the hand wheel pin.

ASSEMBLY TORQUE VALUES

Table 7 – Installation Torque for B7, B7M, L7, and L7M Studs and Cap Screws

Thread Size	Dry/Zinc Plated (Ft-lbs.)	Cad/Teflon Coated (Ft-lbs.)
3/8”- 16UNC	19	11
1/2”- 13UNC	45	27
5/8”-11UNC	88	52
3/4”-10UNC	153	90
7/8”- 9UNC	243	143
1”- 8UNC	361	213
1 1/8”- 8UN	523	305
1 1/4”- 8UN	726	421
1 3/8”- 8UN	976	562
1 1/2”- 8UN	1278	733
1 5/8”- 8UN	1653	934
1 3/4”- 8UN	2054	1169
1 7/8”- 8UN	2539	1440
2”- 8UN	3094	1750

Table 8 – NPT Fitting Installation Torque

Fitting Thread Size	Installation Torque (Ft-lbs.)
1/4” NPT	25
3/8” NPT	39
1/2” NPT	75
3/4” NPT	135
1” NPT	288

TROUBLESHOOTING

Table 9 –Troubleshooting

Issue	Probable Cause	Repair
Will not open or close	Iced up due to restricted flow or low temperature	Inject antifreeze solution into valve body. Check the compatibility of antifreeze solution to avoid damaging the seals. Drain periodically to eliminate water accumulation
	Improper setting of gear or actuator stops	Reset gear or actuator stops
Hard to operate	Accumulation of foreign material in the body	Drain the valve – see drainage procedure
	Infrequent operation, lack of lubrication	Grease the valve – see lubrication procedure
	Gear hard to operate or stuck	Check gear. Lubricate or replace
	Operator not properly installed	Check gear operator
Leak around the seat	Foreign material between seat and ball	Grease the valve – see lubrication procedure. Operate several times to wipe clean
	Valve not fully closed	Check the adapter plate or gear operator for fully closed position
	Worn or damaged seat inserts and/or ball	Disassemble the valve and replace worn parts
	Operator stops not properly set	Adjust stops to proper settings
	Worn or damaged seat O-ring seal	Disassembly the valve and replace seat O-ring. Check O-ring material for application*
Leak around stem	Worn or damaged stem O-ring seal	Grease the stem. Disassemble the valve and replace stem O-ring. Check O-ring material for application*
Leak between body and adapter plate	Worn or damaged adapter O-ring seal	Disassemble the valve and replace adapter O-ring Check O-ring material for application*
	Adapter studs and nuts not properly tightened	Tighten nuts to specified torque
Leak between body and lower cover plate	Worn or damaged lower cover plate O-ring seal	Disassemble the valve and replace cover plate O-ring Check O-ring material for application*
	Cover plate cap screws not properly tightened	Tighten cap screws to specified torque
Grease fitting leaking	Debris in the fitting	Inject small amount of cleaner to flush debris
	Damaged fitting	Tighten safety cap or replace fitting. WARNING: Never remove the entire fitting with the valve under pressure

*Contact a WKM representative for proper trim selection for the required application

CONTACT INFORMATION

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CAMERON
A Schlumberger Company





WKM 370D6 Trunnion-Mounted Ball Valves

Designed and engineered for heavy-duty performance in general purpose petroleum and chemical process applications

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Oklahoma City, Oklahoma, USA

WKM 370D6 Trunnion-Mounted Ball Valve

Cameron is a leading provider of valve, valve automation, and measurement systems to the oil and gas industry. We offer products primarily used to control, direct, and measure the flow of oil and gas as it is moved to refineries, petrochemical plants, and industrial centers for processing.

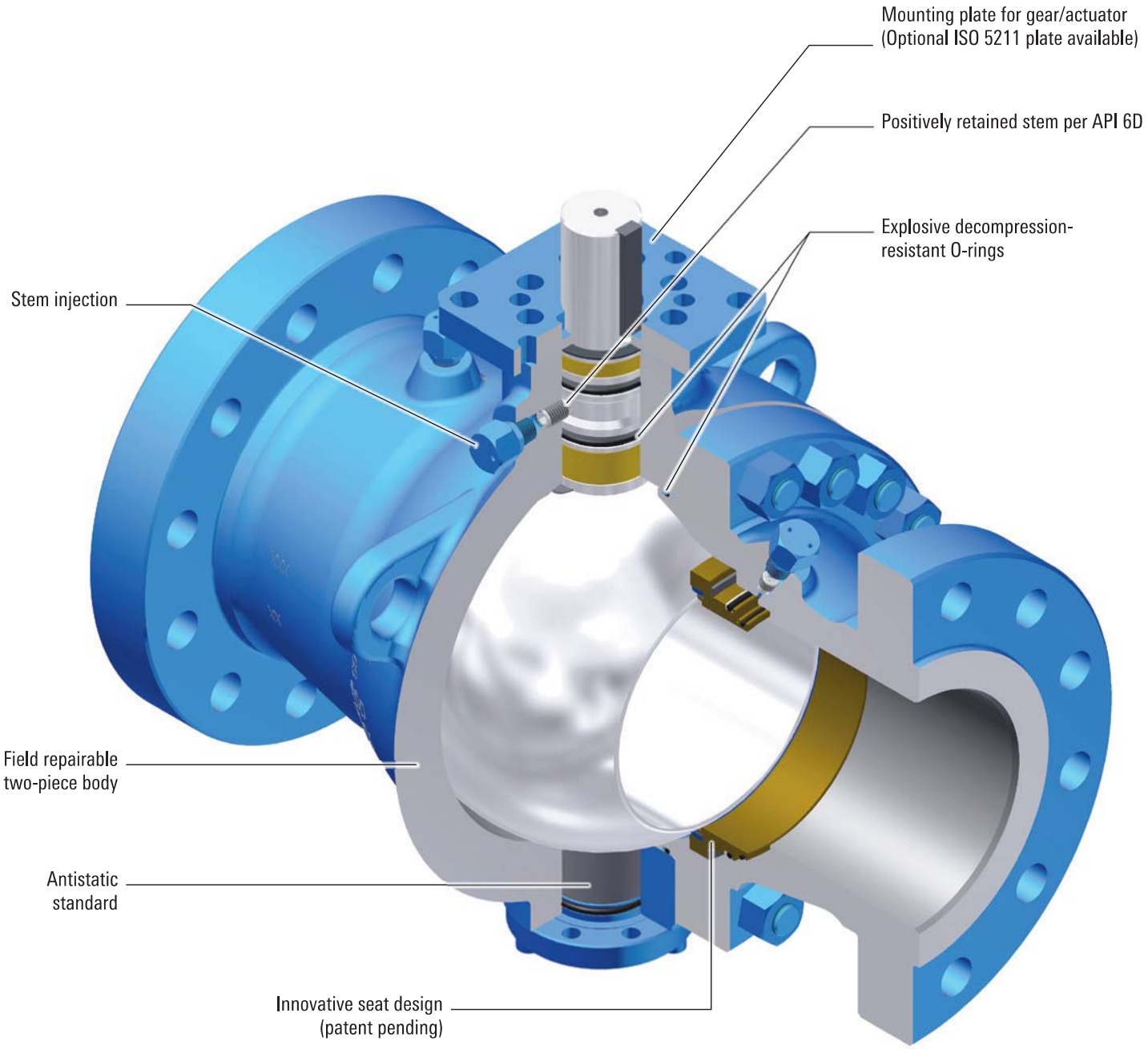
We provide valve products that are sold through distributor networks worldwide. Our products are used in oil, gas, and industrial applications, and include widely recognized brands such as DEMCO*, NAVCO*, NEWCO*, DOUGLAS CHERO*, NUTRON*, THORNHILL CRAVER*, TECHNO*, TOM WHEATLEY*, WHEATLEY*, and WKM*.

The WKM* 370D6 trunnion-mounted ball valve is recognized throughout the world for durable, reliable, and flexible valves built for many challenging situations. Our WKM product line offers a broad portfolio of valves including gate valves, trunnion mounted and floating ball valves, and DynaCentric* butterfly valves, all built to standards for demanding applications.

ASME Classes 150 through 2500

2 to 16 in [50 to 400 mm]

WKM 370D6 ball valves are designed and engineered for heavy-duty performance. Used in many general purpose petroleum and chemical process applications, these valves also can be specified for more demanding applications.



Features and benefits

Fire-tested for safety
The WKM 370D6 ball valves are qualified under API 607 standards.

Actuation-friendly
Valves can come with a DYNATORQUE* gear operator or an ISO 5211 mounting pad for easy actuation.

End connections
Flanged; 2-, 3-, and 4-in Class 150 come in flanged × studded or flanged × flanged configuration

Body style
Two-piece

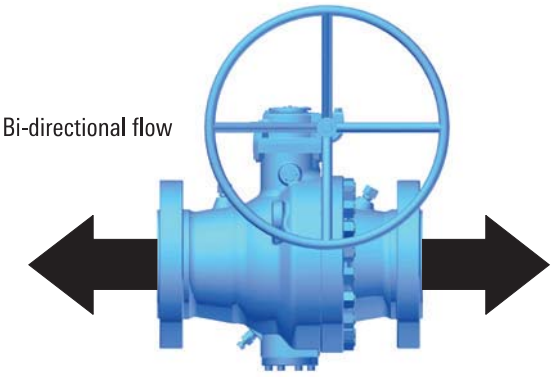
Standard materials
Carbon steel, stainless steel, and low-temperature carbon steel

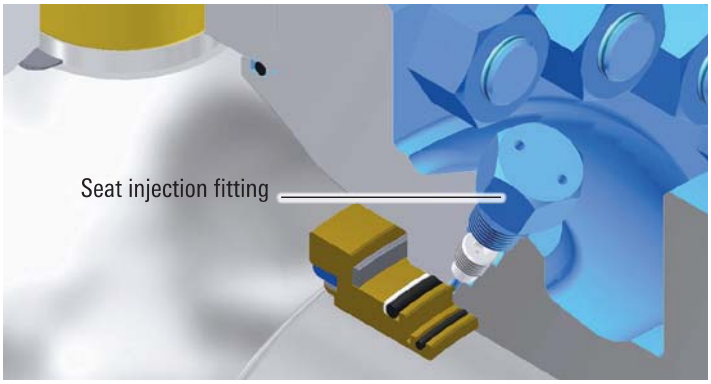
Optional stem materials
316 SS, 410 SS, 4130 LAS, and INCONEL†

Double block-and-bleed operation
The pressure-actuated seats and bleed fittings allow double block-and-bleed operation. When used for block-and-bleed, this feature may permit the valve to take the place of two valves. It also allows the operator to check up and downstream sealing by bleeding off the body pressure. All sizes can block-and-bleed in both the open and closed position.

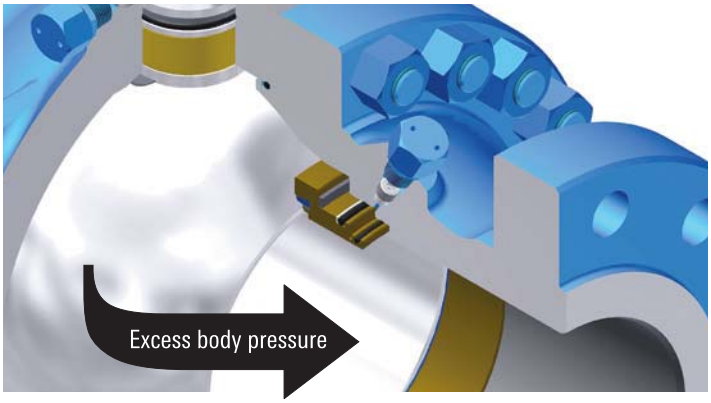
NACE trim standard‡
Compliant with NACE MR0175/ISO 15156 for buried service.

Bi-directional flow
This valve uses pressure-actuated seats with locked-in, non-metallic face seals. To help ensure sealing at low pressure, special wave springs force the seats against the ball. At higher pressures, the upstream seat is forced against the ball by the pressure working across the differential area between the seat insert and the seat O-ring. The higher the pressure, the tighter the seal.





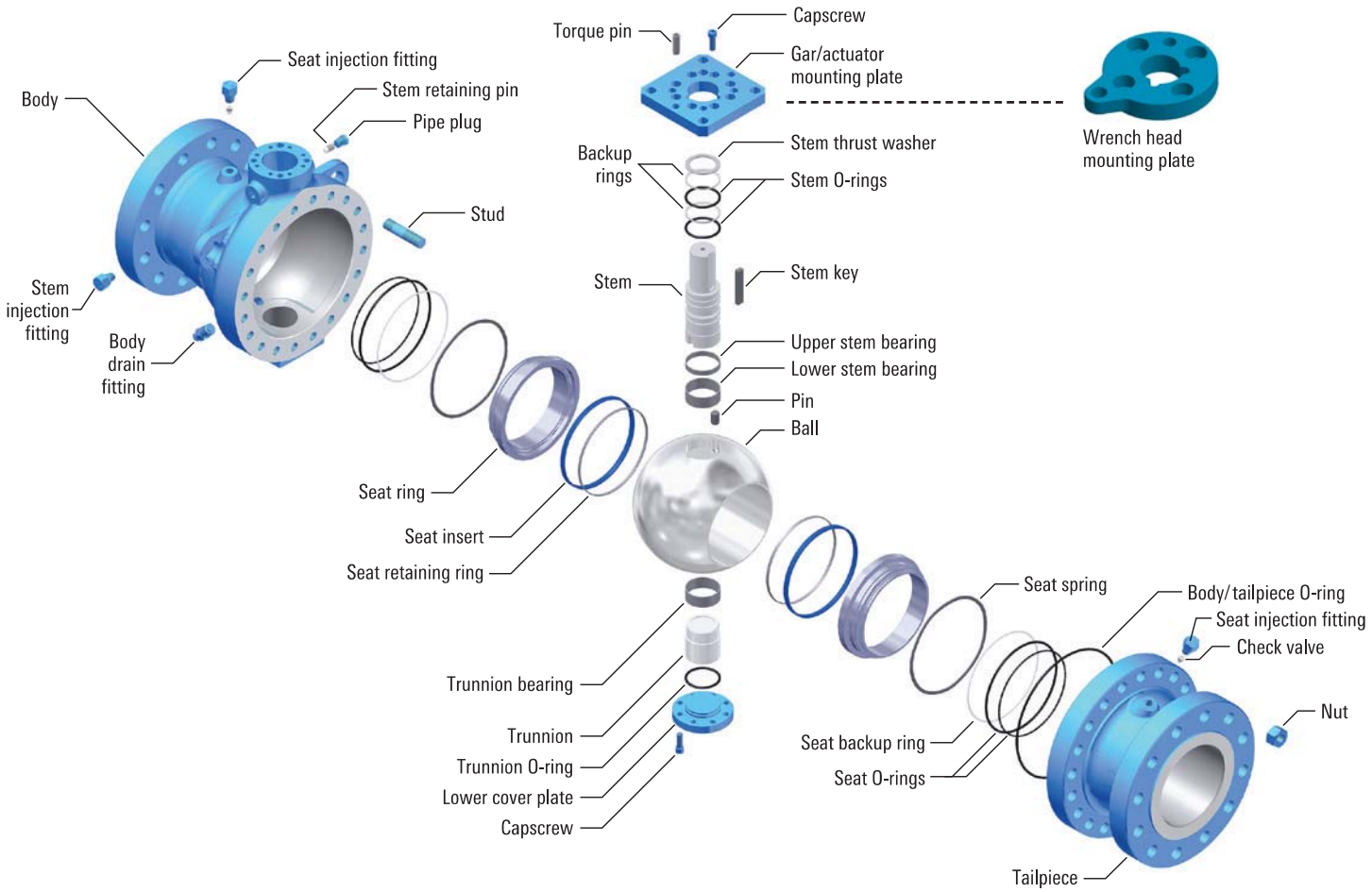
Secondary seat seal injection
In the event of damage to the valve seat, sealant can be injected to temporarily seal the valve.



Automatic body pressure relief
Seats will internally relieve excess body pressure.

‡ NACE MR0175/ISO 15156 Compliance—Materials of construction shall be in compliance with the pre-qualified material requirements specified by NACE MR0175/ISO 15156. According to NACE MR0175/ISO 15156, it is the manufacturer's responsibility to meet metallurgical requirements and the customer's/user's responsibility to ensure that a material will be satisfactory in the intended environment. When given the application requirements (environment) by the customer/user, Cameron can make technical recommendations in accordance with NACE MR0175/ISO 15156, but that in no way certifies or warrants the product or materials for the application.

Standards and specifications



Design and testing standards:

- API 6D
- API 598
- API 608
- API 607 6th Ed. fire-test
- NACE MR0175/ISO 15156
- ASME B16.34 (valves, flange end)
- MSS-SP-6 (standard finishes for pipe flanges)
- MSS-SP-25 (standard marking system for valves)
- MSS-SP-55 (quality standards for steel castings)

In addition, WKM 370D6 trunnion mounted ball valves can be supplied to comply with these standards:

- CE/PED
- ISO 5211 top works
- CRN

ASME Pressure Classes

		ASME Class					
Size, in	**Size, mm**	**150**	**300**	**600**	**900**	**1500**	**2500**
2	50	•	•	•	•	•	•
3 × 2	80 × 50	–	–	•	•	–	–
3	80	•	•	•	•	•	•
4 × 3	100 × 80	–	–	•	•	–	–
4	100	•	•	•	•	•	•
6 × 4	150 × 100	•	•	•	•	•	•
6	150	•	•	•	•	•	–
8 × 6	200 × 150	•	•	•	•	•	–
8	200	•	•	•	•	–	–
10 × 8	250 × 200	•	•	•	•	–	–
10	250	•	•	•	•	–	–
12 × 10	300 × 250	•	•	•	•	–	–
12	300	•	•	•	•	–	–
14	350	•	•	•	–	–	–
16	400	•	•	•	–	–	–

Materials list

Body Group Trim Number				
Part	**Carbon Steel (NACE) 24**	**Carbon Steel Low Temp. (NACE) 37**	**Stainless Steel (NACE) 23**	**Carbon Steel 3 mil ENP (NACE) 27**
Body	A216 Gr. WCC	A352 Gr. LCC	A351 Gr. CF8M	N/A
Tailpiece	A216 Gr. WCC	A352 Gr. LCC	A351 Gr. CF8M	N/A
Lower cover plate	Carbon steel	A350 Gr. LF2	316 SS	N/A
Studs	A320 Gr. L7M zinc plate	A320 Gr. L7M zinc plate	A320 Gr. L7M zinc plate	N/A
Nuts	A194 Gr. 7ML zinc plate	A194 Gr. 7ML zinc plate	A194 Gr. 7ML zinc plate	N/A
Capscrews	L7M	L7M	L7M	N/A
Pipe plug	Stainless steel	Stainless steel	Stainless steel	N/A
Adapter plate	Carbon steel	A350 Gr LF2	A350 Gr. LF2	N/A

NACE indicates compliance with NACE MR0175/ISO 15156.

Internal Group Trim Number				
Ball	A216 Gr. WCC/A105 CS ENP	A352 Gr. LCC/A350 Gr. LF2 ENP	A182 Gr. 316/A351 Gr. CF8M	A216 Gr. WCC/A105 CS 3 mil ENP
Stem drive pin	Alloy steel	Alloy steel	316 SS	Alloy steel
Stem/trunnion	A105 CS ENP	A350 Gr. LF2 ENP	A182 Gr. 316 SS	A105 CS 3 mil ENP
Seat rings	A 216 Gr. WCC/A105 CS ENP	A352 Gr. LCC/A350 Gr. LF2 ENP	A182 Gr. 316/A351 Gr. CF8M	A216 Gr. WCC/A105 CS 3 mil ENP
Seat spring	B637 N07500	B637 N07500	B637 N07500	B637 N07500
Stem and trunnion bearings	CS/filled PTFE	CS/filled PTFE	CS/filled PTFE†	CS/filled PTFE
Thrust washer	CS/filled PTFE	CS/filled PTFE	CS/filled PTFE†	CS/filled PTFE
Ground spring	Stainless steel	Stainless steel	Stainless steel	Stainless steel

Note: Trim 24 is suitable for ambient temperatures from –20 to 400 degF [–29 to 204 degC].
Trim 23 and 37 are suitable for ambient temperatures from –50 to 400 degF [–46 to 204 degC] (must be combined with appropriate seal code).

† 23-23 full stainless steel gets stainless steel thrust washer and bearings.

Seal Group Trim Code				
Part	**YXF† Fire-Tested**	**TFF Classes 150 through 600 Fire-Tested**	**YRF Fire-Tested**	**PWF† Fire-Tested**
Temperature limits	–50† to 250 degF [–46 to 121 degC]	0 to 350 degF [–18 to 177 degC]	–20 to 250 degF [–29 to 121 degC]	–50† to 350 degF [–46 to 177 degC]
Seat face seals	Nylon (N6)	Filled PTFE	Nylon (N6)	PEEK
Stem seal O-rings	JW HNBR	FKM	HNBR	FKM GLT
Body/tailpiece O-rings	JW HNBR	FKM	HNBR	FKM GLT
Seat O-rings	JW HNBR	FKM	HNBR	FKM GLT
Trunnion O-ring	JW HNBR	FKM	HNBR	FKM GLT
Backup rings	Nylon/PEEK	PEEK	Nylon/PEEK	PEEK

† When combined with trim 23 or 37, body and internal group code. Consult Cameron for a complete list of trim temperature ranges.

Trim codes

2	D6	600	RF × RF	24	Y	R	F	24	LG
Size, in [mm]	Valve model	Pressure class	End connections	Body group	Seat group	Seal group	Fire-tested	Internal group	Actuation

Valve model
370D6
370D6P-PED

Size, in [mm]
2 to 16 in [50 to 400 mm]

Pressure class
150 to 2500

End connections	Body group
Stainless steel NACE	23
Carbon steel NACE	24
Carbon low temp NACE	37

Seat group	
Devlon	D
Nylon 6	Y
Filled PTFE	T
PEEK	P

Seal group	
FKM	F
James 985	X
HNBR	R
James Walker 101	S
FKM GLT	W
James Walker FR58	V

Internal group	
Stainless steel NACE	23
Carbon steel NACE	24
3 mil ENP carbon steel NACE	27
Low-temp. carbon steel NACE	37

Actuation	
Less gear	LG
Worm gear	WG
Wrench head	WH

Part number code/how to order

Pressure class
0 Class 150 (flanged × flanged 2, 3, and 4 in)
1 Class 150 (flanged × studded configuration in 2, 3, and 4 in)
2 Class 300
3 Class 600
4 Class 900
5 Class 1500
6 Class 2500

End connection
1 RF Flange
5 RTJ Flange (Class 600 and above)

Body/tailpiece material
1 Carbon steel (24)
2 Stainless steel (23)
3 Low-temp. carbon steel (37)
4 Carbon steel endurobond (26)
5 PED carbon steel (24)
6 PED stainless steel (23)
7 PED low-temp. carbon steel (37)

Seat insert material
1 Nylon 6 (Y)
2 Filled PTFE (T)
3 Peek (P)
4 Nylon 12 (N)
5 Devlon V (D)

Seal material
1 Hi Fluorine FKM (F) 0 degF [–18 degC]
2 AFLAS (L) 30 degF [–1 degC]
3 HNBR (R) –20 degF [–29 degC]
4 James Walker Elasto-Lion 101 (HNBR) (S) –20 degF [–29 degC]
5 James Walker FR58/90 (V) –15 degF [–26 degC]
6 Fluoroelastomer GLT (W) –50 degF [–46 degC]
7 James Walker Elasto-Lion 985 (HNBR) (X) –50 degF [–46 degC]
8 Fluoroelastomer GFLT (G) –30 degF [–34 degC]
9 James Walker FR25/90 (U) –40 degF [–40 degC]

Trim material
1 Carbon steel/1 mil ENP (24)
2 Stainless steel (23)
3 Low-temp. carbon steel (37)
4 Carbon steel/3 mil ENP (27)

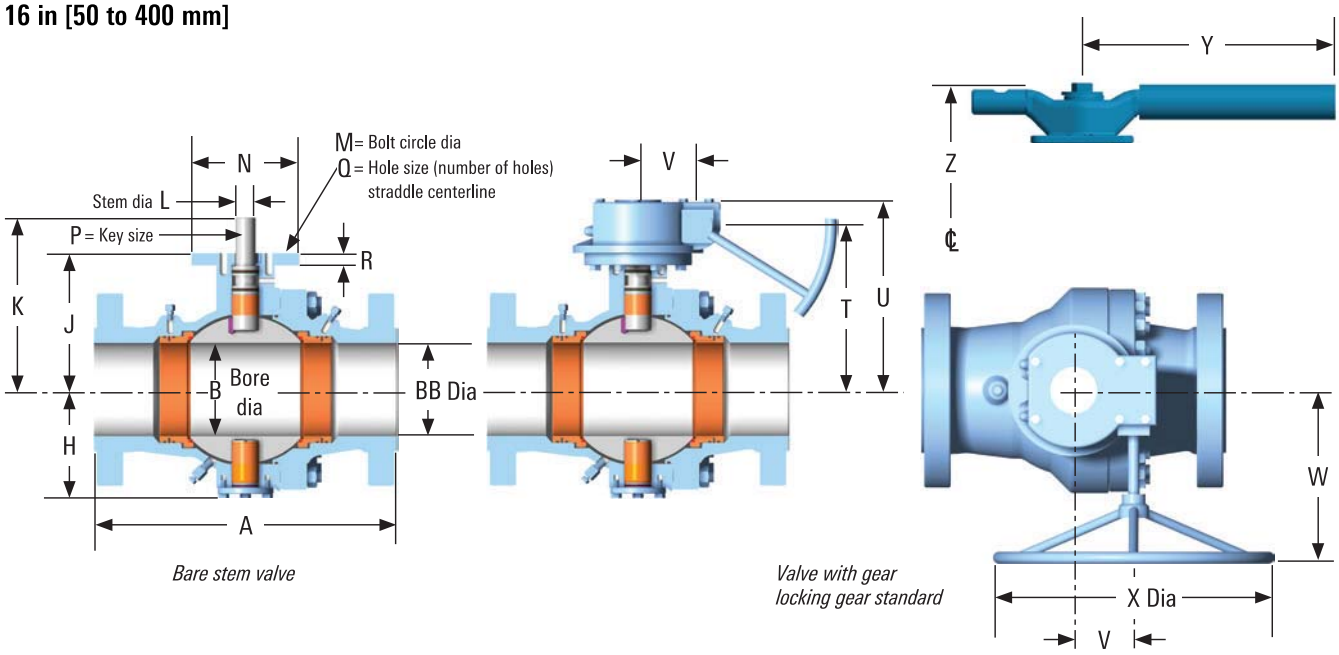
Actuation
1 Less gear (LG)
2 Wrench head (WH) 2-in, 150- to 4-in, 900; 2- and 3-in 1500/2500; and 6-in 150/300 only.
3 Gear operator with lock device (WG)
4 Less gear (LG ISO) ISO top works
5 Gear operator with lock device (WG ISO)
6 Wrench head pipe assembly (WP) 2-in, 150 to 4-in 600; 2-in 1500/2500; and 6-in 150 only.

Valve SE	Base Number
2	2365466
3 × 2	2365467
3	2365468
4 × 3	2365469
4	2365470
6 × 4	2365471
6	2365472
8 × 6	2365473
8	2365474
10 × 8	2365475
10	2365476
12 × 10	2365477
12	2365478
14	2365480
16	2365481

XXXXXXX-XXXXXXX

ASME Class 150 dimensions

2 to 16 in [50 to 400 mm]



Bare stem valve

Valve with gear locking gear standard

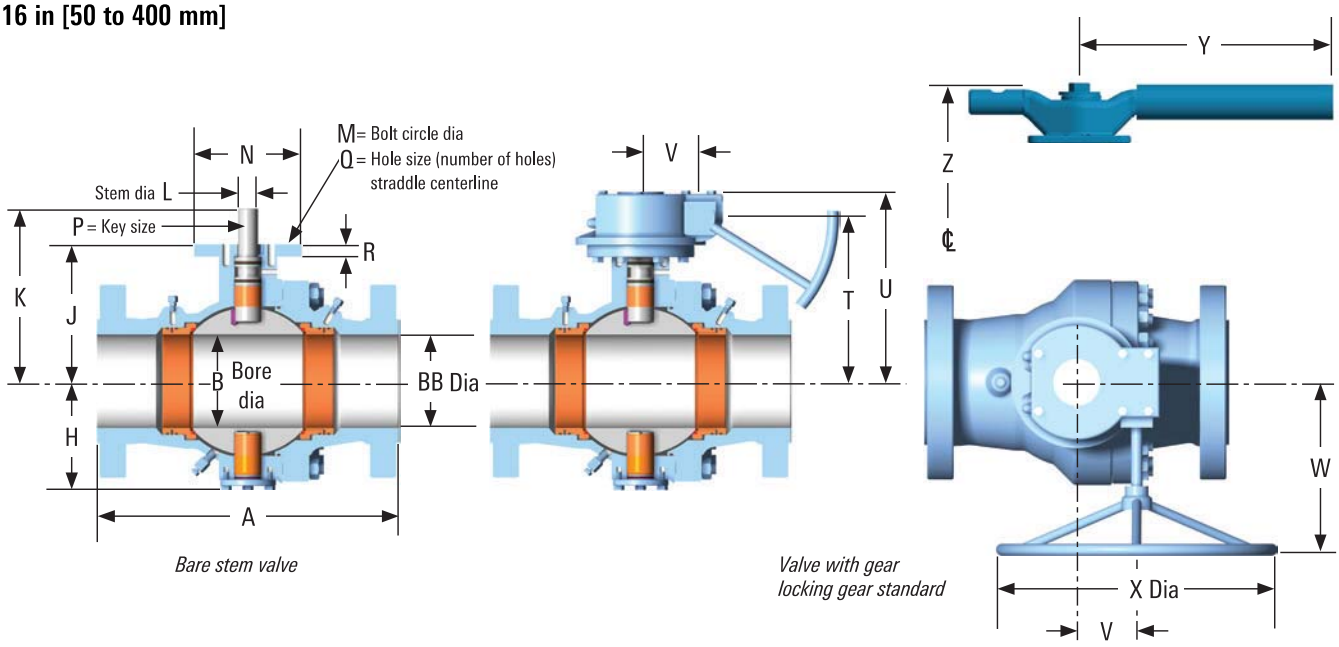
Dimensions

Size, in [mm]	A RF	A RJ	B	BB	H	J	K	L	M†	N†	P	Q†	R	T	U	V	W	X	Y	Z
2 [50]	7.00 [178]	–	2.00 [51]	2.00 [51]	4.31 [109.5]	4.67 [118.6]	6.31 [160.3]	0.862 [21.8]	4.016 [102.00]	4.90 [124.4]	0.318 [8.08]	0.43-[4]	0.59 [14.99]	5.77 [146.6]	7.32 [185.9]	1.75 [44.5]	9.06 [230.12]	6.00 [154.4]	7.7 [196]	6.7 [170]
3 [80]	8.00 [203]	–	3.00 [76]	3.00 [76]	5.19 [131.8]	5.54 [140.7]	7.14 [181.4]	1.098 [27.89]	4.016 [102.00]	4.90 [124.4]	0.318 [8.08]	0.43-[4]	0.59 [14.99]	6.64 [168.7]	8.19 [208.0]	1.75 [44.5]	9.06 [230.12]	6.00 [154.4]	13.7 [348]	7.5 [191]
4 [100]	9.00 [229]	–	4.00 [102]	4.00 [102]	6.65 [168.9]	7.11 [180.6]	9.14 [232.2]	1.413 [35.89]	5.512 [140.00]	6.90 [175.00]	0.398 [10.11]	0.67-[4]	0.77 [19.56]	8.48 [215.4]	10.18 [258.6]	2.51 [63.8]	9.06 [230.12]	6.00 [154.4]	23.9 [607]	9.6 [244]
6 × 4 [150 × 100]	15.50 [394]	–	4.00 [102]	6.00 [152]	6.65 [168.9]	7.11 [180.6]	9.14 [232.2]	1.413 [35.89]	5.512 [140.00]	6.90 [175.00]	0.398 [10.11]	0.67-[4]	0.77 [19.56]	8.48 [215.4]	10.18 [258.6]	2.51 [63.8]	9.06 [230.12]	6.00 [154.4]	–	–
6 [150]	15.50 [394]	–	6.00 [152]	6.00 [152]	8.25 [209.5]	9.17 [232.9]	11.50 [292.1]	1.650 [41.91]	6.00 [152.40]	7.00 [177.8]	0.476 [12.09]	0.56-[4]	0.84 [21.3]	10.54 [267.7]	12.24 [310.9]	2.51 [63.8]	12.19 [309.6]	12.00 [304.8]	38.2 [970]	11.9 [302]
8 × 6 [200 × 150]	18.00 [457]	–	6.00 [152]	8.00 [203]	8.25 [209.5]	9.17 [232.9]	11.50 [292.1]	1.650 [41.91]	6.00 [152.40]	7.00 [177.8]	0.476 [12.09]	0.56-[4]	0.84 [21.3]	10.54 [267.7]	12.24 [310.9]	2.51 [63.8]	12.19 [309.6]	12.00 304.8]	–	–
8 [200]	18.00 [457]	–	8.00 [203]	8.00 [203]	10.06 [255.5]	11.52 [292.6]	14.00 [355.6]	1.886 [47.90]	6.496 [165.00]	8.00 [203.2]	0.556 [14.12]	0.81-[4]	0.94 [23.88]	13.02 [330.7]	14.79 [375.7]	3.00 [76.2]	12.19 [309.6]	16.00 [406.4]	–	–
10 × 8 [250 × 200]	21.00 [533]	–	8.00 [203]	10.00 [254]	10.06 [255.5]	11.52 [292.6]	14.00 [355.6]	1.886 [47.90]	6.496 [165.00]	8.00 [203.2]	0.556 [14.12]	0.81-[4]	0.94 [23.88]	13.02 [330.7]	14.79 [375.7]	3.00 [76.2]	12.19 [309.6]	16.00 [406.4]	–	–
10 [250]	21.00 [533]	–	10.00 [254]	10.00 [254]	12.00 [304.8]	13.42 [340.9]	16.52 [419.6]	2.357 [59.87]	8.00 [203.20]	9.50 [241.3]	0.712 [18.08]	0.81-[4]	0.94 [23.9]	15.30 [388.6]	17.28 [438.9]	3.63 [92.08]	14.94 [379.5]	20.00 [508.0]	–	–
12 × 10 [300 × 250]	24.00 [610]	–	10.00 [254]	12.00 [305]	12.00 [304.8]	13.42 [340.9]	16.52 [419.6]	2.357 [59.87]	8.00 [203.20]	9.50 [241.3]	0.712 [18.08]	0.81-[4]	0.94 [23.9]	15.30 [388.6]	17.28 [438.9]	3.63 [92.08]	14.94 [379.5]	20.00 [508.0]	–	–
12 [300]	24.00 [610]	–	12.00 [305]	12.00 [305]	13.27 [337.0]	14.85 [377.2]	19.75 [501.6]	2.357 [59.87]	8.00 [203.20]	9.50 [241.3]	0.712 [18.08]	0.81-[4]	0.94 [23.9]	16.73 [424.9]	18.71 [475.2]	3.63 [92.08]	14.94 [379.5]	20.00 [508.0]	–	–
14 [350]	27.00 [686]	–	13.25 [337]	13.25 [337]	15.28 [388.1]	16.97 [431.0]	21.04 [534.4]	2.830 [71.88]	10.00 [254.00]	11.90 [302.00]	0.792 [20.12]	0.67-[8]	1.25 [31.80]	19.22 [488.2]	21.68 [550.7]	4.63 [117.5]	18.09 [459.5]	24.00 [609.6]	–	–
16 [400]	30.00 [762]	–	15.25 [387]	15.25 [387]	16.91 [429.5]	18.6 [472.4]	22.67 [575.8]	2.830 [71.88]	10.00 [254.00]	11.90 [302.00]	0.792 [20.12]	0.67-[8]	1.25 [31.80]	20.85 [529.6]	23.31 [592.1]	4.63 [117.5]	19.72 [500.9]	30.00 [762.0]	–	–

†M, N, and Q dimensions are for less gear and with gear configurations only.

ASME Class 300 dimensions

2 to 16 in [50 to 400 mm]



Bare stem valve

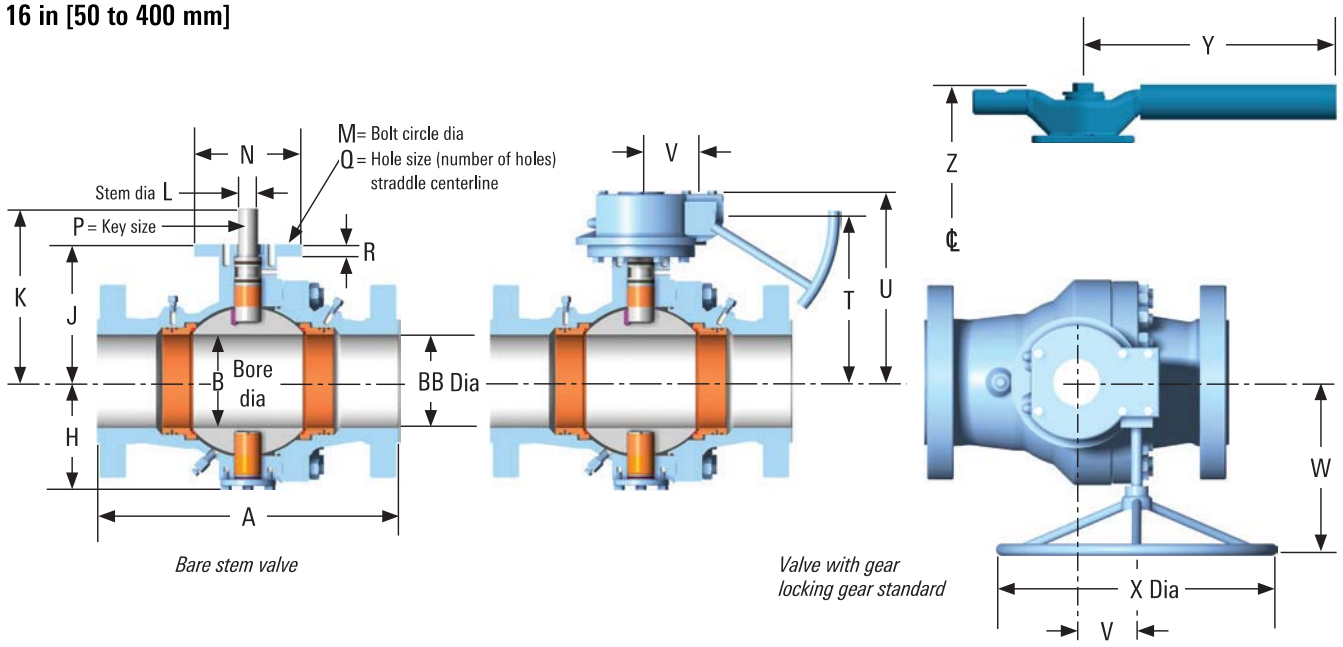
Valve with gear locking gear standard

Dimensions

Size, in [mm]	A RF	A RJ	B	BB	H	J	K	L	M†	N†	P	Q†	R	T	U	V	W	X	Y	Z
2 [50]	8.50 [216]	–	2.00 [51]	2.00 [51]	4.31 [109.5]	4.67 [118.6]	6.31 [160.3]	1.098 [27.89]	4.016 [102.00]	4.90 [124.4]	0.318 [8.08]	0.43-[4]	0.59 [14.99]	5.77 [146.6]	7.32 [185.9]	1.75 [44.5]	9.06 [230.12]	6.00 [154.4]	13.7 [348]	6.7 [170]
3 [80]	11.12 [282]	–	3.00 [76]	3.00 [76]	5.19 [131.8]	5.54 [140.7]	7.14 [181.4]	1.098 [27.89]	4.016 [102.00]	4.90 [124.4]	0.318 [8.08]	0.43-[4]	0.59 [14.99]	6.64 [168.7]	8.19 [208.0]	1.75 [44.5]	9.06 [230.12]	6.00 [154.4]	19.7 [500]	7.5 [191]
4 [100]	12.00 [305]	–	4.00 [102]	4.00 [102]	6.65 [168.9]	7.11 [180.6]	9.14 [232.2]	1.413 [35.89]	5.512 [140.00]	6.90 [175.00]	0.398 [10.11]	0.67-[4]	0.77 [19.56]	8.48 [215.4]	10.18 [258.6]	2.51 [63.8]	9.06 [230.12]	6.00 [154.4]	31.9 [810]	9.6 [244]
6 × 4 [150 × 100]	15.88 [403]	–	4.00 [102]	6.00 [152]	6.65 [168.9]	7.11 [180.6]	9.14 [232.2]	1.413 [35.89]	5.512 [140.00]	6.90 [175.00]	0.398 [10.11]	0.67-[4]	0.77 [19.56]	8.48 [215.4]	10.18 [258.6]	2.51 [63.8]	9.06 [230.12]	6.00 [154.4]	–	–
6 [150]	15.88 [403]	–	6.00 [152]	6.00 [152]	8.25 [209.5]	9.17 [232.9]	11.50 [292.1]	1.650 [41.91]	6.00 [152.40]	7.00 [177.8]	0.476 [12.09]	0.56-[4]	0.84 [21.3]	10.54 [267.7]	12.24 [310.9]	2.51 [63.8]	12.19 [309.6]	12.00 [304.8]	–	–
8 × 6 [200 × 150]	19.75 [502]	–	6.00 [152]	8.00 [203]	8.25 [209.5]	9.17 [232.9]	11.50 [292.1]	1.650 [41.91]	6.00 [152.40]	7.00 [177.8]	0.476 [12.09]	0.56-[4]	0.84 [21.3]	10.54 [267.7]	12.24 [310.9]	2.51 [63.8]	12.19 [309.6]	12.00 304.8]	–	–
8 [200]	19.75 [502]	–	8.00 [203]	8.00 [203]	10.45 [265.4]	11.85 [301.0]	14.95 [379.7]	2.357 [59.87]	8.00 [203.20]	9.50 [241.3]	0.712 [18.08]	0.81-[4]	0.94 [23.88]	13.73 [348.7]	15.71 [399.0]	3.63 [92.08]	13.81 [350.8]	16.00 [406.4]	–	–
10 × 8 [250 × 200]	22.38 [568]	–	8.00 [203]	10.00 [254]	10.45 [265.4]	11.85 [301.0]	14.95 [379.7]	2.357 [59.87]	8.00 [203.20]	9.50 [241.3]	0.712 [18.08]	0.81-[4]	0.94 [23.88]	13.73 [348.7]	15.71 [399.0]	3.63 [92.08]	13.81 [350.8]	16.00 [406.4]	–	–
10 [250]	22.38 [568]	–	10.00 [254]	10.00 [254]	12.00 [304.8]	13.42 [340.9]	16.52 [419.6]	2.357 [59.87]	8.00 [203.20]	9.50 [241.3]	0.712 [18.08]	0.81-[4]	0.94 [23.9]	15.30 [388.6]	17.28 [438.9]	3.63 [92.08]	14.94 [379.5]	20.00 [508.0]	–	–
12 × 10 [300 × 250]	25.50 [648]	–	10.00 [254]	12.00 [305]	12.00 [304.8]	13.42 [340.9]	16.52 [419.6]	2.357 [59.87]	8.00 [203.20]	9.50 [241.3]	0.712 [18.08]	0.81-[4]	0.94 [23.9]	15.30 [388.6]	17.28 [438.9]	3.63 [92.08]	14.94 [379.5]	20.00 [508.0]	–	–
12 [300]	25.50 [648]	–	12.00 [305]	12.00 [305]	14.41 [366.0]	16.10 [408.9]	20.17 [512.3]	2.830 [71.88]	10.00 [254.00]	9.50 [241.3]	0.792 [20.12]	0.67-[8]	1.25 [31.80]	18.35 [466.1]	20.81 [528.6]	4.63 [117.5]	18.09 [459.5]	24.00 [609.6]	–	–
14 [350]	30.00 [762]	–	13.25 [337]	13.25 [337]	15.28 [388.1]	16.97 [431.0]	21.04 [534.4]	2.830 [71.88]	10.00 [254.00]	11.90 [302.00]	0.792 [20.12]	0.67-[8]	1.25 [31.80]	19.22 [488.2]	21.68 [550.7]	4.63 [117.5]	19.72 [500.9]	30.00 [762.0]	–	–
16 [400]	33.00 [838]	–	15.25 [387]	15.25 [387]	18.18 [461.8]	19.89 [505.2]	24.46 [621.3]	3.145 [79.88]	10.375 [263.53]	12.00 [305.00]	0.87 [22.10]	0.67-[8]	1.27 [32.3]	25.01 [635.3]	26.40 [670.6]	5.67 [144.1]	19.78 [502.4]	20.00 [508.0]	–	–

†M, N, and Q dimensions are for less gear and with gear configurations only.

ASME Class 600 dimensions
2 to 16 in [50 to 400 mm]



Bare stem valve

Valve with gear locking gear standard

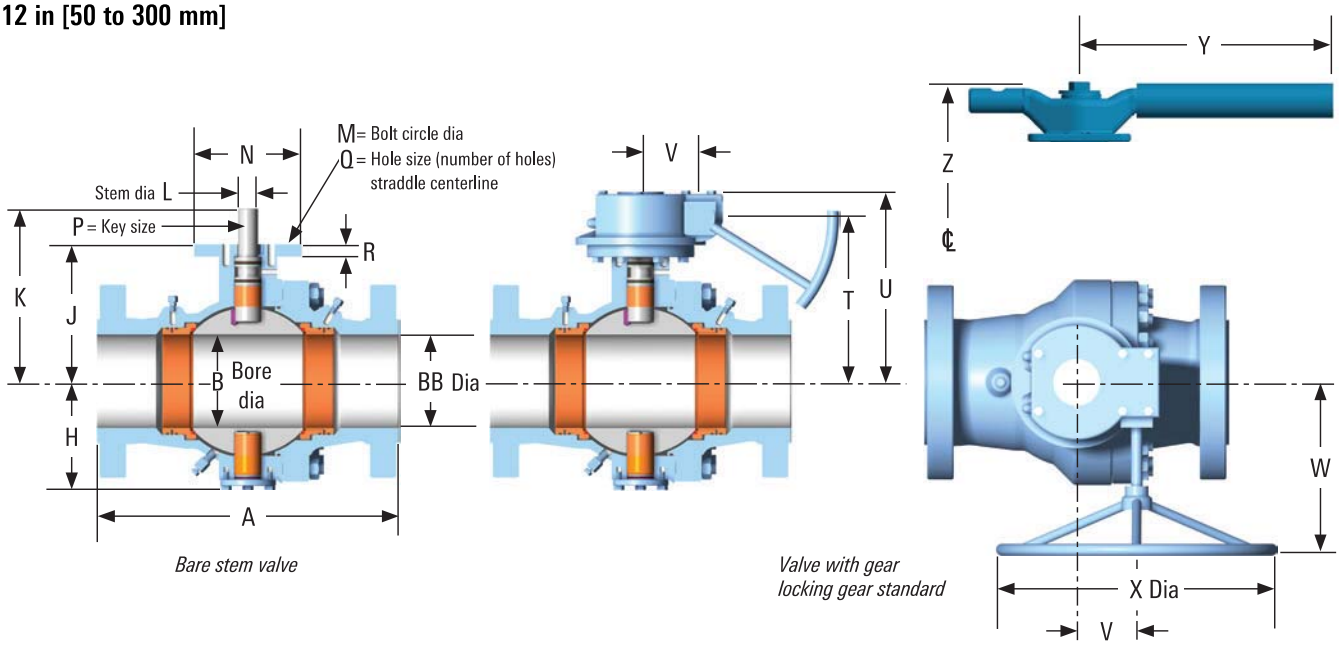
Dimensions

Size, in [mm]	A		B	BB	H	J	K	L	M†	N†	P	Q†	R	T	U	V	W	X	Y	Z
	RF	RJ																		
2 [50]	11.50 [292]	11.62 [295]	2.00 [51]	2.00 [51]	4.31 [109.5]	4.67 [118.6]	6.31 [160.3]	1.098 [27.89]	4.016 [102.00]	4.90 [124.4]	0.318 [8.08]	0.43-[4]	0.59 [14.99]	5.77 [146.6]	7.32 [185.9]	1.75 [44.5]	9.06 [230.12]	6.00 [154.4]	13.7 [348]	6.7 [170]
3 × 2 [80 × 50]	14.00 [356]	14.12 [359]	2.00 [51]	3.00 [76]	4.31 [109.5]	4.67 [118.6]	6.31 [160.3]	1.098 [27.89]	4.016 [102.00]	4.90 [124.4]	0.318 [8.08]	0.43-[4]	0.59 [14.99]	5.77 [146.6]	7.32 [185.9]	1.75 [44.5]	9.06 [230.12]	6.00 [154.4]	–	–
3 [80]	14.00 [356]	14.12 [359]	3.00 [76]	3.00 [76]	5.84 [148.3]	6.23 [158.2]	8.27 [210.1]	1.413 [35.89]	5.512 [140.00]	6.90 [175.00]	0.398 [10.11]	0.67-[4]	0.77 [19.56]	7.60 [193.0]	9.30 [236.2]	2.51 [63.8]	9.06 [230.12]	6.00 [154.4]	31.9 [810]	8.7 [221]
4 × 3 [100 × 80]	17.00 [432]	17.12 [435]	3.00 [76]	4.00 [102]	5.84 [148.3]	6.23 [158.2]	8.27 [210.1]	1.413 [35.89]	5.512 [140.00]	6.90 [175.00]	0.398 [10.11]	0.67-[4]	0.77 [19.56]	7.60 [193.0]	9.30 [236.2]	2.51 [63.8]	9.06 [230.12]	6.00 [154.4]	–	–
4 [100]	17.00 [432]	17.12 [435]	4.00 [102]	4.00 [102]	7.02 [178.3]	7.77 [197.4]	10.10 [256.5]	1.650 [41.91]	6.00 [152.40]	7.00 [177.8]	0.476 [12.09]	0.56-[4]	0.84 [21.3]	9.14 [232.2]	10.84 [275.3]	2.51 [63.8]	12.19 [309.6]	12.00 [304.8]	45.2 [1,148]	10.6 [269]
6 × 4 [150 × 100]	22.00 [559]	22.12 [562]	4.00 [102]	6.00 [152]	7.02 [178.3]	7.77 [197.4]	10.10 [256.5]	1.650 [41.91]	6.00 [152.40]	7.00 [177.8]	0.476 [12.09]	0.56-[4]	0.84 [21.3]	9.14 [232.2]	10.84 [275.3]	2.51 [63.8]	12.19 [309.6]	12.00 [304.8]	–	–
6 [150]	22.00 [559]	22.12 [562]	6.00 [152]	6.00 [152]	8.87 [225.3]	10.04 [255.0]	12.53 [318.3]	1.886 [47.90]	6.496 [165.00]	8.00 [203.2]	0.556 [14.12]	0.81-[4]	0.94 [23.88]	11.54 [293.1]	13.31 [338.1]	3.00 [76.2]	13.31 [338.1]	20.00 [508.0]	–	–
8 × 6 [200 × 150]	26.00 [660]	26.12 [663]	6.00 [152]	8.00 [203]	8.87 [225.3]	10.04 [255.0]	12.53 [318.3]	1.886 [47.90]	6.496 [165.00]	8.00 [203.2]	0.556 [14.12]	0.81-[4]	0.94 [23.88]	11.54 [293.1]	13.31 [338.1]	3.00 [76.2]	13.31 [338.1]	20.00 [508.0]	–	–
8 [200]	26.00 [660]	26.12 [663]	8.00 [203]	8.00 [203]	10.45 [265.4]	11.85 [301.1]	14.95 [379.7]	2.357 [59.87]	8.00 [203.20]	9.50 [241.3]	0.712 [18.08]	0.81-[4]	0.94 [23.9]	13.73 [348.7]	15.71 [399.0]	3.63 [92.08]	16.44 [417.6]	24.00 [609.6]	–	–
10 × 8 [250 × 200]	31.00 [787]	31.12 [790]	8.00 [203]	10.00 [254]	10.45 [265.4]	11.85 [301.1]	14.95 [379.7]	2.357 [59.87]	8.00 [203.20]	9.50 [241.3]	0.712 [18.08]	0.81-[4]	0.94 [23.9]	13.73 [348.7]	15.71 [399.0]	3.63 [92.08]	16.44 [417.6]	24.00 [609.6]	–	–
10 [250]	31.00 [787]	31.12 [790]	10.00 [254]	10.00 [254]	12.91 [327.9]	14.53 [369.1]	18.60 [472.4]	2.830 [71.88]	10.00 [254.00]	11.90 [302.00]	0.792 [20.12]	0.67-[8]	1.25 [31.80]	16.78 [426.2]	19.24 [488.7]	4.63 [117.5]	19.72 [500.9]	30.00 [762.0]	–	–
12 × 10 [300 × 250]	33.00 [838]	33.12 [841]	10.00 [254]	12.00 [305]	12.91 [327.9]	14.53 [369.1]	18.60 [472.4]	2.830 [71.88]	10.00 [254.00]	11.90 [302.00]	0.792 [20.12]	0.67-[8]	1.25 [31.80]	16.78 [426.2]	19.24 [488.7]	4.63 [117.5]	19.72 [500.9]	30.00 [762.0]	–	–
12 [300]	33.00 [838]	33.12 [841]	12.00 [305]	12.00 [305]	14.41 [366.0]	16.1 [408.9]	20.17 [512.3]	2.830 [71.88]	10.00 [254.00]	11.90 [302.00]	0.792 [20.12]	0.67-[8]	1.25 [31.80]	18.35 [466.1]	20.81 [528.6]	4.63 [117.5]	19.72 [500.9]	30.00 [762.0]	–	–
14 [350]	35.00 [889]	35.12 [892]	13.25 [337]	13.25 [337]	16.55 [420.4]	18.54 [470.9]	22.84 [580.1]	3.145 [79.88]	10.375 [263.53]	12.00 [305.00]	0.87 [22.10]	0.67-[8]	1.27 [32.3]	23.66 [601.0]	25.05 [636.3]	5.67 [144.1]	21.28 [540.5]	24.00 [609.6]	–	–
16 [400]	39.00 [991]	39.12 [994]	15.25 [387]	15.25 [387]	18.37 [466.6]	20.17 [512.3]	25.64 [651.3]	3.852 [97.84]	11.732 [298.00]	13.70 [348.00]	1.106 [28.09]	0.83-[8]	1.36 [34.5]	25.36 [644.1]	26.74 [679.2]	7.30 [185.5]	22.59 [573.8]	30.00 [762.0]	–	–

†M, N, and Q dimensions are for less gear and with gear configurations only.

ASME Class 900 dimensions

2 to 12 in [50 to 300 mm]



Bare stem valve

Valve with gear locking gear standard

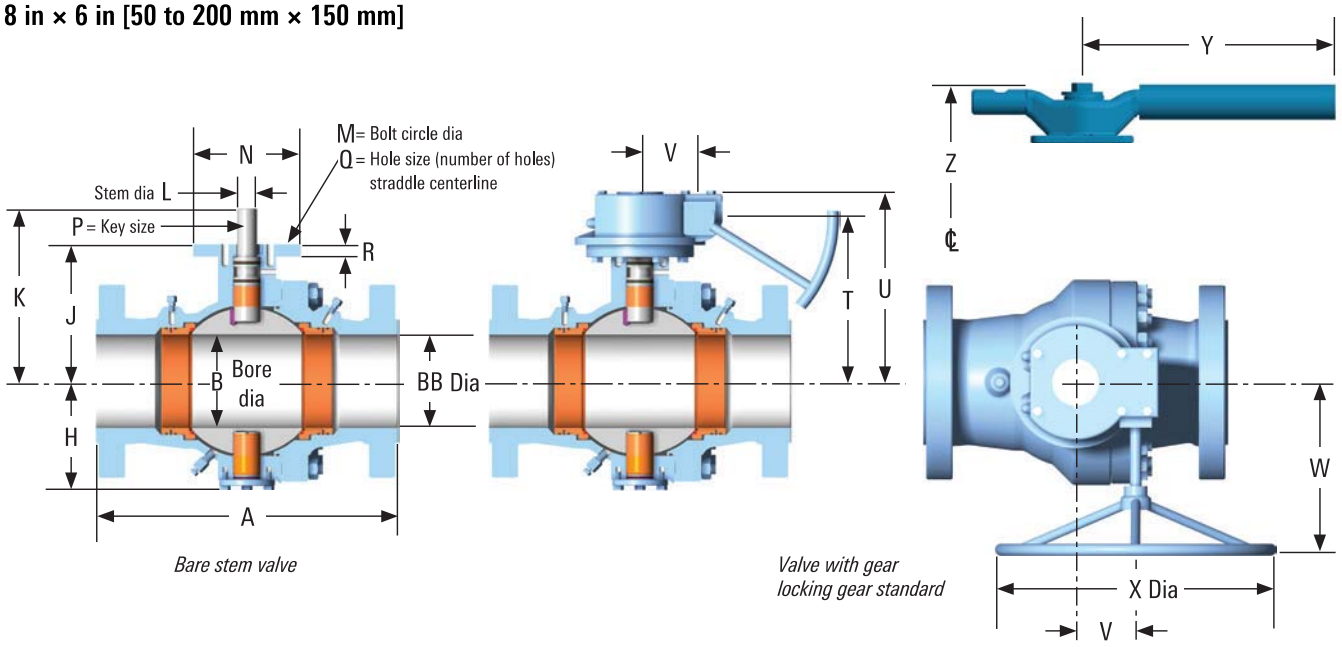
Dimensions

Size, in [mm]	A RF	A RJ	B	BB	H	J	K	L	M†	N†	P	Q†	R	T	U	V	W	X	Y	Z
2 [50]	14.50 [368]	14.62 [371]	2.00 [51]	2.00 [51]	4.31 [109.5]	4.67 [118.6]	6.31 [160.3]	1.098 [27.89]	4.016 [102.00]	4.90 [124.4]	0.318 [8.08]	0.43-[4]	0.59 [14.99]	5.77 [146.6]	7.32 [185.9]	1.75 [44.5]	9.06 [230.12]	6.00 [154.4]	19.7 [500]	6.7 [170]
3 × 2 [80 × 50]	15.00 [381]	15.12 [384]	2.00 [51]	3.00 [76]	4.31 [109.5]	4.67 [118.6]	6.31 [160.3]	1.098 [27.89]	4.016 [102.00]	4.90 [124.4]	0.318 [8.08]	0.43-[4]	0.59 [14.99]	5.77 [146.6]	7.32 [185.9]	1.75 [44.5]	9.06 [230.12]	6.00 [154.4]	–	–
3 [80]	15.00 [381]	15.12 [384]	3.00 [76]	3.00 [76]	5.84 [148.3]	6.23 [158.2]	8.27 [210.1]	1.413 [35.89]	5.512 [140.00]	6.90 [175.00]	0.398 [10.11]	0.67-[4]	0.77 [19.56]	7.60 [193.0]	9.30 [236.2]	2.51 [63.8]	9.06 [230.12]	6.00 [154.4]	36.9 [937]	8.7 [221]
4 × 3 [100 × 80]	18.00 [457]	18.12 [460]	3.00 [76]	4.00 [102]	5.84 [148.3]	6.23 [158.2]	8.27 [210.1]	1.413 [35.89]	5.512 [140.00]	6.90 [175.00]	0.398 [10.11]	0.67-[4]	0.77 [19.56]	7.60 [193.0]	9.30 [236.2]	2.51 [63.8]	9.06 [230.12]	6.00 [154.4]	–	–
4 [100]	18.00 [457]	18.12 [461]	4.00 [102]	4.00 [102]	7.02 [178.3]	7.77 [197.4]	10.10 [256.5]	1.650 [41.91]	6.00 [152.40]	7.00 [177.8]	0.476 [12.09]	0.56-[4]	0.84 [21.3]	9.14 [232.2]	10.84 [275.3]	2.51 [63.8]	12.19 [309.6]	12.00 [304.8]	–	–
6 × 4 [150 × 100]	24.00 [610]	24.12 [613]	4.00 [102]	6.00 [152]	7.02 [178.3]	7.77 [197.4]	10.10 [256.5]	1.650 [41.91]	6.00 [152.40]	7.00 [177.8]	0.476 [12.09]	0.56-[4]	0.84 [21.3]	9.14 [232.2]	10.84 [275.3]	2.51 [63.8]	12.19 [309.6]	12.00 [304.8]	–	–
6 [150]	24.00 [610]	24.12 [613]	6.00 [152]	6.00 [152]	9.12 [231.6]	10.51 [267.0]	13.61 [345.7]	2.357 [59.87]	8.00 [203.20]	9.50 [241.3]	0.712 [18.08]	0.81-[4]	0.94 [23.88]	12.39 [314.7]	14.37 [365.0]	3.63 [92.08]	14.94 [379.5]	20.00 [508.0]	–	–
8 × 6 [200 × 150]	29.00 [737]	29.12 [740]	6.00 [152]	8.00 [203]	9.12 [231.6]	10.51 [267.0]	13.61 [345.7]	2.357 [59.87]	8.00 [203.20]	9.50 [241.3]	0.712 [18.08]	0.81-[4]	0.94 [23.88]	12.39 [314.7]	14.37 [365.0]	3.63 [92.08]	14.94 [379.5]	20.00 [508.0]	–	–
8 [200]	29.00 [737]	29.12 [740]	8.00 [203]	8.00 [203]	11.77 [299.0]	13.13 [333.5]	17.20 [436.9]	2.830 [71.88]	10.00 [254.00]	11.90 [302.00]	0.792 [20.12]	0.67-[8]	1.25 [31.80]	15.38 [390.7]	17.84 [453.1]	4.63 [117.5]	18.09 [459.5]	24.00 [609.6]	–	–
10 × 8 [250 × 200]	33.00 [838]	33.12 [841]	8.00 [203]	10.00 [254]	11.77 [299.0]	13.13 [333.5]	17.20 [436.9]	2.830 [71.88]	10.00 [254.00]	11.90 [302.00]	0.792 [20.12]	0.67-[8]	1.25 [31.80]	15.38 [390.7]	17.84 [453.1]	4.63 [117.5]	18.09 [459.5]	24.00 [609.6]	–	–
10 [250]	33.00 [838]	33.12 [841]	10.00 [254]	10.00 [254]	12.91 [327.9]	14.53 [369.1]	18.60 [472.4]	2.830 [71.88]	10.00 [254.00]	11.90 [302.00]	0.792 [20.12]	0.67-[8]	1.25 [31.80]	16.78 [426.2]	19.24 [488.7]	4.63 [117.5]	19.72 [500.9]	30.00 [762.0]	–	–
12 × 10 [300 × 250]	38.00 [965]	38.12 [968]	10.00 [254]	12.00 [305]	12.91 [327.9]	14.53 [369.1]	18.60 [472.4]	2.830 [71.88]	10.00 [254.00]	11.90 [302.00]	0.792 [20.12]	0.67-[8]	1.25 [31.80]	16.78 [426.2]	19.24 [488.7]	4.63 [117.5]	19.72 [500.9]	30.00 [762.0]	–	–
12 [300]	38.00 [965]	38.12 [968]	12.00 [305]	12.00 [305]	15.80 [401.3]	17.52 [445.0]	22.09 [561.1]	3.145 [79.88]	10.375 [263.53]	12 [305.00]	0.87 [22.10]	0.67-[8]	1.27 [32.3]	22.64 [575.1]	24.03 [610.4]	5.67 [144.1]	21.28 [540.5]	24.00 [609.6]	–	–

†M, N, and Q dimensions are for less gear and with gear configurations only.

ASME Class 1500 and 2500 dimensions

2 to 8 in × 6 in [50 to 200 mm × 150 mm]



Bare stem valve

Valve with gear locking gear standard

Dimensions

ASME Class 1500

Size, in [mm]	A RF	A RJ	B	BB	H	J	K	L	M†	N†	P	Q†	R	T	U	V	W	X	Y	Z
2 [50]	14.50 [368]	14.62 [371]	2.00 [51]	2.00 [51]	5.21 [132.3]	5.54 [140.7]	7.57 [192.3]	1.413 [35.89]	5.512 [140.00]	6.90 [175.00]	0.398 [10.11]	0.67-[4]	0.77 [19.56]	6.91 [175.5]	8.61 [218.7]	2.51 [63.8]	9.06 [230.12]	6.00 [154.4]	23.9 [607]	8.00 [203]
3 [80]	18.50 [470]	18.62 [473]	3.00 [76]	3.00 [76]	6.36 [161.5]	7.13 [181.1]	9.44 [239.8]	1.650 [41.91]	6.00 [152.40]	7.00 [177.8]	0.476 [12.09]	0.56-[4]	0.84 [21.3]	8.50 [215.9]	10.20 [259.1]	2.51 [63.8]	12.19 [309.6]	12.00 [304.8]	–	–
4 [100]	21.50 [546]	21.63 [549]	4.00 [102]	4.00 [102]	7.59 [192.8]	8.70 [221.0]	11.19 [284.2]	1.886 [47.90]	6.496 [165.00]	8.00 [203.2]	0.556 [14.12]	0.81-[4]	0.94 [23.88]	10.20 [259.1]	11.97 [304.0]	3.00 [76.2]	11.56 [293.6]	14.00 [355.6]	–	–
6 × 4 [150 × 100]	27.75 [705]	28.00 [711]	4.00 [102]	6.00 [152]	7.59 [192.8]	8.70 [221.0]	11.19 [284.2]	1.886 [47.90]	6.496 [165.00]	8.00 [203.2]	0.556 [14.12]	0.81-[4]	0.94 [23.88]	10.20 [259.1]	11.97 [304.0]	3.00 [76.2]	11.56 [293.6]	14.00 [355.6]	–	–
6 [150]	27.75 [705]	28.00 [711]	6.00 [152]	6.00 [152]	10.25 [260.4]	10.83 [275.1]	13.61 [345.7]	2.357 [59.87]	8.50 [215.9]	9.50 [241.3]	0.712 [18.08]	0.68-[4]	1.04 [26.4]	12.71 [322.8]	14.69 [373.1]	3.63 [92.08]	16.44 [417.6]	24.00 [609.6]	–	–
8 × 6 [200 × 150]	32.75 [832]	33.12 [841]	6.00 [152]	7.62 [194]	10.25 [260.4]	10.83 [275.1]	13.61 [345.7]	2.357 [59.87]	8.00 [203.20]	9.50 [241.3]	0.712 [18.08]	0.81-[4]	1.04 [26.4]	12.71 [322.8]	14.69 [373.1]	3.63 [92.08]	16.44 [417.6]	24.00 [609.6]	–	–
ASME Class 2500																				
2 [50]	17.75 [451]	17.88 [454]	1.76 [45]	1.76 [45]	5.21 [132.3]	5.54 [140.7]	7.57 [192.3]	1.413 [35.89]	5.512 [140.00]	6.90 [175.00]	0.398 [10.11]	0.67-[4]	0.77 [19.56]	6.91 [175.5]	8.61 [218.7]	2.51 [63.8]	9.06 [230.12]	6.00 [154.4]	36.97 [939]	8.00 203.2]
3 [80]	22.75 [578]	23.00 [584]	2.53 [64]	2.53 [64]	6.91 [175.5]	7.34 [186.4]	9.44 [252.5]	1.650 [41.91]	6.00 [152.40]	7.70 [159.6]	0.476 [12.09]	0.56-[4]	1.09 [27.7]	8.71 [221.2]	10.41 [264.4]	2.51 [63.8]	12.56 [319.0]	14.00 [355.6]	–	–
4 [100]	26.50 [673]	26.88 [983]	3.53 [90]	3.53 [90]	7.75 [196.9]	8.91 [226.3]	11.19 [284.2]	1.886 [47.90]	6.496 [165.00]	8.40 [213.4]	0.556 [14.12]	0.67-[4]	1.16 [29.50]	10.41 [264.4]	12.18 [309.4]	3.00 [76.2]	14.81 [37602]	24.00 [609.6]	–	–
6 × 4 [150 × 100]	36.00 [914]	36.50 [927]	3.53 [90]	5.25 [133]	7.59 [192.8]	8.70 [221.0]	11.19 [284.2]	1.886 [47.90]	6.496 [165.00]	8.40 [213.4]	0.556 [14.12]	0.67-[4]	1.16 [29.50]	10.20 [259.1]	11.97 [304.0]	3.00 [76.2]	11.56 [293.6]	14.00 [355.6]	–	–

†M, N, and Q dimensions are for less gear and with gear configurations only.

Weights, C_v Data

Weights, lb [kg]—Valve Only—Bare Stem											
Valve Port		**Valve Pressure Classes**									
Size, in	**mm**	**150**	**300**	**600**		**900**		**1500**		**2500**	
		RF	**RF**	**RF**	**RTJ**	**RF**	**RTJ**	**RF**	**RTJ**	**RF**	**RTJ**
2	50	41 [19]	53 [24]	64 [29]	68 [31]	101 [46]	108 [49]	139 [63]	146 [66]	185 [84]	194 [88]
3 × 2	80 × 50	–	–	87 [40]	92 [42]	116 [52]	124 [56]	–	–	–	–
3	80	69 [31]	96 [44]	142 [64]	137 [62]	172 [78]	180 [81]	250 [113]	260 [118]	435 [197]	452 [205]
4 × 3	100 × 80	–	–	186 [84]	195 [89]	225 [102]	236 [107]	–	–	–	–
4	100	130 [59]	172 [78]	246 [112]	256 [116]	313 [142]	324 [147]	437 [198]	451 [204]	674 [306]	702 [318]
6 × 4	150 × 100	171 [78]	229 [104]	346 [157]	362 [164]	458 [208]	477 [216]	663 [301]	688 [312]	1,171 [531]	1,231 [558]
6	150	257 [116]	320 [145]	460 [209]	476 [216]	728 [330]	746 [339]	1,039 [471]	1,063 [482]	–	–
8 × 6	200 × 150	304 [138]	410 [186]	582 [264]	602 [273]	926 [420]	956 [434]	1,331 [604]	1,377 [625]	–	–
8	200	475 [215]	632 [287]	846 [384]	867 [393]	1,231 [558]	1,260 [572]	–	–	–	–
10 × 8	250 × 200	532 [241]	719 [326]	1,069 [485]	1,103 [500]	1,456 [660]	1,494 [678]	–	–	–	–
10	250	783 [355]	965 [438]	1,472 [668]	1,503 [682]	1,857 [842]	1,894 [859]	–	–	–	–
12 × 10	300 × 250	880 [399]	1,113 [505]	1,589 [721]	1,622 [736]	2,115 [959]	2,161 [980]	–	–	–	–
12	300	1,165 [528]	1,476 [670]	1,993 [904]	2,025 [918]	2,861 [1,298]	2,905 [1,318]	–	–	–	–
14	350	1,663 [754]	1,972 [895]	2,539 [1,152]	2,576 [1,168]	–	–	–	–	–	–
16	400	2,441 [1,107]	2,940 [1,334]	3,870 [1,755]	3,919 [1,778]	–	–	–	–	–	–

Weights, lb [kg]—Worm Gear Actuator Only											
2	50	8 [4]	8 [4]	8 [4]	8 [4]	8 [4]	8 [4]	15 [7]	15 [7]	15 [7]	15 [7]
3 × 2	80 × 50	–	–	8 [4]	8 [4]	8 [4]	8 [4]	–	–	–	–
3	80	8 [4]	8 [4]	15 [7]	15 [7]	15 [7]	15 [7]	27 [12]	27 [12]	27 [12]	27 [12]
4 × 3	100 × 80	–	–	15 [7]	15 [7]	15 [7]	15 [7]	–	–	27 [12]	27 [12]
4	100	15 [7]	15 [7]	27 [12]	27 [12]	27 [12]	27 [12]	27 [12]	27 [12]	27 [12]	27 [12]
6 × 4	150 × 100	15 [7]	15 [7]	27 [12]	27 [12]	27 [12]	27 [12]	27 [12]	27 [12]	–	–
6	150	27 [12]	27 [12]	27 [12]	27 [12]	60 [27]	60 [27]	60 [27]	60 [27]	–	–
8 × 6	200 × 150	27 [12]	27 [12]	27 [12]	27 [12]	60 [27]	60 [27]	60 [27]	60 [27]	–	–
8	200	27 [12]	60 [27]	60 [27]	60 [27]	74 [34]	74 [34]	–	–	–	–
10 × 8	250 × 200	27 [12]	60 [27]	60 [27]	60 [27]	74 [34]	74 [34]	–	–	–	–
10	250	60 [27]	60 [27]	74 [34]	74 [34]	74 [34]	74 [34]	–	–	–	–
12 × 10	300 × 250	60 [27]	60 [27]	74 [34]	74 [34]	74 [34]	74 [34]	–	–	–	–
12	300	60 [27]	74 [34]	74 [34]	74 [34]	122 [55]	122 [55]	–	–	–	–
14	350	74 [34]	74 [34]	122 [55]	122 [55]	–	–	–	–	–	–
16	400	74 [34]	122 [55]	133 [60]	133 [60]	–	–	–	–	–	–

Note: Weights shown are for worm gear actuator, handwheel, and mounting hardware.

Flow Characteristics, C_v†							
2	50	473	429	369	328	328	207
3 × 2	75 × 50	–	–	136	136	–	–
3	75	1,244	1,055	940	908	818	490
4 × 3	100 × 75	–	–	407	406	–	–
4	100	2,492	2,158	1,813	1,762	1,598	1,014
6 × 4	150 × 100	432	432	552	551	593	414
6	150	5,468	5,403	4,590	4,394	4,112	–
8 × 6	200 × 150	1,294	1,293	1,642	1,637	1,652	–
8	200	10,782	10,293	8,971	8,494	–	–
10 × 8	250 × 200	2,843	2,848	3,578	3,569	–	–
10	250	17,438	16,892	14,352	13,911	–	–
12 × 10	300 × 250	5,195	5,187	6,505	6,454	–	–
12	300	16,892	26,702	22,772	21,221	–	–
14	350	22,742	22,254	21,507	–	–	–
16	400	31,823	31,142	29,902	–	–	–

† Flow of water in galUS/min per 1-psi pressure drop across a fully open valve.

ASME Class 150 through 2500 torque chart

Ball Valve Torque Chart

Valve port size, in [mm]	Pressure class	Pressure (P), gauge psi	Break torque at max. P, in-lb	Run torque at max. P, in-lb	Mast, in-lb
2 [50]	150	80–285	256	147	3,818
2 [50]	300	286–740	613	266	3,818
2 [50], 3 × 2 [75 × 50]	600	741–1,480	898	492	3,818
2 [50], 3 × 2 [75 × 50]	900	1,481–2,220	1,146	706	3,818
2 [50]	1500	2,221–3,705	1,904	1,181	8,334
2 [50]	2500	3,706–6,170	2,496	1,896	8,334
3 [75]	150	0–285	568	329	3,818
3 [75]	300	286–740	1,238	576	3,818
3 [75], 4 × 3 [100 × 75]	600	741–1,480	2,039	1,094	8,334
3 [75], 4 × 3 [100 × 75]	900	1,481–2,220	2,611	1,634	8,334
3 [75]	1500	2,221–3,705	4,399	2,451	13,241
3 [75]	2500	3,706–6,170	6,368	4,016	13,241
4 [100], 6 × 4 [150 × 100]	150	80–285	1,026	604	8,334
	300	286–740	2,125	1,121	8,334
	600	741–1,480	3,581	2,069	13,241
	900	1,481–2,220	4,575	3,008	13,241
	1500	2,221–3,705	7,328	4,079	18,746
	2500	3,706–6,170	9,371	6,581	18,746
6 [150], 8 × 6 [200 × 150]	150	80–285	2,947	1,698	13,241
	300	286–740	4,495	1,988	13,241
	600	741–1,480	7,195	2,846	18,746
	900	1,481–2,220	11,022	4,534	36,792
	1500	2,221–3,705	15,323	7,510	36,792
8 [200], 10 × 8 [250 × 200]	150	80–285	5,146	2,870	18,746
	300	286–740	9,041	3,458	36,792
	600	741–1,480	13,423	4,631	36,792
	900	1,481–2,220	21,210	6,021	69,591
10 [250], 12 × 10 [300 × 250]	150	80–285	8,480	5,541	36,792
	300	286–740	13,149	6,237	36,792
	600	741–1,480	23,638	7,295	69,591
	900	1,481–2,220	30,433	8,013	69,591
12 [300]	150	0–285	11,601	6,311	36,792
	300	286–740	21,179	7,430	69,591
	600	741–1,480	31,608	8,405	69,591
	900	1,481–2,220	46,301	10,701	92,606
14 [350]	150	80–285	16,370	10,275	69,591
	300	286–740	26,595	11,555	69,591
	600	741–1,480	45,288	13,634	92,606
16 [400]	150	80–285	21,999	12,447	69,591
	300	286–740	39,436	14,326	92,606
	600	741–1,480	70,917	17,382	173,880

The above values are new valve torque values, where P is the maximum operating pressure (psig) of the valve.
The above torque values do not contain service factors.
Soaking effects and/or particle matter in the valve may cause an increase in the torque.
The re-seat torque is equal to ~80% of the break torque.
For power operation, multiply all of the above values by a minimum factor of 1.25 or customer specified factor whichever is larger.
For operating temperatures between –20 to –50 degF (–29 to –46 degC) multiply these values by 1.20.
Actuator selection should be made on customer experience and appropriate service factors.

Material Selection Guide

A selection of body, stem, and seat/seal materials for the WKM 370D6 ball valves are available. The following list is intended as a guide in the selection of materials for corrosive service. Material suitability is based on ladings at ambient temperatures. Other temperatures may render a given material/lading combination inappropriate. No material can be expected to resist all the many ladings found in modern industry. Experience has shown that certain materials can perform satisfactorily within certain limits. The physical properties of a material are affected differently by each corrosive medium. Therefore, it sometimes becomes necessary to sacrifice value in another property. As a result, the user must decide which property is of prime importance for his application. Internal moving parts, in contact with the lading, should always carry an "A" rating. Body materials with exposure to corrosive ladings can sometimes carry a "B" rating because metal loss due to corrosive is not as critical.

We strongly recommend that tests be run under actual operating conditions to obtain a material's performance ability in any one corrosive medium.

Lading	External Valve Body Material			Seal Code Trim					Internal Valve Trim			
	Std body 23	Std body 24	Spl body 37	Std YRF	Spl YFF	Spl TFF	Spl PFF	Spl PLF	Std Int 23	Std Int 24	Spl Int 27	Spl Int 37
ACETALDEHYDE	A	C	C	C	D	D	D	C	A	C	A	C
ACETATE SOLVENTS	A	A	A		D	D	D		A	A	A	A
ACETIC ACID (10%)	–	–	–	D	D	A	A	A	–	–	–	–
ACETIC ACID (Glacial)	–	–	–	B	C	C	C	C	–	–	–	–
ACETIC ACID (Conc)	–	–	–	D	D	A	A	C	–	–	–	–
ACETIC ANHYDRIDE	B	D	D	D	D	D	D	D	B	D	B	D
ACETONET	A	A	A	D	D	D	D	D	A	A	A	A
ACETYLENE	A	A	A	A	A	A	A	A	A	A	A	A
ACRYLONITRILE	A	A	A	D	A	A	A	B	A	A	A	A
ALCOHOL-AMYL	A	B	B	B	A	A	A	A	A	B	A	B
ALCOHOL-BUTYL	A	B	B	A	A	A	A	A	A	B	A	B
ALCOHOL-ETHYL (ETHANOL)	A	B	B	A	A	A	A	A	A	B	A	B
ALCOHOL-METHYL (METHANOL)	A	B	B	B	B	A	A	A	A	B	A	B
ALUMINUM CHLORIDE (dry)	A	B	B	A	A	A	A	A	A	B	A	B
ALUMINUM SULFATE (ALUMS)	A	C	C	A	A	A	A	A	A	C	A	C
ALUM'S	A	C	C	A	A	A	A	B	A	C	A	C
AMINES	A	B	B	D	B	B	B	B	A	B	A	B
AMINES BASED-CORROSION INHIBITOR	A	A	A	A	A	A	A	A	A	A	A	A
AMINES RICH	A	B	B	D	B	B	B	B	A	B	A	B
AMMONIA (AQUEOUS)	A	A	A	A	A	A	A	A	A	A	A	A
AMMONIA ANHYDROUS	A	A	A	B	D	D	D	A	A	A	A	A
AMMONIA SOLUTIONS	A	B	B	–	–	–	–	–	A	B	A	B
AMMONIUM BICARBONATE	B	C	C	–	B	A	–	–	B	C	B	C
AMMONIUM CARBONATE	B	B	B	D	A	A	A	A	B	B	B	B
AMMONIUM CHLORIDE	C	D	D	B	B	A	A	A	C	D	C	D
AMMONIUM HYDROXIDE (28%)	B	C	C	D	A	A	A	B	B	C	B	C
AMMONIUM HYDROXIDE CONCENTRATED	B	C	C	B	A	A	A	B	B	C	B	C
AMMONIUM MONOPHOSPHATE	B	D	D	C	B	A	A	–	B	D	B	D
AMMONIUM NITRATE	A	D	D	C	C	A	A	A	A	D	A	D
AMMONIUM PHOSPHATE (DIBASIC)	B	D	D	C	C	A	A	A	B	D	B	D
AMMONIUM PHOSPHATE (TRIBASIC)	B	D	D	B	B	A	A	B	B	D	B	D
AMMONIUM SULFATE	B	C	C	A	A	A	A	A	B	C	B	C
AMYL ACETATE	B	C	C	D	B	A	A	C	B	C	B	C
ANILINE	B	A	A	C	C	A	D	A	B	A	A	A
ANILINE DYES	A	C	C	D	A	A	A	A	A	C	A	C
ANTIMONY TRICHLORIDE	D	D	D	D	D	A	A	A	D	D	–	D

A: Excellent B: Good (slightly attacked) C: Fair (modestly attacked) D: Not recommended –: No data

Reference: http://www.coleparmer.com/techinfo/chemcomp.asp. Chemical Resistance Guide by Compass Publications.

Material selection guide

Lading	External valve body material			Seal code trim					Internal valve trim			
	Std body 23	Std body 24	Spl body 37	Std YRF	Spl YFF	Spl TFF	Spl PFF	Spl PLF	Std Int 23	Std Int 24	Spl Int 27	Spl Int 37
APPLE JUICE	B	D	D	A	A	A	–	–	B	D	–	D
ARSENIC ACID	B	D	D	C	C	A	–	–	B	D	B	D
ASPHALT EMULSION	A	A	A	A	A	A	A	–	A	A	A	A
ASPHALT LIQUID	A	A	A	B	A	A	A	–	A	A	A	A
BARIUM CARBONATE	B	B	B	C	A	A	–	–	B	B	B	B
BARIUM CHLORIDE	C	C	C	A	A	A	A	A	C	C	C	C
BARIUM HYDROXIDE	B	C	C	A	A	A	A	A	B	C	B	C
BARIUM SULFATE	B	B	B	A	A	A	A	A	B	B	B	B
BARIUM SULFIDE	B	B	B	A	A	A	A	A	B	B	B	B
BEER (ALCOHOL INDUSTRY)	A	C	C	A	A	A	A	A	A	C	–	C
BEER (BEVERAGE INDUSTRY)	A	C	C	A	A	A	A	A	A	C	–	C
BEET SUGAR LIQUIDS	A	B	B	A	A	A	–	–	A	B	A	B
BENZALDEHYDE	A	A	A	D	A	A	A	B	A	A	A	A
BENZENE (BENZOL)	A	B	B	D	A	A	A	B	A	B	A	B
BENZOIC ACID	B	D	D	D	D	A	A	A	B	D	B	D
BORAX LIQUORS	B	C	C	A	A	A	A	A	B	C	B	C
BORIC ACID	A	D	D	B	B	A	A	A	A	D	A	D
BRINES	B	D	D	A	A	A	A	A	B	D	B	D
BROMINE	D	D	D	D	D	A	D	D	D	D	–	D
BUNKER OILS (FUEL OILS)	A	B	B	A	A	A	A	B	A	B	A	B
BUTADIENE	A	B	B	D	C	A	A	B	A	B	A	B
BUTANE	A	A	A	A	A	A	A	B	A	A	A	A
BUTTERMILK	A	D	D	A	A	A	A	A	A	D	–	D
BUTYLENE	A	A	A	D	B	A	A	B	A	A	A	A
BUTYRIC ACID	B	D	D	C	C	A	A	A	B	D	B	D
CALCIUM BISULFITE	B	D	D	A	A	A	A	A	B	D	B	D
CALCIUM CARBONATE	B	D	D	A	A	A	A	A	B	D	B	D
CALCIUM CHLORIDE	B	C	C	A	A	A	A	A	B	C	B	C
CALCIUM HYDROXIDE (20%)	B	B	B	A	A	A	A	A	B	B	B	B
CALCIUM HYPOCHLORITE	C	D	D	D	D	A	A	A	C	D	–	D
CALCIUM SULFATE	B	C	C	D	D	A	A	–	B	C	B	C
CARBON BISULFIDE	B	B	B	D	A	A	A	B	B	B	B	B
CARBON DIOXIDE (DRY)	A	A	A	A	A	A	A	A	A	A	A	A
CARBON DIOXIDE (WET)	A	C	C	A	A	A	B	B	A	C	B	C
CARBON TETRACHLORIDE (DRY)	B	A	A	B	A	A	A	B	B	A	B	A
CARBON TETRACHLORIDE (WET)	A	B	B	B	A	A	A	B	A	B	B	B
CARBONATED WATER	A	B	B	A	A	A	A	–	A	B	A	B
CARBONIC ACID	B	D	D	A	A	A	A	A	B	D	B	D
CASTOR OIL	A	B	B	A	A	A	A	A	A	B	A	B
CHINA WOOD OIL (TUNG)	A	B	B	A	A	A	–	–	A	B	A	B
CHLORINATED SOLVENTS (DRY)	A	A	A	D	B	B	B	B	A	A	A	A
CHLORINE (WET)	D	D	D	C	C	A	C	C	D	D	–	D
CHLORINE GAS (DRY)	B	B	B	D	D	A	A	–	B	B	B	B
CHLOROACETIC ACID	C	D	D	D	D	A	A	B	C	D	–	D
CHLOROBENZENE	A	B	B	D	A	A	A	B	A	B	A	B
CHLOROFORM	A	B	B	D	C	A	A	B	A	B	A	B
CHLOROSULPHONIC ACID (DRY)	B	B	B	D	D	A	A	D	B	B	B	B
CHLOROSULPHONIC ACID (WET)	D	D	N	–	–	–	–	–	D	D	–	N
CHROME ALUM	A	B	B	A	A	A	A	A	A	B	A	B
CHROMIC ACID	C	D	D	D	D	A	D	D	C	D	–	D
CITRUS JUICES	B	D	D	A	A	A	A	A	B	D	B	D
COCONUT OIL	B	C	C	A	A	A	A	B	A	C	A	C

A: Excellent B: Good (slightly attacked) C: Fair (modestly attacked) D: Not recommended –: No data

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Material selection guide

Lading	External valve body material			Seal code trim					Internal valve trim			
	Std body 23	Std body 24	Spl body 37	Std YRF	Spl YFF	Spl TFF	Spl PFF	Spl PLF	Std Int 23	Std Int 24	Spl Int 27	Spl Int 37
COFFEE EXTRACTS (HOT)	A	C	C	A	A	A	–	–	A	B	A	C
COKE OVEN GAS	A	B	B	D	A	A	–	–	A	B	A	B
COOKING OIL	A	B	B	A	A	A	A	–	A	B	A	B
COPPER ACETATE (10%)	B	C	C	–	–	A	A	B	B	C	B	C
COPPER CHLORIDE	D	D	D	A	A	A	A	A	D	D	–	D
COPPER NITRATE	B	D	D	D	D	A	A	B	B	D	B	D
COPPER SULFATE	C	D	D	B	B	A	A	A	C	D	–	D
CORN OIL	A	B	B	A	A	A	–	–	A	B	B	B
CORROSION INHIBITOR – AMINE BASED	A	A	A	B	B	A	A	–	A	A	A	A
COTTONSEED OIL	B	C	C	A	A	A	A	A	B	C	B	C
CREOSOTE OIL	B	B	B	A	A	A	A	B	B	B	B	B
CRESYLIC ACID	B	B	B	D	D	A	A	B	B	B	B	B
CRUDE OIL SOUR	A	B	B	C	A	A	A	B	A	B	A	B
CRUDE OIL SWEET	A	B	B	B	A	A	A	B	A	B	A	B
CUTTING OILS, WATER EMULSIONS	A	B	B	A	A	A	A	A	A	B	A	B
CYCLOHEXANE	A	A	A	A	A	A	A	B	A	A	A	A
DIACETONE ALCOHOL	A	A	A	D	A	A	–	–	A	A	A	A
DIESEL FUEL	A	A	A	A	A	A	A	A	A	A	A	A
DIETHANOLAMINE (DEA)	–	–	–	–	–	–	–	–	–	–	–	–
DIETHYLAMINE	A	A	A	B	A	D	A	B	A	A	A	A
DIETHYLENE GLYCOL	–	–	–	A	A	A	A	A	–	–	–	–
DOWTHERMS (A-E)	A	B	B	D	A	A	A	B	A	B	A	B
DRILLING MUD	A	B	B	A	A	A	–	–	A	B	A	B
DRIP COCKS, GAS	A	B	B	–	–	–	–	–	A	B	A	B
DRY CLEANING FLUIDS	A	B	B	C	B	A	A	C	A	B	A	B
EPSOM SALT (Magnesium Sulfate)	B	C	C	–	A	A	A	A	B	C	B	C
ETHANE	A	A	A	A	A	A	A	A	A	A	A	A
ETHANOL (ALCOHOL-ETHYL)	A	B	B	A	A	A	A	A	A	B	A	B
ETHANOLAMINE (MEA)	A	A	A	B	A	A	–	–	A	A	A	A
ETHERS	A	B	B	D	A	A	A	D	A	B	A	B
ETHYL ACETATE	B	B	B	D	B	B	B	D	B	B	B	B
ETHYL ACRYLATE	A	A	A	D	A	A	A	D	A	A	A	A
ETHYL CHLORIDE (DRY)	A	B	B	A	A	A	A	B	A	B	A	B
ETHYL CHLORIDE (WET)	B	B	B	A	A	A	A	B	B	B	B	B
ETHYLENE (LIQUID OR GAS)	A	A	A	B	A	A	A	A	A	A	A	A
ETHYLENE GLYCOL	B	B	B	A	A	A	A	A	B	B	B	B
ETHYLENE OXIDE	B	B	B	D	A	A	A	D	B	B	B	B
ETHYLENE PROPYLENE	A	B	–	–	–	–	–	–	A	B	–	–
FATTY ACIDS	B	D	D	B	A	A	A	A	B	D	B	D
FERRIC CHLORIDE	D	D	D	A	A	A	B	B	D	D	–	D
FERRIC NITRATE	B	D	D	A	A	A	A	A	B	D	–	D
FERRIC SULFATE	B	D	D	A	A	A	A	A	B	D	B	D
FERROUS CHLORIDE	D	D	D	C	C	A	A	–	D	D	–	D
FERROUS SULFATE	B	D	D	D	D	A	A	A	B	D	B	D
FERROUS SULFATE (SAT)	A	C	C	–	–	A	A	–	A	C	S	C
FERTILIZER SOLUTIONS	B	B	B	D	D	D	D	D	B	B	B	B
FISH OILS	A	B	B	B	A	A	A	–	A	B	A	B
FLUORINE	A	B	B	D	D	D	C	–	A	B	A	B
FLUOSILICIC ACID	C	D	D	D	D	A	A	A	C	D	–	D
FOOD FLUIDS – PASTES	A	C	C	B	A	A	–	–	A	C	–	C
FORMALDEHYDE (100%)	A	C	C	B	B	A	A	C	A	C	–	C
FORMALDEHYDE (40%)	A	C	C	B	A	A	A	C	A	C	–	C
FORMIC ACID	B	D	D	D	D	A	B	C	B	D	B	D

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FREON 12	A	B	B	A	B	B	B	D	A	B	A	B
FRUIT JUICES	A	D	D	A	A	A	A	–	A	D	A	D
FUEL JET JP-4	A	A	A	A	A	A	A	B	A	A	A	A
FUEL JET JP-5 100F	A	A	A	A	A	A	A	B	A	A	A	A
FUEL JET JP-6 100F	A	A	A	A	A	A	A	B	A	A	A	A
FUEL OIL	A	B	B	A	A	A	A	A	A	B	A	B
FUEL RP-1	A	A	A	A	A	A	A	A	A	A	A	A
FURFURAL	B	A	A	D	A	A	A	C	B	A	A	A
GALLIC ACID	B	D	D	B	A	B	–	–	B	D	B	D
GAS (MANUFACTURED)	B	B	B	A	A	A	A	A	B	B	B	B
GAS ODORIZERS (VTFEP)	A	B	B	A	A	A	A	A	A	B	A	B
GAS, NATURAL	A	B	B	A	A	A	A	A	A	B	A	B
GASOLINE, AVIATION	A	A	A	A	A	A	A	A	A	A	A	A
GASOLINE, SOUR	A	B	B	C	A	A	A	A	A	B	A	B
GASOLINE, LEADED, LOW OCTANE	A	A	A	A	A	A	A	B	A	A	A	A
GASOLINE, UNLEADED, LOW OCTANE	A	A	A	A	A	A	A	B	A	A	A	A
GELATIN	A	B	B	A	A	A	A	A	A	B	B	B
GLUCOSE	A	B	B	A	A	A	A	A	A	B	A	B
GLUE	A	A	A	–	A	A	–	–	A	A	A	A
GLYCERINE – GLYCEROL	A	B	B	A	A	A	A	A	A	B	A	B
GLYCOLS	B	B	B	A	A	A	A	A	B	B	B	B
GREASE	A	A	A	–	A	A	A	B	A	A	A	A
HEPTANE	A	A	A	A	A	A	A	C	A	A	A	A
HEXANE	A	A	A	A	A	A	A	C	A	A	A	A
HEXANOL, TERTIARY	A	A	A	–	A	–	–	–	A	A	A	A
HYDRAULIC OIL PHOSPHATE ESTER	A	A	A	C	A	A	A	A	A	A	A	A
HYDRAULIC OIL PETROLEUM BASE	A	A	A	A	A	A	A	A	A	A	A	A
HYDROBROMIC ACID	D	D	D	D	D	A	C	C	D	D	–	D
HYDROCHLORIC ACID 37% AIR FREE	D	D	D	D	D	A	A	B	D	D	–	D
HYDROCYANIC ACID	B	D	D	B	B	A	A	A	B	D	B	D
HYDROFLUORIC ACID	D	D	D	D	D	A	D	D	D	D	–	D
HYDROFLUOSILICIC ACID	C	D	D	D	D	A	–	–	C	D	–	D
HYDROGEN GAS	A	B	B	A	A	A	A	A	A	B	A	B
HYDROGEN PEROXIDE 30% (DILUTE)	B	D	D	D	D	A	A	A	B	D	B	D
HYDROGEN PEROXIDE	B	D	D	D	D	A	A	A	B	D	B	D
HYDROGEN SULFIDE (dry)	A	A	A	A	A	A	A	A	A	A	A	A
HYDROGEN SULFIDE (wet)	A	D	D	B	A	A	A	A	A	D	B	D
HYPO (SODIUM THIOSULFATE)	A	D	D	B	A	A	A	A	A	D	A	D
HYPOCHLORITES, SODIUM	C	D	D	B	A	A	A	A	C	D	–	D
ILLUMINATING GAS (coal gas)	A	A	A	–	–	A	A	–	A	A	A	A
INK	A	D	D	–	–	–	–	–	A	D	A	D
IODINE	D	D	D	A	A	A	B	B	D	D	–	D
ISOBUTANE (methylpropane)	–	–	–	–	–	A	A	–	–	–	–	–
ISO-OCTANE	A	A	A	A	A	A	A	C	A	A	A	A
ISOCYANIDE	A	A	A	–	–	–	–	–	A	A	A	A
ISODOFORM	B	B	B	–	–	–	–	–	B	B	B	B
ISOPROPYL ALCOHOL (isopropanol)	B	B	B	B	B	A	A	A	B	B	B	B
ISOPROPYL ETHER	A	A	A	B	A	A	A	D	A	A	A	A
KEROSENE	A	B	B	A	A	A	A	B	A	B	A	B
KETCHUP	A	D	D	A	A	A	A	–	D	A	–	D
KETONES	A	A	A	D	D	D	D	D	A	A	A	A
LACQUERS (SOLVENTS)	A	C	C	D	A	A	–	D	A	C	A	C
LACTIC ACID	A	D	D	–	B	A	A	A	B	D	–	D

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LARD OIL	A	C	C	A	A	A	A	A	A	C	–	C
LEAD ACETATE	B	C	C	B	B	A	A	D	B	D	–	C
LINOLEIC ACID	A	B	B	C	C	A	A	A	A	B	A	B
LINSEED OIL	A	A	A	A	A	A	A	A	A	A	A	A
LIQUEFIED PET GAS (LPG)	A	B	B	A	A	A	A	B	A	B	A	B
LITHIUM BROMIDE	A	D	D	–	–	A	B	A	A	D	–	D
LUBRICATING OIL	A	A	A	A	A	A	A	A	A	A	A	A
MAGNESIUM BISULFATE	A	C	C	–	A	–	–	–	A	C	–	C
MAGNESIUM CHLORIDE	D	C	C	A	A	A	A	A	D	C	–	C
MAGNESIUM HYDROXIDE	A	B	B	B	B	A	A	A	A	B	A	B
MAGNESIUM SULFATE (Epson Salt)	B	B	B	–	A	A	A	A	B	B	–	B
MALEIC ACID	C	B	B	D	A	A	A	A	C	B	B	B
MALEIC ANHYDRIDE	A	D	D	–	–	A	A	A	A	D	–	D
MALIC ACID	A	D	D	A	A	A	A	A	A	D	–	D
MAYONNAISE	A	D	D	–	A	A	A	–	A	D	–	D
MERCAPATANS	A	A	A	A	A	A	–	–	A	A	A	A
MERCURIC CHLORIDE	D	D	D	D	D	A	A	A	D	D	–	D
MERCURIC CYANIDE (10%)	B	D	D	C	A	B	–	–	B	D	–	D
MERCURY	A	A	A	A	A	A	A	A	A	A	A	A
METHANE	A	A	A	A	A	A	A	B	A	A	A	A
METHANOL (ALCOHOL-METHYL)	A	B	B	B	A	A	A	D	A	B	A	B
METHYL ACETATE	A	A	A	D	B	B	B	D	A	A	A	A
METHYL ACETONE	A	A	A	–	D	D	D	–	A	A	A	A
METHYL CELLOSOLVE	B	B	B	C	A	A	–	–	B	B	B	B
METHYL CHLORIDE	A	B	B	D	B	A	A	D	A	B	A	B
METHYL ETHYL KETONE (MEK)	A	A	A	D	B	B	B	D	A	A	A	A
METHYL FORMATE	B	B	B	–	–	A	–	–	B	B	B	B
METHYLAMINE	B	B	B	–	–	A	A	–	B	B	B	B
METHYLENE CHLORIDE	B	B	B	D	C	A	A	–	B	B	B	B
MILK	A	D	D	A	A	A	A	A	A	D	–	D
MINE WATERS (ACID)	B	D	D	–	B	B	–	–	B	D	–	D
MINERAL SPRITS	B	B	B	–	A	A	A	–	B	B	B	B
MINERAL OIL	A	B	B	A	A	A	A	A	A	B	A	B
MIXED ACIDS (COLD)	A	C	C	–	–	–	–	–	A	C	–	C
MOLASSES – CRUDE	A	A	A	–	A	A	A	–	A	A	A	A
MOLASSES, EDIBLE	A	A	A	–	A	A	A	–	A	A	A	A
MTBE 100% MAX (methyl tertiary butyl ether)	A	B	B	–	–	B	B	B	A	D	B	B
MTBE 40% MAX	A	A	A	C	B	B	B	B	A	B	B	A
MURIATIC ACID (hydrochloric acid)	D	D	D	–	D	A	A	A	D	D	–	D
MUSTARD	A	B	B	A	A	A	–	–	A	B	A	B
NAPHTHA (Rubber Solvent)	A	B	B	B	A	B	B	B	A	B	A	B
NAPHTHALENE (COAL TAR DISTILLATE)	A	A	A	D	A	A	A	C	A	A	A	A
NICKEL AMMONIUM SULFATE (20%)	A	D	D	C	A	A	A	A	A	D	–	D
NICKEL CHLORIDE	B	D	D	A	A	A	A	A	C	D	–	D
NICKEL NITRATE (30%)	B	D	D	B	B	A	A	–	B	D	–	D
NICKEL SULFATE	C	D	D	A	A	A	A	A	C	D	–	D
NICOTINIC ACID	A	B	B	–	–	A	–	–	A	B	A	B
NITRIC ACID (10%)	A	D	D	D	D	A	B	D	A	D	–	D
NITRIC ACID (100%)	A	A	A	D	D	A	C	D	A	A	A	A
NITRIC ACID (30%)	A	D	D	D	D	A	C	D	A	D	–	D
NITRIC ACID (80%)	D	A	D	D	D	A	C	D	A	D	–	D
NITRIC ACID ANHYDROUS/AQUEOUS	A	A	A	D	D	A	B	–	A	A	A	A
NITROBENZENE	B	B	B	B	B	A	A	D	B	B	B	B

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NITROGEN	A	A	A	A	A	A	A	A	A	A	A	A
NITROUS ACID (10%)	B	D	D	A	A	A	A	A	B	D	–	D
NITROUS GASES	A	B	B	–	A	A	A	–	A	B	A	B
NITROUS OXIDE	B	A	A	A	A	A	A	–	B	A	B	A
OIL, COTTONSEED	B	C	C	B	B	A	B	A	B	C	B	C
OIL, PETROLEUM (REFINED)	A	A	A	A	A	A	A	A	A	A	A	A
OIL, PETROLEUM (SOUR) H2S & CO2	A	A	A	A	A	A	A	A	A	A	A	A
OIL, WATER MIXTURES	A	B	B	A	A	A	A	A	A	B	A	B
OIL, ANIMAL	A	A	A	A	A	A	A	A	A	A	A	A
OIL, FISH	A	B	B	B	A	A	A	B	A	B	A	B
OIL, FUEL	A	B	B	A	A	A	A	B	A	B	A	B
OIL, LUBE	A	A	A	A	A	A	A	A	A	A	A	A
OIL, MINERAL	A	B	B	A	A	A	A	A	A	B	A	B
OLEIC ACID	A	B	B	C	A	A	A	C	A	B	A	B
OLEUM	B	B	B	B	A	A	A	A	B	B	B	B
OLIVE OIL	A	B	B	A	A	A	A	A	A	B	A	B
OXALIC ACID	A	D	D	B	B	A	A	A	A	D	–	D
OXYGEN (GAS)	A	B	B	D	A	A	A	D	A	B	A	B
OXYGEN (LIQUID)	A	B	B	D	C	C	C	D	A	B	–	B
OZONE	A	C	C	D	A	A	A	D	A	C	A	C
PAINTS AND THINNERS	A	A	A	D	A	A	A	A	A	A	A	A
PALM OIL	B	C	C	D	A	A	A	–	B	C	B	C
PALMITIC ACID	A	C	C	A	A	A	A	A	A	C	A	C
PARAFIN	A	B	B	A	A	A	–	A	A	B	A	B
PARAFORMALDEHYDE	B	B	B	A	A	A	A	–	B	B	B	B
PENTANE	A	B	B	A	A	A	–	A	A	B	A	B
PERCHLOROETHYLENE	B	B	B	C	A	A	A	D	B	B	B	B
PETROLATUM	B	C	C	A	A	A	–	A	B	C	B	C
PHENOL (CARBOLIC ACID)	A	B	B	A	A	A	A	A	A	B	A	B
PHOSGENE (CARBONYL CHLORIDE)	–	–	–	–	B	A	–	–	–	–	–	–
PHOSPHORIC ACID	–	–	–	–	B	A	A	A	–	–	–	–
PHOSPHORIC ACID (40%)	–	–	–	–	B	A	A	A	–	–	–	–
PHOSPHORIC ACID (>40%)	–	–	–	–	B	A	A	A	–	–	–	–
PHOSPHORIC ACID (CRUDE)	–	–	–	–	B	A	A	A	–	–	–	–
PHOSPHORIC ACID (MOLTEN)	–	–	–	–	B	–	–	–	–	–	–	–
PHOSPHORIC ACID (ANHYDRIDGE)	–	–	–	D	B	A	–	–	–	–	–	–
PHTHALIC ACID	B	C	C	C	B	A	A	–	B	C	B	C
PHTHALIC ANHYDRIDE	B	C	C	C	A	A	C	C	B	C	B	C
PICRIC ACID	B	C	C	A	A	A	A	–	B	C	B	C
PINE OIL	A	B	B	A	A	A	–	–	A	B	A	B
PINEAPPLE JUICE	A	C	C	A	A	A	–	–	A	C	–	C
POLYESTER RESIN	A	B	B	–	A	A	A	–	A	B	A	B
POLYETHYLENE GLYCOL	–	–	–	–	–	A	A	B	–	–	–	–
POLYURETHANE	A	A	A	–	–	–	–	–	A	A	A	A
POTASSIUM BISULFITE (10%)	B	D	D	C	A	A	–	–	B	D	–	D
POTASSIUM BROMIDE	B	D	D	C	A	A	A	–	B	D	–	D
POTASSIUM CARBONATE	A	C	C	–	A	A	A	–	A	C	–	C
POTASSIUM CHLORATE	A	B	B	–	C	A	A	A	A	C	–	B
POTASSIUM CHLORIDE	A	C	C	A	A	A	A	A	A	C	–	C
POTASSIUM CYANIDE	B	B	B	A	A	A	–	–	B	B	B	B
POTASSIUM DICHROMATE	A	B	B	B	B	A	A	A	A	B	A	B
POTASSIUM DIPHOSPHATE	A	A	A	–	–	–	–		A	A	A	A
POTASSIUM FERRICYANIDE	A	B	B	C	B	A	A	C	B	B	B	B

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POTASSIUM FERROCYANIDE	A	B	B	B	B	A	A	–	A	B	A	B
POTASSIUM HYDROXIDE 70%	A	A	A	C	C	A	A	B	A	A	A	A
POTASSIUM HYDROXIDE – DILUTE	B	B	B	–	A	A	A	A	B	B	B	B
POTASSIUM IODIDE	B	C	C	C	A	A	–	–	B	C	B	C
POTASSIUM NITRATE	A	B	B	B	B	A	A	A	A	B	A	B
POTASSIUM PERMAGANATE	A	A	A	D	D	A	A	–	A	A	A	A
POTASSIUM SULFATE	A	B	B	A	A	A	A	A	A	B	A	B
POTASSIUM SULFIDE	B	C	C	A	A	A	C	–	B	C	B	C
POTASSIUM SULFITE	A	D	D	A	A	A	–	A	A	D	–	D
PRODUCER GAS	A	B	B	A	A	A	A	A	A	B	A	B
PROPANE	A	A	A	A	A	A	A	A	A	A	A	A
PROPYLENE	A	B	B	C	A	A	A	A	A	B	–	B
PROPYL ALCOHOL (PROPANOL)	A	A	A	A	A	A	A	A	A	A	A	A
PROPYLENE GYLCOL	A	A	A	C	A	A	A	A	A	A	A	A
PYROGALLIC ACID	B	B	B	B	A	A	D	–	B	B	B	B
QUENCH OIL (WATER SOLUBLE)	A	A	A	B	B	A	A	–	A	A	A	A
RESINS-ROSINS	A	C	C	B	A	A	A	–	A	C	–	C
RUBBER LATEX EMULSIONS	A	B	B	A	A	A	A	–	A	B	A	B
SALAD OIL	B	C	C	A	A	A	A	–	B	C	–	C
SALICYLIC ACID	A	D	D	B	A	A	A	A	A	D	A	D
SALT (BRINE (NaCl) saturated)	B	C	C	A	A	A	A	A	B	C	A	C
SEA WATER	A	D	D	A	A	A	A	A	A	D	A	D
SHELLAC (BLEACHED)	A	A	A	C	A	A	A	–	A	A	A	A
SHELLAC (ORANGE)	A	A	A	C	A	A	A	–	A	A	A	A
SILICONE OILS	A	A	A	A	A	A	A	A	A	A	A	A
SILVER NITRATE	B	D	D	B	A	A	A	A	B	D	–	D
SOAP SOLUTIONS (STEARATES)	A	A	A	A	A	A	A	A	A	A	A	A
SODIUM ACETATE	B	B	B	B	B	A	A	B	B	B	B	B
SODIUM ALUMINATE	A	C	C	C	A	A	A	–	A	C	–	C
SODIUM BICARBONATE	B	C	C	A	A	A	A	A	B	C	–	C
SODIUM BISULFATE	A	D	D	A	A	A	A	A	A	D	–	D
SODIUM BISULFITE	D	D	D	A	A	A	A	A	D	D	–	D
SODIUM BORATE (BORAX)	B	C	C	A	A	A	A	A	A	C	B	C
SODIUM BROMIDE	B	C	C	C	B	A	A	–	B	C	B	C
SODIUM CARBONATE	B	B	B	A	A	A	A	A	B	B	B	B
SODIUM CHLORATE	B	C	C	C	A	A	A	C	B	C	B	C
SODIUM CHLORIDE	B	C	C	A	A	A	A	A	B	C	B	C
SODIUM CHROMATE	B	B	B	C	C	A	A	–	B	B	B	B
SODIUM CYANIDE	A	A	A	A	A	A	A	A	A	A	A	A
SODIUM FLUORIDE	C	D	D	C	B	A	A	–	C	D	–	D
SODIUM HYDROXIDE 20%	A	A	A	–	A	A	A	A	A	A	A	A
SODIUM HYDROXIDE 50%	B	B	B	–	A	A	A	A	B	B	B	B
SODIUM HYDROXIDE 80%	B	B	B	–	B	A	A	A	B	B	B	B
SODIUM HYPOCHLORIDE	C	D	D	–	D	A	A	–	C	D	–	D
SODIUM METAPHOSPHATE	A	D	D	A	A	A	A	A	A	D	–	D
SODIUM METASILICATE	A	C	C	C	A	A	A	–	A	C	A	C
SODIUM NITRATE	A	B	B	–	A	A	A	A	A	B	B	B
SODIUM PERBORATE	B	C	C	B	B	A	A	A	B	C	B	C
SODIUM PEROXIDE	B	C	C	B	A	A	A	A	B	C	B	C
SODIUM PHOSPHATE (DIBASIC)	B	B	B	A	A	A	A	A	B	B	B	B
SODIUM PHOSPHATE (TRIBASIC)	B	B	B	B	B	A	A	A	B	B	B	B
SODIUM SILICATE	A	A	A	A	A	A	A	A	A	A	A	A
SODIUM SULFATE NA2S04	A	B	B	A	A	A	A	A	A	B	A	B

A: Excellent B: Good (slightly attacked) C: Fair (modestly attacked) D: Not recommended –: No data

Reference: http://www.coleparmer.com/techinfo/chemcomp.asp. Chemical Resistance Guide by Compass Publications.

Material selection guide

Lading	External valve body material			Seal code trim					Internal valve trim			
	Std body 23	Std body 24	Spl body 37	Std YRF	Spl YFF	Spl TFF	Spl PFF	Spl PLF	Std Int 23	Std Int 24	Spl Int 27	Spl Int 37
SODIUM SULFIDE NA2S02	B	B	B	B	B	A	A	–	B	B	B	B
SODIUM THIOSULFATE	A	D	D	B	B	A	A	–	A	D	–	D
SOUR GAS AND OIL	A	A	A	–	–	–	–	–	A	A	–	A
SOYBEAN OIL	A	B	B	A	A	A	A	A	A	B	B	B
STANNIC CHLORIDE	D	D	D	B	B	A	A	A	D	D	D	D
STANNOUS CHLORIDE	C	D	D	C	C	A	A	A	C	D	–	D
STARCH	A	A	A	A	A	A	A	A	A	A	A	A
STEAM (212F)	A	B	B	D	C	A	A	A	A	B	A	B
STEARIC ACID	A	C	C	B	A	A	A	A	A	C	–	C
STODDARD SOLVENT	B	B	B	A	A	A	A	B	B	B	B	B
STYRENE	A	A	A	–	A	A	A	B	A	A	A	A
SUGAR LIQUIDS	A	B	B	–	A	A	A	–	A	B	A	B
SULFATE, BLACK LIQUORS	B	C	C	–	B	A	–	–	B	C	–	C
SULFATE, GREEN LIQUORS	B	C	C	–	B	A	–	–	B	C	–	C
SULFATE, WHITE LIQUORS	B	D	D	–	B	A	–	–	B	D	–	D
SULFURIC ACID (0 - 7%)	A	B	B	–	C	A	A	B	A	B	A	B
SULFURIC ACID (10% - 100%) H2S04	D	D	D	–	D	A	D	B	D	D	–	D
SULFUROUS ACID	D	D	D	D	D	A	A	A	D	D	–	D
SULFUR	A	B	B	–	A	A	A	–	A	B	A	B
SULFUR DIOXIDE (DRY)	A	B	B	–	A	A	A	B	A	B	A	B
SULFUR TRIOXIDE (DRY)	B	B	B	–	A	A	A	B	B	B	B	B
SYNTHESIS GAS	B	B	B	–	A	A	A	–	B	B	B	B
TALL OIL	B	B	B	–	A	A	A	–	B	B	B	B
TANNIC ACID	B	B	B	A	A	A	A	A	B	B	B	B
TAR – TAR OIL	A	A	A	B	A	A	A	A	A	A	A	A
TARTARIC ACID	A	D	D	B	B	A	A	A	A	D	C	D
TETRAETHYL LEAD	B	C	C	B	B	A	A	C	B	C	–	C
TITANIUM TETRACHLORIDE T1-CL4	–	–	–	B	A	A	–	–	–	–	–	–
TITANIUM TRICHLORIDE T1-CL3	–	–	–	B	A	A	–	–	–	–	–	–
TOLUENE – TOLUOL	A	A	A	C	A	A	A	D	A	A	A	A
TOMATO JUICE	A	C	C	–	A	A	A	–	A	C	–	C
TRANSFORMER OIL	A	A	A	A	A	A	A	A	A	A	A	A
TRIBUTYL PHOSPHATE	A	A	A	D	D	A	–	–	A	A	A	A
TRICHLOROETHYLENE	B	B	B	C	B	A	A	D	B	B	B	B
TUNG OIL (China Wood Oil)	A	B	B	A	A	A	A	A	A	B	A	B
TURPENTINE	A	B	B	B	B	A	A	A	A	B	A	B
UREA	B	C	C	–	–	–	–	–	B	C	–	C
VARNISH	A	C	C	B	A	A	A	B	A	C	–	C
VEGETABLE OIL, EDIBLE	A	B	B	A	A	A	A	A	A	B	–	B
VEGETABLE OIL, NON-EDIBLE	A	B	B	A	A	A	A	A	A	B	A	B
VINEGAR	A	D	D	B	A	A	A	A	A	D	–	D
WATER, DISTILLED	A	D	D	A	A	A	A	A	A	D	A	D
WATER, FRESH	A	C	C	A	A	A	A	A	A	C	A	C
WATER, SALT	A	D	D	A	A	A	A	A	A	D	A	D
WAX, EMULSIONS	A	A	A	–	A	A	A	–	A	A	A	A
WAXES	A	A	A	–	A	A	A	–	A	A	A	A
WHISKEY AND WINE	A	D	D	A	A	A	A	A	A	D	–	D
XYLENE	A	A	A	D	A	A	A	D	A	A	A	A
ZINC CHLORIDE	D	D	D	C	C	A	A	A	D	D	–	D
ZINC HYDROSULFITE	A	A	A	C	A	A	–	–	A	A	A	A
ZINC SULFATE	B	D	D	A	A	A	A	A	B	D	B	D

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WKM 370D6 Trunnion-Mounted Ball Valve



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