

2216L and 2208L Temperature Controllers



**EUROTHERM
CONTROLS**

Installing and Operating Instructions

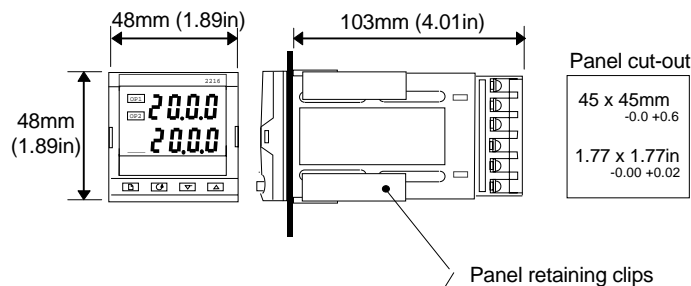
The 2216L and 2208L are precision PID temperature controllers ideal for plastic extrusion machines, ovens, chillers and other heating and cooling processes. The 2216L is in a 48 x 48mm panel size (1/16 DIN) and the 2208L in a 48 x 96 panel size (1/8 DIN). Both controllers have up to three outputs for heating, cooling and alarms. In addition the 2208L has two contact closure inputs to select second setpoint and standby mode (all outputs off, except alarms).

The controller will have been built and configured according to the ordering code given on page 5. Check the ordering code on the controller side labels to determine the configuration of your particular controller.

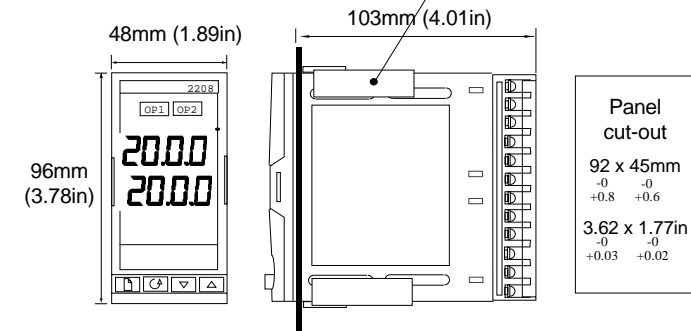
CE This controller meets the European directives on safety and EMC.

DIMENSIONS AND INSTALLATION

Model 2216L



Model 2208L



To install the controller

Please read the safety information on pages 5 & 6 before proceeding.

Prepare the panel cut-out to the size shown

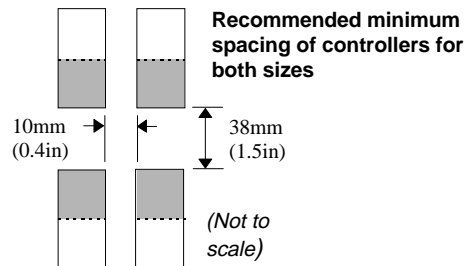
Insert the controller through the cut-out.

Spring the panel retaining clips into place. Secure the controller in position by holding it level and pushing both retaining clips forward.

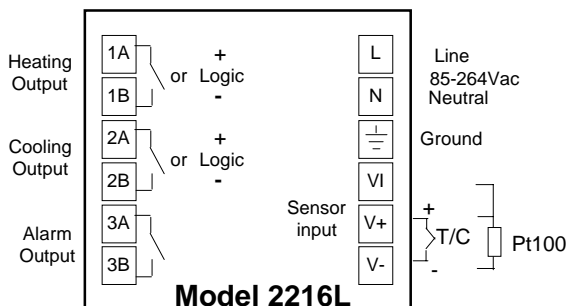
Unplugging the controller

The controller can be unplugged from its sleeve by easing the latching ears outwards and pulling it forward out of the sleeve.

When plugging the controller back into its sleeve, ensure that the latching ears click into place to maintain the IP65 sealing.



ELECTRICAL CONNECTIONS



Output ratings

Relay: 2A, 264Vac resistive
Logic: 18Vdc, 20mA (non-isolated)

Alarm output

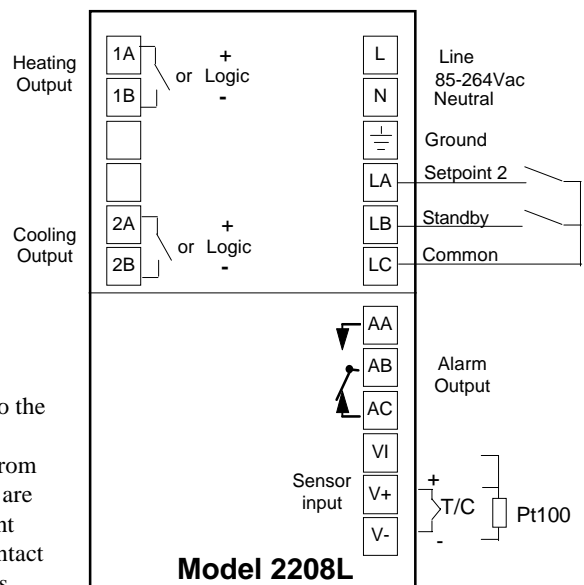
The alarm output is non-latching and de-energised in the alarm state

Grounding

The ground connection is not required for safety purposes but must be connected to satisfy EMC requirements

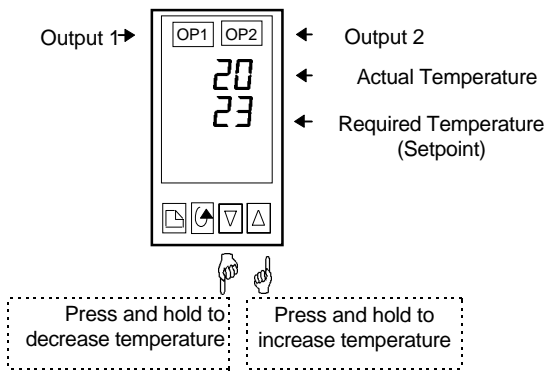
Wire Sizes

All electrical connections are made to the screw terminals at the rear of the controller. These accept wire sizes from 0.5 to 1.5 mm² (16 to 22 AWG), and are protected by a hinged cover to prevent hands or metal making accidental contact with live wires. Rear terminal screws should be tightened to a torque of 0.4 Nm (3.5 lb in).



OPERATION

Switch on the controller. Following a 3 second self-test sequence, you will see the display shown below. It is referred to as the HOME display.



After 2 secs the lower readout will 'blink' indicating that the new setpoint has been accepted.

- OP1** will light when heating is ON
- OP2** will light when cooling is ON

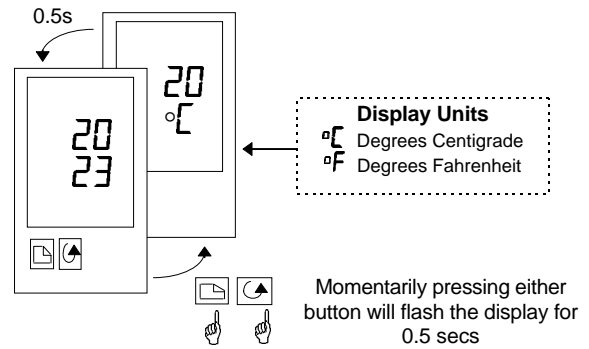
The display may flash an alarm message. The tables below list all of the possible messages and their meaning.

ALARM MESSAGES

Process Alarms	
Message	Meaning
IFSL	Alarm 1, Full Scale Low alarm: The temperature is below the low alarm setting
2FSH	Alarm 2, Full Scale High alarm: The temperature exceeds the high alarm setting
3dEa	Alarm 3, Deviation alarm: The difference between the setpoint and the temperature exceeds the deviation alarm setting
5br	Sensor Break: Input sensor is open circuit or high resistance. Check the sensor.

Diagnostic alarms	
Message	Meaning and Action
EE.Er	Electrically Erasable Memory Error: A parameter value has been corrupted. Contact Eurotherm Controls.
Hw.Er	Hardware error: Return for repair
LLLL	Low display range exceeded: Check input signal
HHHH	High display range exceeded: Check input signal
Err1	Error 1: ROM self-test fail. Return for repair
Err2	Error 2: RAM self-test fail. Return for repair
Err3	Error 3: Watchdog fail. Return for repair
Err4	Error 4: Keyboard failure. Stuck button, or a button was pressed during power up.
Err5	Error 5: Input circuit failure. Return for repair
Pwr.F	Power failure. The line voltage is too low. Check that the supply is within the rated limits

VIEWING THE DISPLAY UNITS



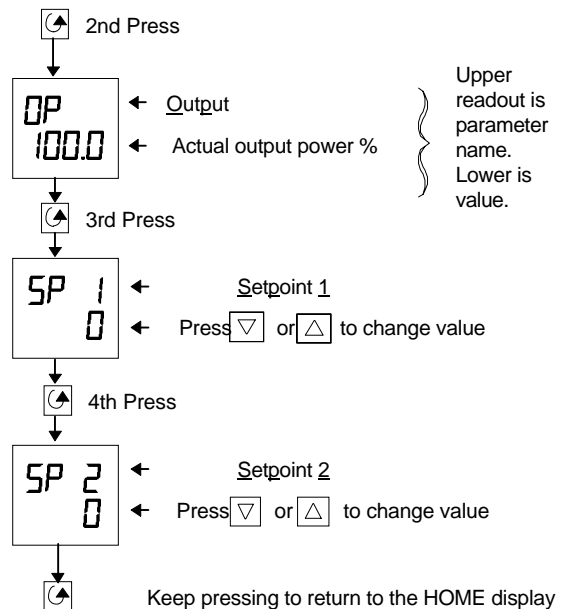
NOTE

If you get lost, pressing and together will return you to the HOME display.

If, at any time, no key is pressed within 45 seconds, the display will always return to the HOME display.

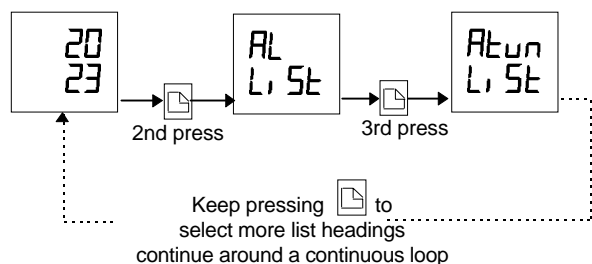
USE OF THE 'SCROLL' BUTTON

Pressing the scroll button will display the output power and the two internal setpoints.



USE OF THE 'PAGE' BUTTON

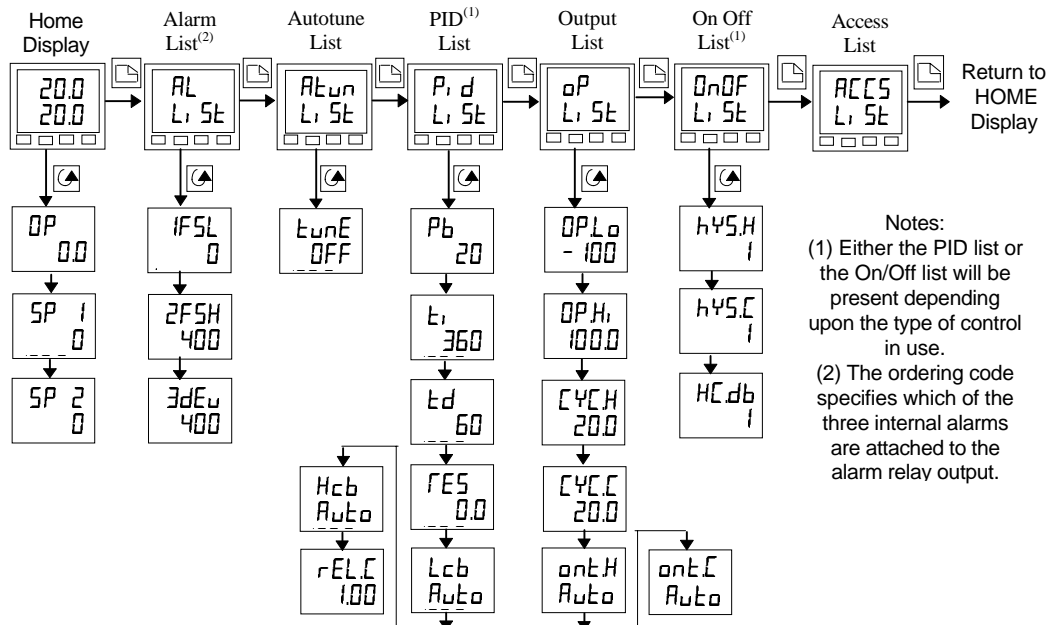
The "PAGE" button accesses parameter LISTS. Parameters are settings in the controller which you can change to suit the process. Examples are: 'Alarms' and 'Autotune'. They are found under headings called **LISTS** and the full set is shown on the next page.



PARAMETER LISTS

Selecting and adjusting a parameter

1. Press to step through the list headings
2. Press to step through the parameters within a particular list
3. The upper display shows the parameter name and the lower display its value
4. Press to decrease the value of a selected parameter
5. Press to increase the value of a selected parameter.



- Notes:
- (1) Either the PID list or the On/Off list will be present depending upon the type of control in use.
 - (2) The ordering code specifies which of the three internal alarms are attached to the alarm relay output.

	Home List	Adjustable Range	Default setting	Customer setting
Home	Measured temperature and Setpoint			
oP	Output power demand	-100.0 to 100.0%		
SP 1	Setpoint 1 value	As per ordering code	0	
SP 2	Setpoint 2 value	As per ordering code	0	

AL	Alarm List	Adjustable Range	Default setting	Customer setting
IFSL	Full Scale Low alarm setting	0 to 9999 °C or °F	Setpoint minimum	
2FSH	Full Scale High alarm setting	0 to 9999 °C or °F	Setpoint maximum	
3dEv	Deviation Band alarm setting	0 to 9999 °C or °F	Setpoint maximum	

ALun	Autotune List (see Tuning)	Adjustable Range	Default setting	Customer setting
AutE	Self tune enable	OFF or on	OFF	

P, d	PID List (see Tuning)	Adjustable Range	Default setting	Customer setting
Pb	Proportional band	0 to 9999 °C or °F	20	
t _i	Integral time	OFF to 9999 secs	360	
t _d	Derivative time	OFF to 9999 secs	60	
rES	Manual reset (appears when t _i set to OFF)	-100 to 100.0	0.0	
Lcb	Cutback low	Auto to 9999 °C or °F	Auto	
Hcb	Cutback high	Auto to 9999 °C or °F	Auto	
rELC	Relative cool gain	0.01 to 9.99	1.00	

oP	Output list	Adjustable Range	Default setting	Customer setting
oPLo	Cooling power limit (Output low limit)	-100 to 0.0 %	-100	
oPHi	Heating power limit (Output high limit)	0.0 to 100.0 %	100.0	
CYCH	Heating output cycle time	0.2 to 999.9 secs	1 for logic output 20.0 for relay	
CYCL	Cooling output cycle time	0.2 to 999.9 secs	5 for logic output 20.0 for relay	
ontH	Heating output minimum on time	Auto to 999.9 secs	Auto (=50mS)	
ontC	Cooling output minimum on time	Auto to 999.9 secs	Auto (=50mS)	

OnOff	On/off list (Used for On/Off control)	Adjustable Range	Default setting	Customer setting
hYSH	Heating output hysteresis	0 to 9999 °C or °F	1	
hYSC	Cooling output hysteresis	0 to 9999 °C or °F	1	
HCDb	Heat/Cool dead band	0 to 9999 °C or °F	0	

ACC5	Access list	Used for re-configuring the controller. (Separate instructions required)
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AUTOMATIC TUNING

In PID control, the output from the controller is the sum of three terms: **P**roportional, **I**ntegral and **D**erivative. These three terms deliver just the right amount of power to hold the temperature at setpoint without oscillation. For stable control, the PID values must be 'tuned' to the characteristics of the process being controlled. In the 2216L and 2208L this is done automatically using advanced tuning techniques.

Automatic tuning is performed by switching the output of the controller On and Off to induce an oscillation in the measured temperature. From the amplitude and period of the oscillation, the PID values, shown in the table below, are calculated.

Parameter	Display	Meaning or Function
Proportional band	P_b	The bandwidth in °C or °F over which the output power is proportioned between minimum and maximum.
Integral time	t_i	Determines the time taken by the controller to remove steady-state error signals.
Derivative time	t_d	Determines how strongly the controller will react to the rate-of-change of temperature.
Low cutback	L_{cb}	The number of °C or °F below setpoint at which the controller will cutback the output power to prevent overshoot on heat up.
High Cutback	H_{cb}	The number of °C or °F above setpoint at which the controller will increase the output power to prevent undershoot on cool down.
Relative cool gain	r_{ELC}	Only present if cooling has been configured. Sets the cooling proportional band by dividing the P_b value by the r_{ELC} value.

If the process cannot tolerate 100% heating or cooling during tuning, the power can be restricted by the heating and cooling limits in the Output list. However, the measured value *must* oscillate to some degree for the tuner to determine values. Tuning is normally performed only once during the initial commissioning of the process. However, if the process under control subsequently becomes unstable (because its characteristics have changed), you can re-tune again at any time. It is best to start tuning the process from ambient temperature, to allow the tuner to calculate more accurately the cutback settings.

Heating and Cooling Output Cycle Times

Before commencing a tuning cycle, set the values of $CYCH$ (heating output cycle time) and $CYCL$ (cooling output cycle time) in the OP (output) list.

For a logic heating output (switching a solid state relay), set $CYCH$ to 10 sec.

For a relay output, set $CYCH$ to 200 sec.

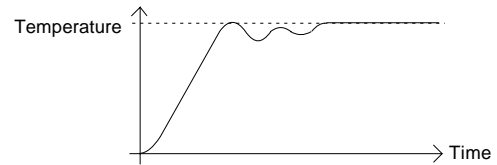
For a logic cooling output used to control a solenoid valve, set $CYCL$ to 50 sec.

Tuning procedure

1. Set the setpoint to the value at which you will normally operate the process.
2. In the $ALUN$ list, select t_{UNE} and set it to 'on'
3. Press the Page and Scroll buttons together to return to the HOME display. The display will flash t_{UNE} to indicate that tuning is in progress.
4. The controller will induce an oscillation in the temperature by turning the heating on and then off.
5. After two cycles of oscillation the tuning will be completed and the tuner will switch itself off.
6. The controller will then calculate the tuning parameters and resume normal control action.

If you want 'Proportional only' or 'P+D' or 'P+I' control, you should set the t_i or t_d parameters to OFF before commencing the tuning cycle. The tuner will leave them off and will not calculate a value for them.

Typical automatic tuning cycle



Calculation of the cutback values

When low cutback or high cutback is set to $AUTO$ their values will be fixed at three times the proportional band, and will not be altered during automatic tuning. If set to any other value, they will be calculated as part of the tuning process.

MANUAL TUNING

If for any reason automatic tuning gives unsatisfactory results, you can manually tune the controller, as follows:

With the process at its normal running temperature:

1. Set *Integral Time* t_i and *Derivative Time* t_d to OFF.
2. Set *High Cutback* and *Low Cutback*, H_{cb} and L_{cb} , to $AUTO$.
3. Ignore the fact that the temperature may not settle precisely at the setpoint
4. Reduce the *proportional band* P_b until the temperature just starts to oscillate. If the temperature is already oscillating, increase the proportional band until it just stops oscillating. Allow enough time between each adjustment for the temperature to stabilise. Make a note of the proportional band value 'B' and the period of oscillation 'T'.
5. Set the PID parameter values according to the formula below:

Type of control	Proportional band ' P_b '	Integral time ' t_i '	Derivative time ' t_d '
Proportional only	2xB	OFF	OFF
P + I	2.2xB	0.8xT	OFF
P + I + D	1.7xB	0.5xT	0.12xT

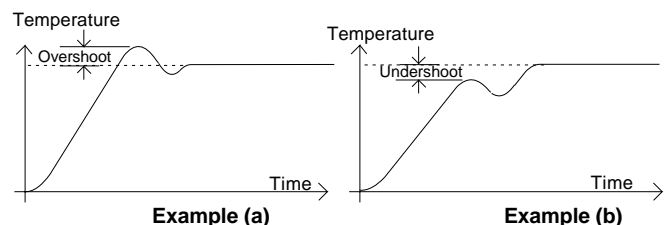
Setting the cutback values

The above procedure sets up the parameters for optimum steady state control. If unacceptable levels of overshoot or undershoot occur during start-up or for large step changes in temperature, then manually set the cutback parameters L_{cb} and H_{cb} .

Proceed as follows:

1. Set the low and high cutback settings to 3 x the proportional band (that is to say, $L_{cb} = H_{cb} = 3 \times P_b$).
2. Note the level of overshoot or undershoot that occurs for large temperature changes (see the diagrams below).

In example (a) increase L_{cb} by the overshoot value. In example (b) reduce L_{cb} by the undershoot value.



When the temperature approaches the setpoint from above, you can set H_{cb} in a similar manner.

Manual reset

When the integral term is set to OFF the parameter *manual reset* (r_{ES}) appears in the $PIDLIST$. This parameter sets the output power when the error signal is zero. This value can be manually adjusted to remove the steady state error - the function normally performed by the Integral term.

RE-CONFIGURATION INSTRUCTIONS

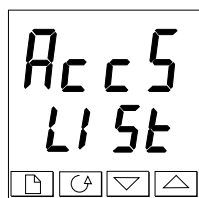
The 2216L and 2208L are normally supplied pre-configured to a customer's requirement using the simple ordering code. The type of heating, cooling and alarm outputs are defined in the ordering code and cannot be changed by the customer because they are part of the fixed hardware build. You can, however, change the following software features:

1. The setpoint limits.
2. The temperature display units: °C or °F
3. The type of control: On/Off or PID
4. The type of input sensor
5. The alarm output configuration
6. To configure outputs 1 & 2 to heating and cooling


These instructions tell you how to make these changes.

TO CHANGE THE SETPOINT LIMITS

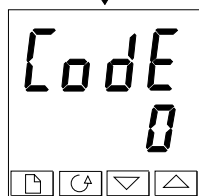
Separate high and low setpoint limits are available for setpoint 1 and setpoint 2. These restrict the range over which the operator can adjust the temperature thereby preventing damage to the product or the plant. To change the limits, first select 'FULL' access level as follows:



Access List Header

Press  until you reach the *AccS* list header.

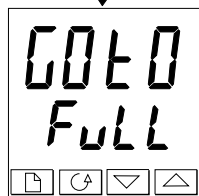
Press 





Password Entry

Enter the password '5744' by pressing the  or  buttons.
When the correct password has been entered the lower readout will change to *PASS* indicating that access is now unlocked.

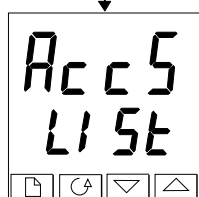
Press 




Go To FULL Level

Select 'FULL' access level by pressing the  or  buttons.
Ignore the other possibilities:
OPER: Operator level
Edit: Edit level
CONF: Configuration level.

Press 

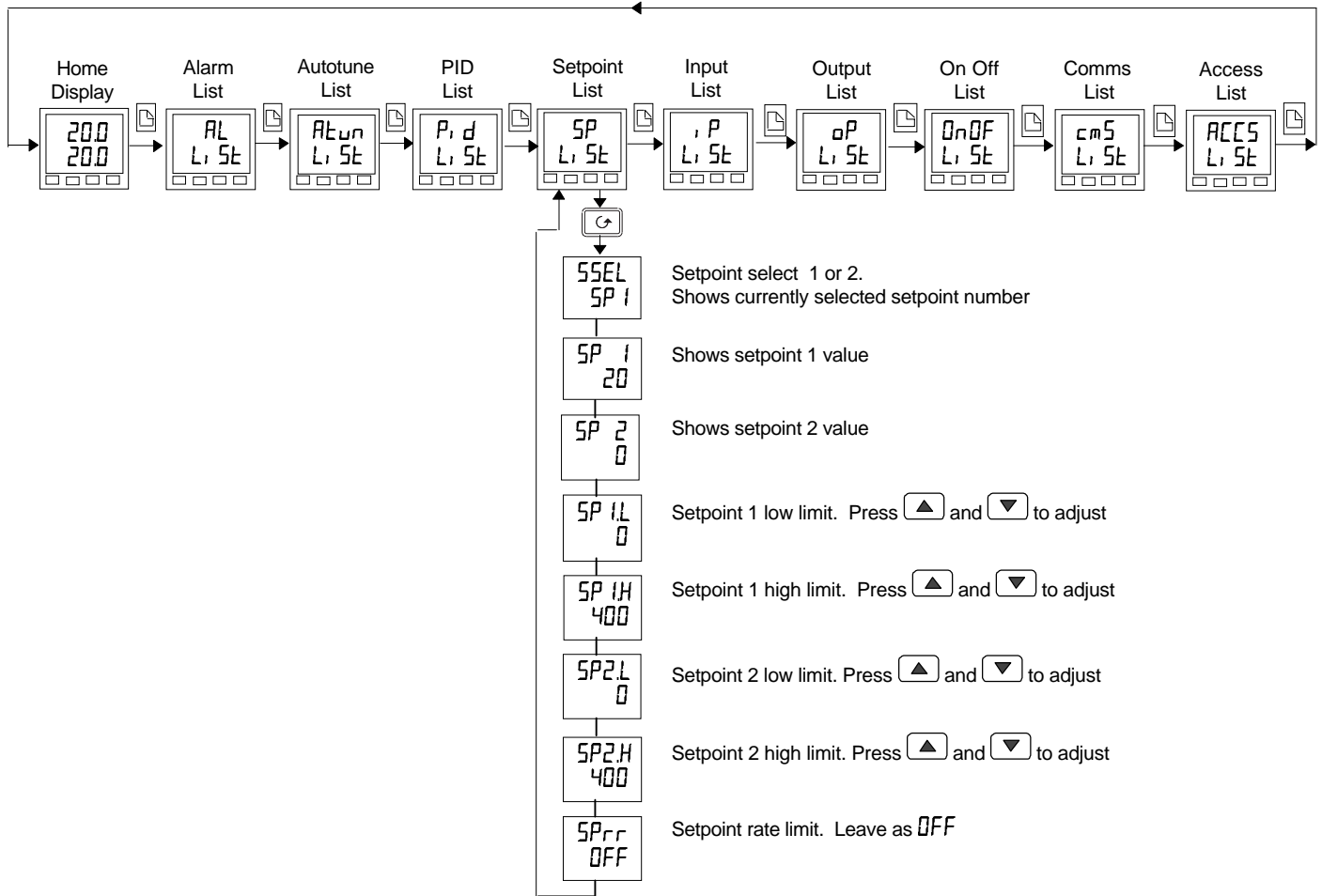


Access List Header

Press  to return to the *AccS* list header.
You are now in Full Access level.

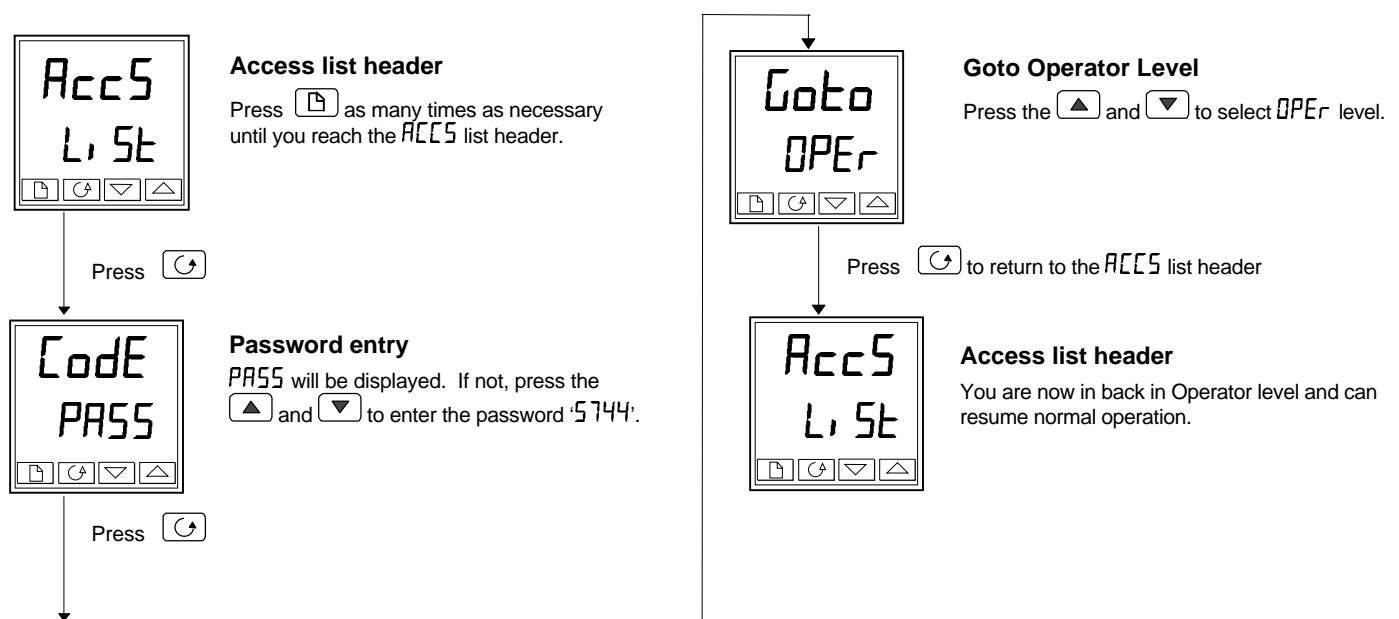
TO CHANGE THE SETPOINT LIMITS ... continued from the previous page.

Having selected **FULL** level, the **FULL** set of parameter lists shown below will be visible. Press to step across the list headers. You will eventually return to the HOME display. The high and low setpoint limits are in the **SP L, St**. To access them, press until you reach the **SP L, St** heading. Then press to step down the parameters within the list. Select the required parameter and adjust pressing the and buttons.



RETURN TO OPERATOR LEVEL

Having adjusted the setpoint limits, return to Operator level as follows.



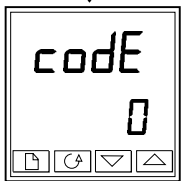
TO CHANGE:

- THE TEMPERATURE DISPLAY UNITS: °C OR °F
- THE TYPE OF CONTROL: ON/OFF OR PID
- THE INPUT SENSOR TYPE
- OUTPUTS 1 AND 2 TO HEATING OR COOLING
- THE ALARM OUTPUT CONFIGURATION,

First select configuration level, as follows:



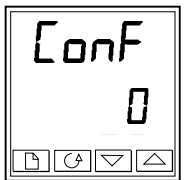
Press 




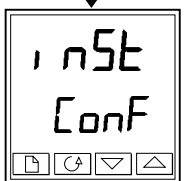
Press 




Press 





Press 





Access list header

Press  until you reach the *AccS* list header.

Password entry



Enter the password '5744' by pressing the  and  buttons. Once the correct password has been entered the lower readout will change to *PASS* indicating that access is now unlocked.

Goto configuration Level

Select *conf* level by pressing the  and  buttons. Ignore the other possibilities:

OPER: Operator level
EDIT: Edit level
FULL: Full access level.


Enter Configuration Password entry

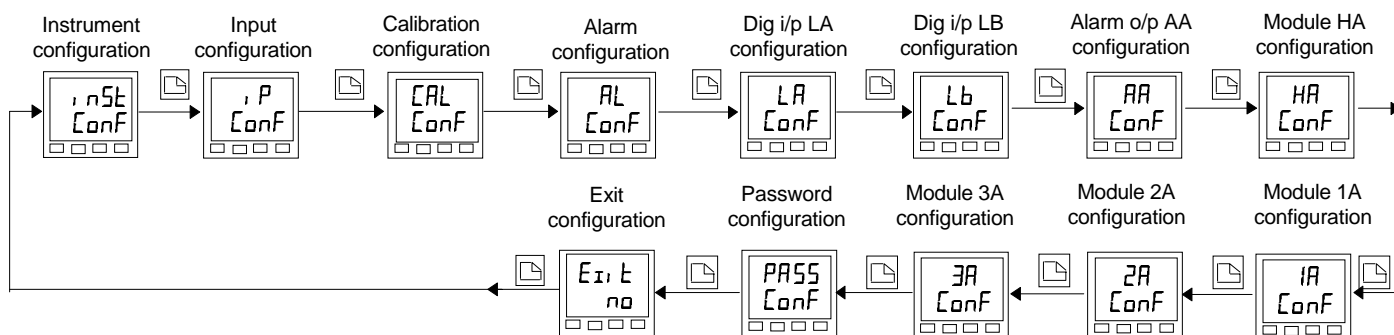
Enter the configuration password 5744 by pressing the  and  buttons. Once the correct password has been entered, lower readout will change to *PASS*.

Configuration level reached

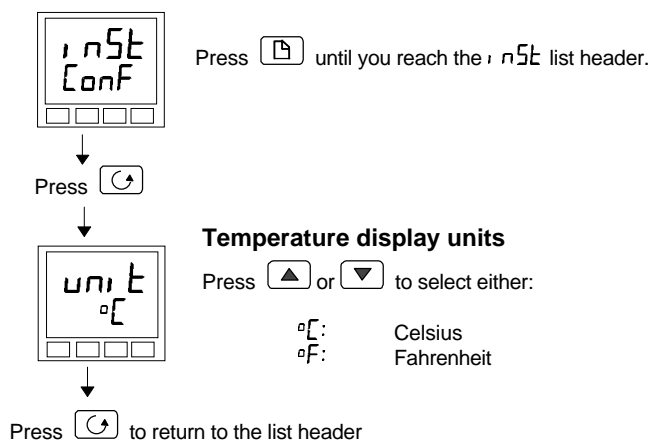
You are now in configuration level.

CONFIGURATION LEVEL:

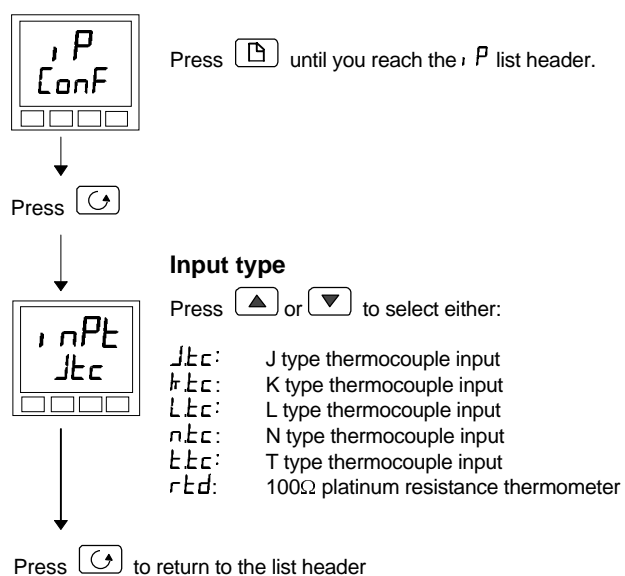
Having selected configuration level as shown on the previous page, Pressing the  button will step across the configuration parameter list headings as shown below. The lower readout will show **CONF** to indicate that it is a list heading.



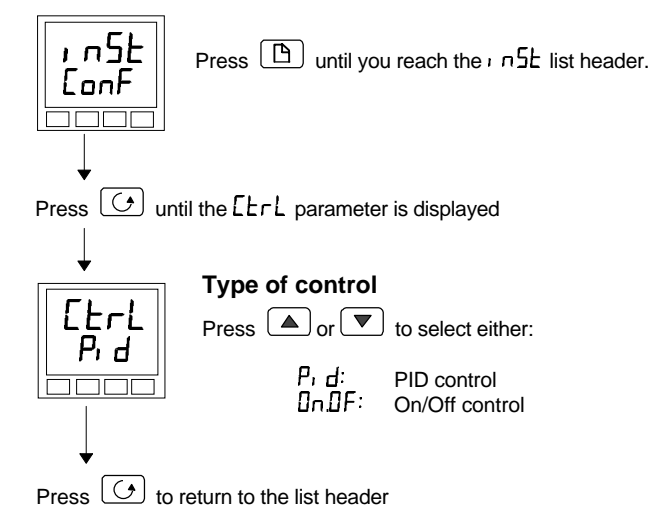
TO CHANGE THE TEMPERATURE DISPLAY UNITS



TO CHANGE THE INPUT SENSOR TYPE



TO CHANGE THE TYPE OF CONTROL



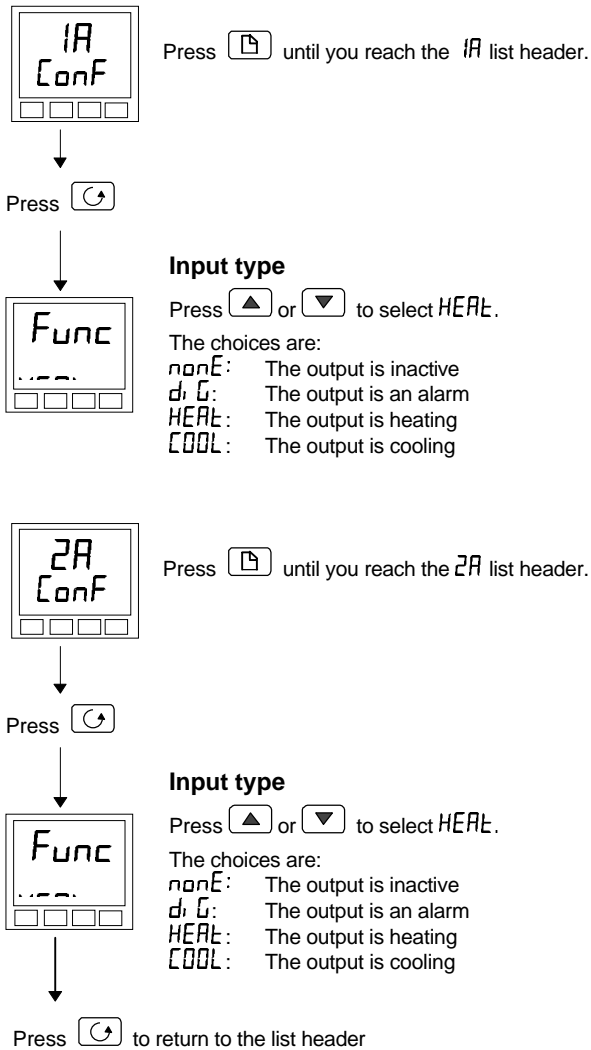
Selecting a new sensor type changes the setpoint limits. Therefore, after changing the sensor type, reset the setpoint limits as described earlier in these instructions.

To CHANGE OUTPUTS 1 & 2 To HEATING OR COOLING

The controller is supplied with output 1 configured as a heating output, and output 2 configured as a cooling output. It is possible to re-configure either output for heating or cooling.

It is also possible to configure both outputs for heating (or cooling) The advantage of this is that one output can be fitted with a relay and the other with a logic, which gives the user the choice of using either a logic output or a relay output for the same function.

Proceed as follows:

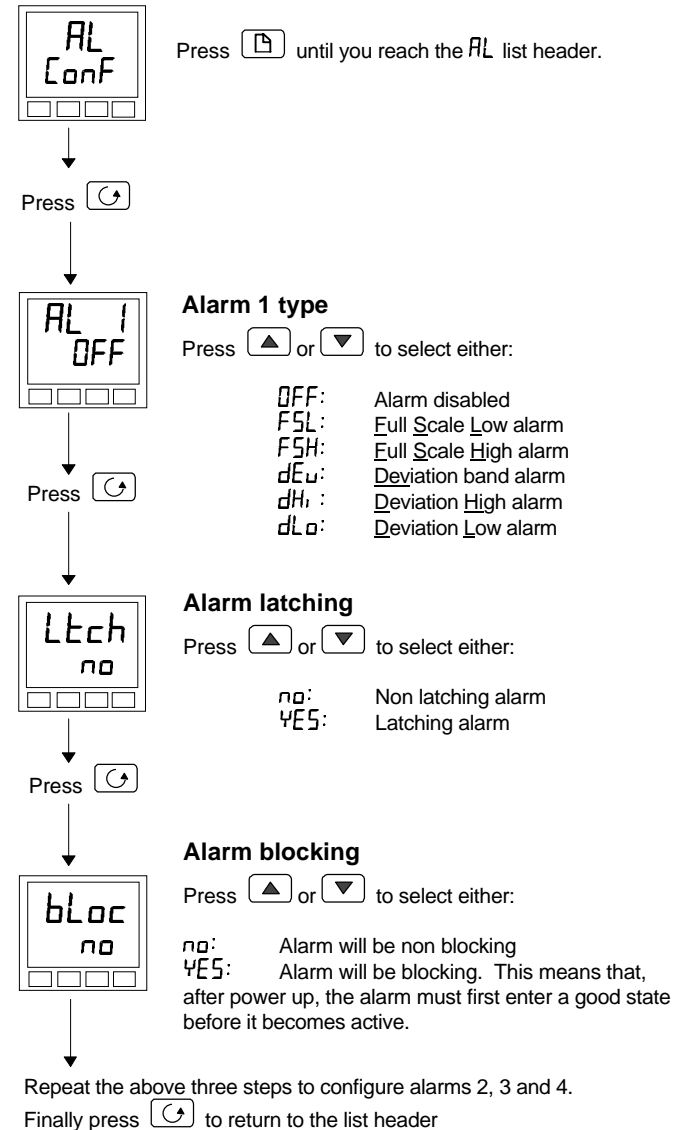


To RECONFIGURE THE ALARM OUTPUT

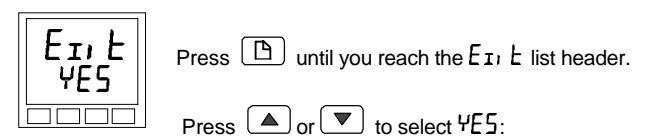
The alarm output is operated by up to four internal 'soft' alarms i.e. indication only. These alarms can be individually configured in the **AL CONF** list.

Note: If an alarm is disabled it will not appear in the alarm list in Operator level.

To re-configure the alarm output proceed as follows:



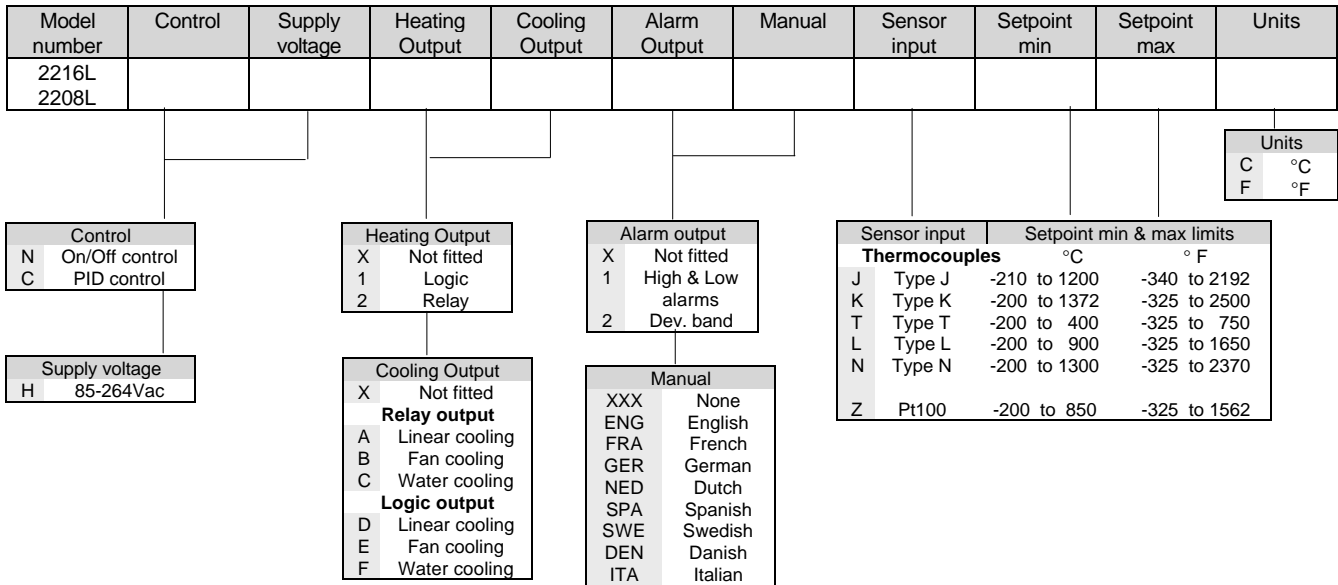
To RETURN TO OPERATOR LEVEL



After a two second delay the controller will return to operator level and normal operation can be resumed.

ORDERING CODE

The controller is built and configured according to the ordering code shown below.



TECHNICAL SPECIFICATION

Environmental ratings-

Panel sealing: IP65, (EN 60529), or 4X, (NEMA 250).
 Operating ambients: 0 to 55°C. Ensure that the enclosure is adequately ventilated. 5 to 95%RH, non condensing
 Atmosphere: Not suitable for use above 2000m or in explosive or corrosive atmospheres.

Equipment ratings

Power supply 100 to 240Vac -15%, +10% / 48 to 62Hz, 10Watts maximum consumption
 Relay (isolated) Maximum: 264Vac, 2A resistive. Minimum: 12Vdc, 100mA.
 Over current protection: Use a minimum of 0.5mm² or 16awg wire for plant connections. External over current protection is required. Use independent fuses for the controller supply and each relay output. Suitable fuses are EN60127 (type T) rated at 2A

Logic outputs and inputs Logic outputs: 18V at 20mA, non-isolated. Logic contact closure inputs: Non-isolated from the sensor input.

Electrical safety

Meets EN 61010, Installation category II, pollution degree 2.
 Voltage transients on any mains power connected to the controller must not exceed 2.5kV.

Isolation: All isolated inputs and outputs have reinforced insulation to protect against electric shock. (See live sensor note)

SAFETY AND EMC INFORMATION

Safety

This controller complies with the European Low Voltage Directive 73/23/EEC, amended by 93/68/EEC, by the application of the safety standard EN 61010.

Electromagnetic compatibility

This controller conforms with the essential protection requirements of the EMC Directive 89/336/EEC, amended by 93/68/EEC, by the application of a Technical Construction File. This controller satisfies the general requirements of the industrial environment defined in EN 50081-2 and EN 50082-2.

GENERAL

The information contained in these instructions is subject to change without notice. While every effort has been made to ensure the accuracy of the information, Eurotherm Controls shall not be held liable for errors contained herein.

Unpacking and storage

The packaging should contain the controller with two panel retaining clips and this instruction leaflet. If on receipt, the packaging or the controller are damaged, do not install it but contact your nearest Eurotherm Controls agent. If the controller is to be stored before use, protect from humidity and dust in an ambient temperature range of -30°C to +75°C.

SERVICE AND REPAIR

This controller has no user serviceable parts. Contact your nearest Eurotherm Controls agent for repair.

Caution: Charged capacitors

Before removing a controller from its sleeve, switch off the supply and wait two minutes to allow capacitors to discharge. Failure to observe this precaution may damage the controller or cause some discomfort to the user.

Electrostatic discharge precautions

When the controller is removed from its sleeve, it is vulnerable to damage by electrostatic discharge from someone handling the controller. To avoid this, before handling the unplugged controller discharge yourself to ground.

Cleaning

Do not use water or water based products to clean labels or they will become illegible. Isopropyl alcohol may be used to clean labels. A mild soap solution may be used to clean other exterior surfaces of the product.

Safety Symbols

The following safety symbols are used on the controller:



Caution, (refer to the accompanying documents)



Functional earth (ground) terminal

Personnel

Installation must only be carried out by qualified personnel

Enclosure of live parts

To prevent hands or metal tools touching parts that may be electrically live, the controller must be installed in an enclosure.

Caution: Live sensors

The logic outputs and the two contact closure inputs are electrically connected to the sensor input (e.g. thermocouple). In some installations the temperature sensor may become live. The controller is designed to operate under these conditions, but you must ensure that this will not damage other equipment connected

to these inputs and outputs, and that service personnel do not touch these connections while they are live. With a live sensor, all cables, connectors and switches for connecting the sensor and non-isolated inputs and outputs must be mains rated.

Wiring

Wire the controller in accordance with the wiring data given in these instructions. Take particular care not to connect AC supplies to the low voltage sensor input or logic outputs. Only use copper conductors for connections, (except thermocouple). Ensure that the installation complies with local wiring regulations.

Power Isolation

The installation must include a power isolating switch or circuit breaker that disconnects all current carrying conductors. The device should be mounted in close proximity to the controller, within easy reach of the operator and marked as the disconnecting device for the controller.

Earth leakage current

Due to RFI Filtering, there is an earth leakage current of less than 0.5mA. This may affect the design of an installation of multiple controllers protected by Residual Current Device (RCD), or Ground Fault Detector (GFD), type circuit breakers.

Voltage rating

The maximum continuous voltage applied between any connection and ground must not exceed 264Vac.

For the above reason the controller should not be wired to a three phase supply with an unearthed star connection. Under fault conditions such a supply could rise above 264Vac with respect to ground and the product would not be safe.

Conductive pollution

Electrically conductive pollution must be excluded from the cabinet in which the controller is mounted. For example, carbon dust is a form of electrically conductive pollution. Where condensation is likely, for example at low temperatures, include a thermostatically controlled heater in the cabinet.

Grounding of the temperature sensor shield

In some installations it is common practice to replace the temperature sensor while the controller is still powered up. Under these conditions, as additional protection against electric shock, we recommend that the shield of the temperature sensor is grounded. Do not rely on grounding through the framework of the machine.

Over-temperature protection

When designing any control system it is essential to consider what will happen if any part of the system should fail. In temperature control applications the primary danger is that the heating will remain constantly on. This could damage the product, the machinery being controlled, or even cause a fire.

Reasons why the heating might remain constantly on include:

- the temperature sensor becoming detached from the process
- thermocouple wiring becoming short circuit;
- the controller failing with its heating output constantly on
- an external valve or contactor sticking in the heating state

Where damage or injury is possible, we recommend fitting a separate over-temperature protection unit, with an independent temperature sensor, which will isolate the heating circuit.

Please note that the alarm relays within the controller will not give protection under all failure conditions.

Installation Requirements for EMC

- For general guidance refer to Eurotherm Controls EMC Installation Guide, HA025464.
- When using relay outputs it may be necessary to fit a filter suitable for suppressing the conducted emissions. The filter requirements will depend on the type of load. For typical applications we recommend Schaffner FN321 or FN612.

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Routing of wires

To minimise the pick-up of electrical noise, the sensor input wiring should be routed away from high-current power cables. Where it is impractical to do this, use shielded cables with the shield grounded at both ends.

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