91 and 91e Installation and Operating Instructions

CE **This controller meets the requirements of the European Directives on Safety and EMC. It is the responsibility of the installer to ensure the safety and EMC compliance of any particular installation.** The installation information contained in this instruction sheet is given to help with this general requirement.

EUROTHERM CONTROLS

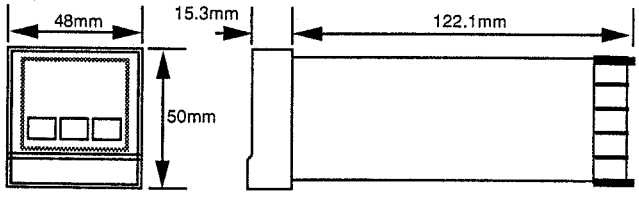
Read Safety Notes on the inside page before commencing

MECHANICAL INSTALLATION

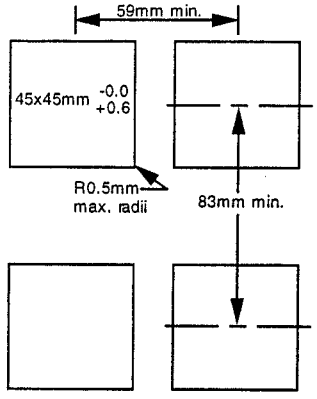
- Prepare panel cutout in sheet metal enclosure. Enclosure temperature must remain within 0-55°C range.
- Install the optional front panel gasket (part no. BO133297) if required. Remove the backing from the gasket and apply it around the panel cutout on the outside of the panel.
- Slide instrument sleeve into the cutout from the front of the panel.
- Position the mounting bracket on the rear of the instrument sleeve with the 2 clips facing the rear.
- While holding the sleeve, slide the mounting bracket towards the panel until the clips engage on the ratchets.
  While still pulling back on the sleeve, press on the upper left and lower right hand corners of the bracket to seat the mounting bracket.
  Another push on the clips with a screwdriver might be necessary to secure the installation.

Panel details

Panel depth: with terminal cover: 126.1mm
with gasket: less 1.5mm
Panel thickness: maximum 13mm



Dimensional details



Panel cutout and minimum spacing

ELECTRICAL CONNECTIONS

Installation Requirements for EMC

To ensure compliance with the European EMC directive certain installation precautions are necessary as follows:

- For general guidance refer to Eurotherm Controls EMC Installation Guide, HA025464.
- When using relay outputs it may be necessary to fit a filter to suppress the emissions. For typical applications we would recommend Schaffner FN321 or FN612, but the filter requirements will depend on the type of load.
- This product complies with the emission requirements of EN 50081-2: 1994, the generic emission standard for the industrial environment. If the unit is used in table top equipment powered by a standard power cable, it is likely that compliance is required to EN 50081-1, the generic emission standard for the domestic and light industrial environment. In this case the unit should be mounted in a suitable metallic cabinet to enclose any electromagnetic emissions. All cables passing outside the cabinet, including the mains leads, should pass through suitable RF filtering such as Schaffner FN321 or FN612.

Power

Respect the polarity of the AC power supply; line wire must be connected to terminal 12, and the neutral must be connected to terminal 11.

Output

- Relay: Contact is closed during ON phase of output cycle (yellow "OP" lamp ON). Relay channel operative only when H.ct parameter (heat cycle time) is 5s or greater. A snubber may be required.
- Logic: Signal goes high (current follows) during ON phase of output cycle (yellow "OP" lamp ON).
  Connect only to opto-isolated device loads, never connect to any grounded circuit. Keep wiring run shorter than 1m and well away from noise generating circuits.

Alarm relay

The alarm output is failsafe: the relay is de-energised during the alarm condition or power down. The attached alarm circuit should be designed for failsafe operation and fused appropriately. A snubber may be required.

Snubbers

Connect snubbers CZ140398 (22nF + 100Ω) across the appropriate output or alarm relay contacts when driving AC inductive loads (mechanical contactors and solenoids). Do not use snubbers when driving high impedance loads. The snubber passes 1mA in 120Vac circuits, and 2mA in 240Vac circuits; this is sufficient to hold in certain relays with high impedance coils and should not be used in such installations.

WARNING

When an alarm contact is to be implemented as part of a failsafe alarm scheme, it is the user's responsibility to verify that the effect of the snubber does not interfere with the operation of the circuit. Certain high impedance circuits are not able to detect a contact opening when the snubber is placed across the contact. In these cases the snubber should not be installed across the relay contact.

Input

WARNING

The input sensor intended for use with this instrument is to be connected uniquely to the input terminals 9 and 10 and never looped to inputs of other instruments. The paralleled inputs of other instruments interfere with proper operating of the sensor break detection circuitry.

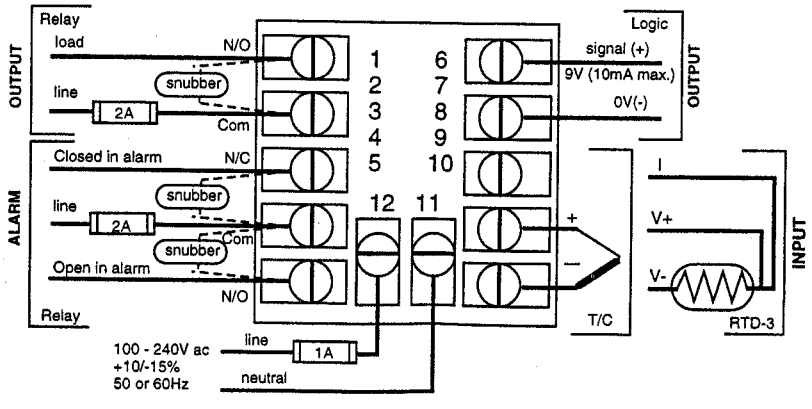
NOTE: The input circuit and the logic output are NOT isolated from one another.

Use of shielded, twisted pair is recommended for the input sensor. The shield must be connected to terminal 10 unless grounded elsewhere.

- Thermocouple: Use appropriate compensation cable. Keep loop resistance as low as possible (1kΩ maximum).
- RTD: Use 3 copper wires of same length and diameter. (20Ω/lead maximum resistance.)

Rear terminal cover (optional)

After wiring, attach rear terminal cover BD133125 with screw FY133264U001.



CONFIGURATION

Procedure

1. Cycle power 'OFF' and 'ON'. Press and hold secret key.
   Self test follows: tESt appears followed by 1111, 8888, then the 4-digit configuration code.
   Hold in secret key until 4-digit configuration code appears and left hand digits flashes.

   NOTE: Touching any other front panel key during the start-up self test could lead to erroneous test results.
2. See configuration code with left digit blinking.
3. Enter new code:
   ▼ = select digit position (1 through 4)
   ▲ = modify digit value.
4. To exit configuration mode do one of these:
   Secret key = accept new configuration; parameter value check follows.
   ↻ = abort; return to previous configuration

Configuration code

1st (left) digit

	alarm function		
0	Off (no alarm function)	4	Full scale low alarm
1	Deviation low alarm	5	Sensor break alarm
2	Deviation high alarm	6	Full scale high alarm
3	Deviation band alarm	7	Loop break alarm

"Alarm functions" assigns alarm type to alarm relay output. Sensor break and loop break alarms are always displayed even if not assigned to alarm relay.

2nd digit: Model 91 only

	sensor type	full specified range °C min	°C max
0	RTD (units' precision display)	-100	400
1	RTD (tenths' precision display)	-99.9	400.0
2	J—Fe/SAMA constantan	0	800
3	K—Chromel™/Alumel™	0	1300
4	L—Fe/Konstantan	0	800
5	N—NiCroSil/NiSil	0	1300
6	R—Pt-13%Rh/Pt	0	1600
7	S—Pt-10%Rh/Pt	0	1600

2nd digit: Model 91e only

	sensor type	full specified range °C min	°C max
0	RTD (units' precision display)	-100	600
1	RTD (tenths' precision display)	-99.9	600.0
2	J—Fe/SAMA constantan	-200	1200
3	K—Chromel™/Alumel™	-250	1372
4	L—Fe/Konstantan	-100	900
5	N—NiCroSil/NiSil	0	1300
6	R—Pt-13%Rh/Pt	0	1767
7	S—Pt-10%Rh/Pt	0	1767
8	T—Cu/Adams constantan	-255	400
9	Platinel II™	-250	1395
A	B—Pt-30%Rh/Pt-6%Rh	600	1820
B	Linear a - 2 point entry scaling		
C	Linear b - Point and span entry scaling		

3rd digit

	upper range limit	prop. band units
0	400°C (752°F)	%
1	400°C (752°F)	°C or °F
2	800°C (1472°F)	%
3	800°C (1472°F)	°C or °F
4	Full specified range	%
5	Full specified range	°C or °F

Lower range limit from tables, above.
Prop band in % expressed as % of 400°C.
Prop band in % expressed as % of 800°C.
Prop band in % expressed as % of full specified range.

4th digit

	display	output control type	action
0	°F	ON/OFF	direct
1	°F	ON/OFF	reverse
2	°F	PID	direct
3	°F	PID	reverse
4	°C	ON/OFF	direct
5	°C	ON/OFF	reverse
6	°C	PID	direct
7	°C	PID	reverse

Select "reverse" for heating applications and "direct" for cooling applications

Configuration example

6347:

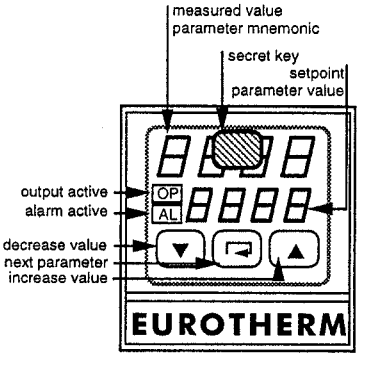
1st digit (6): full scale (absolute) alarm.
2nd digit (3): type K thermocouple input.
3rd digit (4): full specified range for input and proportional band display in %.
4th digit (7): display units in °C, reverse-acting PID control.

OPERATION

Basic procedures

Refer to illustration below.

- To light up buttons: touch any button on front panel.
- To modify setpoint: ▲ and ▼.
- To enter protected list: use ↻ until **AL.SP**, then "**secret key**".
  Continue with ↻ to view parameters.
  [Model 91e only: It is possible to enter the protected list from the °**C** or °**F** display with the "**secret key**".]
- To modify a parameter value: with the parameter mnenomic in upper display, use and ▲ and ▼.
- To return to measured value display when in protected list: "**secret key**".



Front panel pushbuttons, displays and lamps

Alarms

Temperature alarms (configuration codes "1" through "4" and "6" for operation)
If the measured value enters the alarm condition as defined by the configuration code, the red "AL" lamp lights up and the alarm relay is de-energised (failsafe operation). The alarm is non-latching; the lamp goes out and the alarm relay is re-energised as soon as the measured value enters the "safe" condition.

Sensor break alarm (configuration code "5" for alarm relay output).
If the controller has detected that the sensor circuit has failed, then the output power level is forced to 0% and **SnSr FAIL** is displayed.
A failed sensor is detected:

- if the input signal is out of the selected sensor's range,
- if the input is open circuit, or
- if the controller's operating temperature is outside of the 0-55° operating range (thermocouple inputs only).

Upon reinstatement of the input sensor, the controller resumes controlling with the same output power level used at the moment of the break.

Loop break alarm (configuration code "7" for alarm relay output)
If the unit detects a break in the control loop, then **LP.Br** is displayed. The display (and optional relay operation) is latching. To reset, touch any key. The output level is determined by the control algorithm during the alarm condition.
To determine starting values for the **LP.br** parameter:
PID control: Set **LP.Br** equal to or slightly longer than **Int.t.**
ON/OFF control: Set **LP.Br** equal to one period of oscillation around setpoint (ON + OFF times).
For both types of control: increase **LP.Br** if spurious alarms occur; decrease for greater sensitivity.

NOTE: The above described operation of sensor break and loop break alarms always occurs irrespective of the configuration of the alarm relay.

Ramp to setpoint operation

(Model 91e only)

The setpoint ramping feature, shown in figure 1, is enabled by setting **SP.rr** to any value except OFF. Ramping is initiated only by one of two conditions:

- power-up
- change in setpoint.

Upon power up, ramping always starts from the current measured value. The instantaneous setpoint follows a straight line to the target setpoint (the setpoint normally displayed along with the measured value). The speed at which the ramping progresses is selectable by **SP.rr** and remains constant for all ramps until **SP.rr** is changed. When the measured value follows a ramping setpoint through an alarm region, the alarm is detected, annunciated and output as follows:

- Full scale high and low alarms (configurations "4" and "6"). The alarm is non latching; crossing the alarm setpoint into the "safe" region ends the alarm condition.
- Deviation alarms (configurations "1", "2" and "3"). The deviation alarm follows the ramping setpoint. If the measured value cannot track the setpoint within the bounds of the deviation alarm, an alarm condition is generated.

NOTE: Any value for **SP.rr** except OFF inhibits self tuning operation.

Adjustable parameters

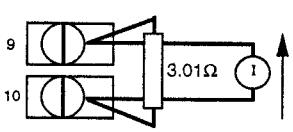
See Adjustable parameter list over the page.

Linear input setup

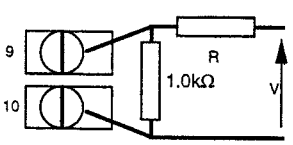
Electrical connections

For all inputs use a shielded twisted pair.

- Millivolt inputs (-10 to 70mV)
  Connect signal leads directly to input terminals 9(+) and 10(-).
- 0-20mA and 4-20mA inputs.
  Connect 3.01Ω shunt (part no. CA 9G3R01) across input terminals 9(+) and 10(-).
- Higher voltage inputs. Voltage divider network is required (Standard voltage dividers can be supplied by Eurotherm or made up by the user). Refer to table for suggested values. Resistor specifications:1%, 0.125W
  minimum, ±100ppm metal or metal oxide film.



0-20mA and 4-20mA input



Voltage inputs

Nominal range	R
-20 to 200mV	2.2k
-0.1 to 1 V	15.0k
-0.5 to 5V	75.0k
-1 to 10V	150k
-2.5 to 25V	392k

Caution

Scaling procedure

There are two methods of entering and scaling linear inputs:

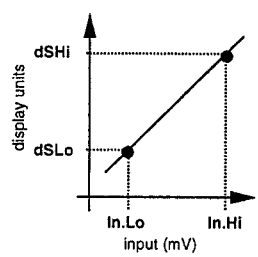
- Linear a: 2-point scaling, set digit 2 of the configuration code to "B".
- Linear b: point and span scaling, set digit 2 of the configuration code to "C".

Linear a and b

1. Set display decimal point position parameter, **dP** to desired value.
2. If reading the input signal directly from the source, connect source (from signal generator or sensor) to input terminals. Apply a signal equal to a known low value for the first setup point.
3. Scroll through the protected list until **In.Lo.** Press on ↻ until **rEAd** appears, release, then push the button again.
   [Alternatively, if no input signal is required or the exact value is known, the input value in millivolts can be set in with ▼ or ▲].
4. Scroll to **dSLo**. Then set in corresponding display value with ▼ and ▲.

Linear a only

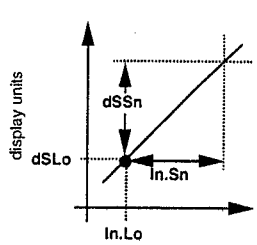
5. Again, if reading the input signal directly from the source, apply a signal equal to a known high value for the second setup point.
6. Scroll through the protects list until **In.Hi.** Press on ↻ until **rEAd** appears, release, then push the button again.
   [Alternatively, if no input signal is required or the exact value is known, the input value in millivolts can be set in with ▲ or ▼].
7. Access **dSHi**. Then set in the corressponding display value with ▲ or ▼.



Linear a: 2-point scaling

Linear b only

8. Access **In.Sn.** With ▲ or ▼ set in the input signal span in millivolts.
9. Access **dSSn.** With▲ or ▼ set in the display span.



Linear b: point & span scaling

TUNING AND ADJUSTMENTS

WARNING

The two PID tuning procedures presented here are based on perturbation response; the step changes involved may be detrimental to sensitive systems.

NOTE: Model 91e only: **SP.rr** must be set to OFF before performing either manual or self-tuning.

PID self tuning procedure

1. Set appropriate values for all parameters except ProP, Int.t, and dEr.t.
   For PI control set **dEr.t** = oFF . For PD control set **Int.t** = oFF. For proportional only control set **Int.t** = **dEr.t** = oFF .
   Model 91e only: The value for **LP.br** is also determined if the starting value is not set to OFF.
2. Initiate self tuning by setting **tunE** to on. The **tunE** message will flash in the lower display.
3. Wait for the tuning operation to finish: **tunE** will no longer be displayed.
4. The values for **ProP**, **Int.t**, and **dEr.t** can be viewed in the protected list (as well as **LP.br** for the Model 91e).
5. See the Display messages list over the page for tuning messages.

PID manual tuning procedure

NOTE: Wait a sufficient period of time after each adjustment to see if the system will stabilize.

1. Set the setpoint to the normal operating temperature, **ProP** = minimum, **Int.t** = oFF, and **dEr.t** = oFF . Observe the peak-to-peak amplitude (A) and period (T) of the oscillation of the measured value. This oscillation may not necessarily be centered about the setpoint.
2. Set **ProP** = 1.1 x A. If stable (probably not at setpoint) go to 3. If not, increase **ProP** until the temperature is stable.
3. Set **Int.t** = T. Wait at least 2 x T. If system becomes stable at setpoint, go to 4. If not, increase Int.t in small (<30%) steps until the temperature is stable at setpoint.
4. Set **dEr.t** = Int.t/6. If stable, go to 5. If not decrease **dEr.t** in small steps until temperature is stable. (**dEr.t** might have to be turned OFF .)
5. The loop should now be stable at setpoint. If not, try the following:
   - If **Int.t** is shorter than the period of oscillation, increase Int.t to be slightly longer than the period. If stability is not achieved after several small increases, then try:
   - Increase **ProP** in several small (<30%) steps. If oscillations continue, try:
   - Set **dEr.t** = oFF . If the temperature is still unstable, try:
   - Set **Int.t** = oFF . If stable, go to step 3 above and repeat. If not, increase ProP until temperature is stable, then go to step 3.

ON/OFF control adjustment

The hysteresis band (represented by **ProP**) should be set as small as possible to minimise ripple of the measured value, but large enough to reduce wear on devices such as mechanical contactors.

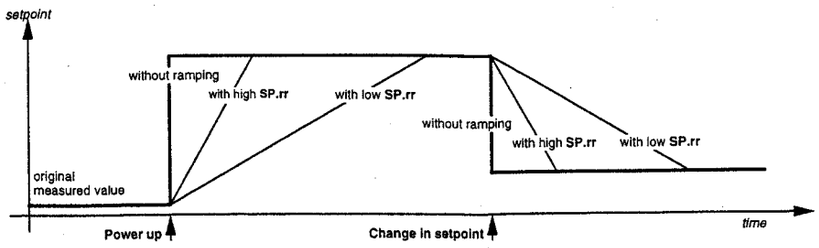


Figure 1 Ramp to Setpoint Operation

LINEAR INPUT SCALING (Replaces "OFSt" parameter in protected list)

In.Lo	Input for low setup point	-9.99 to 70.00mV input signal range	Both linear a and b inputs. To read input signal value from rear terminals: Hold UP or DOWN until "rEAd" appears, release, then press the button again.
dSLo	Display value for low setup point	-999 to 9999, -99.9 to 999.9, or -9.99 to 99.99 process units	Both linear a and b inputs.
In.Hi	Input for high setup point	-9.99 to 70.00mV input signal range	Linear a inputs only. To read input signal value from rear terminals: See procedure for "In.Lo", above."
dSHi	Display value for high setup point	-999 to 9999, -99.9 to 999.9, or -9.99 to 99.99 process units	Linear a inputs only.
In.Sn	Input signal span	0.00 to 70.00mv	Linear b inputs only.
dSSn	Display span	-999 to 9999, -99.9 to 999.9, or -9.99 to 99.99 process units	Linear b inputs only.

Adjustable parameter list

Mnemonic	Parameter	Adjustable range	Comments
OPEN LIST			
none	Setpoint	Upper limit: "SP.Hi" Lower limit: "SP.Lo"	Not adjustable during self tuning.
°C or °F	Display units	View only.	Display units selected in configuration.
tunE	Self tune on demand	Disable self tune: "OFF" Initiate self tune: "on"	Not displayed for ON/OFF control. Model 91e: Not displayed if "SP.rr" enabled.
AL.SP	Alarm setpoint	Configured input sensor range for full scale (absolute temperature) alarms 0 to upper range limit for deviation alarms	Alarm function selected in configuration. "AL.SP" operative only for temperature alarms: configuration codes "1" through "4" and "6". Due to hysteresis, deviation band alarm setting must be at least 2°C.
PROTECTED LIST			**Not accessible if self tuning in progress**
ConF	Configuration code	View only in this list	Can be changed upon power up only.
Id	Instrument model ident.	View only: "91E"	Not included in Model 91 parameter list.
ProP	Proportional band	2 to 400°C, (4 to 720°F), or equivalent in percent	Becomes hysteresis for ON/OFF control. Units (°C, °F or %) selected in configuration.
Int.t		Integral time constant	OFF plus 10 to 2000s Valid for PID control only
dEr.t		Derivative time constant	OFF plus 1 to 200s Valid for PID control only
OFSt	Calibration offset	-99.9 to +99.9°C (-99.9 to 179.8°F)	Display value = measured value + offset
SP.Hi	Setpoint high limit	Configured input sensor range	Must be greater than "SP.Lo"
SP.Lo	Setpoint low limit	Configured input sensor range	Must be less than "SP.Hi"
H.ct	Heat cycle time	Model 91: 1 to 20s Model 91e: 0.2 to 60.0s (5s or more for relay output)	Valid for PID control only, but for ON/OFF control disables relay output if set to 4s or less.
HPL	High power limit	0 -100%	High power limit is adjustable between 0 - 100%
SP.rr	Setpoint ramp rate	OFF plus 0.1 to 50.0°C/min (0.2 to 90.0°F/min.)	Model 91e only. Self-tuning inhibited if ramping enabled.
LP.br	Loop break time constant	OFF plus 10 to 4000s	
LinE	Line frequency	50 Hertz: 60 Hertz:	Default "50". Set to line frequency upon installation.

Display messages list

Message	Display condition	User action/comments
LOOP STATUS MESSAGES		
SnSr **FAIL**	Sensor fail. Input open or reversed; measured value outside of configured range.	Verify input sensor and connections. Message disappears when input signal is reinstated. (Flashes alternate with 'LLLL' or 'HHHH')
HHHH	Sensor break indication up scale	Verify input sensor and connections. Message disappears when input signal is reinstated. (Flashes alternate with 'SnSr').
LLLL	Sensor break indication down scale	Verify input sensor and connections. Message disappears when input signal is reinstated. (Flashes alternate with 'SnSr').
measured value **LP.br**	Loop break. Output at 0 or 100% and measured value moves less than 1/2 of "ProP" setting toward setpoint within time setting of "LP.br".	Verify output device, fuses, wiring and heater. Acknowledge by touching any key.
measured value **SP.rr**	Setpoint ramping in progress.	Model 91e only. Setpoint and "SP.rr" parameter still user-adjustable during ramping.
Flashing value	Display overrange or out of specified accuracy range	Unit should not be used in this range.
SELF TUNE MESSAGES		
measured value **tunE**	Self tuning in progress Message alternates with setpoint	Annunciation only. Adjustment of setpoint and PID values PID values inhibited during self tuning.
tunE **FAIL**	Self tuning operation has failed because controller cannot maintain setpoint.	Acknowledge by touching any key. Remove cause of failure: e.g.heater fuse blown, etc.
LinE **FAIL**	Loss of controller power during self tuning operation renders sampled data questionable.	Acknowledge by touching any key. Verify power supply. Reinstate self running procedure.
SELF DIAGNOSTIC MESSAGES		
tESt **1111**	Internal self test upon power up.	Replace unit if all four 1's do not light up or fails to go to "8888".
8888 **8888**	Display test after above self test. Lasts for approximately 3 seconds.	User should verify that all digits and lamps light up to prevent erroneous readings.
EE **FAIL**	Memory corruption. Message alternates with measured value and setpoint.	Verify and correct all parameter and configuration values. If display persists, replace unit.

SAFETY NOTES

Technical Specification for Safety Purposes

Equipment ratings	
Supply voltage:	85 to 264V a.c. ~.
Supply frequency:	48 to 52, or 58 to 62Hz a.c. ~.
Power consumption:	5 Watts.
Relay output:	Maximum of 264V a.c. ~. Minimum of 10V peak. Maximum current, 2A resistive.
Leakage current:	Snubber components may be fitted externally. The leakage current through these snubber components is less than 2mA at 264V a.c., 50Hz.
Over current protection:	External over current protection devices are required that match the wiring of the installation. A minimum of 0.5mm² or 16/0.2mm wire is recommended. Independent fuses are required for the instrument supply and each relay output. Suitable fuses are T type, (IEC 127; time-lag) as follows: Instrument supply: 85 to 264V a.c. ~ 1A (T). Relay outputs: 2A (T).
Low level I/O:	All other input and output connections are intended for low level signals less than 42V.
Environmental ratings	
Panel sealing:	Instruments are intended to be panel mounted. An optional panel gasket is available to provide panel sealing to IP 54 as defined in EN 60529.
Operating temperature:	0 to 55°C. Ensure the enclosure provides adequate ventilation.
Relative humidity:	5 to 95%, non-condensing.
Atmosphere:	The instrument is not suitable for use above 2000m or in explosive or corrosive atmospheres.
Electrical safety	EN 61010(93), Installation category II, pollution degree 2.
Installation category II:	Voltage transients on any mains power connected to the instrument must not exceed 2.5kV.
Pollution degree 2:	Conductive pollution must be excluded from the cabinet in which the instrument is mounted.
Isolation:	All inputs and outputs (except for the logic output) have a reinforced isolation providing protection against electric shock. The Logic output is electrically connected to the main process variable input, (thermocouple etc.) but have reinforced isolation to all other connections.

Safety Symbols

Various symbols are used on the instrument, they have the following meaning:


Caution, (refer to the accompanying documents)


Equipment is protected by reinforced insulation

Equipment that is protected with reinforced insulation does not require a protective conductor.

Installation Safety Requirements

For safe operation Eurotherm Controls products must be correctly installed in a suitable environment. The following installation guidelines should be carefully considered before operating the equipment;

- **This unit should be installed inside a suitable grounded metal enclosure.** This must prevent live parts being accessible to human hands and metal tools. It is recommended that rear terminal covers (available as an option) be fitted.
- **Wiring installations should comply with all local wiring regulations.** It is the user's responsibility to calculate the maximum possible current in each power and common wire. Do not exceed the rated current for any particular wire size permitted by the local electrical code. Overheated wires and damaged insulation may result from overloading.
- **The installation must include a power isolating switch or circuit breaker.** This device should be in close proximity to the controller, within easy reach of the operator and marked as the disconnecting device for the equipment. SCRs and triacs are not adequate means of isolating the supply, and should always be backed by a suitable mechanical disconnect switch.
- **The maximum voltage applied to the unit must not exceed 264V ac.** Ensure that the voltage which is applied to the unit power supply, between any two isolated circuits, or between any isolated circuit and ground does not exceed 264Vac.
- **The controller must not be wired to a three phase supply with an unearthed star connection.** This is because under fault conditions the supply voltage can rise above 264Vac with respect to earth. The product will not be safe under these conditions.
- **Any voltage transients that occur on power supply lines must not exceed 2.5kV.** Where occasional voltage transients over 2.5kV are expected or measured, the power installation to both the instrument supply and load circuits should include a transient limiting device. These units will typically include gas discharge tubes and metal oxide varistors that limit and control voltage transients on the supply due to lightening strikes or inductive load switching. Devices are available in a range of energy ratings and should be selected to suit conditions at the installation.
- **Conductive pollution must be excluded from the instrument enclosure.** Carbon dust is a conducting pollution, but even particles that are normally non conducting may become conductive with condensation. To secure a suitable atmosphere in conditions of conductive pollution, fit a filter to the air intake of the cabinet. Where condensation is likely, for example in low temperatures, include a thermostatically controlled heater in the cabinet.
- **This unit is not suitable for use in areas subject to hazardous atmospheres.** No Eurotherm Controls product should be connected to a circuit which passes into or through a hazardous area unless appropriate precautions are taken (even though the instrument itself may be located in a safe area). Such an installation should conform to the requirements of the relevant Authority.
- **Grounding.** This instrument has internal circuits which are isolated or "floating." This is necessary to prevent the occurrence of a "ground loop" in signal circuits. To avoid possible shock hazards in the event of an internal fault causing breakdown of insulation, it is recommended that all equipment connected to this unit be enclosed in a grounded metal enclosure. Sheaths of thermocouples (or other sensors) should be properly grounded by a separate conductor (instead of being dependent on grounding via the machine framework).
- **Out-of-limits alarms.** In applications where excessive deviation of a controlled parameter due to equipment failure could cause damage to machinery or materials, or injury to personnel, it is strongly recommended that an additional separate unit with its own input sensor be used to give alarm indication or to shut down the process or both, as may be appropriate. (Note: The alarm function built into controllers may not give sufficient protection in these circumstances). When the controller alarm function or separate alarm units are used they should be checked for correct operation at regular intervals.
- **Configuration.** Many instrument functions are user selectable from the front panel. It is the user's responsibility to verify that the instrument configuration is correct. Personal injury, property loss and equipment damage could result from an improperly configured instrument.
- **ESD precautions.** This instrument contains static sensitive components. Care should be taken to avoid electrostatic discharge (ESD) and thus reduce incidence of damage to the instrument when removed from its sleeve. Any manipulation of the instrument printed circuit boards should be performed on a conductive surface with the personnel in contact with the surface by means of a grounded, metal or conductive plastic wrist strap with a 1MΩ series resistor.
- **Procedure in the event of trouble.** Before beginning any investigation of a fault, the electrical supplies to all equipment concerned should be switched off and isolated. Units suspected of being faulty should be disconnected and removed to a properly equipped workshop for testing. There are no user-service-able parts inside this unit.