

# TupH™ Combination pH/ORP Sensor

**MODEL 396P**



**MODEL 396PVP  
with mating cable**



## ESSENTIAL INSTRUCTIONS

### READ THIS PAGE BEFORE PROCEEDING!

Rosemount Analytical designs, manufactures, and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you must properly install, use, and maintain them 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, using, and maintaining Rosemount Analytical products. Failure to follow the proper instructions may cause any one of the following situations to occur: Loss of life; personal injury; property damage; damage to this instrument; and warranty invalidation.

- Read all instructions prior to installing, operating, and servicing the product. If this Instruction Manual is not the correct manual, telephone 1-800-654-7768 and the requested manual will be provided. Save this Instruction Manual for future reference.
- If you do not understand any of the instructions, contact your Rosemount representative for clarification.
- Follow all warnings, cautions, and instructions marked on and supplied with the product.
- Inform and educate your personnel in the proper installation, operation, and maintenance of the product.
- 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.
- To ensure proper performance, use qualified personnel to install, operate, update, program, and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Rosemount. 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.

### **DANGER** **HAZARDOUS AREA** **INSTALLATION**

This sensor is not Intrinsically Safe. or Explosion Proof. Installations near flammable liquids or in hazardous area locations must be carefully evaluated by qualified on site safety personnel.

To secure and maintain an intrinsically safe installation, an appropriate transmitter/ safety barrier/sensor combination must be used. The installation system must be in accordance with the governing approval agency (FM, CSA or BASEEFA/CENELEC) hazardous area classification requirements. Consult your analyzer/transmitter instruction manual for details.

Proper installation, operation and servicing of this sensor in a Hazardous Area Installation is entirely the responsibility of the user.

### **CAUTION** **SENSOR/PROCESS** **APPLICATION COMPATIBILITY**

**The wetted sensor materials may not be compatible with process composition and operating conditions. Application compatibility is entirely the responsibility of the user.**

## About This Document

This manual contains instructions for installation and operation of the Models 396P and 396PVP TU<sub>p</sub>H Combination pH/ORP Sensors. The following list provides notes concerning all revisions of this document.

<b><u>Rev. Level</u></b>	<b><u>Date</u></b>	<b><u>Notes</u></b>
0	8/95-2/01	This is the initial release of the product manual. The manual has been reformatted to reflect the Emerson documentation style and updated to reflect any changes in the product offering.
A	12/01	Added wiring diagram to page 14.
B	4/02	Revised drawings on pages 6, 7, and 14.
C	7/02	Added 1055 wiring diagrams.
D	8/03	Added Silcore information.
E	5/04	Added 5081 and Xmt wiring info. Deleted obsolete model information.

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# MODEL 396P and 396PVP COMBINATION pH/ORP SENSOR

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## SECTION 1.0

# DESCRIPTION AND SPECIFICATIONS

### 1.1 FEATURES AND APPLICATIONS

The Rosemount Analytical Model 396P and 396PVP Sensors measure the pH or the ORP of aqueous solutions in pipelines, open tanks, or ponds. It is designed for harsh, dirty applications such as sourwater waste treatment and scrubbers, where a high performance, low maintenance, disposable sensor is required.

The combination electrode features a patented, large area polypropylene reference junction for resistance to process coatings, generally found in dirty, high solid applications. The patented helical reference pathway provides added resistance for poisoning applications. In addition, it is available in two configurations: glass/platinum electrode completely recessed within the reference junction for added life in abrasive or rough applications and the glass/platinum electrode partially exposed for added life and accuracy in viscous and low flow applications.

Both Models feature a titanium solution ground constructed in an annular design around the pH/ORP electrode. The solution ground provides glass and reference sensor diagnostics for preventative maintenance when used with the Model 54e, 1055, 5081, 3081, 4081, 81 pH/ORP, and Xmt-P transmitters. In addition Models 396P and 396PVP can be used with most non-diagnostic Rosemount Analytical and other manufacturer's instruments.

Each sensor is housed in a molded polypropylene body with EPDM seals, making it virtually indestructible and chemically resistant. Complete encapsulation eliminates leakage or high humidity problems traditionally found in other pH/ORP designs. The simplified construction, designed with user convenience in mind, does not require electrolyte (KCl) replenishment or any high maintenance troubleshooting procedures.

The Model 396P is offered with or without an optional integral preamplifier to convert the high impedance pH or ORP mV signal into a stable, noise-free signal with transmission capability of up to three miles. A remote preamplifier must be used with Model 396PVP.

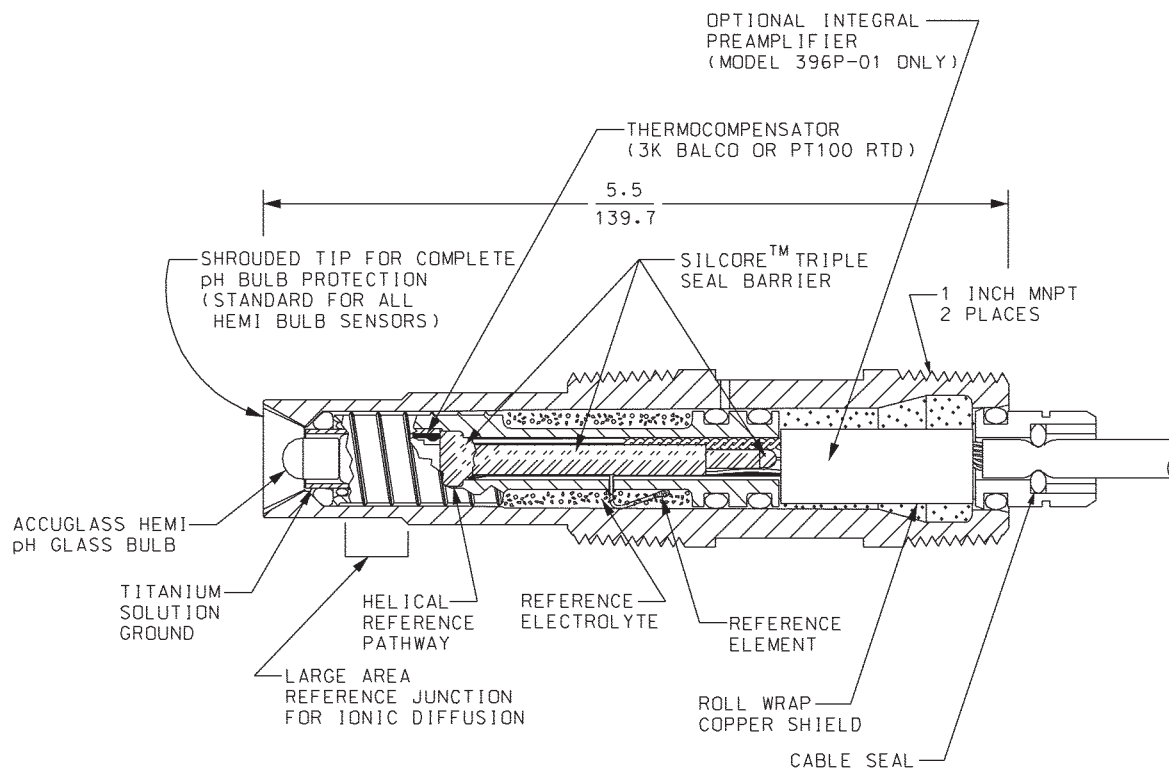
Installation is easily achieved through the wide variety of mounting configurations. The Models 396P and 396PVP feature 1 in. (MNPT) front and rear facing connections for insertion, submersion or flow through pH and ORP applications.

Model 396PVP is offered with a watertight sensor-to-cable connector which eliminates re-wiring and cable twisting when replacing sensors. The Variopol VP multiple pin connector is an integral part of each sensor model and uses a mating VP cable. Once the cable is installed and wired to the analyzer, sensors are easily replaced without replacing the cable, and, if the replacement sensor is the same as its predecessor, without rewiring the analyzer. Also the cable can be disconnected from the sensor before removal from the process which eliminates cable twisting.

***The entire line of TUPH model sensors now incorporate the new SILCORE technology contaminant barrier.*** This triple-seal barrier prevents moisture and material impurities from migrating to the pH sensor's reference electrode's metal lead wire. By preventing these contaminants from compromising the integrity of the pH measurement, sensor life is increased, especially at higher temperatures where increased migrations occur. In addition, the SILCORE technology provides added protection against sensor failure due to vibrations and shock by transferring damaging energy away from the glass-to-metal seal.

***The AccuGLASS pH glass formulations exceed industry standards.*** The AccuGlass pH glass is a result of many years of glass research resulting in a formulation which has been found to increase the life of the sensor. Unlike other pH glasses presently on the market, this glass resists cracking especially at higher temperatures and reduces sodium ion error commonly found in high pH applications. Overall, the AccuGlass formulation enhances the sensor performance to measure pH more accurately and have a longer sensor life than ever before.

*AccuGlass and Silcore are trademarks of Rosemount Analytical.*



**FIGURE 1-1. Cross Section Diagram of the TUpH Patented Reference Technology**

*All TUpH sensors are designed with a large area reference junction, helical reference pathway, and an AccuGlass pH glass bulb. This patented sensor technology ensures superior performance while only requiring minimal maintenance.*

## 1.2 SPECIFICATIONS

<b>Measurements and Ranges</b>	*pH: 0-14 ORP: -1500 to 1500 mv
<b>Available pH AccuGLASS Types</b>	GPLR hemi or flat glass
<b>Wetted Materials</b>	Titanium, Polypropylene, EPDM, glass; platinum (ORP only)
<b>Process Connection</b>	1 in. MNPT front and rear facing threads
<b>Temperature Range</b>	0-100°C (32-212°F)
<b>Pressure Range-Hemi bulb</b>	100-1135 kPa [abs] (0-150 psig)
<b>Pressure Range-Flat bulb</b>	100-790 kPa [abs] (0-100 psig)
<b>Minimum Conductivity</b>	75 µS/cm, nominal; 100 µS/cm
<b>Integral Cable</b>	396P: Code 01 - 25 ft; Code 02 - 15 ft coaxial 396PVP: none - must use mating VP cable
<b>Preamplifier Options</b>	396P: Remote or Integral 396PVP: Remote only
<b>Weight/Shipping Weight</b>	0.45 kg/0.9 kg (1 lb/2 lb)

PERCENT LINEARITY*		
pH range	GPLR hemi bulb	GPLR flat bulb
0 - 2 pH	94%	—
2 - 12 pH	99%	98%
12 - 13 pH	97%	95%
13 - 14 pH	92%	—



### 1.3 ORDERING INFORMATION

The **Model 396P Sensor** is housed in a molded reinforced polypropylene body with 1 in. MNPT threads suitable for insertion, submersion or flow through installation. The sensor includes a general purpose pH electrode or a platinum ORP electrode, a patented reference junction and a solution ground. The Model 396P comes standard with a recessed electrode; an optional slotted tip is also available. In addition, the 396P features an optional integral hermetically sealed preamplifier and 15 ft or 25 ft cable lengths. Automatic temperature compensation, Pt 100 or 3K Balco, is standard with the Model 396P.



*The Model 396P insertion/submersion sensor with integral cable is offered with or without a built-in preamplifier*

MODEL 396P TU <sub>P</sub> H INSERTION/SUBMERSION POLYPROPYLENE pH/ORP SENSOR	
CODE	PREAMPLIFIER/CABLE (Required Selection)
01	With integral preamplifier, 25 ft cable
02	Without integral preamplifier, 15 ft cable
CODE	MEASURING ELECTRODE TYPE (Required Selection)
10	GPLR hemi bulb, General Purpose Low Resistivity (0-14 pH)
12	ORP
13	GPLR flat bulb, General Purpose Low Resistivity (2 - 13 pH)
CODE	ANALYZER/TC COMPATIBILITY (Required Selection)
50	For Models 1181 (3K TC)
54	For Models 1054A/B, 2054, 2081 (Pt 100 RTD)
55	For Models 54e, 3081, 81, 4081, 1055, 5081, Xmt (PT-100 RTD)
CODE	OPTIONAL SELECTION
41	Slotted Tip (not available on flat bulb sensors)
396P - 01 - 10 - 55	
EXAMPLE	

NOTE: The Model 396P is also compatible with Model SCL-P/Q (option 02-54 only).

**TABLE 1-1. RECOMMENDED ACCESSORIES FOR FIRST TIME INSTALLATIONS**

<b>1. Mounting Accessories (optional)</b>	
Choose one: PN 915240-03, PVC flow through tee, 3/4 in. NPT process connection	
PN 915240-04, PVC flow through tee, 1 in. NPT process connection	
PN 915240-05, PVC flow through tee, 1-1/2 in. NPT process connection	
PN 23728-00, acrylic low flow cell	
PN 2002011, 1-1/2 in. CPVC tee with 1-in. FNPT connection	
PN 11275-01, sensor handrail assembly	
<b>2. Junction Boxes (optional)</b>	
<b>Remote Junction Boxes</b> (used with option -02 sensors, for sensor to analyzer distances of more than 15 ft)	
Choose one: PN 23555-00 includes preamplifier for Models 54, 81, 3081, 4081, 5081, Xmt	
PN 23309-03 and PN 22698-02 plug-in preamplifier for Model 1181 Analyzer	
PN 23309-04 and PN 22698-03 plug-in preamplifier for Models 1054A/B series, 2054, 2081 Analyzers	
Choose one: PN 9120516 BNC Adapter for use with remote junction boxes PNs 23309-03, 23309-04	
<b>Remote Junction Box</b> (used with option -01 sensors)	
Choose one: PN 23550-00 cable extension board	
<b>3. Extension cables (used with remote junction boxes)</b>	
Choose one: PN 23646-01, 11 conductor, shielded, prepped	
PN 9200273, 11 conductor, shielded, unprepped	

The **Model 396PVP Sensor** has similar features to the Model 396P. However, the Model 396PVP is offered with the new Variopol (VP) connector and uses a mating VP cable (purchased separately). A remote preamplifier must be used with this sensor.

**A Variopol cable is required for all new installations. See below for cable selection.**



*The Model 396PVP insertion/ submersion sensor with the VP (Variopol) connector*

MODEL 396PVP	TU <sub>P</sub> H INSERTION/SUBMERSION POLYPROPYLENE pH/ORP SENSOR
CODE	MEASURING ELECTRODE TYPE (Required Selection)
10	GPLR hemi bulb, General Purpose Low Resistivity (0-14 pH)
12	ORP
13	GPLR flat bulb, General Purpose Low Resistivity (2 - 13 pH)
CODE	ANALYZER/TC COMPATIBILITY (Required Selection)
50	For Models 1181 (3K TC)
54	For Models 1054A/B, 2054, 2081 (Pt 100 RTD)
55	For Models 54e, 3081, 81, 4081, 1055, 5081, Xmt (PT-100 RTD)
CODE	OPTIONAL SELECTION
41	Slotted Tip (not available on flat bulb sensors)
PN	MATING VP CONNECTOR CABLE ( <b>Required for all new installations</b> )
23645-06	15 ft. cable with mating VP connector, prepped with BNC on analyzer end
23645-07	15 ft. cable with mating VP connector, prepped without BNC on analyzer end*

\*For use with connections to Models 1181, 1054A/B, 2081, 54e, 81, 3081, 4081, 5081, Xmt, and remote junction box PN 23555-00.

## OTHER ACCESSORIES FOR MODELS 396P AND 396PVP

PART	DESCRIPTION
22698-00	Preamplifier plug-in for junction box, for Model 1003,
22698-02	Preamplifier plug-in for junction box, for Models 1181, 1050
22698-03	Preamplifier plug-in for junction box, for Models 1054A/B, 2054, 2081
22743-01	Pt100 preamplifier for Model 1181
22744-01	3K Preamplifier for Model 1181
23557-00	Preamplifier for junction box for Models 54, 3081, 81, 4081, 5081
9210012	Buffer solution, 4.01 pH, 16 oz
9210013	Buffer solution, 6.86 pH, 16 oz
9210014	Buffer solution, 9.18 pH, 16oz
R508-160Z	ORP solution, 460 mv $\pm$ 10 at 20°C
12707-00	Jet Spray Cleaner

### Examples of all sensing tip offerings



**Shrouded Tip** is standard on all hemi bulb sensors



**Optional Slotted Tip** is available on all hemi bulb sensors, ordered as option -41



**Flat Tip** is available with flat glass bulb sensors



**Variopol connector** shown with mating variopol cable receptacle



## SECTION 2.0 INSTALLATION

### 2.1 UNPACKING AND INSPECTION.

Inspect the outside of the carton for any damage. If damage is detected, contact the carrier immediately. Inspect the hardware. Make sure all the items in the packing list are present and in good condition. Notify the factory if any part is missing. If the sensor appears to be in satisfactory condition, proceed to Section 2.2, Mounting.

#### NOTE

Save the original packing cartons and materials as most carriers require proof of damage due to mishandling, etc. Also, if it is necessary to return the sensor to the factory, you must pack the sensor in the same manner as it was received. Refer to Section 6.0 for return instructions. If the sensor is to be stored, the vinyl boot should be filled with pH buffer solution and replaced on sensor tip until ready to use.

#### CAUTION

Buffer solution, in the vinyl boot, may cause skin or eye irritation.

#### WARNING

Glass electrode must be wetted at all times (in storage and in line) to maximize sensor life.

### 2.2 MOUNTING.

The sensor has been designed to be located in industrial process environments. Temperature and pressure limitations must not be exceeded at any time. A caution label regarding this matter is attached to the sensor. Please do not remove the label. See Figure 2-1.

#### CAUTION

Internal electrolyte fill solution may cause skin or eye irritation.

#### Mounting Guidelines:

1. Shake the sensor in a downward motion to remove any air bubbles that may be present inside the tip of the pH glass.

2. Do not install the sensor on the horizontal. The sensor must be 10° off the horizontal to ensure accuracy.
3. Do not install the sensor upside down.
4. Air bubbles may become trapped in the sensor end between the glass bulb and the sensor body. This problem is most commonly encountered in areas of low flow or during calibration. Shake the probe while immersed in solution to remove bubbles. This problem can be avoided by ordering the sensor with the slotted tip (option -41).

In most cases, the pH sensor can simply be installed as shipped and readings with an accuracy of  $\pm 0.6$  pH may be obtained. To obtain greater accuracy or to verify proper operation, the sensor must be calibrated as a loop with its compatible analyzer or transmitter.

#### 2.2.1 Flow Through and Insertion Mounting.

Model 396P and 396PVP Sensors have a 1-inch MNPT process connection at the front of the sensor for mounting into a 1-1/2 inch tee or the process pipes. See Figure 2-1 through Figure 2-7 for installation configurations.

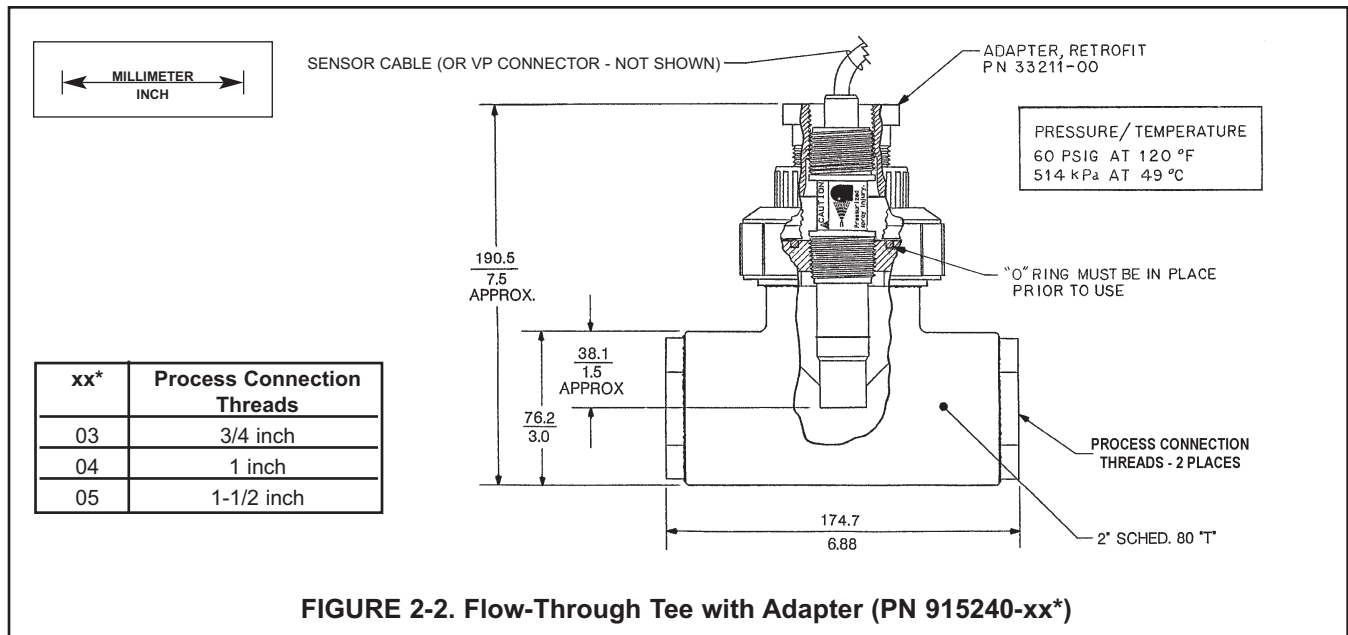
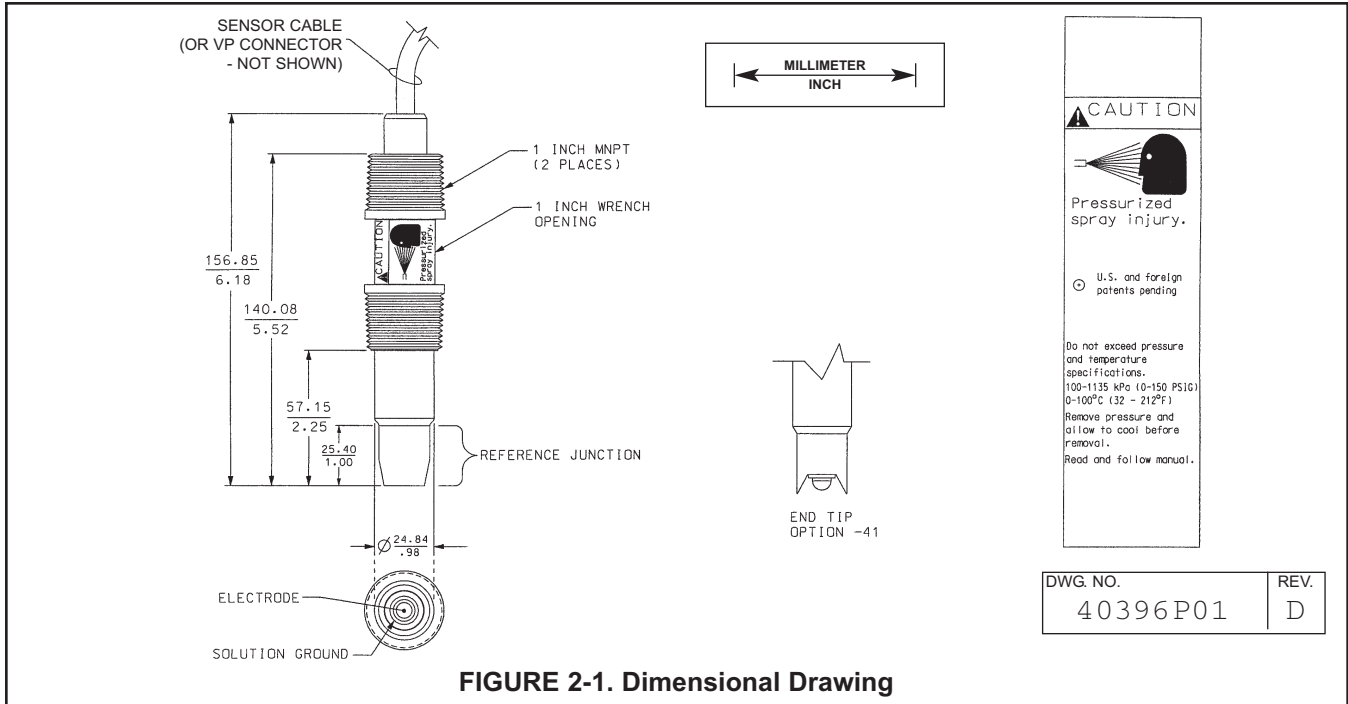
#### NOTE

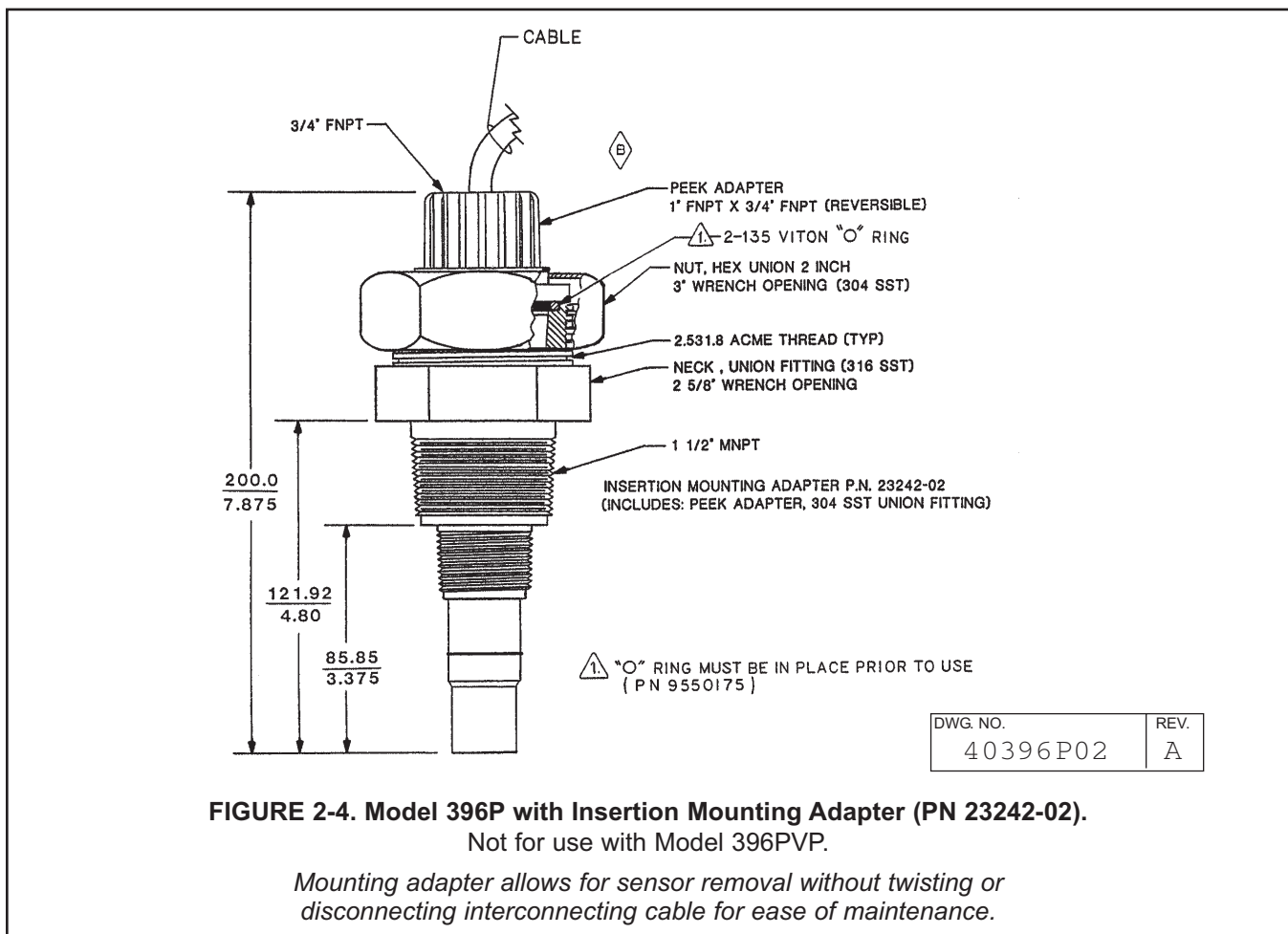
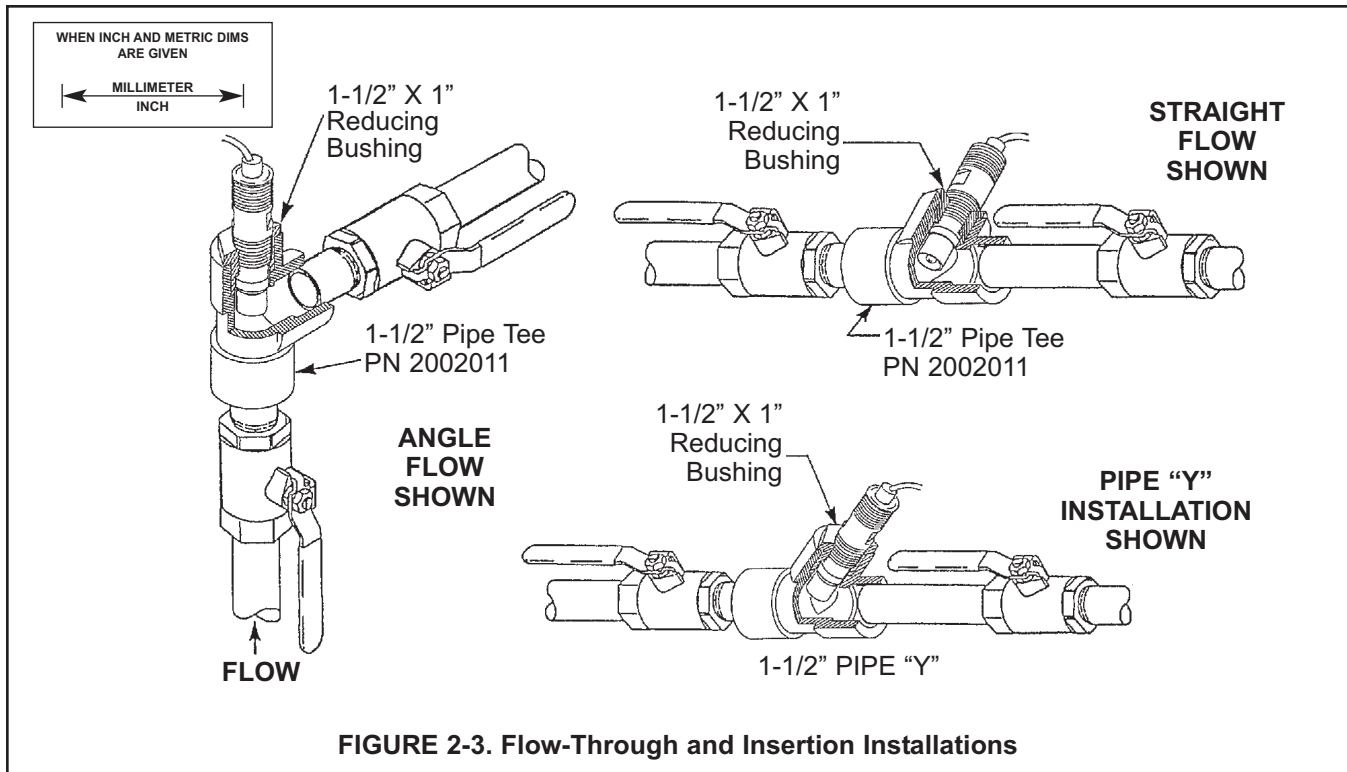
LARGE PIPE WRENCHES MUST NOT BE USED TO TIGHTEN THE SENSOR INTO A FLANGE OR OTHER TYPE OF MOUNTING.

#### 2.2.2 Submersion Mounting.

Model 396P and 396PVP Sensors also have a 1 inch MNPT process connection at the back of the sensor. Utilizing a standard 1 inch union, the sensor may be mounted to a 1 inch SCH 80 CPVC or PVDF standpipe (see Figure 2-x). Tapered pipe threads in plastic tend to loosen after installation. It is therefore recommended that Teflon<sup>1</sup> tape be used on the threads and that the tightness of the connection be checked frequently to assure that no loosening has occurred. To prevent rain water or condensation from running into the sensor, a weatherproof junction box is recommended (see Figure 2-x). The sensor cable must be run through a protective conduit for isolation from electrical interference or physical abuse from the process. The sensor should be installed within 80° of vertical, with the electrode facing down. The sensor's cable should not be run with power or control wiring.

<sup>1</sup> Teflon is a registered trademark of E.I. du Pont de Nemours & Co.





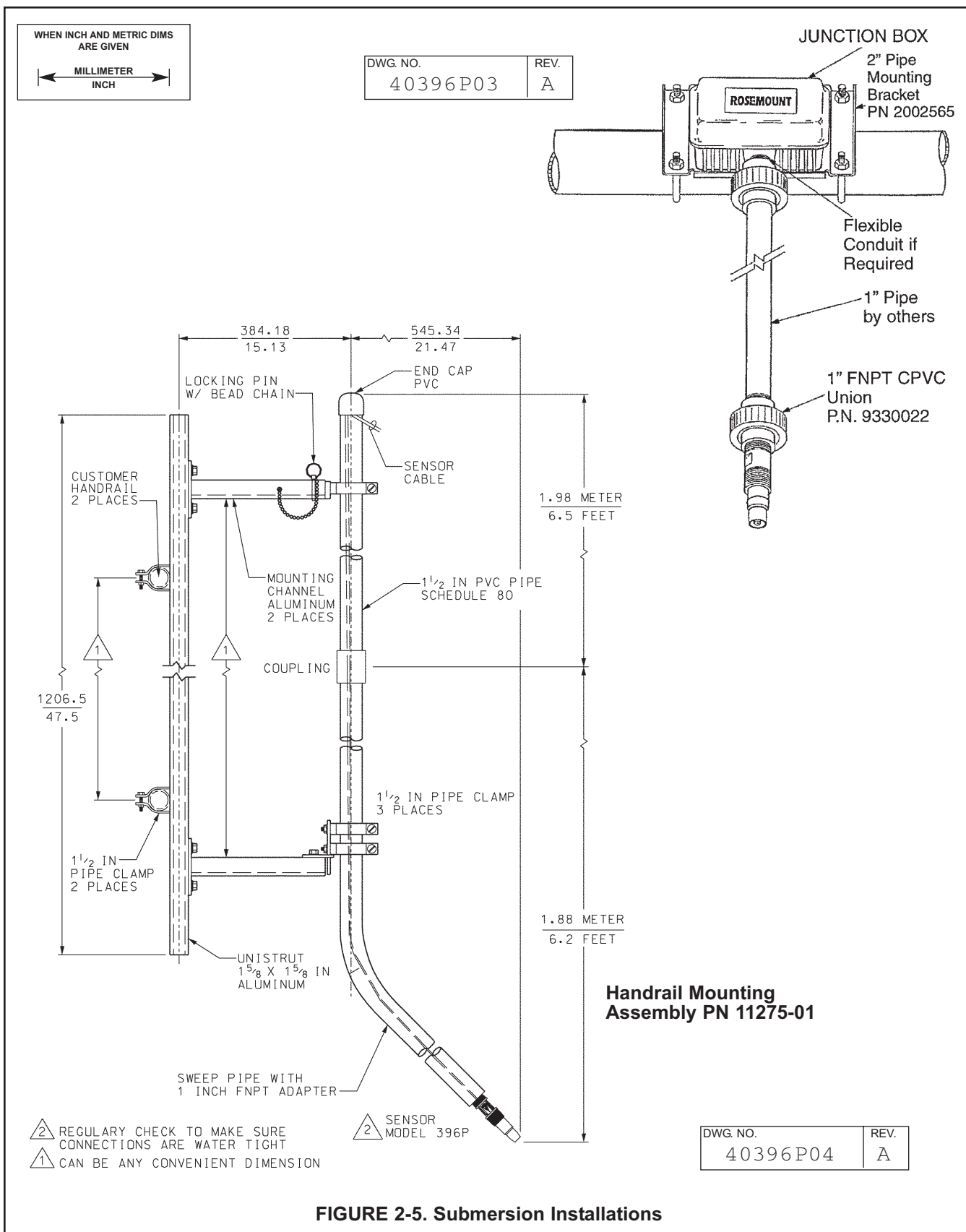
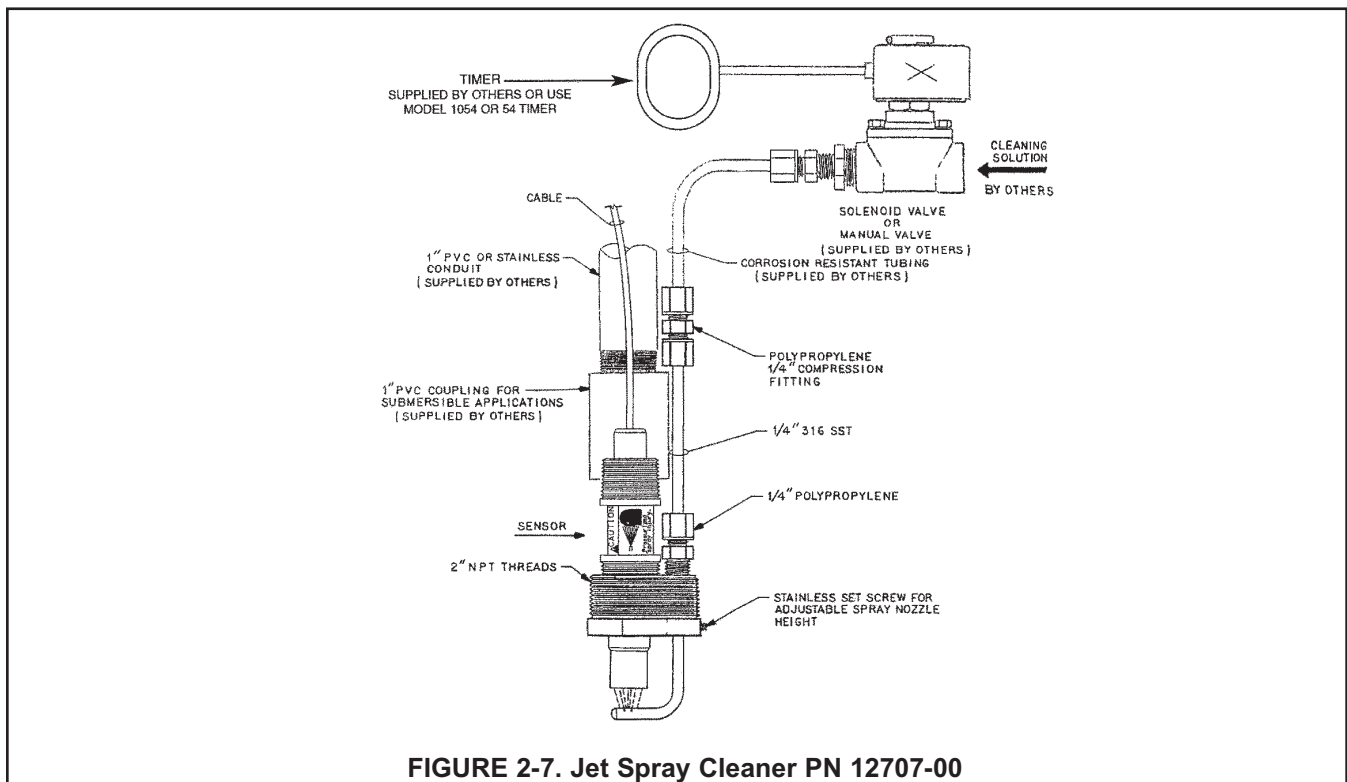
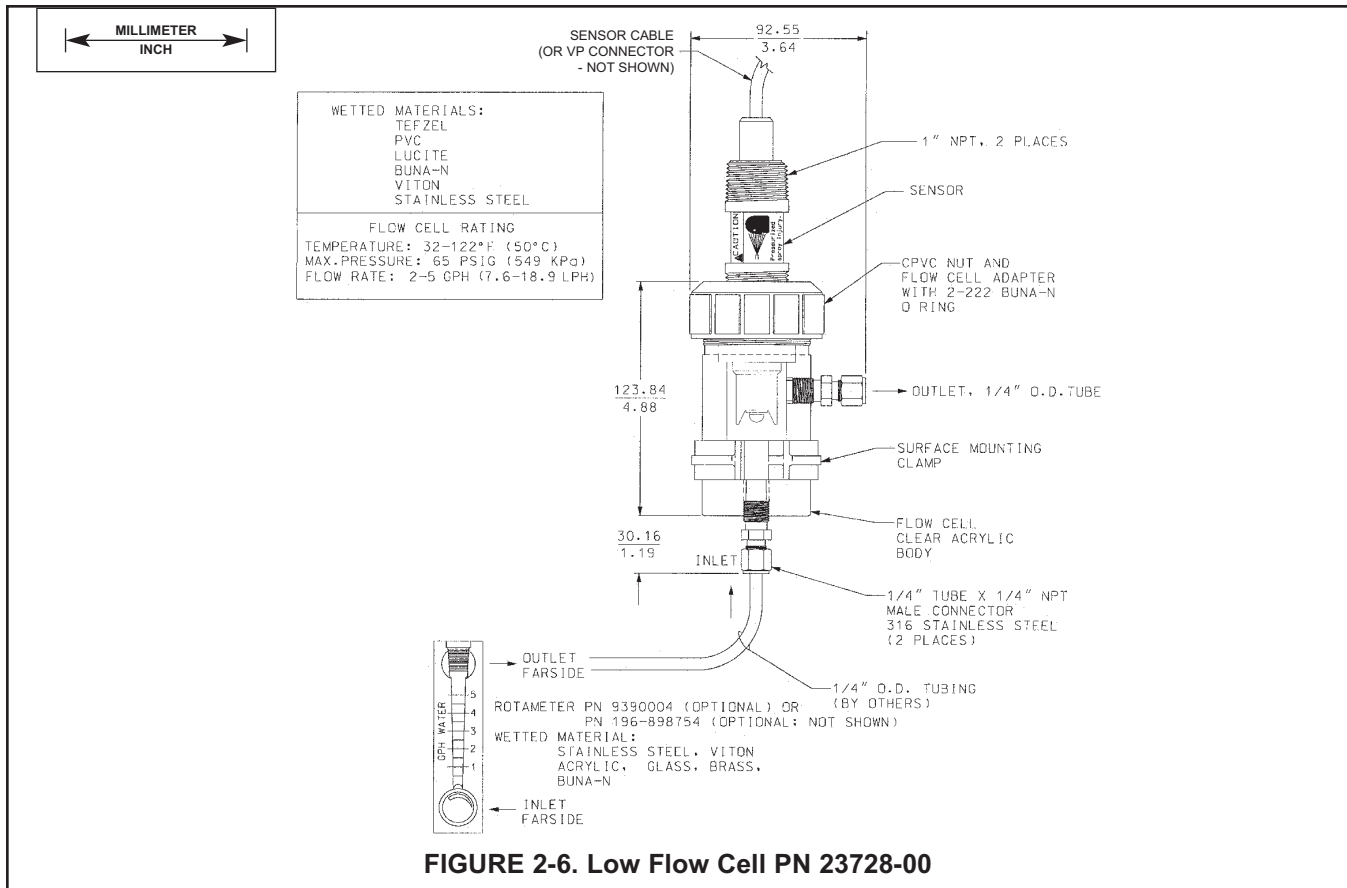


FIGURE 2-5. Submersion Installations



## SECTION 3.0

### WIRING — MODEL 396P-01

Figures in this section provide the guidelines for wiring the 396P-01 sensor to various Analyzer/Transmitter instruments.

To determine which wiring guideline to use, locate the model number of the sensor to be installed.

1. If the cable needs to be extended, use a high quality eleven conductor double shielded instrument cable available from Rosemount Analytical. Refer to Table 3-1 for the appropriate junction box to use and the corresponding wiring details.

#### NOTE

If the cable is too long, loop up the excess cable. If the cable has to be shortened, cut and terminate each conductor neatly and **make sure that the overall (outermost) drain wire is not shorted out with either of the two inner drain wires (shields).**

2. Signal cable should be run in a dedicated conduit (preferably an earth grounded metallic conduit) and should be kept away from AC power lines. For your convenience, a wire nut kit is furnished (in a plastic bag wrapped around the cable).

#### NOTE

For maximum EMI/RFI protection when wiring from the sensor to the junction box, the outer braid of the sensor should be connected to the outer braided shield of the extension cable. The outer braid of the extension cable to the instrument must be terminated at earth ground or by using an appropriate metal cable gland fitting that provides a secure connection to the instrument cable.

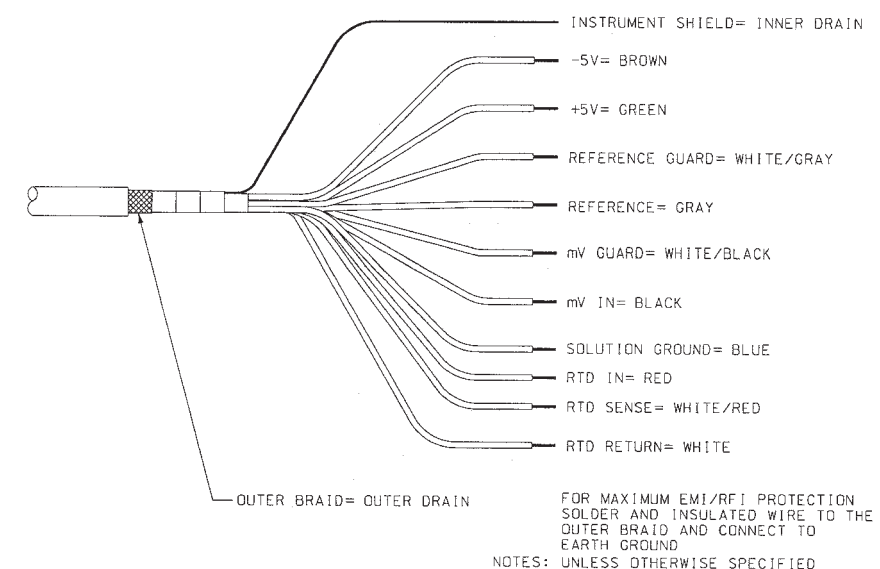
TABLE 3-1. Wiring Matrix Guide

Sensor Model Options	Preamplifier Location			Interconnect (unprepped PN)	Analyzer/Transmitter							Refer to Figure #
	Integral to Sensor	Integral to Analyzer	Remote Junction Box (PN)		1054A, 1054B, 2054 2081	54e, 81, 3081, 4081, 5081	1055	1181	1050 1060	1003 1023	SCL or SoluCube	
396P-01-()-50	✓							✓	✓			3-2
396P-01-()-50	✓		Ext. box (22719-02)	9200254				✓	✓			3-2
396P-01-()-54	✓				✓							3-3
396P-01-()-54	✓		Ext. box (22719-02)	9200254	✓							3-3
396P-01-()-55	✓					✓						3-5
396P-01-()-55	✓		Ext. box (23550-00)	9200273		✓						3-4
396P-01-()-55	✓			9200273 or 23646-01			✓					3-6

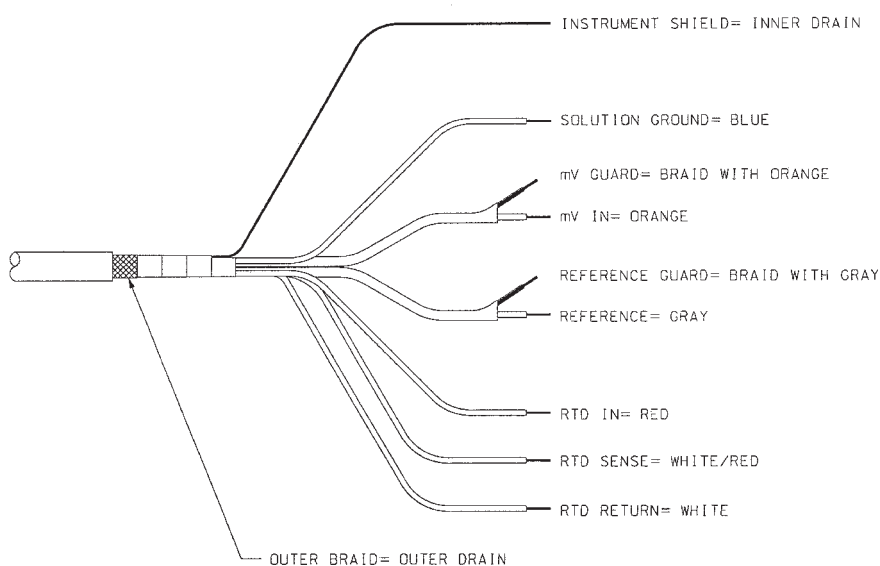


**Wiring.** The Model 396P has an optional built-in pre-amplifier and is offered with a shielded cable. The cable should be handled carefully and kept dry and free of corrosive chemicals at all times. Extreme care should be used to prevent it from being twisted, damaged or scraped by rough, sharp edges or surfaces. Please refer to Figures 3-1 through 3-6 for wiring Model 396P-01.

**DANGER**  
DO NOT CONNECT SENSOR CABLE TO POWER LINES. SERIOUS INJURY MAY RESULT.

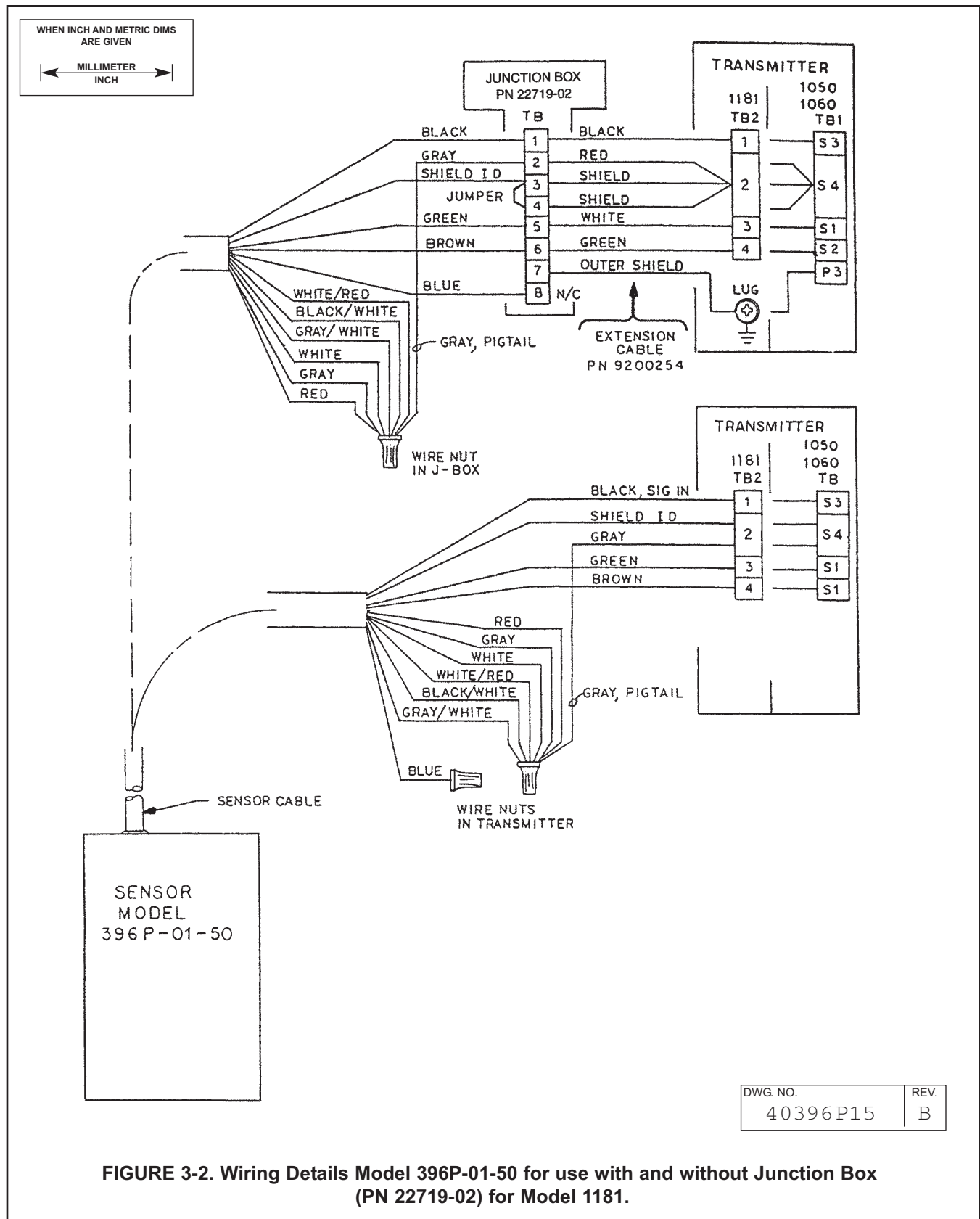


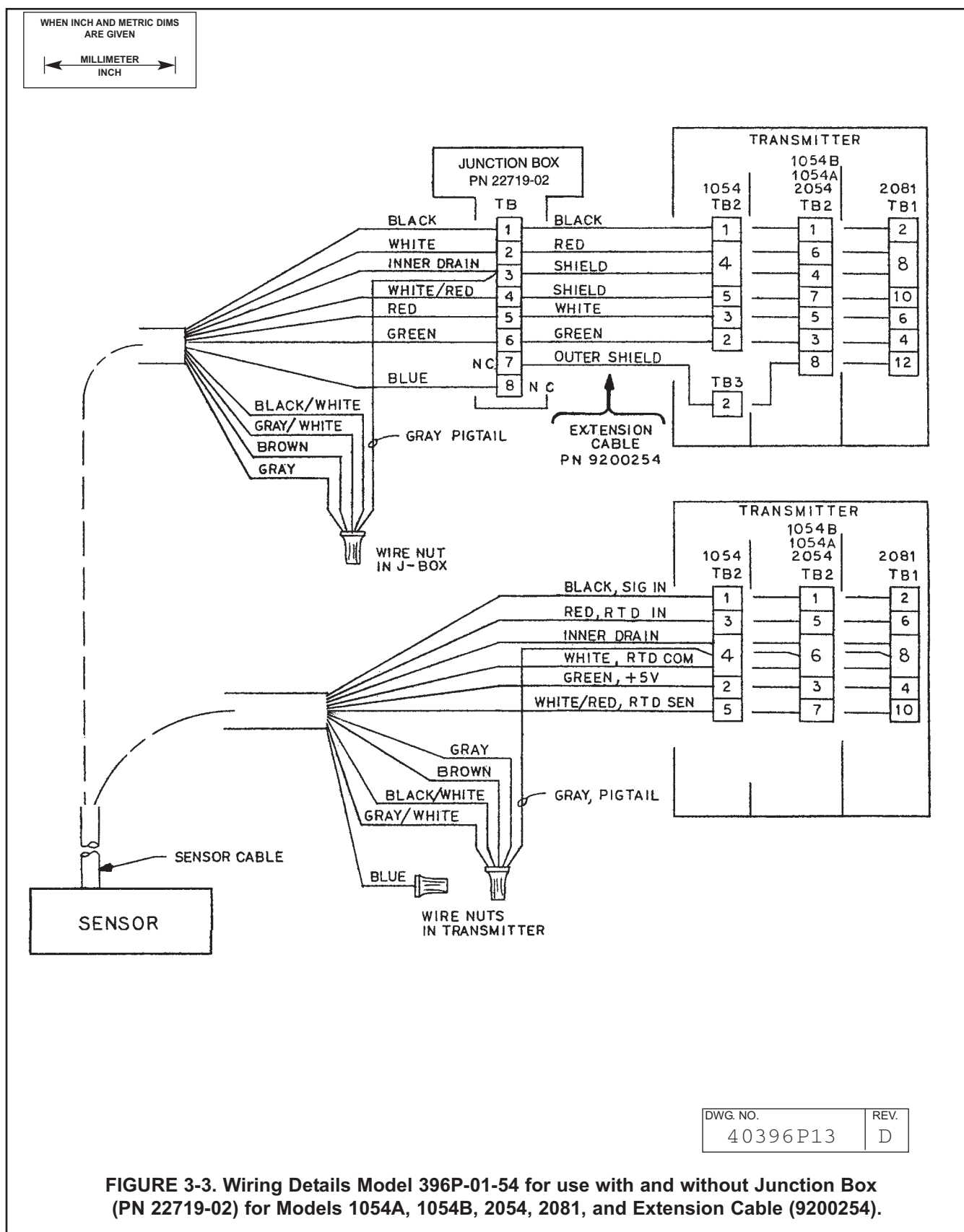
Model 396P  
Option 01 (with  
preamplifier) cable



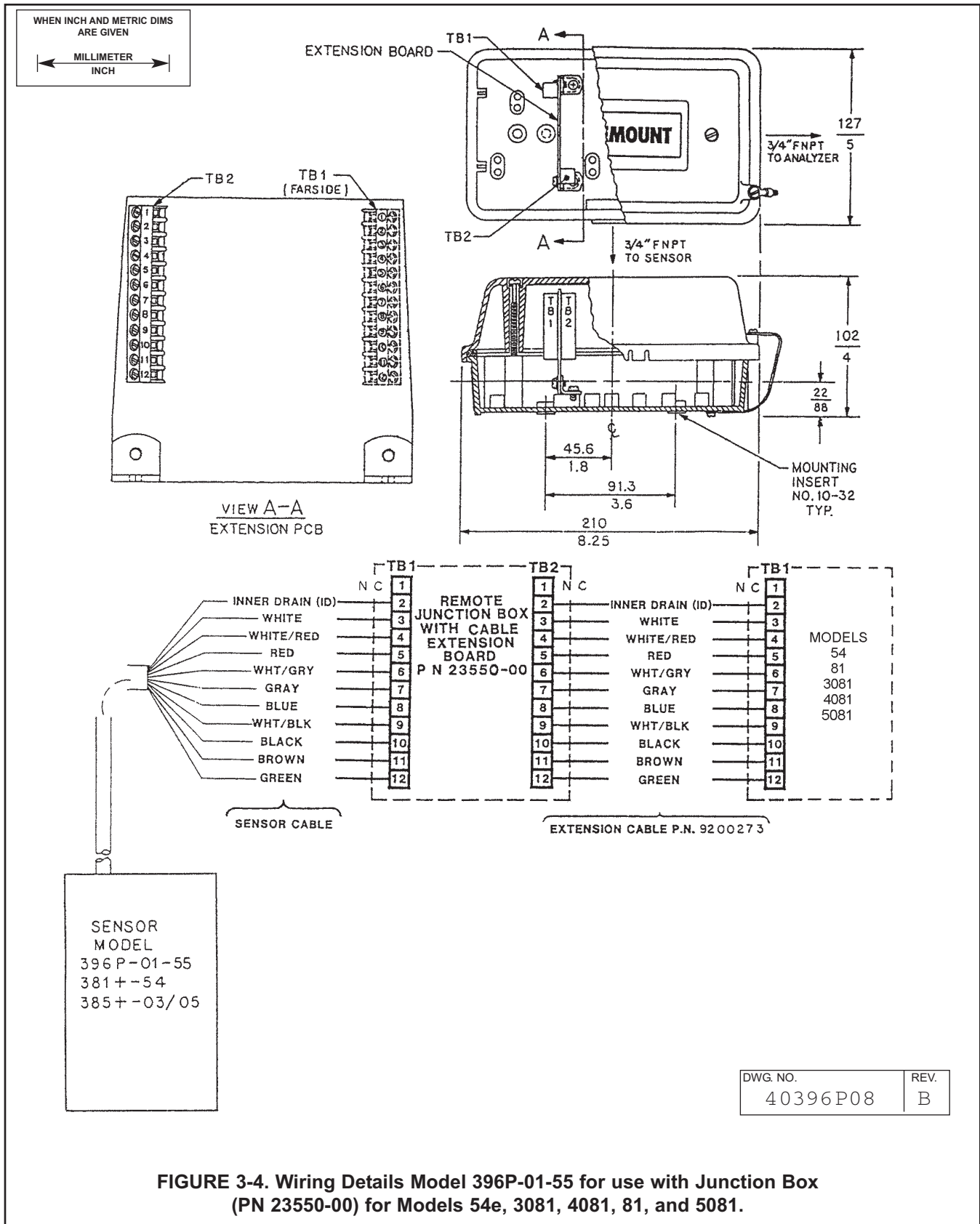
Model 396P  
Option 02 (without  
preamplifier) cable

**FIGURE 3-1. Wire Functions for Model 396P with and without Preamplifier**





DWG. NO.	REV.
40396P13	D



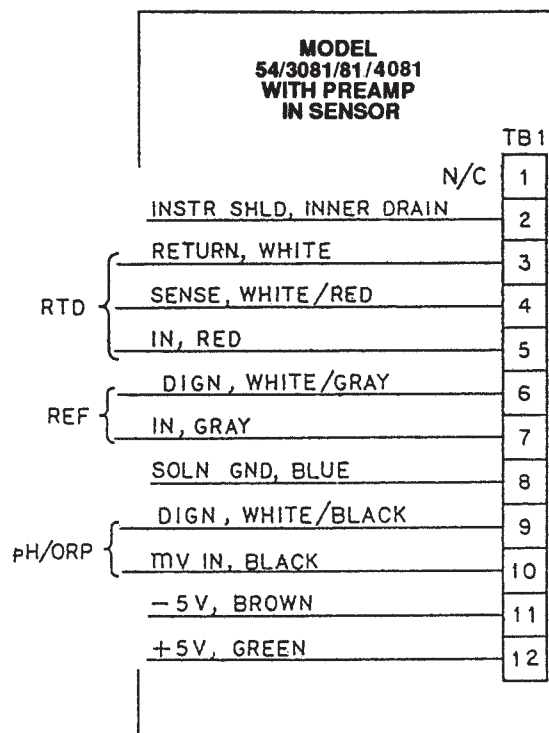


FIGURE 3-5. Wiring Details Model 396P-01-55 for use with Models 54e, 81, 3081, 4081, and 5081

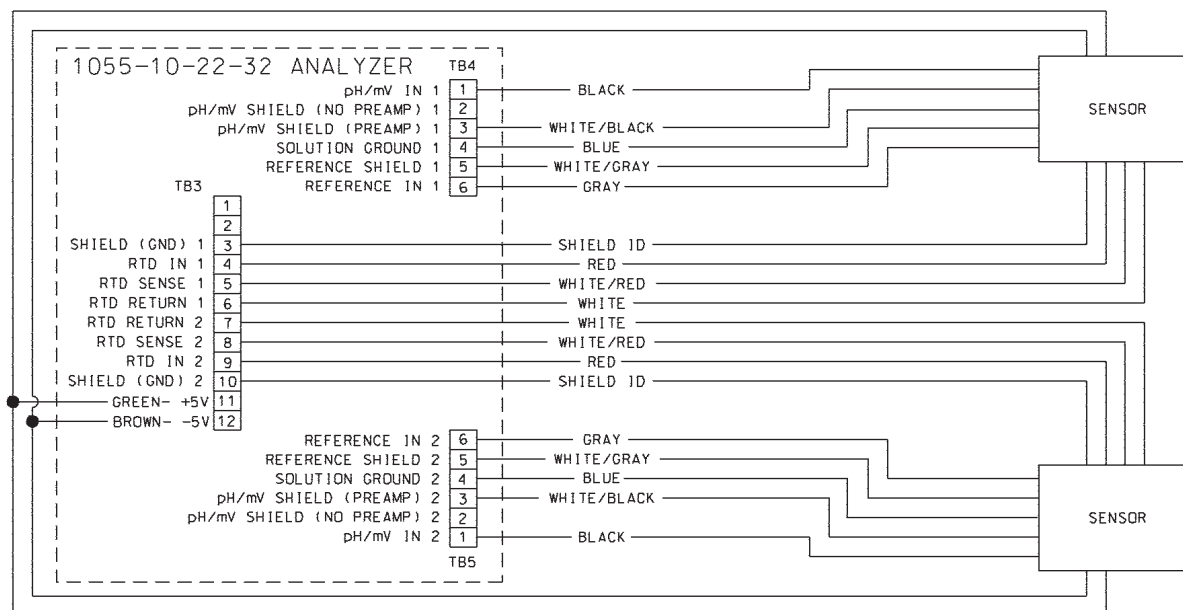


FIGURE 3-6. Wiring Model 396P-01-( )-55 Sensor to Model 1055-10-22-32 Analyzer

## SECTION 4.0

### WIRING — MODELS 396P-02 AND 396PVP

Figures 4-1 thru 4-22 provide the guidelines for wiring the sensor to various Analyzer/Transmitter instruments.

To determine which wiring guideline to use, locate the model number of the sensor to be installed.

1. If the cable needs to be extended, use a high quality eleven conductor double shielded instrument cable available from Rosemount Analytical. Refer to Table 4-1 to refer to the appropriate junction box to use and the corresponding wiring details.

#### NOTE

If the cable is too long, loop up the excess cable. If the cable has to be shortened, cut and terminate each conductor neatly and **make sure that the overall (outermost) drain wire is not shorted out with either of the two inner drain wires (shields).**

2. Signal cable should be run in a dedicated conduit (preferably an earth grounded metallic conduit) and should be kept away from AC power lines. For your convenience, a wire nut kit is furnished (in a plastic bag wrapped around the cable).

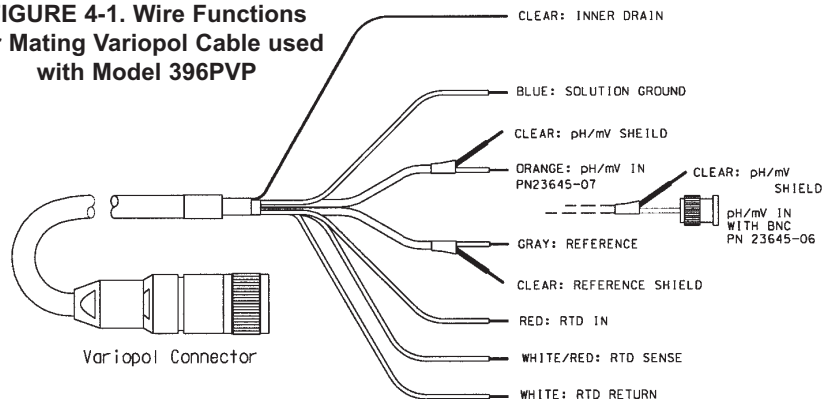
#### NOTE

For maximum EMI/RFI protection when wiring from the sensor to the junction box, the outer braid of the sensor should be connected to the outer braided shield of the extension cable. The outer braid of the extension cable to the instrument must be terminated at earth ground or by using an appropriate metal cable gland fitting that provides a secure connection to the instrument cable.

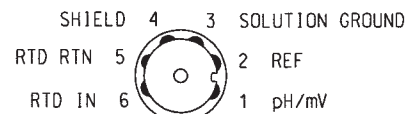
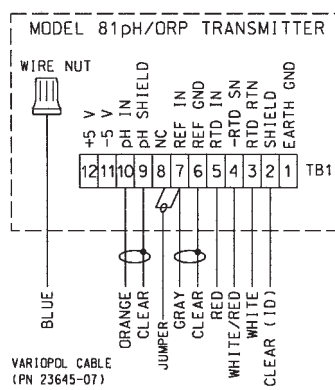
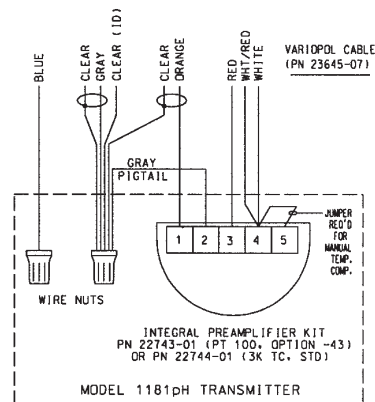
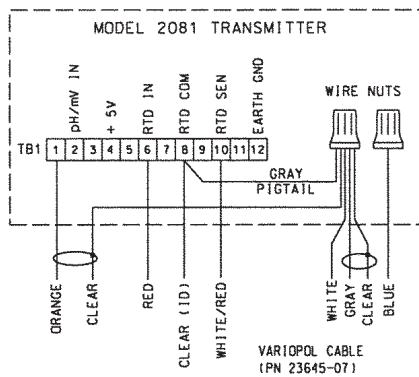
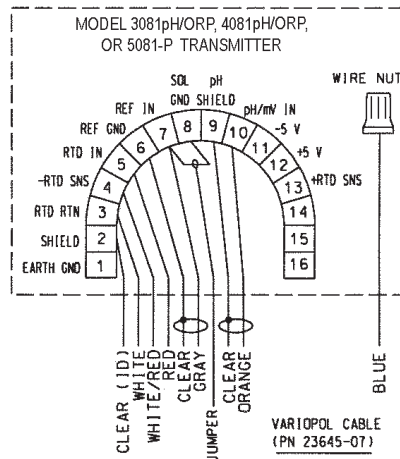
TABLE 4-1. Wiring Matrix Guide

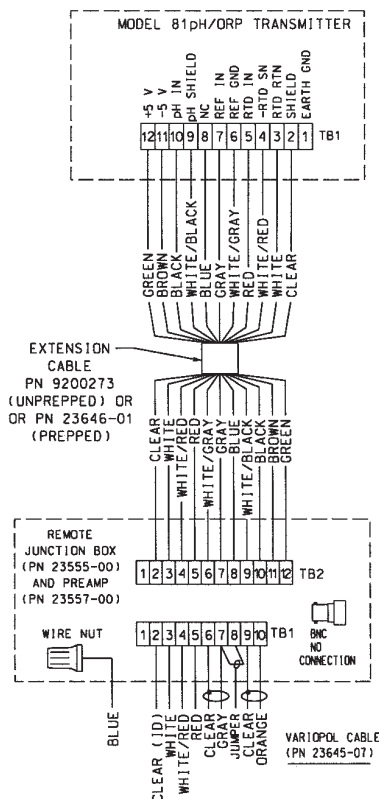
Sensor Model Options	Preamplifier Location			Analyzer/Transmitter								Refer to Figure #
	Integral to Sensor	Integral to Analyzer	Remote Junction Box (PN)	Interconnect (unprepped PN)	1054A, 1054B, 2054 2081	54, 81, 3081, 4081, 5081	1055	1181	1050 1060	1003 1023	SCL or SoluCube	
396P-02-()-55 396PVP-55		✓				✓						4-3, 4-6, 4-9
396P-02-()-50 396PVP-50		✓						✓				4-4
396P-02-()-50 396PVP-50			23309-03	9200254				✓	✓	✓		4-22
396P-02-()-50 396PVP-50			23309-03	9200273 or 23646-01				✓	✓	✓		4-8
396P-02-()-54			23309-04	9200254	✓							4-23
396P-02-()-54 396PVP-54			23309-04	9200273 or 23646-01	✓							4-20
396P-02-()-54 396PVP-54		✓			✓							4-5, 4-18 4-19
396P-02-()-55 396PVP-55			23555-00	9200273 or 23646-01		✓						4-7, 4-10 4-12
396P-02-()-54 396PVP-54		✓		661-898695							✓	4-14
396P-02-54 396PVP-54			23309-04	9200273 or 23646-01	✓							4-11 4-21
396P-02-55 396PVP-55		✓					✓					4-15 4-16
396P-02-55 396PVP-55			✓	9200273 or 23646-01			✓					4-17



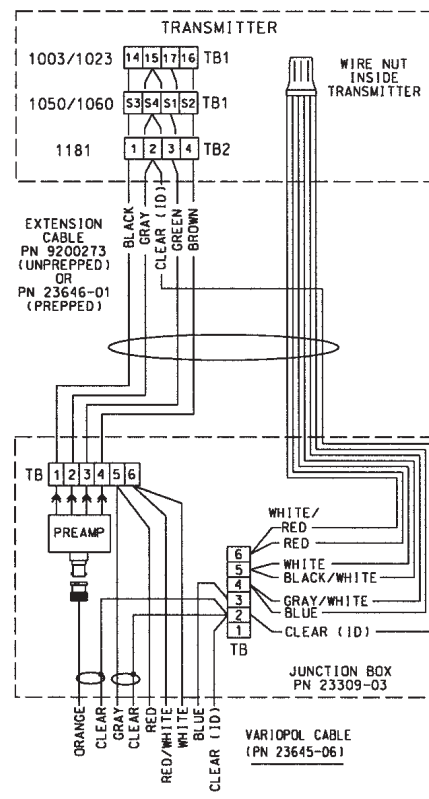
**FIGURE 4-1. Wire Functions  
for Mating Variopol Cable used  
with Model 396PVP**

396PVP, 396RVP

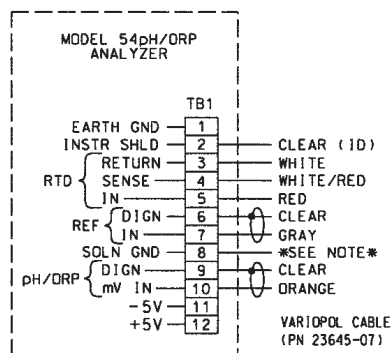
**FIGURE 4-2. Connector Pins  
and Their Functions****FIGURE 4-3. Wiring Details for Models 396PVP  
or 396P-02-55 with Mating Variopol Cable  
(PN 23645-07) for use with Model 81****FIGURE 4-4. Wiring Details for Models 396PVP  
or 396P-02-50 with Mating Variopol Cable  
(PN 23645-07) for use with Model 1181****FIGURE 4-5. Wiring Details for Models 396PVP  
or 396P-02-54 with Mating Variopol Cable  
(PN 23645-07) for use with Model 2081****FIGURE 4-6. Wiring Details for Models 396PVP  
or 396P-02-55 with Mating Variopol Cable  
(PN 23645-07) for use with Models 3081, 4081, 5081**



**FIGURE 4-7. Wiring Details for Models 396PVP or 396P-02-55 with Mating Variopole Cable (PN 23645-07) for use with Remote Junction Box (PN 23555-00) to Model 81**

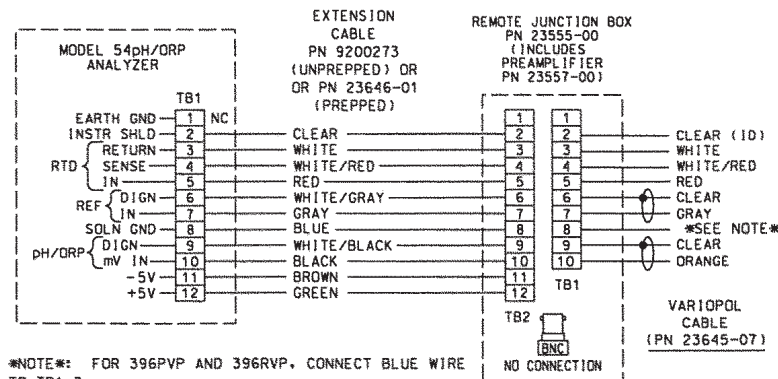


**FIGURE 4-8. Wiring Details for Models 396PVP or 396P-02-50 with Mating Variopole Cable (PN 23645-06) for use with Remote Junction Box (PN 23309-03) to Model 1181**



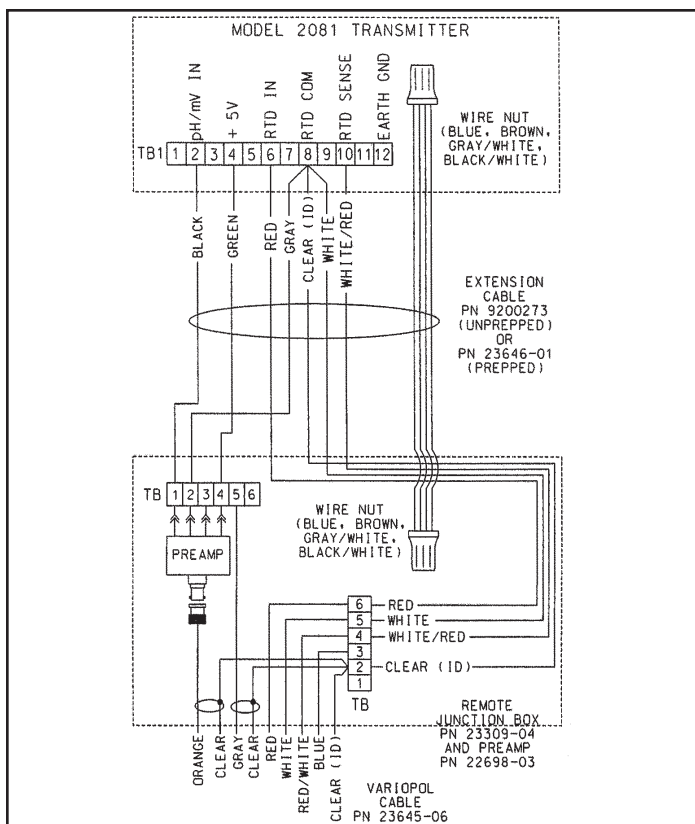
\* NOTE\*: FOR 396PVP AND 396RVP, CONNECT BLUE WIRE TO TB1-8.

**FIGURE 4-9. Wiring Details for Models 396PVP or 396P-02-55 with Mating Variopole Cable (PN 23645-07) for use with Model 54/54e**

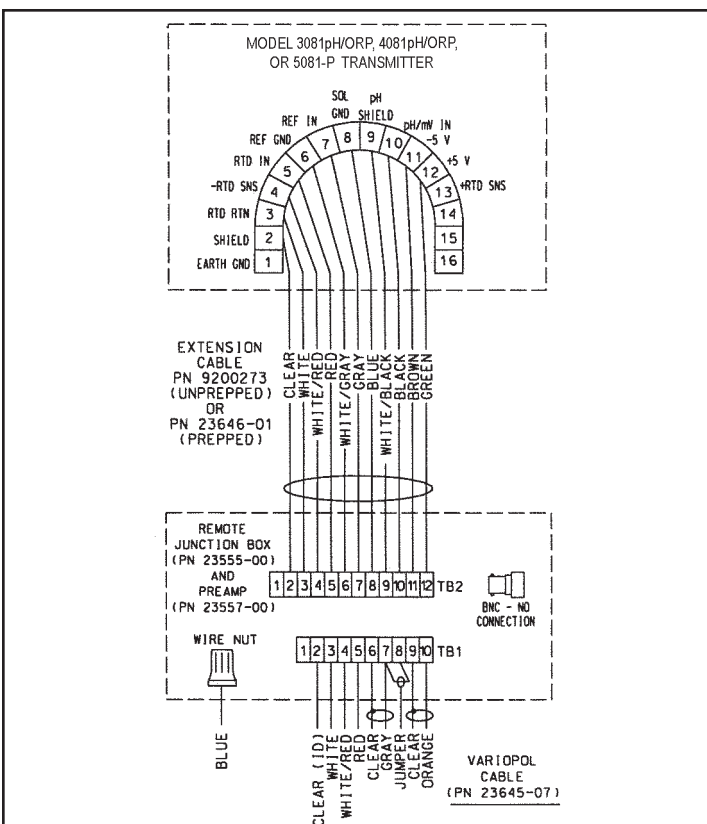


\*NOTE\*: FOR 396PVP AND 396RVP, CONNECT BLUE WIRE TO TB1-8.

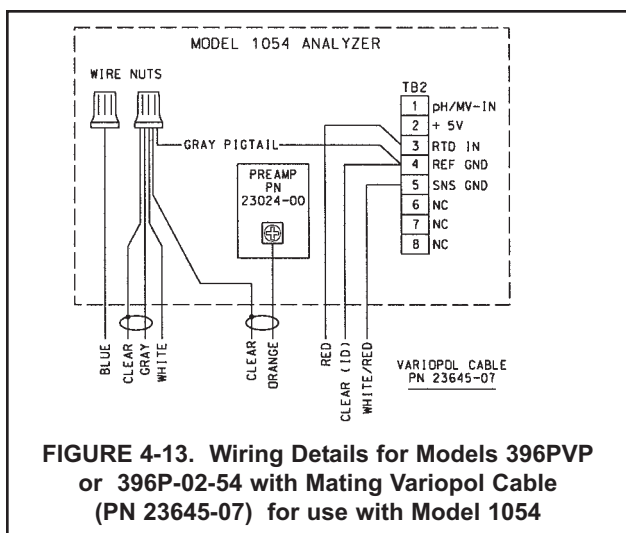
**FIGURE 4-10. Wiring Details for Models 396PVP or 396P-02-55 with Mating Variopole Cable (PN 23645-07) for use with Remote Junction Box (PN 23555-00) to Model 54/54e**



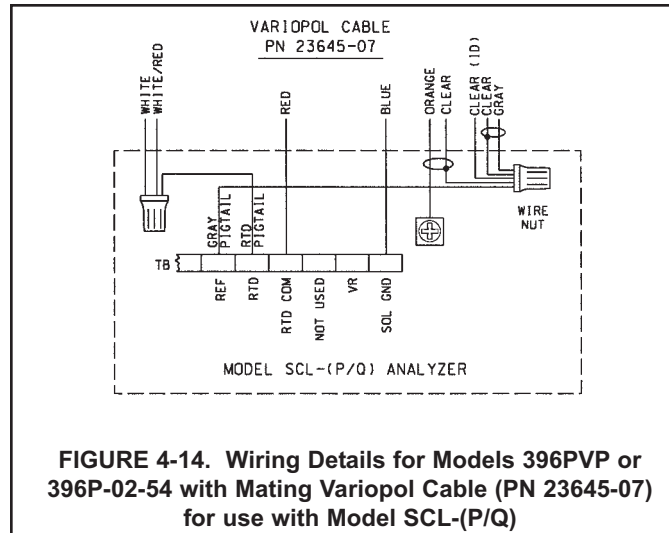
**FIGURE 4-11. Wiring Details for Models 396PVP or 396P-02-54 with Mating Variopole Cable (PN 23645-06) for use with Remote Junction Box (PN 23309-04) to Model 2081**



**FIGURE 4-12. Wiring Details for Models 396PVP or 396P-02-55 with Mating Variopole Cable (PN 23645-07) for use with Remote Junction Box (PN 23555-00) to Models 3081, 4081, & 5081**



**FIGURE 4-13. Wiring Details for Models 396PVP or 396P-02-54 with Mating Variopole Cable (PN 23645-07) for use with Model 1054**



**FIGURE 4-14. Wiring Details for Models 396PVP or 396P-02-54 with Mating Variopole Cable (PN 23645-07) for use with Model SCL-(P/Q)**

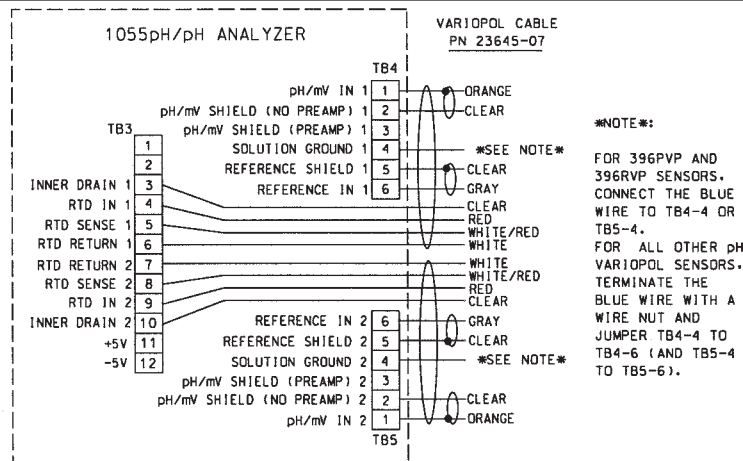


FIGURE 4-15. Wiring Details for Models 396PVP or 396P-02-55 with Mating Variopole Cable (PN 23645-07) for use with Model 1055

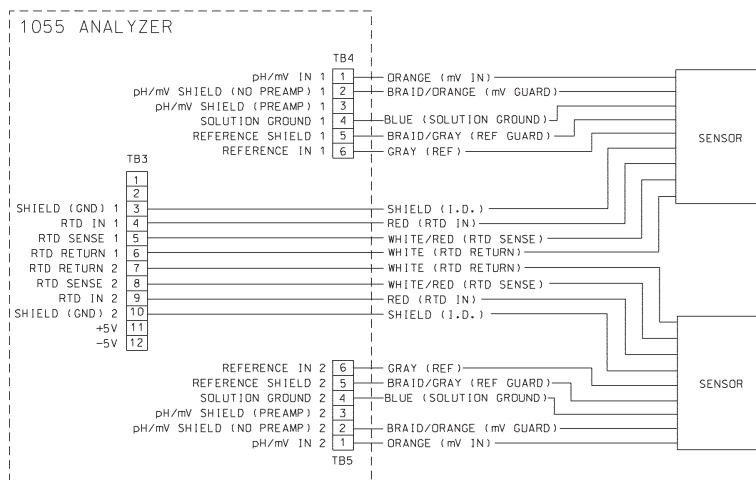


FIGURE 4-16. Wiring Model 396P-(02)-( )-54/55-(61) Sensor to Model 1055-01-10-22-32 Analyzer

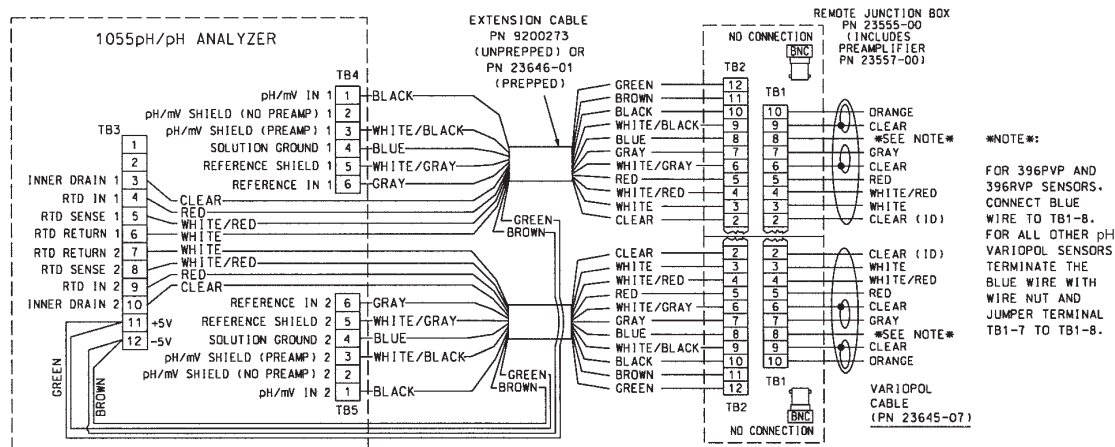
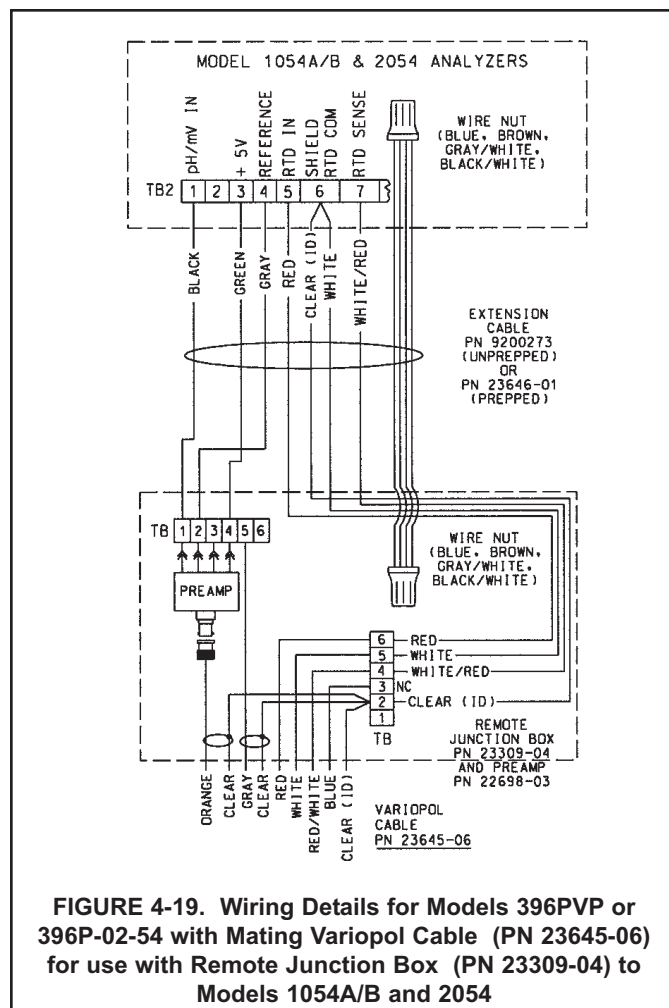
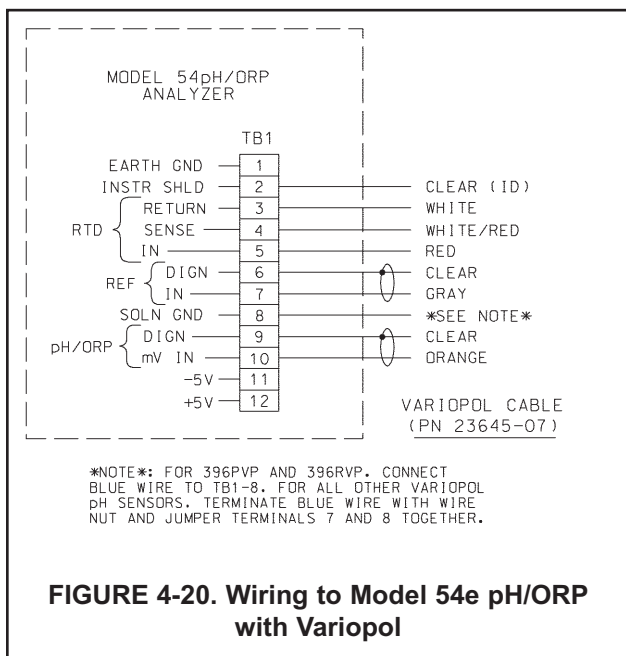
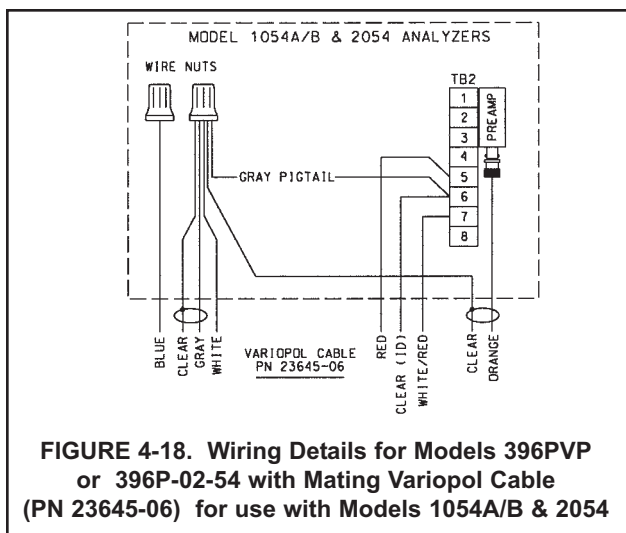
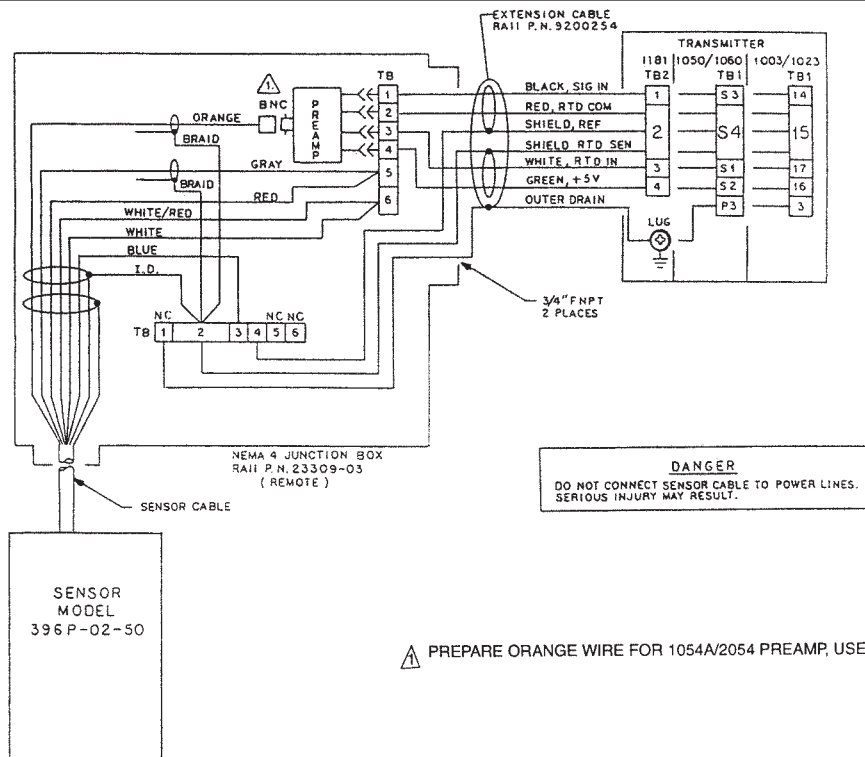


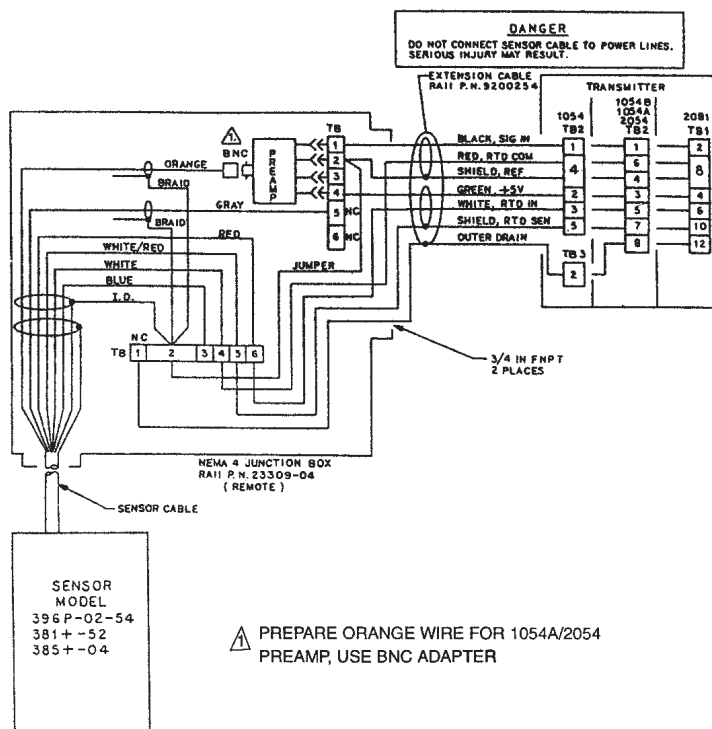
FIGURE 4-17. Wiring Details for Models 396PVP or 396P-02-55 with Mating Variopole Cable (PN 23645-07) for use with Remote Junction Box (PN 23557-00) to Model 1055

NOTE: This wiring diagram can also be used for wiring a Model 396P-01. The wire colors and functions for the extension cable (PN 9200273) are the same as the 396P-01 wire colors and functions.





**FIGURE 4-21. Wiring Details Model 396P-02-50 for use with Junction Box (PN 23309-03) and Remote Preamplifier, Extension Cable (PN 9200254).**



**FIGURE 4-22. Wiring Details Model 396P-02-54 for use with Junction Box (PN 23309-04) and Remote Preamplifier (PN 22698-03), Extension Cable (9200254).**



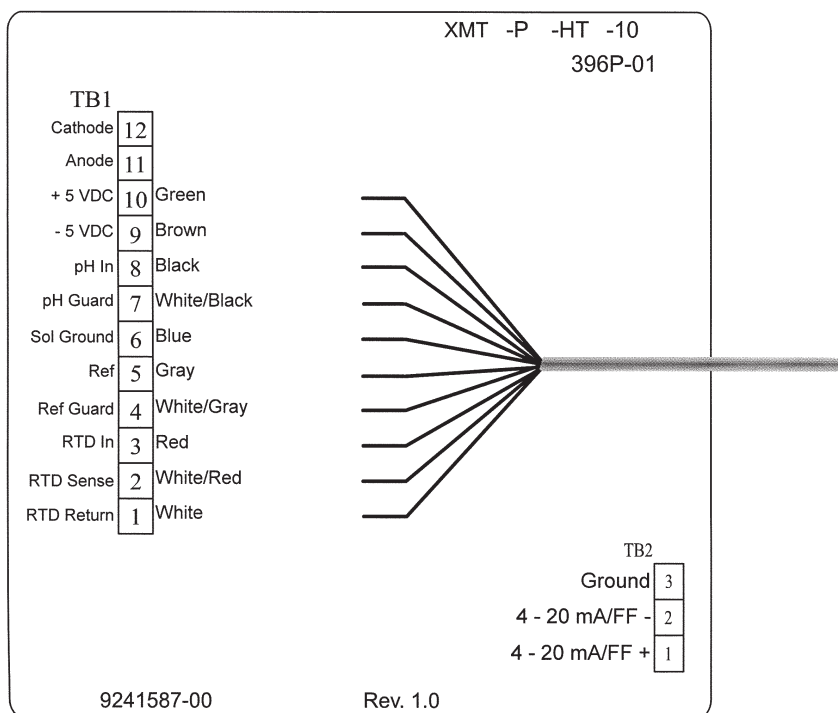


FIGURE 4-23. Wiring Model 396P-01 to Model Xmt-P-HT-10

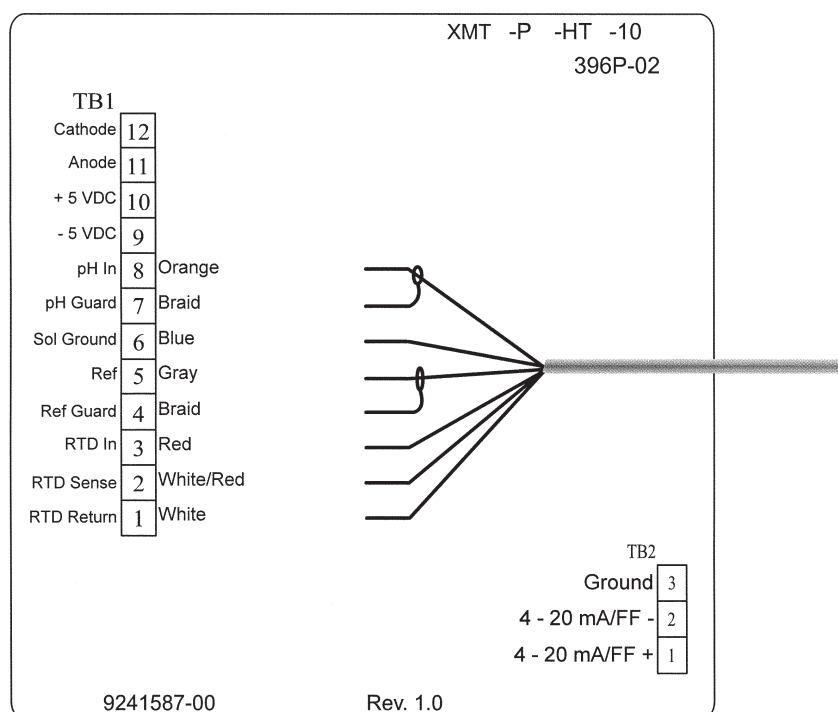


FIGURE 4-24. Wiring Models 396P-02 and 396PVP to Model Xmt-P-HT-10

## SECTION 5.0

# START UP AND CALIBRATION

### 5.1 MODELS 396P and 396PVP pH SENSORS

**5.1.1 SENSOR PREPARATION.** Shake down the sensor to remove any air bubbles that may be present at the tip of the pH glass bulb. In most cases, the pH sensor can simply be installed as shipped and readings with an accuracy of  $\pm 0.6$  pH may be obtained. To obtain greater accuracy or to verify proper operation, the sensor must be calibrated as a loop with its compatible analyzer or transmitter.

**5.1.2 pH CALIBRATION.** After a temporary connection is established between the sensor and the instrument, a buffer calibration may be performed. Consult appropriate pH/ORP analyzer or transmitter instruction manual for specific calibration and standardization procedures, or see below for recommended two-point buffer calibration procedure.

**Recommended two-point buffer calibration procedure:**

Select two stable buffer solutions, preferably pH 4.0 and 10.0 (pH buffers other than pH 4.0 and pH 10.0 can be used as long as the pH values are at least two pH units apart).

**NOTE**

A pH 7.0 buffer solution reads a mV value of approximately zero, and pH buffers read approximately 59.1 mV for each pH unit above or below pH 7.0. Check the pH buffer manufacturer specifications for millivolt values at various temperatures since it may affect the actual value of the buffer solution mV/pH value.

1. Immerse sensor in the first buffer solution. Allow sensor to adjust to the buffer temperature (to avoid errors due to temperature differences between the buffer solution and sensor temperature) and wait for reading to stabilize. Value of buffer can now be acknowledged by analyzer/transmitter.
2. Once the first buffer has been acknowledged by the analyzer/transmitter, rinse the buffer solution off of the sensor with distilled or deionized water.
3. Repeat steps 1 and 2 using the second buffer solution.
4. Once the analyzer/transmitter has acknowledged both buffer solutions, a sensor slope (mV/pH) is established (the slope value can be found within the analyzer/ transmitter).
5. The slope value should read about 59.1 mV/pH for a new sensor and will decrease over time to approximately 47-49 mV/pH. Once the slope reads below the 47-49 mV/pH range, a new sensor should be installed to maintain accurate readings.

**Recommended pH Sensor Standardization:**

For maximum accuracy, the sensor can be standardized online or with a process grab sample after a buffer calibration has been performed and the sensor has been conditioned to the process. Standardization accounts for the sensor junction potential and other interferences. Standardization will not change the sensor's slope but will simply adjust the analyzer's reading to match that of the known process pH.

1. While obtaining a process solution sample (it is recommended that the sample is taken close to the sensor), record the pH value that is shown on the analyzer/transmitter display.
2. Measure and record the pH of the process solution sample with another temperature compensated, calibrated pH instrument. For best results, standardization should be performed at the process temperature.
3. Adjust the analyzer/transmitter value to the standardized value.

### 5.2 MODEL 396P and 396PVP ORP SENSORS

**5.2.1 SENSOR PREPARATION.** Most industrial applications have a number of ORP reactions occurring in sequence or simultaneously. There can be several components that are oxidized or reduced by the reagents that are used. Theoretically, the ORP potential is absolute because it is the result of the oxidation-reduction equilibrium. However, the actual measured potential is dependent on many factors, including the condition of the surface of the ORP platinum electrode. **Therefore, the sensor should be allowed 1-2 hours to become "conditioned" to the stream when first set-up or after being cleaned.**

#### 5.2.2 ORP CALIBRATION

1. Make a temporary electrical connection between the sensor and the instrument.
2. Obtain an ORP standard solution, or a standard solution can also be made quite simply by adding a few crystals of quinhydrone to either pH 4 or pH 7 buffer. Quinhydrone is only slightly soluble therefore a few crystals will be required. (Refer to Section 4.3. for an alternate ORP standard solution).
3. Immerse the sensor in the standard solution. Allow 1-2 minutes for the ORP sensor to stabilize.
4. Adjust the standardize control of the instrument to the solution value shown in Table 5-1 (below) or on the label of the standard solution. The resulting potentials, measured with a clean platinum electrode and saturated KCl/AgCl reference electrode, should be within  $\pm 20$  millivolts of the value. Solution temperature must be noted to ensure accurate interpretation of results. The ORP value of saturated quinhydrone solution is not stable over long periods of time. Therefore, these standards should be made up fresh each time they are used.
5. Remove the sensor from the buffer, rinse and install in the process.

**TABLE 5-1. ORP of Saturated Quinhydrone Solution (In Millivolts)**

	pH 4 Solution			pH 7 Solution		
Temp °C	20	25	30	20	25	30
Millivolt Potential	268	264	260	94	87	80

## SECTION 6.0 MAINTENANCE

The Model 396P and 396PVP Sensors require minimum maintenance. The sensor should be kept clean and free of debris and sediment at all times. The frequency of cleaning by wiping or brushing with a soft cloth or brush is determined by the nature of the solution being measured. The sensor should be removed from the process periodically and checked in buffer solutions.

### WARNING

BEFORE REMOVING THE SENSOR, be absolutely certain that the process pressure is reduced to 0 psig and the process temperature is lowered to a safe level!



If the sensor will not calibrate, refer to your analyzer/transmitter instruction manual for proper test procedures. If it is determined that the sensor has failed, it should be discarded and replaced.

### 6.1 AUTOMATIC TEMPERATURE COMPENSATOR.

The temperature compensator element is temperature sensitive and can be checked with an ohmmeter. Resistance increases with temperature.

The 3K element will read 3000 ohms  $\pm 1\%$  at 25°C (77°F) and a Pt100 will read 110 ohms. Resistance varies with temperature for a 3K and Pt100 element and can be determined according to Table 6-2 or the following formula:

$$R_T = R_0 [1 + R_1 (T - 20)]$$

Where  $R_T$  = Resistance

T = Temperature in °C

Refer to Table 6-1 for  $R_0$  and  $R_1$  values

### 6.2 MODEL 396P & 396PVP pH SENSORS

**4.2.1 ELECTRODE CLEANING.** If the electrode is coated or dirty, clean as follows:

1. Remove the sensor from process.
2. Wipe the glass bulb with a soft, clean, lint free cloth or tissue. If this does not remove the dirt or coating, go to Step 3. (Detergents clean oil and grease; acids remove scale.)
3. Wash the glass bulb in a mild detergent solution and rinse it in clean water. If this does not clean the glass bulb, go to Step 4.

### CAUTION

The solution used during the following check is an acid and should be handled with care. Follow the directions of the acid manufacturer. Wear the proper protective equipment. Do not let the solution come in contact with skin or clothing. If contact with skin is made, immediately rinse with clean water.

4. Wash the glass bulb in a dilute 5% hydrochloric acid solution and rinse with clean water. Soaking the sensor overnight in the acid solution can improve cleaning action.

### NOTE

Erroneous pH results may result immediately after acid soak, due to reference junction potential build-up.

Replace the sensor if cleaning does not restore sensor operation.

TABLE 6-1

$R_0$  and  $R_1$  VALUES FOR TEMPERATURE COMPENSATION ELEMENTS

Temperature Compensation Element	$R_0$	$R_1$
3K	2934	.0045
Pt100	107.7	.00385

TABLE 6-2

TEMPERATURE vs RESISTANCE OF AUTO T.C. ELEMENTS

Temperature °C	Resistance (Ohms) $\pm 1\%$	
	3K	Pt100
0	2670	100.0
10	2802	103.8
20	2934	107.7
25	3000	109.6
30	3066	111.5
40	3198	115.4
50	3330	119.2
60	3462	123.1
70	3594	126.9
80	3726	130.8
90	3858	134.6
100	3990	138.5

## 6.3 MODEL 396P and 396PVP ORP

**4.3.1 Platinum Electrode Check.** The platinum electrode may be checked as follows: There are two types of standard solutions which may be used to check the ORP electrode/transmitter system.

**Type 1:** One type of commonly used ORP standard solution is the saturated quinhydrone solution. Refer to Section 5.2.

CAUTION
The solution used during the following check is an acid and should be handled with care. Follow the directions of the acid manufacturer. Wear the proper protective equipment. If contact with skin or clothing is made, immediately rinse with plenty of clean water.

**Type 2:** A second ORP standard solution is the Ferric-Ferrous Ammonium Sulfate Solution (PN R508-16OZ), and it can be ordered as a spare part; otherwise, it can be prepared from the following recipe: Dissolve 39.2 grams of reagent grade ferrous ammonium sulfate,  $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$  and 48.2 grams of reagent grade ferric ammonium sulfate,  $\text{FeNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ , in approximately 700 milliliters of water (distilled water is preferred, but tap water is acceptable). Slowly and carefully add 56.2 milliliters of concentrated sulfuric acid. Add sufficient water to bring the total solution volume up to 1000 ml. This standard ORP solution, although not as simple to prepare as the quinhydrone recipe, is much more stable, and will maintain its millivolt value for approximately one year when stored in glass containers. This solution (ferric/ferrous ammonium sulfate) will produce a nominal ORP of 476 +20 mV at 25°C when used with a saturated KCl/AgCl reference electrode and platinum measuring electrode. Some tolerance in mV values is to be expected due to the rather large liquid reference junction potentials which can arise when measuring this strongly acidic and concentrated solution. However, if the measuring electrodes are kept clean and in good operating condition, consistently repeatable calibrations can be carried out using this standard solution.

**6.3.2 Cleaning Platinum Electrode.** The electrode can be restored to normal operation by simply cleaning the platinum electrode with baking soda. Polish it by rubbing it with a damp paper towel and baking soda until a bright, shiny appearance is attained.

## SECTION 7.0

# DIAGNOSTICS AND TROUBLESHOOTING

### 7.1 MODEL 54e/81/3081/4081/5081/Xmt DIAGNOSTICS AND TROUBLESHOOTING

The Model 54 Analyzer and Models 81 and 3081 Transmitters automatically search for fault conditions that would cause an error in the measured pH value, as does the Model 1054B pH/ORP Analyzer to a lesser degree. Refer to the applicable Instruction Manual for a complete description of the analyzer's fault conditions.

Table 7-1, below, lists the Model 54's, 4081's, 3081's, and 81's diagnostic messages that indicate a possible sensor problem. A more complete description of the problem and a suggested remedy corresponding to each message is also listed.

**TABLE 7-1. Troubleshooting with Advanced Diagnostics**

DIAGNOSTIC MESSAGE 54		
3081/81/4081	DESCRIPTION OF PROBLEM	REMEDY
"Calibration Warning"	1. Aged glass. 2. Sensor not immersed.	1. Perform buffer calibration. 2. Be sure electrode measuring tip is in process.
CALIBRATE		
"Cracked glass failure"	Broken or cracked glass.	Replace sensor.
GLASS FAIL		
"High reference impede"	1. Liquid junction coated. 2. Reference Cell gel depleted. 3. Sensor not immersed.	1. Clean sensor; replace if necessary. 2. Replace sensor. 3. Be sure electrode measuring tip is in process.
REF FAIL or REF WARN		
"Input voltage high"	pH input shorted or sensor miswired.	Check wiring. Replace sensor if necessary.
"Input voltage low"		
"Old glass warning"	1. Glass electrode worn out. 2. Sensor not immersed.	1. Replace sensor. 2. Be sure electrode measuring tip is in process.
GLASS WARN		
"Reference offset err" (offline only)	Reference electrode poisoned.	Replace sensor.
Std Err		
"Ref voltage high"	1. Reference shorted or sensor miswired.	Check wiring and installation. Replace sensor if necessary.
"Ref voltage low"	2. Sensor not immersed	
"Sensor line open"	1. Open wire between sensor and analyzer. 2. Interconnecting cable greater than 1000 ft.	1. Check sensor wiring. 2. Relocate analyzer.
LINE FAIL		
"Sensor miswired"	1. Open wire between sensor and analyzer. 2. Bad preamplifier.	1. Check wiring. 2. Replace preamplifier. (Code 02 only)
"Temp error high"	1. Open or shorted RTD.	1. Replace sensor.
"Temp error low"	2. Temperature out of range.	2. Check process temperature.
TEMP HI TEMP LO		

**7.2 TROUBLESHOOTING WITHOUT ADVANCED DIAGNOSTICS.**

Table 7-2, below, lists common problems, causes and remedies typically encountered in process measurement.

**TABLE 7-2. Troubleshooting without Advanced Diagnostics**

<b>Problem</b>	<b>Probable Cause</b>	<b>Remedy</b>
Meter reads off scale. (Display reads overrange).	Defective preamplifier	Replace preamplifier (for code 02 sensors). For code 01, replace sensor.
	T.C. element shorted	Check T.C. element as instructed in Section 6.1 and replace sensor if defective.
	Sensor not in process. Sample stream is low or air bubbles are present.	Make sure sensor is in process with sufficient sample stream (refer to Section 2.0 for installation details).
	Open glass electrode	Replace sensor.
	Reference element open - no contact	Replace sensor.
Display reads between 3 and 6 pH regardless of actual pH of solution or sample.	Electrode cracked	Replace sensor.
Meter or display indication swings or jumps widely in AUTO T.C. Mode.	T.C. element shorted	Check T.C. element as instructed in Section 6.1 and replace sensor if defective.
Span between buffers extremely short in AUTO T.C. Mode.	T.C. element open	Check T.C. element as instructed in Section 6.1 and replace sensor if defective.
Sluggish or slow meter indication for real changes in pH level.	Electrode coated	Clean sensor as instructed in Sections 6.2 or Section 6.3.2. Replace sensor if cracked.
	Electrode defective	Replace sensor.
Transmitter cannot be standardized.	Electrode coated or cracked	Clean Sensor as instructed in Sections 6.2 or Section 6.3.2. Replace sensor if cracked.
	Defective preamplifier	Replace preamplifier.
Transmitter short spans between two different buffer values.	Aged glass electrode or high temperature exposure	Replace sensor.
	Electrode coated	Clean Sensor as instructed in Section 6.2 or Section 6.3.2. Replace sensor if cracked.
	Air bubbles trapped in sensor end between glass bulb and sensor body	Shake the sensor in solution. See Section 2.0 for mounting guidelines.



**TABLE 7-3. Model 396P and 396PVP pH/ORP Replacement Parts and Accessories**

PN	DESCRIPTION	QUANTITY
11275-01	Sensor Handrail Mounting Assembly	
2002011	Flow Cell, CPVC, 1 inch FNPT	
23242-02	Mounting Adapter, Insertion, 1¼-inch MNPT (304 S.S.) X 1" FNPT (PEEK)	
23309-03	Junction Box, for remote preamplifier Code-50	
23309-04	Junction Box, for remote preamplifier Code-54	
23646-01	Cable, Extension (Prepped) for Models 54, 81, 3081, 4081, and 5081	
23555-00	Junction Box with preamplifier, Models 54, 81, 3081, 4081, and 5081 compatible	
23557-00	Preamplifier, remote for Junction Box, Models 54, 81, 3081, 4081, and 5081 compatible	
22698-00	Preamplifier, Plug-in, Model 1003 compatible (for Code 02-50)	1
22698-02	Preamplifier, Plug-in, Models 1181 and 1050 compatible (for Code 02-50)	1
22698-03	Preamplifier, Plug-in, Models 1054, 1054A, 1054B, 2054, and 2081 compatible (for Code 02-54)	1
22719-02	Junction Box, w/o Preamplifier	
33081-00	Adapter Insert, PEEK, 1 X 3/4-inch, for 23242-02	
7901631	Shroud, PVC	
9200254	Cable, 4 conductor, 22 AWG, shielded pair, for 1054/A/B, 2054, and 1181	
9200273	Cable, Extension (Unprepped) for Models 54, 81, 3081, 4081, and 5081	
23645-06	15 ft (4.6 m) cable with mating VP connector with BNC on transmitter end	
23645-07	15 ft (4.6 m) cable with mating VP connector with bare wires on transmitter end	
9210012	Buffer Solution, 4.01pH, 16 oz	4
9210013	Buffer Solution, 6.86pH, 16 oz	4
9210014	Buffer Solution, 9.18pH, 16 oz	4
9322014	Union, KYNAR <sup>1</sup>	
9330022	Union, CPVC	
9120516	BNC Adapter	
915240-04	Tee, Flow-through, 2" PVC, 1" NPT	
9550175	O-ring for Mounting Adapter (23242-02)	
R508-160Z	ORP Standard Solution, 460mV $\pm$ 10 at 20°C	
23550-00	Junction Box with Extension Board, Models 54, 81, 3081, 4081, and 5081 compatible	
661-898695	Cable 5 Conductor (for Model 2700 only)	

## SECTION 8.0

### RETURN OF MATERIAL

#### 8.1 GENERAL.

To expedite the repair and return of instruments, proper communication between the customer and the factory is important. Before returning a product for repair, call 1-949-757-8500 for a Return Materials Authorization (RMA) number.

#### 8.2 WARRANTY REPAIR.

The following is the procedure for returning instruments still under warranty:

1. Call Rosemount Analytical for authorization.
2. To verify warranty, supply the factory sales order number or the original purchase order number. In the case of individual parts or sub-assemblies, the serial number on the unit must be supplied.
3. Carefully package the materials and enclose your "Letter of Transmittal" (see Warranty). If possible, pack the materials in the same manner as they were received.
4. Send the package prepaid to:

Rosemount Analytical Inc., Uniloc Division  
Uniloc Division  
2400 Barranca Parkway  
Irvine, CA 92606

Attn: Factory Repair

RMA No. \_\_\_\_\_

Mark the package: Returned for Repair

Model No. \_\_\_\_\_

#### 8.3 NON-WARRANTY REPAIR.

The following is the procedure for returning for repair instruments that are no longer under warranty:

1. Call Rosemount Analytical for authorization.
2. Supply the purchase order number, and make sure to provide the name and telephone number of the individual to be contacted should additional information be needed.
3. Do Steps 3 and 4 of Section 8.2.

#### NOTE

Consult the factory for additional information regarding service or repair.

## WARRANTY

Seller warrants that the firmware will execute the programming instructions provided by Seller, and that the Goods manufactured or Services provided by Seller will be free from defects in materials or workmanship under normal use and care until the expiration of the applicable warranty period. Goods are warranted for twelve (12) months from the date of initial installation or eighteen (18) months from the date of shipment by Seller, whichever period expires first. **Consumables, such as glass electrodes, membranes, liquid junctions, electrolyte, o-rings, catalytic beads, etc., and Services are warranted for a period of 90 days from the date of shipment or provision.**

Products purchased by Seller from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer. Buyer agrees that Seller has no liability for Resale Products beyond making a reasonable commercial effort to arrange for procurement and shipping of the Resale Products.

If Buyer discovers any warranty defects and notifies Seller thereof in writing during the applicable warranty period, Seller shall, at its option, promptly correct any errors that are found by Seller in the firmware or Services, or repair or replace F.O.B. point of manufacture that portion of the Goods or firmware found by Seller to be defective, or refund the purchase price of the defective portion of the Goods/Services.

All replacements or repairs necessitated by inadequate maintenance, normal wear and usage, unsuitable power sources, unsuitable environmental conditions, accident, misuse, improper installation, modification, repair, storage or handling, or any other cause not the fault of Seller are not covered by this limited warranty, and shall be at Buyer's expense. Seller shall not be obligated to pay any costs or charges incurred by Buyer or any other party except as may be agreed upon in writing in advance by an authorized Seller representative. All costs of dismantling, reinstallation and freight and the time and expenses of Seller's personnel for site travel and diagnosis under this warranty clause shall be borne by Buyer unless accepted in writing by Seller.

Goods repaired and parts replaced during the warranty period shall be in warranty for the remainder of the original warranty period or ninety (90) days, whichever is longer. This limited warranty is the only warranty made by Seller and can be amended only in a writing signed by an authorized representative of Seller. Except as otherwise expressly provided in the Agreement, THERE ARE NO REPRESENTATIONS OR WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, AS TO MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE, OR ANY OTHER MATTER WITH RESPECT TO ANY OF THE GOODS OR SERVICES.

## RETURN OF MATERIAL

Material returned for repair, whether in or out of warranty, should be shipped prepaid to:

**Emerson Process Management  
Liquid Division  
2400 Barranca Parkway  
Irvine, CA 92606**

The shipping container should be marked:

Return for Repair

Model \_\_\_\_\_

The returned material should be accompanied by a letter of transmittal which should include the following information (make a copy of the "Return of Materials Request" found on the last page of the Manual and provide the following thereon):

1. Location type of service, and length of time of service of the device.
2. Description of the faulty operation of the device and the circumstances of the failure.
3. Name and telephone number of the person to contact if there are questions about the returned material.
4. Statement as to whether warranty or non-warranty service is requested.
5. Complete shipping instructions for return of the material.

Adherence to these procedures will expedite handling of the returned material and will prevent unnecessary additional charges for inspection and testing to determine the problem with the device.

If the material is returned for out-of-warranty repairs, a purchase order for repairs should be enclosed.



*The right people,  
the right answers,  
right now.*

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<http://www.raihome.com>

*Specifications subject to change without notice.*



Credit Cards for U.S. Purchases Only.



## Emerson Process Management

### Liquid Division

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Irvine, CA 92606 USA  
Tel: (949) 757-8500  
Fax: (949) 474-7250

<http://www.raihome.com>