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EUROTHERM

3508
3504

PROCESS CONTROLLERS

ENG **Engineering handbook**

HVS
PRECONISATEUR DE SOLUTIONS DEPUIS 1986

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3508 and 3504 Process Controllers

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Issue Status of This Manual

Issue 3.0 of this manual applies to software version 1.2.

Notes about this handbook:-

1. Chapter 1 Installation and Operation, Part Number HA027987, is essentially the same as the User Handbook, supplied with the product.
2. Further chapters describe configuration of the controller and operation in level 3. The order of chapters is the same order as the subject headers presented in the controller.
3. Related handbooks, all of which can be downloaded from www.eurotherm.co.uk, may be useful for further information
   a. EMC booklet Part No. HA025464
   b. 2000 Series Communications Part No. HA026230
   c. DeviceNet Communications Part No. HA027506
   d. Profibus Communications Part No. HA026290
   e. IO Expander Part No. HA026893
4. Whenever the symbol ☺ appears in this handbook it indicates a helpful hint

3508 and 3504 Process Controllers

1. CHAPTER 1 INSTALLATION AND OPERATION

1.1 What Instrument Do I Have?

Thank you for choosing this Controller.

The 3508 controller is supplied in the standard 1/8 DIN size (48 x 96mm front panel). The 3504 controller is supplied in the standard ¼ DIN size (96 x 96mm front panel). They are intended for permanent installation, for indoor use only, in an electrical panel which encloses the rear housing, terminals and wiring on the back.

1.1.1 Contents of Package

When unpacking your controller please check that the following items have been included.

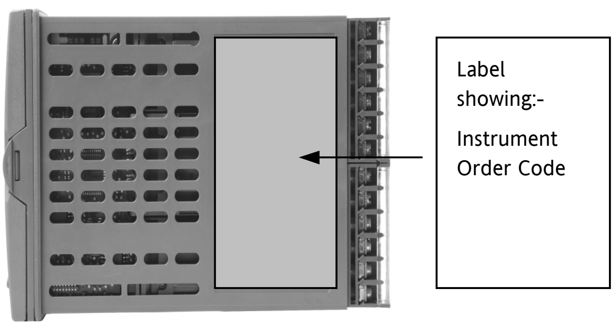
1.1.1.1 3508 or 3504 Controller Mounted in its Sleeve

The 3504 contains up to six plug-in hardware modules; the 3508 has up to three. Additionally digital communications modules can be fitted in two positions.

3508 Controller

3504 Controller

The modules provide an interface to a wide range of plant devices and those fitted are identified by an ordering code printed on a label fixed to the side of the instrument. Check this against the description of the code given in section 1.2 to ensure that you have the correct modules for your application. This code also defines the basic functionality of the instrument which may be:-



- Controller only
- Programmer and controller
- Control type – Standard PID, valve positioner
- Digital communications type
- Options

1.1.1.2 Panel Retaining Clips

Two clips are required to secure the instrument sleeve in the panel. These are supplied fitted to the sleeve.

1.1.1.3 Accessories Pack

For each input a load resistor value 2.49Ω is supplied for mA measurement. This will need to be fitted across the respective input terminals

A User Guide Part No HA027987. This guide is repeated here as Chapter 1 and explains:-

- How to install the controller
- Physical wiring to the plant devices
- First switch on - 'out of the box'.
- Principle of operation using the front panel buttons
- Introduction to configuration through iTools PC software

1.2 3504 and 3508 Ordering Code

Model Number	Function	Supply Voltage	No of Loops	Application	Programs	Recipes	Toolkit Wires	Colour

Model Number	
3504	3504 Standard
3508	3508 Standard

Function	
Null	Controller
F	Profibus controller

Supply Voltage	
VH	100-240Vac
VL	20-29Vac/dc

Loops	
1	Single

Application	
XX	Standard
VP	Valve Position
ZC	Zirconia

Programs	
01	1 prog 5 segments
10	10 prog 50 segments
25	25 prog 100 segments
50	50 prog 200 segments

Recipes	
1	1 recipe
4	4 recipes
8	8 recipes

Toolkit Wires	
XX	30 wires
60	60 wires
120	120 wires
250	250 wires

Colour	
G	Eurotherm green
S	Silver

1.2.1 Input and Output Modules

3504 only (IO Slot 4 – IO Slot 6)

IO Slot 1	IO Slot 2	IO Slot 3	IO Slot 4	IO Slot 5	IO Slot 6	Comms H	Comms J

Config Tools	Product Language	Manuals Language	Warranty	Cal Cert	Custom Label

IO Slots 1-3 (3508); 1-6 (3504)	
XX	None fitted
R4	Change over relay
R2	2 pin relay
RR	Dual relay
T2	Triac
TT	Dual triac
D4	DC control
AM	Analogue input (not slot 2 or 5)
D6	DC retransmission
TL	Triple logic input
TK	Triple contact input
TP	Triple logic output
VU	Potentiometer input
MS	24Vdc transmitter PSU
G3	Transducer PSU 5 or 10Vdc
LO	Isolated single logic output

H Comms Slot	
XX	Not Fitted
A2	232 Modbus
Y2	2-wire 485 Modbus
F2	4-wire 485 Modbus
AE	232 EI-Bisynch
YE	2-wire 485 EI-Bisynch
FE	4-wire 485 EI-Bisynch
ET	Ethernet 10base
PB	Profibus
DN	Devicenet

J Comms Slot	
XX	Not Fitted
A2	232 Modbus
Y2	2-wire 485 Modbus
F2	4-wire 485 Modbus
EX	IO Expander

Config Tools	
XX	None
IT	Standard iTools

Instrument Language	
ENG	English
FRA	French
GER	German
SPA	Spanish

Manuals Language	
ENG	English
FRA	French
GER	German
SPA	Spanish
XXX	None

Extended Warranty	
WL005	Extended 5 year

Cal Certificate	
XXXXX	None
CAL1	Cert of conformity
CAL2	Factory cal cert
CAL3	Custom Cal Cert

Custom Labels	
F1234	Special No
XXXXX	None

Non-standard Option	
EU1234	Special No
EC1234	Custom curve
EE1234	Custom config
ES1234	Cust software

Example 3504/VH/1/XX/10/4/60/G/TT/XX/XX/XX/XX/XX/Y2/XX/IT/ENG/ENG/WL003/XXXX

3504 CONTROLLER, 100-240Vac, 10 programs, 4 recipes, 60 wires, dual triac output, 2-wire J485 comms, iTools, English manual

1.3 How to Install the Controller

This instrument is intended for permanent installation, for indoor use only, and to be enclosed in an electrical panel.

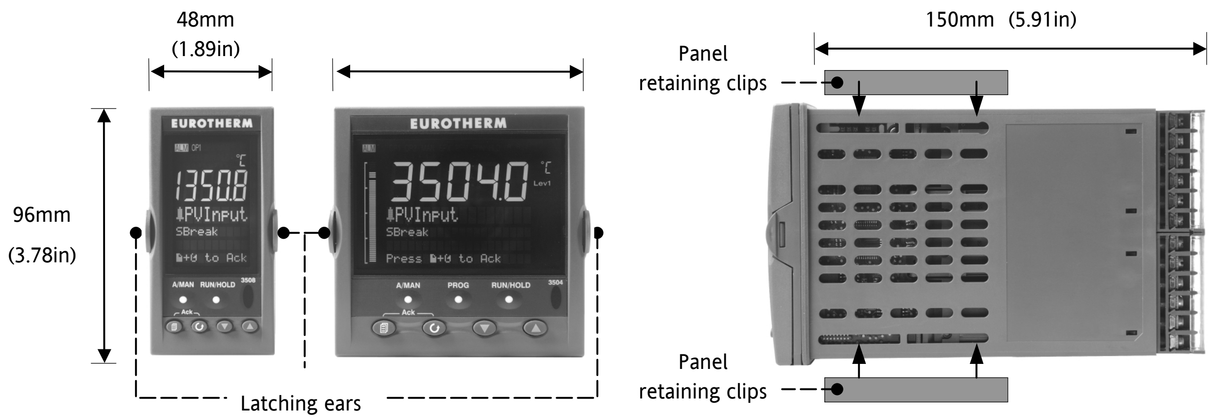
Select a location where minimum vibrations are present and the ambient temperature is within 0 and 50ºC (32 and 122ºF).

The instrument can be mounted on a panel up to 15mm thick.

To assure IP65 and NEMA 4 front protection, use a panel with smooth surface texture.

Please read the safety information, Appendix B, before proceeding and refer to the EMC Booklet part number HA025464 for further information.

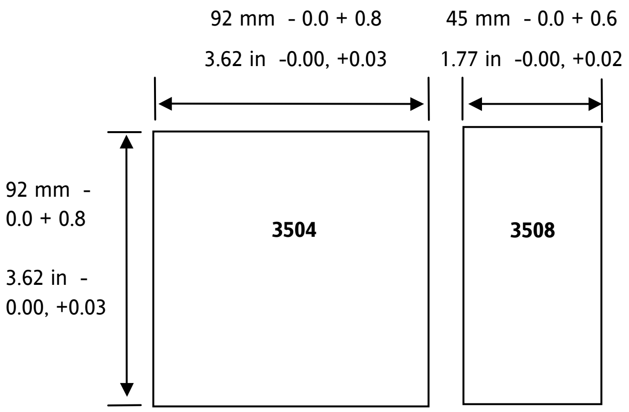
1.3.1 Dimensions



1.3.2 To Install the Controller

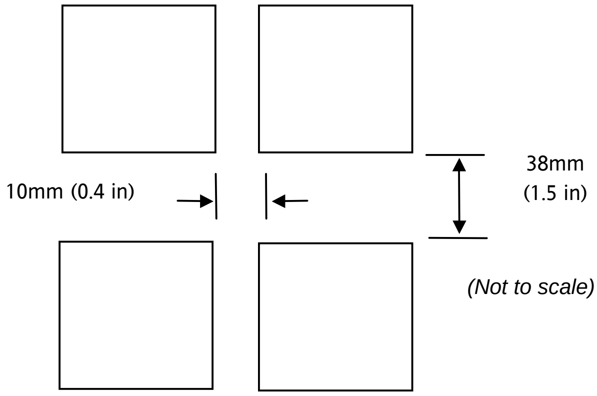
1.3.2.1 Panel Cut-out

1. Prepare the panel cut-out to the size shown in the diagram
2. Insert the controller through the cut-out.
3. Spring the panel retaining clips into place. Secure the controller in position by holding it level and pushing both retaining clips forward.
4. Peel off the protective cover from the display



1.3.2.2 Recommended Minimum Spacing

5. The recommended minimum spacing between controllers shown here should not be reduced to allow sufficient natural air flow

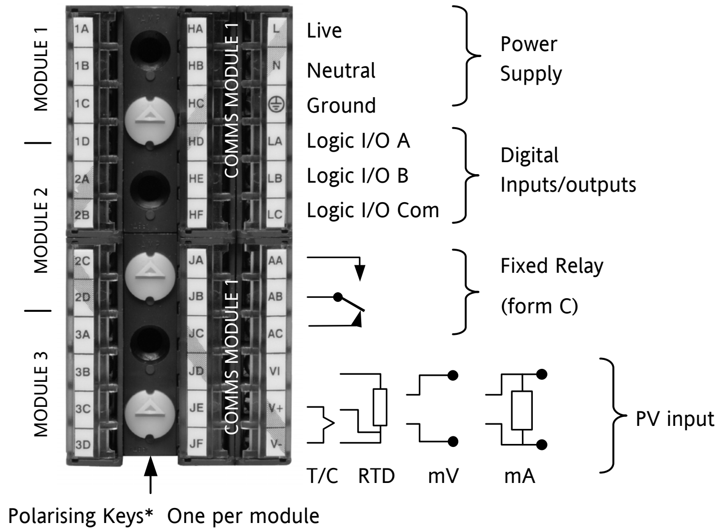


1.3.3 Unplugging the Controller

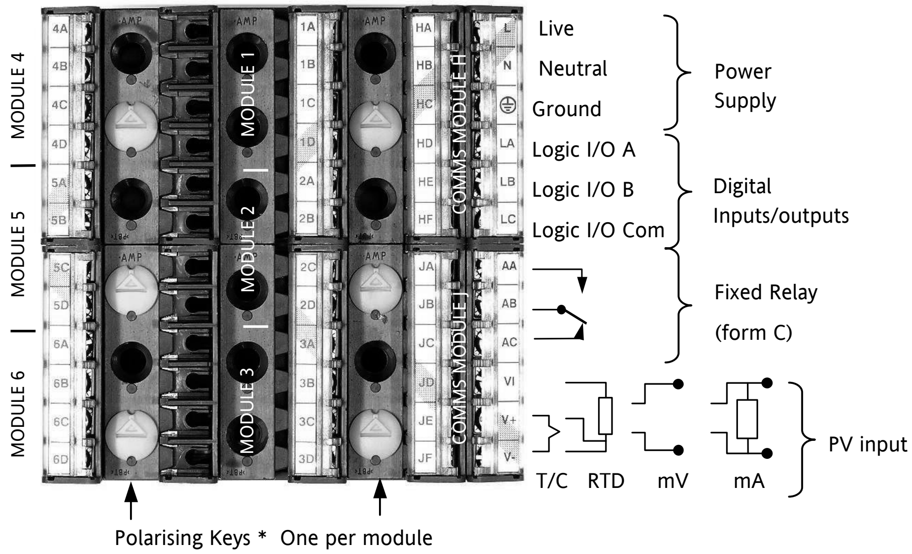
The controller can be unplugged from its sleeve by easing the latching ears outwards and pulling it forward out of the sleeve. When plugging it back into its sleeve, ensure that the latching ears click back into place to maintain the IP65 sealing.

1.4 Electrical Connections

3508



3504



* Polarising Key

Polarising keys are intended to prevent modules which are not supported in this controller from being fitted into the controller. An example might be an unisolated module (coloured red) from a 2400 controller series. When pointing towards the top, as shown, the key prevents a controller, fitted with an unsupported module, from being plugged into a sleeve which has been previously wired for isolated modules. If an unisolated module is to be fitted, it is the users responsibility to ensure that it is safe to install the controller in the particular application. When this has been verified the polarising key may be adjusted with a screwdriver to point in the down direction.

1.4.1 Wire Sizes

The screw terminals accept wire sizes from 0.5 to 1.5 mm (16 to 22AWG). Hinged covers prevent hands or metal making accidental contact with live wires. The rear terminal screws should be tightened to 0.4Nm (3.5lb in).

1.5 Standard Connections

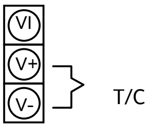
These are connections which are common to all instruments in the range.

1.5.1 PV Input (Measuring Input)

Notes:

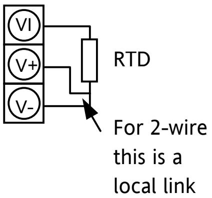
1. Do not run input wires together with power cables
2. When shielded cable is used, it should be grounded at one point only
3. Any external components (such as zener barriers, etc) connected between sensor and input terminals may cause errors in measurement due to excessive and/or un-balanced line resistance or possible leakage currents
4. Not isolated from the logic outputs and digital inputs

1.5.1.1 Thermocouple or Pyrometer Input



Use the correct type of thermocouple compensating cable, preferably shielded, to extend wiring

1.5.1.2 RTD Input

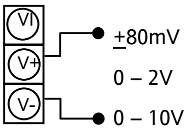


The resistance of the three wires must be the same

The line resistance may cause errors if it is greater than 22Ω

Note: the RTD wiring is not the same as 2400 series instruments. It is the same as 26/2700 series

1.5.1.3 Linear Input V, mV and High Impedance V



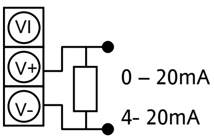
mV range ±40mV or ±80mV

High level range 0 – 10V

High Impedance mid level range 0 – 2V

A line resistance for voltage inputs may cause measurement errors

1.5.1.4 Linear Input mA



Connect the supplied load resistor equal to 2.49Ω for mA input

The resistor supplied is 1% accuracy 50ppm

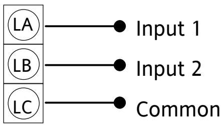
A resistor 0.1% accuracy 15ppm resistor can be supplied as an orderable option

1.5.2 Digital I/O

These terminals may be configured as logic inputs, contact inputs or logic outputs in any combination. It is possible to have one input and one output on either channel.

⚠ **The Digital IO is not isolated from the PV input**

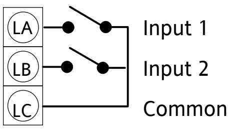
1.5.2.1 Logic Inputs



Voltage level logic inputs, 12V, 5-40mA

Active > 10.8V
Inactive < 7.3V

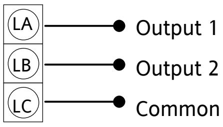
1.5.2.2 Contact Closure Inputs



Contact open > 1200Ω

Contact closed < 480Ω

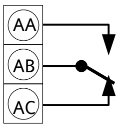
1.5.3 Digital (Logic) Outputs



The logic outputs are capable of driving SSR or thyristors up to 9mA, 18V
It is possible to parallel the two outputs to supply 18mA, 18V.

Note : The Digital IO terminals are not isolated from the PV.

1.5.4 Relay Output



Relay rating, min: 1V, 1mAdc. Max: 264Vac 2A resistive

Relay shown in de-energised state

Isolated output 240Vac CATII

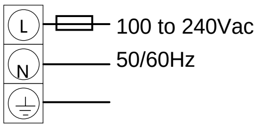
1.5.4.1 General Note About Inductive Loads

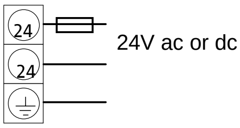
High voltage transients may occur when switching inductive loads such as some contactors or solenoid valves.

For this type of load it is recommended that a 'snubber' is connected across the normally open contact of the relay switching the load. The snubber typically consists of a 15nF capacitor connected in series with a 100Ω resistor and will also prolong the life of the relay contacts.

⚠ When the relay contact is open and it is connected to a load, the snubber passes a current (typically 0.6mA at 110Vac and 1.2mA at 240Vac. It is the responsibility of the installer to ensure that this current does not hold on the power to an electrical load. If the load is of this type the snubber should not be connected.

1.5.5 Power Supply Connections





1. Before connecting the instrument to the power line, make sure that the line voltage corresponds to the description on the identification label
2. For supply connections use 16AWG or larger wires rated for at least 75ºC
3. Use copper conductors only
4. For 24V the polarity is not important
5. It is the Users responsibility to provide an external fuse or circuit breaker.

    For 24 V ac/dc fuse type T rated 4A 250V

    For 100/240Vac fuse type T rated 1A 250V

Safety requirements for permanently connected equipment state:

- a switch or circuit breaker shall be included in the building installation
- it shall be in close proximity to the equipment and within easy reach of the operator
- it shall be marked as the disconnecting device for the equipment

Note: a single switch or circuit breaker can supply more than one instrument

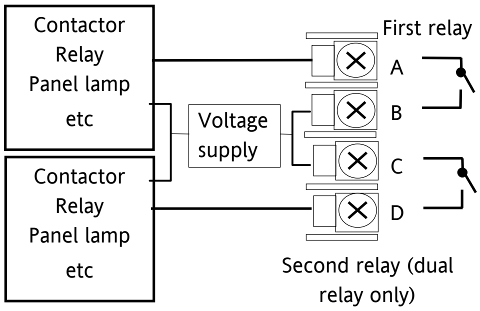
1.6 Plug in I/O Module Connections

Plug in I/O modules can be fitted in three positions in the 3508 and six positions in 3504. The positions are marked Module 1, Module 2, Module 3, Module 4, Module 5, Module 6. With the exception of the Analogue Input module, any other module listed in this section, can be fitted in any of these positions. To find out which modules are fitted check the ordering code printed on a label on the side of the instrument. If modules have been added, removed or changed it is recommended that this is recorded on the instrument code label.

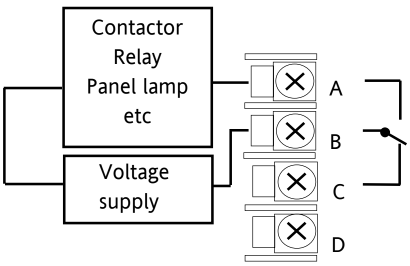
The function of the connections varies depending on the type of module fitted in each position and this is shown below. All modules are isolated.

1.6.1 I/O Modules

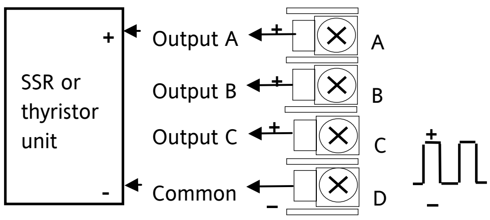
<table>
<tr><th>I/O Module</th><th>Typical usage</th><th>H/W Code</th><th>Connections and examples of use</th></tr>
<tr><td colspan="4">Note: The order code and terminal number is pre-fixed by the module number.
Module 1 is connected to terminals 1A, 1B, 1C, 1D; module 2 to 2A, 2B, 2C, 2D, etc.</td></tr>
<tr><td>Relay (2 pin)
and
Dual Relay

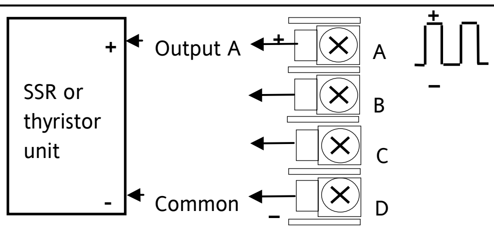
2A, 264Vac max
1mA 1V min</td><td>Heating, cooling, alarm, program event, valve raise, valve lower</td><td>R2 and
RR</td><td>

Isolated output 240Vac CATII</td></tr>
<tr><td>Change Over Relay

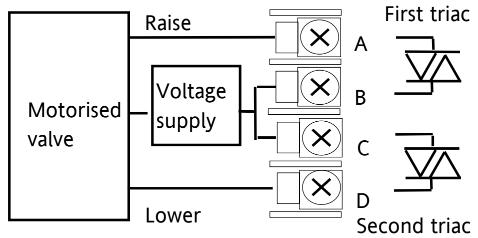
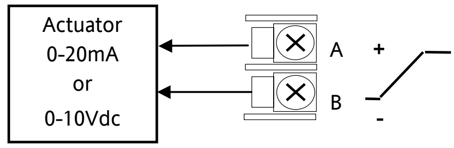
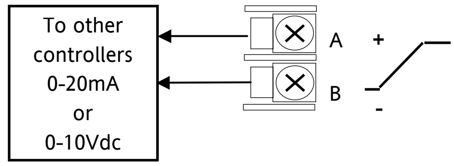
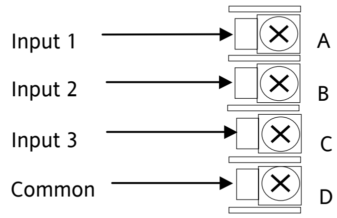
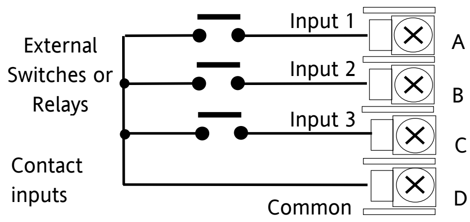
(2A, 264Vac max)
1mA 1V min</td><td>Heating, cooling, alarm, program event, valve raise, valve lower</td><td>R4</td><td>

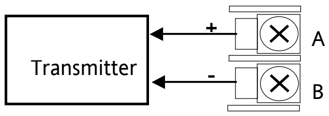
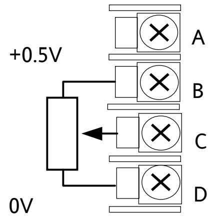
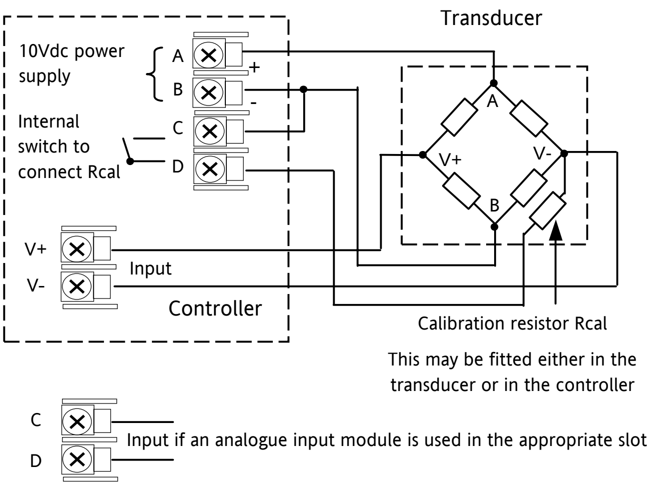
Isolated output 240Vac CATII</td></tr>
<tr><td>Triple Logic Output

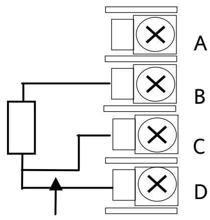
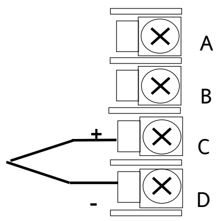
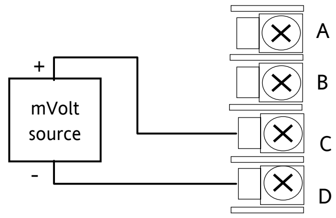
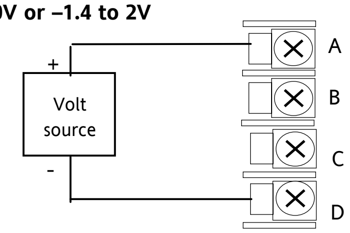
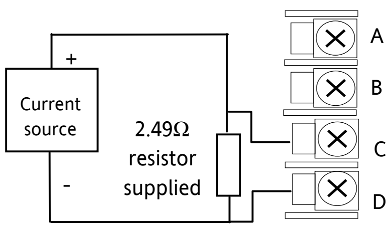
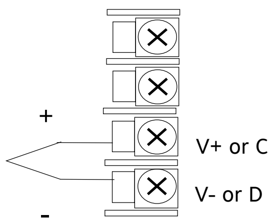
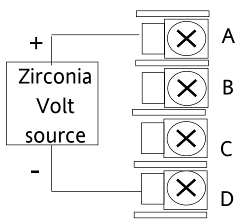
(18Vdc at 8mA max.)</td><td>Heating, cooling, program events</td><td>TP</td><td>

Isolated output 240Vac CATII</td></tr>
<tr><td>Isolated Single Logic Output</td><td>Heating, cooling, program events</td><td>LO</td><td>

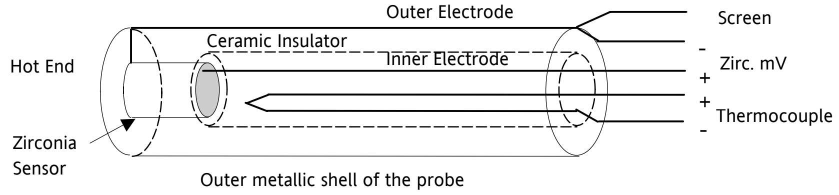
Isolated output 240Vac CATII</td></tr>
</table>

Triac and Dual Triac (0.7A, 30 to 264Vac combined rating)	Heating, cooling, valve raise, valve lower	T2 and TT	 Note 1: Dual relay modules may be used in place of dual triac. Isolated output 240Vac CATII **Note 2:-** **The combined current rating for the two triacs must not exceed 0.7A.**
I/O Module	**Typical usage**	**H/W Code**	**Connections and examples of use**
DC Control (10Vdc, 20mA max)	Heating, cooling e.g. to a 4-20mA process actuator	D4	 Isolated output 240Vac CATII
DC Re-transmission (10Vdc, 20mA max)	Logging of PV, SP, output power, etc., (0 to 10Vdc, or 0 to 20mA)	D6	 Isolated output 240Vac CATII
Triple Logic Input	Events e.g. Program Run, Reset, Hold	TL	Logic inputs <5V OFF >10.8V ON Limits: -3V, +30V  Isolated output 240Vac CATII
Triple Contact Input	Events e.g. Program Run, Reset, Hold	TK	 Contact inputs <100Ω ON >28KΩ OFF Isolated output 240Vac CATII

24V Transmitter Supply (20mA)	To power an external transmitter	MS	 Isolated output 240Vac CATII
Potentiometer input 100Ω to 15KΩ			 Isolated output 240Vac CATII
Transducer Power Supply Configurable 5V or 10Vdc Minimum load resistance 300Ω			Calibration resistor – may be internal or external  Isolated output 240Vac CATII

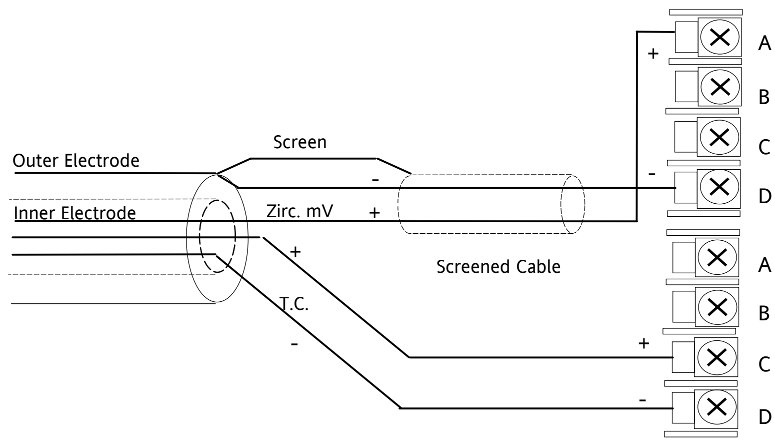
I/O Module	Typical usage	Order Code	Connections and examples of use
Analogue Input (T/C & RTD) Modules 1, 3 4, & 6 only (mV, V and mA)	Second or third PV input	PV	**3-wire RTD**  For 2-wire this is a local link **Thermocouple**  **mV (±40mV up ±80mV)**  **Voltage** **-3 to 10V or –1.4 to 2V**  **Current 0 to 20mA or (4 to 20mA)**  Isolated output 240Vac CATII
Analogue Input (T/C & RTD) **Modules 1, 3, 4 & 6 only** PV Input Module **Modules 1, 3, 4 & 6 only**	Zirconia Probe	AM PV	The temperature sensor of the zirconia probe can be connected to the Fixed PV input, terminals V+ and V-, or to an Analogue Input module, terminals C & D. The Volt Source connected to an Analogue Input module, terminals A & D.  Fixed PV (or an Analogue Input Module)  Analogue Input Module Isolated output 240Vac CATII

1.6.2 Zirconia Probe Construction



1.6.3 Zirconia Probe Screening Connections

The zirconia sensor wires should be screened and connected to the outer shell of the probe if it is situated in an area of high interference.



1.7 Digital Communications Connections

Digital Communications modules can be fitted in two positions in both 3508 and 3504 controllers. The connections being available on HA to HF and JA to JF depending on the position in which the module is fitted. The two positions could be used, for example, to communicate with 'iTools' configuration package on one position, and to a PC running a supervisory package on the second position.

Communications protocols may be ModBus, EIBisynch, DeviceNet, Profibus or Ethernet.

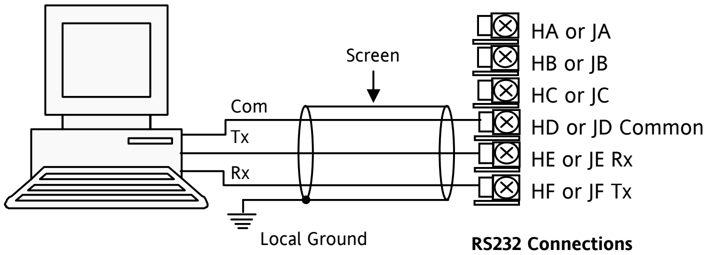
Note:- In order to reduce the effects of RF interference the transmission line should be grounded at both ends of the screened cable. However, if such a course is taken care must be taken to ensure that differences in the earth potentials do not allow circulating currents to flow, as these can induce common mode signals in the data lines. Where doubt exists it is recommended that the Screen (shield) be grounded at only one section of the network as shown in all of the following diagrams.

1.7.1 Modbus Slave (H or J Module) or EIBisynch

A further description of ModBus and EIBisynch communications is given in 2000 series Communications Handbook, Part No. HA026230.

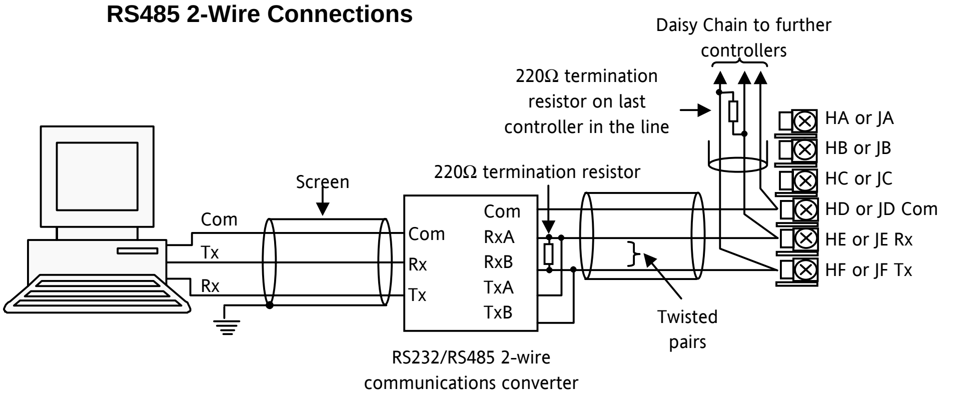
- Digital communications modules isolated 240Vac CATII

RS232 Connections



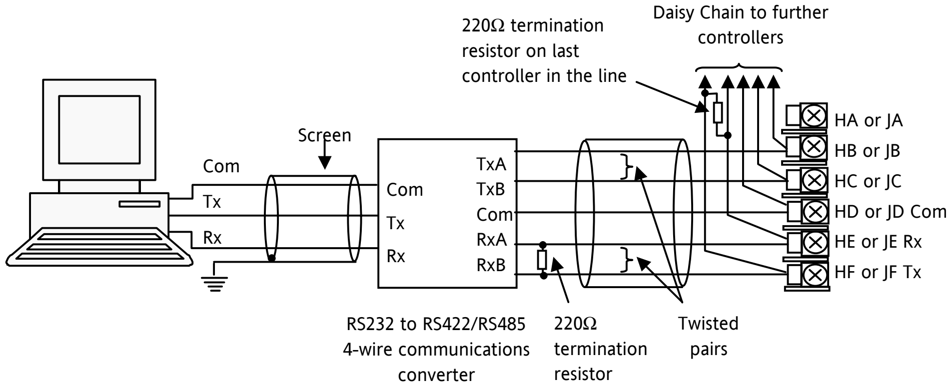
RS232 Connections

RS485 2-Wire Connections



The KD485 communications converter is recommended for interfacing to RS485. This unit is also used to buffer an RS485 network when it is required to communicate with more than 32 instruments on the same bus, and may also be used to bridge 2-wire RS485 to 4-wire RS422.

RS422/RS485 4-Wire Connections



The 261 or KD485 communications converter is recommended for:

Interfacing 4-wire to 2-wire connections.

To buffer an RS422/485 network when more than 32 instruments on the same bus are required

To bridge 2-wire RS485 to 4-wire RS422.

1.7.2 Devicenet Wiring

A description of DeviceNet is given in the DeviceNet Communications Handbook Part No HA027506 which can be downloaded from www.eurotherm.co.uk.

Terminal Reference	CAN Label	Color Chip	Description
HA	V+	Red	DeviceNet network power positive terminal. Connect the red wire of the DeviceNet cable here. If the DeviceNet network does not supply the power, connect to the positive terminal of an external 11-25 Vdc power supply.
HB	CAN_H	White	DeviceNet CAN_H data bus terminal. Connect the white wire of the DeviceNet cable here.
HC	SHIELD	None	Shield/Drain wire connection. Connect the DeviceNet cable shield here. To prevent ground loops, the DeviceNet network should be grounded in only one location.
HD	CAN_L	Blue	DeviceNet CAN_L data bus terminal. Connect the blue wire of the DeviceNet cable here.
HE	V-	Black	DeviceNet network power negative terminal. Connect the black wire of the DeviceNet cable here. If the DeviceNet network does not supply the power, connect to the negative terminal of an external 11-25 Vdc power supply.
HF			Connect to instrument earth

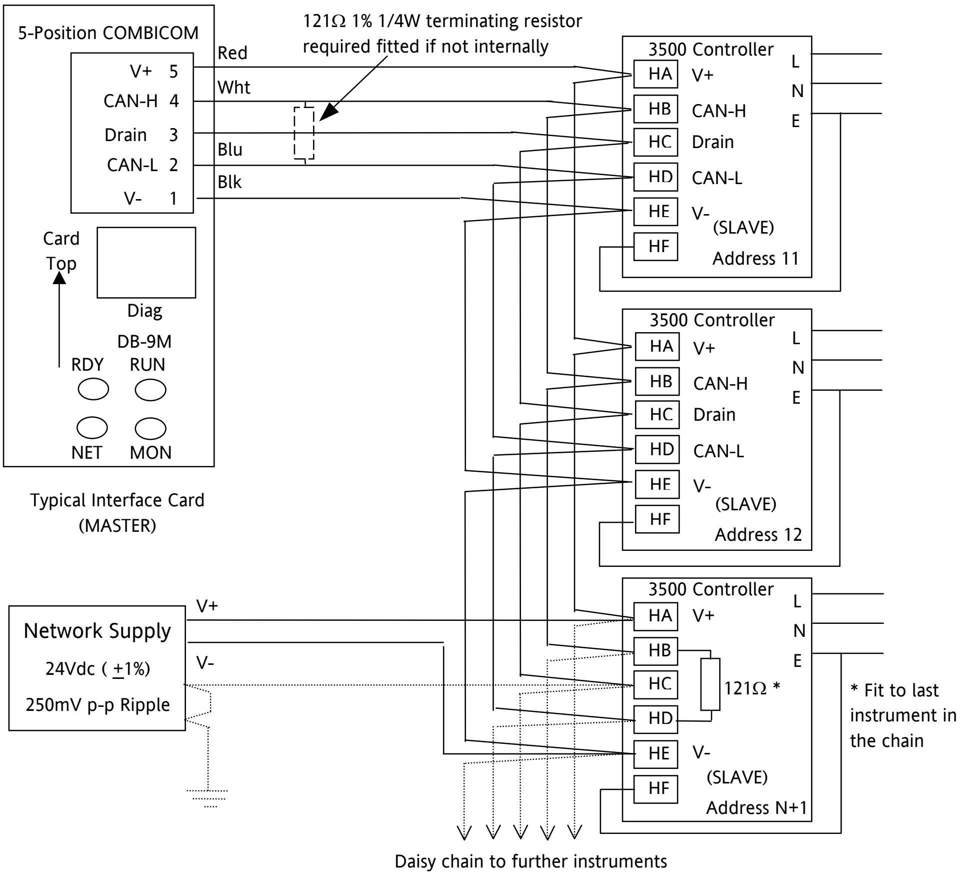
Note: Power taps are recommended to connect the DC power supply to the DeviceNet trunk line. Power taps include:

A Schottky Diode to connect the power supply V+ and allows for multiple power supplies to be connected.

2 fuses or circuit breakers to protect the bus from excessive current which could damage the cable and connectors.

The earth connection, HF, to be connected to the main supply earth terminal.

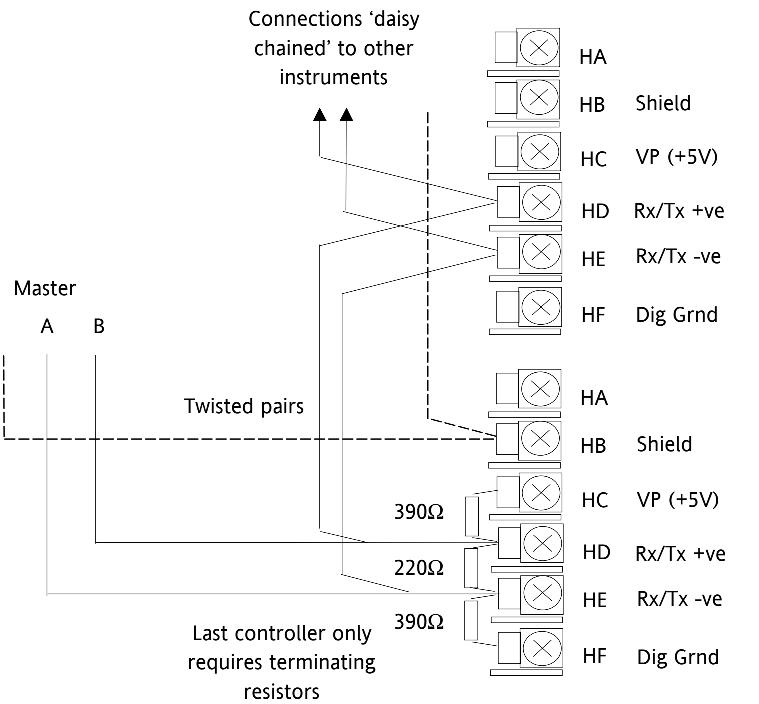
1.7.3 Example Devicenet Wiring Diagram



1.7.4 Profibus

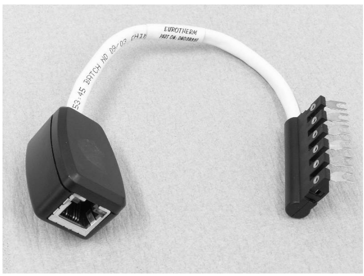
A description of ProfiBus is given in the Profibus Communications Handbook Part No HA026290 which can be downloaded from www.eurotherm.co.uk.

1.7.5 Example Profibus Wiring

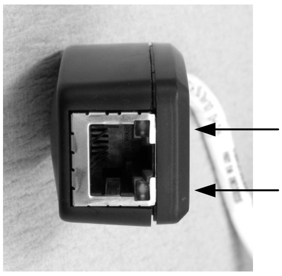


1.7.6 Ethernet

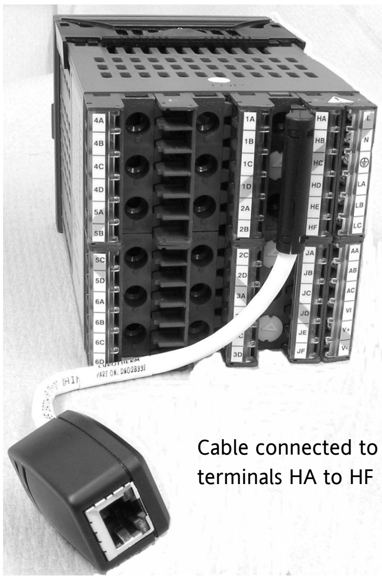
When the controller is supplied with the Ethernet communications option a special cable assembly is also supplied. This cable must be used since the magnetic coupling is contained within the RJ45 connector. It consists of an RJ45 connector (socket) and a termination assembly which must be connected to terminals HA to HF.



View of cable which may also be ordered separately as Part No SUB/35/COMMS/EA



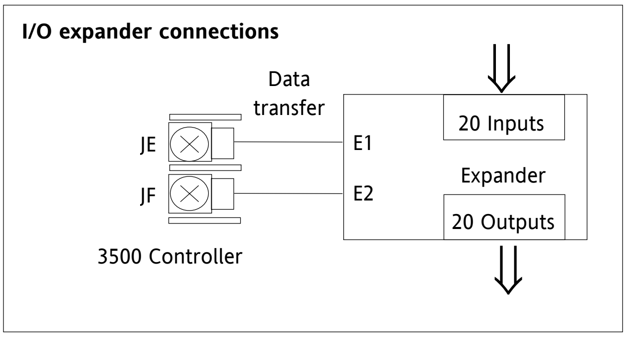
Activity and power on LED indicators



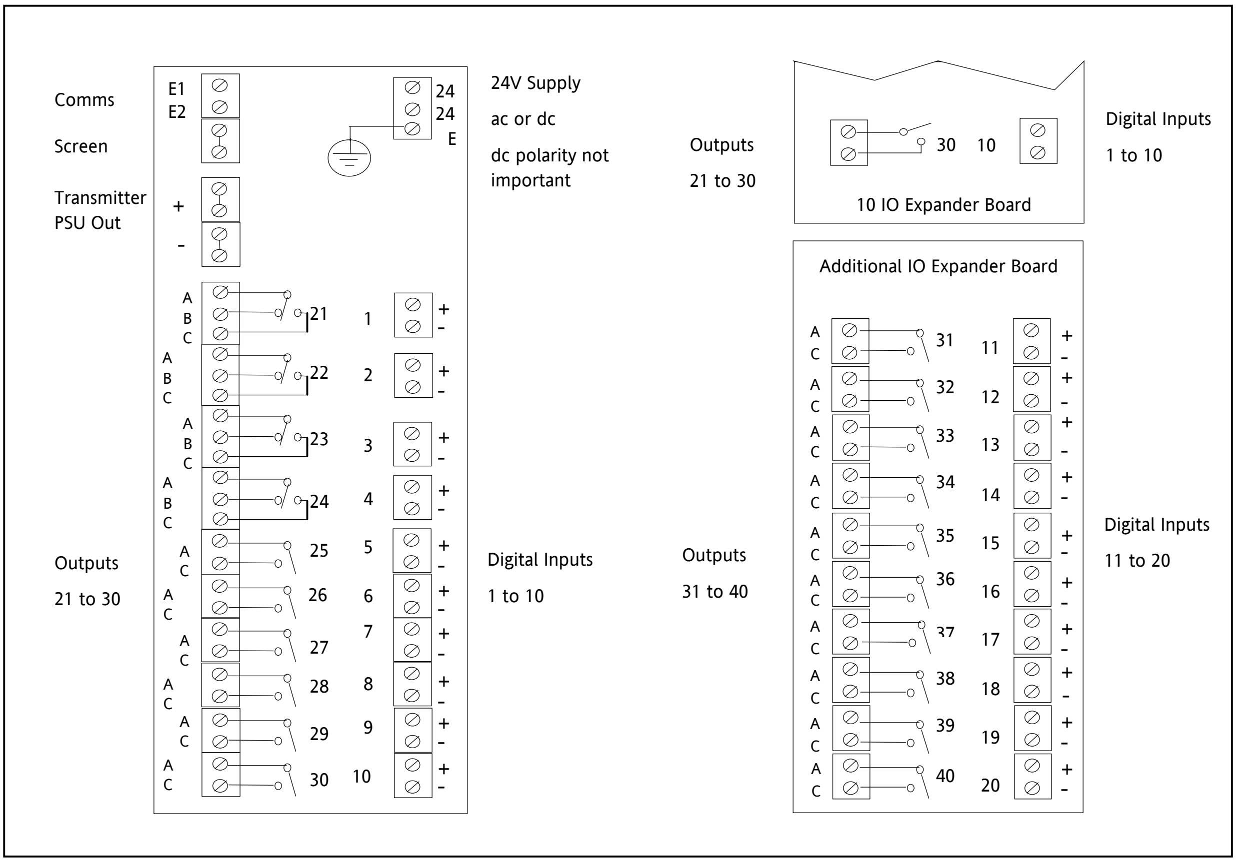
Cable connected to terminals HA to HF

1.7.7 I/O Expander (or Additional Digital Input)

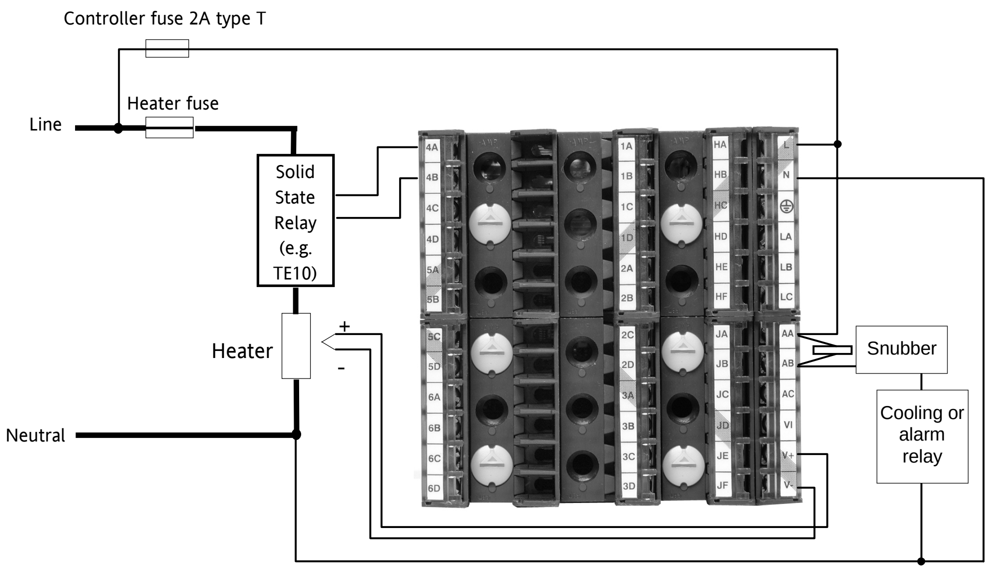
An I/O expander (Model No 2000IO) can be used with 3500 series controllers to allow the number of I/O points to be increased by up to a further 20 digital inputs and 20 digital outputs. Data transfer is performed serially via an IO Expander module which is fitted in digital communications slot J.



For details of the IO Expander refer to the Operating Instructions HA026893. The connections for this unit are reproduced below for convenience.



1.7.8 Example Wiring Diagram



Please refer to the EMC Electromagnetic Compatibility Handbook Part No. HA025464 for details of good wiring practice. This can be downloaded from www.eurotherm.co.uk.

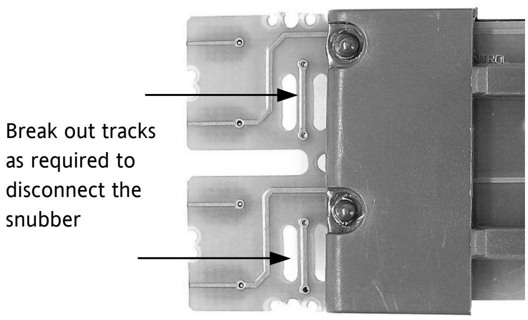
1.7.9 Snubbers

Snubbers are used to prolong the life of relay contacts and to reduce interference when switching inductive devices such as contactors or solenoid valves. The fixed relay (terminals AA/AB/AC) is not fitted internally with a snubber and it is recommended that a snubber be fitted externally, as shown in the example wiring diagram. If the relay is used to switch a device with a high impedance input, no snubber is necessary.

All relay modules are fitted internally with a snubber since these are generally required to switch inductive devices. However, snubbers pass 0.6mA at 110V and 1.2mA at 230Vac, which may be sufficient to hold on high impedance loads. If this type of device is used it will be necessary to remove the snubber from the circuit.

The snubber is removed from the relay module as follows:-

1. Unplug the controller from its sleeve
2. Remove the relay module
3. Use a screwdriver or similar tool to snap out the track. The view below shows the tracks in a Dual Relay Output module.



1.8 Getting Started

A brief start up sequence consists of a self test in which all elements of the display are illuminated and the software version is shown. What happens next depends on one of two conditions;-

1. Power up out of the box – when the controller has no preset configuration and is switched on for the very first time it will start up in 'QuickStart mode. This is an intuitive tool for configuring the controller and is described in section 1.9 below.
2. The controller has been powered up previously and is already configured. In this case go to section 1.11.

1.9 Quick Start - New Controller (Unconfigured)

When the controller is switched on for the very first time it will display the 'Startup' screen shown below.

* Manual mode is always selected when in Quick Start mode because the controller resets to cold start when Quick Start is selected.

Controller Display 3504 3508

1.9.1 To Configure Parameters in Quick Start Mode

Press ▲ or ▼ to select Quick Start Mode or Configuration Mode. **'Config'** will allow you to enter full configuration mode, covered in detail in later sections of this handbook.

Press ⟳ to scroll through the list of parameters

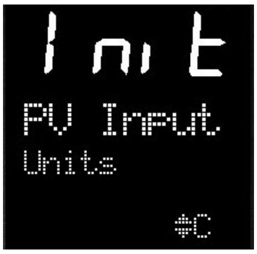
Edit the parameters using the ▲ or ▼ buttons

Each time ⟳ button is pressed a new parameter will be presented

This is illustrated by the following example:- (The views shown are taken from the 3508 controller but the same information is included in the 3504).

☺ Backscroll – to scroll back through parameters press and hold ⟳ then press ▲ to go back through the list of parameters. You can also press and hold ⟳ + ▼ to go forward - this has the same effect as pressing ⟳ alone.

Example

Do This	Display	Additional Notes
1. From the Start view press 2. Press or to change the **'Units'** 3. A different parameter is selected each time is pressed.		The first parameter to be configured is **'Units'**. It resides in the '**PV Input List'** because it is associated with the process variable. When the required choice is selected a brief blink of the display indicates that it has been accepted
4. Continue setting up the parameters presented until the **'Finished'** view is displayed. 5. If all parameters are set up as required press or to **'Yes'**		If you wish to scroll around the parameters again do not select Yes but continue to press . When you are satisfied with the selections select 'Yes'. The display will then show the 'HOME' display shown in section 1.11.

The following table summarises all the parameters which can be set up by the above procedure.

1.9.2 Quick Start Parameters

Parameters shown in **Bold** are defaults.

Group	Parameter	Value	Availability
PV Input	Units Used to select the engineering units for the PV	**C**, F, K V. mV, A, mA, pH, mmHg, psi, Bar, mBar, %RH, %, mmWG, inWG, inWW, Ohms, PSIG, %O2, PPM, %CO2, %CP, %/sec, mBar/Pa/T, sec, min, hrs, None	Always
PV Input	Resolution Used to select the required decimal point position for the PV	**XXXXX**, XXXX.X, XXX.XX, XX.XXX, X.XXXX	Always
PV Input	Range Type Used to select the linearisation algorithm required and the input sensor.	Thermocouple: J, **K**, L, R, B, N, T, S, PL2, C. RTD: Pt100 Linear: 0-50mV, 0-5V, 1-5V, 0-10V, 2-10V, 0-20mA, 4-20mA	Always
PV Input	Range High Configures the maximum display range and SP limits	Depends on Range type selected. Default **1200**	Always
PV Input	Range Low Configures the minimum display range and SP limits	Depends on Range type selected. Default **0**	Always
Loop	Control Channel 1 Sets the control type for channel 1 (normally Heat)	**PID,** VPU, VPB, Off, OnOff	Always
Loop	Control Channel 2 Sets the control type for channel 2 (normally Cool)	PID, VPU, VPB, **Off,** OnOff	Always
LgcIO LA	Logic OP (or IP) function The LA Logic I/O port can be an output or an input. This parameter is used to select its function.	**Not Used,** Chan 1, Chan 2, Alarm 1 to 8, Any Alarm, New Alarm, ProgEvnt1 to 8, (outputs) Auto Man, AlarmAck, ProgRun, ProgReset, ProgHold (Inputs)	[Note 1] [Note 2]
LgcIO LA	Min OnTime This applies to both LA and LB inputs	**Auto** 0.01 to 150.00	Only appears if Control Channel = VPB and the channel is allocated to the LA output [Note 2]
LgcIO LB	Logic OP (or IP) function The LB Logic I/O port can be an output or an input. This parameter is used to select its function.	**Not Used** All parameters the same as LA I/O	Only appears if Control Channel = VPB and the channel is allocated to the LB output [Note 2]
RlyOP AA	Relay function This relay is always fitted.	**Not Used,** Chan 1, Chan 2, Alarm 1 to 8, Any Alarm, New Alarm, ProgEvnt1 to 8	Always. [Note 3]

Note 1) Parameters only appear if the function has been turned on, eg If 'Control Channel 1' = 'Off', 'Chan 1' does not appear in this list. When a control channel is configured for valve positioning, LgcIO LA and LgcIO LB act as a complementary pair. If, for example, Chan 1 is connected to LgcIO LA (valve raise) then LgcIO LB is automatically set to Chan 1 (valve lower). This ensures the valve is never raised and lowered simultaneously.
The same complementary behaviour also applies to dual output modules and channels A and C of triple output modules

Note 2) If any input function, for example Chan 1, is connected to another input it will not appear in this list

Note 3) For valve position control Chan 1 or Chan 2 will not appear in this list. Valve position outputs can only be dual outputs such as LA and LB or dual relay/triac output modules

Modules

The following parameters configure the plug in I/O modules. I/O Modules can be fitted in any available slot in the instrument (6 slots in 3504, 3 slots in 3508). The controller automatically displays parameters applicable to the module fitted - if no module is fitted in a slot then it does not appear in the list.

Each module can have up to three inputs or outputs. These are shown as A, B or C after the module number and this corresponds to the terminal numbers on the back of the instrument. If the I/O is single only A appears. If it is dual A and C appears if it is triple A, B and C appear.

Module type	Parameter	Value	Availability
Change over relay (R4) **2 pin relay (R2)** **Triac output (T2)**	Relay (Triac) function	**Not Used** All parameters the same as RlyOP AA	Always (if the module is fitted)
Dual Relay (RR) **Dual triac output (TT)**	Relay (Triac) function	**Not Used** All parameters the same as RlyOP AA	Always (if the module is fitted)
	Relay function	**Not Used** All parameters the same as RlyOP AA	Always (if the module is fitted)
Single Logic Output (LO)	Logic Out function	**Not Used** All parameters the same as RlyOP AA	Always (if the module is fitted)
Triple Logic Output (TP)	Logic OP function	**Not Used** All parameters the same as RlyOP AA	Always (if the module is fitted)
DC Output (D4) **DC Retransmission (D6)**	DC Output function	**Not Used** – Module fitted but not configured Chan 1 – Channel 1 control output Chan 2 – Channel 2 control output SP Retran – Setpoint retransmission PV Retran – Process variable retransmission ErrRtran – Error Retransmission PwrRtran – Power output retransmission	Always (if the module is fitted)
	Range Type	**0–5V,** 1-5V, 1–10V, 2–10V, 0-29mA, 4-20mA	
	Display High	**100.0**	
	Display Low	**0**	
Triple Logic Input (TL) **Triple Contact Input (TK)**	Logic Input function	**Not Used** – Module fitted but not configured Auto Man – Auto/manual AltSP Sel – Alternative SP select AlarmAck – Alarm acknowledge ProgRun – Programmer run ProgReset – Programmer reset ProgHold – Programmer hold	A function can only be allocated to one input. eg if AlarmAck is configured on X*A it is not offered for the other inputs * is the module number
Analogue Input (AM)	Analogue IP function	**Not Used** – Module fitted but not configured Loop PV – Loop process variable Remote SP – Remote setpoint RemOPH – Remote output power maximum RemOPL – Remote output power minimum ch1VlvPos, ch2VlvPos – To read valve position from feedback potentiometer	ch1VlvPos and ch2VlvPos only appear if the control channel 1 or control channel 2 is set to VPB. Remote SP does not appear if the programmer option is supplied

Module type	Parameter	Value		Availability
	Range Type	Thermocouple: J, **K**, L, R, B, N, T, S, PL2, C. RTD: Pt100 Linear: 0-50mV, 0-5V, 1-5V, 0-10V, 2-10V, 0-20mA, 4-20mA		Not shown if analogue IP function not used
	Display High	**100.0**		These parameters only appear for Range Type = Linear
	Display Low	**0.0**		
Potentiometer Input (VU)	Pot Input function	**Not Used** Loop PV Remote SP RemOPH RemOPL Ch1VlvPos Ch2VlvPos	Module fitted but not configured Loop process variable Remote setpoint Remote output power maximum Remote output power minimum Channel 1 valve position Channel 1 valve position	Ch1VlvPos/Ch2VlvPos only appear if the channel = VPB Remote SP does not appear if the programmer option is supplied
Transducer Power Supply (G3)	TdcrPSU function	**5 Volts** 10 Volts		Always (if the module is fitted)
Transmitter power supply (M5)	No parameters. Used to show the ID of the module if fitted			

Alarms

Group	Parameter	Value		Availability
Alarm 1 to 8	Type	**None** Abs High Abs Low Dev High Dev Low Dev Band	No alarm type configured Absolute high Absolute low Deviation high Deviation low Deviation band	Always
Alarm 1 to 8	Source	**None** PV Input Loop PV ModX Ip	Not connected Connected to process variable Connected to loop process variable for deviation alarms Connected to a suitable module eg Analog IP (X = module number)	Always if Type ≠ None PV Input and ModX Ip do not appear if Type = Deviation
Alarm 1 to 8	Setpoint	To adjust the alarm threshold within the range of the source.		Always if Type ≠ None
Alarm 1 to 8	Latch	**None** Auto Manual Event	No latching Automatic latching see section 1.15.1 Manual latching see section 1.15.1 Alarm beacon does not light but any output associated with the event will activate and a scrolling message will appear.	Always if Type ≠ None

Finished	Exit	**No** Yes	Continue back around the quick configuration list Go to normal operation	

1.10 To Re-enter Quick Start Mode

If you have exited from Quick Start mode (by selecting 'Yes' to the 'Finished' parameter) and you need to make further changes, the Quick start mode can be entered again at any time. The action which takes place depends on one of two previous conditions as follows:-

1.10.1 Power up After a Quick Start Configuration

1. Hold down then power up the controller. Keep this button pressed until the Quick start screen as shown in section 1.9 is displayed.
2. Press to enter the quick start list. You will then be asked to enter a passcode.
3. Use or to enter the passcode – default 4 – the same as the configuration level passcode. If an incorrect code is entered the display reverts to the 'Quick Start' view section 1.9.

It is then possible to repeat the quick configuration as described previously.

The Quick Start view shown in section 1.9 now contains an additional parameter - **'Cancel'**. This is now always available after a power up, and, if selected, will take you into normal operating mode, section 1.11.

1.10.2 Power up After A Full Configuration

Repeat 1,2 and 3 above.

Full configuration allows a greater number of parameters to be configured in a deeper level of access. This is described later in this handbook.

If the controller has been re-configured in this level, a **'WARNING'** message, **'Delete config?'** - **'No'** or **'Yes'**, will be displayed. If 'No' is selected the display drops back to the 'GoTo' screen.

1. Use or to select 'Yes'
2. Press to confirm or to cancel. (If no button is pressed for about 10 seconds the display returns to the WARNING message).

If 'Yes' is selected the **Quick start defaults** will be re-instated. It is then necessary to reset **all** the Quick start parameters.

1.11 Normal Operation

Switch on the controller. Following a brief self-test sequence, a new controller will start up in AUTO mode and Operator Level 1. This section describes the operation of the controller in this level – further levels of operation are given in subsequent sections.

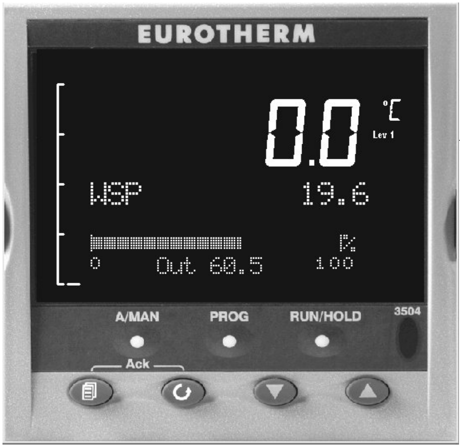
AUTO is the normal closed loop temperature control mode which means that the output power is adjusted automatically by the controller in response to the measurement from the input sensor. In this mode the format of the display for a new instrument is shown below. It is called the HOME display.

Indicator beacons (listed below)

Process Variable (PV)

Setpoint (SP)

Message display



Current level of access indication shown 3504 only

Lev1

Lev2

Lev3

3508 **3504**

1.11.1 Beacon Display and Description

OP1	Illuminates when output 1 is ON (normally heating)
OP2	Illuminates when output 2 is ON (normally cooling or alarm)
MAN	Illuminates when manual mode active
REM	Illuminates when remote setpoint active
SPX	Illuminates when alternative setpoint active
ALM	If an alarm occurs the red alarm beacon flashes. This is accompanied by a message showing the source of the alarm, for example 'Boiler overheating'. To acknowledge press and . The message disappears. If the alarm condition is still present the beacon lights continuously. When cleared it will extinguish. A full description of the alarm operation is given in section 1.15.
RUN	Illuminates when programmer running – flashing indicates End
HLD	Illuminates when programmer held
J	Flashes when J Channel comms active
H	Flashes when H Channel comms active
IR	Flashes when infra red communications active

In general throughout this handbook instrument views will use the 3504. The displayed information is similar for the 3508 but in some cases is shortened due to display limitations.

1.12 The Operator Buttons

Page Scroll Lower Raise

A/MAN This button can be disabled	Manual operation means that the controller output power is adjusted by the user. The input sensor is still connected and reading the PV but the control loop is open. When pressed, this toggles between automatic and manual operation. • If the controller is in manual mode, 'MAN' light will be indicated If the controller is powered down in Manual operation it will resume this mode when it is powered up again.
PROG	To select the programmer summary page
RUN/HOLD This button can be disabled	• Press once to start a program. 'RUN' will be indicated • Press again to hold a program. 'HLD' will be indicated • Press and hold for at least two seconds to reset a program. 'RUN' will flash at the end of a program 'HLD' will flash during holdback Programmer operation is fully described in Chapter 21
	Press to select new PAGE headings
	Press to select a new parameter in the page
	Press to decrease an analogue value, or to change the state of a digital value
	Press to increase an analogue value, or to change the state of a digital value

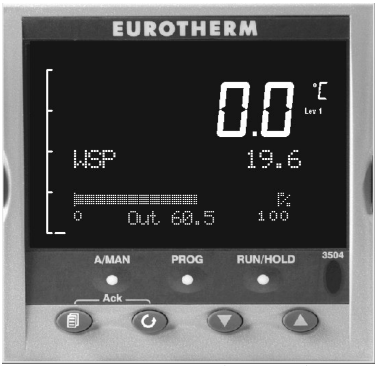
1.12.1 Shortcut Key Presses

Backpage	Press and hold . Then press . The page headers scroll backward at each press. (With still pressed you can press to page forward. This action is the same as pressing alone).
Backscroll	Press and hold when in a list. Then press . Parameters scroll backward at each press. Press and hold when in a list header. Then press. . Parameters scroll forward at each press.
Jump to the HOME display	Press +
Alarm Ack/reset	Press + when the HOME screen is being displayed. All active alarms will be acknowledged

1.13 To Set The Required Temperature (Setpoint)

From the HOME display, press ▲ or ▼ button.

3504 View



3508 View

WSP is the current Working SetPoint.

When the ▲ or ▼ button is pressed the mnemonic changes to the setpoint source, e.g. SP1

Setpoint Value

Press and hold ▼ to lower the setpoint

Press and hold ▲ to raise the setpoint

A momentary press of either button will show the setpoint in use eg SP1.

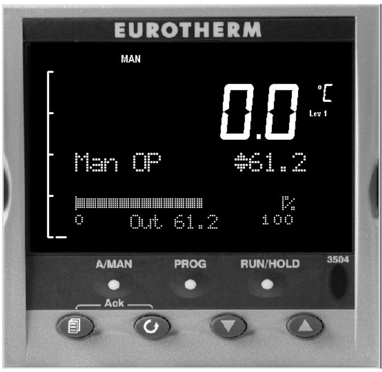
The new setpoint is accepted when the button is released and is indicated by a brief flash of the setpoint display

1.14 To Select Manual Operation

Press  button.

'Man OP' will be displayed

3504 View



3508 View

Upper display shows Actual Temperature (or Process Variable 'PV')

Lower display shows output power

Press and hold ▼ to lower the output power

Press and hold ▲ to raise the output power

The output power will change continuously while either of these buttons are pressed

If the controller is powered down in either Auto or Manual operation it will resume the same mode when it is powered up again.

1.15 Alarm Indication

If an alarm occurs it is indicated as follows:-

The red alarm (ALM) beacon in the top left of the display flashes

Alarm number is indicated together with the flashing 🔔

A default message or a pre-programmed message appears showing the source of the alarm

Invitation to acknowledge the new alarm

1.15.1 To Acknowledge an Alarm

Press ⊜ and ⊙ **(Ack)** together.

The action, which now takes place, will depend on the type of latching, which has been configured

Non Latched Alarms

If the alarm condition is present when the alarm is acknowledged, the alarm beacon will be continuously lit. This state will continue for as long as the alarm condition remains. When the alarm condition disappears the indication will also disappear.

If a relay has been attached to the alarm output, it will de-energise when the alarm condition occurs and remain in this condition until the alarm is acknowledged **AND** it is no longer present.

If the alarm condition disappears before it is acknowledged the alarm indication disappears as soon as the condition disappears.

Automatic Latched Alarms

The alarm continues to be active until both the alarm condition is removed AND the alarm is acknowledged. The acknowledgement can occur **BEFORE** the condition causing the alarm is removed.

Manual Latched Alarms

The alarm continues to be active until both the alarm condition is removed AND the alarm is acknowledged. The acknowledgement can only occur **AFTER** the condition causing the alarm is removed.

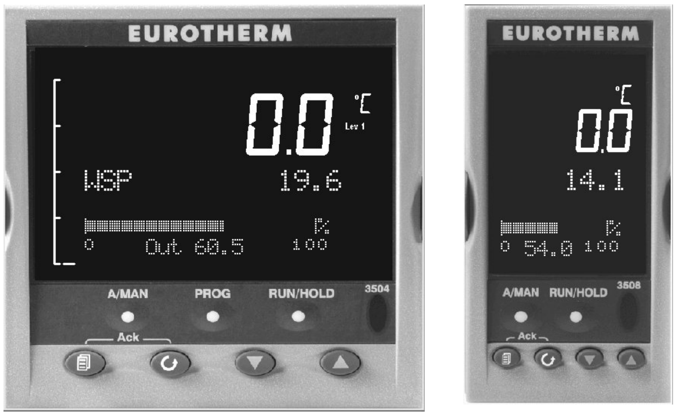
1.16 Message Centre

The lower section of the HOME display contains an alpha-numeric set of messages. These messages change between different controller types and operating modes and are grouped in summary pages. The 3504 contains more information than the 3508, and generally the parameter descriptions are longer due to the larger display.

1.16.1 Summary Pages

Press ⊜. A set of pre-defined summary pages are shown at each press. These are typically a summary of programmer, loop and alarm operation. A further eight customised pages are also possible and these can be programmed off line using iTools programming software.

3504 **3508**



Press ⊜

At each press a new page will be shown

Loop Summary

This view shows heat only.

For **heat/cool** the bar graph is bi-directional (± 100%)

For **valve position** control the user interface will display either heat only or heat/cool summary pages.

Programmer Summary

This display is only shown if the Programmer option has been enabled

Alarm Summary

Alarm Settings

All configured alarms will be listed

Control

Transducer

This display is only shown if the Transducer option has been enabled. See Chapter 23 for transducer calibration

1.16.2 How to Edit Parameters

In the above summary pages, press to scroll to further parameters (where applicable).

Press or to change the value of the parameter selected.

Any parameter preceded by ⬍ is alterable provided the system is in a safe state to allow the parameter to be changed. For example, 'Program Number' cannot be changed if the program is running - it must be in 'Reset' or 'Hold' mode. If an attempt is made to alter the parameter its value is momentarily replaced by '---' and no value is entered.

Some parameters are protected under a higher level of security – Level 2. In these cases it will be necessary to select 'Access Level 2'. This is carried out as follows:-

1. Press and hold until the display shows

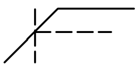
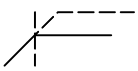
2. Press to select Level 2
3. Press again to enter a security code. This is defaulted to 2. If an incorrect code is entered the display reverts to that shown in 1 above. If the default of 2 is not accepted this means that the code has been changed on your particular controller. It will be necessary to refer to the Access level chapter 2.
4. 'Pass' is displayed momentarily. You are now in Level 2.

1.16.3 Programmer Summary Page

Provided it has been ordered and enabled the 3500 series controllers can program the rate of change of setpoint. Up to 50 programs and up to a maximum of 200 segments can be stored and run. Chapter 21 explains setpoint programming in more detail.

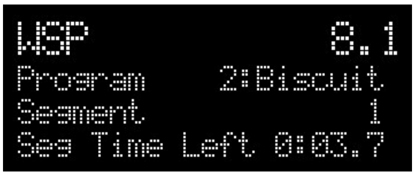
1.16.3.1 To Select a Parameter

Press ⟳ to scroll through a list of parameters. On the 'Programmer Summary' shown here, the list of parameters which can be selected are:-

Parameter Name	Parameter Description	Value		Default	Available in Level
Program	Program number (and name if this has been configured)	1 to max number of programs		1	Lev 1 Alterable when prog in reset
Segment	Segment number (and type on 3504) Only appears when the programmer is running	1 to max number of segments		1	Lev 1
Seg Time Left	Segment Time Left Only appears when the programmer is running	hrs:mins:secs		Read only	Lev 1
Status	Program Status	End Run Hold Holdback	Prog ended Prog running Prog held In holdback		Lev 1
PSP	Profile setpoint value	Can be changed in Hold			Lev 1
Cycles Left	Number of repeat cycles left to run Can only be changed in Hold or Reset	1 to maximum number of cycles set			Lev 1 R/O in Run
Advance 	Sets the program setpoint equal to the target setpoint and moves to the next segment. Only operates when the programmer is running (not in Hold)	No Yes	This is a momentary action	No	Lev 1
SkipSeg 	Moves immediately to the next segment and starts from the current setpoint value. Only operates when the programmer is running (not in Hold)	No Yes	This is a momentary action	No	Lev 1
Fast Run	This is only available in level 3 as described in later chapters. Set to 'Yes' and then run the program. The programmer will run through the segments at a fast rate. It is intended to be used only to test a new program and should not be used on an active process	No Yes	Fast run disabled Fast run enabled		Lev 3
Events or Rst Events	State of the event outputs when the program is running or when in reset	☐ Event inactive ■ Event active			Lev 1
Prg. TimeLeft	Time remaining to end of selected program	hrs:mins:secs			Lev 1

1.16.3.2 To Select and Run a Program

In this example it is assumed that the program to be run has already been entered. Setpoint programming is described in detail in Chapter 21 of the Engineering Handbook.

Do This	The Display You Should See	Additional Notes
1. From any display press until the 'Programmer User Display' is shown		
2. Press to **'Program'** 3. Press or to choose the program number to be run		In this example Program Number 2 is chosen and has been given a user defined name. In the 3504 Program names can be entered using the off-line programming package 'iTools'.
4. Press		'RUN' is displayed in the indicator beacons section of the main display. The view shown here shows current working setpoint, program being run, current segment number and time left to complete this segment.
5. To Hold a program press		Press again to continue the program. When the program is complete 'RUN' will flash
6. To Reset a program press for at least 3 seconds		'RUN' will extinguish and the controller will return to the HOME display shown in section 1.10.

An alternative way to run, hold or reset the program is to scroll to 'Program Status' using and select 'Run', 'Hold' or 'Reset' using or

1.16.4 Alarm Summary Page

This page shows a summary of all analogue alarms. Press ⟳ to scroll through the alarms.

The diagram illustrates that an alarm is present in the system but that none of the alarms need acknowledgement.

A New Alarm occurs when any new alarm becomes active. This parameter may be used to activate a relay output to provide external audible or visual indication.

1.16.5 Alarms Setting Page

Up to eight analogue alarms can be configured. The alarm thresholds can be set in Level 2 in this page.

Press ⟳ to scroll through the alarms.

Press ▲ or ▼ to set the threshold values

Analogue alarm 1, configured as Absolute High and set to operate at 123.00

Analogue alarm 2, configured as Absolute Low and set to operate at -10.00

1.16.6 Control Summary Page

Parameters which define the way a control loop operates can be set in this page. Control parameters are further described in Chapter 20.

Press ⟳ to scroll through a list of parameters.

Press ⏶ or ⏷ to change the value of the selected parameter.

On the Control Summary page the following parameters are available:-

Parameter Name	Parameter Description	Value	Default	Available in Level
SP Select	To select SP1 or SP2	Between range limits set in higher levels of access	As order code	Lev 1
SP1	To set the value of SP1			Lev 1
SP2	To set the value of SP2			Lev 1
SP Rate	To set the rate at which the setpoints change			Lev 1 alterable in Lev 2
Tune [1]	To start self tuning	Off On	Off	
PB [1]	To set proportional band	0 to 99999		
Ti [1]	To set integral time	Off to 99999		
Td [1]	To set derivative time	Off to 99999		
R2G [1]	To set relative cool gain	0.1 to 10.0		
CBH [1]	To set cut back high	Auto to 99999		
CBL [1]	To set cut back low	Auto to 99999		
Output Hi	To set a high limit on the control output	-100.0 to 100.0%	100.0	
Output Lo	To set a low limit on the control output	-100.0 to 100.0%	0.0	
Ch1 OnOff Hyst	Channel 1 hysteresis (Only if configured for On/Off control)	0.0 to 200.0		
Ch2 OnOff Hyst	Channel 2 hysteresis (Only if channel 2 is configured and for On/Off control)	0.0 to 200.0		
Ch2 DeadB	Channel 2 deadband. To set the period in which there is no output from either channel. (This does not appear if channel 2 is not configured)	Off to 100.0		
Ch1 TravelT	Motor travel time if valve control output on channel 1	0.0 to 1000.0 seconds		
Ch1 TravelT	Motor travel time if valve control output on channel 1	0.0 to 1000.0 seconds		
Safe OP	To set an output level under sensor break conditions	-100.0 to 100.0%	0.0	

[1] Does not appear if control is configured for On/Off parameters

2. CHAPTER 2 ACCESS TO FURTHER PARAMETERS

Parameters are available under different levels of security defined as Level 1, Level 2, Level 3 and Configuration Level. Level 1 has no security password since it contains a minimal set of parameters generally sufficient to run the process on a daily basis. Level 2 allows parameters, such as those used in commissioning a controller, to be adjusted. Level 3 and Configuration level parameters are also available as follows:-

2.1.1 Level 3

Level 3 makes all operating parameters available and alterable (if not read only)

Examples are:-

Range limits, setting alarm levels, communications address.

The instrument will continue to control when in Levels 1, 2 or 3.

2.1.2 Configuration Level

This level makes available all parameters including the operating parameters so that there is no need to switch between configuration and operation levels during commissioning. It is designed for those who may wish to change the fundamental characteristics of the instrument to match the process.

Examples are:-

Input (thermocouple type); Alarm type; communications type.

WARNING

Configuration level gives access to a wide range of parameters which match the controller to the process. Incorrect configuration could result in damage to the process being controlled and/or personal injury. It is the responsibility of the person commissioning the process to ensure that the configuration is correct.

In configuration level the controller is not controlling the process or providing alarm indication. Do not select configuration level on a live process.

Operating Level	Home List	Full Operator	Configuration	Control
Level 1	✓			Yes
Level 2	✓			Yes
Level 3	✓	✓		Yes
Configuration	✓	✓	✓	No

2.1.3 To Select Different Levels of Access

<table>
<tr><th>Do This</th><th>The Display You Should See</th><th>Additional Notes</th></tr>
<tr><td>1. From any display press and hold ⎗</td><td>
</td><td>After a few seconds the display will show Goto ⇕ Level 1.

If no button is pressed for about 2 minutes the display returns to the HOME display.

This is a view for the 3504, and shows additional parameters in the list. The 3508 shows these parameters one at a time

In either controller, press ↻ to scroll through the list of parameters</td></tr>
<tr><td>2. Press ▲ or ▼ to choose different levels of access</td><td>

⇓

</td><td>The choices are:

Level 1

Level 2

Level 3

Configuration</td></tr>
<tr><td>3. Press ▲ or ▼ to enter the correct code for the level chosen</td><td>

⇓

</td><td>The default codes are:<table><tr><td>Level 1</td><td>None</td></tr><tr><td>Level 2</td><td>2</td></tr><tr><td>Level 3</td><td>3</td></tr><tr><td>Configuration</td><td>4</td></tr></table>If an incorrect code is entered the display reverts to the previous view.</td></tr>
<tr><td>4. The controller is now in configuration level in this example</td><td>
</td><td>Press ⎗ to scroll through the list headers in the chosen level starting with Access List. The full list of headers is shown in the Navigation Diagram, section 3.1.2.</td></tr>
<tr><td>5. To return to a lower level, press and hold (if necessary) ⎗ to return to the Access Page

6. Press ▲ or ▼ to select the level</td><td>
</td><td>It is not necessary to enter a code when going from a higher level to a lower level.

When Level 1 is selected the display reverts to the HOME display

Do not power down while the controller is changing levels. If a power down does occur an error message – EConF – will appear – see also section 11.6 'Diagnostic Alarms'</td></tr>
</table>

☺ A special case exists if a security code has been configured as '0' If this has been done it is not necessary to enter a code and the controller will enter the chosen level immediately.

☺ When the controller is in configuration level the ACCESS list header can be selected from any view by pressing ⎗ and ↻ together.

☺ An alternative way to access configuration level is to power up the instrument with ▲ and ▼ buttons pressed. You will then be asked to enter the security code to take you to configuration level.

2.2 Access Parameter List

The following table summarises the parameters available under the Access list header

List Header - Access		Sub-headers: None			
Name	**Parameter Description**	**Value**		**Default**	**Access Level**
Goto	To select different levels of access. Passcodes prevent accidental edit	Lev.1 Lev.2 Lev.3 Config	Operator mode level 1 Operator mode level 2 Operator mode level 3 Configuration level	Lev.1	L1
Level2 Code *	To customise the passcode to access level 2	0 to 9999		2	Conf
Level3 Code *	To customise the passcode to access level 3	0 to 9999		3	Conf
Config Code *	To customise the passcode to access configuration level	0 to 9999		4	Conf
IR Mode	To activate/de-activate the front panel InfraRed port. This is normally deactivated. The IR port is used to link the instrument to a PC and may be used for configuring the instrument using iTools when a digital comms link is not available. It requires an IR clip, available from Eurotherm, to link your Instrument to a PC.	Off On	Inactive Active	Off	Conf
A/Man Func	This enables or disables the front panel A/MAN button	On Off	Enabled Disabled	On	Conf
Run/Hold Func	This enables or disables the front panel RUN/HOLD button	On Off	Enabled Disabled	On	Conf
Customer ID	To set an identification number for the controller	0 to 9999		0	Conf
Keylock	When set to 'All' no front panel key is active. This protects the instrument from accidental edits during normal operation. To restore access to the keyboard from operator levels you must power up the instrument with the ▲ and ▼ buttons pressed. This will take you directly to the configuration level password entry.	None All	Front panel keys active All Edits and Navigation are prevented.	None	Conf
Standby	Set to 'Yes' to select standby mode. In standby all control outputs are set to zero. The controller automatically enters standby mode when it is in Configuration level or during the first few seconds after switch on.	No Yes		No	Conf

The format of this table is used throughout this manual to summarise all parameters in a list.

The title of each table is the list header.

Column 1 shows the mnemonic (Name) of the parameter as it appears on the display

Column 2 describes the meaning or purpose of the parameter

Column 3 the value of the parameter

Column 4 a description of the enumeration

Column 5 the default value set when the controller is first delivered

Column 6 the access level for the parameter. If the controller is in a lower access level the parameter will not be shown

*** When changing passwords please make a record the new password**

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3. CHAPTER 3 FUNCTION BLOCKS

The controller software is constructed from a number of ‘function blocks’. A function block is a software device which performs a particular duty within the controller. It may be represented as a ‘box’ which takes data in at one side (as inputs), manipulates the data internally (using parameter settings) and ‘outputs’ the data. Some of these parameters are available to the user so that they can be adjusted to suit the characteristics of the process which is to be controlled.

A representation of a function block is shown below.

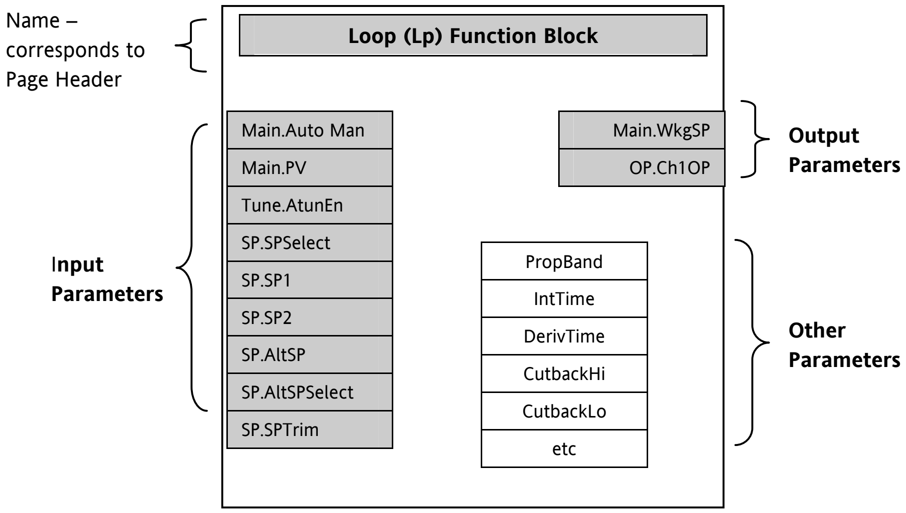


Figure 3-1: Example of a Function Block

In the controller, parameters are organised in simple lists. The top of the list shows the list header. This corresponds to the name of the function block and is generally presented in alphabetical order. This name describes the generic function of the parameters within the list. For example, the list header **‘AnAlm’** contains parameters which enable you to set up analogue alarm conditions.

3.1 To Access a Function Block

Press the Page button until the name of the function block is shown in the page header.

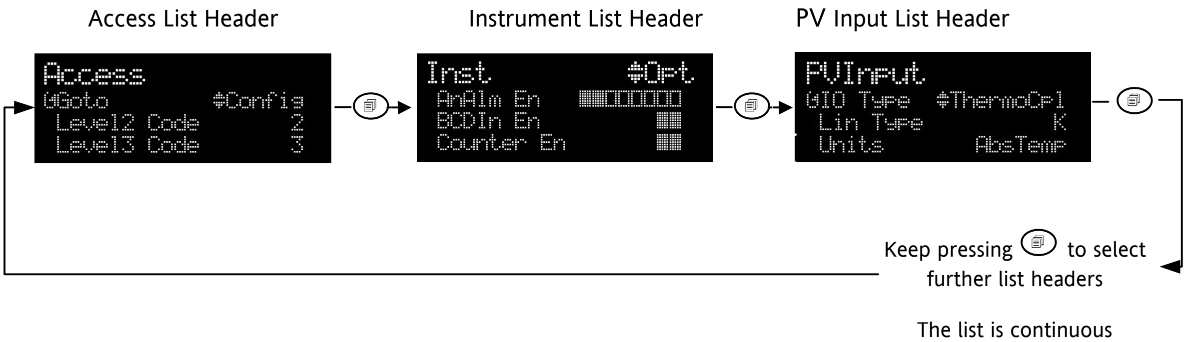
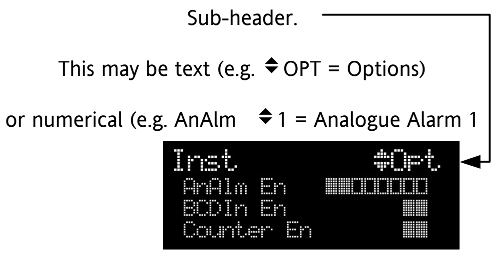


Figure 3-2: Parameter List Headings

3.1.1 Sub-Lists or Instances

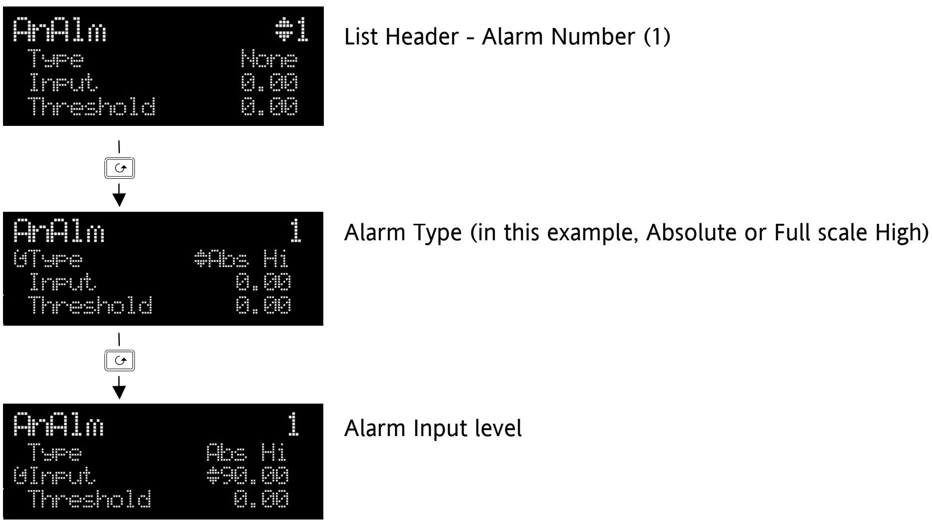
In some cases the list is broken down into a number of sub-headers to provide a more comprehensive list of parameters. An example of this is shown above for the Instrument List. The sub-header is shown in the right hand corner. To select a different sub-header press or



3.1.2 To Access a Parameters in a Function Block

Press the scroll button until the required parameter is located.

Each parameter in the list is selected in turn each time this button is pressed. The following example shows how to select the first two parameters in the Alarm List. All parameters in all lists follow the same format.



Press for further parameters. This list is continuous and will scroll back to the top of the list

OR

Press to jump back to the top of the list.

Figure 3-3: Parameters

3.1.3 To Change the Value of a Parameter

Press ⓐ or ⓥ to raise or lower the value of an analogue (numeric) parameter or to change the selection of enumerated parameter options.

Any parameter preceded by ⬍ is alterable provided the system is in a safe state to allow the parameter to be changed. For example, 'Program Number' cannot be changed if the program is running - it must be in 'Reset' mode. If an attempt is made to alter the parameter its value is momentarily replaced by '---' and no value is entered.

3.1.3.1 Analogue Parameters

When the raise or lower button is first depressed there is a single increment or decrement of the least significant digit. Either button can be held down to give a repeating action at an accelerating rate.

3.1.3.2 Enumerated Parameters

Each press of the raise or lower button changes the state of the parameter. Either button can be held down to give a repeating action but not at an accelerating rate. Enumerated parameters are allowed to wrap around.

3.1.3.3 Time Parameters

Time parameters start with a resolution of 0.1 second to 59:59.9	mm:ss.s	0:00.0
When 59:59.9 is reached the resolution becomes 1 second to 99:59:59	hh:mm:ss	1:00:00
When this limit is reached the resolution becomes 1 minute to 500:00	hhh:mm	100:00

3.1.3.4 Boolean Parameters

These are similar to enumerated parameters but there are only two states. Pressing either the raise or lower button causes the parameter to toggle between states.

3.1.3.5 Digital Representation Characters

Parameters whose values are used digitally (i.e. bitfields) are represented by:

■ - On State or

□ - Off State

A parameter may be represented by using any number of bits between 1 and 16 inclusive. Scrolling on to the parameter selects the leftmost bit, and subsequent scroll operations move the selected bit right by one. Backscroll may be used to move the selected bit towards the left. Raise and lower buttons are used to turn the selected bit on or off respectively.

3.2 Navigation Diagram

The diagram below shows all the function blocks available in the 3500 series controllers as list headings in configuration level. A function block will not be shown if it has not been enabled or ordered if it is a chargeable option. Select in turn using :-

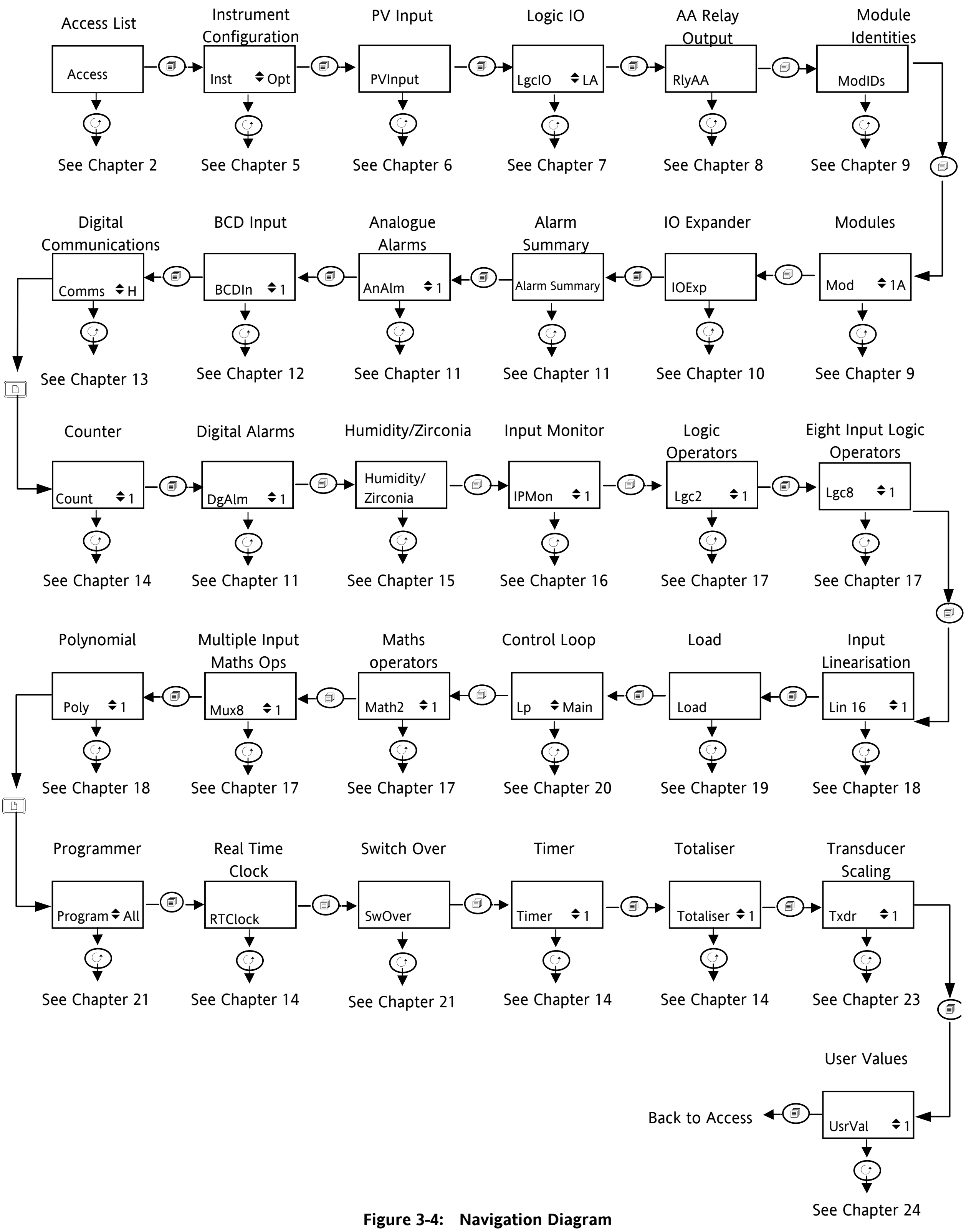


Figure 3-4: Navigation Diagram

4. CHAPTER 4 FUNCTION BLOCK WIRING

Input and output parameters of function blocks are wired together in software to form a particular instrument or function within the instrument. A simplified overview of how these may be interconnected to produce a single control loop is shown below.

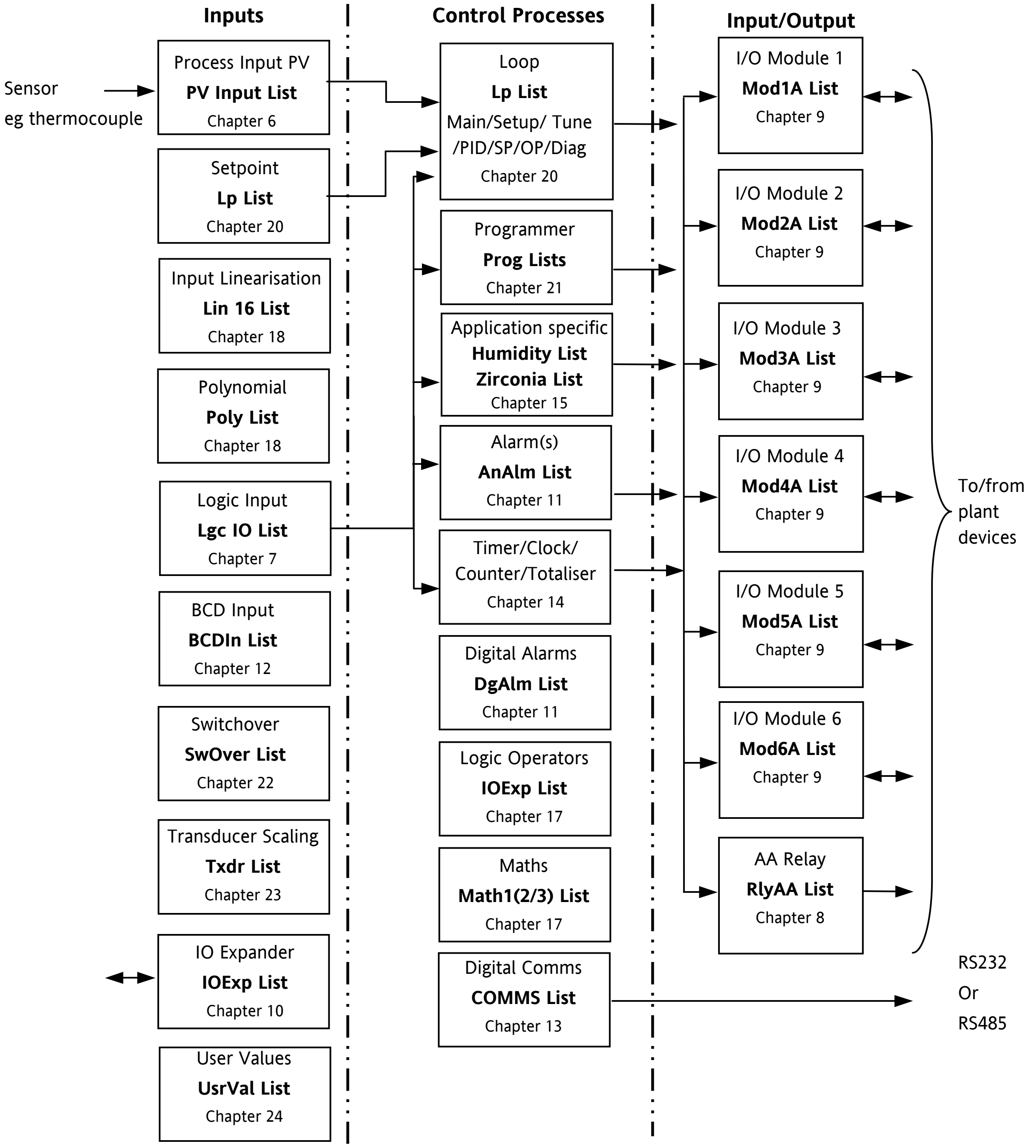


Figure 4-1: Controller Example

Function blocks are wired (in software) using the Quick Start mode and/or full configuration mode. In the controller example here, the Process Variable (PV) is measured by the sensor and compared with a Setpoint (SP) set by the user.

The purpose of the control block is to reduce the difference between SP and PV (the error signal) to zero by providing a compensating output to the plant via the output driver blocks.

The timer, programmer and alarms blocks may be made to operate on a number of parameters within the controller, and digital communications provides an interface to data collection and control.

The controller can be customised to suit a particular process by ‘soft wiring’ between function blocks. The procedure is described in the following sections.

4.1 Soft Wiring

Soft Wiring (sometimes known as User Wiring) refers to the connections which are made in software between function blocks. Soft wiring, which will generally be referred to as ‘Wiring’ from now on, is possible through the operator interface of the instrument. This is described in the next section but it is recommended that this method is only used if small changes are required, for example, when the instrument is being commissioned.

The preferred method of wiring uses the iTools configuration package since it is quicker and easier. Wiring using iTools is described in chapter 26.

4.1.1 Wiring Example

In general every function block has at least one input and one output. Input parameters are used to specify where a function block reads its incoming data (the ‘Input Source’). The input source is usually wired to the output from a preceding function block. Output parameters are usually wired to the input source of subsequent function blocks.

The value of a parameter which is not wired can be adjusted through the front panel of the controller provided it is not Read Only (R/O) and the correct access level is selected.

All parameters shown in the function block diagrams are also shown in the parameter tables, in the relevant chapters, in the order in which they appear on the instrument display (alphabetical).

Figure 4-2 shows an example of how the channel 1 (heat) output from the PID block might be wired to the logic output connected to terminals LA/LC.

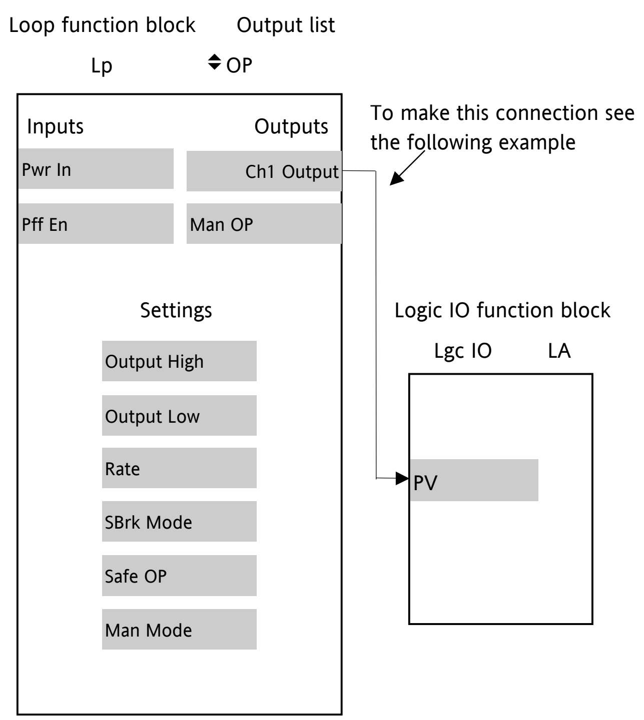


Figure 4-2: Function Block Wiring

4.1.2 Wiring Through the Operator Interface

The example shown in the previous section will be used.

Select configuration level as described in section 2.1.3. Then:-

Do This	The Display You Should See	Additional Notes
1. From any display press to locate the page in which the parameter is to be found. (In this example **'LgcIO'** page) 2. Press or if necessary to select a sub-header. (In this example **'LA'**) 3. Press to scroll to the parameter to be wired **TO**. (In this example **'PV'**)	 Indicates parameter selected	This locates the parameter you want to wire TO
4. Press A/MAN to display **'WireFrom'**		In configuration mode the A/MAN button is the Wire button.
5. Press (as instructed) to navigate to the list header which contains parameter you want to wire **FROM.**		You will also need to use or to select a sub-header, if appropriate, and to scroll to the parameter - in this example **'Ch1 Output'** in the **'Lp OP'** page
6. Press A/MAN		This 'copies' the parameter to be wired FROM
7. Press as instructed to confirm	 Indicates that the parameter is wired	This 'pastes' the parameter to 'PV'

4.1.3 To Remove a Wire

Do This	The Display You Should See	Additional Notes
8. Select the wired parameter eg LgcIO PV in the above example,		
9. Press A/MAN		This locates the parameter you want to wire TO
10. Press Ack to clear the **'WireFrom'** display		This is the quick way to select no wire. You can also select this by pressing repeatedly
11. Press A/MAN		
12. Press to OK		

4.1.4 Wiring a Parameter to Multiple Inputs

You can repeat the procedure given in section 4.1.2. but it is also possible to 'Copy' and 'Paste' a parameter. In configuration level the RUN/HOLD button becomes a copy function. The following example wires Ch1 Output to both LA and LB PV inputs.

Do This	The Display You Should See	Additional Notes
1. Select Ch1 Output	Lp OP Output Hi 100.0 Output Lo -100.0 Ch1 Output 0.0	
2. Press RUN/HOLD	LpOP Ch1 Output Copied	This copies channel 1 output
3. Select the parameter to wire to. In this case LgcIO LA PV	LgcIO LA IO Type Input Invert No PV 1	
4. Press A/MAN	WireFrom ----------------	
5. Press RUN/HOLD	WireFrom Lp OP Ch1 Output	
6. Press A/MAN	LpOP Ch1 Output →Cancel →OK	
7. Press ⟳ to OK	LgcIO LA IO Type Input Invert No PV 1	
8. Now repeat 3 to 8 but for LgcIO LB	LgcIO LB IO Type Input Invert No PV 1	

4.1.5 Wiring Using iTools

The recommended method of wiring is to use iTools.

A description of how iTools may be used for graphical wiring is given in Chapter 26.

4.1.6 Wiring Floats with Status Information

There is a subset of float values which may be derived from an input which may become faulty for some reason, e.g. sensor break, overrange, etc. These values have been provided with an associated status which is automatically inherited through the wiring. The list of parameters which have associated status is as follows:-

Block	Input Parameters	Output Parameters
Loop.Main	PV	PV
Loop.SP		TrackPV
Loop.OP	CH1PotPosition	
	CH2PotPosition	
Math2	In1	
	In2	
		Out
Programmer.Setup	PVIn	
Poly	In	
		Out
Load		PVOut1
		PVOut2
Lin16	In	
		Out
Txdr	InVal	
		OutVal
IPMonitor	In	
SwitchOver	In1	
	In2	
		Out
Total	In	
Mux8	In1..8	
		Out
Lgc2	In1	
	In2	
UsrVal	Val	Val
Humidity		RelHumid
		DewPoint
	WetTemp	
	DryTemp	
	PsychroConst	
	Pressure	
IO.MOD	A.PV, B.PV, C.PV	A.PV, B.PV, C.PV
IO.PV	PV	PV

Parameters appear in both lists where they can be used as inputs or outputs depending on configuration. The action of the block on detection of a 'Bad' input is dependent upon the block. For example, the loop treats a 'Bad' input as a sensor break and takes appropriate action; the Mux8 simply passes on the status from the selected input to the output, etc.

The Poly, Lin16, SwitchOver, Mux8, IO.Mod, and IO.PV blocks can be configured to act on bad status in varying ways. The options available are as follows:-

0: Clip Bad

The measurement is clipped to the limit it has exceeded and its status is set to 'BAD', such that any function block using this measurement can operate its own fallback strategy. For example, control loop may hold its output to the current value.

1: Clip Good

The measurement is clipped to the limit it has exceeded and its status is set to 'GOOD', such that any function block using this measurement may continue to calculate and not employ its own fallback strategy.

2: Fallback Bad

The measurement will adopt the configured fallback value which has been set by the user. In addition the status of the measured value will be set to 'BAD', such that any function block using this measurement can operate its own fallback strategy. For example, control loop may hold its output to the current value.

3: Fallback Good

The measurement will adopt the configured fallback value which has been set by the user. In addition the status of the measured value will be set to 'GOOD', such that any function block using this measurement may continue to calculate and not employ its own fallback strategy

4: Up Scale

The measurement will be forced to adopt its high limit. This is like having a resistive pull up on an input circuit. In addition the status of the measured value will be set to 'BAD', such that any function block using this measurement can operate its own fallback strategy. For example, the control loop may hold its output to the current value.

5: Down Scale

The measurement will be forced to adopt its low limit. This is like having a resistive pull down on an input circuit. In addition the status of the measured value will be set to 'BAD', such that any function block using this measurement can operate its own fallback strategy. For example, the control loop may hold its output to the current value.

4.1.7 Edge Wires

If the Loop.Main.AutoMan parameter was wired from a logic input in the conventional manner it would be impossible to put the instrument into manual from the front panel of the instrument. Other parameters need to be controlled by wiring but also need to be able to change under other circumstances, e.g. Alarm Acknowledgements. for this reason some Boolean parameters are wired in an alternative way. These are listed as follows:-

SET DOMINANT

When the wired in value is 1 the parameter is always updated. This will have the effect of overriding any changes through the front panel or through digital communications. When the wired in value changes to 0 the parameter is initially changed to 0 but is not continuously updated. This permits the value to be changed through the front panel or through digital communications.

Loop.Main.AutoMan

Programmer.Setup.ProgHold

Access.StandBy

RISING EDGE

When the wired in value changes from 0 to 1, a 1 is written to the parameter. At all other times the parameter is not updated by the wire. This type of wiring is used for parameters which start an action and when once completed the block clears the parameter. When wired to, these parameters can still be operated from the front panel or through digital communications.

Loop.Tune.AutotuneEnable

Programmer.Setup.ProgRun

Programmer.Setup.AdvSeg

Programmer.Setup.SkipSeg

Alarm.Ack

AlmSummary.GlobalAck

DigAlarm.Ack

Txdr.ClearCal

Txdr.StartCal

Txdr.StartHighCal

Txdr.StartTare

IPMonitor.Reset

Instrument.Diagnostics.ClearStats

BOTH EDGE

This type of edge is used for parameters which may need to be controlled by wiring or but should also be able to be controlled from the front panel or through digital communications. If the wired in value changes then the new value is written to the parameter by the wire. At all other times the parameter is free to be edited from the front panel or through digital communications.

Loop.SP.RateDisable

Loop.OP.RateDisable

Comms.BroadcastEnabled

4.1.8 Operation of Booleans and Rounding

4.1.8.1 Mixed Type Wiring

Parameters of function blocks are one of the following types shown below. Wires which connect one type to another cause a type conversion to occur. The values wired may also be rejected or clipped depending on type and limits.

BOOLEANs (including Edges)

Any value greater than or equal to 0.5 wired to a boolean (or edge) is considered true. When wired to other values booleans will be considered as 0 or 1.

INTEGER

Values outside the limits of the integer will be clipped to the limits.

ENUMERATED INTEGER

Values which are outside the limits of an enumerted parameter or do not have a defined enumeration will not be written.

BINARY INTEGER (PIANO KEYS)

A value which exceeds the number of bits used by the parameter will be rejected.

FLOAT

Values outside the limits of a float parameter will be clipped to the limits. Wiring from a float to any other type will be rounded to the nearest integer. Where the value falls half way between two integers it will be rounded towards the higher absolute value. I.e. -3.5 rounds to -4 and +3.5 rounds to +4.

TIME

Times can only be wired to or from other times or floats. When wired to or from floats the float value is in seconds.

STRING

String values can not be wired.

NOTE: In 3500 Firmware V1.12 and before floats were truncated, rather than rounded and booleans rejected any value but 0 or 1.

5. CHAPTER 5 INSTRUMENT CONFIGURATION

5.1 WHAT IS INSTRUMENT CONFIGURATION?

Instrument configuration allows you to:-

1. Enable controller options
2. Customise the display
3. Read information about the controller
4. Read internal diagnostics

5.2 To Select Instrument Configuration

Select Configuration level as described in Chapter 2.

The first view displayed is the header **‘Inst’** plus the sub-header ‘**⬍ Opt’.**

This allows you to enable or disable instrument options. The ‘⬍’ symbol indicates further sub-headers are available. To select these press ▲ or ▼.

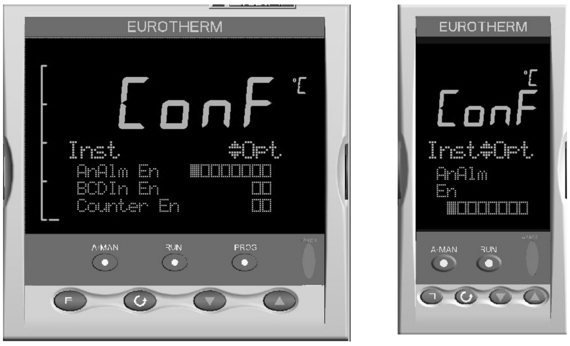


Figure 5-1: Instrument Configuration Displays

5.3 To Enable Controller Options

Options may be enabled or disabled. If the option is enabled a list header containing parameters applicable to the feature will be available as shown in the Navigation diagram, section 3.2. If the option is disabled the list header will not be shown, thus ensuring that only those parameters which are relevant to the application are displayed.

Chargeable options can only be enabled if they have been ordered.

1. Press ⟳ to scroll to the option required
2. Press ▲ or ▼ to edit the option. ☐ = Disabled ■ = Enabled

5.3.1 Options Available in the Instrument Configuration List

The following table lists the options which can be enabled in the controller:-

List Header: Inst		Sub-header: Opt		
Name ⟳ to select	**Parameter Description**	**Value** ▲ or ▼ to change	**Default**	**Access Level**
AnAlm En	Analogue alarms	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ All 8 analogue alarms disabled ■ ■ ■ ■ ■ ■ ■ ■ All 8 analogue alarms enabled		Conf
BCDIn En	BCD switch input	☐ ☐ Both inputs disabled ■ ■ Both inputs enabled		Conf
Counter En	Counters	☐ ☐ Both counters disabled ■ ■ Both counters enabled		Conf
DgAlm En	Digital alarms	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ All 8 digital alarms disabled ■ ■ ■ ■ ■ ■ ■ ■ All 8 digital alarms enabled		Conf
Humidity En	Humidity control	☐ Humidity block disabled ■ Humidity block enabled		Conf
IO Exp En	IO expander	☐ IO expander disabled ■ IO expander enabled		Conf
IP Mon En	Input monitor	☐ ☐ Both monitors disabled ■ ■ Both monitors enabled		Conf
Lgc2 En1 Lgc2 En2 Lgc2 En3	Logic operators	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ All 8 logic operators disabled ■ ■ ■ ■ ■ ■ ■ ■ All 8 logic operators enabled		Conf
Lgc8 En	Logic 8 operator	☐ ☐ Both operators disabled ■ ■ Both operators enabled		Conf
Lin16Pt En	Input linearisation	☐ ☐ Both input linearisation tables disabled ■ ■ Both input linearisation tables enabled		Conf
Load En	Load enable	☐ Load disabled ■ Load enabled	As order code	Conf
Loop En	Loop enable	☐ Control Loop disabled ■ Control Loop enabled	As order code	Conf
Math2 En1 Math2 En2 Math2 En3	Analogue (Maths) Operators	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ All 8 maths operators disabled ■ ■ ■ ■ ■ ■ ■ ■ All 8 maths operators enabled	As order code	Conf
Mux8 En	Multiplexor	☐ ☐ ☐ ☐ All four multiplexors disabled ■ ■ ■ ■ All four multiplexors enabled		Conf
Poly En	Polynomial linearisation block	☐ ☐ Both polynomials disabled ■ ■ Both polynomials enabled		Conf
Progr En	Programmer	☐ Programmer disabled ■ Programmer enabled		Conf
RTClock En	Real time clock	☐ Real time clock disabled ■ Real time clock enabled		Conf
SwOver En	Switch over block	☐ Switch over block disabled ■ Switch over block enabled		Conf
Timer En	Timers	☐ ☐ ☐ ☐ All four timers disabled ■ ■ ■ ■ All four timers enabled	As order code	Conf
Totalise En	Totalisers	☐ ☐ Both totalisers disabled ■ ■ Both totalisers enabled		Conf
TrScale En	Transducer scaling	☐ ☐ Both transducer inputs disabled ■ ■ Both transducer inputs enabled		Conf

UsrVal En1 UsrVal En1	User values	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ All 8 user values disabled ■ ■ ■ ■ ■ ■ ■ ■ All 8 user values enabled		Conf
ZirconiaEn	To enable the Zirconia function block. This is only available if ordered	☐ Zirconia block disabled ■ Zirconia block enabled		

Note:- The left most flag indicates the first instance e.g. Alarm1.

5.4 Display Formatting

The display which will shown in Operator levels 1 to 3 may be customised.

This is achieved in the **'Inst'** configuration list using the sub-header **'Dis'**.

5.4.1 To Customise the Display

The controller must be in Configuration level. Then:-

Do This	The Display You Should See	Additional Notes
1. Press ⊜ as many times as necessary until **'Inst'** is displayed 2. Press ⊕ or ⊖ to select **'Dis'**		If a parameter from, say, the previous display is being shown, then it will be necessary to press ⊜ to return to the top of the list
3. Press ⟳ to scroll to the first parameter - **'Home Page'** 4. Press ⊕ or ⊖ to change the selection		In operator level the instrument, by default, shows 'Loop' parameters in the HOME display. The HOME display may also show:- Program Programmer parameters Custx Up to 8 views may be customised Cust1 will select the first Access Access parameters
		The following table shows the full list of parameters available to customise the display ⇓

List Header: Inst		Sub-header: Disp			
Name ⊙ to select	**Parameter Description**	**Value** ▲ or ▼ to change		**Default**	**Access Level**
Units	Instrument temperature units as shown in the top right of the display	C F K	° Celsius ° Fahrenheit Kelvin		L3
Home Page	Configures which set of parameters are shown in the message display of the HOME view when the controller is in operator level.	Loop Program Custom 1 to 8 Access	Loop summary Program summary Customised Access	Loop	Conf
Home Timeout	In operator level the controller can be made to revert to the HOME display after a fixed time following selection of other pages	Off to 0:01 to 1:00 hr	Off = the controller will not revert to the HOME display	0:01 (1 min)	Conf
Loop Summary	A summary of the Loop parameters are displayed in the message centre (section 1.16.) in the selected operating level	On Off	Enabled Disabled	On	Conf
Prog Summary	A summary of the Program parameters are displayed in the message centre (section 1.16.) in the selected operating level	On Off	Enabled Disabled	On	Conf
Alarm Summary	Enables/disables the alarm summary page in operator levels	On Off	Enabled Disabled	On	Conf
Prog Edit	Defines the level in which a program may be edited	Level1 Level2 Level3		Level3	Conf
Control Page	Defines in which level the control summary page is shown	Off Level1 Level2		Level1	Conf
Alarm Page	Defines in which level the alarm page is shown				
Bar Scale Max	Upper limit of the vertical bar graph scale	-99999 to 99999		1000	Conf
Bar Scale Min	Lower limit of the vertical bar graph scale	-99999 to 99999		0	Conf
Main Bar Val	Main bar graph value	This can be wired to any parameter. See also section			L3
Aux1 Bar Val	First auxiliary bar graph value				L3
Aux2 Bar Val	Second auxiliary bar graph value				L3
Language	To select the language (when available)	English (French, German, Italian)			Conf

5.4.2 Bar Graph (3504 Only)

The bar graph shown on the left hand side of the display can be wired to any analogue parameter. The example shown in section 26.11.1. shows the bar graph wired to the main PV. Markers can also be placed on the bar graph which can be used to indicate minimum and maximum points. These points are defined by the parameters ‘Aux1 Bar Val’ and ‘Aux2 Bar Val’ respectively. The markers may be fixed in position by leaving these two parameters unwired and entering an analogue value. Alternatively, they may be wired – in the following example they are wired to low and high alarm points.

Figure 5-2: Bar Graph Markers

5.5 Instrument information

This list provides information about the controller as follows:-

List Header: Inst	**Sub-header: Inf**
Name ◯ to select	**Parameter Description**
Inst Type	The type of instrument e.g., 3504, can be used over comms to identify the instrument being communicated with
Version Num	The version of instrument software. Can be used to identify the build of software being used and hence what features are available. If an upgrade is performed, this will be updated and the instrument non volatile ram will be re-initialised.
Serial Num	The unique serial number of the instrument. This is set at the factory and cannot be changed.
Passcode1	Codes required to remotely upgrade the controller cost options
Passcode2	Codes required to remotely upgrade the controller cost options
Passcode3	Codes required to remotely upgrade the controller cost options
Company ID	Allows a unique identification number to be entered for the particular controller

5.6 Instrument Diagnostics

This list provides fault finding diagnostic information as follows:-

List Header: Inst	**Sub-header: Diag**
Name to select	**Parameter Description**
CPU % Free	This is the amount of free CPU Time left. It shows the percentage of the tasks ticks that are idle.
CPU % Min	A benchmark of the lowest reached value of the CPU free percentage.
Con Ticks	This is the number of ticks that have elapsed while the instrument was performing the control Task.
Max Con Tick	A benchmark of the maximum number of ticks that have elapsed while the instrument was performing the control Task
UI Ticks	This is the number of ticks that have elapsed while the instrument was performing the user interface Task.
Max UI Ticks	A benchmark of the maximum number of ticks that have elapsed while the instrument was performing the user interface Task
Clear Stats	Resets the instrument performance bench marks.
Power FF	The measurement of the instruments line voltage. This may be wired to the control loop PFF Value parameter such that the control algorithm can compensate for mains voltage fluctuations when the instrument is connected to the same phase as the heater.
Error Count	The number of errors logged since the last Clear Log. Note: If an error occurs multiple times only the first occurrence will be logged, but each event will increment the count.

Error1	The first error to occur	0	There is no error
Error2	The second error to occur	1	Bad or unrecognised module ident. A module has been inserted and has a bad or unrecognised ident. Either the module is damaged or the module is unsupported.
Error3	The third error to occur	3	Factory calibration data bad. The factory calibration data has been read from an I/O module and has not passed the checksum test. Either the module is damaged or has not been initialised.
Error4	The fourth error to occur	4	Module changed for one of a different type. A module has been changed for one of a different type. The configuration may now be incorrect
Error5	The fifth error to occur	5	I/O Chip DFC1 communication failure. The onboard generic I/O Chip DFC1 will not communicate. This could indicate a build fault in the instrument.
Error6	The sixth error to occur	6	I/O Chip DFC2 communication failure. The onboard generic I/O Chip DFC2 will not communicate. This could indicate a build fault in the instrument.
Error7	The seventh error to occur	7	I/O Chip DFC3 communication failure. The onboard generic I/O Chip DFC3 will not communicate. This could indicate a build fault in the instrument.
Error8	The eight error to occur	10	Calibration data write error. An error has occurred when attempting to write calibration data back to an I/O module's EE.
		11	Calibration data write error. An error occurred when trying to read calibration data back from the EE on an I/O module.
		13	Fixed PV input error. An error occurred whilst reading data from the fixed PV Input EE.
		18	Checksum error. The checksum of the NVol Ram has failed. The NVol is considered corrupt and there the instrument configuration may be incorrect.
		20	Resistive identifier error. An error occurred when reading the resistive identifier from an i/o module. The module may be damaged.
		33	Unused
		34	Unused

		43	Invalid custom linearisation table. One of the custom linearisation tables is invalid. Either it has failed checksum tests or the table downloaded to the instrument is invalid.
		49	Unused
		53	Unused
		54	Unused
		55	The Instrument wiring is either invalid or corrupt.
		56	Non Vol write to volatile. An attempt was made to perform a checksummed Non Vol write to a non checksumed address.
		58	Recipe load failure. The selected recipe failed to load.
Clear Log	Clears the error log entries and count.		
String Count	Number of User Strings Defined		
String Space	Space Available For User Strings.		
Segments Left	Number of Available Program Segments Gives the number of unused program segments. Each time a segment is allocated to a program, this value is reduced by one.		
Ctl Stack Free	Control Stack Free Space (words) The number of words of un-used stack for the control task		
Comms Stack Free	Comms Stack Free Space (words) The number of words of un-used stack for the comms task		
UI Stack Free	HMI Stack Free Space (words) The number of words of un-used stack for the HMI task		
Disp Stack Free	Display Driver Stack Free Space (words) The number of words of un-used stack for the display driver task.		
Idle Stack Free	Idle Stack Free Space (words) The number of words of un-used stack for the idle (background) task.		

6. CHAPTER 6 PROCESS INPUT

The process input list characterizes and ranges the signal from the input sensor. The Process Input parameters provide the following features:-

Input Type and linearisation	Thermocouple (TC) and 3-wire resistance thermometer (RTD) temperature detectors Volts, mV or mA input through external shunt or voltage divider, available with linear, square root or custom linearisation See the table in section 6.2.1. for the list of input types available
Display units and resolution	The change of display units and resolution will apply to all the parameters related to the process variable
Input filter	First order filter to provide damping of the input signal. This may be necessary to prevent the effects of excessive process noise on the PV input from causing poor control and indication. More typically used with linear process inputs.
Fault detection	Sensor break is indicated by an alarm message 'Sbr'. For thermocouple it detects when the impedance is greater than pre-defined levels; for RTD when the resistance is less than 12Ω.
User calibration	Either by simple offset or by slope and gain. See section 6.2.6. for further details.
Over/Under range	When the input signal exceeds the input span by more than 5% the PV is shown as 'HHHHH' or 'LLLLL'. The check is executed twice: before and after user calibration and offset adjustments. The same indications apply when the display is not able to show the PV, for example, when the input is greater than 9999.9°C with one decimal point.

6.1 To select PV Input

Select Level 3 or Configuration level as described in Chapter 2.

Then press ⊜ as many times as necessary until the header 'PVInput' ' is displayed

6.2 Process Input Parameters

List Header - PV Input		Sub-headers: None			
Name ⟳ to select	**Parameter Description**	**Value** ▲ or ▼ to change		**Default**	**Access Level**
IO Type	PV input type. Selects input linearisation and range	Thermocouple	Thermocouple		Conf R/O L3
		RTD	Platinum resistance thermometer		
		Log10	Logarithmic		
		HZ Volts	High impedance voltage input (typically used for zirconia probes)		
		Volts	Voltage		
		mA	milli amps		
		80mV	80 milli volts		
		40mV	40 milli volts		
		Pyrometer	Pyrometer		
Lin Type	Input linearisation	see section 6.2.1.			Conf R/O L3
Units	Display units used for units conversion	see section 6.2.3.			Conf
Res'n	Resolution	XXXXX to X.XXXX			Conf

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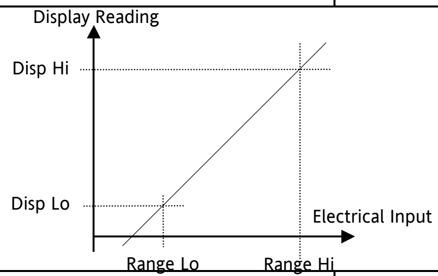
CJC Type	To select the cold junction compensation method	Internal 0ºC 45ºC 50ºC External Off	See description in section 6.2.2. for further details	Internal	Conf
SBrk Type	Sensor break type	Low	Sensor break will be detected when its impedance is greater than a 'low' value		Conf
		High	Sensor break will be detected when its impedance is greater than a 'high' value		
		Off	No sensor break		
SBrk Alarm	Sets the alarm action when a sensor break condition is detected	ManLatch	Manual latching — see also the alarm Chapter 11 Alarms		L3
		NonLatch	No latching		
		Off	No sensor break alarm		
Disp Hi	Configures the maximum displayable reading.	see also section 6.2.7. 			L3
Disp Lo	Configures the minimum displayable reading.				L3
Range Hi	Configures the maximum (electrical) input level.				L3
Range Lo	Configures the minimum (electrical) input level				L3
Fallback	Fallback Strategy See also section 6.2.5.	Downscale	Meas Value = Input range lo - 5%		Conf
		Upscale	Meas Value = Input range Hi + 5%		
		Fall Good	Meas Value = Fallback PV		
		Fall Bad	Meas Value = Fallback PV		
		Clip Good	Meas Value = Input range Hi/lo +/- 5%		
		Clip Bad	Meas Value = Input range Hi/lo +/- 5%		
Fallback PV	Fallback value See also section 6.2.5.		Instrument range		Conf
Filter Time	Input filter time. An input filter provides damping of the input signal. This may be necessary to prevent the effects of excessive noise on the PV input.		Off to 500:00 (hhh:mm) m:ss.s to hh:mm:ss to hhh:mm	0:00.4	L3
Emiss	Emissivity. This parameter only appears if the input is configured for Pyrometer. It is used to compensate for the different reflectivity produced by different type of surface		Off 0.1 to 1.0	1.0	L3
Meas Value	The current electrical value of the PV input				R/O
PV	The current value of the PV input after linearisation		Instrument range		R/O
Offset	Used to add a constant offset to the PV see section 6.2.6.		Instrument range		L3
CJC Temp	Reads the temperature of the rear terminals at the thermocouple connection				L3 R/O
SBrk Value	Sensor break Value Used for diagnostics only, and displays the sensor break trip value				R/O
Lead Res	The measured lead resistance on the RTD				R/O

Cal State	Calibration state Calibration of the PV Input is described in Chapter 25.	Idle			Conf L3 R/O
Status	PV Status The current status of the PV.	0 1 2 3 4 5	Normal operation Initial startup mode Input in sensor break PV outside operating limits Saturated input Uncalibrated channel		R/O

6.2.1 Input Types and Ranges

Used to select the linearisation algorithm required by the input sensor.

A selection of default sensor linearisations are provided for thermocouples/RTD's and Pyrometers.

If linearisation type is linear a y=mx+c relationship is applied between DisplayHigh/DisplayLow and RangeHigh/RangeLow.

If the sensor being used has a special type of linearisation 3 custom tables may be configured by downloading an appropriate table from an extensive library

Input Type		**Min Range**	**Max Range**	**Units**	**Min Range**	**Max Range**	**Units**
J	Thermocouple type J	-210	1200	ºC	-238	2192	ºF
K	Thermocouple type K	-200	1372	ºC	-238	2498	ºF
L	Thermocouple type L	-200	900	ºC	-238	1652	ºF
R	Thermocouple type R	-50	1700	ºC	-58	3124	ºF
B	Thermocouple type B	0	1820	ºC	-32	3308	ºF
N	Thermocouple type N	-200	1300	ºC	-238	2372	ºF
T	Thermocouple type T	-200	400	ºC	-238	752	ºF
S	Thermocouple type S	-50	1768	ºC	-58	3214	ºF
PL2	Platinell	0	1369	ºC	32	2466	ºF
C	Thermocouple type C						
PT100	Pt100 resistance thermometer	-200	850	ºC	-328	1562	ºF
Linear	mV or mA linear input	-10.00	80.00				
SqRoot	Square root						
Tbl 1	Customised linearisation table 1						
Tbl 2	Customised linearisation table 2						
Tbl 3	Customised linearisation table 3						
If no custom linearisation table has been loaded the message 'No tbl 1, 2 or 3' is displayed and must be acknowledged							

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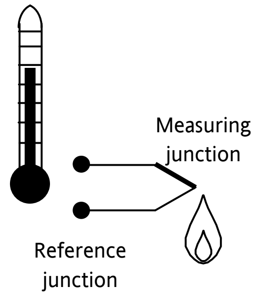
6.2.2 CJC Type



A thermocouple measures the temperature difference between the measuring junction and the reference junction. The reference junction, therefore, must either be held at a fixed known temperature or accurate compensation be used for any temperature variations of the junction.

6.2.2.1 Internal Compensation

The controller is provided with a temperature sensing device which senses the temperature at the point where the thermocouple is joined to the copper wiring of the instrument and applies a corrective signal.

Where very high accuracy is needed and to accommodate multi-thermocouple installations, larger reference units are used which can achieve an accuracy of ±0.1°C or better. These units also allow the cables to the instrumentation to be run in copper. The reference units are contained basically under three techniques. Ice-Point, Hot Box and Isothermal

6.2.2.2 The Ice-Point

There are usually two methods of feeding the EMF from the thermocouple to the measuring instrumentation via the ice-point reference. The bellows type and the temperature sensor type.

The bellows type utilises the precise volumetric increase which occurs when a known quantity of ultra pure water changes state from liquid to solid. A precision cylinder actuates expansion bellows which control power to a thermoelectric cooling device. The temperature sensor type uses a metal block of high thermal conductance and mass, which is thermally insulated from ambient temperatures. The block temperature is lowered to 0°C by a cooling element, and maintained there by a temperature sensing device.

Special thermometers are obtainable for checking the 0°C reference units and alarm circuits that detect any movement from the zero position can be fitted.

6.2.2.3 The Hot Box

Thermocouples are calibrated in terms of EMF generated by the measuring junctions relative to the reference junction at 0°C. Different reference points can produce different characteristics of thermocouples, therefore referencing at another temperature does present problems. However, the ability of the hot box to work at very high ambient temperatures, plus a good reliability factor has led to an increase in its usage. The unit can consist of a thermally insulated solid aluminium block in which the reference junctions are embedded.

The block temperature is controlled by a closed loop system, and a heater is used as a booster when initially switching on. This booster drops out before the reference temperature, usually between 55°C and 65°C, is reached, but the stability of the hot box temperature is now important. Measurements cannot be taken until the hot box reaches the correct temperature.

6.2.2.4 Isothermal Systems

The thermocouple junctions being referenced are contained in a block which is heavily thermally insulated. The junctions are allowed to follow the mean ambient temperature, which varies slowly. This variation is accurately sensed by electronic means, and a signal is produced for the associated instrumentation. The high reliability factor of this method has favoured its use for long term monitoring.

6.2.2.5 CJC Options in 3500 Series

0: CJC measurement at instrument terminals

1: CJC based on external junctions kept at 0C (Ice Point)

2: CJC based on external junctions kept at 45C (Hot Box)

3: CJC based on external junctions kept at 50C (Hot Box)

4: CJC based on independent external measurement

5: CJC switched off

6.2.3 Display Units

None

Abs Temp ºC/ºF/ºK,

V, mV, A, mA,

PH, mmHg, psi, Bar, mBar, %RH, %, mmWG, inWG, inWW, Ohms, PSIG, %O2, PPM, %CO2, %CP, %/sec,

RelTemp ºC/ºF/ºK(rel),

sec, min, hrs,

6.2.4 Sensor Break Value

The controller continuously monitors the impedance of a transducer or sensor connected to any analogue input (including plug in modules). This impedance, expressed as a percentage of the impedance which causes the sensor break flag to trip, is a parameter called 'SBrk Trip Imp' and is available in the parameter lists associated with both Standard and Module inputs of an analogue nature.

The table below shows the typical impedance which causes sensor break to trip for various types of input and high and low 'SBrk Impedance parameter settings. The impedance values are only approximate (±25%) as they are not factory calibrated.

PV Input (Also applies to the Analogue Input module)			
mV input (±40mV or ±80mV)		**Volts (±10V)**	
SBrk Impedance – High SBrk Impedance - Low	~ 12KΩ ~ 3KΩ		
Volts input (-3V to +10V) and HZ Volts input (-1.5 to 2V)			
SBrk Impedance – High SBrk Impedance - Low		~ 20KΩ ~ 5KΩ	

6.2.5 Fallback

A Fallback strategy may be used to configure the default value for the PV in case of an error condition. The error may be due an out of range value, a sensor break, lack of calibration or a saturated input.

The Status parameter would indicate the error condition and could be used to diagnose the problem.

Fallback has several modes and may be associated with the Fallback PV parameter

The Fallback PV may be used to configure the value assigned to the PV in case of an error condition. The Fallback parameter should be configured accordingly.

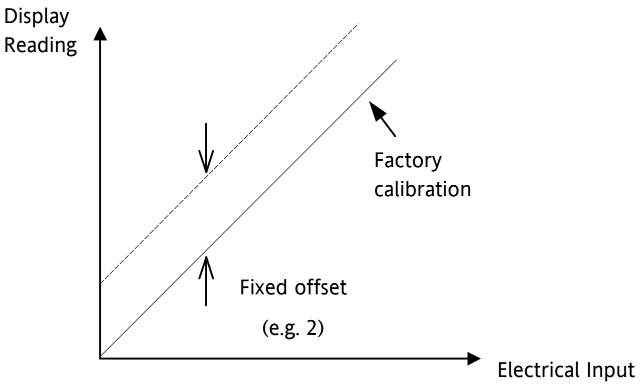
The fallback parameter may be configured so as to force a Good or Bad status when in operation. This in turn allows the user to choose to override or allow error conditions to affect the process.

6.2.6 PV Offset

All ranges of the controller have been calibrated against traceable reference standards. This means that if the input type is changed it is not necessary to calibrate the controller. There may be occasions, however, when you wish to apply an offset to the standard calibration to take account of known errors within the process, for example, a known sensor error or a known error due to the positioning of the sensor. In these instances it is not advisable to change the reference calibration, but to apply a user defined offset.

It is also possible to apply a two point offset and this is described in the next section.

PV Offset applies a single offset over the full display range of the controller and can be adjusted in Level 3. It has the effect of moving the curve up a down about a central point as shown in the example below:-



6.2.6.1 Example: To Apply an Offset:-

- Connect the input of the controller to the source device which you wish to calibrate to
- Set the source to the desired calibration value
- The controller will display the current measurement of the value
- If the display is correct, the controller is correctly calibrated and no further action is necessary. If you wish to offset the reading:-

Do This	The Display You Should See	Additional Notes
7. Select Level 3 or Conf as described in Chapter 2. Then press to select **'PVInput'**	PVInput IO Type ThermoCpl SBrk Alarm ManLatch Filter Time 0:00.4	
8. Press to scroll to **'Offset'** 9. Press or to adjust the offset to the reading you require	PVInput Meas Value 0.00 PV 2 Offset 2.0	In this case an offset of 2.0 units is applied

6.2.7 PV Input Scaling

PV input scaling applies to the linear mV input range only. This is set by configuring the 'IO Type' parameter to 40mV, 80mV, mA, Volts or HZVolts. Using an external burden resistor of 2.49Ω, the controller can be made to accept 4-20mA from a current source. Scaling of the PV input will match the displayed reading to the electrical input levels from the transducer. PV input scaling can only be adjusted in configuration level and is not provided for direct thermocouple, pyrometer or RTD inputs.

The graph below shows an example of input scaling, where it is required to display 75.0 when the input is 4mV and 500.0 when the input is 20mV .

If the input exceeds ±5% of the Range Lo or Range Hi settings, sensor break will be displayed.

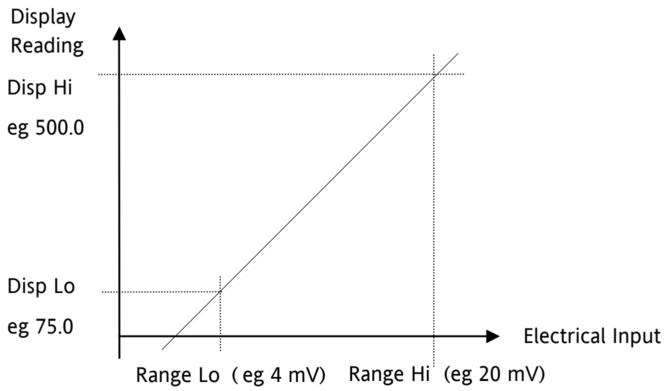
For mA inputs

4-20mA = 9.96-49.8mV with 2.49Ω load resistor

0-20mA = 0-49.8mV with 2.49Ω load resistor

mA input will detect sensor break if mA < 3mA

Use a current source to remove shunt resistor errors



6.2.7.1 Example: To Scale a Linear Input:-

Do This	The Display You Should See	Additional Notes
1. Select Conf as described in Chapter 2. Then press to select **'PVInput'**	PVInput IO Type mA Lin Type Linear Units None	
2. Press to scroll to **'IO Type'** 3. Press or to **'mA'**, 'Volts' or mV	PVInput IO Type mA Lin Type Linear Units None	Linearisation type and resolution should also be set as appropriate.
4. Press to scroll to **'Disp Hi'** 5. Press or to **'500.00'**	PVInput SBrk Type Low SBrk Alarm NonLatch Disp Hi 500.0	Resolution set to XXXX.X in this example
6. Press to scroll to **'Disp Lo'** 7. Press or to **'75.00'**	PVInput SBrk Alarm NonLatch Disp Hi 500.0 Disp Lo 75.0	
8. Press to scroll to **'Range Hi'** 9. Press or to **'20.000'**	PVInput Disp Hi 500.0 Disp Lo 75.0 Range Hi 20.000	The controller will read 500.0 for a mA input of 20.00
10. Press to scroll to **'Range Lo'** 11. Press or to **'4.000'**	PVInput Disp Lo 75.0 Range Hi 20.000 Range Lo 4.000	The controller will read 75.0 for a mA input of 4.00

7. CHAPTER 7 LOGIC INPUT/OUTPUT

There are two logic IO channels, standard on all controllers, which may be configured independently as inputs or outputs. Connections for these are made to terminals LA and LB, with LC as the common for both. Parameters in the '**LgcIO'** lists allow each IO to be configured independently under the sub-headers LA and LB. Note, that the two IO are not isolated from each other since they share a common return. They are, however, isolated from other connections.

7.1 To select Logic IO list

Select Level 3 or Configuration level as described in Chapter 2.

Then press as many times as necessary until the header **'LgcIO'** ' is displayed

7.2 Logic IO Parameters

List Header - LgcIO		Sub-header - LA and LB			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
IO Type	To configure the type of input or output	Input	Logic input	Input	Conf R/O L3
		ContactCl	Contact closure input		
		OnOff	On off output		
		Time Prop	Time proportioning output		
		ValvRaise See Note 1	Motorised valve position output – raise on LA only		
Invert	Sets the sense of the logic input or output	No Yes	No inversion Inverted	No	Conf
The next five parameters are only shown when 'IO Type' = 'Time Prop' outputs					
Min OnTime	Minimum output on/off time. Prevents relays from switching too rapidly	Auto 0.01 to 150.00 seconds	Auto = 20ms. This is the fastest allowable update rate for the output	Auto	L3
Disp Hi	The maximum displayable reading	0.00 to 100.00		100.00	L3
Disp Lo	The minimum displayable reading	0.00 to 100.00		0.00	L3
Range Hi	The maximum (electrical) input/output level	0.00 to 100.00			L3
Range Lo	The minimum (electrical) input/output level	0.00 to 100.00			L3
Meas Val	The current value of the output demand signal.	0 1	On (unless Invert = Yes) Off (unless Invert = Yes)		L3 R/O
PV	When configured as an output, this is the desired output value; when configured as an input the current state of the digital input is displayed	0 to 100 or 0 to 1 (OnOff)			L3
The following parameters are additional if 'IO Type' = 'Valve Rais'					
Inertia	Set this parameter to match the inertia (if any) of the motor	0.0 to 9999.9 secs		0.0	L3
Backlash	Compensates for any backlash which may be present in the linkages	0.0 to 9999.9 secs		0.0	L3
Cal State	Calibration status	Idle Raise Lower	This is only applicable to valve position outputs		L3

PV can be wired to the output of a function block. For example if it is used for control it may be wired to the control loop output (Ch1 Output) as shown in the example in section 4.1.1.

Note 1: LA and LB work in a complementary manner in Valve Positioning (VP) applications. When LA is set to ValvRais LB is automatically set to ValvLowr. IOType for LB is NOT alterable in VP applications. Configuration settings applied to LA will be applied to LB automatically.

7.2.1 Example: To Configure a Time Proportioning Logic Output

Select configuration level as described in section 2.1.3. Then:-

Do This	The Display You Should See	Additional Notes
13. From any display press until the **'LgcIO'** page is reached		
14. Press or as necessary to select **'LA'** or **'LB'**		
15. Press to scroll to **'IO Type'**		
16. Press or to **'Time Prop'**		

7.2.2 Example: To Calibrate a VP Output

The 'Cal State' parameter in this list allows you to fully open or fully close the valve when it is required to calibrate a feedback potentiometer used with a bounded VP control.

Do This	The Display You Should See	Additional Notes
1. From the **'LgcIO' 'LA'** page, press to scroll to **'Cal State'**		The loop is temporarily disconnected to allow the valve to drive fully open.
2. Press or to select **'Raise'**		
3. Now select the page header which contains the Potentiometer Input module		
4. Press to scroll to **'Cal State'** in the **Potentiometer list**		
5. Press or to select **'Hi'.** Then **'Confirm'**. The controller will automatically calibrate to the potentiometer position. The messages **'Go'** and **'Busy'** will be displayed during this time. If successful the message **'Passed'** will be displayed and if unsuccessful **'Failed'** will be displayed. A fail could be due to the potentiometer value being out of range.		
6. Drive the valve fully closed using **'Lower'** in the **'LgcIO'** page. Then repeat 3, 4 and 5 for the **'Lo'** calibration point		

7.2.3 Logic Output Scaling

If the output is configured for time proportioning control, it can be scaled such that a lower and upper level of PID demand signal can limit the operation of the output value.

By default, the output will be fully off for 0% power demand, fully on for 100% power demand and equal on/off times at 50% power demand. You can change these limits to suit the process. It is important to note, however, that these limits are set to safe values for the process. For example, for a heating process it may be required to maintain a minimum level of temperature. This can be achieved by applying an offset at 0% power demand which will maintain the output on for a period of time. Care must be taken to ensure that this minimum on period does not cause the process to overheat.

If Range Hi is set to a value <100% the time proportioning output will switch at a rate depending on the value - it will not switch fully on.

Similarly, if Range Lo is set to a value >0% it will not switch fully off.

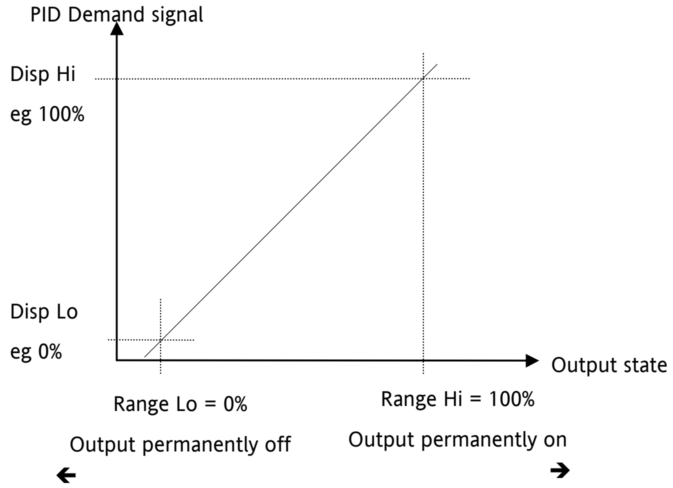


Figure 7-1: Time Proportioning Output

7.2.4 Example: To Scale a Proportioning Logic Output

Select level 3 or configuration level as described in section 2.1.3. Then:-

Do This	The Display You Should See	Additional Notes
1. From the **'LgcIO'** page, press ⊜ to scroll to **'Disp Hi'** 2. Press ⊙ or ⊙ to set the PID demand limit. This will normally be 100% 3. Repeat the above for **'Disp Lo'**. This will normally be set to zero	LgcIO LA Min OnTime Auto Disp Hi 100.00 Disp Lo 0.00	
4. Press ⊜ to scroll to **'Range Hi'** 5. Press ⊙ or ⊙ to set the upper output limit. 6. Repeat the above for **'Range Lo'** to set the lower switching limit	LgcIO LA Disp Lo 0.00 Range Hi 90.00 Range Lo 8.00	In this example the output will switch on for 8% of the time when the PID demand signal is at 0%. Similarly, it will remain on for 90% of the time when the demand signal is at 100%

8. CHAPTER 8 AA RELAY OUTPUT

A changeover relay is standard on all 3500 series controllers and is connected to terminals AA (normally open), AB (common) and AC (normally closed).

Parameters in the **'RlyAA'** list allow the relay functions to be set up.

8.1 To Select AA Relay List

Select Level 3 or Configuration level as described in Chapter 2.

Then press as many times as necessary until the header 'RlyAA' is displayed

8.2 AA Relay Parameters

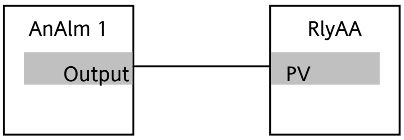
List Header - RlyAA		**No Sub-headers**			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
IO Type	To configure the function for the relay	OnOff	On off output		Conf R/O L3
		Time Prop	Time proportioning output		
Invert	To change the normal operating state of the relay	No	Relay de-energised when output demand off Relay energised when output demand on This is the normal setting if the relay is used for control		Conf R/O L3
		Yes	Relay energised when output demand off Relay de-energised when output demand on This is the normal setting if the relay is used for an alarm		
The next five parameters are only shown when 'IO Type' = 'Time Prop' outputs					
Min OnTime	The minimum logic on time (in seconds). Prevents relay from switching too rapidly	Auto 0.01 to 150.00 seconds	If set to 0 - Auto the minimum on time will be 110mS. For a time proportioning output the on/off times at 50%power is as shown:- 110ms 110ms On Off 	Auto	L3
Disp Hi	Maximum output demand signal	0.00 to 100.00		100.00	L3
Disp Lo	Minimum output demand signal	0.00 to 100.00		0.00	L3
Range Hi	Electrical output high	0.00 to 100.00			L3
Range Lo	Electrical output low	0.00 to 100.00			L3
Meas Val	Status of the digital output.	0 1	On (unless Invert = Yes) Off (unless Invert = Yes)		L3 R/O L3
PV	The current (analogue) value of the output	0 to 100 or 0 to 1 (OnOff)			L3 R/O L3

PV can be wired to the output of a function block. For example if it is used for control it may be wired to the control loop output (Ch1 Output) as shown in the example in section 4.1.1.

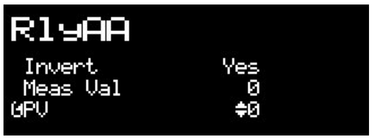
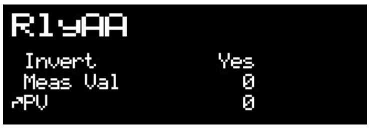
If it is used for an alarm it may be wired to the 'Output' parameter in an alarm list.

8.2.1 Example: To Wire the AA Relay to an Alarm

In this example the relay will be made to operate when analogue alarm 1 occurs.



Select configuration level as described in section 2.1.3. Then:-

Do This	The Display You Should See	Additional Notes
17. From any display press until the **'RlyAA'** page is reached 18. Press to scroll to **'PV'**		Set 'IO Typ' to 'OnOff' Set 'Invert' to 'Yes' This locates the parameter to be wired to
19. Press **A/MAN** to display '**WireFrom'**		If the parameter is already wired the display shown below is shown
20. Press (as instructed) as many times as necessary to select the **'AnAlm'** page 21. Press or to select **'1'** 22. Press to scroll to **'Output'**		This selects Analogue Alarm 1. The relay can also be wired to operate on one or more alarms. This 'copies' the parameter to be wired from
23. Press **A/MAN**		This 'pastes' the parameter to 'PV'
24. Press as instructed to confirm		Note the arrow next to the parameter which has been wired

8.2.2 Relay Output Scaling

If the output is configured for time proportioning control, it can be scaled such that a lower and upper level of PID demand signal can limit the operation of the output value.

The procedure for this is the same as logic outputs described in section 7.2.3.

9. CHAPTER 9 MODULE CONFIGURATION

Plug in IO modules provide additional analogue and digital IO. These modules can be fitted in any of six slots. The terminal connections for these are given in Installation and Basic Operation, Chapter 1.

The type and position of any modules fitted in the controller is shown in the order code printed on the label on the side of the controller. This can be checked against the order code in Chapter 1.

The module part number is printed on the side of the plastic case of the module.

All modules fitted are identified in the controller under the page heading **'ModIDs'**.

Modules are available as single channel, two channel or three channel IO as listed below:-

Module	Order Code	Idents Displayed As	Number of Channels	Module Part No.
No module fitted	XX	No Module		
Change over relay 2 pin relay Dual relay	R4 R2 RR	COvrRelay Form A Relay DualRelay	1 1 2	AH025408U002 AH025245U002 AH025246U002
Triple logic output	TP	TriLogic	3	AH025735U002
Isolated single logic output	LO	SinLogic	1	AH025735U002
Triac Dual triac	T2 TT	Triac DualTriac	1 2	AH025253U002 AH025409U002
DC control	D4	DCControl	1	AH025728U003
DC retransmission	D6	DCRetran	1	AH025728U002
Analogue input module	AM	DCInput	1	AH025686U004
Triple logic input Triple contact input	TL TK	TriLogIP TriConIP	3 3	AH025317U002 AH025861U002
Potentiometer input	VU	PotIP	1	AH025864U002
24V transmitter supply	MS	TXPSU	1	AH025862U002
5V or 10VdcTransducer power supply	G3	TransPSU	1	AH026306U002

Note: If an incorrect module is fitted (for example, from a 2000 series controller), **'Bad Ident'** will be displayed.

Table 9-1: I/O Modules

Parameters for the above modules, such as input/output limits, filter times and scaling of the IO, can be adjusted in the Module IO pages

9.1 To Fit a New Module

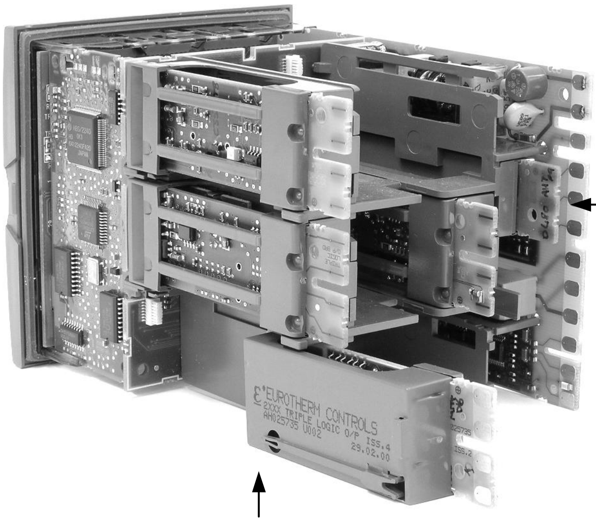
IO modules can be fitted in any of six slots in the 3504 and any of three slots in 3508 controllers.

Communications modules can be fitted in any of two slots

A list of available IO modules is given in Table 9-1

These modules are fitted simply by sliding them into the relevant position as shown below.

When a module has been changed, the controller will power up with the message **'!:Error Module Changed'**. This must be acknowledged by pressing and together.



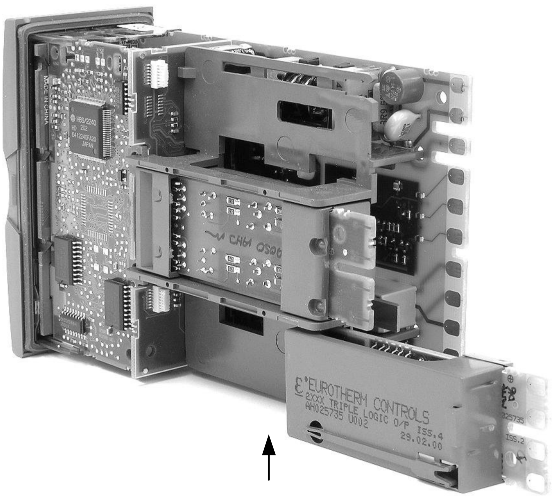


Figure 9-1: View of the Plug-in Modules

9.2 Module Identification

Press [page button] until the list header **'ModIDs'** is displayed. The type of IO module fitted in any of the six slots (three if 3508) is shown. The identification of the module fitted is shown in Table 9-1.

9.3 Module Types

The tables in the following pages list the parameters available for the different modules.

9.3.1 Relay, Logic or Triac Outputs

These modules are used to provide an output to a two state output device such as a contactor, SSR, motorized valve driver, etc.

List Header - Mod		**Sub-headers: xA (triac, changeover or 2-pin relay); xA and xC (dual relay, dual triac); xA, xB, xC (triple logic) x = the number of the slot in which the module is fitted**			
Name [page button] **to select**	**Parameter Description**	**Value** [up] **or** [down] **to change**		**Default**	**Access Level**
Ident	Channel type	Relay Logic Out Triac	Any relay output Logic output Triac or dual triac output		L3 R/O
IO Type	To configure the function of the relay	OnOff	On off output		Conf R/O L3
		Time Prop	Time proportioning output		
		ValvRais	Motor valve position raise. See note 1		
Invert	To change the normal operating state of the relay	No	Relay de-energised when output demand off Relay energised when output demand on Normal setting if the relay is used for control		Conf R/O L3
		Yes	Relay energised when output demand off Relay de-energised when output demand on Normal setting if the relay is used for an alarm		
Meas Value	Current state of the output	0 1	Off (if 'Invert' = 'No') On (if 'Invert' = 'No')		L3 R/O
PV	Normally wired to the output of a function block such as PID output to control a plant actuator	0 1	Demand for output to be off (if 'Invert' = 'No') Demand for output to be on (if 'Invert' = 'No') Alterable if not wired		Conf R/O L3
Status	Module status	OK	Normal operation See note 2		R/O
The next seven parameters are only shown when '**IO Type'** = '**Time Prop'** outputs					
Min OnTime	Minimum output on/off time. Prevents relay from switching too rapidly	Auto 0.01 to 150.00 sec	Auto = 110mS	5 sec	L3

Disp Hi	Maximum output demand signal	0.00 to 100.00		100.00	L3
Disp Lo	Minimum output demand signal	0.00 to 100.00		0.00	L3
Range Hi	Electrical output high	0.00 to 100.00			L3
Range Lo	Electrical output low	0.00 to 100.00			L3
Meas Value	Status of the digital output.	0 1	On (unless Invert = Yes) Off (unless Invert = Yes)		L3 R/O L3
PV	The current (analogue) value of the output	0 to 100			R/O L3
The following parameters are additional if **'IO Type'** = **'Valve Rais'**					
Inertia	Set this parameter to match the inertia (if any) of the motor	0.0 to 9999.9 secs		0.0	L3
Backlash	This parameter compensates for any backlash which may be present in the linkages	0.0 to 9999.9 secs		0.0	L3
Cal State	Calibration state	Idle Raise lower	See also section 7.2.2. for an explanation		L3

Note 1

A triple logic output, a dual relay output or a dual triac output module may be used for a valve position output. If Valve Raise is configured on channel output A then Valve Lower is automatically allocated to channel output C. Channel output B (triple logic output) is only available as an on/off or time proportioning output.

Valve raise/lower is not available on a single isolated logic output

Note 2

Status displays a message giving the current operating condition of the module. These may be:-

0: Normal operation

1: Initial startup mode

2: At least one input in sensor break

3: At least one input in sensor break

4: At least one PV outside operating limits

5: At least one PV outside operating limits

6: At least one saturated input

7: At least one saturated input

8: At least one uncalibrated channel

9: At least one uncalibrated channel

25: No Module

The number is the enumeration of the status.

9.3.2 Single Isolated Logic Output

This provides isolation from other IO and should be used, for example, in applications where the sensor and the output device may be at supply potential. It is only available as a time proportioning or on/off output.

List Header - Mod		**Sub-headers: xA**			
Name **to select**	**Parameter Description**	**Value** **or** **to change**		**Default**	**Access Level**
Ident	Channel type	Logic Out	Logic output		L3 R/O
IO Type	To configure the function of the relay	OnOff	On off output		Conf R/O L3
		Time Prop	Time proportioning output		
Invert	To change the normal operating state of the relay	No	Relay de-energised when output demand off Relay energised when output demand on Normal setting if the relay is used for control		Conf R/O L3
		Yes	Relay energised when output demand off Relay de-energised when output demand on Normal setting if the relay is used for an alarm		
Meas Value	Current state of the output	0 1	Off (if 'Invert' = 'No') On (if 'Invert' = 'No')		L3 R/O
PV	Normally wired to the output of a function block such as PID output to control a plant actuator	0 1	Demand for output to be off (if 'Invert' = 'No') Demand for output to be on (if 'Invert' = 'No') Alterable if not wired		Conf R/O L3
Status	Module status	OK	Normal operation See note 2		R/O
The next six parameters are only shown when '**IO Type**' = '**Time Prop**' outputs					
Min OnTime	Minimum output on/off time. Prevents relay from switching too rapidly	Auto 0.01 to 150.00 sec	Auto = 110mS	5 sec	L3
Disp Hi	Maximum output demand signal	0.00 to 100.00		100.00	L3
Disp Lo	Minimum output demand signal	0.00 to 100.00		0.00	L3
Range Hi	Electrical output high	0.00 to 100.00			L3
Range Lo	Electrical output low	0.00 to 100.00			L3
Meas Value	Status of the digital output.	0 1	On (unless Invert = Yes) Off (unless Invert = Yes)		L3 R/O L3

9.3.3 DC Control Output or DC Retransmission

The DC output module is used as a control output to interface with an analogue actuator such as valve driver or thyristor unit.

The DC retransmission module is used to provide an analogue output signal proportional to the value which is being measured. It may be used for chart recording or retransmit a signal to another controller. This function is often performed through digital communications where greater accuracy is required.

List Header - Mod		**Sub-headers: xA** **x = the number of the slot in which the module is fitted**			
Name **to select**	**Parameter Description**	**Value** **or to change**		**Default**	**Access Level**
Ident	Channel type	DC Output DCRetran	DC Output DC retransmission		L3 R/O
IO Type	To configure the output drive signal	Volts mA	Volts dc milli-amps dc	As order code	Conf L3 R/O
Res'n	Display resolution	XXXXX to X.XXXX			Conf
Disp Hi	Display high reading	-99999 to 99999 decimal points depend on resolution HHHHH = out of high range LLLLL = out of low range		100	L3
Disp Lo	Display low reading			0	L3
Range Hi	Electrical high input level	0 to 10		10	L3
Range Lo	Electrical low input level			0	L3
Meas Value	The current output value				R/O
PV					L3
Cal State	Calibration state	Idle Lo Hi Confirm Go Abort Busy Passed Failed Accept	Non calibrating state Select calibration of the low position Select calibration of the high position Confirm the position to calibrate Start calibration Abort calibration Controller automatically calibrating Calibration OK Calibration bad To store the new values	Idle	Conf
Status	Working condition of the module	OK	Normal operation See note 2		R/O

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9.3.4 Analogue Input

The analogue input module provides additional analogue inputs for multi-loop controllers or other multi input measurements.

List Header - Mod		Sub-headers: xA x = the number of the slot in which the module is fitted			
Name (select button) **to select**	**Parameter Description**	**Value** (up) or (down) **to change**		**Default**	**Access Level**
Ident	Channel type	DC Input			L3 R/O
IO Type	PV input type Selects input linearisation and range	Thermocouple	Thermocouple		Conf L3 R/O
		RTD	Platinum resistance thermometer		
		Log10	Logarithmic		
		HZ Volts	High impedance voltage input (typically used for zirconia probes)		
		Volts	Voltage		
		mA	milli amps		
		80mV	80 milli volts		
		40mV	40 milli volts		
		Pyrometer	Pyrometer		
Lin Type	Input linearisation	see section 9.3.5			L3 R/O
Units	Controller units	see section 9.3.6			Conf
Res'n	Resolution	XXXXX to X.XXXX			Conf
CJC Type	To select the cold junction compensation method	Internal 0°C 45°C 50°C External Off	See description in section 6.8.2. for further details	Internal	Conf
SBrk Type	Sensor break type	Low	Sensor break will be detected when its impedance is greater than a 'low' value		Conf
		High	Sensor break will be detected when its impedance is greater than a 'high' value		
		Off	No sensor break		
SBrk Alarm	Sets the alarm action when a sensor break condition is detected	ManLatch	Manual latching — see also Chapter 11 'Alarms'		L3
		NonLatch	No latching		
		Off	No sensor break alarm		
Disp Hi	Display reading high	see section 9.4.1.			L3
Disp Lo	Display reading low				L3
Range Hi	Input high value				L3
Range Lo	Input low value				L3
Fallback	Configures the default value in	Downscale	Same as PV input		Conf

	case of an erroneous condition. The error may be due an out of range value, a sensor break, lack of calibration or a saturated input. The Status parameter would indicate the error condition and could be used to diagnose the problem. Fallback has several modes and may be associated with the Fallback PV parameter.	Upscale Fall Good Fall Bad Clip Good Clip Bad	See section 4.1.6. for further explanation		
Fallback PV	To set the value of PV during a sensor break		Instrument range		Conf
Filter Time	Input filter time. An input filter provides damping of the input signal. This may be necessary to prevent the effects of excessive noise on the PV input.		Off to 500:00 (m:ss.s) (hh:mm:ss) or (hh:mm)	0:00.4	L3
Emiss	Emissivity. This parameter only appears if the input is configured for Pyrometer. It is used to compensate for the different reflectivity produced by different type of surface		Off 0.1 to 1.0	1.0	L3
Meas Value	The current electrical value of the PV input				L3 R/O
PV	The current value of the PV input in engineering units		Instrument range		L3 R/O
Offset	Single offset value applied to the input see section 6.8.6.		Instrument range		L3
CJC Temp	Reads the temperature of the rear terminals at the thermocouple connection				Conf R/O
SBrk Value	Used for diagnostics only, and displays the sensor break trip value.				L3 R/O
Lead Res	The measured lead resistance on the RTD				L3 R/O
Cal State	Calibration state	Idle Lo Hi Confirm Go Abort Busy Passed Failed Accept	Non calibrating state Select calibration of the low position Select calibration of the high position Confirm the position to calibrate Start calibration Abort calibration Controller automatically calibrating Calibration OK Calibration bad To store the new values		Conf
Status	The current status for the channel.	0 1 2 3 4 5	Normal operation Initial startup mode Input in sensor break PV outside operating limits Saturated input Uncalibrated channel		L3 R/O

9.3.5 Input Types and Ranges

Input Type		Min Range	Max Range	Units	Min Range	Max Range	Units
J	Thermocouple type J	-210	1200	ºC	-238	2192	ºF
K	Thermocouple type K	-200	1372	ºC	-238	2498	ºF
L	Thermocouple type L	-200	900	ºC	-238	1652	ºF
R	Thermocouple type R	-50	1700	ºC	-58	3124	ºF
B	Thermocouple type B	0	1820	ºC	32	3308	ºF
N	Thermocouple type N	-200	1300	ºC	-238	2372	ºF
T	Thermocouple type T	-200	400	ºC	-238	752	ºF
S	Thermocouple type S	-50	1768	ºC	-58	3214	ºF
PL2	Thermocouple Platinel II	0	1369	ºC	32	2466	ºF
C	Thermocouple type C						
PT100	Pt100 resistance thermometer	-200	850	ºC	-328	1562	ºF
Linear	mV or mA linear input	-10.00	80.00				
SqRoot	Square root						
Custom	Customised linearisation tables						

9.3.6 Display Units

None

Abs Temp ºC/ºF/ºK,

V, mV, A, mA,

PH, mmHg, psi, Bar, mBar, %RH, %, mmWG, inWG, inWW, Ohms, PSIG, %O2, PPM, %CO2, %CP, %/sec,

RelTemp ºC/ºF/ºK(rel),

Custom 1, Custom 2, Custom 3

sec, min, hrs,

9.3.7 Triple Logic Input and Triple Contact Input

This module may be used to provide additional logic inputs.

List Header - Mod		Sub-headers: xA, xB, xC x = the number of the slot in which the module is fitted			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Ident	Channel type	Logic Inp	Logic input or contact input		L3 R/O
IO Type	Function of the module	Input			L3 R/O
PV	State of the measured input	0 1	Demand for output to be off Demand for output to be on		Conf R/O L3
Status	Module status	OK	Normal operation See note 2		R/O

9.3.8 Potentiometer Input

This module may be connected to a feedback potentiometer fitted to a motorized valve driver, or to provide a measured value from any other potentiometer input between 330Ω and 15KΩ. The excitation voltage is 0.5Vdc.

List Header - Mod		Sub-headers: xA x = the number of the slot in which the module is fitted			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Ident	Channel type	Pot Input	Potentiometer input		L3 R/O
Units	Engineering units.	None			Conf
Res'n	Display resolution	XXXXX to X.XXXX			Conf
SBrk type	Allows one of three strategies to be configured if potentiometer break is indicated. Same as analogue input	Low	Sensor break will be detected when its impedance is greater than a 'low' value		Conf
		High	Sensor break will be detected when its impedance is greater than a 'high' value		Conf
		Off	No sensor break		Conf
SBrk Alarm	To configure the alarm action should the potentiometer become disconnected	Off NonLatch ManLatch	No sensor break alarm Non latching sensor break alarm Manual latching sensor break alarm		L3
Fallback	Condition to be adopted if the 'Status' parameter ≠ OK	Clip Bad Clip Good Fall Bad Fall Good Upscale DownScale			Conf
Fallback PV		-99999 to 99999			Conf
Filter Time	To adjust the input filter time constant to reduce the effect of noise on the input signal	Off or 0:00.1 to 500:00		0:00:04	L3

Meas Value	The current value in engineering units				L3 R/O
PV	Requested output/current input signal level (after linearisation where applicable).				L3 R/O
SBrk Value	Used for diagnostics only, and displays the sensor break trip value.				L3 R/O
Cal State	This parameter allows the controller to be calibrated against the maximum and minimum positions of the potentiometer. Adjust the pot to minimum position, select **'Lo'** followed by **'Confirm'**. The controller will automatically calibrate to this position. Repeat for the minimum position and selecting **'Hi'**. If the potentiometer is part of the valve positioning motor it may be difficult to adjust the pot position. In this case refer back to section 7.2.2.	Idle Lo Hi Confirm Go Abort Busy Passed Failed Accept Save User Save Fact Load Fact	Non calibrating state Select calibration of the low position Select calibration of the high position Confirm the position to calibrate Start calibration Abort calibration Controller automatically calibrating Calibration OK Calibration bad To start using the new values To store the new values to EE memory (For User calibration) To store the new values to EE memory (For Factory calibration: password protected) Load factory calibration (Save User required for permanent use of Factory calibration).	Idle	Conf L3 R/O
Status	Working condition of the module	OK Sbreak	Potentiometer input broken		R/O

9.3.9 Transmitter Power Supply

This module may be used to provide 24Vdc to power an external transmitter.

List Header - Mod		**Sub-headers: xA, xB, xC** **x = the number of the slot in which the module is fitted**			
Name **to select**	**Parameter Description**	**Value** **or to change**		**Default**	**Access Level**
Ident	Channel type	TxPSU	Transducer power supply		L3 R/O
Status	Module status	OK	Normal operation See note 2		R/O

9.3.10 Transducer Power Supply

The transducer power supply may be used to power an external transducer which requires an excitation voltage of 5 or 10V. It contains an internal shunt resistor for use when calibrating the transducer. The value of this resistor is 30.1KΩ ±0.25% when calibrating a 350Ω bridge.

List Header - PV Input		**Sub-headers: xA** **x = the number of the slot in which the module is fitted**			
Name **to select**	**Parameter Description**	**Value** **or to change**		**Default**	**Access Level**
Ident	Channel type	TransPSU	Transducer power supply		R/O
Meas Value	The current output value				R/O
PV	Requested output/current input signal level (after linearisation where applicable). Normally wired				
Status	The current status for the channel.	OK	Normal operation see note 2		R/O
Shunt		External Internal	Select external calibration resistor Select internal calibration resistor 30.1KΩ	External	Conf
Voltage	To select the output voltage	10 Volts 5 Volts	10 Volts 5 Volts		Conf

9.4 MODULE SCALING

The controller is calibrated for life against known reference standards during manufacture, but user scaling allows you to offset the ‘permanent’ factory calibration to either:-

1. Scale the controller to your reference standards
2. Match the calibration of the controller to an individual transducer or sensor
3. To compensate for known offsets in process measurements

9.4.1 Analogue Input Scaling and Offset

Scaling of the analogue input uses the same procedure as described for the PV Input (Chapter 6) and applies to linear process inputs only, eg linearised transducers, where it is necessary to match the displayed reading to the electrical input levels from the transducer. PV input scaling is not provided for direct thermocouple or RTD inputs.

Figure 9-2 shows an example of input scaling. where an electrical input of 4-20mA requires the display to read 2.5 to 200.0 units.

Offset has the effect of moving the whole curve, shown in Figure 9-2, up or down about a central point. The ‘Offset’ parameter is found in the ‘Mod’ page under the number of the slot position in which the Analogue Input module is fitted.

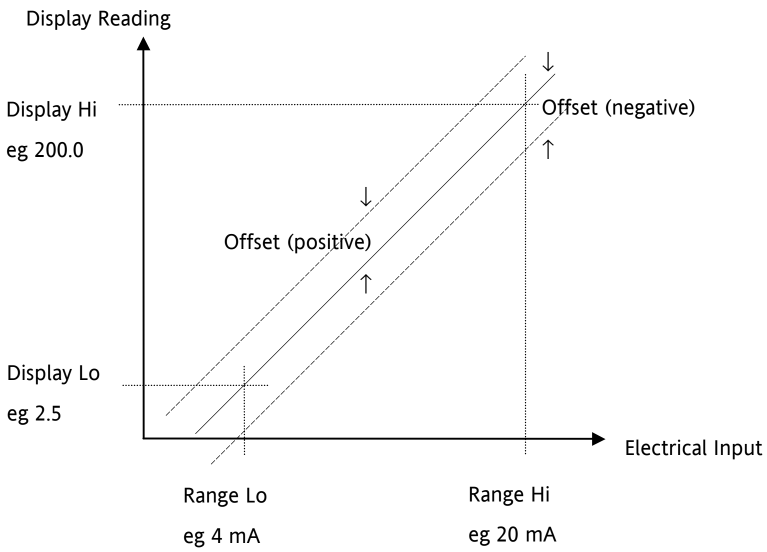


Figure 9-2: Input Scaling (Standard IO)

To scale a mA analogue input as shown in the above example:-

(This also applies to V or mV input types).

12. Select Conf as described in Chapter 2. Then press to select the page header in which the analogue input module is fitted
13. Press to scroll to **‘Disp Hi’**. Then press or to **’200.0’**
14. Press to scroll to **‘Disp Lo’**. Then press or to **‘2.5’**
15. Press to scroll to **‘Range Hi’**. Then press or to ‘**20.0’**
16. Press to scroll to **‘Range Lo’**. Then Press or to **‘4.00’**
17. Press to scroll to **‘Offset’**. Then Press or to adjust the offset in a positive or negative direction as required

9.4.2 Relay, Logic or Triac Output Scaling

If the output is configured for time proportioning control, it can be scaled such that a lower and upper level of PID demand signal can limit the operation of the output value.

By default, the output will be fully off for 0% power demand, fully on for 100% power demand and equal on/off times at 50% power demand. You can change these limits to suit the process. It is important to note, however, that these limits are set to safe values for the process. For example, for a heating process it may be required to maintain a minimum level of temperature. This can be achieved by applying an offset at 0% power demand which will maintain the output on for a period of time. Care must be taken to ensure that this minimum on period does not cause the process to overheat.

If Range Hi is set to a value <100% the time proportioning output will switch at a rate depending on the value - it will not switch fully on.

Similarly, if Range Lo is set to a value >0% it will not switch fully off.

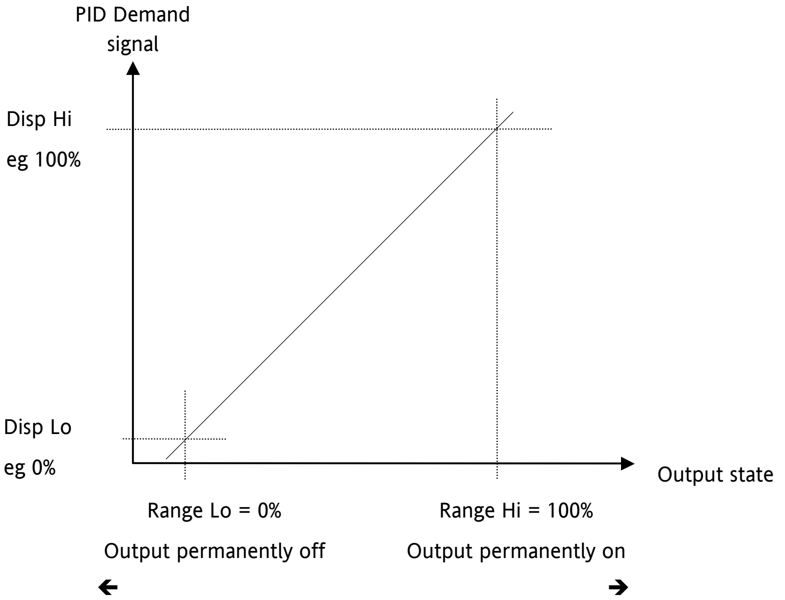


Figure 9-3: Time Proportioning Output

The procedure for adjusting these parameters is the same as that given in the previous section.

9.4.3 Analogue Output Scaling

Analogue control or retransmission outputs are scaled in exactly the same way as above except that Range Lo and Hi corresponds to the electrical output (0 to 10V, 4 to 20mA, etc). For an analogue retransmission output Disp Lo and Hi correspond to the reading on the display and for an analogue control output Disp Lo and Hi corresponds to the PID demand output signal from the control block.

9.4.4 Potentiometer Input Scaling

When using the controller in bounded valve position mode, it is necessary to calibrate the feedback potentiometer to correctly read the position of the valve. The minimum position of the potentiometer corresponds to a measured value reading of 0 and the maximum position corresponds to 100. This may be carried out in Access level 3:-

1. Adjust the potentiometer for the minimum required position. This may not necessarily be on the end stop.
2. Press ⟳ to scroll to **'Cal State'.** Then press ▲ or ▼ to **'Lo'** and '**'Confirm'.** The display will show **'Go'** followed by **'Busy'** while the controller automatically calibrates to the minimum position. When complete **'Passed'** should be displayed. If **'Failed'** is displayed this may indicate that the potentiometer is outside the range of the input.
3. Adjust the potentiometer for the maximum required position. This may not necessarily be on the end stop.
4. Repeat 2 above for the 'Hi' position
5. The controller will now use these values until it is powered down. If it required to store these values, which is the usual case, press ▲ or ▼ to **'Accept'.** The controller will store these values for future use.

10. CHAPTER 10 IO EXPANDER

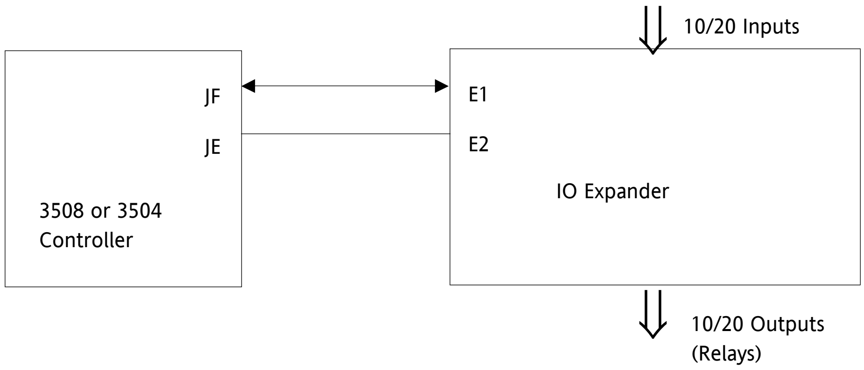
The IO Expander is an external unit which can be used in conjunction with the 3500 series controllers to allow the number of digital IO points to be increased. There are two versions:-

10 Inputs and 10 Outputs

20 Inputs and 20 Outputs

Each input is fully isolated and voltage or current driven. Each output is also fully isolated consisting of four changeover contacts and six normally open contacts in the 10 IO version and four changeover and sixteen normally open contacts in the 20 IO version.

Data transfer is performed serially via an IO Expander module which is fitted in the J serial communications slot. This module is identified as 'IOExp' in the 'Comms' 'J' parameter list (see Chapter 13). It should be noted that, when this module is fitted in the J comms slot the remaining parameters in the 'Comms' 'J' list are not used.



It is recommended that a cable length of 10 metres is not exceeded, however, no shielding or twisted pair cable is required.

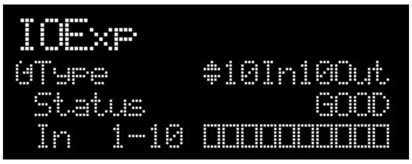
Figure 10-1: IO Expander Data Transfer

Wiring connections and further details of the IO Expander are given in the IO Expander Handbook, Part No. HA026893.

When this unit is connected to the controller it is necessary to set up parameters to determine its operation. These parameters can be set up in Level 3 or configuration level.

The IO Expander is enabled in Inst/Options Page, see Chapter 5.

10.1 To Configure the IO Expander

Do This	The Display You Should See	Additional Notes
25. From any display press until the **'IOExp'** page is reached		
Press to scroll to **'Type'** 26. Press or to select **'10In10Out'**		This configured an Io Expander for 10 inputs and 10 outputs. A further choice is 20In20Out

Remaining parameters in the Analogue Operators list are accessed and adjusted in the same way.

The list of parameters available is shown in the following table ⇓

10.1.1 IO Expander Parameters

List Header: IOExp	Sub-headers: None			
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Expander Type	Expander type	None 10In 10Out 20In 20Out	None 10 inputs 10 outputs 20 inputs 20 outputs	Conf
Status	IO Expander status	Good COMM FAIL	OK No communications	L3 R/O
In 1-10	Status of the first 10 digital inputs □□□□□□□□□□ to ■■■■■■■■■■	= Off ■ = On		L3 R/O
In 11-20	Status of the second 10 digital inputs □□□□□□□□□□ to ■■■■■■■■■■	= Off ■ = On		L3 R/O
Out21-30	Status of the first 10 digital outputs. Press to select outputs in turn. The flashing underlined output can be changed using ⬍ buttons. ⬍□□□□□□□□□□ to ⬍■■■■■■■■■■	= Off ■ = On		L3
Out31-40	Status of the second 10 digital outputs. Press to select outputs in turn. The flashing underlined output can be changed using ⬍ buttons. ⬍□□□□□□□□□□ to ⬍■■■■■■■■■■	= Off ■ = On		L3
Inv21-30	To change the sense of the first 10 outputs.	= direct ■ = Inverted		L3
Inv31-40	To change the sense of the second 10 outputs.	= direct ■ = Inverted		L3
In1 to In 20	State of each configured input	0 or 1	These are normally wired to a digital source. If not wired they can be changed here	L3
Out21 to Out 40	State of each configured output	0 or 1	Off or On	L3

11. CHAPTER 11 ALARMS

Alarms are used to alert an operator when a pre-set level has been exceeded. They are indicated by a message in the message centre and the red ALM beacon as described in section 1.15. They may also switch an output– usually a relay (see section 11.3.2) – to allow external devices to be operated when an alarm occurs.

Alarms can be divided into two main types. These are:-

Analogue alarms - operate by monitoring an analogue variable such as the process variable and comparing it with a set threshold.

Digital alarms – operate when the state of a boolean variable changes, for example, sensor break.

Number of Alarms - up to eight analogue and eight digital alarms may be configured. Any alarm can be enabled in the 'Inst' 'Opt' list as described in Chapter 5.

11.1 Further Alarm Definitions

Soft Alarms are indication only and do not operate an output.

Events are indication only but can operate an output. They can also be configured, using the editing tool (iTools), to provide text messages on the display. For the purpose of the configuration of this controller, alarms and events can be considered the same.

Hysteresis is the difference between the point at which the alarm switches 'ON' and the point at which it switches 'OFF'. It is used to provide a definite indication of the alarm condition and to prevent alarm relay chatter.

Latching Alarm used to hold the alarm condition once an alarm has been detected. It may be configured as:-

None	Non latching	A non latching alarm will reset itself when the alarm condition is removed
Auto	Automatic	An auto latching alarm requires acknowledgement before it is reset. The acknowledgement can occur BEFORE the condition causing the alarm is removed.
Manual	Manual	The alarm continues to be active until both the alarm condition is removed AND the alarm is acknowledged. The acknowledgement can only occur AFTER the condition causing the alarm is removed.
Event	Event	ALM beacon does not light but an output associated with this parameter will activate and a scrolling message will appear if this has been configured.

Blocking Alarms The alarm may be masked during start up. Blocking prevents the alarm from being activated until the process has first achieved a safe state. It is used, for example, to ignore start up conditions which are not representative of running conditions. A blocking alarm is re-initiated after a setpoint change.

Delay Applies to analogue alarms. A short time can be set for each alarm which prevents the output from going into the alarm state. The alarm is still detected as soon as it occurs, but if it cancels before the end of the delay period then no output is triggered. The timer for the delay is then reset. It is also reset if an alarm is changed from being inhibited to uninhibited.

11.2 Analogue Alarms

Analogue alarms operate on variables such as PV, output levels, etc. They can be soft wired to these variables to suit the process.

11.2.1 Analogue Alarm Types

Absolute High - an alarm occurs when the PV exceeds a set high threshold.

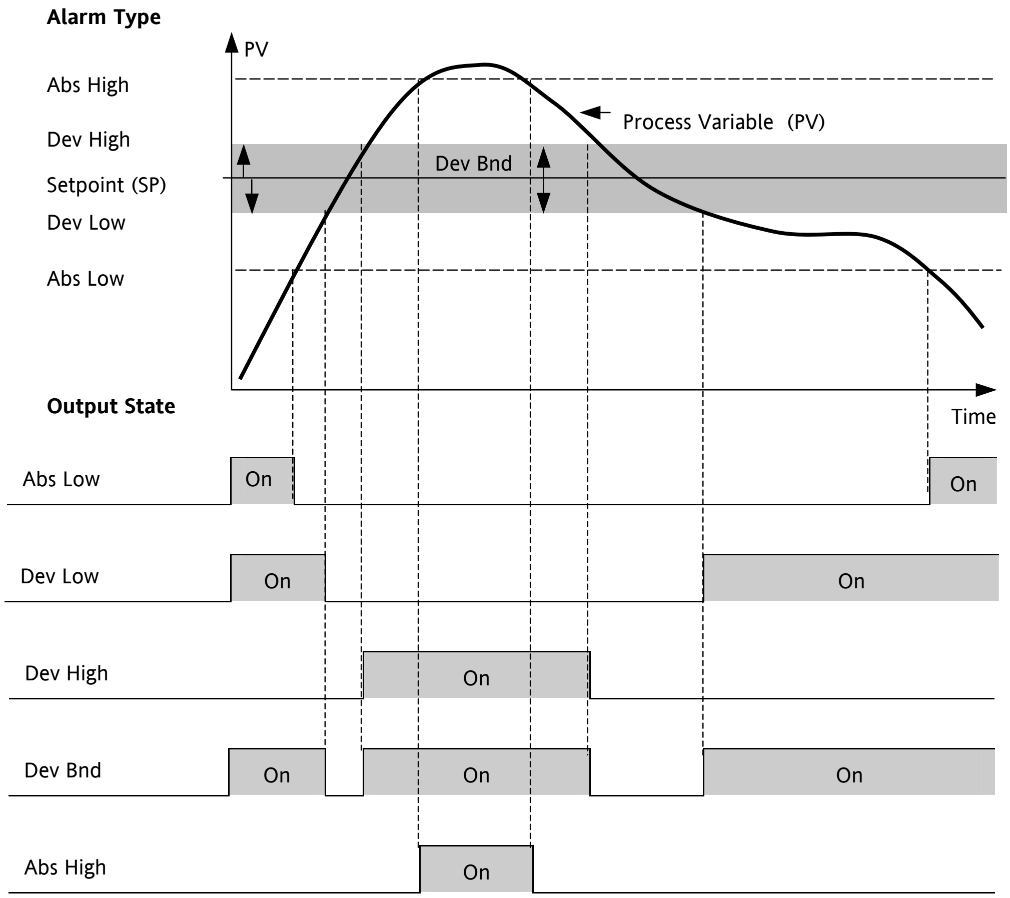
Absolute Low - an alarm occurs when the PV exceeds a set low threshold.

Deviation High - an alarm occurs when the PV is higher than the setpoint by a set threshold

Deviation Low - an alarm occurs when the PV is lower than the setpoint by a set threshold

Deviation Band - an alarm occurs when the PV is higher or lower than the setpoint by a set threshold

These are shown graphically below for changes in PV plotted against time. (Hysteresis set to zero)



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11.3 Digital Alarms

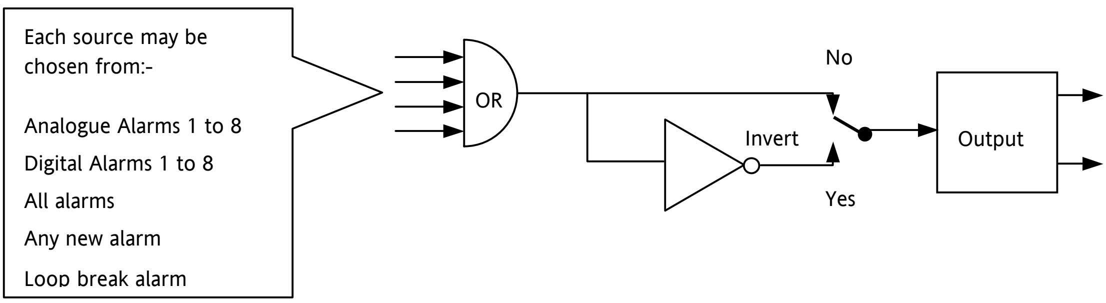
Digital alarms operate on Boolean variables. They can be soft wired to any suitable Boolean parameter such as digital inputs or outputs. When the state of the variable changes an alarm message is shown on the display. This message can be customised as described in Chapter 26.

11.3.1 Digital Alarm Types

Pos Edge	The alarm will trigger when the input changes from a low to high condition
Neg Edge	The alarm will trigger when the input changes from a high to low condition
Edge	The alarm will trigger on any change of state of the input signal
High	The alarm will trigger when the input signal is high
Low	The alarm will trigger when the input signal is low

11.3.2 Alarm Relay Output

As explained in Chapter 8, alarms can operate a specific output (usually a relay). Any individual alarm can operate an individual output or any combination of alarms, up to four, can operate an individual output. They are either supplied pre-configured in accordance with the ordering code or set up in configuration level.



11.3.3 How Alarms are Indicated

- ALM beacon flashing red = a new alarm (unacknowledged)
- This is accompanied by a scrolling alarm message. A typical default message will show the source of the alarm followed by the type of alarm. For example, 'AnAlm 1' is the default message for analogue alarm 1.
- Using Eurotherm iTools configuration package, it is also possible to download customised alarm messages. An example might be, 'Process Too Hot' for an analogue alarm or 'Vent open' for a digital alarm.
- If more than one alarm is present they are listed in the AlmSmry' (Alarm Summary) page.

ALM beacon on continuously = alarm has been acknowledged

Further details of alarm indication are shown in section 1.15.

11.3.4 To Acknowledge an Alarm

Press and **(Ack)** together.

The action, which now takes place, will depend on the type of latching, which has been configured

Non Latched Alarms

If the alarm condition is present when the alarm is acknowledged, the alarm beacon will be continuously lit. This state will continue for as long as the alarm condition remains. When the alarm condition disappears the indication will also disappear.

If a relay has been attached to the alarm output, it will de-energise when the alarm condition occurs and remain in this condition until the alarm is acknowledged **AND** it is no longer present.

If the alarm condition disappears before it is acknowledged the alarm indication disappears as soon as the condition disappears.

Automatic Latched Alarms

The alarm continues to be active until both the alarm condition is removed AND the alarm is acknowledged. The acknowledgement can occur **BEFORE** the condition causing the alarm is removed.

Manual Latched Alarms

The alarm continues to be active until both the alarm condition is removed AND the alarm is acknowledged. The acknowledgement can only occur **AFTER** the condition causing the alarm is removed.

11.4 Alarm Parameters

Eight alarms are available. Parameters do not appear if the Alarm Type = None. The following table shows the parameters to set up and configure alarms.

List Header: AnAlm	**Sub-headers: 1 to 8**				
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Type	Selects the type of alarm	None Abs Hi Abs Lo Dev Hi Dev Lo Dv Bnd	Alarm not configured Full Scale High Full Scale Low Deviation High Deviation Low Deviation band	As order code	Conf L3 R/O
Input	This is the parameter that will be monitored and compared against the threshold value to see if an alarm condition has occurred	Instrument range			L3
Reference	The reference value is used in deviation alarms and the threshold is measured from this reference and not from its absolute value.	Instrument range			L3
Threshold	The threshold is the value that the input is compared against to determine if an alarm has occurred.	Instrument range			L3
Output	The output indicates whether the alarm is on or off depending on the alarm condition, latching and acknowledge, inhibiting and blocking.	Off On	Alarm output deactivated Alarm output activated		L3 R/O
Inhibit	Inhibit is an input to the Alarm function. It allows the alarm to be switched OFF. Typically the Inhibit is connected to a digital input or event so that during a phase of the process alarms do not activate. For Example, if the door to a furnace is opened the alarms may be inhibited until the door is closed again.	No Yes	Alarm not inhibited Inhibit function active	As order code	L3
Hyst	Hysteresis is used to prevent signal noise from causing the Alarm output to oscillate. Alarm outputs become active as soon as the PV exceeds the Alarm Setpoint. They return to inactive after the PV has returned to the safe region by more than the hysterisis value. Typically the Alarm hysterisis is set to a value that is greater than the oscillations seen on the instrument display	Instrument range			L3
Latch	Determine the type of latching the alarm will use, if any. Auto latching allows acknowledgement while the alarm condition is still active, whereas manual latching needs the condition to revert back to safe before the alarm can be acknowledged. See also the description at the beginning of this chapter	None Auto Manual Event	No latching is used Automatic Manual Event		L3
Ack	Used in conjunction with the latching parameter. It is set when the user responds to an alarm.	No Yes	Not acknowledged Acknowledged		L3

Block	Alarm Blocking is used to prevent alarms from activating during start-up. In some applications, the measurement at start-up is in an alarm condition until the system has come under control. Blocking causes the alarms to be ignored until the system is under control (in the safe state), after this any deviations trigger the alarm	No Yes	No blocking Blocking		L3
Priority	There are three levels of priority, *low*, *medium* and *high*. When an alarm is triggered a popup is shown on the instrument display. Higher level alarms override lower level ones.	Med	A medium priority alarm will cause a pop-up and supersedes a low priority alarm.	Med	L3
		High	A high priority alarm supersedes both low and medium alarms.		
		Low	A low priority alarm will cause a pop-up.		
Delay	This is a small delay between sensing the alarm condition and displaying it. If in the time between the two, the alarm goes safe, then no alarm is shown and the delay timer is reset. It can be used on systems that are prone to noise.	0:00.0 to 500 mm:ss.s hh:mm:ss hhh:mm		0:00.0	L3

11.4.1 Example: To Configure Alarm 1

Enter configuration level as described. Then:-

Do This	The Display You Should See	Additional Notes
1. Press as many times as necessary to select **'AnAlm'**		Up to 8 alarms can be selected using or provided they have been enabled in the '**Inst**' '**Opt'** page
1. Press to select **'Type'** 2. Press or to select the required alarm type		Alarm Type choices are:- None Alarm not configured Abs Hi Full Scale High Abs Lo Full Scale Low Dev Hi Deviation High Dev Lo Deviation Low Dv Bnd Deviation Band
3. Press to select **'Threshold'** 4. Press or to set the alarm trip level		This is the alarm threshold setting for. In this example the high alarm will be detected when the measured value exceeds 100.00. The current measured value is 50.00 as measured by the 'Input' parameter. This parameter will normally be wired to an internal source such as the PV.

5. Press ⟳ to select **'Hyst'** 6. Press ▲ or ▼ to set the hysteresis		In this example the alarm will cancel when the measured value decreases 2 units below the trip level (at 98 units)
7. Continue to select parameters using ⟳ and setting their values using ▲ or ▼		

11.5 Diagnostic Alarms

Diagnostic alarms indicate a possible fault within the controller or connected devices.

Display shows	What it means	What to do about it
E.Conf	A change made to a parameter takes a finite time to be entered. If the power to the controller is turned off before the change has been entered then this alarm will occur. Do not turn the power off to the controller while ConF is flashing	Enter configuration mode then return to the required operating mode. It may be necessary to re-enter the parameter change since it will not have been entered in the previous configuration.
E.CaL	Calibration error	Re-instate Factory calibration
E2.Er	EEPROM error	Return to factory for repair
EE.Er	Non-vol memory error	Note the error and contact your supplier
E.Lin	Invalid input type. This refers to custom linearisation which may not have been applied correctly or may have been corrupted.	Go to the INPUT list in configuration level and set a valid thermocouple or input type

11.6 To Set Up Alarms Using iTools

iTools may be used to configure alarms and enter alarm messages. See Chapter 26 for a details.

12. BCD INPUT

The Binary Coded Decimal (BCD) input function block uses a number of digital inputs and combines them to make a numeric value. A very common use for this feature is to select a setpoint program number from panel mounted BCD decade switches.

The block uses 4 bits to generate a single digit.

Two groups of four bits are used to generate a two digit value (0 to 99)

The block outputs four results

1. Units Value: The BCD value taken from the first four bits (range 0 – 9)
2. Tens Value: The BCD value taken from the second four bits (range 0 – 9)
3. BCD Value: The combined BCD value taken from all 8 bits (range 0 – 99)
4. Decimal Value: The decimal numeric equivalent of Hexadecimal bits (range 0 – 255)

The following table shows how the input bits combine to make the output values.

<table>
<tr><td>Input 1</td><td rowspan="4">Units value (0 – 9)</td><td rowspan="8">BCD value (0 – 99)</td><td rowspan="8">Decimal value (0 – 255)</td></tr>
<tr><td>Input 2</td></tr>
<tr><td>Input 3</td></tr>
<tr><td>Input 4</td></tr>
<tr><td>Input 5</td><td rowspan="4">Tens value (0 – 9)</td></tr>
<tr><td>Input 6</td></tr>
<tr><td>Input 7</td></tr>
<tr><td>Input 8</td></tr>
</table>

Since the inputs cannot all be guaranteed to change simultaneously, the output will only update after all the inputs have been stable for two samples.

12.1 BCD Parameters

List Header - BCDIn		**Sub-headers: 1 and 2**			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
In 1	Digital Input 1	On or Off	Alterable from the operator interface if not wired	Off	L3
In 2	Digital Input 2	On or Off		Off	L3
In 3	Digital Input 3	On or Off		Off	L3
In 4	Digital Input 4	On or Off		Off	L3
In 5	Digital Input 5	On or Off		Off	L3
In 6	Digital Input 6	On or Off		Off	L3
In 7	Digital Input 7	On or Off		Off	L3
In 8	Digital Input 8	On or Off		Off	L3
Dec Value	Decimal value of the inputs	0 – 255	See examples below		L3 R/O
BCD Value	Reads the value (in BCD) of the switch as it appears on the digital inputs	0 – 99	See examples below		
Units	Units value of the first switch	0 – 9	See examples below		L3 R/O
Tens	Units value of the second switch	0 – 9	See examples below		L3 R/O

In 1	In 2	In 3	In 4	In 5	In 6	In 7	In 8	Dec	BCD	Units	Tens
1	0	0	0	0	0	0	0	1	1	1	0
1	1	1	1	0	0	0	0	15	9	9	0
0	0	0	0	1	1	1	1	240	90	0	9
1	1	1	1	1	1	1	1	255	99	9	9

12.1.1 Example: To wire a BCD Input

The BCD digital input parameters may be wired to digital input terminals of the controller. There are two standard digital input terminals which may be used (LA and LB), but it may also be necessary to use a triple digital input module in addition. The wiring procedure is the same and the example given below wires BCD input 1 to LA.

Do This	The Display You Should See	Additional Notes
27. From any display press until the **'BCDIn'** page is reached 28. Press or to select **'1'** or **'2'** as required		In this example BCD block 1 is used.
29. Press to scroll to **'In1'**		
30. Press to display **'WireFrom'**		
31. Using and select the parameter which is to be wired from. In this example Logic input LA		PV is the parameter required and this procedure 'copies' the parameter to be wired from
32. Press		
33. Press to confirm		This 'pastes' the parameter to 'In1' Note the arrow next to the parameter which indicates it has been wired

13. DIGITAL COMMUNICATIONS

Digital Communications (or 'comms' for short) allows the controller to communicate with a PC or a networked computer system or any type of communications master using the protocols supplied. Communications can be used for many purposes – data logging for archiving and plant diagnostic purposes; cloning for saving instrument set ups for future expansion of the plant or to allow you to recover a set-up after a fault.

This product supports the following protocols:-

- MODBUS RTU ® a full description of which can be found on www.modbus.org. See also 2000 series Communications Handbook, part number HA026230.
- EI-Bisynch. See also 2000 series Communications Handbook, part number HA026230.
- DeviceNet. See also DeviceNet Communications Handbook Part No. HA027506
- Profibus. See also Profibus Communications Handbook Part No. HA026290
- Ethernet.

The above handbooks may be downloaded from www.eurotherm.co.uk.

There are two communications ports available within the instrument; these are defined as the 'H' and 'J' ports and act as a communications slave. Various communications modules may be fitted to each port.

The following table shows the protocols supported by each port within the instrument:-

Port	ModBus	EI-Bisynch	DeviceNet	Profibus	Ethernet
H	✔	✔	✔	✔	✔
J	✔	✔	X	X	X

Wiring connections for each of these protocols is given in Chapter1.

Note:- When using DeviceNet with instrument firmware version 1.10 and greater, the DeviceNet module must have the part no. AH027179U003

13.1 Serial Communications

ModBus and EI-Bisynch use RS232 and RS485 2-wire serial communications. The wiring connections for these and the other protocols are given in Chapter 1.

13.1.1 RS232

RS232 uses a three wire cable (Tx, Rx, Gnd). The signals are single ended, i.e. there is a single wire for transmit and another for receive. This makes RS232 less immune to noise in industrial applications. RS232 can only be used with one instrument. To use RS232 the PC will be equipped with an RS232 port, usually referred to as COM 1.

To construct a cable for RS232 operation use a three core screened cable.

The terminals used for RS232 digital communications are listed in the table below. Some PC's use a 25 way connector although the 9 way is more common.

Standard Cable Colour	PC socket pin no. 9 way	25 way	PC Function *	Instrument Terminal	Instrument Function
White	2	3	Receive (RX)	HF or JF	Transmit (TX)
Black	3	2	Transmit (TX)	HE or JE	Receive (RX)
Red	5	7	Common	HD or JD	Common
Link together	1 4 6	6 8 11	Rec'd line sig. detect Data terminal ready Data set ready		
Link together	7 8	4 5	Request to send Clear to send		
Screen		1	Ground		

* These are the functions normally assigned to socket pins. Please check your PC manual to confirm.

13.1.2 RS485

The RS485 standard allows one or more instruments to be connected (multi dropped) using a two wire connection, with cable length of less than 1200M. 31 instruments and one master may be connected. The balanced differential signal transmission is less prone to interference and should be used in preference to RS232 in noisy environments. RS485 may be used with Half Duplex Communications such as MODBUS RTU.

To use RS485, buffer the RS232 port of the PC with a suitable RS232/RS485 converter. The Eurotherm KD485 Communications Adapter unit is recommended for this purpose. The use of a RS485 board built into the computer is not recommended since this board may not be isolated, which may cause noise problems or damage to the computer, and the RX terminals may not be biased correctly for this application.

To construct a cable for RS485 operation use a screened cable with one (RS485) twisted pair plus a separate core for common. Although common or screen connections are not necessary, their use will significantly improve noise immunity.

The terminals used for RS485 digital communications are listed in the table below.

Standard Cable Colour	PC Function *	Instrument Terminal	Instrument Function
White	Receive (RX+)	HF or JF (B) or (B+)	Transmit (TX)
Red	Transmit (TX+)	HE or JE (A) or (A+)	Receive (RX)
Green	Common	HD or JD	Common
Screen	Ground		

* These are the functions normally assigned to socket pins. Please check your PC manual to confirm .

13.2 Configuration Ports

In addition to the above communications the 'H' port also supports infrared (IR Clip) and configuration (CFG Clip) communications see also Chapter 26. These interfaces always adhere to default settings regardless of the 'H' port set up. These are:-

- ModBus protocol
- Instrument address 255
- Baud rate 19K2
- No parity

13.2.1 IR Clip

An IR Clip is available from Eurotherm which clips to the front of the controller as shown. It is enabled/disabled via the "IR Mode" parameter within the "Access" page of the instrument. When enabled the IR communications override all standard 'H' port communications. None of the standard communications detailed above will be responded to while IR Mode is enabled. 'H' port activities will not interfere with IR Clip communications.

Fitting of the CFG clip is the only communications mechanism that overrides IR clip communications.

13.2.2 CFG Clip

A configuration clip is also available from Eurotherm which interfaces directly with the main printed circuit board in the controller. It can be clipped into position with the controller in or out of its sleeve. The CFG Clip is automatically detected when connected but should not be used while 'H' port communications are active. Note: The CFG clip must be powered externally to ensure detection and may be used to power the instrument or while the instrument is already powered.

The DeviceNet communications module should not be fitted while using the CFG Clip as communications conflicts will occur. The minimum revision for DeviceNet communications module software used with the 3500 instruments is revision 1.6. This is identified by the module part no. AH027179U003.

The Ethernet communications module should also not be fitted while using the CFG Clip. This is because both the DeviceNet and Ethernet Communications Modules maintain constant messaging between themselves and the instrument even when no external messages are being received.

The CFG clip may be used while RS232/RS485/ProfiBus communications modules are fitted but it is not recommended that communications are active on these modules while the CFG clip is in use as conflict may occur.

Fitting of the CFG clip while the IR clip is in use will result in the IR communications being overridden and the CFG clip communications accepted.

Full instrument cloning is supported via the CFG clip without the need for instrument power although errors may be reported with I/O module settings. This is due to the modules not being powered during the operation so confirmation of downloaded settings will not be possible. Configuration of IO module settings via the CFG Clip when the instrument is not powered is not possible as the modules are not powered and therefore not detected.

13.3 Broadcast Master Communications

Broadcast master communications will to allow the 3500 series controllers to send a single value to any slave instruments using a Modbus broadcast using function code 6 (Write single value). This allows the 3500 to link through digital communications with other products without the need for a supervisory PC to create a small system solution.

Example applications include multi-zone profiling applications or cascade control using a second controller. The facility provides a simple and precise alternative to analogue retransmission.

⚠ **Warning**

When using broadcast master communications, bear in mind that updated values are sent many times a second. Before using this facility, check that the instrument to which you wish to send values can accept continuous writes. ***Note that in common with many third party lower cost units, the Eurotherm 2200 series and the 3200 series prior to version V1.10 do not accept continuous writes to the temperature setpoint. Damage to the internal non-volatile memory could result from the use of this function. If in any doubt, contact the manufacturer of the device in question for advice.***

When using the 3200 series fitted software version 1.10 and greater, use the Remote Setpoint variable at Modbus address 26 if you need to write to a temperature setpoint. This has no write restrictions and may also have a local trim value applied. There is no restriction on writing to the 2400 or 3500 series.

13.3.1 3500 Broadcast Master

The 3500 broadcast master can be connected to up to 31 slaves if no segment repeaters are used. If repeaters are used to provide additional segments, 32 slaves are permitted in each new segment. The master is configured by selecting a Modbus register address to which a value is to be sent. The value to send is selected by wiring it to the Broadcast Value. Once the function has been enabled, the instrument will send this value out over the communications link every control cycle (110ms).

Notes:-

1. The parameter being broadcast must be set to the same decimal point resolution in both master and slave instruments.
2. If iTools, or any other Modbus master, is connected to the port on which the broadcast master is enabled, then the broadcast is temporarily inhibited. It will restart approximately 30 seconds after iTools is removed. This is to allow reconfiguration of the instrument using itools even when broadcast master communications is operating.

A typical example might be a multi zone oven where the setpoint of each zone is required to follow, with digital accuracy, the setpoint of a master.

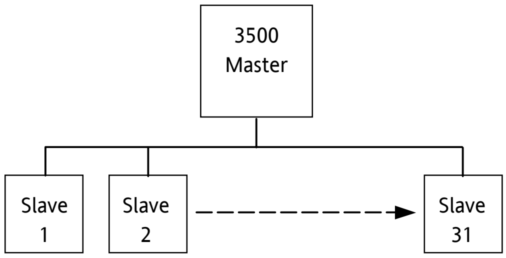


Figure 13-3: Broadcast Comms

13.3.2 Wiring Connections - Broadcast Communications

The Digital Communications module for the master can be fitted in either Comms Module slot H or J and uses terminals H(J)A to h(J)F.

The Digital Communications module for the slave is fitted in either slot J or slot H

RS422, RS485 4-wire or RS232

Rx connections in the master are wired to Tx connections of the slave

Tx connections in the master are wired to Rx connections of the slave

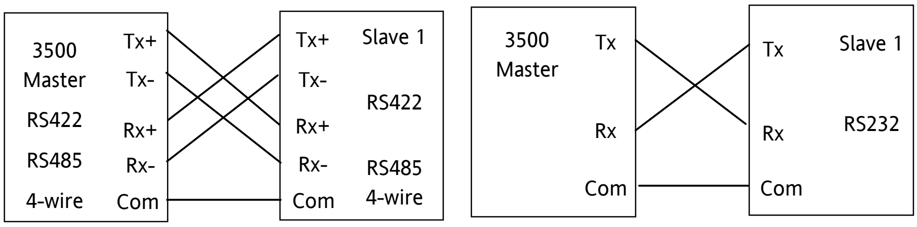


Figure 13-4: Rx/Tx Connections for RS422, RS485 4-wire, Rs232

RS485 2-wire

Connect A (+) in the master to A (+) of the slave

Connect B (-) in the master to B (-) of the slave

This is shown diagrammatically below

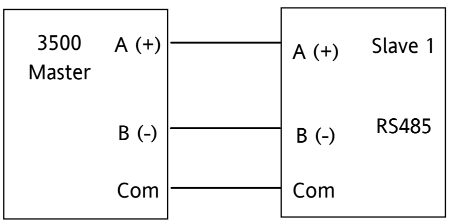


Figure 13-5: Rx/Tx Connections RS484 2-wire

13.4 Digital Communications Parameters

The following table shows the parameters available.

List Header - Comms		Sub-headers: H and J			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Ident	Identifies that the comms module is fitted in the H or J slot	None Comms	No module fitted Communications module fitted	As ordered	R/O
Protocol	Digital communications protocol	MODBUS EIBISYNCH Profibus DeviceNet Ethernet		MODBUS	
Baud Rate	Communications baud rate Not applicable to Profibus or Ethernet	Modbus/EI-Bisynch 4800 9600 19,200	Devicenet 125K 250K 500K	9600 EI-Bi 19K2 Mod 125K Dnet	Conf L3 R/O
Parity	Communications parity (not Devicenet or Profibus)	None Even Odd	No parity Even parity Odd parity	None	Conf L3 R/O
Address	Instrument address	1 to 254 Modbus/EI-Bisynch 0 to 126 Profibus 0 to 63 Devicenet		1	L3
Resolution	Comms resolution (Modbus only)	Full Integer	Full Integer	Full	Conf
Network	Network Status For Profibus and DeviceNet only. Displays status of the network and connection	Ready Offline	Network connected and working Network not connected		R/O
Comms Delay	Rx/Tx delay time (not Devicenet or Profibus)	No Yes	No delay Fixed delay. This inserts a delay between Rx and Tx to ensure that the drivers used by intelligent RS232/RS485 converters have sufficient time to switch over.	No	Conf L3 R/O
Rx Timeout	Timeout value (not shown if Devicenet)	None to			
H Activity	Comms activity in H or J module	0 or 1			
Broadcast See section 13.3	To enable broadcast master communications. This is only applicable for Modbus protocol.	No Yes	Not enabled 0mS Enabled 10mS	No	
Dest Addr ⚠ See section 13.3	Address of the parameter being written to slaves. For example, to write to power output set the value to 3, the Modbus address of the parameter being written to.	0 to 32767			
Bcast Val See section 13.3	Value to be sent to instruments on the network. This would normally be wired to a parameter within the 3500 master	Range of the parameter wired. In the case of a Boolean the value will be 0 or 1.			

13.4.1 Communications Identity

The identity **'id'** shows that a communications board is fitted or not.

13.4.2 Communication Address

On a network of instruments an address is used to specify a particular instrument. Each instrument on a network should have a unique address. Address 255 (and address 244 when using Ethernet) is reserved for factory use.

13.4.3 Baud Rate

The baud rate of a communications network specifies the speed that data is transferred between instrument and master. A baud rate of 9600 equates to 9600 Bits per second. Since a single character requires 8 bits of data plus start, stop, and optional parity, up to 11 bits per byte may be transmitted. 9600 baud equates approximately to 1000 Bytes per second. 4800 baud is half the speed – approx. 500 Bytes per second.

In calculating the speed of communications in your system it is often the Latency between a message being sent and a reply being started that dominates the speed of the network.

For example, if a message consists of 10 characters (10msec at 9600 Baud) and the reply consists of 10 characters, then the transmission time would be 20 msec. However, if the Latency is 20msec, then the transmission time has become 40msec.

13.4.4 Parity

Parity is a method of ensuring that the data transferred between devices has not been corrupted.

Parity is the lowest form of integrity in the message. It ensures that a single byte contains either an even or an odd number of ones or zero in the data.

In industrial protocols, there are usually layers of checking to ensure that the first byte transmitted is good. Modbus applies a CRC (Cyclic Redundancy Check) to the data to ensure that the package is correct.

13.4.5 RX/TX Delay Time

In some systems it is necessary to introduce a delay between the instrument receiving a message and its reply. This is sometimes caused by communications converter boxes which require a period of silence on the transmission to switch over the direction of their drivers.

13.5 Example 1:- To Set Up Instrument Address

This can be done in operator level 3:-

Do This	The Display You Should See	Additional Notes
1. Press as many times as necessary to select **'Comms'**		
2. Press to scroll to 'Address' 3. Press or to select the address for the particular controller		Up to 254 can be chosen but note that no more than 31 instruments should be connected to a single RS485 link. For further information see 2000 Series Communications Handbook Part No. HA026230 available on www.eurotherm.co.uk

13.6 Example 2: To Send SP from the Master to PV in a Slave

1. Wire the **setpoint** in the master to '**Bcast Val'**. The procedure for this is shown in section 4.1.2. or using iTools section 26.10.
2. Set '**Dest Addr'** in the master to '**2**'. 2 is the modbus value for '**Target SP'**. The value of the master setpoint will be shown in the lower display on the slave (assuming the slave has been configured for SP in the lower display).

13.7 Modbus Addresses

The Modbus addresses for all parameters is available from www.eurotherm.co.uk. The list below gives a selection from this list of the most popular addresses.

Address Decimal	Address Hex	Parameter	Address Decimal	Address Hex	Parameter
1	0x0001	Loop.Main.PV	38	0x0026	PV.Emissivity
2	0x0002	Loop.Main.TargetSP	39	0x0027	Loop.Diag.Error
3	0x0003	Loop.OP.ManualOutVal	45	0x002d	LgcIO.LA.MinOnTime
4	0x0004	Loop.Main.ActiveOut	46	0x002e	Loop.OP.PotCalibrate
5	0x0005	Loop.Main.WorkingSP	47	0x002f	Alarm.1.Hysteresis
6	0x0006	Loop.PID.ProportionalBand	48	0x0030	Loop.PID.ProportionalBand2
7	0x0007	Loop.Setup.ControlAction	49	0x0031	Loop.PID.IntegralTime2
8	0x0008	Loop.PID.IntegralTime	50	0x0032	Loop.PID.ManualReset2
9	0x0009	Loop.PID.DerivativeTime	51	0x0033	Loop.PID.DerivativeTime2
11	0x000b	Loop.SP.RangeLow	52	0x0034	Loop.PID.RelCh2Gain2
12	0x000c	Loop.SP.RangeHigh	53	0x0035	Loop.OP.Ch1PotPosition
13	0x000d	Alarm.1.Threshold	54	0x0036	LgcIO.LA.MinOnTime
14	0x000e	Alarm.2.Threshold	55	0x0037	Loop.Diag.IntegralOutContrib
15	0x000f	Loop.SP.SPSelect	56	0x0038	Programmer.Run.CurSeg
16	0x0010	Loop.OP.Ch2Deadband	57	0x0039	Programmer.Run.FastRun
17	0x0011	Loop.PID.CutbackLow	58	0x003a	Programmer.Run.ProgTimeLeft
18	0x0012	Loop.PID.CutbackHigh	59	0x003b	Programmer.Run.CyclesLeft
19	0x0013	Loop.PID.RelCh2Gain	63	0x003f	Programmer.Run.SegTimeLeft
21	0x0015	Loop.OP.Ch1TravelTime	66	0x0042	Loop.SP.SPTrimHighLimit
22	0x0016	Programmer.Run.CurProg	67	0x0043	Loop.SP.SPTrimLowLimit
23	0x0017	Programmer.Run.ProgStatus	68	0x0044	Alarm.2.Hysteresis
24	0x0018	Loop.SP.SP1	69	0x0045	Alarm.3.Hysteresis
25	0x0019	Loop.SP.SP2	71	0x0047	Alarm.4.Hysteresis
27	0x001b	Loop.SP.SPTrim	72	0x0048	Loop.PID.ActiveSet
28	0x001c	Loop.PID.ManualReset	73	0x0049	Instrument.Diagnostics.ErrCount
29	0x001d	Programmer.Run.CurSegType	78	0x004e	Loop.SP.RateDisable
30	0x001e	Loop.OP.OutputHighLimit	81	0x0051	Alarm.3.Threshold
31	0x001f	Loop.OP.OutputLowLimit	82	0x0052	Alarm.4.Threshold
34	0x0022	Loop.OP.SafeOutVal			
35	0x0023	Loop.SP.Rate			
36	0x0024	Programmer.Run.SegTimeLeft			
37	0x0025	Loop.OP.Rate			

13.8 Ethernet

13.8.1 Instrument setup

Note1: It is recommended that you setup the communications settings for each instrument *before connecting it to any Ethernet network*. This is not essential but network conflicts may occur if the default settings interfere with equipment already on the network. By default the instruments are set to a fixed IP address of 192.168.111.222 with a default SubNet Mask setting of 255.255.255.0.

Note2: IP Addresses are usually presented in the form "xxx.xxx.xxx.xxx". Within the instrument *each element of the IP Address is shown and configured separately*.

"**IP address 1**" relates to the first set of three digits, IP address 2 to the second set of three digits and so on. This also applies to the SubNet Mask, Default Gateway and Preferred master IP Address.

13.8.2 MAC address display

Each Ethernet module contains a unique MAC address, normally presented as a 12 digit hexadecimal number in the format "aa-bb-cc-dd-ee-ff".

In the **3500** instruments MAC addresses are shown as 6 separate hexadecimal values in the "COMMS" page. MAC1 shows the first pair of digits (example "0xAA"), MAC2 shows the second pair of digits and so on.

The MAC address can be found by powering up the instrument and navigating to the "**COMMS**" page. At the bottom of the "**COMMS**" page you will find a 'Show Mac' parameter. Set this parameter to 'Yes' and the MAC address of the Ethernet communications card fitted will appear in the list.

13.8.3 DHCP Settings

You need to consult with your network administrator to determine if the IP Addresses for the instruments should be fixed or Dynamically allocated by a DHCP server.

If the IP Addresses are to be dynamically allocated then all MAC addresses must be supplied to the network administrator.

For fixed IP Addresses the Network Administrator will provide the IP address as well as a SubNet Mask. These must be configured into the instrument during set-up through the "COMMS" page. Remember to note the allocated addresses.

13.8.4 Network Connection

Screw the "RJ45" adapter into the instrument "H" port, as shown in section 1.7.6. Use standard CAT5 cable to connect to the Ethernet 10BaseT switch or hub. Use cross-over cable only if connecting one-to-one with a PC acting as network master.

13.8.5 Dynamic IP Addressing

Within the "**Comms**" page of the instrument set the "**DHCP enable**" parameter to "**Dynamic**". Once connected to the network and powered, the instrument will acquire its "IP address", "SubNet Mask" and "Default gateway" from the DHCP Server and display this information within a few seconds.

13.8.6 Fixed IP Addressing

Within the "**Comms**" page of the instrument ensure the "**DHCP enable**" parameter is set to "**Fixed**", then set the IP address and SubNet Mask as required (and defined by your network administrator).

13.8.7 Additional notes

1. The "**Comms**" page also includes configuration settings for "**Default Gateway**", these parameters will be set automatically when Dynamic IP Addressing is used. When fixed IP addressing is used these settings are only required if the instrument needs to communicate wider than the local area network i.e. over the internet – see your network administrator for the required setting.
2. The "**Comms**" page also includes configuration settings for "**Preferred Master**". Setting this IP address to the IP Address of a particular PC will guarantee that one of the 4 available Ethernet sockets will always be reserved for that PC (reducing the number of available sockets for anonymous connections to 3).

13.8.8 iTools Setup

iTools configuration package, version V5.60 or later, may be used to configure Ethernet communications.

The following instructions configure Ethernet.

To include a Host Name/Address within the iTools scan:-

1. Ensure iTools is **NOT** running before taking the following steps
2. Within Windows, click **'Start'**, the **'Settings'**, then '**Control Panel'**
3. In control panel select **'iTools'**
4. Within the iTools configuration settings select the **'TCP/IP'** tab
5. Click the **'Add'** button to add a new connection
6. Enter a name for this TCP/IP connection
7. Click the '**Add'** button to add the host name (details from your network administrator) or IP address of the instrument in the '**Host Name/ Address'** section
8. Click '**OK'** to confirm the new Host Name/IP Address you have entered
9. Click '**OK'** to confirm the new TCP/IP port you have entered
10. You should now see the TCT/IP port you have configured within the TCP/IP tab of the iTools control panel settings

iTools is now ready to communicate with an instrument at the Host Name/Ip Address you have configured

13.8.9 Ethernet Parameters

List Header - Comms		Sub-header: H			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Ident	Identifies that the comms module is fitted in the selected slot H or J	None Comms	No module fitted Communications module fitted		R/O
Protocol	Digital communications protocol	MODBUS; EIBISYNCH; Profibus; Devicenet; Ethernet			
Address	Instrument address	1 to 253		1	
DHCP enable	See section 13.8	Fixed Dynamic		Fixed	
IP Address 1	See section 13.8	0 to 255		192	
IP Address 2	See section 13.8	0 to 255		168	
IP Address 3	See section 13.8	0 to 255		111	
IP Address 4	See section 13.8	0 to 255		222	
Subnet mask 1	See section 13.8	0 to 255		255	
Subnet mask 2	See section 13.8	0 to 255		255	
Subnet mask 3	See section 13.8	0 to 255		255	
Subnet mask 4	See section 13.8	0 to 255		0	
Default GW 1	See section 13.8			0	
Default GW 2	See section 13.8			0	
Default GW 3	See section 13.8			0	
Default GW 4	See section 13.8			0	
Pref mstr IP 1	See section 13.8			0	
Pref mstr IP 2	See section 13.8			0	
Pref mstr IP 3	See section 13.8			0	
Pref mstr IP 4	See section 13.8			0	
Show MAC	See section 13.8	No; Yes		No	
Network	Status of network	Running Offline	Network connected and working Network not connected or working		R/O

14. COUNTERS, TIMERS, TOTALISERS, REAL TIME CLOCK

A series of function blocks are available which are based on time/date information. These may be used as part of the control process.

14.1 Counters

Up to two counters are available. They provide a synchronous edge triggered event counter.

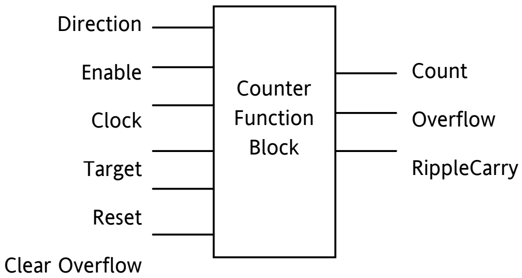


Figure 14-1: Counter Function Block

When configured as an Up counter, Clock events increment Count until reaching the Target. On reaching Target RippleCarry is set true. At the next clock pulse, Count returns to zero. Overflow is latched true and RippleCarry is returned false.

When configured as a down counter, Clock events decrement Count until it reaches zero. On reaching zero RippleCarry is set true. At the next clock pulse, Count returns to the Target count. Overflow is latched true and RippleCarry is reset false

Counter blocks can be cascaded as shown in the diagram below

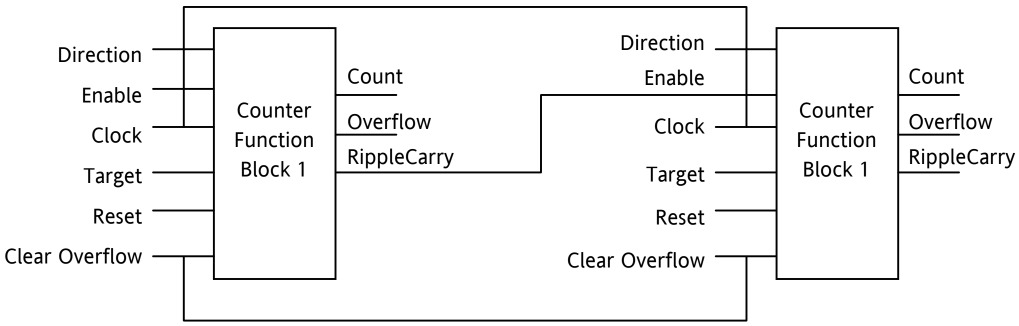


Figure 14-2: Cascading Counters

The RippleCarry output of one counter acts as an enabling input for the next counter. In this respect the next counter in sequence can only detect a clock edge if it was enabled on the previous clock edge. This means that the Carry output from a counter must lead its Overflow output by one clock cycle. The Carry output is, therefore, called a RippleCarry as it is NOT generated on an Overflow (i.e. Count $\geq$ Target) but rather when the count reaches the target (i.e. Count = Target). The timing diagram below illustrates the principle for the Up Counter.

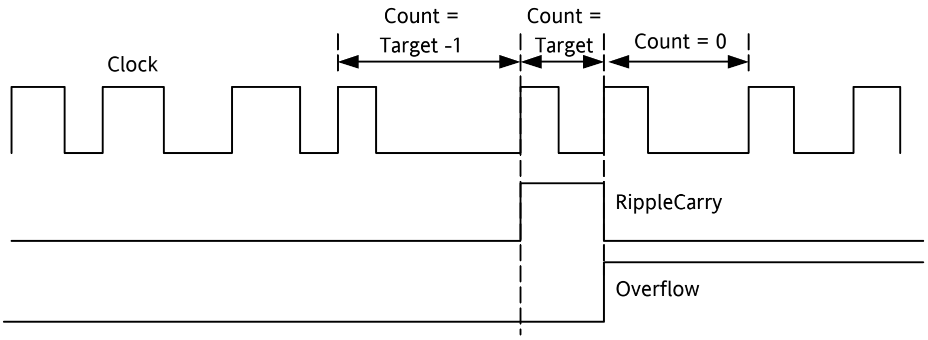


Figure 14-3: Timing Diagram for an Up Counter

14.1.1 Counter Parameters

List Header - Count		Sub-headers: 1 to 2			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Enable	Counter enable. Counter 1 or 2 is enabled in the Instrument configuration page but they can also be turned on or off in this list	Yes No	Enabled Disabled	Yes	L3
Direction	Defines count up or count down. This is not intended for dynamic operation (i.e. subject to change during counting). It can only be set in configuration level.	Up Down	Up counter Down counter	Up	Conf L3 R/O
Ripple Carry	Ripple carry to act as an enabling input to the next counter. It is turned On when the counter reaches the target set	Off			R/O
Overflow	Overflow flag is turned on when the counter reaches zero				R/O
Clock	Tick period to increment or decrement the count. This is normally wired to an input source such as a digital input.	0 1	No clock input Clock input present	0	R/O if wired
Target	Level to which the counter is aiming	0 to 99999			L3
Count	Counts each time a clock input occurs until the target is reached.	0 to 99999			R/O
Reset	Resets the counter	No Yes	Not in reset Reset	No	L3
Clear O'flow	Clear overflow	No Yes	Not cleared Cleared	No	L3

14.2 Timers

Up to four timers can be configured. Each one can be configured to a different type and can operate independently of one another.

14.2.1 Timer Types

Each timer block can be configured to operate in four different modes. These modes are explained below

14.2.2 On Pulse Timer Mode

This timer is used to generate a fixed length pulse from an edge trigger.

- The output is set to On when the input changes from Off to On.
- The output remains On until the time has elapsed
- If the 'Trigger' input parameter recurs while the Output is On, the Elapsed Time will reset to zero and the Output will remain On
- The triggered variable will follow the state of the output

The diagram illustrates the behaviour of the timer under different input conditions.

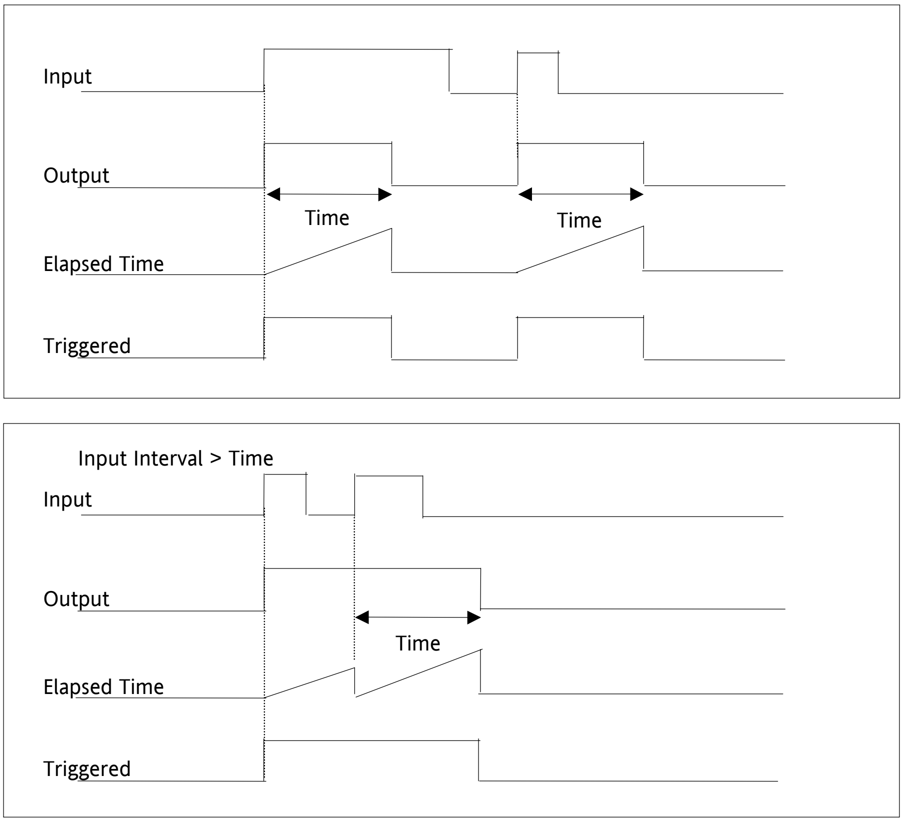


Figure 14-4: On Pulse Timer Under Different Input Conditions

14.2.3 Off Delay Timer Mode

This timer provides a delay between the trigger event and the Timer output. If a short pulse triggers the Timer, then a pulse of one sample time (110ms) will be generated after the delay time.

- The Output is set to Off when the Input changes from Off to On.
- The Output remains Off until the Time has elapsed.
- If the Input returns to Off before the time has elapsed, the Timer will continue until the Elapsed Time equals the Time. It will then generate a pulse of one Sample Time duration.
- Once the Time has elapsed, the Output will be set to On.
- The Output will remain On until the Input is cleared to Off.
- The Triggered variable will be set to On by the Input changing from Off to On. It will remain On until both the Time has elapsed and the Output has reset to Off.

The diagram illustrates the behaviour of the timer under different input conditions.

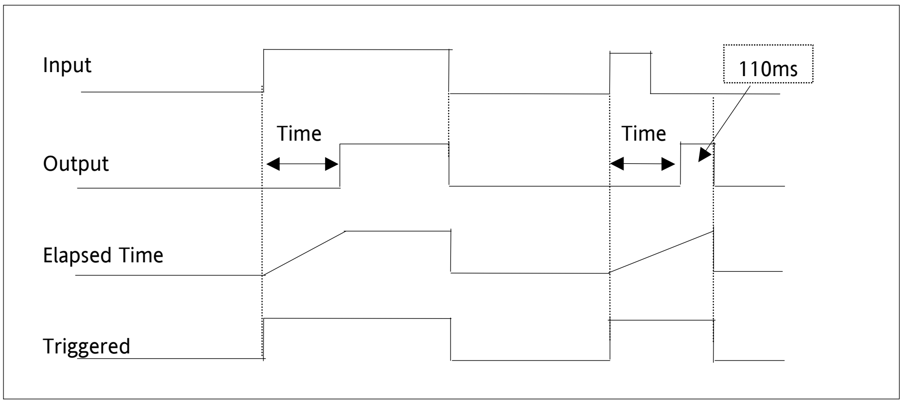


Figure 14-5: Off Delay Timer Under Different Input Conditions

14.2.4 One Shot Timer Mode

This timer behaves like a simple oven timer.

- When the Time is edited to a non-zero value the Output is set to On
- The Time value is decremented until it reaches zero. The Output is then cleared to Off
- The Time value can be edited at any point to increase or decrease the duration of the On time
- Once set to zero, the Time is not reset to a previous value, it must be edited by the operator to start the next On-Time
- The Input is used to gate the Output. If the Input is set, the time will count down to zero. If the Input is cleared to Off, then the Time will hold and the Output will switch Off until the Input is next set.

Note: since the Input is a digital wire, it is possible for the operator to NOT wire it, and set the Input value to On which permanently enables the timer.

- The Triggered variable will be set to On as soon as the Time is edited. It will reset when the Output is cleared to Off.

The behaviour of the timer under different input conditions is shown below.

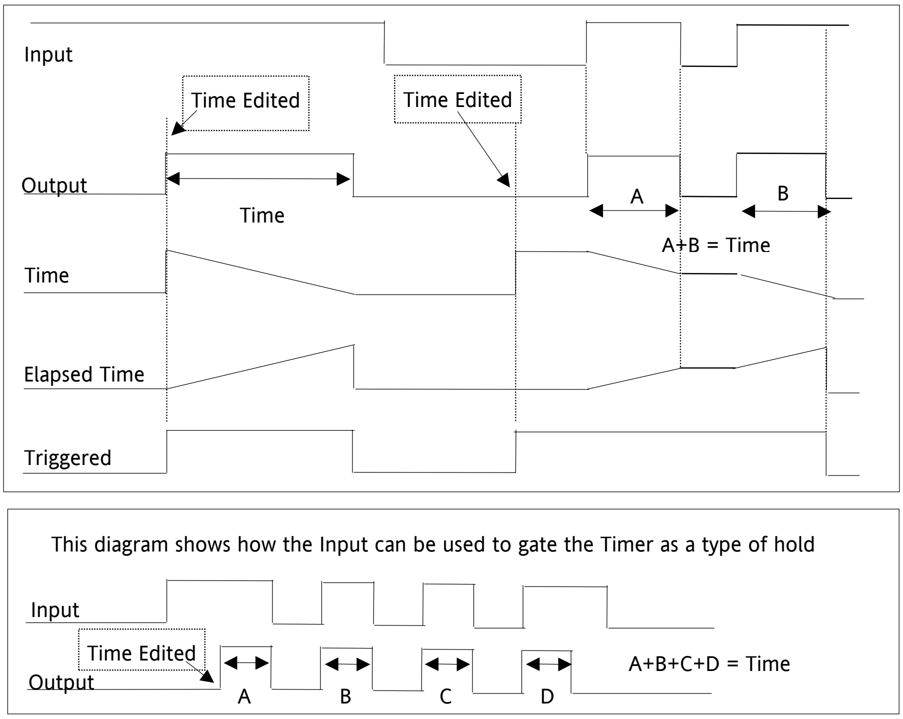


Figure 14-6: One Shot Timer

14.2.5 Compressor or Minimum On Timer Mode

This timer has been targeted at guaranteeing that the output remains On for a duration after the input signal has been removed. It may be used, for example, to ensure that a compressor is not cycled excessively.

- The output will be set to On when the Input changes from Off to On.
- When the Input changes from On to Off, the elapsed time will start incrementing towards the set Time.
- The Output will remain On until the elapsed time has reached the set Time. The Output will then switch Off.
- If the Input signal returns to On while the Output is On, the elapsed time will reset to 0, ready to begin incrementing when the Input switches Off.
- The Triggered variable will be set while the elapsed time is >0. It will indicate that the timer is counting.

The diagram illustrates the behaviour of the timer under different input conditions.

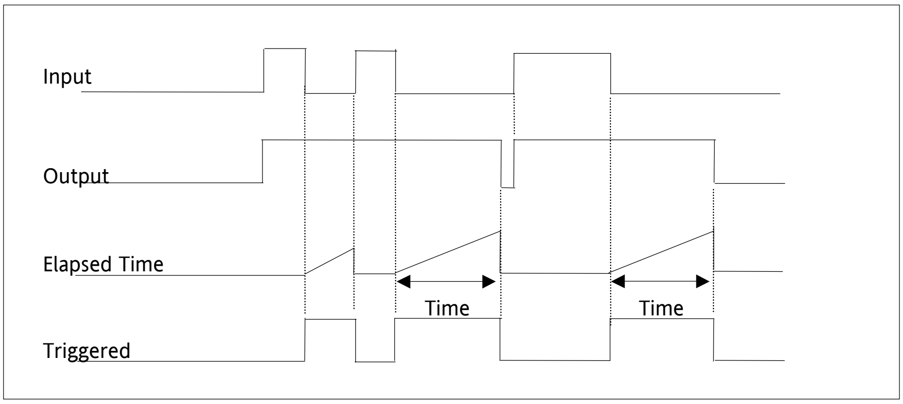


Figure 14-7: Minimum On Timer Under Different Input Conditions

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14.2.6 Timer Parameters

List Header - Timer		Sub-headers: 1 to 4			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Type	Timer type	Off	Timer not configured	Off or as ordered	Conf
		On Pulse	Generates a fixed length pulse from an edge trigger		
		Off Delay	Provides a delay between input trigger event and timer putput		
		One Shot	Simple oven timer which reduces to zero before switching off		
		Min-On Ti	Compressor timer guaranteeing that the output remains ON for a time after the input signal has been removed		
Time	Duration of the timer. For re-trigger timers this value is entered once and copied to the time remaining parameter whenever the timer starts. For pulse timers the time value itself is decremented.	0:00.0 to 99:59:59			L3
Elapsed Time	Timer elapsed time	0:00.0 to 99:59:59			R/O L3
Input	Trigger/Gate input. Turn On to start timing	Off On	Off Start timing	Off	L3
Output	Timer output	Off On	Output off Timer has timed out		L3
Triggered	Timer triggered (timing). This is a status output to indicate that the timers input has been detected	Off On	Not timing Timer timing		R/O L3

The above table is repeated for Timers 2 to 4.

14.3 Totalisers

There are two totaliser function blocks which are used to measure the total quantity of a measurement integrated over time. A totaliser can, by soft wiring, be connected to any measured value. The outputs from the totaliser are its integrated value and an alarm state. The user may set a setpoint which causes the alarm to activate once the integration exceeds the setpoint.

The totaliser has the following attributes:-

1. Run/Hold/Reset

In Run the totaliser will integrate its input and continuously test against an alarm setpoint.

In Hold the totaliser will stop integrating its input but will continue to test for alarm conditions.

In Reset the totaliser will be zeroed, and alarms will be reset.

2. Alarm Setpoint

If the setpoint is a positive number, the alarm will activate when the total is greater than the setpoint.

If the setpoint is a negative number, the alarm will activate when the total is lower (more negative) than the setpoint.

If the totaliser alarm setpoint is set to 0.0, the alarm will be off. It will not detect values above or below.

The alarm output is a single state output. It may be cleared by resetting the totaliser, or by changing the alarm setpoint.

3. The total is limited to a maximum of 99999 and a minimum of -19999.
4. The totaliser ensures that resolution is maintained when integrating small values onto a large total.

14.3.1 Totaliser Parameters

List Header - Total		**Sub-headers: 1 to 2**		
Name to select	**Parameter Description**	**Value** or to change	**Default**	**Access Level**
TotalOp	The totalised value	99999 t o-19999		R/O L3
In	The value to be totalised	-9999.9 to 9999.9. Note:- the totaliser stops accumulating if the input is 'Bad'.		L3
Units	Totaliser units	None AbsTemp V, mV, A, mA, PH, mmHg, psi, Bar, mBar, %RH, %, mmWG, inWG, inWW, Ohms, PSIG, %O2, PPM, %CO2, %CP, %/sec, RelTemp mBar/Pa/T sec, min, hrs,		Conf
Res'n	Totaliser resolution	XXXXX XXXX.X XXX.XX XX.XXX X.XXXX	XXXXX	Conf
Alarm SP	Sets the totalised value at which an alarm will occur	-99999 to 99999		L3

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Fax: 03 26 85 19 08, Tel : 03 26 82 49 29 Site web : www.hvssystem.com

Alarm Output	This is a read only value which indicates the alarm output On or Off. The totalised value can be a positive number or a negative number. If the number is positive the alarm occurs when Total > + Alarm Setpoint If the number is negative the alarm occurs when Total > - Alarm Setpoint	Off On	Alarm inactive Alarm output active	Off	L3
Run	Runs the totaliser	No Yes	Timer not running Select Yes to run the timer	No	L3
Hold	Holds the totaliser at its current value Note: The Run & Hold parameters are designed to be wired to (for example) digital inputs. Run must be 'on' and Hold must be 'off' for the totaliser to operate.	No Yes	Timer not in hold Hold timer	No	L3
Reset	Resets the totaliser	No Yes	Timer not in reset Timer in reset	No	L3

14.4 Real Time Clock

A real time clock is used to provide a daily and weekly scheduling facility and provides two corresponding alarms. The configuration for an alarm is an On-Day and an On-Time and an Off-Day and an Off-Time.

The day options supported are:-

Day Option	Description
Never	Disables the alarm feature
Monday	Alarm will only be available on a Monday
Tuesday	Alarm will only be available on a Tuesday
Wednesday	Alarm will only be available on a Wednesday
Thursday	Alarm will only be available on a Thursday
Friday	Alarm will only be available on a Friday
Saturday	Alarm will only be available on a Saturday
Sunday	Alarm will only be available on a Sunday
Mon-Fri	Alarm will only be available between Monday to Friday
Mon-Sat	Alarm will only be available on between Monday to Saturday
Sat-Sun	Alarm will only be available on between Saturday to Sunday
Everyday	Alarm always available

For example, it is possible to configure an alarm to be activated at 07:30 on Monday and deactivated at 17:15 on Friday

The output from the Real Time Clock alarms may be used to place the instrument in standby or to sequence a batch process.

The Real Time Clock function will set/clear the alarm outputs only at the time of the alarm. Therefore, it is possible to manually override the alarms by editing the output to On/Off between alarm activations.

The Real Time Clock does not display date or year.

14.4.1 Real Time Clock Parameters

List Header - RTClock		Sub-headers: None			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Mode	This parameter can be used to set the clock	Running Edit Stopped	Normal operation Allows the clock to be set Clock stopped (saves battery life)	Running	L3
Day	Displays the day or allows the day to be set when in Edit mode	See table above			L3
Time	Displays the time or allows the time to be set when in Edit mode	00:00:00 to 23:59:59			L3
On Day1 On Day2	Days when alarm 1 and 2 are activated	See table above			L3
On Time1 On Time2	Time of day when alarm 1 and 2 are activated	00:00:00 to 23:59:59			L3
Off Day1 Off Day2	Days when alarm 1 and 2 are de-activated	See table above			L3
Off Time1 Off Time2	Time of day when alarm 1 and 2 are de-activated	00:00:00 to 23:59:59			L3
Out1 Out2	Alarm 1 and 2 output	Off On	Alarm output not activated Alarm output activated		L3

15. APPLICATION SPECIFIC

15.1 Humidity Control

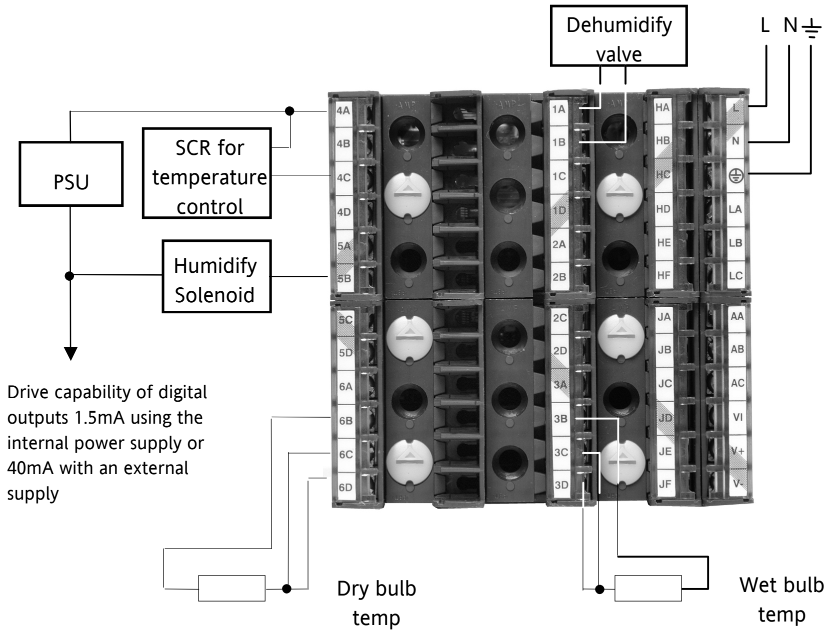
15.1.1 Overview

Humidity (and altitude) control is a standard feature of the 3500 controller. In these applications the controller may be configured to generate a setpoint profile (see Chapter 20 'Programmer Operation').

Also the controller may be configured to measure humidity using either the traditional Wet/Dry bulb method (figure 15.1) or it may be interfaced to a solid state sensor.

The controller output may be configured to turn a refrigeration compressor on and off, operate a bypass valve, and possibly operate two stages of heating and/or cooling

15.1.2 Example Of Humidity Controller Connections



In the above example the following modules are fitted. This will change from installation to installation:

Module 1	Analogue or relay to drive dehumidify valve
Module 3	PV input module for wet bulb temperature RTD
Standard Digital I/O	Used as logic outputs for humidify solenoid valve and temperature control SCR
Standard PV Input	For the dry bulb RTD used for the temperature control and humidity calculation

Figure 15-1: Example of Humidity Controller Connections

15.1.3 Temperature Control Of An Environmental Chamber

The temperature of an environmental chamber is controlled as a single loop with two control outputs. The heating output time proportions electric heaters, usually via a solid state relay. The cooling output operates a refrigerant valve which introduces cooling into the chamber. The controller automatically calculates when heating or cooling is required.

15.1.4 Humidity Control Of An Environmental Chamber

Humidity in a chamber is controlled by adding or removing water vapour. Like the temperature control loop two control outputs are required, i.e. Humidify and Dehumidify.

To humidify the chamber water vapour may be added by a boiler, an evaporating pan or by direct injection of atomised water.

If a boiler is being used adding steam increases the humidity level. The humidify output from the controller regulates the amount of steam from the boiler that is allowed into the chamber.

An evaporating pan is a pan of water warmed by a heater. The humidify output from the controller humidity regulates the temperature of the water.

An atomisation system uses compressed air to spray water vapour directly into the chamber. The humidify output of the controller turns on or off a solenoid valve.

Dehumidification may be accomplished by using the same compressor used for cooling the chamber. The dehumidify output from the controller may control a separate control valve connected to a set of heat exchanger coils.

15.2 Humidity Parameters

List Header - Humidity		Sub-headers: None			
Name (select button) to select	**Parameter Description**	**Value** (up) or (down) to change		**Default**	**Access Level**
Res'n	Resolution of the relative humidity	XXXXX XXXX.X XXX.XX XX.XXX X.XXXX			Conf
PsycK	The psychrometric constant at a given pressure (6.66E-4 at standard atmospheric pressure). The value is dependent on the speed of air-flow across the wet bulb, and hence the rate of evaporation. 6.66E-4 is for the ASSMANN ventilated Psychrometer.	0.0 to 10.0		6.66	L3
Pressure	Atmospheric Pressure	0.0 to 2000.0		1013.0 mbar	L3
WetT	Wet Bulb Temperature	Range units			
WetOffs	Wet bulb temperature offset	-100.0 to 100.0		0.0	L3
DryT	Dry Bulb Temperature	Range units			
RelHumid	Relative Humidity is the ratio of actual water vapour pressure (AVP) to the saturated water vapour pressure (SVP) at a particular temperature and pressure	0.0 to 100.0		100	R/O
DewPoint	The dew point is the temperature to which air would need to cool (at constant pressure and water vapour content) in order to reach saturation	-999.9 to 999.9			R/O
SBreak	Indicates that one of the probes is broken.	No Yes	No sensor break detection Sensor break detection enabled		Conf

15.3 Zirconia (Carbon Potential) Control

A 3500 controller may be supplied to control carbon potential, order code ZC. The controller is often a programmer which generates carbon potential profiles. In this section it is assumed that a programmer is used.

Calculation of PV: The Process Variable can be Carbon Potential, Dewpoint or Oxygen concentration. The PV is derived from the probe temperature input, the probe mV input and remote gas reference input values. Various probe makes are supported. In the 3500 Carbon Potential and Dewpoint can be displayed together.

The following definitions may be useful:-

15.3.1 Temperature Control

The sensor input of the temperature loop may come from the zirconia probe but it is common for a separate thermocouple to be used. The controller provides a heating output which may be connected to gas burners or thyristors to control electrical heating elements. In some applications a cooling output may also be connected to a circulation fan or exhaust damper.

15.3.2 Carbon Potential Control

The zirconia probe generates a millivolt signal based on the ratio of oxygen concentrations on the reference side of the probe (outside the furnace) to the amount of oxygen in the furnace.

The controller uses the temperature and carbon potential signals to calculate the actual percentage of carbon in the furnace. This second loop generally has two outputs. One output is connected to a valve which controls the amount of an enrichment gas supplied to the furnace. The second output controls the level of dilution air.

15.3.3 Sooting Alarm

In addition to other alarms which may be detected by the controller, the 3500 can trigger an alarm when the atmospheric conditions are such that carbon will be deposited as soot on all surfaces inside the furnace.

15.3.4 Automatic Probe Cleaning

The 3500 has a probe clean and recovery strategy that can be programmed to occur between batches or manually requested. At the start of the cleaning process a ‘snapshot’ of the probe mV is taken, and a short blast of compressed air is used to remove any soot and other particles that may have accumulated on the probe. A minimum and maximum cleaning time can be set by the user. If the probe mV has not recovered to within 5% of the snapshot value within the maximum recovery time set then an alarm is given. This indicates that the probe is ageing and replacement or refurbishment is due. During the cleaning and recovery cycle the PV is frozen, thereby ensuring continuous furnace operation. A flag ‘PvFrozen’ is set which can be used in an individual strategy, for example to hold the integral action during cleaning.

15.3.5 Endothermic Gas Correction

A gas analyser may be used to determine the CO concentration of the endothermic gas. If a 4-20mA output is available from the analyser, it can be fed into the 3500 to automatically adjust the calculated % carbon reading. Alternatively, this value can be entered manually.

15.3.6 Clean Probe

As these sensors are used in furnace environments they require regular cleaning. Cleaning (Burn Off) is performed by forcing compressed air through the probe. Cleaning can be initiated either manually or automatically using a timed period. During cleaning the PV output is frozen.

15.3.7 Probe Status

After cleaning an alarm output, MinCalcT, is generated if the PV does not return to 95% of its previous value within a specified time. This indicates that the probe is deteriorating and should be replaced.

15.3.8 Sooting Alarm

An output is generated which indicates that the furnace is about to soot.

15.4 Zirconia Parameters

List Header - Zirconia		Sub-headers: None			
Name to select	**Parameter Description**	**Value** ▲ or ▼ to change		**Default**	**Access Level**
Probe Type	Configures the type of probe to be used	Drayton Accucarb SSI MacDhui %O2 LogO2 BoschO2 ZircoDew ProbeMV BoschCarb BarberC MMICarb AACC	Drayton Accucarb SSI MacDhui Oxygen Log Oxygen Bosch Oxygen Dewpoint. Probe mV Bosch Carbon Barber-Colman MMI Carbon AACC		L3
Res'n	Resolution of the calculated result	XXXXX XXXX.X XXX.XX XX.XXX X.XXXX			L3
Parameters shown in shaded rows below are not applicable to O2 probes					
GasRef	Gas reference value	-9999.9 to 9999.9		20.0	L3
RemGasRef	Remote gas reference value	-9999.9 to 9999.9		0.0	L3
RemGasEn	Enable the remote gas reference. This can be an internal value from the user interface or from an external source	0 1	Internal External	0	L3
MinCalTemp	Minimum calculation temperature	-99999 to 99999		720	L3
OxygenExp	Oxygen exponent				
Tolerance	Tolerance of the sooting	-9999.9 to 9999.9		1.0	L3
CleanFreq	Frequency of the cleaning process	0:00:00 to 99:59:59 or 100:00 to 500:00		4:00:00	L3
CleanTime	Sets the duration of the clean	0:00:00 to 99:59:59 or 100:00 to 500:00		0:00:00	L3
MinRcovTime	Minimum recovery time after purging	0:00:00 to 99:59:59 or 100:00 to 500:00		0:00:00	L3
MaxRcovTime	Maximum recovery time after purging	0:00:00 to 99:59:59 or 100:00 to 500:00		0:10:00	L3
TempInput	Zirconia probe temperature input value	Temp range			L3
TempOffset	Sets a temperature offset for the probe	-99999 to 99999		0	L3
ProbeInput	Zirconia probe mV input				L3
ProbeOffset	Zirconia probe mV offset	-99999 to 99999		0	L3
Oxygen	Calculated oxygen				
CarbonPot	Calculated carbon potential				R/O

DewPoint	Zirconia control process value The O2 or dew point value derived from temperature and remote gas reference inputs				R/O
SootAlm	Probe sooting alarm output	No Yes	No alarm output In alarm		L3 R/O
ProbeFault	Probe fault	No Yes			L3
PvFrozen	This is a Boolean which freezes the PV during a purging cycle. It may have been wired, for example, to disable control output during purging	No Yes			R/O
CleanValve	Enable the clean valve	No Yes			R/O
CleanState	The burn off state of the zirconia probe	Waiting Cleaning Recovering			R/O
CleanProbe	Enable clean probe This may be wired to initiate automatically or if un-wired can be set by the user	No Yes	Do not clean probe Initiate probe clean	No	L3
Time2Clean	Time to next clean	0:00:00 to 99:59:59 or 100:00 to 500:00			L3 R/O
ProbeStatus	Indicates the status of the probe	OK MVSbr TempSbr MinCalcT	Normal working Probe input in sensor break Temperature input in sensor break Probe deteriorating		L3 R/O

15.5 Example of Carbon Potential Control Connections

In this example the following modules are assumed:-

Module 1Dual relay or logic output.

Module 3 Analogue Input set to HZ Volts 0 – 2V input.

Module 4Triple Logic Output

Probe clean digital input is on the LB logic input.

The sooting alarm is operated by the AA Relay.

The temperature is measured on the fixed PV input.

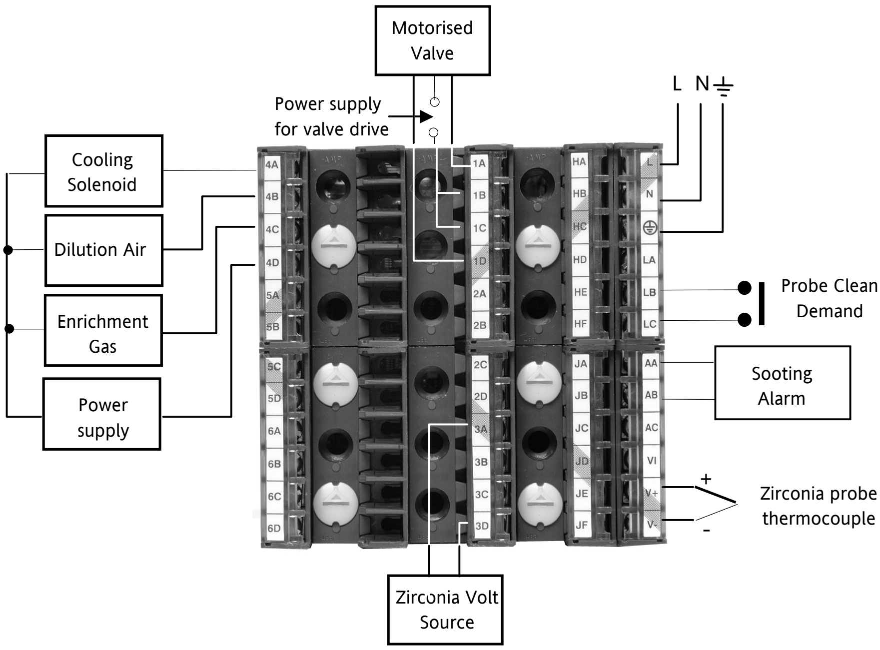


Figure 15-2: Example of Carbon Potential Controller Connections

16. INPUT MONITOR

The input monitor may be wired to any variable in the controller. It then provides three functions:-

1. Maximum detect
2. Minimum detect
3. Time above threshold

16.1.1 Maximum Detect

This function continuously monitors the input value. If the value is higher than the previously recorded maximum, it becomes the new maximum.

This value is retained following a power fail.

16.1.2 Minimum Detect

This function continuously monitors the input value. If the value is lower than the previously recorded minimum, it becomes the new minimum.

This value is retained following a power fail.

16.1.3 Time Above Threshold

This function increments a timer whenever the input is above a threshold value. If the timer exceeds 24 hours per day, a counter is incremented. The maximum number of days is limited to 255. A timer alarm can be set on the timer so that once the input has been above a threshold for a period, an alarm output is given.

Applications include:-

- Service interval alarms. This sets an output when the system has been running for a number of days (up to 90 years)
- Material stress alarms - if the process cannot tolerate being above a level for a period. This is a style of 'policeman' for processes where the high operating point degrades the life of the machine.
- In internal wiring applications in the controller

16.2 Input Monitor Parameters

List Header - IPMon		Sub-headers: 1 or 2			
Name (select button) to select	**Parameter Description**	**Value** (up) or (down) to change		**Default**	**Access Level**
Input	The input value to be monitored	May be wired to an input source. The range will depend on the source			L3. R/O if wired
Max	The maximum measured value recorded since the last reset	As above			R/O L3
Min	The minimum measured value recorded since the last reset	As above			R/O L3
Threshold	The input timer accumulates the time the input PV spends above this trigger value.	As above			L3
Days Above	Accumulated days the input has spent above threshold since the last reset.	Days is an integer count of the 24 hour periods only. The Days value should be combined with the Time value to make the total time above threshold.			R/O L3
Time Above	Accumulated time above the 'Threshold' since last reset.	The time value accumulates from 00:00.0 to 23:59.9. Overflows are added to the days value			R/O L3
Alm Days	Days threshold for the monitors time alarm. Used in combination with the Alm Time parameter. The Alm Out is set to true if the inputs accumulated time above threshold is higher than the timer high parameters.	0 to 255		0	L3
Alm Time	Time threshold for the monitors time alarm. Used in combination with the Alm Days parameter. The Alm Out is set to true if the inputs accumulated time above threshold is higher than the timer high parameters.	0:00.0 to 99:59:59		0:00.0	L3
Alm Out	Set true if the accumulated time that the input spends above the trigger value is higher than the alarm setpoint.	Off On	Normal operation time above setpoint exceeded		R/O L3
Reset	Resets the Max and Min values and resets the time above threshold to zero.	No Yes	Normal operation Reset values	No	L3
In Status	Monitors the status of the input	Good Bad	Normal operation The input may be incorrectly wired		R/O L3

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17. CHAPTER 17 LOGIC AND MATHS OPERATORS.

17.1 Logic Operators

Logic Operators allow the controller to perform logical calculations on **two** input values. These values can be sourced from any available parameter including Analogue Values, User Values and Digital Values.

The parameters to use, the type of calculation to be performed, input value inversion and 'fallback' value are determined in Configuration level. In levels 1 to 3 you can view the values of each input and read the result of the calculation.

The Logic Operators page is only available if the operators have been enabled in **'Inst'** page sub-header **'Opt'**. It is possible to enable any one of 24 separate calculations – they do not have to be in sequence. In the 'Inst' 'Opts' page they are shown in three sets of 8 labelled 'Lgc2 En1' (enable operator set 1 to 8), 'Lgc2 En2' (enable operator set 9 to 16), and 'Lgc2 En3' (enable operator set 17 to 24). **'Lgc2'** denotes a two input logic operator. When logic operators are enabled a page headed 'Lgc2' can be found using the button. This page contains up to twenty four instances which are selected using the or buttons.

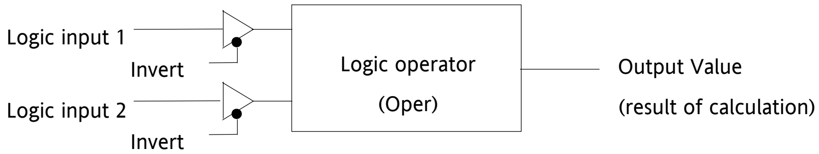


Figure 17-1: 2 Input Logic Operators

Logic Operators are found under the page header **'Lgc2'**.

17.1.1 Logic 8

Logic 8 operators can perform logic calculations on up to **eight** inputs. The calculations are limited to AND,OR,XOR. Up to two 8 input operators can be enabled in **'Inst'** page sub-header **'Opt'**. They are labelled **'Lgc8'** to denote eight input logic operators. When Lgc8 operators are enabled a page headed 'Lgc8' can be found using the button. This page contains up to two instances which are selected using the or buttons.

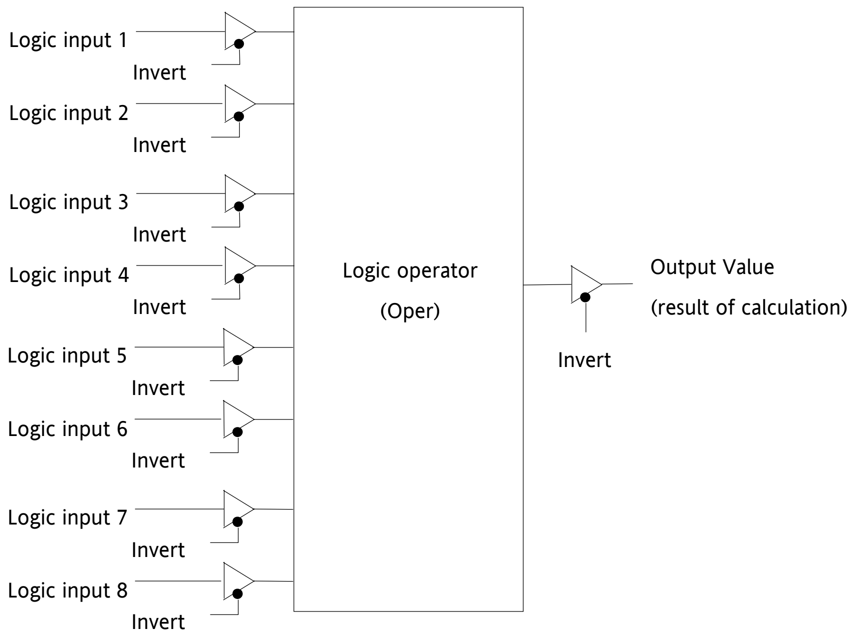


Figure 17-2: 8 Input Logic Operators

17.1.2 Logic Operations

The following calculations can be performed:

Oper	Operator description	Input 1	Input 2	Output Invert = None
0: OFF	The selected logic operator is turned off			
1: AND	The output result is ON when both Input 1 and Input 2 are ON	0	0	Off
		1	0	Off
		0	1	Off
		1	1	On
2: OR	The output result is ON when either Input 1 or Input 2 is ON	0	0	Off
		1	0	On
		0	1	On
		1	1	Off
3: XOR	Exclusive OR. The output result is true when one and only one input is ON. If both inputs are ON the output is OFF.	0	0	Off
		1	0	On
		0	1	On
		1	1	Off
4: Latch	Input 1 sets the latch, Input 2 resets the latch.	0	0	
		1	0	
		0	1	
		1	1	
5: Equal (==)	The output result is ON when Input 1 = Input 2	0	0	On
		1	0	Off
		0	1	Off
		1	1	On
6: Not equal (<>)	The output result is ON when Input 1 = Input 2	0	0	Off
		1	0	On
		0	1	Off
		1	1	On
7: Greater than (>)	The output result is ON when Input 1 > Input 2	0	0	Off
		1	0	On
		0	1	Off
		1	1	Off
8: Less than (<)	The output result is ON when Input 1 < Input 2	0	0	Off
		1	0	Off
		0	1	On
		1	1	Off
9: Equal to or Greater than (=>)	The output result is ON when Input 1 ≥ Input 2	0	0	On
		1	0	On
		0	1	Off
		1	1	On
10: Less than or Equal to (<=)	The output result is ON when Input 1 ≤ Input 2	0	0	On
		1	0	Off
		0	1	On
		1	1	On

Note 1: The numerical value is the value of the enumeration

Note 2: For options 1 to 4 an input value of less than 0.5 is considered false and greater than or equal to 0.5 as true.

17.1.3 Logic Operator Parameters

List Header – Lgc2 (2 Input Operators)		Sub-headers: 1 to 24			
Name (select key) to select	**Parameter Description**	**Value** (up) or (down) to change		**Default**	**Access Level**
Oper	To select the type of operator	See previous table		None	Conf L3 R/O
Input1	Input 1	Normally wired to a logic, analogue or user value. May be set to a constant value if not wired.		0	L3
Input2	Input 2				
Fall Type	The fallback state of the output if one or both of the inputs is bad	0: FalseBad	The output value is FALSE and the status is GOOD.		Conf L3 R/O
		1: TrueBad	The output value is FALSE and the status is BAD		
		2: FalseGood	The output value is TRUE and the status is GOOD		
		3: TrueGood	The output value is TRUE and the status is BAD.		
Invert	The sense of the input value, may be used to invert one or both of the inputs	0: None	Neither input inverted		Conf L3 R/O
		1: Input1	Invert input 1		
		2: Input2	Invert input 2		
		3: Both	Invert both inputs		
Output	The output from the operation is a boolean (true/false) value.	On	Output activated		R/O
		Off	Output not activated		
Status	The status of the result value	Good			R/O
		Bad			

17.2 Eight Input Logic Operators

The eight input logic operator may be used to perform operations on eight inputs. It is possible to enable two eight input logic operators from the **'Inst' 'Opt'** page. When this is done a page headed '**Lgc8'** can be found using the ⊜ button. This page contains up to two instances which are selected using the ▲ or ▼ button.

17.2.1 Eight Input Logic Operator Parameters

List Header – Lgc8 (8 Input Operators)		**Sub-headers: 1 to 2**			
Name ⊜ to select	**Parameter Description**	**Value** ▲ or ▼ to change		**Default**	**Access Level**
Oper	To select the type of operator	0: OFF 1: AND 2: OR 3: XOR	Operator turned off Output ON when all inputs are ON Output ON when one input is ON Exclusive OR	OFF	Conf L3 R/O
NumIn	This parameter is used to configure the number of inputs for the operation	1 to 8			Conf L3 R/O
Invert	Used to invert selected inputs prior to operation. This is a status word with one bit per input, the left hand bit inverts input 1.	☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ No inputs inverted ■ ■ ■ ■ ■ ■ ■ ■ All 8 inputs inverted When configuring over comms, the invert parameter is interpreted as a bitfield where: 0x1 - input 1 0x2 - input 2 0x4 - input 3 0x8 - input 4 0x10 - input 5 0x20 - input 6 0x40 - input 7 0x80 - input 8		☐	L3
Out Invert	Invert the output	No Yes	Output not inverted Output inverted	No	L3
In1 to In8	Input state 1 to 8	Normally wired to a logic, analogue or user value. When wired to a floating point, values less than or equal to –0.5 or greater than or equal to 1.5 will be rejected (e.g. the value of the lgc8 block will not change). Values between –0.5 and 1.5 will be interpreted as ON when greater than or equal to 0.5 and OFF when less than 0.5. May be set to a constant value if not wired.		Off	L3
Out	Output result of the operator	On Off	Output activated Output not activated		R/O

17.3 Maths Operators

Maths Operators (sometimes known as Analogue Operators) allow the controller to perform mathematical operations on two input values. These values can be sourced from any available parameter including Analogue Values, User Values and Digital Values. Each input value can be scaled using a multiplying factor or scalar.

The parameters to use, the type of calculation to be performed and the acceptable limits of the calculation are determined in Configuration level. In access level 3 you can change values of each of the scalars.

The 'Math' Operators page is only available if the operators have been enabled in **'Inst'** page sub-header **'Opt'**. It is possible to enable any one of 24 separate calculations – they do not have to be in sequence. In the 'Inst' 'Opts' page they are shown in three sets of 8 labelled 'Math2 En1' (enable operator set 1 to 8), 'Math 2 En2' (enable operator set 9 to 16), and 'Math En3' (enable operator set 17 to 24). **'Math2'** denotes a two input math operator. When math operators are enabled a page headed 'Math2' can be found using the button. This page contains up to twenty four instances which are selected using the or button.

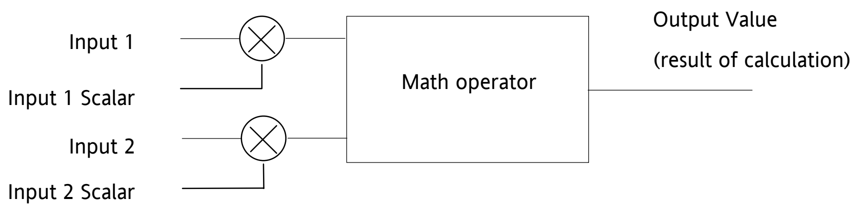
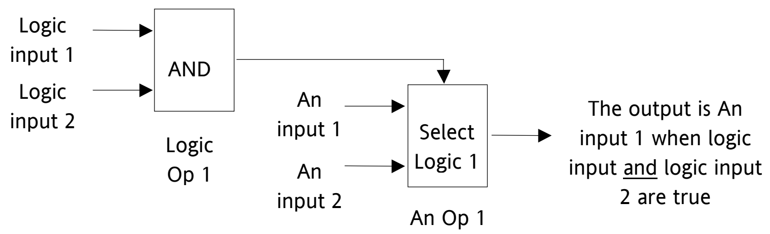


Figure 17-3: 2 Input Math Operators

17.3.1 Math Operations

The following operations can be performed:

0: Off	The selected analogue operator is turned off
1: Add	The output result is the addition of Input 1 and Input 2
2: Subtract (Sub)	The output result is the difference between Input 1 and Input 2 where Input 1 > Input 2
3: Multiply (Mul)	The output result is the Input 1 multiplied by Input 2
4: Divide (Div)	The output result is Input 1 divided by Input 2
5: Absolute Difference (AbsDif)	The output result is the absolute difference between Input 1 and 2
6: Select Max (SelMax)	The output result is the maximum of Input 1 and Input 2
7: Select Min (SelMin)	The output result is the minimum of Input 1 and Input 2
8: Hot Swap (HotSwp)	Input 1 appears at the output provided input 1 is 'good'. If input 1 is 'bad' then input 2 value will appear at the output. An example of a bad input occurs during a sensor break condition.
9: Sample and Hold (SmpHld)	Normally input 1 will be an analogue value and input B will be digital. The output tracks input 1 when input 2 = 1 (Sample). The output will remain at the current value when input 2 = 0 (Hold). If input 2 is an analogue value then any non zero value will be interpreted as 'Sample'.
10: Power	The output is the value at input 1 raised to the power of the value at input 2. I.e. input $1^{\text{input 2}}$
11: Square Root (Sqrt)	The output result is the square root of Input 1. Input 2 has no effect.
12: Log	The output is the logarithm (base 10) of Input 1. Input 2 has no effect
13: Ln	The output is the logarithm (base n) of Input 1. Input 2 has no effect
14: Exp	The output result is the exponential of Input 1. Input 2 has no effect
15: 10 x	The output result is 10 raised to the power of Input 1 value. I.e. $10^{\text{input 1}}$. Input 2 has no effect
51: Select	Any logic value may be used to control which Analogue Input is switched to the output of the Analogue Operator. If the output from the logic operator is true input 1 is switched through to the output. If false input 2 is switched through to the output. See example below:- 

When Boolean parameters are used as inputs to analogue wiring, they will be cast to 0.0 or 1.0 as appropriate. Values <= -0.5 or >= 1.5 will not be wired. This provides a way to stop a Boolean updating. Analogue wiring (whether simple re-routing or involving calculations) will always output a real type result, whether the inputs were booleans, integers or reals.

Note: The numerical value is the value of the enumeration

17.3.2 Math Operator Parameters

List Header – Math2 (2 Input Operators)		Sub-headers: 1 to 24		
Name to select	**Parameter Description**	**Value** or to change	**Default**	**Access Level**
Operation	To select the type of operator	See previous table	None	Conf
Input1 Scale	Scaling factor on input 1	Limited to max float *	1.0	L3
Input2 Scale	Scaling factor on input 2	Limited to max float *	1.0	L3
Output Units	Units applicable to the output value	None AbsTemp V, mV, A, mA, PH, mmHg, psi, Bar, mBar, %RH, %, mmWG, inWG, inWW, Ohms, PSIG, %O2, PPM, %CO2, %CP, %/sec, RelTemp mBar/Pa/T sec, min, hrs,	None	Conf
Output Res'n	Resolution of the output value	XXXXX. XXXX.X, XXX.XX, XX.XXX, X.XXXX		Conf
Low Limit	To apply a low limit to the output	Max float* to High limit (decimal point depends on resolution)		Conf
High Limit	To apply a high limit to the output	Low limit to Max float* (decimal point depends on resolution)		Conf
Fallback	The state of the Output and Status parameters in case of a fault condition. This parameter could be used in conjunction with fallback value	Clip Bad Clip Good Fall Bad Fall Good Upscale DownScale Descriptions, see section 17.4.2.		Conf
Fallback Val	Defines (in accordance with Fallback) the output value during fault conditions.	Limited to max float * (decimal point depends on resolution)		Conf
Input1 Value	Input 1 value (normally wired to an input source – could be a User Value)	Limited to max float * (decimal point depends on resolution)		L3
Input2 Value	Input 2 value (normally wired to an input source – could be a User Value)	Limited to max float * (decimal point depends on resolution)		L3
Output Value	Indicates the analogue value of the output	Between high and low limits		R/O
Status	This parameter is used in conjunction with Fallback to indicate the status of the operation. Typically, status is used to flag fault conditions and may be used as an interlock for other operations.	Good Bad		R/O

* Max float in this instrument is ±9,999,999,999

17.3.3 Sample and Hold Operation

The diagram below shows the operation of the sample and hold feature.

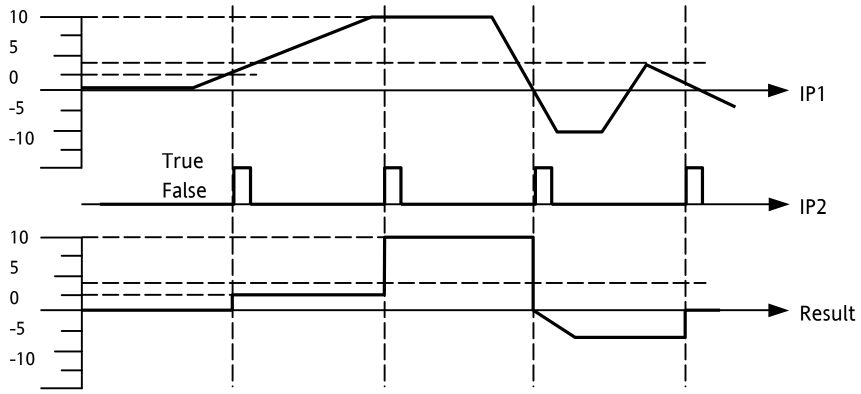


Figure 17-4: Sample and Hold

17.4 Eight Input Analog Multiplexers

The eight Input analog multiplexers may be used to switch one of eight inputs to an output. It is usual to wire inputs to a source within the controller which selects that input at the appropriate time or event. It is possible to enable two multiplexers from the **'Inst' 'Opt'** page. When this is done a page headed '**Mux8**' can be found using the ⊜ button. This page contains up to two instances which are selected using the ⊕ or ⊖ button.

17.4.1 Multiple Input Operator Parameters

List Header – Mux8 (8 Input Operators)		Sub-headers: 1 to 2			
Name ⊜ to select	**Parameter Description**	**Value** ⊕ or ⊖ to change		**Default**	**Access Level**
Low Limit	The high limit for all inputs and the fall back value.	-99999 to High limit (decimal point depends on resolution)			Conf
High Limit	The low limit for all inputs and the fall back value.	Low limit to 99999 (decimal point depends on resolution)			Conf
Fallback	The state of the Output and Status parameters in case of a fault condition. This parameter could be used in conjunction with Fallback Val.	Clip Bad Clip Good Fall Bad Fall Good Upscale DownScale	Descriptions see section 17.4.2.		Conf
Fallback Val	Used (in accordance with Fallback) to define the output value during fault conditions	-99999 to 99999 (decimal point depends on resolution)			Conf
Select	Used to select which input value is assigned to the output.	Input1 to Input8			L3
Input1 to 8	Input values (normally wired to an input source)	-99999 to 99999 (decimal point depends on resolution)			L3
Output	Indicates the analogue value of the output	Between high and low limits			R/O
Status	Used in conjunction with Fallback to indicate the status of the operation. Typically, status is used to flag fault conditions and may be used as an interlock for other operations.	Good Bad			R/O

17.4.2 Fallback

The fallback strategy will come into effect if the status of the input value is bad or if the input value is outside the range of Input Hi and Input Lo.

In this case the fallback strategy may be configured as:-

Fallback Good – the output value will be the fallback value and the output status will be 'Good'.

Fallback Bad – the output value will be the fallback value and the output status will be 'Bad'.

Clip Good – If the input is outside a limit the output will be clipped to the limit and the status will be 'Good'.

Clip Bad – If the input is outside a limit the output will be clipped to the limit and the status will be 'Bad'.

Upscale – the output value will be Output Hi and the output status will be 'Bad'.

Downscale – the output value will be Output Lo and the output status will be 'Bad'.

18. CHAPTER 18 INPUT CHARACTERISATION

18.1 Input Linearisation

The Lin16 function block converts an input signal into an output PV using a series of up to 14 straight lines to characterise the conversion.

The function block provides the following behaviour.

1. The Input values must be monotonic and constantly rising.
2. To convert the MV to the PV, the algorithm will search the table of inputs until the matching segment is found. Once found, the points either side will be used to interpolate the output value.
3. If during the search, a point is found which is not above the previous (below for inverted) then the search will be terminated and the segment taken from the last good point to the extreme (In Hi-Out Hi) see following diagram.

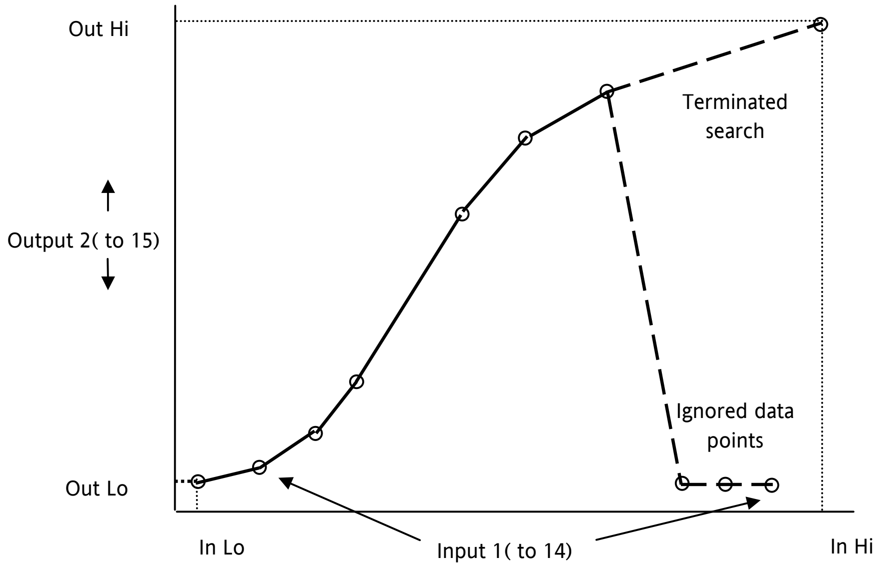


Figure 18-1: Linearisation Example

Notes:

1. The linearisation block works on rising inputs/rising outputs or rising inputs/falling outputs. It is not suitable for outputs which rise and fall on the same curve.
2. Input Lo/Output Lo and Input Hi/Output Hi are entered first to define the low and high points of the curve. It is not necessary to define all 15 intermediate points if the accuracy is not required. Points not defined will be ignored and a straight line fit will apply between the last point defined and the Input Hi/Output Hi point. If the input source has a bad status (sensor break, or over-range) then the output value will also have a bad status.

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1. If the input value is outside the translated range then the output status will indicate Bad, and the value will be limited to the nearest output limit.
2. The units and resolution parameters will be used for the output values. The input values resolution and units will be specified by the source of the wire.
3. If the 'Out Low' is higher than the 'Out High' then the translation will be inverted.

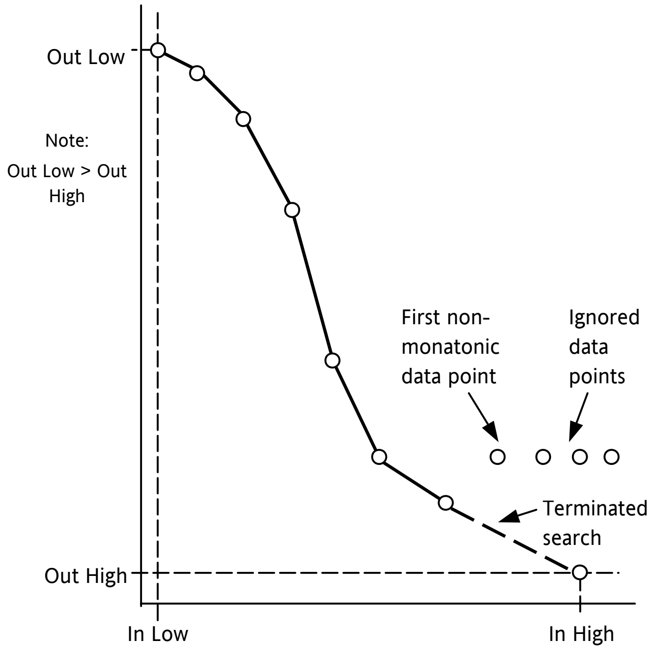


Figure 18-2: How an Inverted Curve will Terminate its search when it detects non-monatonic data

18.1.1 Compensation for Sensor Non-Linearities

The custom linearisation feature can also be used to compensate for errors in the sensor or measurement system. The intermediate points are, therefore, available in Level 1 so that known discontinuities in the curve can be calibrated out. The diagram below shows an example of the type of discontinuity which can occur in the linearisation of a temperature sensor.

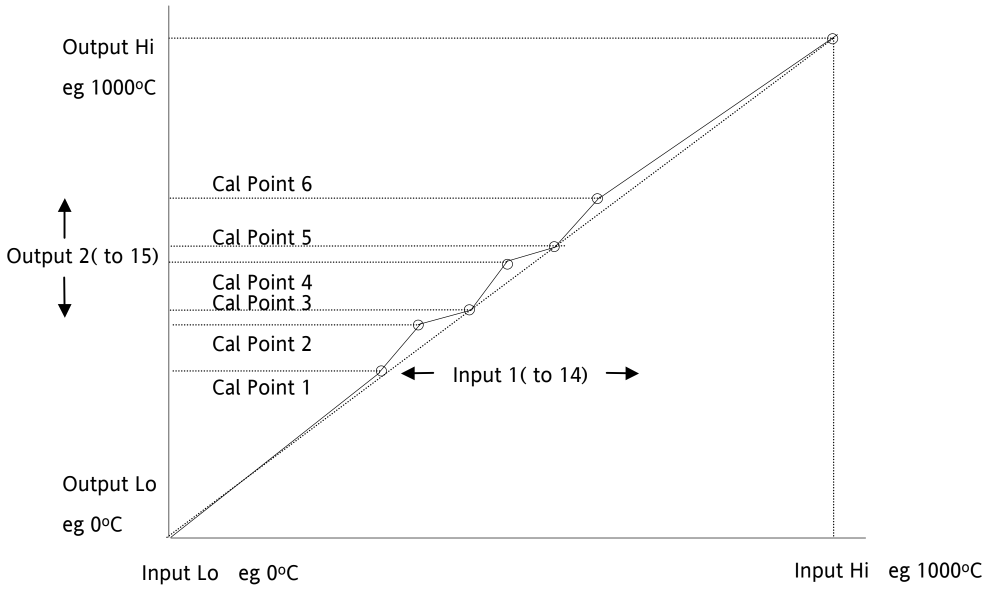


Figure 18-3: Compensation for Sensor Discontinuities

The calibration of the sensor uses the same procedure as described above. Adjust the output (displayed) value against the corresponding input value to compensate for any errors in the standard linearisation of the sensor.

18.1.2 Input Linearisation Parameters

List Header – Lin16		Sub-headers: 1 to 2		
Name (select button) to select	**Parameter Description**	**Value** (up) or (down) to change	**Default**	**Access Level**
Units	Units of the linearised output	None AbsTemp V, mV, A, mA, PH, mmHg, psi, Bar, mBar, %RH, %, mmWG, inWG, inWW, Ohms, PSIG, %O2, PPM, %CO2, %CP, %/sec, RelTemp mBar/Pa/T sec, min, hrs,		Conf
Out Res'n	Resolution of the output value	XXXXX. XXXX.X, XXX.XX, XX.XXX, X.XXXX		Conf
Input	Input measurement to linearise. Wire to the source for the custom linearisation	Range of the source of the input		L3
Fall Value	In the event of a bad status, the output may be configured to adopt the fallback value. This allows the strategy to dictate a safe output in the event of a fault being detected.			L3 R/O
Output	The result of the linearisation			R/O
In Low	Adjust to the low input value			L3 R/O
Out Low	Adjust to correspond to the low input value			L3 R/O
In High	Adjust to the high input value			L3 R/O
Out High	Adjust to correspond to the high input value			L3 R/O
In1	Adjust to the first break point			L3 R/O
Out1	Adjust to correspond to input 1			L3
to				
In14	Adjust to the last break point			L3 R/O
Out14	Adjust to correspond to input 14			L3
Status	Status of the block. A value of zero indicates a healthy conversion.	Good: Within operating limits Bad: A bad output may be caused by a bad input signal (perhaps the input is in sensor break) or an output which is out of range		R/O

Note:

The 16 point linearisation does not force you to use all 16 points. If fewer points are required, then the curve can be terminated by setting the first unwanted value to be below the previous point. If the curve is a continuously decreasing one, then it may be terminated by setting the first unwanted point above the previous one.

18.2 Polynomial

List Header – Poly		Sub-headers: 1 to 2		
Name ⊜ to select	**Parameter Description**	**Value** ▲ or ▼ to change	**Default**	**Access Level**
Input Lin	To select the input type. The linearisation type selects which of the instruments linearisation curves is applied to the input signal. The instrument contains a number of thermocouple and RTD linearisations as standard. In addition there are a number of custom linearisations which may be downloaded using iTools to provide linearisations of non-temperature sensors.	J , K, L, R, B, N, T, S, PL2, C, PT100, Linear, SqRoot	J	Conf L3 R/O
Units	Units of the output	None AbsTemp V, mV, A, mA, PH, mmHg, psi, Bar, mBar, %RH, %, mmWG, inWG, inWW, Ohms, PSIG, %O2, PPM, %CO2, %CP, %/sec, RelTemp mBar/Pa/T sec, min, hrs,		Conf L3 R/O
Out Res'n	Resolution of the output value	XXXXX. XXXX.X, XXX.XX, XX.XXX, X.XXXX	XXXXX	Conf L3 R/O
Input	Input Value The input to the linearisation block	Range of the input wired to		L3
Output	Output value	Between Out Low and Out High		L3 R/O
In High	Input high scale	In Low to99999	0	L3
In Low	Input low scale	-99999 to In High	0	L3
Out High	Output high scale	Out Low to 99999	0	L3
Out Low	Output low scale	-99999 to Out High	0	L3
Fall Type	Fallback Type The fallback strategy will come into effect if the status of the input value is bad or if the input value is outside the range of input high scale and input low scale. In this case the fallback strategy may be configured as:	Clip Bad: If the input is outside a limit the output will be clipped to the limit and the status will be BAD		Conf
		Clip Good: If the input is outside a limit the output will be clipped to the limit and the status will be GOOD		
		Fall Bad: The output value will be the fallback value and the output status will be BAD		
		Fall Good: The output value will be the fallback value and the output status will be GOOD		
		Upscale: The output value will be output high scale and the output status will be BAD		

		DownScale	The output value will be the output low scale and the output status will be BAD		
Fall Value	Value to be adopted by the output in the event of Status = Bad				L3
Status	Indicates the status of the linearised output:	Good	Good indicates the value is within range and the input is not in sensor break.		L3 R/O
		Bad	Indicates the Value is out of range or the input is in sensor break. Note: This is also effected by the configured fallback strategy		

19. CHAPTER 19 LOAD

The load simulation block provides styles of load which can be used to allow an instrument configuration to be tested before connection to the process plant. In the current issue of firmware the simulated loads available are Oven and Furnace.

19.1 Input Linearisation Parameters

List Header – Load		Sub-headers: None			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Type	The type of load simulation to use. Oven is a simple load of 3 first order lags, providing a single process value for connection to the control loop. Furnace consists of 12 interactive first order lags giving a slave PV, followed by 6 interactive first order lags giving a master PV.	Oven Furnace	Simulates the characteristics of a typical oven Simulates the characteristics of a typical furnace	Oven	Conf
Res'n	The display resolution of the resultant PV Out.				Conf
Units	The Units of the resultant PV.				Conf
Gain	The gain of the load, the input power is multiplied by gain, before use by the load.				L3
TC1	The time constant of lag 1 in the Oven load and slave lags (1-12) of the Furnace load. The time constant has units of seconds.				L3
TC2	The time constant of lag 2/3 of the Oven load and master lags (13-18) of the furnace load.				L3
Atten (Furnace load only)	Attenuation Between PV1 and PV2 Stages. Used in the advanced furnace load and defines an attenuation factor between the slave and master lags				L3
Ch 2 Gain	Defines the relative gain when cooling is requested, applied to the input power when the power requested is < 0.				L3
PVFault	The load function block provides 2 PV outputs, sensor fault can be used to generate a fault condition on these PV's such that the bad status is passed along a wire to be consumed by another block such as the loop. The sensor fault can be confiured as:	None PVOut1 PVOut2 Both	No fault conditions. Fault on the first output (slave). Fault on the second output (master). A fault on first and second outputs (master and slave).		L3
PV Out1	First Process Value The PV in Process Value an Oven load or the Slave PV in a furnace load.				L3 R/O
PV Out2 (Furnace load only)	Second Process Value Second process value, lagged from PVOut1, used as a cascade master input. The Master PV in the Furnace load.				L3 R/O

LoopOP CH1	Loop output channel 1 input. The output of the loop as wired to the load simulation, this is the power requested of the load. This can be used as the heat demand.				L3
LoopOP CH2	Loop output channel 2 input. The output of the loop as wired to the load simulation, this is the power requested of the load. This can be used as the cool demand.				L3
Noise	Noise Added to PV This is used to make the PV of the load appear noisy, and hence more like a real measurement.	Off 1 to 99999	The amount of noise is specified in engineering units.	Off	L3
Offset	Process offset Used to configure an offset in the process. In a temperature application this could represent the ambient operating temperature of the plant.				L3

20. CHAPTER 20 CONTROL LOOP SET UP

Software version 1 contains one loop of control. It contains two outputs, Channel 1 and Channel 2, each of which can be configured for PID, On/Off or Valve Position (bounded or unbounded).

The control function block is divided into a number of sections the parameters of which are all listed under the page header **'Lp'**.

The 'Lp' page contains sub-headers for each section as shown diagrammatically below.

20.1 What is a Control Loop?

An example of a heat only temperature control loop is shown below:-

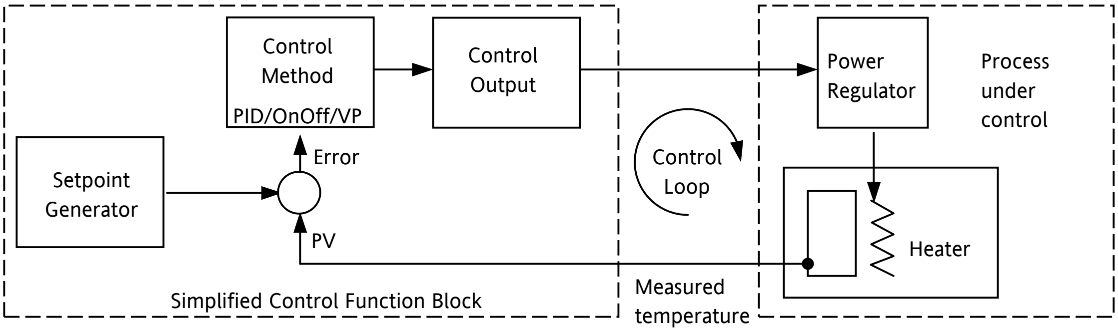


Figure 20-1: Single Loop Single Channel

The actual temperature measured at the process (PV) is connected to the input of the controller. This is compared with a setpoint (or required) temperature (SP). If there is an error between the set and measured temperature the controller calculates an output value to call for heating or cooling. The calculation depends on the process being controlled but normally uses a PID algorithm. The output(s) from the controller are connected to devices on the plant which cause the heating (or cooling) demand to be adjusted which in turn is detected by the temperature sensor. This is referred to as the control loop.

20.2 Loop Parameters - Main

These parameters provide an overview of the loop.

List Header – Lp		Sub-header: Main			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
AutoMan	To select Auto or Manual operation. This is in addition to the A/MAN button.	Auto Man	Automatic (closed loop) operation Manual (output power adjusted by the user) operation	Auto	L3
PV	The process variable input value. This is typically wired from an analog input.	Range of the input source			L3
Inhibit	Used to stop the loop controlling. If enabled the loop will stop control and the output of the loop will be set to the safe output value. On exit from inhibit the transfer will be bumpless. This may be wired to an external source	No Yes	Inhibit disabled Inhibit enabled	No	L3
Target SP	The value of setpoint at which the control loop is aiming. It may come from a number of different sources, such as internal SP and remote SP.	Between setpoint limits			L3
WSP	The current value of the setpoint being used by the control loop. It may come from a number of different sources, such as internal SP and Remote SP. The working setpoint is always read-only as it is derived from other sources.	Between setpoint limits			R/O
Work OP	The actual output of the loop before it is split into the channel 1 and channel 2 outputs.				R/O
IntHold	Stop integral action	No Yes	Integral hold disabled Integral hold enabled	No	L3

20.3 Loop Set up

These parameters configure the type of control.

List Header – Lp		Sub-header: Setup			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Ch1 Control	Selects the channel 1 control algorithm. Different algorithms may be selected for channels 1 and 2. In temperature control applications, Ch1 is usually heating, Ch2 is cooling	Off OnOff PID VPU VPB	Channel turned off On/off control 3 term or PID control Valve position unbounded Valve position bounded		Conf L3 R/O
Ch2 Control	Control type for channel 2				
Control Act	Control Action	Rev Dir	Reverse acting. The output increases when the PV is below SP. This is the best setting for heating control. Direct acting. The output increases when the PV is above SP. This is the best setting for cooling control		Conf L3 R/O

PB Units	Proportional band units. See also section 20.4.1.	Eng Percen t	Engineering units eg C or F Per cent of loop span (Range Hi - Range Lo)		Conf L3 R/O
Deriv Type	Selects whether the derivative acts only on PV changes or on Error (either PV or Setpoint changes).	PV Error	Only changes in PV cause changes to the derivative output. Changes to either PV or SP will cause a derivative output.	PV	Conf L3 R/O
The above two parameters do not appear if either Ch1 or Ch2 are configured for Off or OnOff control					

20.3.1 Types of Control Loop

On/Off Control

On/Off control simply turns heating power on when the PV is below setpoint and off when it is above setpoint. If cooling is used, cooling power is turned on when the PV is above setpoint and off when it is below. The outputs of such a controller will normally be connected to relays – hysteresis may be set as described in the Alarms section to prevent relay chatter or to provide a delay in the control output action.

PID Control

PID control, also referred to as 'Three Term Control', is a technique used to achieve stable straight line control at the required setpoint. The three terms are:

P Proportional band
I Integral time
D Derivative time

The output from the controller is the sum of the contributions from these three terms. The combined output is a function of the magnitude and duration of the error signal, and the rate of change of the process value. It is possible to turn off integral and derivative terms and control on only proportional, proportional plus integral or proportional plus derivative.

Motorised Valve Control

This algorithm is designed specifically for positioning motorised valves. It operates in boundless or bounded mode.

Boundless VP control (VPU) does not require a position feedback potentiometer for control purposes.

Bounded VP (VPB) control requires a feedback potentiometer as part of the control algorithm.

Note, however that a potentiometer may be used with boundless mode but it is used solely for indication of the valve position and is not used as part of the control algorithm. The control is performed by delivering a 'raise' pulse, a 'lower' pulse or no pulse in response to the control demand signal via relay or triac outputs.

Motorised Valve Control in Manual mode

Bounded VP controls in manual mode by the fact that the inner positional loop is still running against the potentiometer feedback, so it is operating as a position loop.

In boundless mode the algorithm is a velocity mode positioner. When manual is selected the model predicts where the valve will move to based on the edit of the manual power. Effectively, when the raise or lower key is pressed, +100% or –100% velocity is put into the model for the duration of the key press and the raise or lower output is turned on. If the travel time for the valve is set correctly, the position indicated on the controller will fairly accurately match the actual valve position.

If any drift occurs in the model, it is reset at 100% and 0 and the valve driven back to the end stop, so it resets.

This technique makes boundless VP look like a positional loop in manual even though it is not. This enables combinations of heating and cooling e.g. PID heat, VPU cool and have the manual mode work as expected.

20.4 PID Control

The PID controller consists of the following parameters:-

Parameter	Meaning or Function
Proportional Band 'PB'	The proportional term, in display units or %, delivers an output which is proportional to the size of the error signal.
Integral Time 'Ti'	Removes steady state control offsets by ramping the output up or down in proportion to the amplitude and duration of the error signal.
Derivative Time 'Td'	Determines how strongly the controller will react to the rate of change in the measured value. It is used to prevent overshoot and undershoot and to restore the PV rapidly if there is a sudden change in demand.
High Cutback 'CBH'	The number of display units, above setpoint, at which the controller will increase the output power, in order to prevent undershoot on cool down.
Low Cutback 'CBL'	The number of display units, below setpoint, at which the controller will cutback the output power, in order to prevent overshoot on heat up.
Relative Cool Gain 'R2G'	Only present if cooling has been configured. Sets the cooling proportional band, which equals the heat proportional band value divided by the cool gain value.

20.4.1 Proportional Term

The proportional term delivers an output which is proportional to the size of the error signal. An example of this is shown below, for a temperature control loop, where the proportional band is 10°C and an error of 3°C will produce an output of 30%.

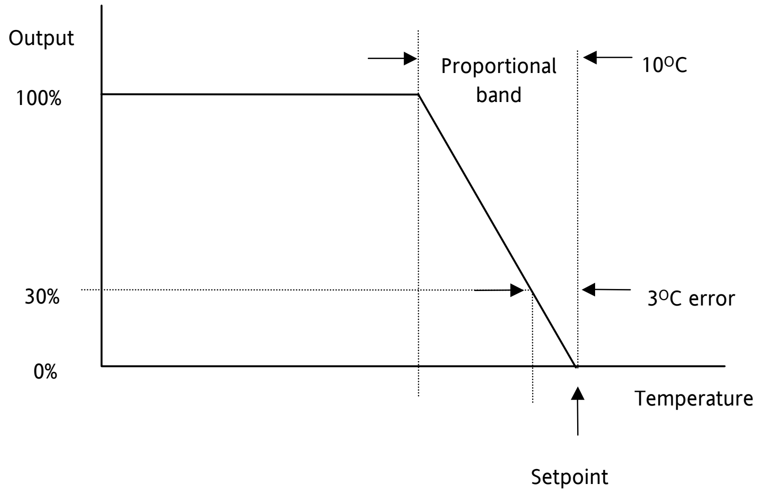


Figure 20-2: Proportional Action

Proportional only controllers will, in general, provide stable straight line control, but with an offset corresponding to the point at which the output power equals the heat loss from the system.

The proportional term may be set in engineering units, as shown in the above example, or as a percentage of the controller range. In the above example, if the input range is 0 to 1000°C the proportional band is set to 1%.

20.4.2 Integral Term

The integral term removes steady state control offset by ramping the output up or down in proportion to the amplitude and duration of the error signal. The ramp rate (reset rate) is the integral time constant, and must be longer than the time constant of the process to avoid oscillations.

20.4.3 Derivative Term

The derivative term is proportional to the rate of change of the temperature or process value. It is used to prevent overshoot and undershoot of the setpoint by introducing an anticipatory action. The derivative term has another beneficial effect. If the process value falls rapidly, due, for example, an oven door being opened during operation, and a wide proportional band is set the response of a PI controller can be quite slow. The derivative term modifies the proportional band according to this rate of change having the effect of narrowing the proportional band. Derivative action, therefore, improves the recovery time of a process automatically when the process value changes rapidly.

Derivative can be calculated on change of PV or change of Error. For applications such as furnace control, it is common practice to select Derivative on PV to prevent thermal shock caused by a sudden change of output following a change in setpoint.

20.4.4 High and Low Cutback

While the PID parameters are optimised for steady state control at or near the setpoint, high and low cutback parameters are used to reduce overshoot and undershoot for large step changes in the process. They respectively set the number of degrees above and below setpoint at which the controller will start to increase or cutback the output power.

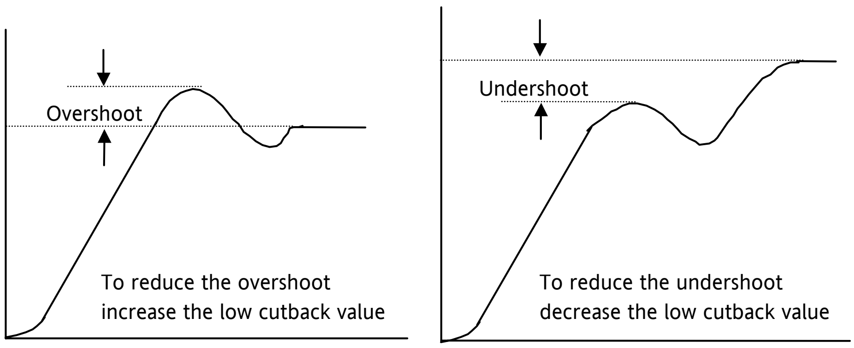


Figure 20-3: High and Low Cutback

20.4.5 Integral action and manual reset

In a full three-term controller (that is, a PID controller), the integral term automatically removes steady state errors from the setpoint. If the controller is set as a PD controller, the integral term will be set to 'OFF'. Under these conditions the measured value may not settle precisely at setpoint. The Manual Reset parameter (MR) represents the value of the power output that will be delivered when the error is zero. You must set this value manually in order to remove the steady state error.

20.4.6 Relative Cool Gain

The gain of channel 2 control output, relative to the channel 1 control output.

Relative Ch2 Gain compensates for the different quantities of energy needed to heat, as opposed to that needed to cool, a process. For example: water cooling applications might require a relative cool gain of 4 (cooling is 4 times faster than the heat-up process).

(This parameter is set automatically when Autotune is used). A nominal setting of around 4 is often used.

20.4.7 Loop Break Time

The loop is considered to be broken if the PV does not respond to a change in the output. Since the time of response will vary from process to process the Loop Break Time parameter allows a time to be set before a loop break alarm is initiated. In these circumstances the output power will drive to high or low limit. For a PID controller, if the PV has not moved by 0.5 x Pb in the loop break time the loop is considered to be in break. The loop break time is set by the Autoune, a typical value is 12 x Td.

For an On/Off controller LBT loop break detection is also based on loop break time as 0.1*SPAN where SPAN = Range High – Range Low. Therefore, if the output is at limit and the PV has not moved by 0.1*SPAN in the loop break time a loop break will occur.

20.4.8 Cooling Algorithm

The method of cooling may vary from application to application.

For example, an extruder barrel may be cooled by forced air (from a fan), or by circulating water or oil around a jacket. The cooling effect will be different depending on the method. The cooling algorithm may be set to linear where the controller output changes linearly with the PID demand signal, or it may be set to water, oil or fan where the output changes non-linearly against the PID demand. The algorithm provides optimum performance for these methods of cooling.

20.4.9 Gain Scheduling

Gain scheduling is the automatic transfer of control between one set of PID values and another. It may be used in very non-linear systems where the control process exhibits large changes in response time or sensitivity, see diagram below. This may occur, for example, over a wide range of PV, or between heating or cooling where the rates of response may be significantly different. The number of sets depends on the non-linearity of the system. Each PID set is chosen to operate over a limited (approximately linear) range.

In the 3500 controller, this is done at a pre-settable strategy defined by the parameter 'Sched Type'. The choices are:

Set	The PID set can be selected manually or from a digital input
SP	The transfer between one set and the next depends on the value of the SP
PV	The transfer between one set and the next depends on the value of the PV
Error	The transfer between one set and the next depends on the value of the error
OP	The transfer between one set and the next depends on the value of the OP demand
Rem	The transfer between one set and the next depends on the value from a remote source for example, a digital input
Soft Wired	To a parameter chosen by the user.

The 3500 controller has three sets of PID values – the maximum number which you may wish to use is set by 'Num Sets' parameter.

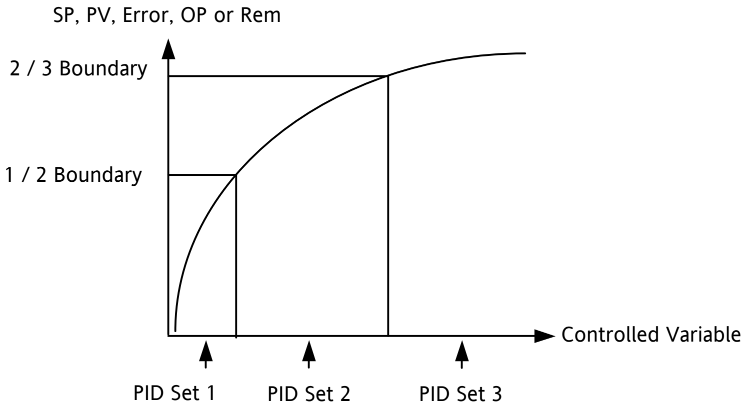


Figure 20-4: Gain Scheduling in a Non-Linear System

20.4.10 PID Parameters

List Header – Lp		Sub-header: PID			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Sched Type	To choose the type of gain scheduling	Off Set SP PV Error OP Rem	See above for explanation	Off	L3
Num Sets Note 1	Selects the number of PID sets to present. Allows the lists to be reduced if the process does not require the full range of PID sets.	1 to 3		1	L3
Active Set Note 1	Currently working set	Set1 Set2 Set3		Set1	R/O
Boundary 1-2 Note 1	Sets the level at which PID set 1 changes to PID set 2	Range units The 'Boundary' parameter only applies when 'Sched Type' = SP, PV, Error, OP or Rem			L3
Boundary 3-4 Note 1	Sets the level at which PID set 2 changes to PID set 3				
PB/PB2/PB3	Proportional band Set1/Set2/Set3	0 to 99999 Eng units		300	L3
Ti/Ti2/Ti3	Integral term Set1/Set2/Set3				L3
Td/Td2/Td3	Derivative term Set1/Set2/Set3				L3
R2G/R2G2/ R2G3	Relative cool gain Set1/Set2/Set3				L3
CBH/CBH2/ CBH3	Cutback high Set1/Set2/Set3				L3
CBL/CBL2/ CBL3	Cutback low Set1/Set2/Set3				L3
MR/MR2/MR3	Manual reset Set1/Set2/Set3. This must be set to 0.0 when the integral term is set to a value			0.0	L3
LBT/LBT2/LBT3	Loop break time Set1/Set2/Set3	Off or 1 to 99999	Seconds	100	L3

If the control type is set to On/Off, only LBT is shown in the PID list.

Note 1:

These parameters only appear if 'Sched Type' ≠ 'Off'.

20.5 Tuning

In tuning, you match the characteristics (PID parameters) of the controller to those of the process being controlled in order to obtain good control. Good control means:

Stable, 'straight-line' control of the PV at setpoint without fluctuation

No overshoot, or undershoot, of the PV setpoint

Quick response to deviations from the setpoint caused by external disturbances, thereby rapidly restoring the PV to the setpoint value.

Tuning involves calculating and setting the value of the parameters listed in the above table.

20.5.1 Automatic Tuning

This controller uses a one-shot tuner which automatically sets up the initial values of the parameters listed in the table on the previous page.

20.5.2 One-shot Tuning

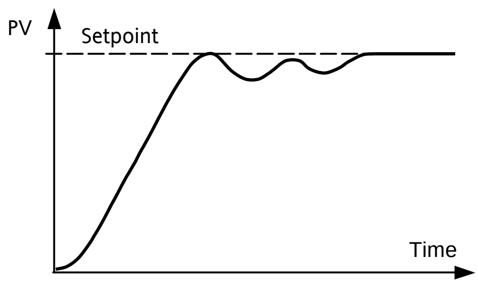
The 'one-shot' tuner works by switching the output on and off to induce an oscillation in the measured value. From the amplitude and period of the oscillation, it calculates the tuning parameter values.

If the process cannot tolerate full heating or cooling being applied, then the levels can be restricted by setting the high power limit ('Output Hi') and low power limit ('Output Lo'). However, the measured value *must* oscillate to some degree for the tuner to be able to calculate values.

A One-shot Tune can be performed at any time, but normally it is 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 for the new conditions.

It is best to start tuning with the process at ambient conditions and with the SP close to the normal operating level. This allows the tuner to calculate more accurately the low cutback and high cutback values which restrict the amount of overshoot, or undershoot.

Typical automatic tuning cycle



Autotune starts 1 minute after being turned on to determine steady state conditions.

Tuning normally takes place at a PV which has a value of setpoint x 0.7.

The power is automatically turned on and off to cause oscillations.

From the results the values shown in the table are calculated

20.5.3 Calculation of the cutback values

Low cutback and *High cutback* are values that restrict the amount of overshoot, or undershoot, that occurs during large step changes in PV (for example, under start-up conditions).

If either low cutback, or high cutback, is set to 'Auto' the values are fixed at three times the proportional band, and are not changed during automatic tuning.

To tune the cutback values, first set them to values other than Auto, then perform a tune as usual.

20.5.4 Manual Tuning

If for any reason automatic tuning gives unsatisfactory results, you can tune the controller manually. There are a number of standard methods for manual tuning. The one described here is the Ziegler-Nichols method.

With the process at its normal running conditions:

Set the Integral Time and the Derivative Time to OFF.

Set High Cutback and Low Cutback to 'Auto'.

Ignore the fact that the PV may not settle precisely at the setpoint.

If the PV is stable, reduce the proportional band so that the PV just starts to oscillate. If PV is already oscillating, increase the proportional band until it just stops oscillating. Allow enough time between each adjustment for the loop to stabilise. Make a note of the proportional band value 'PB' and the period of oscillation 'T'.

Set the proportional band, integral time and derivative time parameter values according to the calculations given in the table below:-

Type of control	Proportional band (PB)	Integral time (Ti) seconds	Derivative time (Td) seconds
Proportional only	2xPB	OFF	OFF
P + I control	2.2xPB	0.8xT	OFF
P + I + D control	1.7xPB	0.5xT	0.12xT

20.5.5 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 PV, then manually set the cutback parameters.

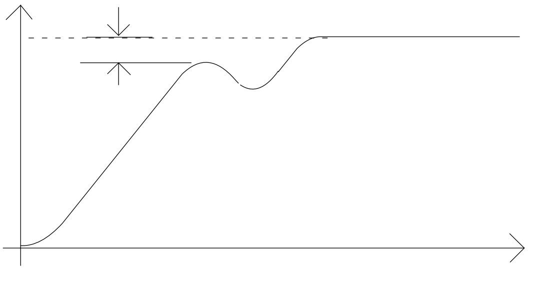
Proceed as follows:

Set the low and high cutback values to three proportional bandwidths (that is to say, 'CBH'= 'CBL' = 3 x PB).

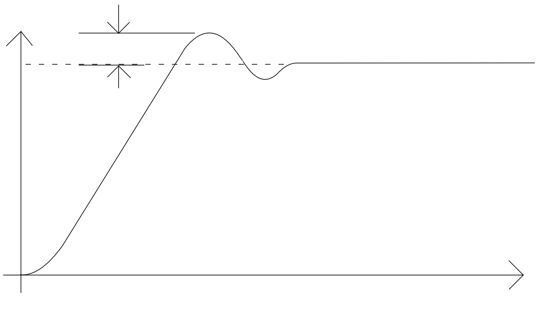
Note the level of overshoot, or undershoot, that occurs for large PV changes (see the diagrams below).

In example (a) decrease Low Cutback by the undershoot value. In example (b) increase Low Cutback by the overshoot value.

Example (a)



Example (b)



Where the PV approaches setpoint from above, you can set High Cutback in a similar manner.

20.5.6 Tune Parameters

List Header – Lp		Sub-header: Tune			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Enable	To start self tuning	Off On	Stop Start	Stop	L3
High Output	Set this to limit the maximum output power level which the controller will supply during the tuning process. If the high output power limit set in the output list is lower the autotune high limit will be clipped to this value.	Between Low Output and 100.0		!00.0	L3
Low Output	Set this to limit the minimum % output power level which the controller will supply during the tuning process. If the low output power limit set in the output list is higher the autotune low limit will be clipped to this value.	Between High Output and 0.0		0.0	L3
State	Shows if self tuning is in progress	OFF			R/O
Stage	Shows the progress of the self tuning	Reset			R/O
Stage Time	Time in the particular stage				R/O

20.6 Setpoint Function Block

The controller setpoint is the **Working Setpoint** which may be sourced from a number of alternatives. This is the value ultimately used to control the process variable in a loop.

The working setpoint may be derived from:-

1. SP1 or SP2, both of which are manually set by the user and can be switched into use by an external signal or through the user interface.
2. From an external (remote)analogue source
3. The output of a programmer function block and will, therefore, vary in accordance with the program in use.

The setpoint function block also provides the facility to limit the rate of change of the setpoint before it is applied to the control algorithm. It will also provide upper and lower limits. These are defined as setpoint limits for the local setpoints and instrument range high and low for other setpoint sources. All setpoints are ultimately subject to a limit of range hi and range lo.

User configurable methods for tracking are available, such that the transfer between setpoints and between operational modes will not cause a bump in the setpoint.

20.6.1 Setpoint Function Block

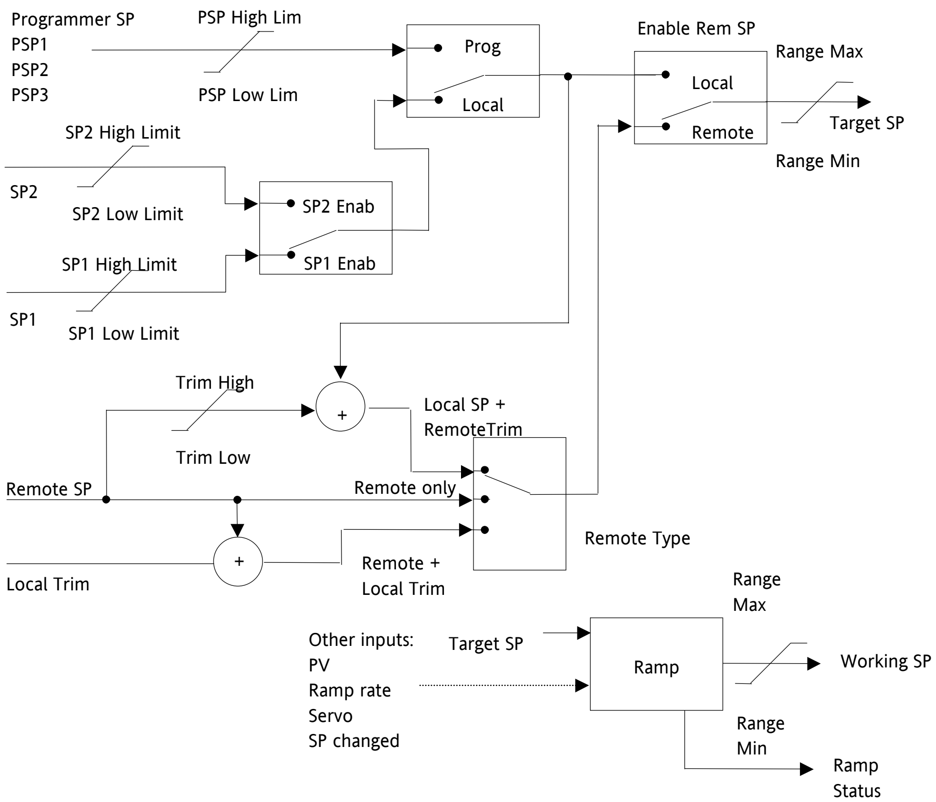


Figure 20-5: Setpoint Function Block

20.6.2 SP Tracking

When setpoint tracking is enabled and the local setpoint is selected, the local setpoint is copied to 'TrackSP'. Tracking now ensures that the alternate SP follows or tracks this value. When the alternate setpoint is selected it initially takes on the tracked value thus ensuring that no bump takes place. The new setpoint is then adopted gradually. A similar action takes place when returning to the local setpoint.

20.6.3 Manual Tracking

When the controller is operating in manual mode the currently selected SP tracks the PV. When the controller resumes automatic control there will be no step change in the resolved SP.

20.6.4 Rate Limit

Rate limit will control the rate of change of setpoint. It is enabled by the **'Rate'** parameter. If this is set to Off then any change made to the setpoint will be effective immediately. If it is set to a value then any change in the setpoint will be effected at the value set in units per minute. Rate limit also acts on SP2 and when switching between SP1 and SP2.

When rate limit is active the '**RateDone**' parameter will display '**No**'. When the setpoint has been reached this parameter will change to '**Yes**'.

When '**Rate'** is set to a value (other than Off) an additional parameter '**SPRate Disable'** is displayed which allows the setpoint rate limit to be turned off and on without the need to adjust the 'Rate' parameter between Off and a value.

20.6.5 Setpoint Parameters

List Header – Lp		**Sub-header: SP**			
Name (button) to select	**Parameter Description**	**Value** (▲) or (▼) to change		**Default**	**Access Level**
Range Hi	The Range limits provide a set of absolute maximums and minimums for setpoints within the control loop. Any derived setpoints are ultimately clipped to be within the Range limits. If the Proportional Band is configured as % of Span, the span is derived from the Range limits.	Full range of the input type			Conf
Range Lo					Conf
SP Select	Select local or alternate setpoint	SP1 SP2	Setpoint 1 Setpoint 2	SP1	L3
SP1	Primary setpoint for the controller	Between SP high and SP low limits			L3
SP2	Setpoint 2 is the secondary setpoint of the controller. It is often used as a standby setpoint.				L3
SP HighLim	Maximum limit allowed for the local setpoints	Between Range Hi and Range Lo			L3
SP LowLim	Minimum limit allowed for the local setpoints				L3
Alt SP En	To enable the alternative setpoint to be used. This may be wired to a source such as the programmer Run input. See note 1	No Yes	Alternative setpoint disabled Alternative setpoint enabled		L3
Alt SP	This may be wired to an alternative source such as the programmer or remote setpoint See note 1				L3

Rate	Limits the maximum rate at which the working setpoint can change. The rate limit may be used to protect the load from thermal shock which may be caused by large step changes in setpoint.	Off or 0.1 to 9999.9 engineering units per minute		Off	L3
RateDone	Flag which indicates when the setpoint is changing or completed	No Yes	Setpoint changing Complete		R/O
SPRate Disable	Setpoint rate disable	No Yes	Enabled Disabled		L3
SP Trim	Trim is an offset added to the setpoint. The trim may be either positive or negative, the range of the trim may be restricted by the trim limits Setpoint trims may be used in a retransmission system. A master zone may retransmit the setpoint to the other zones, a local trim may be applied to each zone to produce a profile along the length of the machine	Between SP Trim Hi and SP Trim Lo			L3
SP Trim Hi	Setpoint trim high limit				L3
SP Trim Lo	Setpoint trim low limit				L3
Man Track	To enable manual tracking. When the loop is switched from Manual to Auto, the Setpoint is set to the current PV. This is useful if the load is started in Manual Mode, then later switched to Auto to maintain the operating point.	Off On	Manual tracking disabled Manual tracking enabled		L3 R/O
SP Track	Setpoint tracking ensures bumpless transfer in setpoint when switching between a local and an alternate setpoint such as the programmer. This enables the tracking interface provided by TrackPV and TrackVal, which is used by the programmer and other setpoint providers external to the control loop	Off On	Setpoint tracking disabled Setpoint tracking enabled		Conf
Track PV	The programmer tracks the PV when it is servoing or tracking.				L3 R/O
Track SP	Manual Tracking Value. The SP to track for manual tracking.				L3 R/O

Note 1:-

Connections to the programmer are made automatically when the loop and programmer are enabled and there are no existing connections to these parameters.

20.7 Output Function Block

The output function block allows you to set up output conditions from the control block, such as output limits, hysteresis, output feedforward, behaviour in sensor break, etc.

List Header – Lp		Sub-header: OP		
Name to select	**Parameter Description**	**Value** or to change	**Default**	**Access Level**
Output Hi	Maximum output power delivered by channels 1 and 2. By reducing the high power limit, it is possible to reduce the rate of change of the process, however, care should be taken as reducing the power limit will reduce the controllers ability to react to disturbance.	Between Output Lo and 100.0%	100.0	L3
Output Lo	Minimum (or maximum negative) output power delivered by channels 1 and 2	Between Output Hi and -100.0%	-100.0	L3
Ch1 Output	Channel 1 (Heat) output. The Ch1 output is the positive power values (0 to Output Hi) used by the heat output. Typically this is wired to the control output (time proportioning or DC output).	Between output Hi and Output Lo		L3 R/O
Ch2 Output	The Ch2 output is negative portion of the control output (0 – Output Lo) for heat/cool applications. It is inverted to be a positive number so that it can be wired into one of the outputs (time proportioning or DC outputs).	Between output Hi and Output Lo		L3 R/O
Ch2 DeadB	Ch1/Ch2 Deadband is a gap in percent between output 1 going off and output 2 coming on and vice versa. For on/off control this is taken as a percentage of the hysteresis.	Off to 100.0%	Off	L3
The following four parameters only appear if Ch1/2 are configured for valve position control (Ch1/2 Control = VPU/VPB in Lp Setup page)				
Ch1 TravelT	Valve travel time for the channel 1 valve to travel from 0% (closed) to 100% (open). In a Valve positioner application, Channel one is connected to both a Raise and a Lower output. In a Heat/Cool application Channel 1 is the heat valve.	0.0 to 1000.0 seconds		L3
Ch2 TravelT	Travel time for Channel 2 valve to travel from 0% (closed) to 100% (open). In a Heat/Cool application, Channel 2 is the cool valve.	0.0 to 1000.0 seconds		L3
Nudge Raise	Causes the valve to move by one minimum on time towards the CH1 open. This parameter is provided for so that digital communications can control the valve			L3
Nudge Lower	Causes the valve to move by one minimum on time towards the CH1 close.			L3
The following pot feedback parameters appear if Ch1/2 are configured for VPB – valve position bounded mode				

PotCal	Starts the potentiometer calibration by selecting which potentiometer to calibrate. e.g. if a valve is used to control the cooling of a process, then the ch2 potentiometer must be calibrated. Note: Potentiometer input modules must be fitted and wired directly to the loops Ch1 or Ch2 pot position parameters. See section 9.4.4 for details on pot calibration	Off CH1 CH2	Pot cal disabled Calibrate channel 1 Calibrate channel 2		Conf
Ch1 Pot Pos	The position of the channel 1 actuator as measured by a pot position feedback. This is used by the bounded VP control algorithm as the PV of the positional loop. Note: PotCal can be used to automatically calibrate the potentiometer feedback.				L3
Ch1 Pot Brk	Indicates the Channel 1 pot is broken. This parameter requires that the pot position is wired from an input channel. This value is taken from the wire.	Off On		Off	L3
Ch2 Pot Pos	The position of the channel 2 actuator as measured by a pot position feedback. This is used by the bounded VP control algorithm as the PV of the positional loop				L3
Ch2 Pot Brk	Indicates the Channel 2 pot is broken. This value is taken from the wire and is provided by the pot input module.	Off On		Off	L3
PotBrk Mode	Defines the action which takes place if the feedback potentiometer becomes open circuit. An alarm message is given whenever the fault occurs.	Raise Lower Rest Model	The valve is opened The valve is closed The valve remains in its current position The controller tracks the actual position of the valve and sets up a model of the system so that it continues to control when the potentiometer becomes faulty		L3
Rate	Limits the rate at which the output from the PID can change in % change per minute. Output rate limit is useful in preventing rapid changes in output from damaging the process or the heater elements.	Off to 9999.9 engineering units per minute		Off	L3
Ch1 OnOff Hyst	Channel hysteresis only shown when channel 1 is configured as OnOff. Hysteresis sets the difference between output on and output off to prevent (relay) chatter.	0.0 to 200.0		10.0	L3
Ch2 OnOff Hyst		0.0 to 200.0		10.0	L3
Sbrk Mode	Defines the action taken if the Process Variable is bad, i.e. the sensor has failed. This can be configured as hold, in which case the output of the loop is held at its last good value. Alternately the output can switch to a safe output power defined at configuration.	Safe Hold	To select the level set by 'Safe OP' To hold the current output level at the point when sensor break occurs	Safe	L3

Safe OP	Sets the output level to be adopted when in a sensor break condition	Between output Hi and Output Lo			L3
Man Mode	Selects the mode of manual operation.	Track Step	In auto the manual output tracks the control output such that a change to manual mode will not result in a bump in the output. on transition to manual the output will be the manual op value as last set by the operator.		L3
ManOP	The output when the loop is in manual. Note: In manual mode the controller will still limit the maximum power to the power limits, however, it could be dangerous if the instrument is left unattended at a high power setting. It is important that the over range alarms are configured to protect your process. *We recommend that all processes are fitted with an independent over range "policeman"*	Between output Hi and Output Lo			L3 R/O
PffEn See section 20.7.1	Power feedforward enable. This adjusts the output signal to compensate for changes in voltage to the controller supply	No Yes	Disabled Enabled		
Pwr In	Measured power input				L3 R/O
Cool Type	Selects the type of cooling channel characterisation to be used. Can be configured as water, oil or fan cooling.	Linear Oil Water Fan	These are set to match the type of cooling medium applicable to the process		Conf L3 R/O
FF Type	Feedforward type The following four parameters appear if FF Type ≠ None	None	No signal fed forward	None	Conf
		Remote	A remote signal fed forward		
		SP	Setpoint fed forward		
		PV	PV fed forward		
FF Gain	Defines the gain of the feedforward value, the feed forward value is multiplied by the gain				Conf
FF Offset	Defines the offset of the feedforward value this is added to the scaled feedforward.				L3
FF Trim Lim	Feedforward trim limits the effect of the PID output. Defines symmetrical limits around the PID output, such that this value is applied to the feedforward signal as a trim.				L3
FF OP	The calculated Feedforward Value.				L3 R/O
Track OP	Value for the loop output to track when OP Track is Enabled.				
Track En	When enabled, the output of the loop will follow the track output value. The loop will bumplessly return to control when tracking is turned off.	Off On	Disabled Enabled		L3

RemOPL	Remote output low limit. Can be used to limit the output of the loop from a remote source or calculation. This must always be within the main limits.	-100.0 to 100.0		L3
RemOPH	Remote output high limit	-100.0 to 100.0		L3

20.7.1 Power Feed Forward Enable

Power feedforward is a feature which monitors the line voltage and compensates for fluctuations before they affect the process temperature. This allows the output power to be corrected for fluctuations in the line voltage when using electrical heating. The use of this will give better steady state performance when the line voltage is not stable.

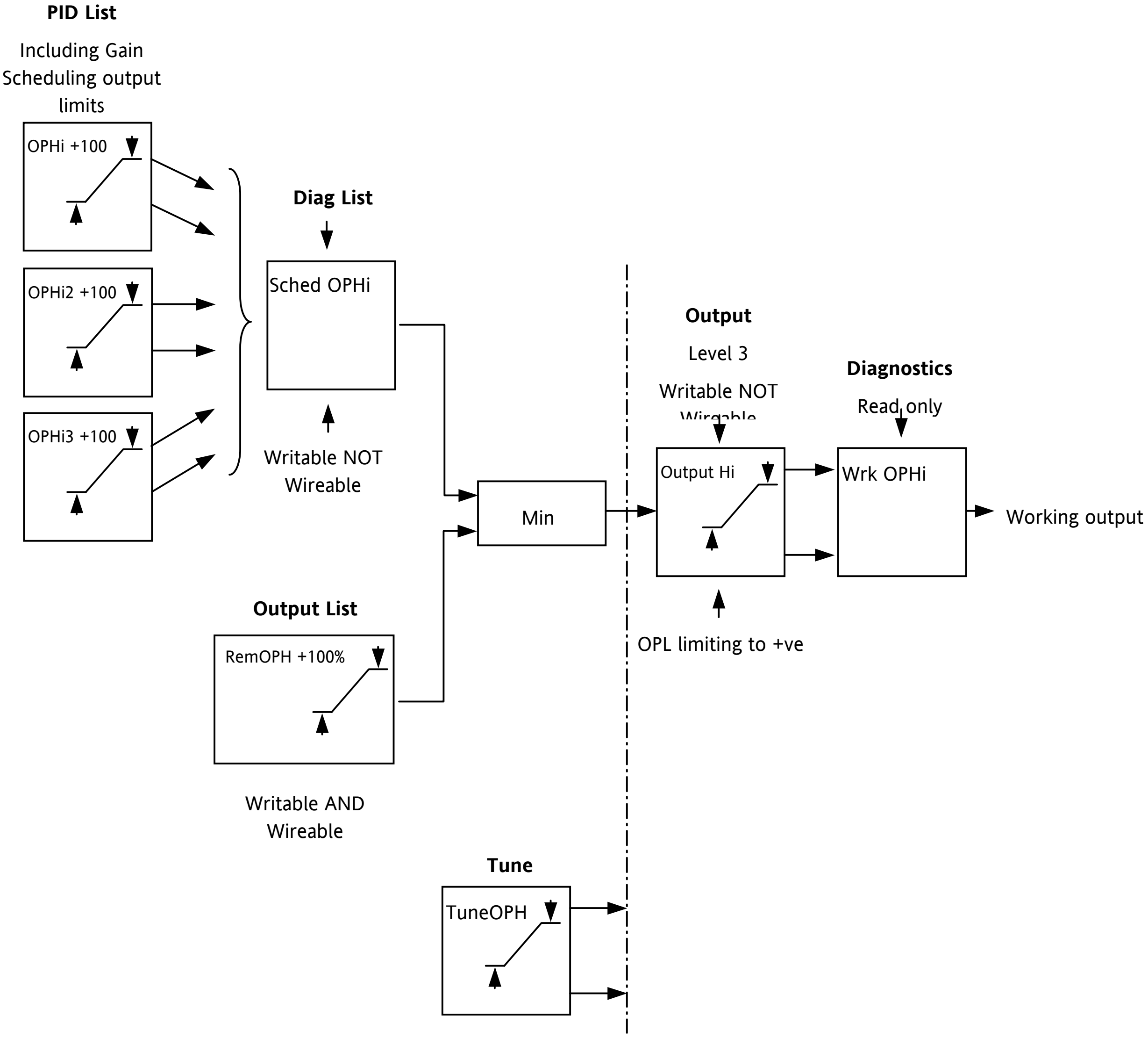
It is mainly used for digital type outputs which drive contactors or solid state relays. It is generally not necessary when analogue thyristor control is used since compensation for power changes is included in the thyristor driver. It should also be disabled for any non-electric heating process.

Consider a process running at 25% power, with zero error and then the line voltage falls by 20%. The heater power would drop by 36% because of the square law dependence of power on voltage. A drop in temperature would result. After a time, the thermocouple and controller would sense this fall and increase the ON-TIME of the contactor just enough to bring the temperature back to set point. Meanwhile the process would be running a bit cooler than optimum which may cause some imperfection in the product.

With power feedforward enabled the line voltage is monitored continuously and ON-TIME increased or decreased to compensate immediately. In this way the process need never suffer a temperature disturbance caused by a line voltage change.

20.7.2 Output Limits

The diagram shows where output limits are applied.



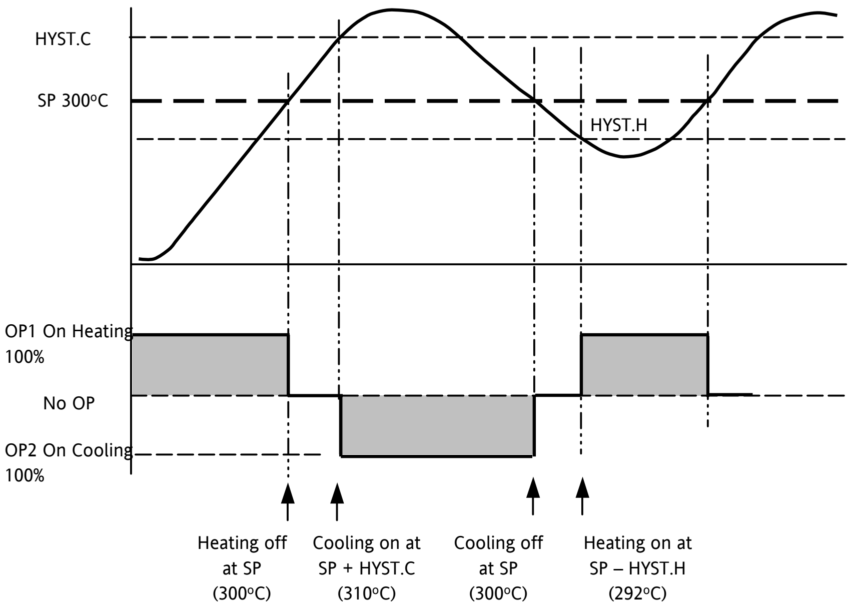
- Individual output limits may be set in the PID list for each set of PID parameters when gain scheduling is used.
- The parameters 'Sched OPHi' and 'Sched OPHLo', found in the Diagnostics List, may be set to values which override the gain scheduling output values.
- A limit may also be applied from an external source. These are 'RemOPH' and 'RemOPLo' (Remote output high and low) found in the Output List. These parameters are wireable. For example they may be wired to an analogue input module so that a limit may applied through some external strategy. If these parameters are not wired ±100% limit is applied every time the instrument is powered up.
- The tightest set (between Remote and PID) is connected to the output where an overall limit is applied using parameters 'Output Hi' and 'Output Lo' settable in Level 3.
- 'Wrk OPHi' and 'Wrk OPHLo' found in the Diagnostics list are read only parameters showing the overall working output limits.
- The tune limits are a separate part of the algorithm and are applied to the output during the tuning process. The overall limits 'Output Hi' and 'Output Lo' always have priority.

20.7.3 Effect of Control Action, Hysteresis and Deadband

For temperature control '**Control Act'** will be set to '**Rev'**. For a PID controller this means that the heater power decreases as the PV increases. For an on/off controller output 1 (usually heat) will be on (100%) when PV is below the setpoint and output 2 (usually cool) will be on when PV is above the setpoint

Hysteresis applies to on/off control only. It defines the difference in temperature between the output switching off and switching back on again. The examples below shows the effect in a heat/cool controller.

Deadband (**Ch2 DeadB**) can operate on both on/off control or PID control where it has the effect of widening the period when no heating or cooling is applied. However, in PID control its effect is modified by both the integral and derivative terms. Deadband might be used in PID control, for example, where actuators take time to complete their cycle thus ensuring that heating and cooling are not being applied at the same time. Deadband is likely to be used, therefore, in on/off control only. The second example below adds a deadband of 20 to the above example.



Heating and Cooling Type both on/off

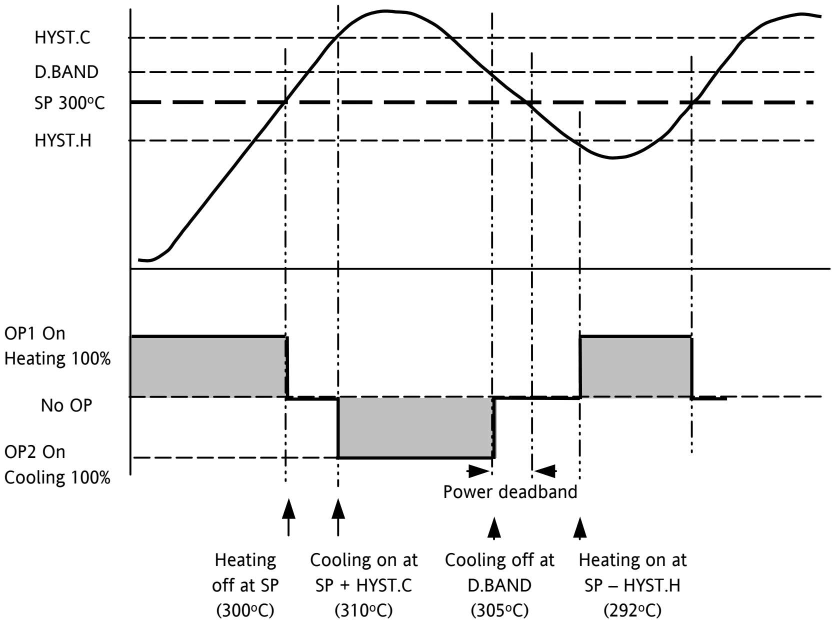
Setpoint = 300°C

Control Action = reverse

Heating Hysteresis = 8°C

Cooling Hysteresis = 10°C

Deadband = OFF



Heating and Cooling Type both on/off

Setpoint = 300°C

Control Action = reverse

Heating Hysteresis = 8°C

Cooling Hysteresis = 10°C

Deadband 50% of cooling hysteresis = 5°C

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21. CHAPTER 21 SETPOINT PROGRAMMER

In a setpoint programmer you can set up a profile in the controller in which the setpoint varies in a pre-determined way over a period of time. Temperature is a very common application where it is required to 'ramp' the process value from one level to another over a set period of time.

The **Program** is divided into a flexible number of **Segments** - each being a single time duration. The total number of segments available is **200** or **50 per program** and it is possible to store up to **50 separate programs.**

It is often necessary to switch external devices at particular times during the program. Up to eight digital 'event' outputs can be programmed to operate during those segments.

An example of a program and two event outputs is shown below.

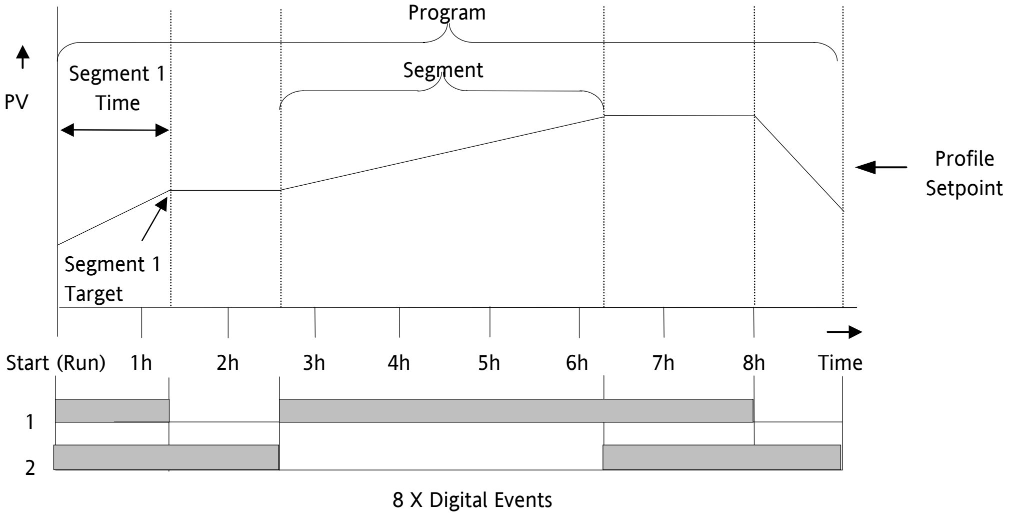


Figure 21-1: A Setpoint Program

Each individual segment can be configured as **Time-to-Target** or **Ramp-Rate**. This allows a single program to use both modes. A program with all segments configured as Time-to-Target is shown below.

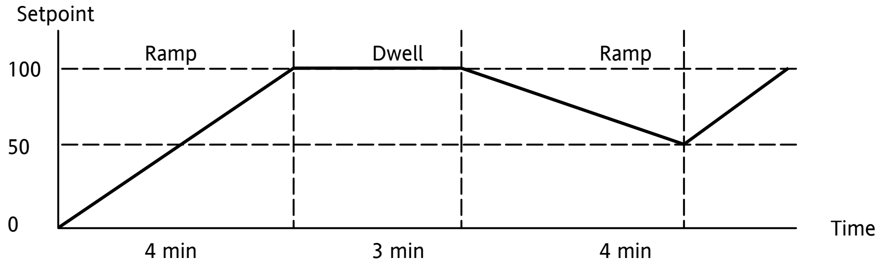


Figure 21-2: Time to Target Programmer

A ramp rate programmer specifies it's ramp segments as maximum setpoint changes per time unit. The diagram below demonstrates a ramp rate programmer.

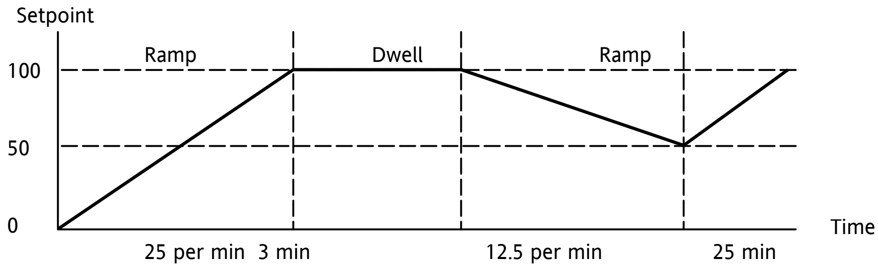


Figure 21-3: Ramp Rate Programmer

21.1 Programmer Operating States

21.1.1 Reset

In reset the programmer is inactive and the controller behaves as a standard controller. It will:-

1. Continue to control with the setpoint determined by the next available source, SP1, SP2, Alternative Setpoint.
2. Allow edits to all segments
3. Return all controlled outputs to the configured reset state.

21.1.2 Run

In run the programmer working setpoint varies in accordance with the profile set in the active program. A program will always run – non configured programs will default to a single Dwell end segment.

21.1.3 Hold

A programmer may only be placed in Hold from the Run or Holdback state. In hold the setpoint is frozen at the current programmer setpoint and the time remaining parameter frozen at its last value. In this state you can make temporary changes to program parameters such as a target setpoint, ramp rates and times. These changes will only remain effective until the end of the currently running segment, when they will be overwritten by the stored program values.

21.1.4 Program Cycles

If the Program Cycles parameter is chosen as greater than 1, the program will execute all its segments (including calls to other programs) then repeat from the beginning. The number of cycles is determined by the parameter value. The Program Cycles parameter has a range of 0 to 999 where 0 is enumerated to CONTinuous.

21.1.5 Servo

Servo can be set in configuration so that when a program is run the setpoint can start from the initial controller setpoint or from the current process value. Whichever it is, the starting point is called the servo point. This can be set in the program.

Servo to PV will produce a smooth and bumpless start to the process.

Servo to SP may be used in a Ramp Rate programmer to guarantee the time period of the first segment. (Note: in a Time to Target programmer the segment duration will always be determined by the setting of the Segment Duration parameter.)

21.1.6 Skip Segment

Moves immediately to the next segment and starts the segment from the current setpoint value.

21.1.7 Advance Segment

Sets the program setpoint equal to the target setpoint and moves to the next segment.

21.1.8 Fast x10 mode

Executes the program at 10x the normal speed. It is provided so that programs can be tested **but the process should not be run in this state**.

21.1.9 Sensor break recovery

On sensor break, the program state changed to HOLD if the current state is RUN or HOLDBACK. Sensor break is defined as status bad on the PV Input parameter. If the program state is in HOLD when PV input status returns to OK, the program state is automatically set back to RUN.

21.1.10 Holdback (Guaranteed Soak)

Holdback freezes the program if the process value (PV) does not track the setpoint (SP) by more than a user defined amount. The instrument will remain in HOLDBACK until the PV returns to within the requested deviation from setpoint. The display will flash the HOLD beacon.

In a **Ramp** it indicates that the PV is lagging the SP by more than the set amount and that the program is waiting for the process to catch up.

In a **Dwell** it freezes the dwell time if the difference between the SP and PV exceeds the set limits.

In both cases it guarantees the correct soak period for the product.

Each program can be configured with a holdback value. Each segment determines the holdback function.

Holdback will cause the execution time of the program to extend, if the process cannot match the demanded profile.

Holdback state will not change the user's access to the parameters. The parameters will behave as if in the RUN state.

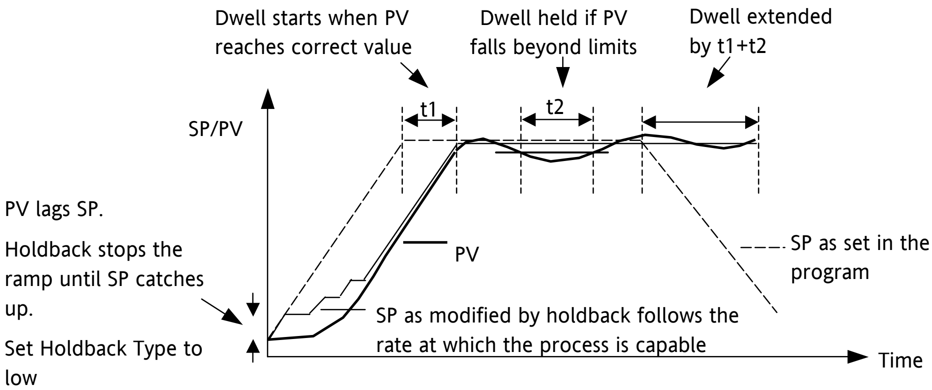


Figure 21-4: Effect of Holdback to Produce Guaranteed Soak

The above diagram demonstrates that the demanded setpoint (SP) will only change at the rate specified by the program when the PV's deviation is less than the holdback value. When the Deviation between the setpoint and PV is greater than the holdback value (HBk Val) the setpoint ramp will pause until the deviation returns to within the band.

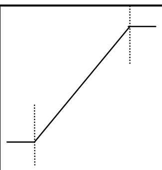
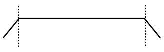
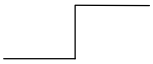
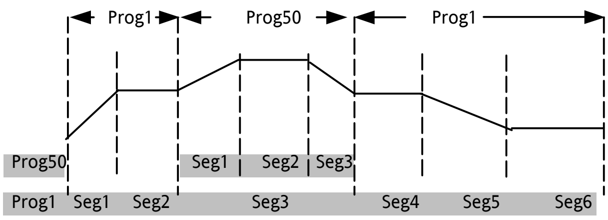
The next segment will not start until the deviation between Setpoint and PV is less than the holdback value.

Four types of Holdback are available:-

None	Holdback is disabled for this segment.
High	Holdback is entered when the PV is greater than the Setpoint **plus** HBk Val.
Low	Holdback is entered when the PV is lower than the Setpoint **minus** HBk Val.
Band	Holdback is entered when the PV is **either** greater than the Setpoint **plus** HBk Val **or** lower than the Setpoint **minus** HBk Val

21.1.11 Segment Types

A segment may be set as:-

Ramp		A Ramp segment provides a controlled change of setpoint from an original to a target setpoint. The duration of the ramp is determined by the rate of change specified. Two styles of ramp are possible in the range, Ramp-Rate or Time-To-Target. The ramp is specified by the target setpoint and the desired ramp rate. The ramp rate parameter is presented in engineering units (ºC, ºF, Eng.) per real time units (Seconds, Minutes or Hours). If the units are changed, all ramp rate are re-calculated to the new units and clipped if necessary.
Dwell		The setpoint remains constant for a specified period at the specified target. The operating setpoint of a dwell is inherited from the previous segment.
Step		The setpoint changes instantaneously from its current value to a new value at the beginning of a segment. A Step segment has a minimum duration of 1 second.
Call		A CALL segment may only be selected in instruments offering multiple programs. The segment allows programs to be nested within each other. To prevent re-entrant programs from being specified, only higher number programs may be called from a lower program. i.e. program 1 may call programs 2 through 50, but program 49 may only call program 50. When a CALL segment is selected the operator may specify how many cycles the called program will execute. The number of cycles is specified in the calling program. If a called program has a number of cycles specified locally, they will be ignored. A CALL segment will not have a duration, a CALL segment will immediately transfer execution to the called program and execute its first segment. Called programs do not require any modification, the calling program treats any END segments as return instructions. The example shows Prog 50 (Ramp/Dwell/Ramp) inserted in place of segment 3/Program1. Prog 50 can be made to repeat using the 'Cycles' parameter. 
End		A program may contain one End segment. This allows the program to be truncated to the number of segments required. The end segment can be configured to have an indefinite dwell or to reset the program. This is selectable by the user. If a number of program cycles are specified for the program, then the End segment is not executed until the last cycle has completed.

21.1.12 Power Fail Recovery

In the event of power fail to the controller, a strategy may be set in configuration level, which defines how the controller behaves on restoration of the power. These strategies include:

Continue	The program setpoint returns immediately to its last value prior to the power down. This may cause full power to be applied to the process for a short period to heat the process back to its value prior to the power failure.
Ramp back	This will servo the program setpoint to the measured value (the PV Input parameter value), then return to the target setpoint at the current (or previous) ramp rate. The setpoint is not allowed to step change the program setpoint. The outputs will take the state of the segment which was active before power was interrupted.
Reset	The process is aborted by resetting the program. All event outputs will take the reset state.

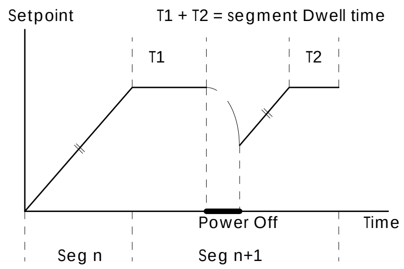
The display does not warn the operator that a power interruption has occurred.

21.1.12.1 Ramp back (Power fail during Dwell segments.)

If the interrupted segment was a Dwell, then the ramp rate will be determined by the previous ramp segment.

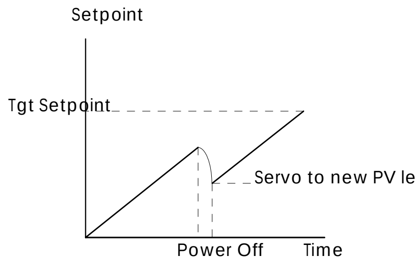
On achieving the Dwell setpoint, the dwell will continue from the point at which the power was interrupted.

Note: If a previous ramp segment does not exist, i.e. the first segment of a program is a dwell, then the Dwell will continue at the "servo to PV" setpoint.



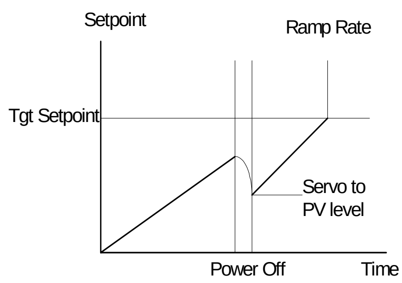
21.1.12.2 Ramp back (power fail during Ramp segments)

If the interrupted segment was a ramp, then the programmer will servo the program setpoint to the PV, then ramp towards the target setpoint at the previous ramp rate. Previous ramp rate is the ramp rate at power fail.



21.1.12.3 Ramp back (power fail during Time-to-target segments)

If the programmer was defined as a Time-to-Target programmer then when the power is returned the previous ramp rate will be recovered. The Time remaining will be recalculated. The rule is to maintain RAMP RATE, but alter TIME REMAINING.



21.1.13 Sync mode

This mode will allow two or more programmers to by synchronised together. This means that the start of each segment (excluding the first) will begin at the same time. Two or more instruments may be synchronised by wiring the "end of segment" and "sync input" parameters between units. (see diagram below).

Set "SyncMode" to Yes

Wire instruments as follows :-

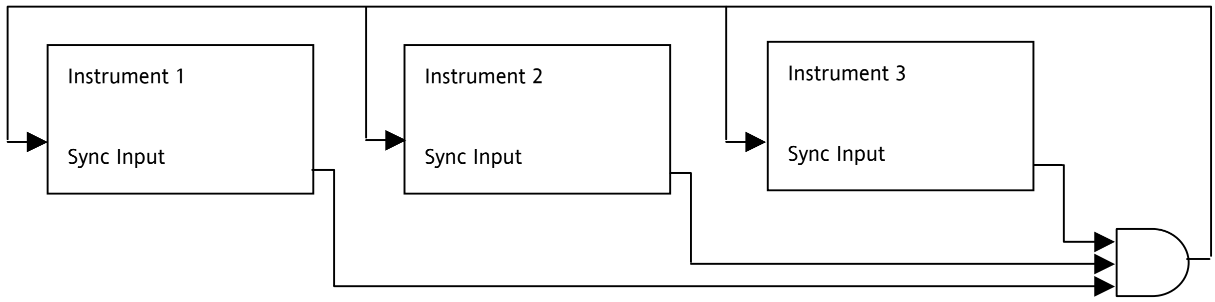


Figure 21-5: Synchronisation of three controllers

At the end of a segment, the program will be put into a temporary hold state (program status will continue to show that the program is running), the hold beacon will flash, the end_of_segment parameter will be true. Once all segments have completed, the SyncInput goes high and the next segment is started.

If the "SyncMode" is disabled, the "End_Of_Segment" parameter is guaranteed to be true for 1 tick at the end of every segment.

21.2 Creating or Editing a Program

Press as many times as necessary to select the '**Program'** page, or, in configuration level, press the PROG button and this will select the first sub-header - '**All**'. This allows you to configure and view parameters common to all programs in the controller. The following is a list of the parameters.

List Header – Program		**Sub-header: All (only available in configuration level)**			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
PV Input	The programmer uses the PV input for a number of functions In holdback, the PV is monitored against the setpoint, and if a deviation occurs the program is paused. The programmer can be configured to start its profile from the current PV value (servo to PV). The programmer monitors the PV value for Sensor Break. The programmer holds in sensor break.	The PV Input is normally wired from the loop TrackPV parameter. Note: This input is automatically wired when the programmer and loop are enabled and there are no existing wires to track interface parameters. Track interface parameters are Programmer.Setup, PVInput, SPInput, Loop.SP, AltSP, Loop.SP, AltSPSelect.			Conf
SP Input	The programmer needs to know the working setpoint of the loop it is trying to control. The SP input is used in the servo to setpoint start type.	SP Input is normally wired from the loop Track SP parameter as the PV input.			Conf
Servo	The transfer of program setpoint to PV Input (normally the Loop PV) or the SP Input (normally the Loop setpoint).	PV SP	See also section 21.1.5.		Conf
Power Fail	Power fail recovery strategy	Ramp Reset Cont	See section 21.1.12.		Conf
Sync Input	The synchronise input is a way of synchronising programs. At the end of a segment the programmer will inspect the sync. input, if it is True (1) then the programmer will advance to the next segment. It is typically wired from the end of segment output of another programmer. Only appears if 'SyncMode' = 'Yes'	0 1	This will normally be wired to the 'End of Seg' parameter as shown in section 21.1.13.		Conf
Max Events	To set the maximum number of output events required for the program. This is for convenience to avoid having to scroll through unwanted events when setting up each segment	1 to 8			Conf
SyncMode	Allows multiple controllers to be synchronised at the end of each segment	No Yes	Sync output disabled Sync output enabled		Conf
Prog Reset	Flag showing reset state	No/Yes	Can be wired to logic inputs to provide remote program control		R/O
Prog Run	Flag showing run state	No/Yes			R/O
Prog Hold	Flag showing hold state	No/Yes			R/O
Event 1 to 8	Flags showing event states	No/Yes			R/O
End of Seg	Flag showing end of segment state	No/Yes			R/O

Now select the program number to be created or edited. (Press ⊜ followed by ▲ or ▼).

Programs can be created and edited in Level 3 or configuration level.

This gives access to parameters which allow you to set up each segment of the selected program. The following table lists these parameters:-

List Header – Program		**Sub-header: 1 to 50**			
Name ⊜ to select	**Parameter Description**	**Value** ▲ or ▼ to change		**Default**	**Access Level**
Segments Used	This value automatically increments when another segment is added	1 to 50		1	R/O
Holdback Value	Deviation between SP and PV at which holdback is applied. This value applies to the whole program.	Minimum setting 0			L3
Ramp Units	Time units applied to the segments	Sec Min Hour	Seconds Minutes Hours		L3
Cycles	Number of times the whole program repeats	Cont 1 to 999	Repeats continuously Program executes once to 999 times		L3
Segment	To select the segment to set up	1 to 50			L3
Segment Type	To define the type of segment. See also section 21.1.11.	End Rate Time Dwell Step Call	Last segment in the program Rate of change of SP Duration to new SP Duration at previous SP Rapid change to new SP To insert a new program in the current program	End	L3
End Type	Only shown if 'Segment Type' = 'End'. Defines the action to be taken at the end of the program	Dwell Reset	The program will remain at last SP indefinitely The program will return to controller only mode	Dwell	L3
Call Program	Only shown if 'Segment Type' = 'Call'. Enter the program number to be inserted in place of the selected segment	Up to 50 (current program number excluded)			L3
Call Cycles	Only shown if 'Segment Type' = 'Call'. Defines the number of times the inserted program repeats	Cont 1 to 999	Repeats continuously Program executes once to 999 times		L3
Holdback Type	Sets the type of holdback applicable to the selected segment	Off Low High Band	No holdback applied Deviation low Deviation high Deviation high and low		L3

Duration	Only shown if 'Segment Type' = 'Dwell' or 'Time'. Sets the time to execute the segment.	0:00.0 to 500:00 0.1 sec to 500 hours		L3
Target SP	Only shown if 'Segment Type' = 'Rate', 'Time' or 'Step'. To enter the SP which is to be achieved at the end of the segment			L3
Ramp Rate	Only shown if 'Segment Type' = 'Rate'. To enter the rate in units/time at which the SP is required to change	0.1 to 9999.9 units per sec, min or hour		L3
Event Outs	To define the state of up to eight event outputs in the selected segment □□□□□□□□ to ■■■■■■■■	= Off ■ = On		L3

21.3 To Select, Run, Hold or Reset a Program

When the controller is ordered as a programmer a 'User Screen' is configured to allow quick access to the programmer. The example below uses this screen.

Do This	The Display You Should See	Additional Notes
10. From any display press until the 'Programmer User Display' is shown	WSP 156.0 Program 1 Status Reset PSP 0.0	
11. Press to **'Program'** 12. Press or to choose the program number to be run	WSP 0.5 Program #2:Biscuit	In this example Program Number 2 is chosen and has been given a user defined name. In the 3504 Program names can be entered using the off-line programming package 'iTools'.
13. Press RUN or select 'Status' and set this to 'Run'	WSP 8.1 Program 2:Biscuit Segment 1 Seg Time Left 0:03.7	'RUN' is displayed in the indicator beacons section of the main display. The view shown here shows current working setpoint, program being run, current segment number and time left to complete this segment.
14. To Hold a program press RUN		Press RUN again to continue the program. When the program is complete 'RUN' will flash
15. To Reset a program press RUN for at least 3 seconds		'RUN' will extinguish and the controller will return to the HOME display shown in section 1.10.

Notes:-

1. An alternative way to run, hold or reset the program from this screen, is to scroll to 'Program Status' using and select 'Run', 'Hold' or 'Reset' using or
2. If the program number has been previously selected the program can be run, held or reset just by pressing the RUN button

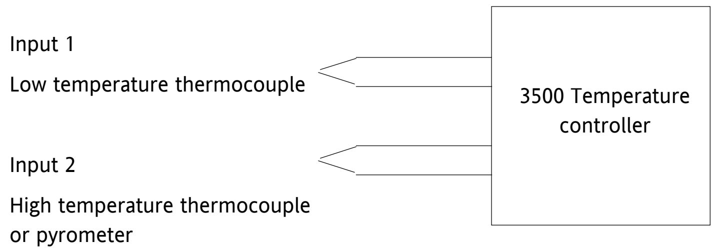
21.4 Program Editing Using iTools

ITools may be used to enter or edit programs, see Chapter 26 for a description.

22. CHAPTER 22 SWITCH OVER

This facility is commonly used in temperature applications which operate of a wide range of temperature. A thermocouple may be used to control at lower temperatures and a pyrometer then controls at very high temperatures. Alternatively two thermocouples of different types may be used.

The diagram below shows a process heating over time with boundaries which define the switching points between the two devices. The higher boundary (2 to 3) is normally set towards the top end of the thermocouple range and this is determined by the 'Switch Hi' parameter. The lower boundary (1 to 2) is set towards the lower end of the pyrometer (or second thermocouple) range using the parameter 'Switch Lo'. The controller calculates a smooth transition between the two devices.



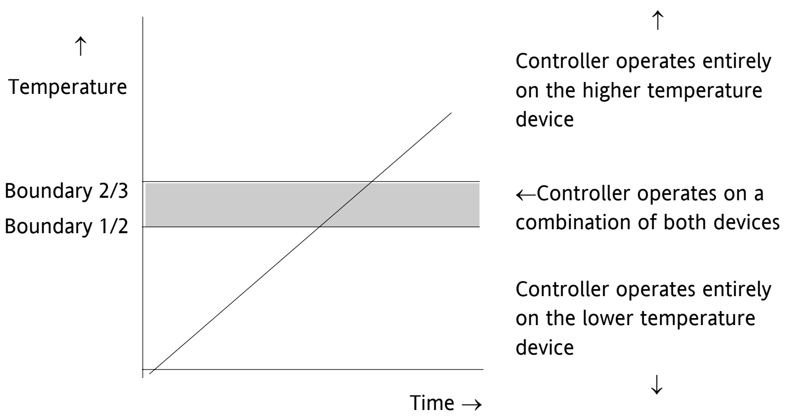


Figure 22-1: Thermocouple to Pyrometer Switching

22.1.1 Example: To Set the Switch Over Levels

Select Level 3 or configuration level

1. Press as many times as necessary to display the 'SwOver' header
2. Press to scroll to 'Switch Hi'
3. Press or to a value which is suitable for the pyrometer (or high temperature thermocouple) to take over the control of the process
4. Press to scroll to 'Switch Lo'
5. Press or to a value which is suitable for the low temperature thermocouple to control the process

22.1.2 Switch Over Parameters

List Header – SwOver		Sub-headers: None			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Input Hi	Sets the high limit for the switch over block. It is the highest reading from input 2 since it is the high range input sensor.	Input range			L3
Input Lo	Sets the low limit for the switch over block. It is the lowest reading from input 1 since it is the low range input sensor				L3
Switch Hi	Defines the high boundary of the switchover region	Between Input Hi and Input Lo			L3
Switch Lo	Defines the low boundary of the switchover region.				L3
Input 1	The first input value. This must be the low range sensor.	These will normally be wired to the thermocouple/pyrometer input sources via the PV Input or Analogue Input Module. The range will be the range of the input chosen.			R/O if wired
Input 2	The second input value. This must be the high range sensor				R/O if wired
Fall Value	In the event of a bad status, the output may be configured to adopt the fallback value. This allows the strategy to dictate a safe output in the event of a fault being detected	Between Input Hi and Input Lo		0.0	L3
Fall Type	Fall back type	Clip Bad Clip Good Fall Bad Fall Good Upscale Downscale		Clip Bad	Conf
Selected IP	Indicates which input is currently selected	Input 1 Input 2	0: Input 1 has been selected 1: Input 2 has been selected 2: Both inputs are used to calculate the output		R/O
ErrMode	The action taken if the selected input is BAD	UseGood ShowBad	0: Assumes the value of a good input If the currently selected input is BAD the output will assume the value of the other input if it is GOOD 1: If selected input is BAD the output is BAD	UseGood	Conf
Switch PV	The process variable produced from the 2 input measurements				R/O
Status	Status of the switchover block	Good Bad			R/O

23. CHAPTER 23 TRANSDUCER SCALING

The 3500 controller includes two transducer calibration function blocks which may be enabled in configuration level in the 'Inst' 'Opt' page. These are a software function blocks which provide a method of offsetting the calibration of the controller input when compared to a known input source. Transducer scaling is often performed as a routine operation on a machine to take out system errors. For this reason it can be carried out in operator level 1 as already described in Chapter 1.

Transducer scaling can be applied to any input or derived input, i.e. the PV Input or Analogue Input fitted in one of the module slots. These can be wired in configuration level to the above inputs.

Four types of calibration are explained in this chapter in Level 3 or configuration levels:-

- Auto-tare
- Shunt Calibration
- Load Cell Calibration
- Comparison Calibration

23.1 Auto-Tare Calibration

The auto-tare function is used, for example, when it is required to weigh the contents of a container but not the container itself.

The procedure is to place the empty container on the weigh bridge and 'zero' the controller. Since it is likely that following containers may have different tare weights the auto-tare feature is always available in the controller at access level 1. The procedure to enter a tare offset has already been described in chapter 1.

In level 3 or configuration level further parameters are available which are used to pre-configure the tare measurement or for interrogation purposes. Tare calibration may be carried out no matter what type of transducer is in use.

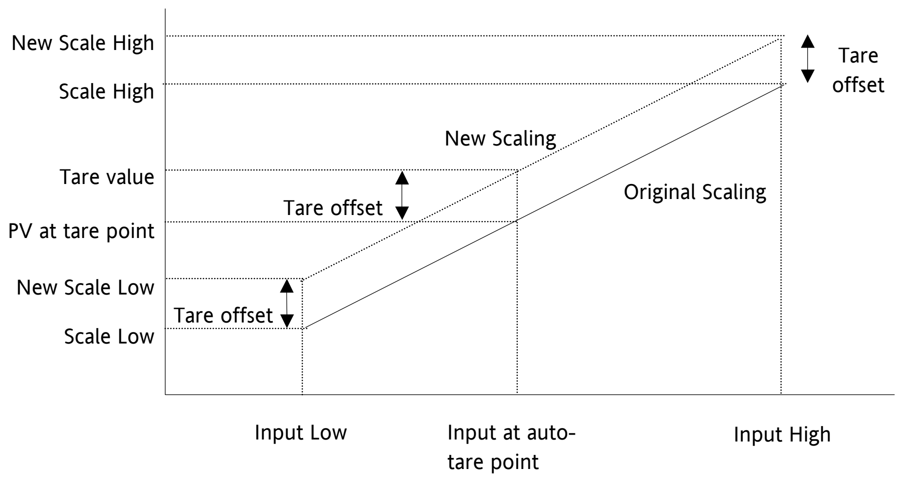


Figure 23-1: Effect of Auto Tare

23.2 Strain Gauge

A strain gauge consists of resistive four wire measurement bridge where all four arms are in balance when no load is being measured. It is energised by a power supply normally 5Vdc or 10Vdc which is a module fitted into any slot. It is calibrated by switching a calibration resistor across one arm of the four wire measurement bridge. For this reason the calibration is referred to as 'Shunt' calibration. The value of this resistor is chosen so that it represents 80% of the span of the transducer.

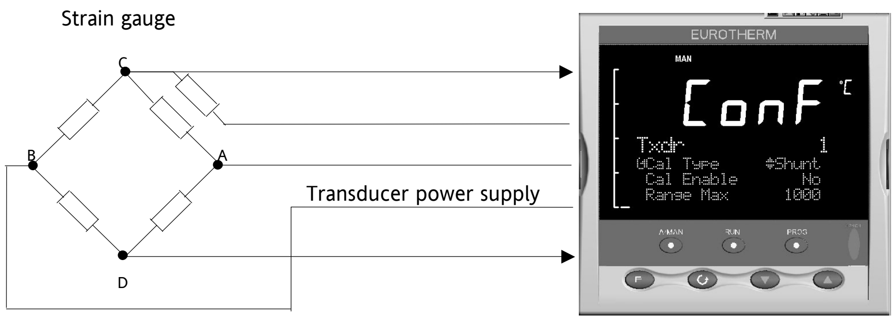


Figure 23-2: Strain Gauge

23.3 Load Cell

A load cell provides an analogue output which can be in Volts, milli-Volts or milli-Amps. This may be connected to the PV Input or Analogue Input. The wiring connections are shown in Chapter 1.

When no load is placed on the cell the output is normally zero. However, in practice there may be a residual output and this can be calibrated out in the controller.

The high end is calibrated by placing a reference weight on the load cell and performing a high end calibration in the controller.

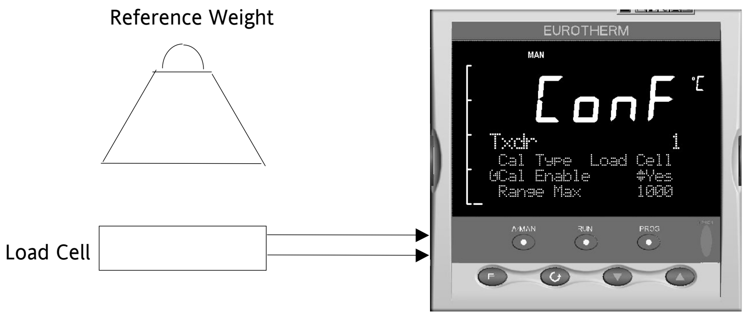


Figure 23-3: Load Cell Calibration

23.4 Comparison Calibration

Comparison calibration is used to calibrate the controller against a second reference instrument.

The load is removed (or taken to a minimum) from the reference device. The controller low end calibration is done using the 'Cal Enable' parameter and entering the reading from the reference instrument.

Add a weight and when the reading has become stable select the 'Cal Hi Enable' parameter then enter the new reading from the reference instrument.

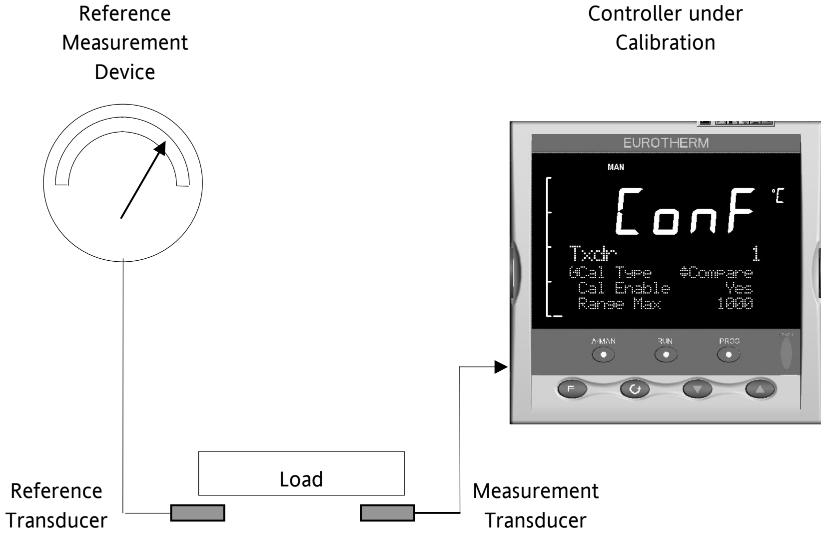


Figure 23-4: Comparison Calibration

23.5 Transducer Scaling Parameters

List Header – Txdr		Sub-headers: 1 or 2			
Name (to select)	**Parameter Description**	**Value** ▲ or ▼ to change		**Default**	**Access Level**
Cal Type	Used to select the type of transducer calibration to perform See descriptions at the beginning of this chapter.	1: Off 1: Shunt 2: Load Cell 3: Compare	Transducer type unconfigured Shunt calibration Load Cell Comparison	Off	Conf
Cal Enable	To make the transducer ready for calibration. Must be set to Yes to allow calibration to be done at L1. This includes Tare Cal.	No Yes	Not ready Ready	No	Conf
Range Max	The maximum permissible range of the scaling block	Range min to 99999		1000	Conf
Range Min	The minimum permissible range of the scaling block	-19999 to Range max		0	Conf
Start Tare	Begin tare calibration	No Yes	 Start tare calibration	No	L1 if 'Cal Enable' = 'Yes'
Start Cal	Starts the Calibration process. Note: for Load Cell and Comparison calibration 'Start Cal' starts the first calibration point.	No Yes	 Start calibration	No	L1 if 'Cal Enable' = 'Yes'
Start Hi Cal	For Load Cell and Comparison calibration the 'Start High Cal' must be used to start the second calibration point.	No Yes	 Start high calibration	No	L1 if 'Cal Enable' = 'Yes'
Clear Cal	Clears the current calibration constants. This returns the calibration to unity gain	No Yes	 To delete previous calibration values	No	L3
Tare Value	Enter the tare value of the container				Conf
Input Hi	Sets the scaling input high point				L3
Input Lo	Sets the scaling input low point				L3
Scale Hi	Sets the scaling output high point. Usually the same as the 'Input Lo'				L3
Scale Lo	Sets the scaling output low point. Usually 80% of 'Input Hi'				L3
Cal Band	The calibration algorithms use the threshold to determine if the value has settled. When switching in the shunt resistor, the algorithm waits for the value to settle to within the threshold before starting the high calibration point.				Conf
Shunt State	Indicates when the internal shunt calibration resistor is switched in. Only appears if 'Cal Type' = 'Shunt'	Off On	Resistor not switched in Resistor switched in		L1

Cal Active	Indicates calibration taking place	Off On	Inactive Active		L1 R/O
Input Value	The input value to be scaled.	-9999.9 to 9999.9			L3
Output Value	The Input Value is scaled by the block to produce the Output Value				L3
Output Status	The status of the output accounting for sensor fail signals passed to the block and the state of the scaling.	Good Bad			Conf
Cal Status	Indicates the progress of calibration	0: Idle 1: Active 2: Passed 3: Failed	No calibration in progress Calibration in progress Calibration Passed Calibration Failed		L1 R/O

23.5.1 Parameter Notes

Enable Cal	This may be wired to a digital input for an external switch. If not wired, then the value may be changed. When enabled the transducer parameters may be altered as described in the previous sections. When the parameter has been turned On it will remain on until turned off manually even if the controller is powered cycled.
Start Tare	This may be wired to a digital input for an external switch. If not wired, then the value may be changed.
Start Cal	This may be wired to a digital input for an external switch. If not wired, then the value may be changed. It starts the calibration procedure for: Shunt Calibration The low point for Load Cell Calibration The low point for Comparison Calibration
Start Hi Cal	This may be wired to a digital input for an external switch. If not wired, then the value may be changed. It starts:- The high point for Load Cell Calibration The high point for Comparison Calibration
Clear Cal	This may be wired to a digital input for an external switch. If not wired, then the value may be changed. When enabled the input will reset to default values. A new calibration will overwrite the previous calibration values if Clear Cal is not enabled between calibrations.

23.6 Transducer Summary Page

If the Transducer function block has been enabled then a transducer summary page is available in operator level 1 and 2. This means that calibration of the transducers can be done at this level although with some small limitations. This section describes the calibration procedure which can be carried out in levels 1 and 2.

23.6.1 Tare Calibration

The 3500 controller has an auto-tare function which is used, for example, when it is required to weigh the contents of a container but not the container itself.

The procedure is to place the empty container on the weighbridge and 'zero' the controller. Since it is likely that following containers may have different tare weights the auto-tare feature is available in the controller at access level 1 (provided 'Cal Enable' is set to 'Yes' in configuration level).

The procedure is as follows:-

Do This	The Display You Should See	Additional Notes
1. Place the empty container on the weigh bridge		
2. Press until the Txdr1 (or 2) page is displayed 3. Press until 'Start Tare' is displayed	Txdr1 0.0 0.0 1000.0 Start Tare ⇕No	
4. Press or to select 'Yes'	Txdr Cal Started	The controller automatically calibrates the to the tare weight which is measured by the transducer and stores this value. During this measurement the displays shown here will be shown
	Txdr1 Start Tare ⇕Yes Cal Status Active	
	Txdr Cal Passed	
	Txdr Cal Failed Press ▤+↺ to Ack	If the calibration fails the message Cal Failed will be shown. This may be due to the measured input being out of range
	Txdr1 Start Cal ⇕No Cal Status Failed	

23.6.2 Strain Gauge

This is also known as shunt calibration since it refers to switching a calibration resistor across one arm of a four wire measurement bridge in a strain gauge transducer. Connections for this are shown in section 1.6.1.

To calibrate a strain gauge:-

Do This	The Display You Should See	Additional Notes
1. Remove all load from the transducer to establish a zero reference 2. Select Txdr1 (or 2) as in the previous example		
3. Press ⟳ to 'Start Cal' 4. Press ▲ or ▼ to select 'Yes'		
5. The controller will now calibrate both the zero and span		The status during calibration is displayed in the same way as the previous example. The controller automatically performs the following sequence 1. Disconnect the shunt resistor 2. Calculate the low point calibration value by continuously averaging two lots of 50 measurements of the input until stable readings are obtained 3. Connect the shunt resistor 4. Calculate the high point calibration value by averaging two lots of 50 measurements of the input

23.6.3 Load Cell

A load cell with V, mV or mA output may be connected to the PV Input or an analogue input module. The wiring connections are shown in section 1.6.1.

To calibrate a load cell:

Do This	The Display You Should See	Additional Notes
1. Remove all load from the transducer to establish a zero reference 2. Select Txdr1 (or 2) as in the previous example		
3. Press ⟲ to 'Start Cal' 4. Press ▲ or ▼ to select 'Yes'	Txdr1 Start Tare No Start Cal ⇕Yes Start Hi Cal No	The controller will calibrate to the low point
5. Place a reference weight on the load cell		
6. Press ⟲ to 'Start Hi Cal' 7. Press ▲ or ▼ to select 'Yes'	Txdr1 Start Cal No Start Hi Cal ⇕Yes Cal Status Passed	The controller will then calibrate to the high point.

23.6.4 Comparison Calibration

Comparison calibration is used to calibrate the controller against a second reference instrument.

The input may be set to any value and, when the system is stable, a reading is taken from the reference measurement device and entered into the controller. The controller stores both this new target value and the actual reading taken from its input.

The process is repeated at a different value, with the controller storing both the new target value and the reading taken from its input.

To calibrate against a known reference source:-

Do This	The Display You Should See	Additional Notes
1. Remove or reduce the load from the transducer to establish a low end reference 2. Select Txdr1 (or 2) as in the previous example		
3. Press ⟳ to 'Start Cal' 4. Press ▲ or ▼ to select 'Yes'	Txdr1 0.0 0.0 1000.0 Start Tare No Start Cal ⇕Yes	
5. Press ⟳ to 'Cal Adjust' 6. Press ▲ or ▼ to enter the reading from the reference instrument	Txdr1 Start Cal ⇕Yes Cal Adjust 0 Cal Status Active Txdr1 Start Cal Yes Cal Adjust ⇕7 Cal Status Active	The controller will not continue until a number has been entered even if the number is the same as that shown on the display.
7. Press ⟳ to confirm as requested on the display	Cal Adjust 7? ▤→Cancel ⟳→OK	
8. Add a load to the transducer to obtain a high end reading on the reference instrument 9. Repeat 3 to 7 above for the high end reading using the 'Start Hi Cal' parameter	Txdr1 Start Cal No Start Hi Cal ⇕No Cal Status Passed	

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24. CHAPTER 24 USER VALUES

User values are registers provided for use in calculations. They may be used as constants in equations or temporary storage in extended calculations. Up to 16 User Values available provided they have been enabled in the 'Inst' Options page (Chapter 5) in configuration level. Each User Value can then be set up in the **'UserVal'** page.

24.1 User Value Parameters

List Header – UsrVal		Sub-headers: 1 to 16			
Name (button) to select	**Parameter Description**	**Value** (up) or (down) to change		**Default**	**Access Level**
Units	Units assigned to the User Value	None Abs Temp ºC/ºF/ºK, V, mV, A, mA, PH, mmHg, psi, Bar, mBar, %RH, %, mmWG, inWG, inWW, Ohms, PSIG, %O2, PPM, %CO2, %CP, %/sec, RelTemp ºC\ºF\ºK(rel), Custom 1, Custom 2, Custom 3, Custom 4, Custom 5, Custom 6, sec, min, hrs,			Conf
Res'n	Resolution of the User Value	XXXXX to X.XXXX			Conf
High Limit	The high limit may be set for each user value to prevent the value being set to an out-of-bounds value.				L3
Low Limit	The low limit of the user value may be set to prevent the user value from being edited to an illegal value. This is important if the user value is to be used as a setpoint.				L3
Value	To set the value within the range limits	See note 1			L3
Status	Can be used to force a good or bad status onto a user value. This is useful for testing status inheritance and fallback strategies.	Good Bad	See note 1		L3

Note 1:-

If 'Value' is wired into but 'Status' is not, then, instead of being used to force the Status it will indicate the status of the value as inherited form the wired connection to 'Value'.

25. CHAPTER 25 CALIBRATION

In this chapter calibration refers to calibration of the PV input and the Analogue Input module. Calibration is accessed using the 'Cal State' parameter which is only available in configuration level. Since the controller is calibrated during manufacture to traceable standards for every input range, it is not necessary to calibrate the controller when changing ranges. Furthermore, a continuous automatic check and correction of the calibration during the controllers normal operation means that it is calibrated for life. However, it is recognised that, for operational reasons, it may be a requirement to check or re-calibrate the controller. It is always possible to revert to the factory calibration if necessary.

25.1 Input Calibration

Inputs which can be calibrated:-

- **mV Input.** This is a linear 80mV range calibrated at two fixed points. This should always be done before calibrating either thermocouple or resistance thermometer inputs. mA ranges are included in the mV range.
- **Thermocouple** calibration involves calibrating the temperature offset of the CJC sensor only. Other aspects of thermocouple calibration are also included in mV calibration.
- **Resistance Thermometer**. This is also carried out at two fixed points - 150Ω and 400Ω.

25.2 Precautions

Before starting any calibration procedure the following precautions should be taken:-

1. When calibrating mV inputs make sure that the calibrating source outputs less than 250mV before connecting it to the mV terminals. If accidentally a large potential is applied (even for less than 1 second), then at least one hour should elapse before commencing the calibration.
2. RTD and CJC calibration must not be carried out without prior mV calibration.
3. A pre-wired jig built using a spare instrument sleeve may help to speed up the calibration procedure especially if a number of instruments are to be calibrated.
4. Power should be turned on only after the controller has been inserted in the sleeve of the pre-wired circuit. Power should also be turned off before removing the controller from its sleeve.
5. Allow at least 10 minutes for the controller to warm up after switch on.

25.2.1 To Calibrate mV Range

Calibration of the mV range is carried out using a 50 milli-volt source, connected as shown in the diagram below. mA calibration is included in this procedure.

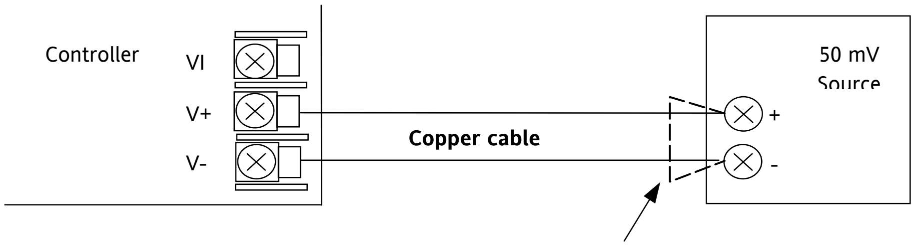


Figure 25-1: Connections for mV Input Calibration

For best results 0mV should be calibrated by disconnecting the copper wires from the mV source and short circuiting the input to the controller

To calibrate the PV Input:-

Do This	The Display You Should See	Additional Notes
1. From any display press ◯ as many times as necessary to select the input to be calibrated	PVInput IO Type ⇕40 mV Lin Type Linear Units None	This may be 'PVInput' or a 'DC Input' module
2. Press ◯ to select **'Cal State'**	PVInput Offset 0.0 SBrk Value 0.0 Cal State ⇕Idle	
3. **Set mV source for 0mV**		
4. Press ▲ or ▼ to choose **'Lo-0mV'** 5. Press ▲ or ▼ to choose **'Confirm'**	PVInput Offset 0.0 SBrk Value 0.0 Cal State ⇕Lo-0mV PVInput Offset 0.0 SBrk Value 0.0 Cal State ⇕Confirm	Abort by pressing ▲ or ▼
6. Press ◯ to select 'Go'	PVInput Offset 0.0 SBrk Value 0.0 Cal State ⇕Go PVInput Offset 0.0 SBrk Value 0.0 Cal State ⇕Busy PVInput Offset 0.0 SBrk Value 0.0 Cal State ⇕Passed	The controller will automatically perform the calibration procedure. At any stage you can Abort by pressing ▲ or ▼

7. Press or to **'Accept'**

It is also possible to 'Abort' at this stage.

The controller then returns to the 'Idle' state.

By pressing Accept, this means that the calibration will be used for as long as the controller is switched on. When the controller is switched off the calibration will revert to that set during manufacture.

To use the new calibration permanently select 'Save User' as described in the next section

8. **Set mV source for 50mV**

9. Press to select **'Hi-50mV'**

10. Now repeat 5, 6 and 7 above to calibrate the high mV range

The controller will again automatically calibrate to the injected input mV.

If it is not successful then **'Fail'** will be displayed

25.2.2 To Save the New Calibration Data

11. Press to select **'Save User'**

The new calibration data will be used following a power down of the controller

25.2.3 To Return to Factory Calibration

12. Press to select **'Load fact'**

The factory calibration will be reinstated

25.2.4 Thermocouple Calibration

Thermocouples are calibrated, firstly, by following the previous procedure for the mV ranges, then calibrating the CJC.

This can be carried out using an external CJC reference source such as an ice bath or using a thermocouple mV source. Replace the copper cable shown in the diagram below with the appropriate compensating cable for the thermocouple in use.

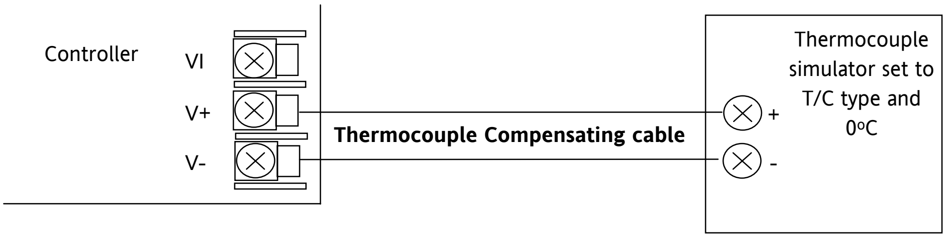
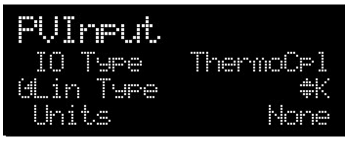


Figure 25-2: Conections for Thermocouple Calibration

Set the mV source to **internal compensation** for the thermocouple in use and set the output for **0mV**. Then:-

Do This	The Display You Should See	Additional Notes
1. This example is for PV Input configured as a type K thermocouple		
2. From the mV calibration, press ⏶ or ⏷ to select **'CJC'**		
3. Press ⟳ to select **'Confirm'** 4. The remaining procedure is the same as described in the previous section		The controller automatically calibrates to the CJC input at 0mV. As it does this the display will show 'Busy' then 'Passed', assuming a successful calibration. If it is not successful then 'Failed' will be displayed. This may be due to an incorrect input mV

25.2.5 RTD Calibration

The two points at which the RTD range is calibrated are 150.00Ω and 400.00Ω.

Before starting RTD calibration:

- A decade box with total resistance lower than 1K must be connected in place of the RTD as indicated on the connection diagram below **before the instrument is powered up**. If at any instant the instrument was powered up without this connection then at least 10 minutes must elapse from the time of restoring this connection before RTD calibration can take place.
- The instrument should be powered up for at least 10 minutes.

Before using or verifying RTD calibration:

- The mV range must be calibrated first.

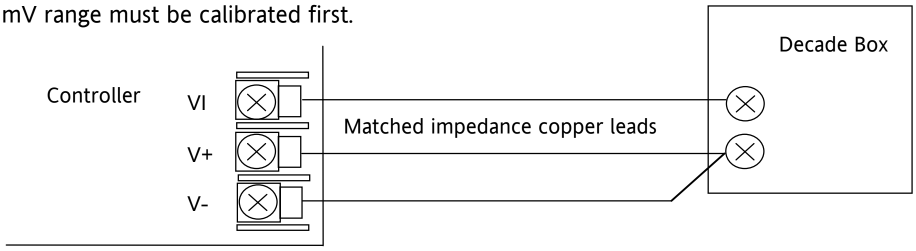


Figure 25-3: Connections for RTD Calibration

Do This	The Display You Should See	Additional Notes
1. This example is for PV Input configured as a Pt100 RTD		
2. Press (cycle button) to select **'Lo-150ohm'**		
3. **Set the decade box for 150.00Ω**		
4. Press ▲ or ▼ to choose 'Confirm'		The controller automatically calibrates to the injected 150.00Ω input. As it does this the display will show 'Busy' then 'Pass', assuming a successful calibration. If it is not successful then 'Failed' will be displayed. This may be due to an incorrect input resistance
5. **Set the decade box for 400.00Ω**		
6. Repeat the procedure for **'Hi-400ohm'**		The calibration data can be saved or you can return to Factory Calibration as described in sections 25.2.2. and 25.2.3.

25.3 Calibration Parameters

The following table lists the parameters available in the Calibration List.

List Header - PV Input		Sub-headers: None			
Name to select	**Parameter Description**	**Value** or to change		**Default**	**Access Level**
Cal State	Calibration state of the input	Idle	Normal operation	Idle	Conf L3 R/O
		Lo-0mv	Low input calibration for mV ranges		
		Hi-50mV	High input calibration for mV ranges		
		Lo-0v	Low input calibration for V/Thermocouple ranges		
		Hi-8V	High input calibration for V/thermocouple ranges		
		Lo-0v	Low input calibration for HZ Volts range		
		Hi-1V	High input calibration for HZ Volts range		
		Lo-150ohm	Low input calibration for RTD range		
		Hi-400ohm	High input calibration for RTD range		
		Load Fact	Restore factory calibration values		
		Save User	Save the new calibration values		
		Confirm	To start the calibration procedure when one of the above has been selected		
		Go	Starting the automatic calibration procedure		
		Busy	Calibration in progress		
		Passed	Calibration successful		
		Failed	Calibration unsuccessful		

The above list shows the parameters which appear during a normal calibration procedure. The full list of possible values follows – the number is the enumeration for the parameter.

1: Idle

2: Low calibration point for Volts range

3: High calibration point for Volts range

4: Calibration restored to factory default values

5: User calibration stored

6: Factory calibration stored

11: Idle

12: Low calibration point for HZ input

13: High calibration point for the HZ input

14: Calibration restored to factory default values

15: User calibration stored

16: Factory calibration stored

20: Calibration point for factory rough calibration

21: Idle

22: Low calibration point for the mV range

23: Hi calibration point for the mV range

24: Calibration restored to factory default values

25: User calibration stored

26: Factory calibration stored

30: Calibration point for factory rough calibration

31: Idle

32: Low calibration point for the mV range

33: High calibration point for the mV range

34: Calibration restored to factory default values

35: User calibration stored

36: Factory calibration stored

41: Idle

42: Low calibration point for RTD calibration (150 ohms)

43: Low calibration point for RTD calibration (400 ohms)

44: Calibration restored to factory default values

45: User calibration stored

46: Factory calibration stored

51: Idle

52: CJC calibration used in conjunction with Term Temp parameter

54: Calibration restored to factory default values

55: User calibration stored

56: Factory calibration stored

200: Confirmation of request to calibrate

201: Used to start the calibration procedure

202: Used to abort the calibration procedure

210: Calibration point for factory rough calibration

212: Indication that calibration is in progress

213: Used to abort the calibration procedure

220: Indication that calibration completed successfully

221: Calibration accepted but not stored

222: Used to abort the calibration procedure

223: Indication that calibration failed

26. CHAPTER 26 CONFIGURATION USING ITOOLS

An introduction to using iTools to configure 3500 series instruments is given in the User Guide supplied with your controller. This chapter explains the features in more detail. Any configuration of the instrument which has been described so far through the user interface can be done using iTools. iTools also allows additional features to be configured.

26.1 Features

- Parameter Set up
- Device Operation
- Device Recipe
- Program Editing
- Configuration of User Pages
- Graphical Wiring
- Cloning

26.2 On-Line/Off-line Editing

If you open the editor on a real device then all the changes you make will be written to the device immediately. All the normal instrument rules apply so you will be able to make the same changes to the programmer of a running instrument that you could make using its front panel.

If you open a program file or open the Programmer Editor on a simulation you will need to save the program or send it to a real device.

Offline programming is actually done using an instrument simulation that can hold as many programs as a real instrument. If you wish to create a set of programs which will all be used in a single instrument you can create a new program and then change the program number using the spin control and edit another program. Each program must be saved separately. If you make a change to one program and switch to another program you will be prompted to save that program.

26.3 Connecting a PC to the Controller

The controller may be connected to the PC running iTools using the RS232 or RS485 communications digital communications ports H or J as shown in section 1.7.1. Alternatively, using the IR clip or configuration clip as shown in section 13.2..

Open iTools and, with the controller connected, press 

on the iTools menu bar. iTools will search the communications ports and TCPIP connections for recognisable instruments. Controllers connected with the configuration clip (CPI), will be found at address 255 regardless of the address configured in the controller.

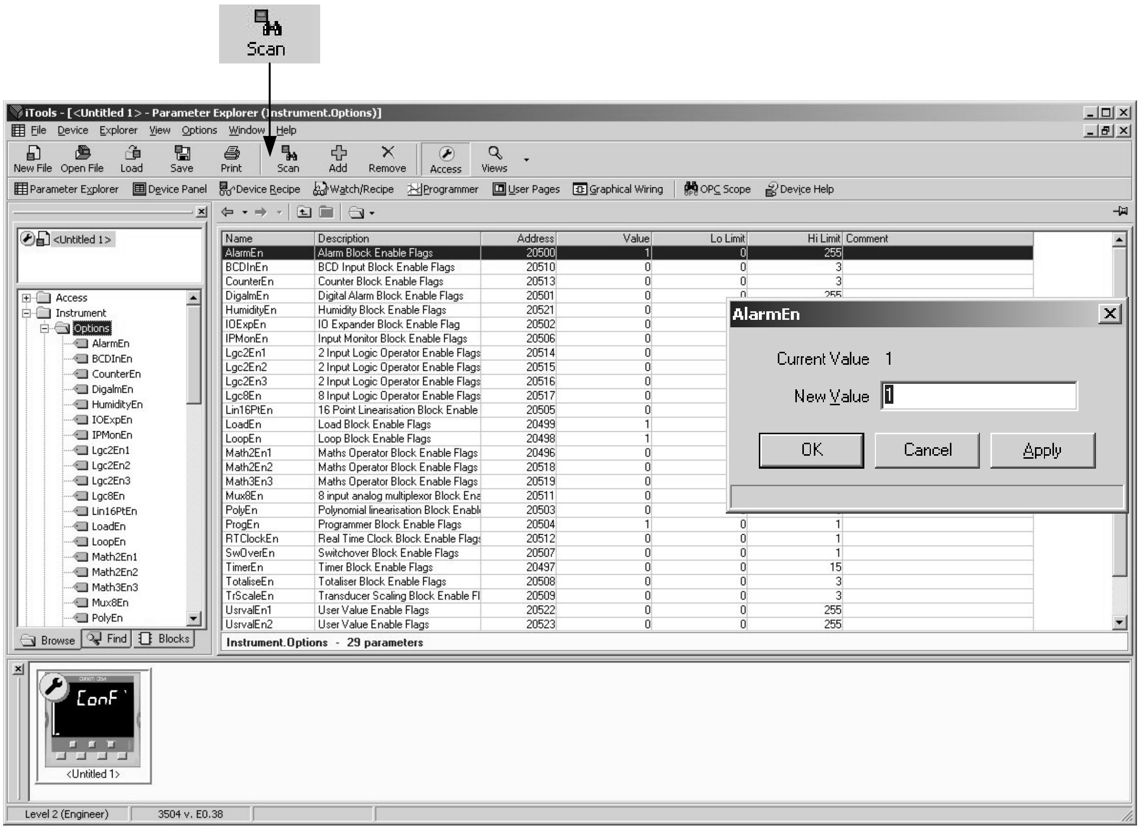
The iTools handbook, part no. HA026179, provides further step by step instructions on the general operation of iTools. This and the iTools software may be downloaded from www.eurotherm.co.uk.

In the following pages it is assumed that the user is familiar with these instructions and has a general understanding of Windows.

26.4 Parameter Set Up

Allows parameters to be configured.

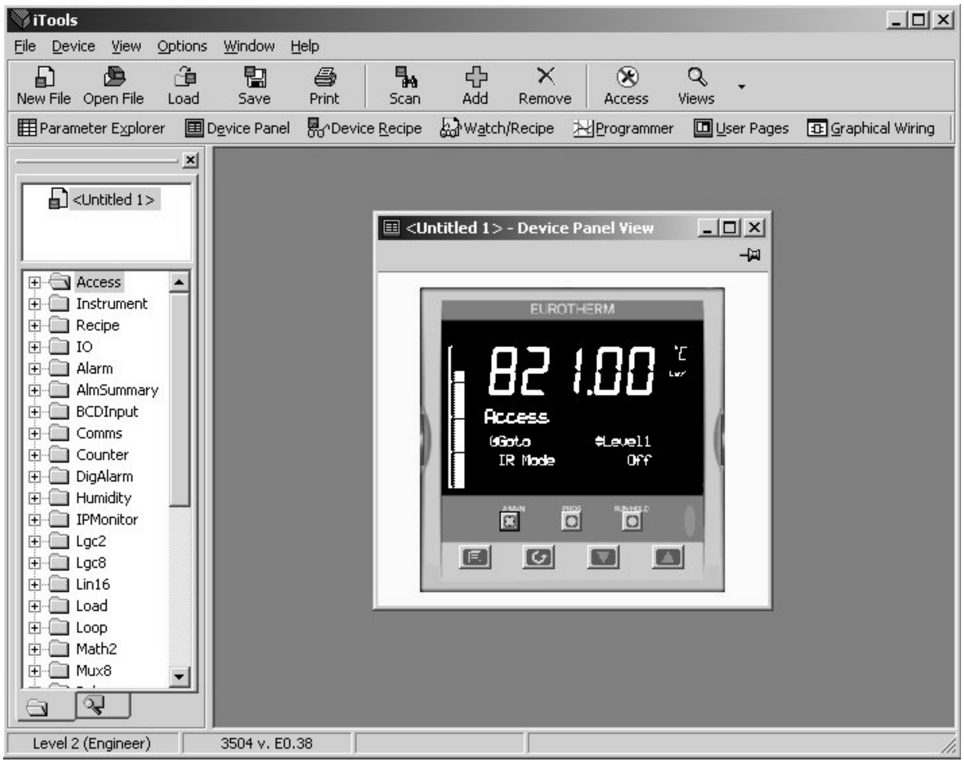
1. Press Parameter Explorer to get this view
2. Open up the parameter list by double clicking the required folder. Right click in the parameter list to reveal or hide columns.
3. To change the value of a parameter, double click the parameter and change its value using the pop-up window
4. The 'Access' button puts the controller into configuration mode. In this mode the controller can be set up without its outputs being active. Press 'Access' again to return to operating level.
5. The instrument view is optional. Select 'Panel Views' in the 'View' menu.
6. To find a parameter select the 'Find' tab



The example above shows how to enable an alarm

26.5 Device Panel

Press Device Panel for this feature. The Panel displays the active instrument panel. This can be used for remote viewing, diagnostics or Training. iTools can be used OFF-LINE to configure the product. The panel view gives an indication of how the instrument will appear when the configuration is downloaded.



The front panel control buttons, shown in the Device Panel display, are active and clicking on them with the mouse will cause the display to behave as a real instrument.

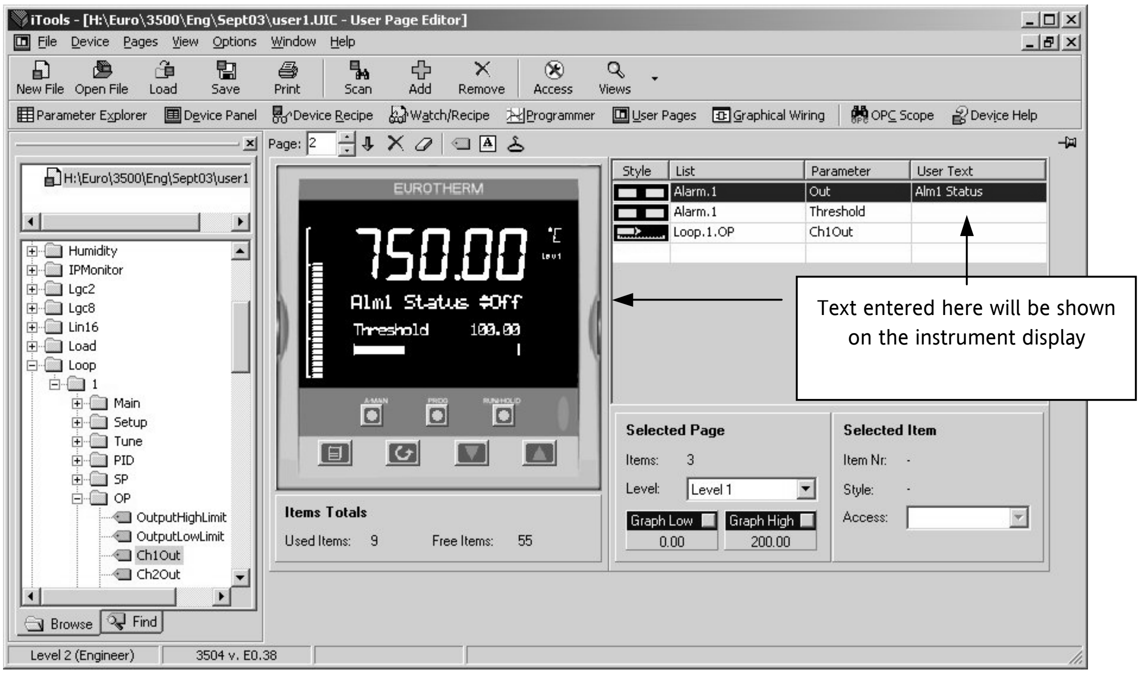
☺ Clicking on the Page button with Ctrl pressed emulates pressing the page and scroll buttons together.

26.6 User Pages Editor

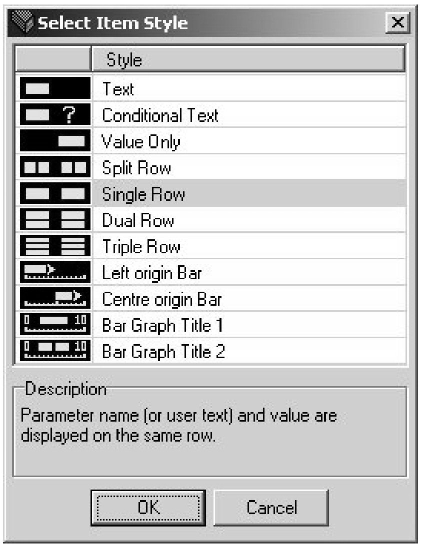
Up to 8 User Pages with a total of 64 lines can be created and downloaded into the controller so that the controller display shows only the information which is of interest to the user.

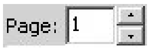
Press 

to select this feature



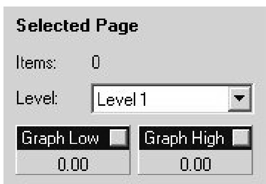
26.6.1 To Create a User Page



1. Press 

to select the page number, 1 to 8
2. Double click in the table to the right of the instrument display
3. The pop up window shows a list of styles
4. Choose the style then select the parameter from the pop up list. To enter user text (where applicable) either right click or double click under 'User Text'. If the style is text only you will be prompted to enter this as soon as the style is selected.
5. Right click in the list to:
   a. Insert an item
   b. Remove an item
   c. Edit Wire. Allows you to change the parameter selected
   d. Edit Text. Allows you to enter your own text for the parameter displayed
   e. Edit Style. This is shown in the pop up window
   f. Read Parameter Properties
   g. Open Parameter Help

5. Select the operator level at which the user page will be displayed
6. If a bar graph is displayed set the low and high graph axes



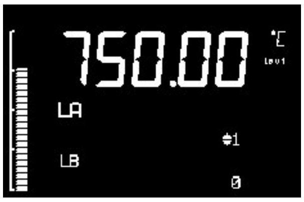
The format of the user page is shown in the instrument view

The user page can now be saved and downloaded to the instrument.

26.6.2 Style Examples

The following examples show the controller display produced for each individual style entered.

<table>
<tr><th>Select Item Style</th><th>Action</th><th>Controller Display</th></tr>
<tr><td>1. Text</td><td>Text entered will appear on the first line of the controller display. E.g.
<table><tr><th>Style</th><th>List</th><th>Parameter</th><th>User Text</th></tr><tr><td></td><td>(text only)</td><td></td><td>Primary Process</td></tr></table>Further lines of text may be added. Up to four lines will be shown on the controller display at any time.

Use to scroll through the text on the controller display</td><td></td></tr>
<tr><td>2. ? Conditional Text</td><td>Text entered will only be shown if a condition is true. e.g
<table><tr><th>Style</th><th>List</th><th>Parameter</th><th>User Text</th></tr><tr><td>?</td><td>IO.LgcIO.LA</td><td>PV</td><td>Too Hot</td></tr></table>The text only appears when the logic input on LA is true</td><td></td></tr>
<tr><td>3. Value Only</td><td>The value of the chosen parameter will be displayed in the first and subsequent rows. E.g.
<table><tr><th>Style</th><th>List</th><th>Parameter</th><th>User Text</th></tr><tr><td></td><td>Loop.1.Main</td><td>PV</td><td>(no user text)</td></tr></table>This style does not have user text</td><td></td></tr>
<tr><td>4. Split Row</td><td>The value of a parameter may be displayed to the left and to the right of the controller display. The following example shows the entry set up for digital inputs LA and Lb
<table><tr><th>Style</th><th>List</th><th>Parameter</th><th>User Text</th></tr><tr><td></td><td>IO.LgcIO.LA</td><td>PV</td><td>LA</td></tr><tr><td></td><td>IO.LgcIO.LB</td><td>PV</td><td>LB</td></tr></table></td><td></td></tr>
<tr><td>5. Dual Row</td><td>The value of a parameter and a user defined label may be displayed on two lines of the controller display. The following example shows the entry set up for digital inputs LA and Lb
<table><tr><th>Style</th><th>List</th><th>Parameter</th><th>User Text</th></tr><tr><td></td><td>IO.LgcIO.LB</td><td>PV</td><td>LA</td></tr><tr><td></td><td>IO.LgcIO.LA</td><td>PV</td><td>LB</td></tr></table></td><td></td></tr>
<tr><td>6. Triple Row

See Note 1</td><td>The description can be up to 20 characters long and is spread between the first two lines on the display. The parameter value appears on the third line.
<table><tr><th>Style</th><th>List</th><th>Parameter</th><th>User Text</th></tr><tr><td></td><td>Lgc2.1</td><td>In1</td><td>Up to 16 characters</td></tr></table></td><td></td></tr>
</table>

7. Left origin Bar

This places a bar graph to the left of the display with user text to the right. Keep the user text length to a minimum.

Style	List	Parameter	User Text
	Loop.1.SP	SP1	Temp

Do not forget to set up the Graph Low and High limits

8. Centre origin Bar

This places a bar graph with centre origin to the left of the display with user text to the right. Keep the user text length to a minimum.

Style	List	Parameter	User Text
	Loop.1.Diag	Error	Error

Do not forget to set up the Graph Low and High limits

9. Bar Graph Title 1

This adds Text, Graph Low and High Limits only. If this is associated with a parameter the name of the parameter is used as the text. The text is truncated if too long

It is necessary to add the bar graph as a separate item.

Style	List	Parameter	User Text
	(text only)		Pressure
	Loop.1.SP	SP1	

10. Bar Graph Title 2

This adds centre zero value (0.00) to the bar graph plus text. The display will show graph limits, text and the parameter value. If this takes up too many characters then priority is given first to the value, then to the text, then to the limits.

Style	List	Parameter	User Text
	Loop.1.Diag	Error	Err
	Loop.1.Main	PV	

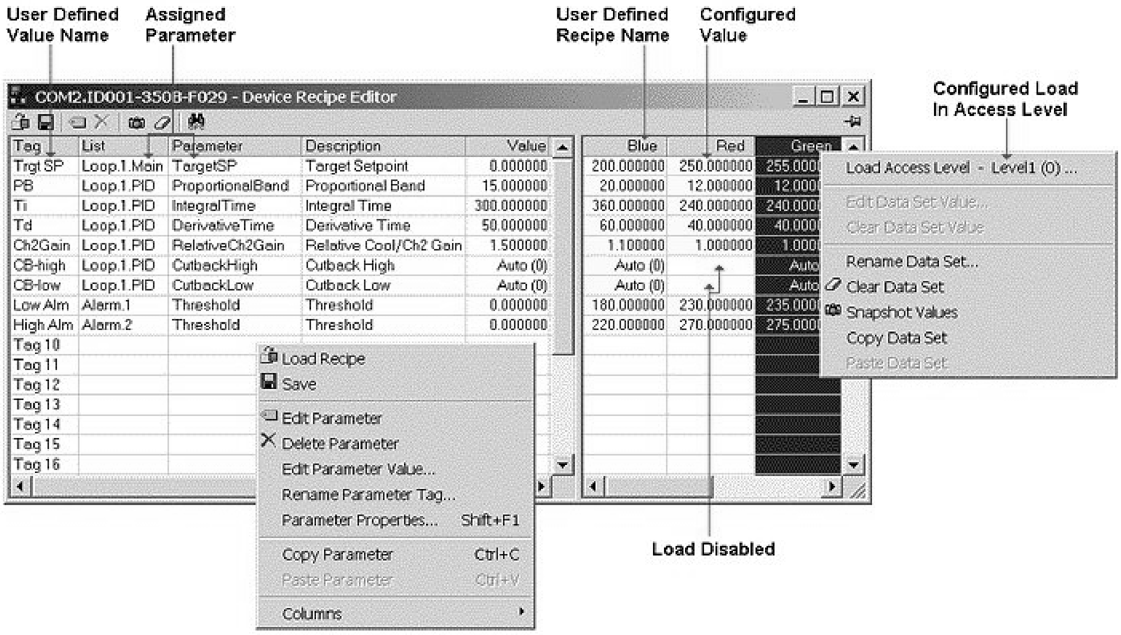
Note 1:- A user page is produced by adding styles one after another. Generally this can be made in any order. However, the default style of 3500 series displays is to show a heading in the first line of the alpha numeric section, followed by a list of parameters and their descriptions - the scroll button being used in operator mode to select parameters. When producing a user page, it is recommended that this default style is followed avoid confusion during operation.

In the case of a Triple Line display, if this placed as the first item in the user page, the first line (of user text) takes up the title space. If another Triple Line style follows this you will be unable to scroll to this in operator mode. To avoid this make the first line a title (using 'Text' style).

26.7 Recipe Editor

Press Device Recipe for this feature. Up to 8 recipes can be stored. They can also be named by the user. Recipes allow the operator to change the operating values of up to 24 parameters in an instrument for different batch items/processes by simply selecting a particular recipe to load. Recipes are important for reducing error in setup and they remove the need for operator instructions fixed to the panel next to the instrument.

The Recipe Editor is used during configuration to assign the required parameters and to set up the values to be loaded for each recipe.



26.7.1 Recipe Menu Commands

Load Recipe Used to load a recipe file into the instrument

Save Used to save the current recipe configuration into a file

Edit Parameter Used to assign a parameter to a Tag. Parameters can also be assigned by 'drag and drop' from the iTools parameter list

Delete Parameter Used to delete an assigned parameter from the recipes

Edit Parameter Value Used to edit the current value of the assigned parameter

Rename Parameter Tag Allows the user to rename the Tag of the associated parameter. This tag is used on the instrument to identify assigned parameters (default Value1 - Value24)

Parameter Properties Used to find the properties and help information of the selected parameter

Copy Parameter Used to copy the currently selected parameter

Paste Parameter Used to assign a previously copied parameter to the selected Tag

Columns Used to hide/show the Description and Comment Columns

Load Access Level Used to configure the lowest access level in which the selected recipe is allowed to load

Level1 Permitted to load when the instrument is in any of the access levels

Level2 Permitted to load when the instrument is in Level2, Level3 or Config access levels

Level3 Permitted to load when the instrument is in Level3 or Config access levels

Config Permitted to load when the instrument is in the Config access level

Never Never permitted to load

Note: Over comms, whilst the instrument is in operator mode, recipes that have been configured to load in Levels 1, 2 and 3 can be loaded. Whilst the instrument is in Config mode all recipes can be loaded.

Edit Data Set Value Used to edit the value of the selected assigned parameter within the selected recipe. Values can also be edited via double left clicking the value itself

Clear Data Set Value Used to clear the value of the selected assigned parameter within the selected recipe, thus disabling it from loading when the recipe is selected to load

Rename Data Set Allows the user to rename the selected recipe. This name is used to identify individual recipes (default Set1 - Set8). Note: Number of recipes dependent upon features

Clear Data Set Used to clear all values in the selected recipe, thus disabling all from loading when the recipe is selected to load

Snapshot Values Used to copy all of the assigned parameters current values into the selected recipe

Copy Data Set Used to copy all values of the selected recipe

Paste Data Set Used to paste all values of a previously copied recipe into the selected recipe

26.8 To Set up Alarms Using iTools

26.8.1 Example: To Customise Analogue Alarm Messages

a. Connect the controller to iTools as described in the iTools User Handbook part no HA026179. This may be downloaded from www.eurotherm.co.uk.

b. Double click on the **'Alarm'** folder to display the Parameter Explorer. With the controller in configuration mode double click '**Message**' and enter a name for the alarm. This name will be displayed on the controller when the alarm occurs. This is shown in the simulation below.

c. If the alarm has not been set up, then, with the controller in configuration level, double click on '**Type**' and select the alarm type from the pull down menu.

d. Repeat for all other parameters. Parameters shown in blue are not alterable in the current operating level of the instrument.

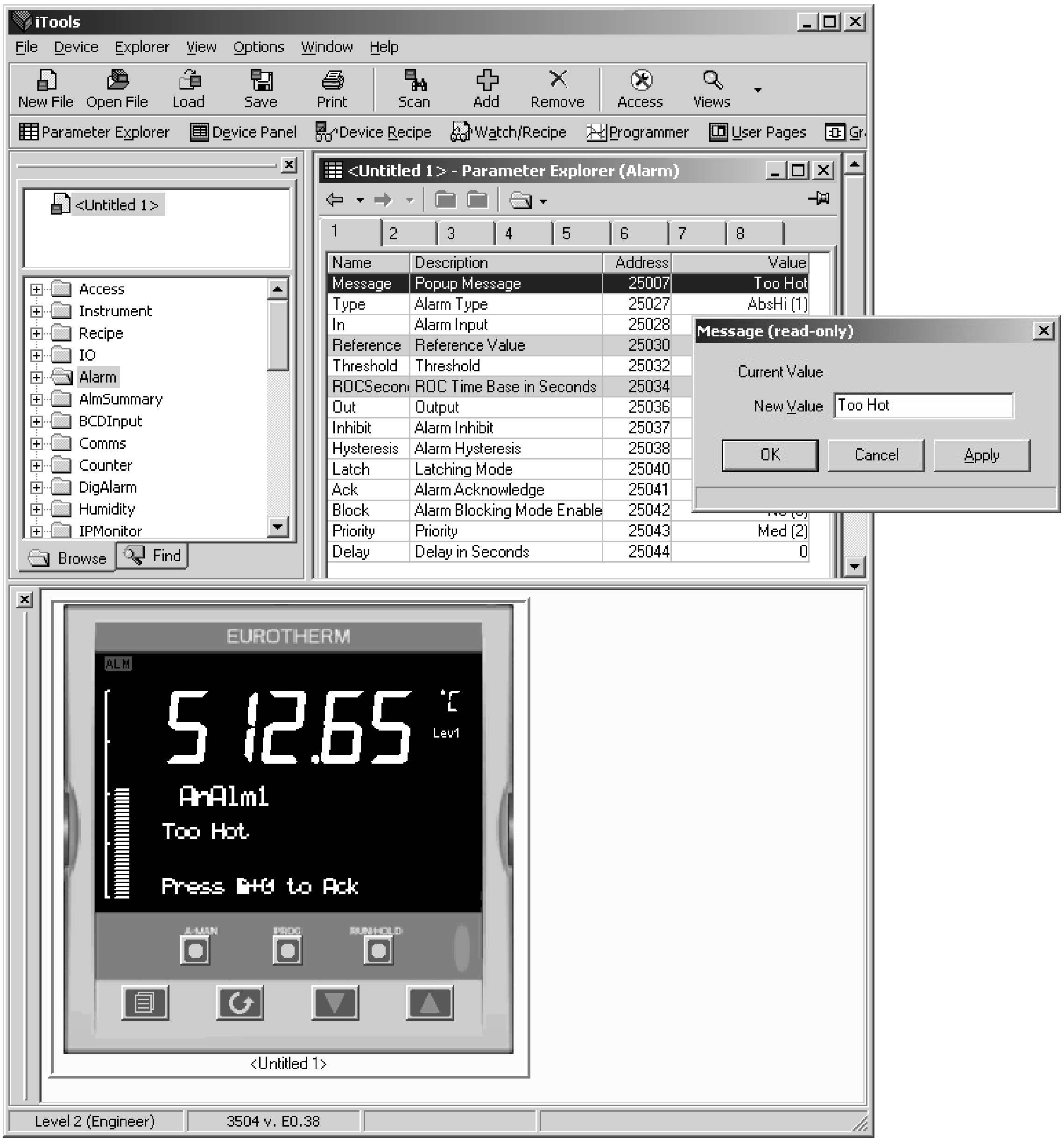


Figure 26-1: Configuring Analogue Alarms using iTools

26.8.2 Alarm Summary Page in iTools

Click on the folder **'AlmSummary'**. A list of alarm states is displayed. In the view below the Limits column and Comment column have been opened by right clicking in the parameter list and selecting **'Columns'** in the drop down menu.

To add a comment, select '**Add Parameter Comment'** from the same drop down and enter the required text.

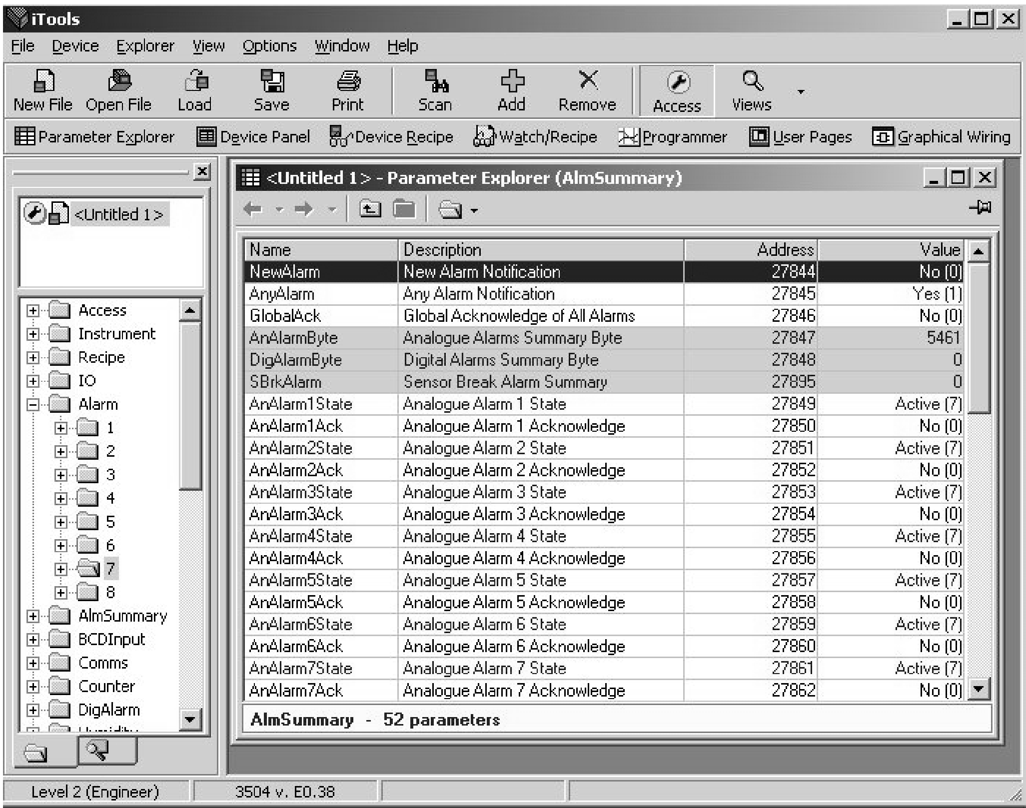


Figure 26-2: Alarm Summary Page

26.8.3 To Customise Digital Alarm Messages

The procedure is the same as for analogue alarms using the **'DigAlarm'** folder.

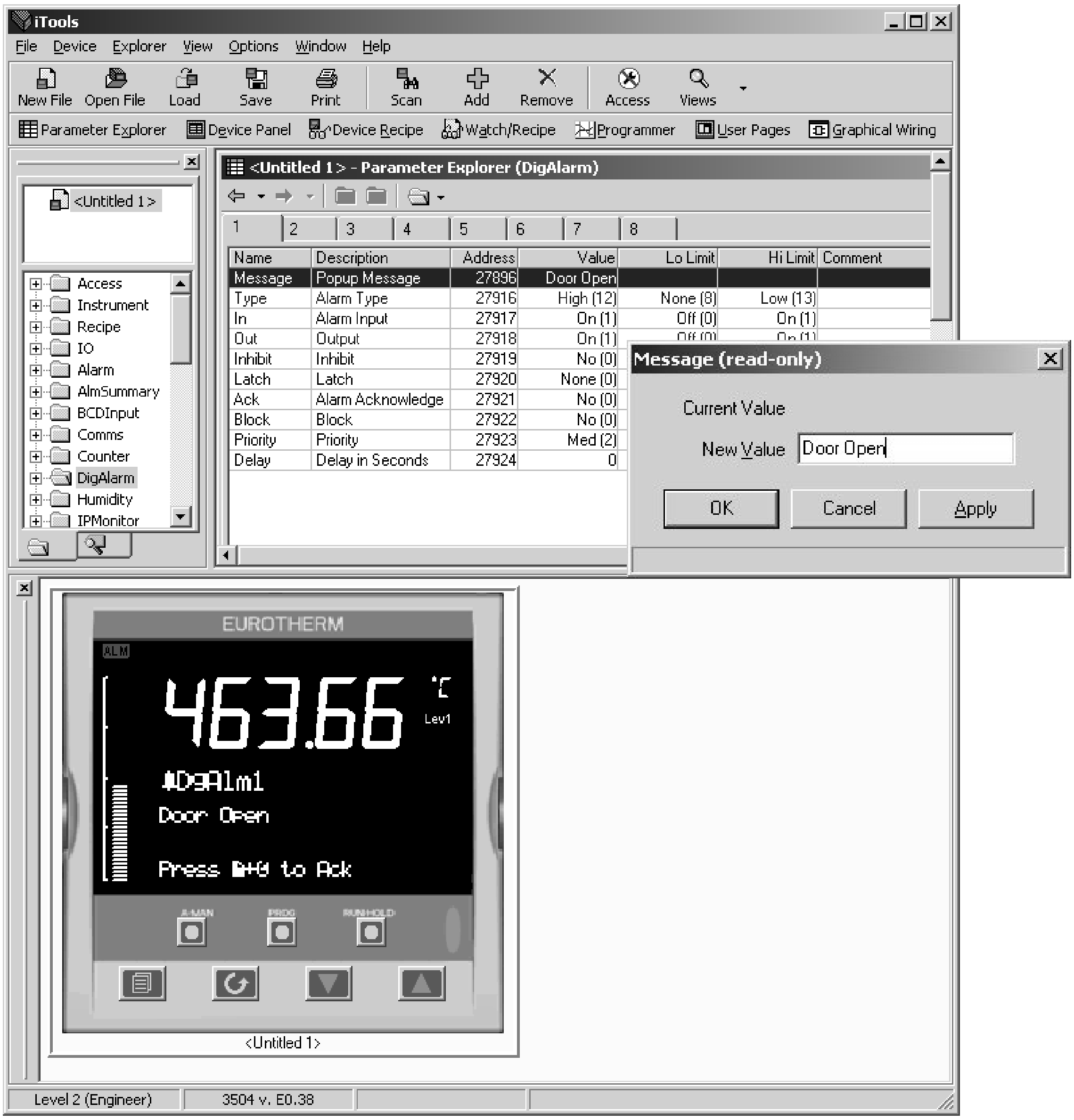


Figure 26-4: Configuring Digital Alarm Messages using iTools

HVS PRECONISATEUR DE SOLUTIONS DEPUIS 1986
2 rue René Laennec 51500 Taissy France
Fax: 03 26 85 19 08, Tel : 03 26 82 49 29
E-mail:hvssystem@hvssystem.com
Site web : www.hvssystem.com

26.9 Program Editor

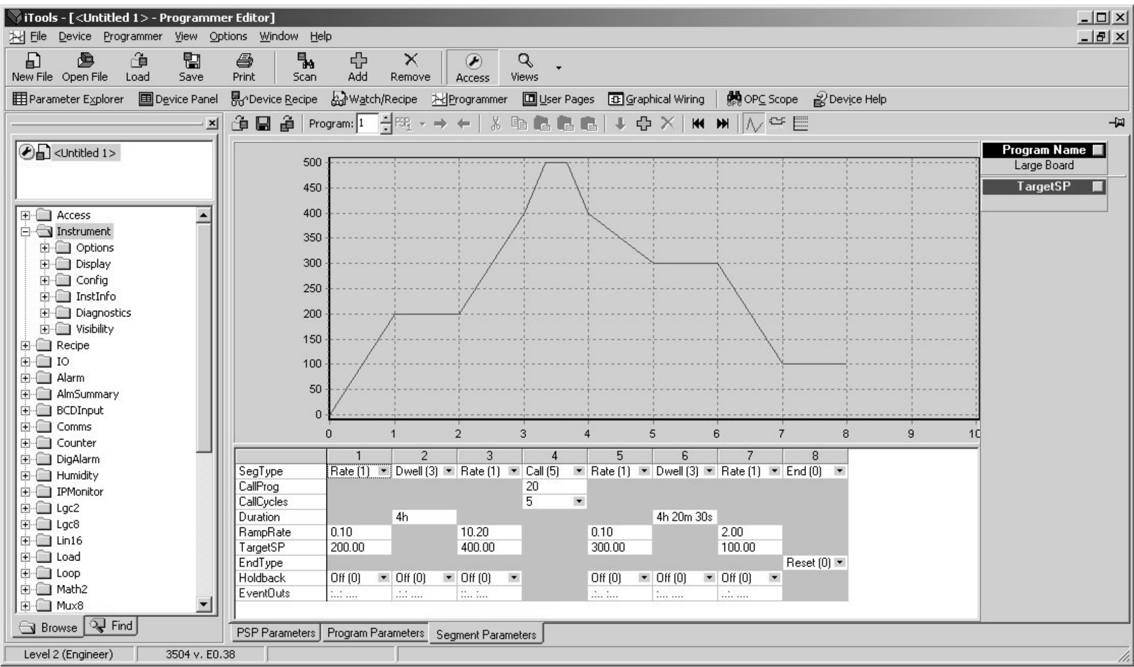
ITools provides a convenient method of entering and editing programs directly in the controller. Setpoint programs can be created graphically, stored and downloaded into the controller.

26.9.1 Analog View

This view is used for editing the analog setpoints. The event outputs are displayed using dots in the digital output row and are not editable. Hold the mouse pointer over the digital setpoint cell and a tooltip pops up showing the number, name and value of each of the digitals.

- From the iTools menu select 'Program Editor'.

1. Press Programmer to edit the analog setpoints
2. Select a program number using Program: 1
3. Double click Program Name and enter a name for the program
4. Right click in the blank area and choose 'Add Segment'
5. Select 'Segment Type' from the drop down and enter the segment details
6. Repeat for all required segments



26.9.1.1 Step

The trace steps from the old to the new value half way through the segment display.

26.9.1.2 Ramp

The point at which the ramp will reach the target is calculated and the ramp is plotted from the start of the segment to this point. .

26.9.1.3 Dwell

Jumps to the dwell target at the start of the segment and stays there.

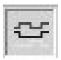
26.9.1.4 Call

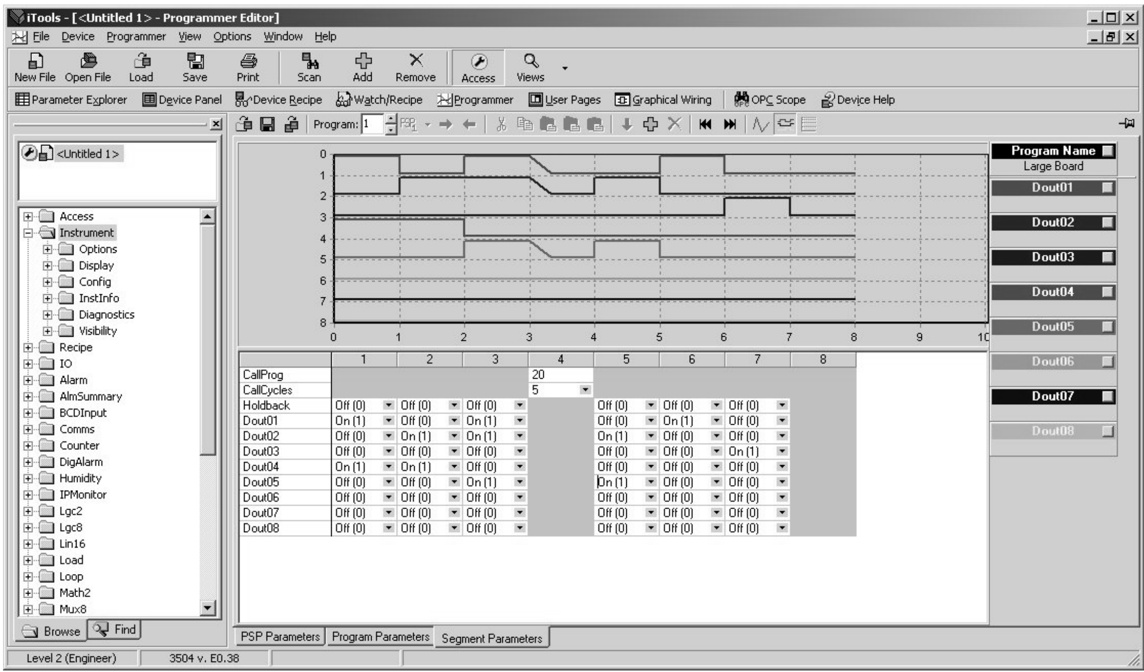
Shows the profile of the called program compressed to fit in one segment. If the called program calls another program it is treated as a dwell.

The graph has a context menu with one entry - 'Copy Chart'. This copies the visible part of the graph onto the clipboard as a Windows Metafile.

26.9.2 Event Outputs

These are set in the 'Digital View' as follows:-

1. Press  to select the digital events view.
2. Right click in the blank area to 'Add Segment'
3. Use the pull downs to turn the digital event On or Off in the selected segment



26.9.3 The Spreadsheet

The segment values are shown in a spreadsheet format. Each cell either contains a set of enumerated values shown as a drop down list, a numerical value, or a duration.

To change an enumeration either type its numeric value or choose from the drop down list. If the enumeration is for an event output and so only has the values 'On (1)' and 'Off (0)' you can double click the cell to change to the other value.

To change a numeric value, click on the cell and type the new value. It is accepted when you move on to another cell using the 'enter', tab or arrow keys.

To change a duration type it in the format '__h __m __s __ms' where _ is a number. You can leave bits out but if they appear they must be in the order shown. E.g., '1m 30s' is acceptable but '30s 1m' is not.

☺ If you select and copy spreadsheet cells they are put on the clipboard as tab separated values which can be pasted into Microsoft Excel.

26.9.4 Menu Entries and Tool Buttons

Most of the menu entries documented above have an associated tool button that performs the same action. Hold the mouse over each button to find out what it does.

26.9.5 The Context Menu

There is a context menu on the spreadsheet that has 'Select All', 'Copy', 'Paste Insert', 'Paste Over', 'Insert' and 'Delete' entries. These perform the same actions as those in the Edit menu.

26.9.6 Naming Programs

The programs can be given names. These names are saved in the program file and as comments in any clone file made from the instrument. The program name is also written to the instrument. To enter a name, either double click the trace label or click the small grey button on it. You can enter up to 16 characters as the name.

26.9.7 Entering a Program

You can connect to a device or load a clone file as you normally would and then select the programmer view using the view button on the toolbar or the context menu for the device.

To create a new program, create a new clone file and start the programmer editor using that clone.

Note that if you need to be able to put the device/simulation into configuration mode this can only be done within iTools.

26.9.8 Making Changes to a Program

There are three tabs along the bottom of the editor, the last one shows the segment data in a graph and a grid. The others show standard iTools lists which are used to set up programmer related parameters for the whole instrument and for the current program. You will only see the parameters that set up instrument wide program parameters if the instrument is in configuration mode.

The 'Segment Parameters' tab is the default and the one where the program itself is edited. To change a numeric value click in the tab, type the new number and enter. To change an enumerated value click on the down arrow button and choose the new value. The segment values are edited 'in place' whereas the iTools parameter lists popup a dialog to change the value.

If you are connected to a device the changes will be written to it immediately. If you created a new program or opened a saved program you will have to save the changes to a file.

26.9.9 Saving Programs

The stand alone editor has a 'File|Save' menu entry which is used to write the program out to a file. Each program is saved in a separate file. If you wish to clone all of the programs from one instrument to another you will have to use the iTools cloning facilities to do this.

When using the editor within iTools, there is an entry on the Programmer menu for saving programs.

26.9.10 Moving Programs Around

The 'File|Send To' menu entry can be used to copy a program to a connected instrument. A dialog pops up in which you have to select the instrument and the destination program number. You can use this to copy programs within the same instrument or to open a program file and download it.

26.9.11 Printing a Program

There is no direct printing support in the Programmer Editor, but you can generate a report using Microsoft Excel as follows:

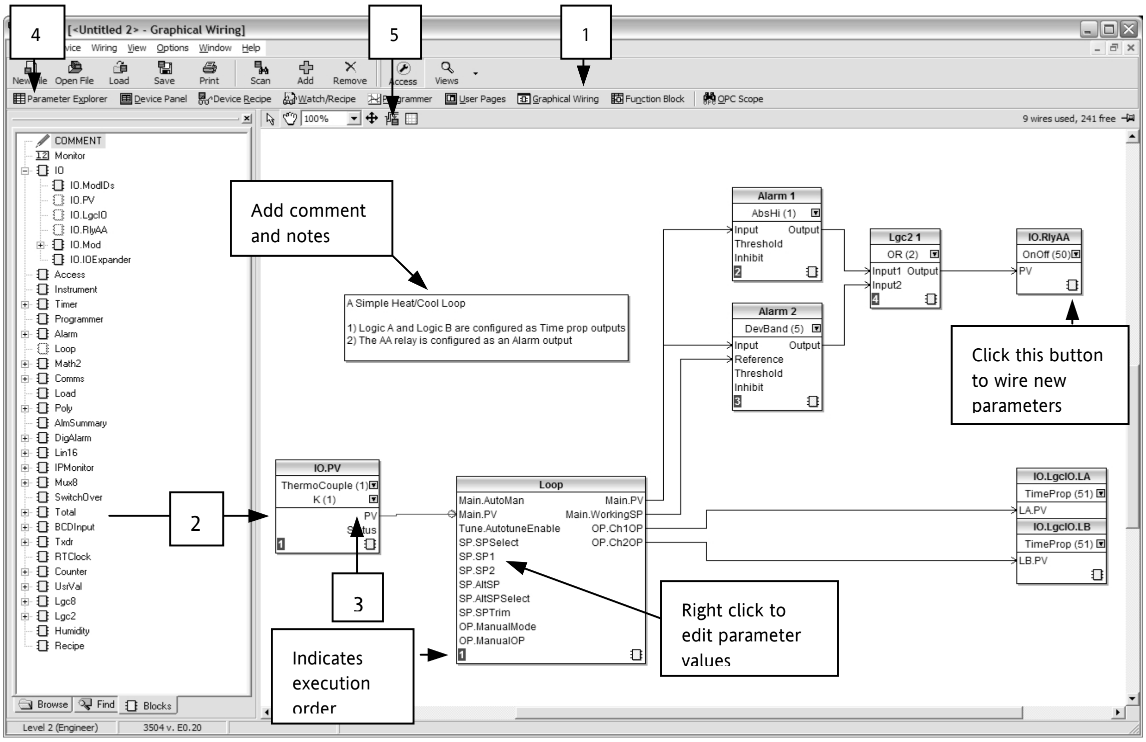
- Right click on the graph and choose 'Copy Chart'.
- Open a new spreadsheet in Excel and paste the chart, position to taste.
- Go back to the Programmer Editor and Choose 'Edit|Select All' followed by 'Edit|Copy'.
- Switch to Excel, choose the top left cell for the segment data and then choose 'Edit|Paste'.
- Optionally delete any columns that have no settings and format the cells.
- Print the spreadsheet.

The program is listed down rather than across the page so long programs can be printed.

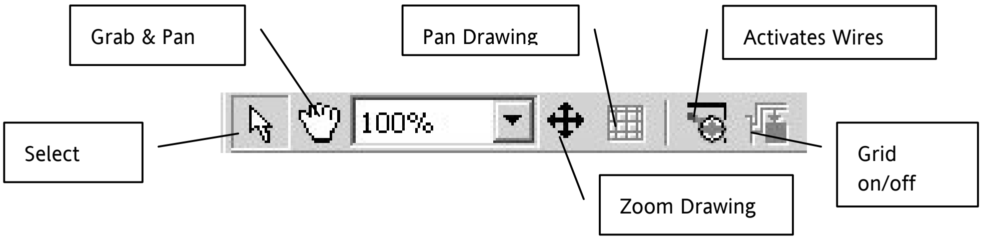
26.10 Graphical Wiring Editor

Select [Graphical Wiring] (GWE) to view and edit instrument wiring. You can also add comments and monitor parameter values.

1. Drag and drop required function blocks into the graphical wiring from the list in the left pane
2. Click on parameter to be wired from and drag the wire to the parameter to be wired to (do not hold mouse button down)
3. Right click to edit parameter values
4. Select parameter lists and switch between parameter and wiring editors
5. Download to instrument when wiring completed
6. Add comments and notes
7. Dotted lines around a function block show that the function requires downloading



Graphical Wiring Toolbar



The following terms are used:

26.10.1.1 Function Block

A Function Block is an algorithm which may be wired to and from other function blocks to make a control strategy. The Graphical Wiring Editor groups the instrument parameters into function blocks. Examples are: a control loop and a mathematical calculation.

Each function block has inputs and outputs. Any parameter may be wired from, but only parameters that are alterable may we wired to.

A function block includes any parameters that are needed to configure or operate the algorithm.

26.10.1.2 Wire

A wire transfers a value from one parameter to another. They are executed by the instrument once per control cycle.

Wires are made from an output of a function block to an input of a function block. It is possible to create a wiring loop, in this case there will be a single execution cycle delay at some point in the loop. This point is shown on the diagram By a | | symbol and it is possible to choose where that delay will occur.

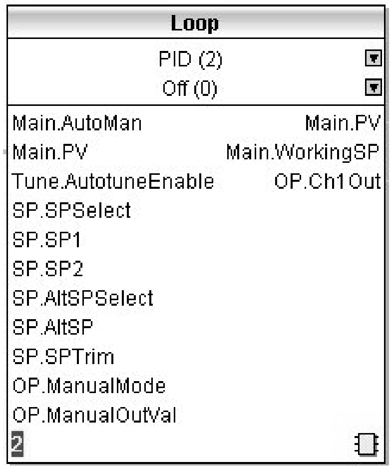
26.10.1.3 Block Execution Order

The order in which the blocks are executed by the instrument depends on the way in which they are wired.

The order is automatically worked out so that the blocks execute on the most recent data.

26.10.2 Using Function Blocks

If a function block is not faded in the tree then it can be dragged onto the diagram. The block can be dragged around the diagram using the mouse.



A labelled loop block is shown here. The label at the top is the name of the block.

When the block type information is alterable click on the box with the arrow in it on the right to edit that value.

The inputs and outputs which are considered to be of most use are always shown. In most cases all of these will need to be wired up for the block to perform a useful task. There are exceptions to this and the loop is one of those exceptions.

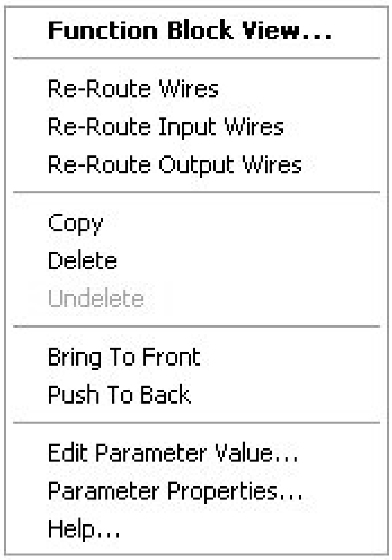
If you wish to wire from a parameter which is not shown as a recommended output click on the icon in the bottom right and a full list of parameters in the block will be shown, click on one of these to start a wire.

To start a wire from a recommended output just click on it.

Click 'Select Output' to wire new parameters

26.10.2.1 Function Block Context Menu

The function block context menu has the following entries:-



Function Block View...	Brings up an iTools parameter list which shows all the parameters in the function block. If the block has sub-lists these are shown in tabs
Re-Route Wires	Throw away current wire route and do an auto-route of all wires connected to this block
Re-Route Input Wires	Only do a re-route on the input wires
Re-Route Output Wires	Only do a re-route on the output wires
Copy	Right click over an input or output and copy will be enabled, this menu item will copy the iTools "url" of the parameter which can then be pasted into a watch window or OPC Scope
Delete	If the block is downloaded mark it for delete, otherwise delete it immediately
Undelete	This menu entry is enabled if the block is marked for delete and unmarks it and any wires connected to it for delete

Bring To Front	Bring the block to the front of the diagram. Moving a block will also bring it to the front
Push To Back	Push the block to the back of the diagram. Useful of there is something underneath it
Edit Parameter Value	This menu entry is enabled when the mouse is over an input or output parameter. When selected it creates a parameter edit dialog so the value of that parameter can be changed
Parameter Properties	Selecting this entry brings up the parameter properties window. The parameter properties window is updated as the mouse is moved over the parameters shown on the function block
Help	Selecting this entry brings up the help window. The help window is updated as the mouse is moved over the parameters shown on the function block. When the mouse is not over a parameter name the help for the block is shown

26.10.3 Tooltips

Hovering over different parts of the block will bring up tooltips describing the part of the block beneath the mouse.

If you hover over the parameter values in the block type information a tooltip showing the parameter description, it's OPC name, and, if downloaded, it's value will be shown.

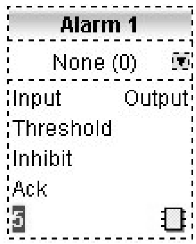
A similar tooltip will be shown when hovering over inputs and outputs.

26.10.4 Series 3000 Instruments

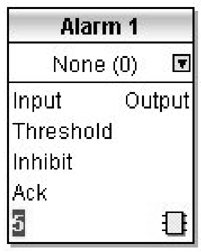
The blocks in a series 3000 instrument are enabled by dragging the block onto the diagram, wiring it up, and downloading it to the instrument

When the block is initially dropped onto the diagram it is drawn with dashed lines.

When in this state the parameter list for the block is enabled but the block itself is not executed by the instrument.



Once the download button is pressed the block is added to the instrument function block execution list and it is drawn with solid lines.



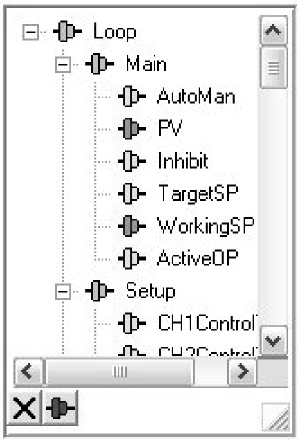
If a block which has been downloaded is deleted, it is shown on the diagram in a ghosted form until the download button is pressed.

This is because it and any wires to/from it are still being executed in the instrument. On download it will be removed from the instrument execution list and the diagram. A ghosted block can be undeleted using the context menu.

When a dashed block is deleted it is removed immediately.

26.10.5 Using Wires

26.10.5.1 Making A Wire Between Two Blocks

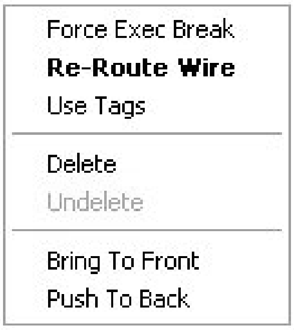


- Drag two blocks onto the diagram from the function block tree.
- Start a wire by either clicking on a recommended output or clicking on the icon at the bottom right corner of the block to bring up the connection dialog. The connection dialog shows all the connectable parameters for the block, if the block has sub-lists the parameters are shown in a tree. If you wish to wire a parameter which is not currently available click the red button at the bottom of the connection dialog. Recommended connections are shown with a green plug, other parameters which are available are yellow and if you click the red button the unavailable parameters are shown red. To dismiss the connection dialog either press the escape key on the keyboard or click the cross at the bottom left of the dialog.
- Once the wire has started the cursor will change and a dotted wire will be drawn from the output to the current mouse position.
- To make the wire either click on a recommended input to make a wire to that parameter or click anywhere except on a recommended input to bring up the connection dialog. Choose from the connection dialog as described above.
- The wire will now be auto-routed between the blocks.

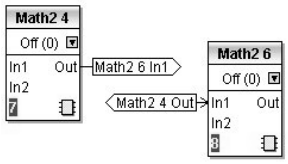
New wires on series 3000 instruments are shown dotted until they are downloaded

26.10.5.2 Wire Context Menu

The wire block context menu has the following entries on it.



Force Exec Break	If wires form a loop a break point has to be found where the value which is written to the block input comes from a block which was last executed during the previous instrument execute cycle thus introducing a delay. This option tells the instrument that if it needs to make a break it should be on this wire
Re-Route Wire	Throw away wire route and generate an automatic route from scratch
Use Tags	If a wire is between blocks which are a long way apart, then rather than drawing the wire, the name of the wired to/from parameter can be shown in a tag next to the block. This menu entry toggles this wire between drawing the whole wire and drawing it as tags
Delete	For series 3000 instruments if the wire is downloaded mark it for delete, otherwise delete it immediately
Undelete	This menu entry is enabled if the wire is marked for delete and unmarks it for delete
Bring To Front	Bring the wire to the front of the diagram. Moving a wire will also bring it to the front
Push To Back	Push the wire to the back of the diagram



26.10.5.3 Wire Colours

Wires can be the following colours:

Black	Normal functioning wire.
Red	The wire is connected to an input which is not alterable when the instrument is in operator mode and so values which travel along that wire will be rejected by the receiving block
Blue	The mouse is hovering over the wire, or the block to which it is connected it selected. Useful for tracing densely packed wires
Purple	The mouse is hovering over a 'red' wire

26.10.5.4 Routing Wires

When a wire is placed it is auto-routed. The auto routing algorithm searches for a clear path between the two blocks. A wire can be auto-routed again using the context menus or by double clicking the wire.

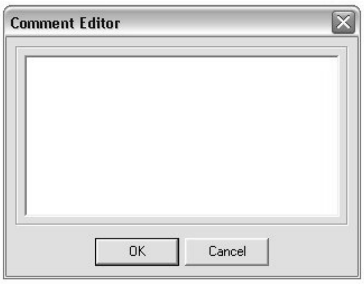
If you click on a wire segment you can drag it to manually route it. Once you have done this it is marked as a manually routed wire and will retain it's current shape. If you move the block to which it is connected the end of the wire will be moved but as much of the path as possible of the wire will be preserved.

If you select a wire by clicking on it, it will be drawn with small boxes on it's corners.

26.10.5.5 Tooltips

Hover the mouse over a wire and a tooltip showing the names of the parameters which are wired and, if downloaded, their current values will also be shown.

26.10.6 Using Comments

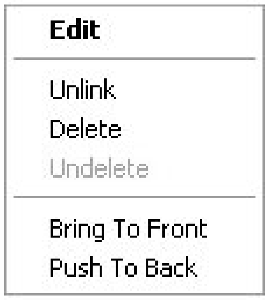


Drag a comment onto the diagram and the comment edit dialog will appear.

Type in a comment. Use newlines to control the width of the comment, it is shown on the diagram as typed into the dialog. Click OK and the comment text will appear on the diagram. There are no restrictions on the size of a comment. Comments are saved to the instrument along with the diagram layout information.

Comments can be linked to function blocks and wires. Hover the mouse over the bottom right of the comment and a chain icon will appear, click on that icon and then on a block or a wire. A dotted wire will be drawn to the top of the block or the selected wire segment.

26.10.6.1 Comment Context Menu



The comment context menu has the following entries on it.

Edit	Open the comment edit dialog to edit this comment
Unlink	If the comment is linked to a block or wire this will unlink it
Delete	For series 3000 instruments if the comment is downloaded mark it for delete, otherwise delete it immediately
Undelete	This menu entry is enabled if the comment is marked for delete and unmarks it for delete
Bring To Front	Bring the comment to the front of the diagram. Moving a comment will also bring it to the front
Push To Back	Push the comment to the back of the diagram. Useful if there is something underneath it

26.10.7 Using Monitors

Drag a monitor onto the diagram and connect it to a block input or output or a wire as described in 'Using Comments'.

The current value (updated at the iTools parameter list update rate) will be shown in the monitor. By default the name of the parameter is shown, double click or use the context menu to not show the parameter name.

26.10.7.1 Monitor Context Menu

The monitor context menu has the following entries on it.

Show Names	Show parameter names as well as values
Unlink	If the monitor is linked to a block or wire this will unlink it
Delete	For series 3000 instruments if the monitor is downloaded mark it for delete, otherwise delete it immediately
Undelete	This menu entry is enabled if the monitor is marked for delete and unmarks it for delete
Bring To Front	Bring the monitor to the front of the diagram. Moving a monitor will also bring it to the front
Push To Back	Push the monitor to the back of the diagram. Useful if there is something underneath it

26.10.8 Downloading To Series 3000 Instruments

Series 3000 wires have to be downloaded to the instrument together. When the wiring editor is opened the current wiring and diagram layout is read from the instrument. No changes are made to the instrument function block execution or wiring until the download button is pressed. Any changes made using the instrument front panel after the editor is opened will be lost on download.

When a block is dropped on the diagram instrument parameters are changed to make the parameters for that block available. If you make changes and close the editor without saving them there will be a delay while the editor clears these parameters.

When you download, the wiring is written to the instrument which then calculates the block execution order and starts executing the blocks. The diagram layout including comments and monitors is then written into instrument flash memory along with the current editor settings. When you reopen the editor the diagram will be shown positioned the same as when you last downloaded.

26.10.9 Selections

Wires are shown with small blocks at their corners when selected. All other items have a dotted line drawn round them when they are selected.

26.10.9.1 Selecting Individual Items

Clicking on an item on the drawing will select it.

26.10.9.2 Multiple Selection

Control click an unselected item to add it to the selection, doing the same on a selected item unselects it.

Alternatively, hold the mouse down on the background and wipe it to create a rubber band, anything which isn't a wire inside the rubber band will be selected.

Selecting two function blocks also selects any wires which join them. This means that if you select more than one function block using the rubber band method any wires between them will also be selected.

Pressing Ctrl-A selects all blocks and wires.

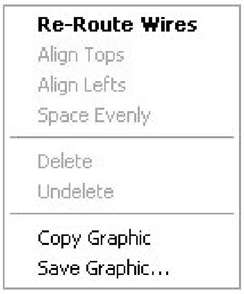
26.10.10 Colours

Items on the diagram are coloured as follows:

Red	Function blocks, comments and monitors which partially obscure or are partially obscured by other items are drawn red. If a large function block like the loop is covering a small one like a math2 the loop will be drawn red to show that it is covering another function block. Wires are drawn red when they are connected to an input which is currently unalterable. Parameters in function blocks are coloured red if they are unalterable and the mouse pointer is over them
Blue	Function blocks, comments and monitors which are not coloured red are coloured blue when the mouse pointer is over them. Wires are coloured blue when a block to which the wire is connected is selected or the mouse pointer is over it. Parameters in function blocks are coloured blue if they are alterable and the mouse pointer is over them
Purple	A wire which is connected to an input which is currently unalterable and a block to which the wire is connected is selected or the mouse pointer is over it is coloured purple (red + blue)

26.11 Diagram Context Menu

The diagram context menu has the following entries on it:-

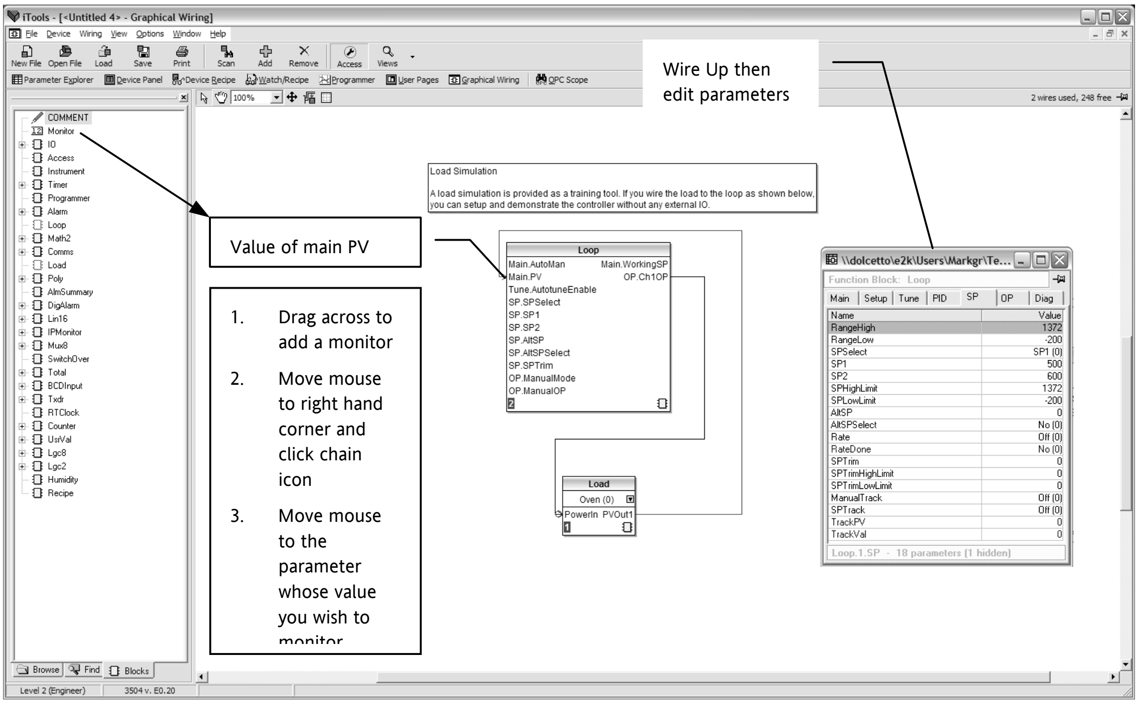


Re-Route Wires	Throw away current wire route and do an auto-route of all selected wires. If no wires are selected this is done to all wires on the diagram
Align Tops	Line up the tops of all the selected items except wires
Align Lefts	Line up the left hand side of all the selected items except wires
Space Evenly	This will space the selected items such that their top left corners are evenly spaced. Select the first item, then select the rest by control-clicking them in the order you wish them to be spaced, then choose this menu entry
Delete	Delete, or mark for delete (series 3000 instruments) all selected items
Undelete	This menu entry is enabled if any of the selected items are marked for delete and unmarks them when selected
Copy Graphic	If there is a selection it is copied to the clipboard as a Windows metafile, if there is no selection the whole diagram is copied to the clipboard as a Windows metafile. Paste into your favourite documentation tool to document your application. Some programs render metafiles better than others, the diagram may look messy on screen but it should print well
Save Graphic	Same as Copy Graphic but saves to a metafile rather than putting it on the clipboard

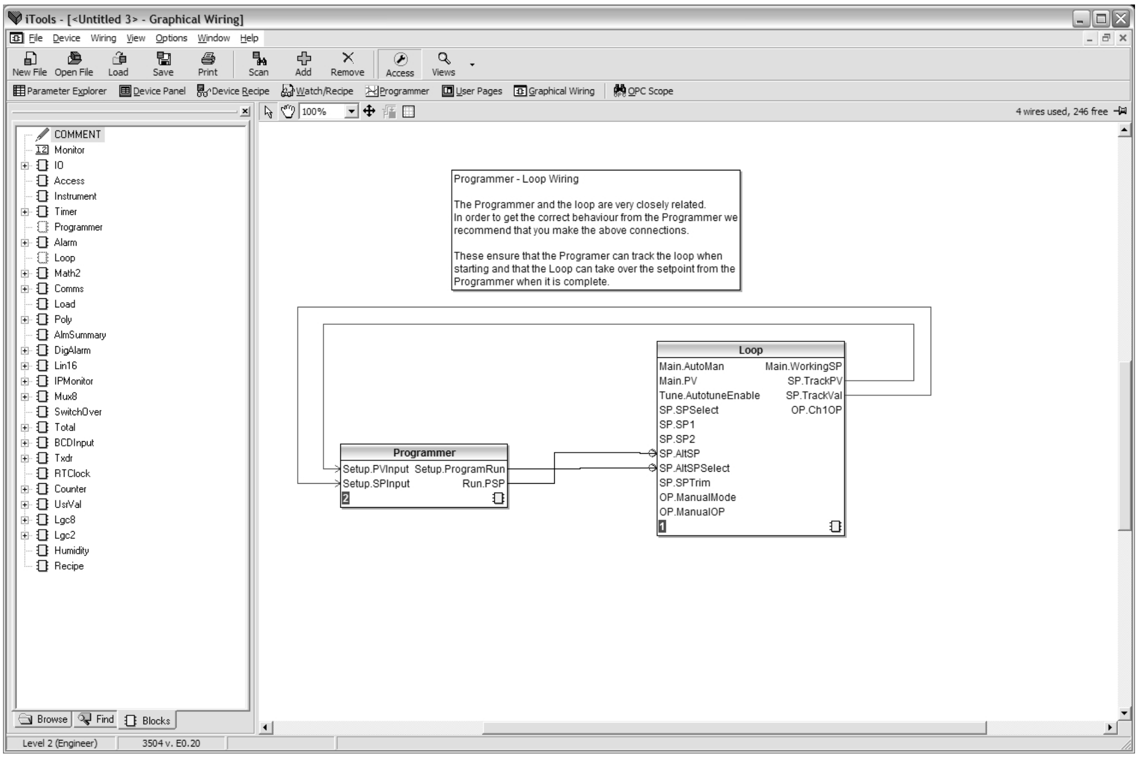
26.11.1 Other Examples of Graphical Wiring

Simulated Load

This may be useful as a test to show the action of a closed loop PID controller.

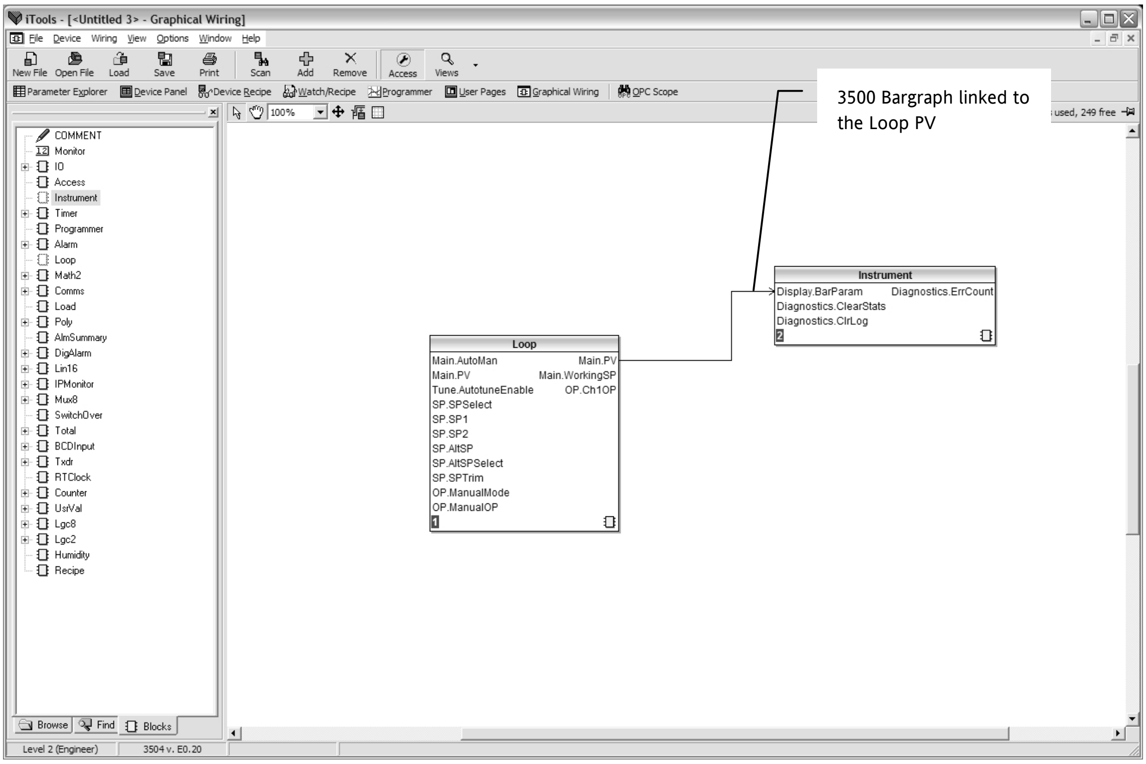


Loop/Programmer Wiring

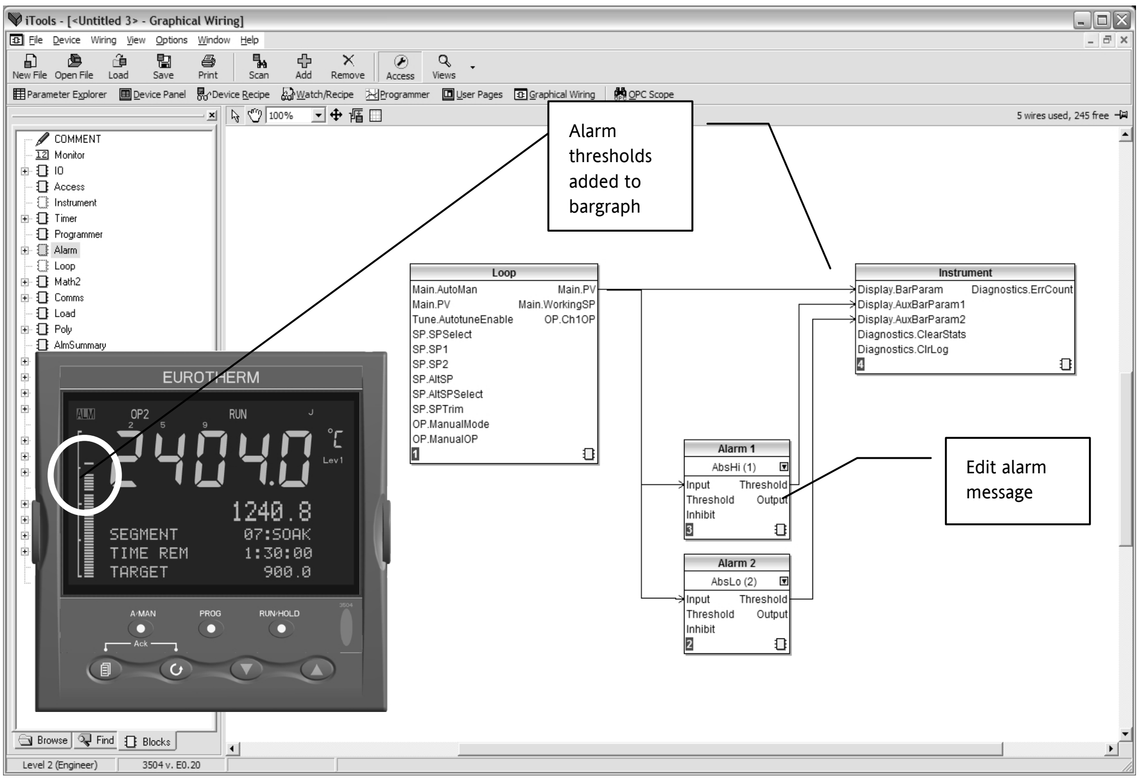


Note: The wires on this diagram are auto generated if the loop and programmer are enabled and there are no wires connected to the four inputs.

Bargraph



Bargraph with Alarm Values Displayed



26.12 Cloning

The cloning feature allows the configuration and parameter settings of one instrument to be copied into another. Alternatively a configuration may be saved to file and this used to download to connected instruments. The feature allows new instruments to be rapidly set up using a known reference source or standard instrument. Every parameter and parameter value is downloaded to the new instrument which means that if the new instrument is used as a replacement it will contain exactly the same information as the original. Cloning is generally only possible if the following applies:

- The target instrument has the same hardware configuration as the source instrument
- The target instrument firmware (ie. Software built into the instrument) is the same as or a later version than that of the source instrument. The instrument firmware version is displayed on the instrument when power is applied.

⚠ **It is the users responsibility to ensure that the information cloned from one instrument to another is correct for the process to be controlled, and that all parameters are correctly replicated into the target instrument.**

Below is a brief description of how to use this feature. Further details are available in the iTools Handbook

26.12.1 Save to File

The configuration of the controller made in the previous sections may be saved as a clone file. This file can then be used to download the configuration to further instruments.

From the File menu use 'Save to File' or use the 'Save' button on the Toolbar.

26.12.1.1 Loading a Clone File Using The IR & Config Clips

When iTools is communicating with the instrument via the IR or Config Clips and a clone file is loaded, ALL parameters are cloned, including communications parameters.

This is possible as the actual communications mechanism will not be altered by changing these parameters. The communication mechanism will be fixed within the instrument by the use of these clips, see above.

26.12.1.2 Loading a Clone File using 'H'/'J' Port Communications

When iTools is communicating with the instrument via the 'H' or 'J' port and a clone file is loaded, all relevant parameters EXCLUDING the comms parameters will be cloned.

This is necessary to remove the risk of changes in communications settings terminating the communications with iTools during the clone procedure.

26.12.2 To Clone a New Controller

Connect the new controller to iTools and Scan to find this instrument as described at the beginning of this chapter.

From the File menu select 'Load Values From File' or select 'Load' from the toolbar. Choose the required file and follow the instruction. The new instrument will be configured to this file.

26.12.3 To Clone Directly from One Controller to Another

Connect the second controller to iTools and scan for the new instrument

From the File menu select 'Send to Device'. Select the controller to be cloned and follow the instructions. The old instrument will be configured the same as the new one.

27. APPENDIX A PARAMETER INDEX

Below is an index of parameters used in the 3500 series controllers. The three columns on the left hand side are sorted by function block and the three columns on the right are sorted alphabetically. Both refer to the section in which the parameters will be found in this issue of the manual.

Parameters in order of page header		
Parameter	**Page Header**	**Section**
	Access	
Goto	Access	2.2
Level2 Code	Access	2.2
Level3 Code	Access	2.2
Config Code	Access	2.2
IR Mode	Access	2.2
Customer ID	Access	2.2
Keylock	Access	2.2
Standby	Access	2.2
A/Man Func	Access	2.2
Run/Hold Func	Access	2.2
	Inst Options	
Math2 En1	Inst Options	5.3
Timer En	Inst Options	5.3
Loop En	Inst Options	5.3
Load En	Inst Options	5.3
AnAlm En	Inst Options	5.3
DgAlm En	Inst Options	5.3
IO Exp En	Inst Options	5.3
Poly En	Inst Options	5.3
Progr En	Inst Options	5.3
Lin16Pt En	Inst Options	5.3
IP Mon En	Inst Options	5.3
SwOver En	Inst Options	5.3
Totalise En	Inst Options	5.3
TrScale En	Inst Options	5.3
BCDIn En	Inst Options	5.3
Mux8 En	Inst Options	5.3
RTClock En	Inst Options	5.3
Counter En	Inst Options	5.3
Lgc2 En1	Inst Options	5.3
Lgc2 En2	Inst Options	5.3
Lgc2 En3	Inst Options	5.3
Lgc8 En	Inst Options	5.3
Math2 En2	Inst Options	5.3
Math2 En3	Inst Options	5.3

Parameters in alphabetical order		
Parameter	**Page Header**	**Section**
A		
A/Man Func	Access	2.2
Ack	AnAlm 1 to 16	11.4
Active Set	Loop PID	20.4
Address	Comms H or J	13.3
Advance	Programmer Summary	1.13
Alarm OP	totaliser 1 to 4	14.3
Alarm Page	Inst Display	5.4
Alarm SP	totaliser 1 to 2	14.3
Alarm Summary	Inst Display	5.4
Alm Days	IPMonitor 1 to 11	16.2
Alm Out	IPMonitor 1 to 8	16.2
Alm Time	IPMonitor 1 to 9	16.2
Alt SP	Loop Setpoint	20.6
Alt SP En	Loop Setpoint	20.6
AnAlm En	Inst Options	5.3
Atten	Load	19.1
AutoMan	Loop Main	20.2
Aux1 Bar Val	Inst Display	5.4
Aux2 Bar Val	Inst Display	5.4
B		
Backlash	Modules	9.3
BarScale Max	Inst Display	5.4
BarScale Min	Inst Display	5.4
Baud Rate	Comms H or J	13.3
Bcast Val	Comms H or J	13.3
BCD Value	BCDin 1 and 11	12.1
BCDIn En	Inst Options	5.3
Block	AnAlm 1 to 17	11.4
Boundary 1-2	Loop PID	20.4
Boundary 2-3	Loop PID	20.4
Broadcast	Comms H or J	13.3
C		
Cal State	PV Input	6.8
Cal Active	Txdr 1 or 17	23.5
Cal Band	Txdr 1 or 16	23.5

Parameters in order of page header		
Parameter	**Page Header**	**Section**
Humidity En	Inst Options	5.3
UsrVal En1	Inst Options	5.3
UsrVal En2	Inst Options	5.3
	Inst Display	
Home Timeout	Inst Display	5.4
Units	Inst Display	5.4
Loop Summary	Inst Display	5.4
Prog Summary	Inst Display	5.4
Alarm Summary	Inst Display	5.4
Prog Edit	Inst Display	5.4
Control Page	Inst Display	5.4
Alarm Page	Inst Display	5.4
BarScale Max	Inst Display	5.4
BarScale Min	Inst Display	5.4
Main Bar Val	Inst Display	5.4
Aux1 Bar Val	Inst Display	5.4
Aux2 Bar Val	Inst Display	5.4
Language	Inst Display	5.4
	Inst Information	
Inst Type	Inst Information	5.5
Version Num	Inst Information	5.5
Serial Num	Inst Information	5.5
Passcode1	Inst Information	5.5
Passcode2	Inst Information	5.5
Passcode3	Inst Information	5.5
	Inst Diagnostics	
Max Con Tick	Inst Diagnostics	5.6
CPU % Min	Inst Diagnostics	5.6
CPU % Free	Inst Diagnostics	5.6
Con Ticks	Inst Diagnostics	5.6
UI Ticks	Inst Diagnostics	5.6
Power FF	Inst Diagnostics	5.6
Error Count	Inst Diagnostics	5.6
Error 1	Inst Diagnostics	5.6
Error 2	Inst Diagnostics	5.6
Error 3	Inst Diagnostics	5.6
Error 4	Inst Diagnostics	5.6
Error 5	Inst Diagnostics	5.6
Error 6	Inst Diagnostics	5.6
Error 7	Inst Diagnostics	5.6

Parameters in alphabetical order		
Parameter	**Page Header**	**Section**
Cal Enable	Txdr 1 or 4	23.5
Cal State	Modules	9.3
Cal Status	Txdr 1 or 20	23.5
Cal Type	Txdr 1 or 2	23.5
Call Cycles	Program 1 to 58	21.2
Call Program	Program 1 to 57	21.2
CBH	Loop PID	20.4
CBH2	Loop PID	20.4
CBH3	Loop PID	20.4
CBL	Loop PID	20.4
CBL2	Loop PID	20.4
CBL3	Loop PID	20.4
Ch1 Control	Loop Setup	20.3
Ch1 Pot Brk	Loop Output	20.7
Ch1 OnOff Hys	Loop Output	20.7
Ch1 Output	Loop Output	20.7
Ch1 Pot Pos	Loop Output	20.7
Ch1 TravelT	Loop Output	20.7
Ch2 Control	Loop Setup	20.3
Ch2 Gain	Load	19.1
Ch2 DeadB	Loop Output	20.7
Ch2 OnOff Hys	Loop Output	20.7
Ch2 Output	Loop Output	20.7
Ch2 Pot Brk	Loop Output	20.7
Ch2 Pot Pos	Loop Output	20.7
Ch2 TravelT	Loop Output	20.7
CJC Temp	PV Input	6.8
CJC Temp	Modules	9.3
CJC Type	Modules	9.3
CJC Type	PV Input	6.8
Clear Cal	Txdr 1 or 5	23.5
Clear Log	Inst Diagnostics	5.6
Clear O'flow	Counter 1 to 10	14.1
Clear Stats	Inst Diagnostics	5.6
Clock	Counter 1 to 6	14.1
Comms Delay	Comms H or J	13.3
Comms StackFree	Inst Diagnostics	5.6
Con Ticks	Inst Diagnostics	5.6
Config Code	Access	2.2
Control Act	Loop Setup	20.3

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Parameters in order of page header		
Parameter	**Page Header**	**Section**
Error 8	Inst Diagnostics	5.6
Clear Log	Inst Diagnostics	5.6
Clear Stats	Inst Diagnostics	5.6
String Count	Inst Diagnostics	5.6
String Space	Inst Diagnostics	5.6
Segments Left	Inst Diagnostics	5.6
Ctl Stack Free	Inst Diagnostics	5.6
Max UI Ticks	Inst Diagnostics	5.6
Comms StackFree	Inst Diagnostics	5.6
UI Stack Free	Inst Diagnostics	5.6
Disp Stack Free	Inst Diagnostics	5.6
Idle StackFree	Inst Diagnostics	5.6
	Timer 1 to 4	
Elapsed Time	Timer 1 to 4	14.2
Output	Timer 1 to 5	14.2
Time	Timer 1 to 6	14.2
Triggered	Timer 1 to 7	14.2
Type	Timer 1 to 8	14.2
Input	Timer 1 to 9	14.2
	Program All	
PV Input	Program All	21.2
SP Input	Program All	21.2
Servo	Program All	21.2
Power Fail	Program All	21.2
Sync Input	Program All	21.2
Max Events	Program All	21.2
SyncMode	Program All	21.2
Prog Reset	Program All	21.2
Prog Run	Program All	21.2
Prog Hold	Program All	21.2
End Of Seg	Program All	21.2
Event 1	Program All	21.2
Event 2	Program All	21.2
Event 3	Program All	21.2
Event 4	Program All	21.2
Event 5	Program All	21.2
Event 6	Program All	21.2
Event 7	Program All	21.2
Event 8	Program All	21.2

Parameters in alphabetical order		
Parameter	**Page Header**	**Section**
Control Page	Inst Display	5.4
Cool Type	Loop Output	20.7
Count	Counter 1 to 8	14.1
Counter En	Inst Options	5.3
CPU % Free	Inst Diagnostics	5.6
CPU % Min	Inst Diagnostics	5.6
Ctl Stack Free	Inst Diagnostics	5.6
Customer ID	Access	2.2
Cycles	Program 1 to 53	21.2
Cycles Left	Programmer Summary	1.13
CarbonPot	Zirconia	15.4
CleanFreq	Zirconia	15.4
CleanTime	Zirconia	15.4
CleanValve	Zirconia	15.4
CleanState	Zirconia	15.4
CleanProbe	Zirconia	15.4
D		
Day	RTClock	14.4
Days Above	IPMonitor 1 to 10	16.2
Dec Value	BCDin 1 and 10	12.1
Delay	AnAlm 1 to 19	11.4
Deriv Type	Loop Setup	20.3
Dest Addr	Comms H or J	13.3
DewPoint	Humidity	15.2
DewPoint	Zirconia	15.4
DgAlm En	Inst Options	5.3
Direction	Counter 1 to 3	14.1
Disp Stack Free	Inst Diagnostics	5.6
Disp Hi	AA Relay	8.2
Disp Hi	Modules	9.3
Disp Hi	PV Input	6.8
Disp Lo	AA Relay	8.2
Disp Lo	Modules	9.3
Disp Lo	PV Input	6.8
DryT	Humidity	15.2
E		
Elapsed Time	Timer 1 to 4	14.2
Emiss	PV Input	6.8
Emiss	Module	9.3
Enable	Counter 1 to 2	14.1

Parameters in order of page header		
Parameter	**Page Header**	**Section**
	Programmer Summary	
Advance	Programmer Summary	1.13
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Reset	totaliser 1 to 10	14.3
	BCDin 1 and 2	
In1	BCDin 1 and 2	12.1
In2	BCDin 1 and 3	12.1
In3	BCDin 1 and 4	12.1
In4	BCDin 1 and 5	12.1
In5	BCDin 1 and 6	12.1
In6	BCDin 1 and 7	12.1
In7	BCDin 1 and 8	12.1
In8	BCDin 1 and 9	12.1
Dec Value	BCDin 1 and 10	12.1
BCD Value	BCDin 1 and 11	12.1
Units	BCDin 1 and 12	12.1
Tens	BCDin 1 and 13	12.1
	Txdr 1 or 2	
Cal Type	Txdr 1 or 2	23.5
Input Value	Txdr 1 or 3	23.5
Cal Enable	Txdr 1 or 4	23.5
Clear Cal	Txdr 1 or 5	23.5
Start Cal	Txdr 1 or 6	23.5
Start Hi Cal	Txdr 1 or 7	23.5
Start Tare	Txdr 1 or 8	23.5
Range Min	Txdr 1 or 9	23.5
Range Max	Txdr 1 or 10	23.5
Tare Value	Txdr 1 or 11	23.5
Input Hi	Txdr 1 or 12	23.5
Input Lo	Txdr 1 or 13	23.5
Scale Hi	Txdr 1 or 14	23.5
Scale Lo	Txdr 1 or 15	23.5
Cal Band	Txdr 1 or 16	23.5

Parameters in alphabetical order		
Parameter	**Page Header**	**Section**
Res'n	totaliser 1 to 6	14.3
Res'n	UsrVal 1 to 17	24.1
Res'n	Zirconia	15.4
Ripple Carry	Counter 1 to 4	14.1
RTClock En	Inst Options	5.3
Run	totaliser 1 to 8	14.3
Run/Hold Func	Access	2.2
S		
Safe OP	Loop Output	20.7
Sbreak	Humidity	15.2
SBrk Alarm	PV Input	6.8
SBrk Type	PV Input	6.8
SBrk Value	PV Input	6.8
SBrk Alarm	Modules	9.3
Sbrk Mode	Loop Output	20.7
SBrk Type	Modules	9.3
SBrk Value	Modules	9.3
Scale Hi	Txdr 1 or 14	23.5
Scale Lo	Txdr 1 or 15	23.5
Sched Type	Loop PID	20.4
Seg Time Left	Programmer Summary	1.13
Segment	Program 1 to 54	21.2
Segment	Programmer Summary	1.13
Segment Type	Program 1 to 55	21.2
Segments Used	Program 1 to 50	21.2
Segments Left	Inst Diagnostics	5.6
Select	Mux10	17.4
Selected IP	Switch Over	22.1
Serial Num	Inst Information	5.5
Servo	Program All	21.2
Shunt	Modules	9.3
SkipSeg	Programmer Summary	1.13
SootAlm	Zirconia	15.4
SP HighLim	Loop Setpoint	20.6
SP Input	Program All	21.2
SP LowLim	Loop Setpoint	20.6
SP Select	Loop Setpoint	20.6
SP1	Loop Setpoint	20.6
SP2	Loop Setpoint	20.6
SPTrack	Loop Setpoint	20.6

Parameters in order of page header		
Parameter	**Page Header**	**Section**
Cal Active	Txdr 1 or 17	23.5
Output Value	Txdr 1 or 18	23.5
Output Status	Txdr 1 or 19	23.5
Cal Status	Txdr 1 or 20	23.5
	RTClock	
Day	RTClock	14.4
On Day1	RTClock	14.4
On Day2	RTClock	14.4
Mode	RTClock	14.4
Off Day1	RTClock	14.4
Off Day2	RTClock	14.4
Out1	RTClock	14.4
Out2	RTClock	14.4
Time	RTClock	14.4
On Time1	RTClock	14.4
On Time2	RTClock	14.4
Off Time1	RTClock	14.4
Off Time2	RTClock	14.4
	Counter 1 to 2	
Enable	Counter 1 to 2	14.1
Direction	Counter 1 to 3	14.1
Ripple Carry	Counter 1 to 4	14.1
Overflow	Counter 1 to 5	14.1
Clock	Counter 1 to 6	14.1
Target	Counter 1 to 7	14.1
Count	Counter 1 to 8	14.1
Reset	Counter 1 to 9	14.1
Clear O'flow	Counter 1 to 10	14.1
	UsrVal 1 to 16	
Units	UsrVal 1 to 16	24.1
Res'n	UsrVal 1 to 17	24.1
High Limit	UsrVal 1 to 18	24.1
Low Limit	UsrVal 1 to 19	24.1
Value	UsrVal 1 to 20	24.1
Status	UsrVal 1 to 21	24.1
	Lgc8	
Oper	Lgc8	17.2
Invert	Lgc8	17.2
NumIn	Lgc8	17.2
In1	Lgc8	17.2

Parameters in alphabetical order		
Parameter	**Page Header**	**Section**
SPTrim	Loop Setpoint	20.6
SPTrim Hi	Loop Setpoint	20.6
SPTrim Lo	Loop Setpoint	20.6
Stage	Loop Tune	20.5
Stage Time	Loop Tune	20.5
Standby	Access	2.2
Start Cal	Txdr 1 or 6	23.5
Start Hi Cal	Txdr 1 or 7	23.5
Start Tare	Txdr 1 or 8	23.5
State	Loop Tune	20.5
Status	IOExp	10.1
Status	Lin16	18.1
Status	Logic Operators Lgc 1 to 8	17.1
Status	Math2 1 to 32	17.3
Status	Modules	9.3
Status	Mux22	17.4
Status	Polynomial	18.2
Status	Programmer Summary	1.13
Status	PV Input	6.8
Status	Switch Over	22.1
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String Count	Inst Diagnostics	5.6
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Switch PV	Switch Over	22.1
Switch Hi	Switch Over	22.1
Switch Lo	Switch Over	22.1
SwOver En	Inst Options	5.3
Sync Input	Program All	21.2
SyncMode	Program All	21.2
T		
Tare Value	Txdr 1 or 11	23.5
Target	Counter 1 to 7	14.1
Target SP	Loop Main	20.2
Target SP	Program 1 to 61	21.2
TC1	Load	19.1
TempInput	Zirconia	15.4
TempOffset	Zirconia	
TC2	Load	19.1

Parameters in order of page header		
Parameter	**Page Header**	**Section**
In2	Lgc8	17.2
In3	Lgc8	17.2
In4	Lgc8	17.2
In5	Lgc8	17.2
In6	Lgc8	17.2
In7	Lgc8	17.2
In8	Lgc8	17.2
Out	Lgc8	17.2
Out Invert	Lgc8	17.2
	Logic Operators Lgc 1 to 2	
Oper	Logic Operators Lgc 1 to 2	17.1
Input1	Logic Operators Lgc 1 to 3	17.1
Input2	Logic Operators Lgc 1 to 4	17.1
Fall Type	Logic Operators Lgc 1 to 5	17.1
Invert	Logic Operators Lgc 1 to 6	17.1
Output	Logic Operators Lgc 1 to 7	17.1
Status	Logic Operators Lgc 1 to 8	17.1
	Humidity	
RelHumid	Humidity	15.2
DewPoint	Humidity	15.2
Res'n	Humidity	15.2
WetOffs	Humidity	15.2
WetT	Humidity	15.2
DryT	Humidity	15.2
Sbreak	Humidity	15.2
PsycK	Humidity	15.2
Pressure	Humidity	15.2
	IOExp	
Expander Type	IOExp	10.1
Status	IOExp	10.1
In 1-10	IOExp	10.1
In 11-20	IOExp	10.1
Out21-30	IOExp	10.1
Out31-40	IOExp	10.1
Inv21-30	IOExp	10.1
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Parameters in alphabetical order		
Parameter	**Page Header**	**Section**
Td	Loop PID	20.4
Td2	Loop PID	20.4
Td3	Loop PID	20.4
Tens	BCDin 1 and 13	12.1
Threshold	AnAlm 1 to 11	11.4
Threshold	IPMonitor 1 to 2	16.2
Ti	Loop PID	20.4
Ti2	Loop PID	20.4
Ti3	Loop PID	20.4
Time	RTClock	14.4
Time	Timer 1 to 6	14.2
Time2Clean	Zirconia	15.4
Time Above	IPMonitor 1 to 7	16.2
Timer En	Inst Options	5.3
Tolerance	Zirconia	15.4
Totalise En	Inst Options	5.3
TotalOp	totaliser 1 to 3	14.3
TrackEn	Loop Output	20.7
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TrackPV	Loop Setpoint	20.6
TrackSP	Loop Setpoint	20.6
Triggered	Timer 1 to 7	14.2
TrScale En	Inst Options	5.3
Type	AnAlm 1 to 8	11.4
Type	Load	19.1
Type	Timer 1 to 8	14.2
U		
UI Stack Free	Inst Diagnostics	5.6
UI Ticks	Inst Diagnostics	5.6
Units	BCDin 1 and 12	12.1
Units	Inst Display	5.4
Units	Lin16	18.1
Units	Load	19.1
Units	Modules	9.3
Units	Polynomial	18.2
Units	PV Input	6.8
Units	totaliser 1 to 5	14.3
Units	UsrVal 1 to 16	24.1
UsrVal En1	Inst Options	5.3
UsrVal En2	Inst Options	5.3

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Parameters in order of page header		
Parameter	**Page Header**	**Section**
	Zirconia	
Probe Type	Zirconia	15.4
Res'n	Zirconia	15.4
GasRef	Zirconia	15.4
RemGasRef	Zirconia	15.4
RemGasEn	Zirconia	15.4
MinCalTemp	Zirconia	15.4
OxygenExp	Zirconia	15.4
Tolerance	Zirconia	15.4
CleanFreq	Zirconia	15.4
CleanTime	Zirconia	15.4
MinRcovTime	Zirconia	15.4
MaxRcovTime	Zirconia	15.4
TempInput	Zirconia	15.4
TempOffset	Zirconia	15.4
ProbeInput	Zirconia	15.4
ProbeOffset	Zirconia	15.4
Oxygen	Zirconia	15.4
CarbonPot	Zirconia	15.4
DewPoint	Zirconia	15.4
SootAlm	Zirconia	15.4
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CleanState	Zirconia	15.4
CleanProbe	Zirconia	15.4
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Parameters in alphabetical order		
Parameter	**Page Header**	**Section**
V		
Value	UsrVal 1 to 20	24.1
Version Num	Inst Information	5.5
Voltage	Modules	9.3
W		
WetOffs	Humidity	15.2
WetT	Humidity	15.2
Work OP	Loop Main	20.2
WSP	Loop Main	20.2

28. APPENDIX B SAFETY AND EMC INFORMATION

This controller is manufactured in the UK by Eurotherm Controls Ltd.

Please read this section carefully before installing the controller

This controller is intended for industrial temperature and process control applications when it will meet the requirements of the European Directives on Safety and EMC. If the instrument is used in a manner not specified in this manual, the safety or EMC protection provided by the instrument may be impaired. The installer must ensure the safety and EMC of any particular installation.

Safety

This controller complies with the European Low Voltage Directive 73/23/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, by the application of appropriate product specific international standards. This instrument satisfies the general requirements of the commercial and industrial environments defined in EN 61326. For more information on product compliance refer to the Technical Construction File.

GENERAL

The information contained in this manual is subject to change without notice. While every effort has been made to ensure the accuracy of the information, your supplier shall not be held liable for errors contained herein.

Unpacking and storage

The packaging should contain an instrument mounted in its sleeve, two mounting brackets for panel installation and an Installation & Operating guide. Certain ranges are supplied with an input adapter.

If on receipt, the packaging or the instrument are damaged, do not install the product but contact your supplier. If the instrument is to be stored before use, protect from humidity and dust in an ambient temperature range of -10°C to +70°C.

SERVICE AND REPAIR

This controller has no user serviceable parts. Contact your supplier for repair.

Caution: Charged capacitors

Before removing an instrument from its sleeve, disconnect the supply and wait at least two minutes to allow capacitors to discharge. It may be convenient to partially withdraw the instrument from the sleeve, then pause before completing the removal. In any case, avoid touching the exposed electronics of an instrument when withdrawing it from the sleeve.

Failure to observe these precautions may cause damage to components of the instrument or some discomfort to the user.

Electrostatic discharge precautions

When the controller is removed from its sleeve, some of the exposed electronic components are 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.

INSTALLATION SAFETY REQUIREMENTS

Safety Symbols

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

⚠ Caution (refer to the accompanying documents ⏚ Protective Conductor Terminal

Personnel

Installation must only be carried out by suitably 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 controller is designed to operate with the temperature sensor connected directly to an electrical heating element. However you must ensure that service personnel do not touch connections to these inputs while they are live. With a live sensor, all cables, connectors and switches for connecting the sensor must be mains rated.

The logic IO is not isolated from the PV inputs.

Wiring

It is important to connect the controller in accordance with the wiring data given in this guide. Take particular care not to connect AC supplies to the low voltage sensor input or other low level inputs and outputs. Only use copper conductors for connections (except thermocouple inputs) and ensure that the wiring of installations comply with all local wiring regulations. For example in the UK use the latest version of the IEE wiring regulations, (BS7671). In the USA use NEC Class 1 wiring methods.

Power Isolation

The installation must include a power isolating switch or circuit breaker. 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 instrument.

Overcurrent protection

The power supply to the system should be fused appropriately to protect the cabling to the units.

Voltage rating

The maximum continuous voltage applied between any of the following terminals must not exceed 264Vac:

- relay output to logic, dc or sensor connections;
- any connection to ground.

The controller must 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. To secure a suitable atmosphere, install an air filter to the air intake of the cabinet. Where condensation is likely, for example at low temperatures, include a thermostatically controlled heater in the cabinet.

This product has been designed to conform to BSEN61010 installation category II, pollution degree 2. These are defined as follows:-

Installation Category II

The rated impulse voltage for equipment on nominal 230V supply is 2500V.

Pollution Degree 2

Normally only non conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation shall be expected.

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. Apart from spoiling the product, this could damage any process 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 condition
- the controller setpoint set too high.

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

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

- For general guidance refer to 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.
- If the unit is used in table top equipment which is plugged into a standard power socket, then it is likely that compliance to the commercial and light industrial emissions standard is required. In this case to meet the conducted emissions requirement, a suitable mains filter should be installed. We recommend Schaffner types FN321 and FN612.

Routing of wires

To minimise the pick-up of electrical noise, the low voltage DC connections and 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. In general keep cable lengths to a minimum.

29. APPENDIX C TECHNICAL SPECIFICATION

All figures quoted at an ambient temperature from 0 to 50ºC unless otherwise stated.

29.1.1 Control Options

No. of Loops	1
Control Loops	On/Off, single PID
Control Outputs	Analogue, Time proportioned or Motorised Valve control with or without feedback.
Cooling Algorithms	Linear, Water, Fan, Oil
Auto/Manual Control	Bumpless transfer or forced manual output.
Setpoint rate Limit	Off to 9999.9 engineering units per minute
Motorised Valve Control	Valve Position bounded or unbounded. Individual Valve Positions for heat and cool
Tuning	One-shot Auto tune or Manual.
Loop Alarms	High absolute, Low absolute, Deviation high, Deviation low, Deviation band, All with separate hysteresis.
Application Specific	Humidity control

29.1.2 Display

3504	Primary Large 5 digit display, Information centre 16 character header and 3 lines of 20 characters
3508	Primary Large 41/2 digit display, Information centre 8 character header and 3 lines of 10 characters
Technology	LCD with yellow/green backlight Red alarm beacon

29.1.3 Standard Digital I/O

Allocation	2 Off. Not isolated from each other. Not isolated from the PV inputs. Logic Bi-directional input/outputs Logic or Contact closure input
Digital inputs	Voltage level: input Inactive 0 to 7.3Vdc, Active 10.8V to 24Vdc Contact closure: input active <480ohms, inactive >1200ohms
Digital outputs	18Vdc at 9 to 15mA drive capability.
Changeover relay	Contact rating Min Load 1mA at 1V Max Load 2A at 264Vac resistive 1,000,000 operations with addition of external snubber

29.1.4 All Analogue and PV Inputs

Sample rate	9Hz (110msec.)
Input filtering	OFF to 999.9 seconds of filter time constant (f.t.c.). Default setting is 1.6 seconds
User calibration	Both the user calibration and a transducer scaling can be applied.
Sensor break	a.c. sensor break on each input (i.e. fast responding and no dc errors with high impedance sources).
Ranges	mV, mA, volts -2V to +10V, -1V to +2V or RTD (pt100), pyrometer inputs
Thermocouple types	Most linearisations including K, J, T, R, B, S, N, L, PII, C, D, E with linearisation error < ±0.2°C
	CJC: Automatic (internal), external, 0°C, 45°C, 50°C reference blocks
General	Resolution (noise free) is quoted as a typical figure with f.t.c. set to the default value = 1.6 second.
	Resolution generally improves by a factor of two with every quadrupling of f.t.c.
	Calibration is quoted as offset error + percentage error of absolute reading at ambient temperature of 25°C
	Drift is quoted as extra offset and absolute reading errors per degree of ambient change from 25°C.

29.1.5 PV Input

Accuracy	±0.1% ±1lsd	
Sample rate	9Hz	
Input filter	Off, 0.2s to 60s filter time constant. Default setting 1.6s.	
40mV Range	Range	-40mV to +40mV
	Resolution	1.9µV (unfiltered)
	Measurement noise	1.0µV peak to peak with 1.6s input filter.
	Linearity error	0.003% (best fit straight line)
	Calibration error	±4.6µV ±0.053% of measurement, at 25C ambient.
	Temperature coefficient	±0.2µV/C ±28ppm/C of measurement, from 25C ambient.
	Input leakage current	±14nA
	Input resistance	100MΩ
80mV Range	Range	-80mV to +80mV
	Resolution	3.2µV
	Measurement noise	3.3µV peak to peak with 1.6s input filter.
	Linearity error	0.003% (best fit straight line)
	Calibration error	±7.5µV ±0.052% of measurement, at 25C ambient.
	Temperature coefficient	±0.2µV/C ±28ppm/C of measurement, from 25C ambient.
	Input leakage current	±14nA
	Input resistance	100MΩ
2V Range	Range	-1.4V to +2.0V
	Resolution	82µV
	Measurement noise	90µV peak to peak with 1.6s input filter.
	Linearity error	0.015% (best fit straight line)
	Calibration error	±420µV ±0.044% of measurement, at 25C ambient.
	Temperature coefficient	±125µV/C ±28ppm/C of measurement, from 25C ambient.
	Input leakage current	±14nA
	Input resistance	100MΩ
10V Range	Range	-3.0V to +10V
	Resolution	500µV
	Measurement noise	550µV peak to peak with 1.6s input filter.
	Linearity error	0.007% for zero source resistance (best fit straight line) Add 0.003% for each 10Ω of source + lead resistance.

	Calibration error	±1.5mV ±0.063% of measurement, at 25C ambient.
	Temperature coefficient	±66µV/C ±60ppm/C of measurement, from 25C ambient.
	Input resistance	62.5kΩ to 667kΩ depending on input voltage.
PT100	Range	0 to 400Ω (-200C to +850C)
	Resolution	50mC
	Measurement noise	50mC peak to peak with 1.6s input filter.
	Linearity error	0.033% (best fit straight line)
	Calibration error	±310mC ±0.023% of measurement in C, at 25C ambient.
	Temperature coefficient	±10mC/C ±25ppm/C of measurement in C, from 25C ambient.
	Lead Resistance	0Ω to 22Ω, matched lead resistances.
	Bulb current	200µA
Thermocouple	Uses 40mV and 80mV ranges.	
	Types	J, K, L, R, B, N, T, S, PL2 and C.
	Linearisation error	±0.2C
	Internal Cold Junction	
	Calibration error	±1.0C at 25C ambient.
	Ambient rejection ratio	40:1 from 25C ambient.
	External Cold Junction	0C, 45C and 50C.

29.1.6 Analogue Input Module

mV input	100mV range - used for thermocouple, linear mV source, or 0-20mA with 2.49Ω external burden resistor.
	Calibration: ± 10µV + 0.2% of reading
	Resolution: 6µV
	Drift: < ± 0.2µV + 0.004% of reading per °C
	Input impedance: >10MΩ, Leakage: <10nA
0 - 2Vdc input	-0.2V to +2.0V range - used for zirconia.
	Calibration: ± 2mV + 0.2% of reading
	Resolution: 30µV
	Drift: < ± 0.1mV + 0.004% of reading per °C
	Input impedance: >10MΩ, Leakage: <20nA
0 - 10Vdc input	-3V to +10.0V range - used for voltage input.
	Calibration: ± 2mV + 0.2% of reading
	Resolution: 200µV
	Drift: < ± 0.1mV + 0.02% of reading per °C
	Input impedance: >69KΩ
Pt100 input	0 to 400ohms (-200°C to +850°C), 3 matched wires - up to 22Ω in each lead without errors.
	Calibration: ±(0.4°C + 0.15% of reading in °C)
	Resolution: 0.08°C
	Drift: < ±(0.015°C + 0.005% of reading in °C) per °C
	Bulb current: 0.3mA.
Thermocouple	Internal compensation: CJC rejection ratio >25:1 typical.
	CJ Temperature calibration error at 25°C: <± 2°C
	0°C, 45°C and 50°C external compensation available.

29.1.7 Digital Input Modules

Module type	Triple contact input, Triple logic input
Contact closure	Active <100ohms, inactive >28kohms
Logic inputs	Current sinking : active 10.8Vdc to 30Vdc at 2.5mA
	inactive -3 to 5Vdc at <-0.4mA

29.1.8 Digital Output Modules

Module types	Single relay, dual relay, single triac, dual triac, triple logic module (isolated)
Relay rating	2A, 264Vac resistive (100mA, 12V minimum)
Single Logic drive	12Vdc at 24mA
Triple logic drive	12V at 9mA per output
Triac rating	0.75A, 264Vac resistive

29.1.9 Analogue Output Modules

Module types	1 channel DC control, 1 channel DC retransmission (5 max.)
Range	0-20mA, 0-10Vdc
Resolution	1 part in 10,000 (2,000-noise free) 0.5% accurate for retransmission
	1 part in 10,000 2.5% accurate for control

29.1.10 Transmitter PSU

Transmitter	24Vdc at 20mA

29.1.11 Transducer PSU

Bridge voltage	Software selectable 5 or 10Vdc
Bridge resistance	300Ω to 15KΩ
Internal shunt resistor	30.1KΩ at 0.25%, used for calibration of 350Ω bridge at 80%

29.1.12 Potentiometer Input

Pot resistance	330Ω to 15KΩ, excitation of 0.5 volts

29.1.13 Digital communications

Allocation	2 modules fitted in slots H & J (isolated)
Modbus; EI-Bisynch	RS232, 2 wire or 4 wire RS485, max baud 19.2KB in H module & 9.6KB in J module
Profibus DP	High Speed, RS485, 1.5Mbaud (**Slot H only**)
Ethernet	
DeviceNet	Max baud rate 500KB

29.1.14 Master communications

Allocation	Slot J
Modbus	RS485 4-wire or RS232
Parameters	25 read/write

29.1.15 Alarms

No of Alarms	8 Analogue, 8 digital. Can be wired to any internal parameter
Alarm types	Full scale, deviation, sensor break plus application specific
Modes	Latching or non-latching, blocking, time delay

29.1.16 Control Functions

No of loops	One
Modes	On/off, PID, motorised valve with or without feedback
Cooling algorithms	Linear, water, oil or fan
PID sets	3 per loop
Manual mode	Bumpless transfer or forced manual output, manual tracking available
Setpoint rate limit	Display units per second, minute or hour

29.1.17 Setpoint Programmer

Programmer modes	Synchronous
Programmer types	Time to Target or Ramp Rate
No of programs	A maximum of 50 programs. Programs can be given user defined 16 character names
No of segments	200 segments total or 50 per program
Event outputs	Up to 8, can be assigned individually to segments or called as part of an event group

29.1.18 I/O Expander

10 I/O version	4 changeover relays, 6 normally open relay contacts, 10 logic inputs
20 I/O version	4 changeover relays, 16 normally open relay contacts, 20 logic inputs

29.1.19 Advanced Functions

Timers	4, On Pulse, Off delay, one shot and min-On
Totalisers	2, trigger level & reset input
Counters	2, up or down counters
Real time clock	Day of week and time
Application blocks	24 digital operations
	24 analogue operations
	2 eight input logic operators, 2 eight input analogue operators
	16 user values
	BCD input
	Customised input linearisations
	Mathematical Add, Subtract, Multiply, Divide, Constant, Absolute difference, Maximum, Minimum, Sample and Hold, Input 1 to the power of input 2, Square root, Log(10), Ln, 10 to the power of input 1, i.e. to the power of input 1
	Logical AND, OR, XOR, Latch, Equal, Not Equal, Greater than, Less than, Greater than or equal to, Less than or equal to.
	Humidity Wet and dry bulb technique
Software Tools	iTools Configuration Tool
	OPC Scope Trending and Data logging
	iClone Lite Lightweight configuration cloning
	Graphical Wiring Editor Drag and drop wiring tool, self-documenting
	View Builder Custom Animation Screens
	iTools Wizard Question and Answer configuration screens

29.1.20 General Specification

Supply	100 to 240Vac -15%, +10%. 48 to 62Hz. 20 watts max
Inrush Current	High Voltage controller – 30A duration 100µs
	Low Voltage controller – 15A duration 100µs
Operating ambient	0°C - 50°C (32°F to 131°F) and 5 to 95% RH non condensing
Storage temp	-10°C to +70°C (14°F to 158°F)
Panel sealing	IP65, plug in from front panel
Dimensions and weight	
3504	96H x 96W x 150D (mm)
3508	96H x 48W x 150D (mm)
Electromagnetic compatability	EN61326-1 Suitable for domestic, commercial and light industrial as well as heavy industrial environments. (Class B emissions, Industrial Environment immunity).
	With Ethernet module fitted product is only suitable for industrial environments, (class A emissions).
Safety standards	EN61010, installation category II (voltage transients must not exceed 2.5kV), pollution degree 2
Atmospheres	Not suitable for use above 2000m or in explosive or corrosive atmospheres

30. DECLARATION OF CONFORMITY

EUROTHERM invensys

Declaration of Conformity

Manufacturer's name:	**Eurotherm Limited**
Manufacturer's address:	**Faraday Close, Worthing, West Sussex, BN13 3PL, United Kingdom**
Product type:	**Process controller and programmer**
Models:	**3504 Status level A1 and above** **3508 Status level A1 and above**
Safety specification:	**EN61010-1**
EMC emissions specification:	**EN61326 Class B (Ethernet option: Class A)**
EMC immunity specification:	**EN61326 Industrial locations**

Eurotherm Limited hereby declares that the above products conform to the safety and EMC specifications listed. Eurotherm Limited further declares that the above products comply with the EMC Directive 89 / 336 / EEC amended by 93 / 68 / EEC, and also with the Low Voltage Directive 73 / 23 / EEC.

Signed: Dated: 5th August 2004

Signed for and on behalf of Eurotherm Limited
William Davis
(General Manager)

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CE

CE This indicator meets the European directives on safety and EMC

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