invensys

Eurotherm

2500

Engineering
Handbook
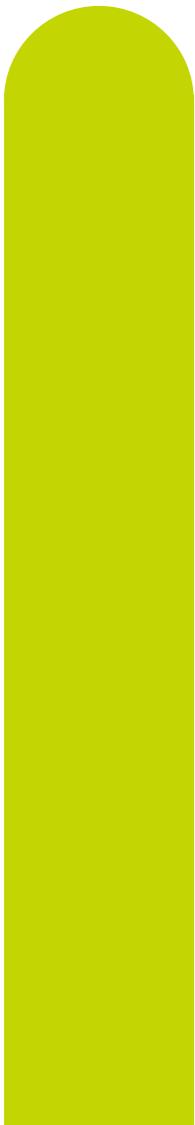
2500 Process Controller
Version 3.7 and version 4.3 (SYSIO)

HA027115/5
February 2014

Model 2500 DIN Rail Controller
Engineering Handbook
Contents

ISSUE STATUS OF THIS MANUAL

Issue 3.0 contains the following changes:-
Contents updated to include 2500 IOC note below
Chapter 2 updated to include Modbus and Profibus links
Chapter12 updated to include the parameter Unit ID Enable
Index added

2500 IOC – Version 3.7 and Version 4.3 (SYSIO) Software Upgrade Notification.

The above software versions introduce additional fault action and sensor break detection parameters for Analogue Inputs.

Existing Users

Caution should be exhibited when loading existing applications.
Carefully check Fault actions responses.

Issue 4.0 moves Safety and EMC Information to the beginning of the manual. Module specifications updated and moved to Appendix A . Re-format to A4 size.

Issue 5.0 amends AI2 and AI4 mA accuracy and noise specifications.

SAFETY and EMC INFORMATION

Please read this section carefully before installation

This controller is manufactured in the UK by Eurotherm Ltd.

It is intended for industrial temperature and process control applications when it will meet the requirements of the European Directives on Safety and EMC. Use in other applications, or failure to observe the installation instructions of this handbook may impair the safety or EMC protection provided by the controller. It is the responsibility of the installer to ensure the safety and EMC of any particular installation.

Safety

This controller complies with the European Low Voltage Directive 2006/95/EC, by the application of the safety standard EN 61010.

Electromagnetic compatibility

This controller conforms with the essential protection requirements of the EMC Directive 2004/108/EC, by the application of a Technical Construction File.

This instrument satisfies the general requirements of an industrial environment as described by EN 50081-2 and EN 50082-2. For more information on product compliance refer to the Technical Construction File.

Service and repair

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

Some module terminal units may contain fuses and must be replaced by the correct type of fuse. These are T type rated at 2 Amps to EN60127.

Electrostatic discharge precautions

When a module is removed from the base, any exposed electronic components are vulnerable to damage by electrostatic discharge from someone handling it . To avoid this, before handling the unplugged module discharge yourself to ground.

If removing a PCB from its sleeve, for example - to remove snubbers from the Relay Module, please use anti-static precautions.

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)   Functional earth (ground) terminal

Protective earth terminal

Personnel

Installation must only be carried out by qualified personnel.

Enclosure of live parts

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

Blank Terminal Unit

Bases are supplied to hold 4, 8 or 16 modules. In the event that a base is not fully populated a blank terminal unit, part number 026373, will be supplied with the system. It is important that this is fitted into the position immediately to the right of the last module in order to maintain IP20 rating. See Chapter 3 'Terminal Units' for installation details.

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.

Wiring

It is important to connect the controller in accordance with the wiring data given in this handbook. 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. This device should be in close proximity to the controller, within easy reach of the operator and marked as the disconnecting device for the instrument.

Earth leakage current

Due to RFI Filtering there may be an earth leakage current of up to 3.5mA. This may affect the design of an installation of multiple controllers protected by Residual Current Device, (RCD) or Ground Fault Detector, (GFD) type circuit breakers.

Overcurrent protection

It is recommended that the DC power supply to the system is fused appropriately to protect the cabling to the units. The 2500 provides a fuse on the IOC Terminal Unit to protect the supply from a fault within the 2500.

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

Voltage transients across the power supply connections, and between the power supply and ground, must not exceed 2.5kV. Where occasional voltage transients over 2.5kV are expected or measured, the power installation to both the instrument supply and load circuits should include a transient limiting device.

These units will typically include gas discharge tubes and metal oxide varistors that limit and control voltage transients on the supply line due to lightning strikes or inductive load switching. Devices are available in a range of energy ratings and should be selected to suit conditions at the installation.

Conductive pollution

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 in conditions of conductive pollution, fit 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.

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.

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.

Installation requirements for EMC

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

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

Routing of wires

To minimise the pick-up of electrical noise, the wiring for low voltage dc and particularly the sensor input 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.

Functional Insulation

This is defined as: Insulation between conductive parts that is necessary only for the proper functioning of the equipment. This does not necessarily provide protection against electric shock.

Reinforced Insulation

This is defined as: Insulation between conductive parts which provides protection against electric shock.

Additional EMC Protection on Profibus IOC

In environments where excessive noise levels are likely, it is recommended that a ferrite clamp is fitted around the Profibus cable. This has the effect of increasing the noise immunity from 2KV to 3.7KV.

A suitable ferrite clamp is Richo type MSFC -5T.

1. Chapter 1   INTRODUCTION

Thank you for selecting the 2500 DIN Rail Controller and Data Acquisition Unit. This chapter provides an overview of your controller.

1.1.   ABOUT THIS HANDBOOK

This handbook is intended for those who wish to configure and use the 2500 DIN Rail Controller and Data Acquisition Unit.

It may be used in conjunction with the following related handbooks:

Subject	Handbook Name	Part Number
Installation and hardware details of the 2500 DIN Rail Controller	2500 Installation and Wiring Handbook. (Supplied with the instrument)	HA026178
Description of configuration tool for 2000 series instruments	iTools User Handbook. (Supplied with iTools software)	HA026179
EMC and Wiring Practice	EMC Installation Guide	HA025464
Serial Communcations	2000 Communications Handbook	HA026230

In general chapters are presented in the order in which these 'folders' appear in iTools.

Chapter 1 provides an overview of the 2500 Unit.

Chapter 2 describes Modbus, Profibus, Devicenet and Ethernet versions of the Input Output Controller (IOC) modules.

Chapter 3 describes how the 2500 is configured using "iTools". iTools is a software package running on a personal computer under Windows 95, 98, 2000, ME, XP or NT(service pack 4 or later). It provides a 'view' into the controller and allows configuration, commissioning and if necessary operation. The general features of the iTools package are described in more detail in the User Handbook HA026179. As iTools is an essential partner for the 2500, this engineering manual makes frequent references to it.

The remaining chapters provide more information about all the functions available in the 2500, including details about how to configure each function, what the parameters mean and typical applications.

Appendix D is a Glossary of terms used in this manual

1.2.   SYMBOLS USED IN THIS MANUAL

Symbol	Meaning
(xx)	Numbers in ( ) are the enumerated values for a parameter
📖	Read only
✎	Write only
·9	Range set between high and low limits in engineering units
·%	Range set between high and low limits in %
🕐	Time units days, hours, minutes, seconds, ms
☺	Hint or useful information

1.2.1. File Paths

Parameters are located in lists. Each list is associated with a particular subject such as Alarms, Control, etc.

The following example shows how a parameter is located in a file path:

Control → LOOP01 → L01CFG → Ctrl

Where 'Ctrl' is the parameter (Control Type) found in the path 'Control' 'Loop number 1' 'Loop number 1 configuration list'.

1.3.   STATUS WORDS

Status Words group together commonly accessed parameters in convenient categories so that they may be read as a single transaction. An example may be alarm states as shown in section 5.10. The 'Global Alarm Status Word' from Table 5-7 is reproduced below. This is a bit map of 16 bits and the value shown in each table in this manual is a decimal number. For example if the value is 31 then the first four bits are set.

The example below shows how this may be calculated:-

In Hexadecimal 31 = 1F

| 1F = | 0001 1111 | Bits set |
| | 7654 3210 | Bit area |

This shows that bits 0 to 4 are set

Bit	Value (Decimal)	Set when:		Value (Hex)	Bit Field
0	1	Any channel - Sensor break detected		0	0000
1	2	Any channel - CJC failed		1	0001
2	4	Any channel - Channel not in use		2	0010
3	8	Any channel - Analogue output saturated		3	0011
4	16	Any channel - Initialising		4	0100
5	32	Any channel - Invalid Analogue Cal data		5	0101
6	64	Reserved for future use		6	0110
7	128	Any channel - Module fault		7	0111
8	256	Any Module is missing		8	1000
9	512	Any Wrong Module fitted		9	1001
10	1024	Any Unrecognised Module fitted		A	1010
11	2048	Any Module Comms Error		B	1011
12	4096	Reserved for future use		C	1100
13	8192	Reserved for future use		D	1101
14	16384	Reserved for future use		E	1110
15	32768	Reserved for future use		F	1111

Table 1-1: Global IO Status Word and Bit Field

1.4.   WHAT IS THE 2500?

The 2500 is a modular system which can provide multi-loop PID control, analogue and digital I/O, signal conditioning and computational blocks with a variety of plug-in modules.

I/O Control Module (IOC)
Always mounted in the left hand position.
This view shows the Modbus IOC

2500M Plug-in I/O Modules
Can be mounted in any order

Configuration port RS232

Address switch

Digital communications ports RS485/422

Optional Fuses or Isolator links

Plant and Process Connections

2500B Base
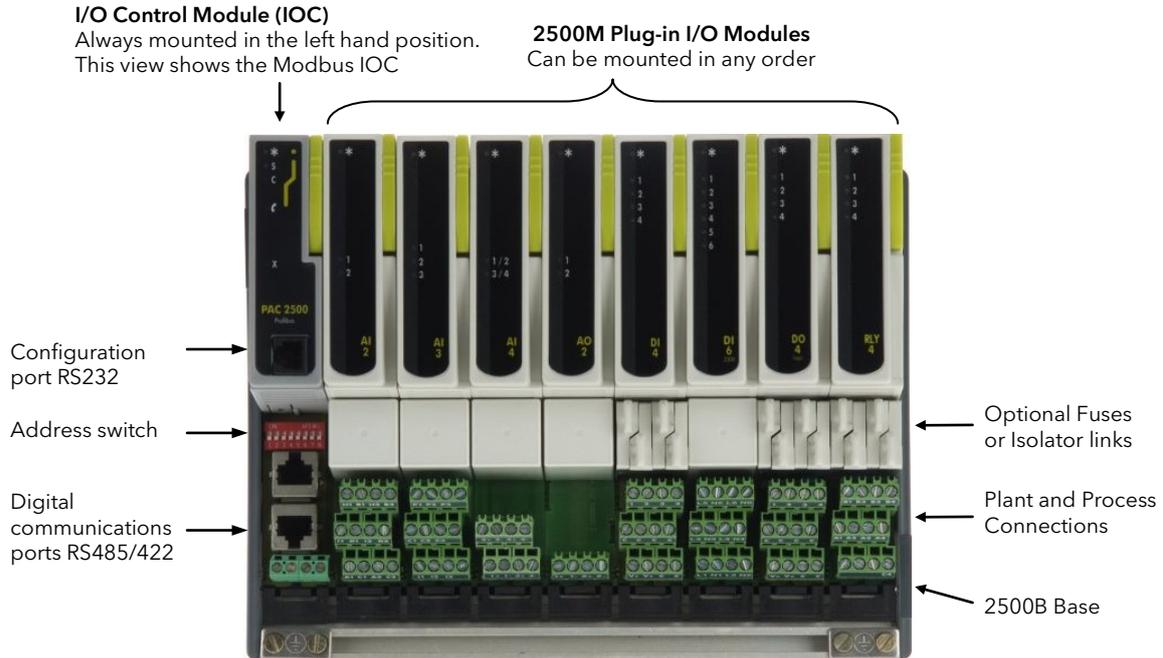
Figure 1-1:   General View of the 2500 DIN Rail Controller and I/O Unit

The base unit (2500B) can be provided in different sizes, with up to 16 I/O modules. The base can be mounted on DIN rail (35mm top-hat), or just bolted to a wall.

Terminal Units (2500T) clip into the base, providing customer connections to and from the plant devices and interconnections between modules and the Input Output Control module (IOC). Terminal units are specific to particular modules as defined in the order code, Appendix B.

I/O Modules (2500M) clip into the Terminal Units. These modules are dedicated to specific functions - analogue or digital, input or output. The IOC module (2500E or 2500C) contains the configuration for the system and communications support. Three communications versions are available for Modbus, Profibus or Devicenet.

The system requires 24Vd.c. at an average of 100mA per module. A suitable power supply is 2500P available in 2.5, 5 or 10 amp versions.

1.5.   WHAT DOES THE 2500 DO?

The 2500 system functions around a database core. In this database all important system numbers and values are stored as parameters at specific addresses. Examples are measured voltages, PVs, status words, channel settings, limits, PID loop values.

This database is updated regularly every 110ms (nominal). At each update input channel values are recorded and output channel signals are set. All computational blocks - PID loops, Toolkit blocks, user wiring and so on are also calculated and updated on each 110ms tick.

Network communications is implemented as a gateway to the database. Any network transaction driven by an external master effectively reads and writes to database parameters. The only difference is that the network updates are asynchronous - the transaction rate is set by the master.

There are two key aspects to the use of the 2500:-

1.   the set-up or configuration of the system to implement the desired control strategy;
2.   the run-time execution of that strategy.

This handbook concentrates on configuration aspects as being a convenient way to explore the considerable number of features available in the 2500 system.

1.6.   THE COMPONENTS OF THE 2500

The 2500 is normally supplied as a number of separate parts, identified by a unique model code printed on labels on the packaging and on each item. These codes are explained in Appendix B.

The parts can be briefly classified as follows:

the Base -	"2500B"
the I/O Controller Module -	"2500E" (or the superseded "2500C")
the I/O Modules -	"2500M"
the Terminal Units -	"2500T"
the 24V Power Supply -	"2500P" mounted separately from the 2500 base
Accessories -	"2500A" (e.g. cables and terminators)

The electrical interconnection of these parts is shown in the block diagram below. The Base unit contains a PCB linking the modules together - the I/O Bus.
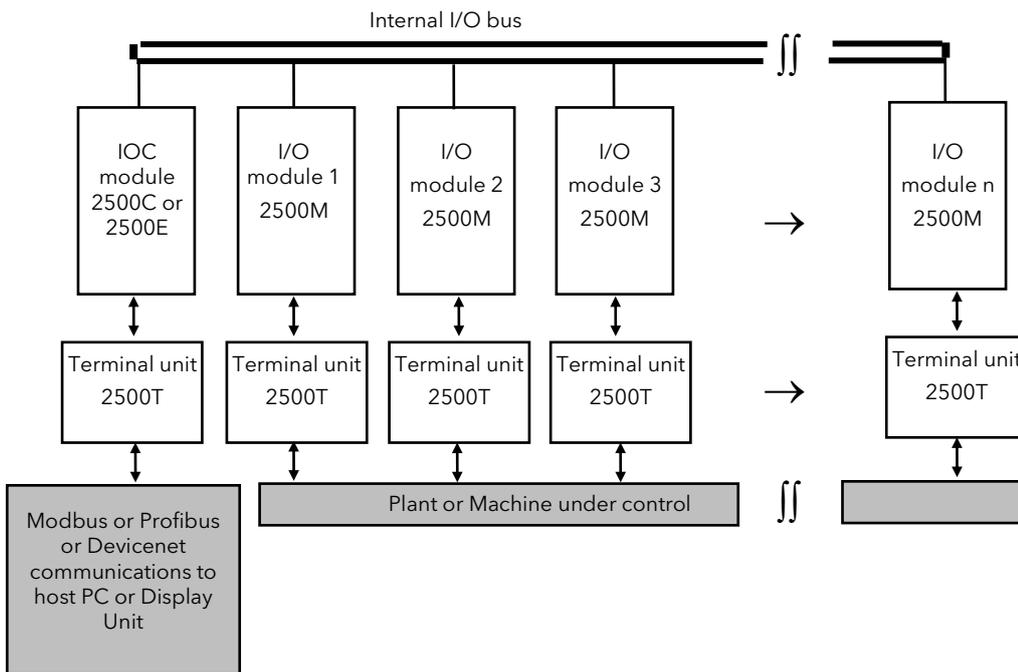
Figure 1-2:   2500 Block Diagram

1.7.   UNPACKING THE INSTRUMENT

The instrument is despatched in a special pack, designed to give adequate protection during transit. Should the outer box show signs of damage, it should be opened immediately, and the contents examined. If there is evidence of damage, the instrument should not be operated and the local representative contacted for instructions. After the instrument has been removed from its packing, the packing should be examined to ensure that all accessories and documentation have been removed. The packing should then be stored against future transport requirements.

1.8.   MECHANICAL INSTALLATION

The 2500 base unit is intended to be mounted in an enclosure, or in an environment suitable for IP20 rated equipment. It can be DIN or bulkhead mounted. When mounted on DIN rail it is locked with the clamps at each end. The unit can be mounted in any orientation, but it is normal to refer to the I/O Bus PCB as the top, as in Figure 1-3 below.
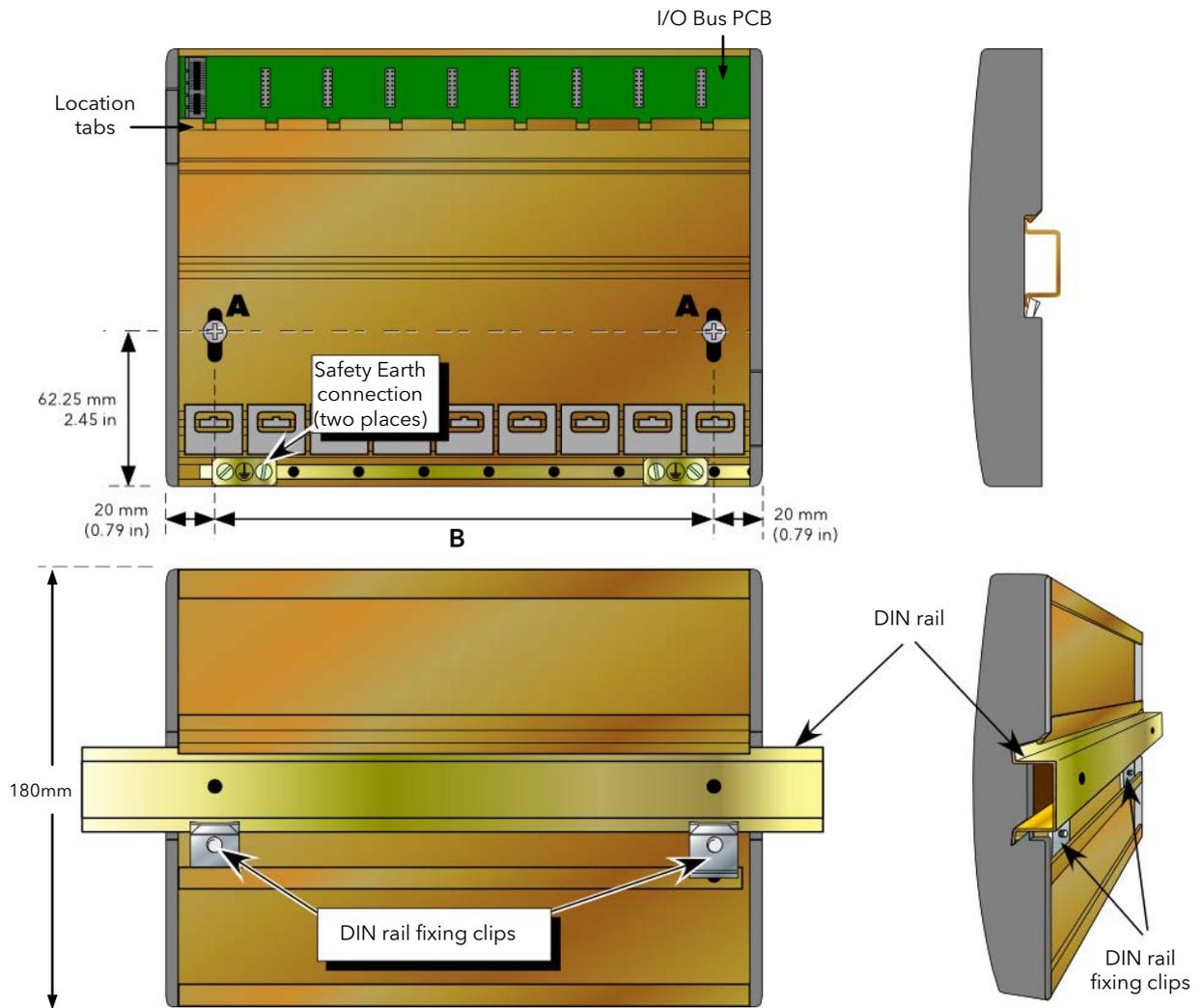
Figure 1-3: The 2500 Base and Terminal Units

Warning

The equipment should not be operated without a protective earth conductor connected to one of the earth terminals on the base unit. The earth cable should have at least the current rating of the largest power cable used to connect the instrument. The protective earth cable should be terminated with a suitable tinned copper eyelet, retained by one of the screw and washer supplied with the base unit, tightened to a torque of 1.2Nm (10.5lbin). This connection also provides a ground for EMC purposes.

Dimension B

2 module	46 mm
4 module	96 mm
8 module:	200 mm
10 module:	249 mm
12 module	300 mm
16 module	402 mm

1.8.1. DIN Rail Mounting

For DIN rail mounting, symmetrical, horizontally-mounted 35x7.5 or 35x15 DIN rail to BS EN50022 should be used.

1. Mount the DIN rail, using suitable bolts, ensuring that it makes good electrical contact with the enclosure metal work either via the bolts or by means of a suitable earthing cable.
2. Loosen the screws ('A' in Figure 1-3) in the base unit, two or three turns, and allow them, and the associated fixing clips to slide to the bottom of the screw slot.
3. Lower the base unit onto the DIN rail such that the top edge of the rail fits into the slot on the underside of the support bar (see Figure 1-3)
4. Slide the screws 'A' and associated clips as far as they will go towards the top of the screw slots, ensuring that the top of each fixing clip locates behind the bottom edge of the DIN rail.
5. Tighten the screws, and check that the base unit is fully secure on the rail.

1.8.2. Panel Mounting

Warning

Bolts heads must not exceed 5mm in height, or there will be insufficient isolation clearance between the bolt head and the relevant terminal unit(s).

1. Remove the screws ('A' in Figure 1-3) and associated fixing clips.
2. Holding the base unit horizontally on the panel, mark the position of the two holes on the panel
3. Drill two suitable holes in the panel and use two suitable bolts (M5 recommended) to secure the base unit to the panel, ensuring that good electrical contact with the enclosure metal work is made either via the bolts or by means of a suitable earthing cable.

1.8.3. Terminal Unit Installation

1. Isolate the supply power to the instrument
2. Insert the tag at the top of the terminal unit printed circuit board into the relevant slot in the Base Unit (action 'B' in Figure 1-4.)
3. Press on the bottom of the terminal unit until a 'click' confirms that the retention clip has sprung back into position to secure the terminal unit (action 'C').

Note: If the Base Unit is not fully populated a blank Terminal Unit (supplied) must be fitted immediately to the right of the final module position in order to maintain IP20 rating.

1.8.4. Terminal Unit Removal

1. Remove any module fitted on the terminal unit (section 1.8.6 below)
4. If necessary remove all wiring from the terminal unit
5. Press the retention clip at the bottom of the terminal unit and lift the terminal unit out (action 'D').
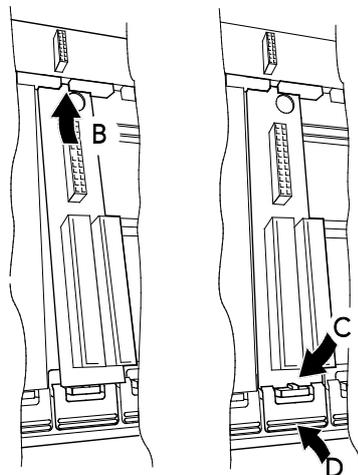
Figure 1-4:   Terminal Unit installation/removal

1.8.5. To Fit a Module

Note: Polarising keys prevent modules from being fitted to unsuitable terminal units.

1. Pull the module retaining lever forwards into the unlocked position as shown in Figure 1-5.
2. Offer the module up to the terminal unit and the backplane, and push home.
3. Return the retaining lever to the locked position.

1.8.6. Module Removal

1. Pull the module retaining lever forwards into the unlocked position as shown in Figure 1-5.
2. Disengage the module from the backplane connector and lift the module out of the base unit.
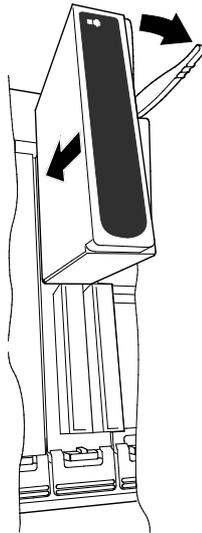
Figure 1-5: I/O Module (Side View)

1.9.   I/O MODULE FUNCTIONS

The 2500 system provides I/O modules designed to accept wiring directly from common control plant transducers , such as thermocouples, transmitters, valve positioners. The I/O modules provide the basic hardware interface. Software features adapt this interface for different ranges or functions, and add signal processing capability. The following is a summary of the hardware interface capability:-

Analogue input modules provide:-	• 150mVd.c. range at high impedance • 10Vd.c. range through a medium impedance attenuator • 2V high-impedance range is provided for Zirconia probe applications • 4-20mA range is supported with appropriate terminal units • Linearised 3-Wire resistance measurement • Potentiometer input • Linearised thermocouple measurement. The TC terminal units support a cold junction temperature sensor for thermocouple applications for automatic CJC
Analogue output modules support:-	• 4-20mA • 0-10Vd.c. ranges, switched by software.
Digital input modules accept:-	• Industrial logic levels (24Vd.c.) • Line supply (115Va.c. or 230Va.c.), • Switch contact inputs. Debounce and event detect is included.
Digital output modules provide:-	• Switched outputs for 24Vd.c. applications at up to 100mA. • Channels can be configured for time proportioning on/off and valve position algorithms.
Relay modules provide:-	• Contacts outputs for power applications to 2A at 240Va.c. • Channels can be configured as digital output modules

2. Chapter 2   The IOC Module

2.1.   OVERVIEW

The Input / Output Controller module (IOC) is the central processing unit of the 2500 system.

The IOC maintains a database of all system parameters, updated on a regular tick interval for consistent control loop behaviour.

Parameters are at fixed published addresses, so any subset of parameters can be easily accessed through network communications.

Each parameter has attributes by design - visibility, alterability and volatility. This last means that critical information (like the configuration) is preserved even after power-down.

Figure 2-1:   The IOC

All I/O modules are controlled by the IOC as a background task. The IOC:-

- verifies I/O module types fitted against the configuration specified
- initialises and tests modules at start-up and with hot-swap
- sets the hardware to ranges appropriate against the configuration
- sets module electrical outputs or reads inputs on a regular tick
- maintains a set of alarms to track faults and exceptions

Complex strategies can be built up from calculation blocks and tools, operating on the raw input and output data connected together with user defined software "wires":

- Up to 8 PID control blocks provide instant sophisticated control loops
- "Toolkit Block" functions provide user-wireable software components like timers, totalisers and counters
- Alarms provide limit control and easy exception handling

The IOC supports several communications interfaces for configuration and large networked systems, SCADA packages, T940 and the Visual Supervisor, PLCs and so on:

- an RS232 interface using an RJ11 connector is used for system configuration
- Modbus 3-wire or 5-wire communications
- Profibus DP or Profibus DPv1 communications
- *DeviceNet* communications

The last three each require a dedicated version of the IOC and Terminal Unit; the "Configuration Port" is standard on all IOCs.

2.2.   OPERATING MODES

The IOC offers several operating modes:-

▪ The 'Run' mode provides the normal execution of the I/O and control strategy.

▪ The 'Config' mode unlocks system parameters for configuration or re-configuration, while inhibiting the output modules.

▪ The 'Standby' mode is a transition mode normally inserted by the IOC when changing from one mode to another.

▪ The 'Fail' mode is drastic, invoked only if the IOC detects a hardware problem

⚠️ Note:- The IOC contains an applications specific program - the 'control strategy'. Obviously accidental change to a strategy could adversely affect the controlled plant, even introducing risk of hazard.

To avoid risk the IOC 'Config' mode forces I/O module outputs to a electrical low levels. While it is possible to change some parameters in 'Run' mode; any such change must be implemented only with the utmost caution.

Similarly when changing an IOC there is a risk of accident - for example, the new IOC could have an inappropriate strategy configured for the specific application. Before changing one IOC for another ensure that the new module contains the correct strategy.

A 'Configuration Key', order code 2500A/CFGKEY, is available which should be plugged into the RJ11 socket before the IOC is powered up (see also section 2.2.3.). With this in place the IOC will start up in the safer 'Config' mode. **This plug must be removed from the IOC after power-up.** The IOC will stay in the 'Config' mode after the plug is removed, and the strategy can be verified in any way appropriate. The 'Run' mode can then be set by the network master by writing to the Requested Instrument Mode parameter.

2.2.1. Run Mode

The operating mode or 'Run' mode is the normal machine state. In 'Run' mode the green indicator LED marked "★" is illuminated, the 'C' and 'S' LEDs extinguished..

Control loops, toolkit blocks, wires, alarms, input and output blocks are all executed and the parameters in the database updated. Appropriate parameters (for example, output channel PVs) can be modified over network communications.

Parameters associated with the design of the strategy are locked; for example, soft wires cannot be modified; channel types cannot be changed; calibration values cannot be modified.

Software versions from 3.26 permit limited on-line reconfiguration of many 'Config' parameters to allow fine-tuning of a strategy design. This does not include critical control loop parameters. This state is protected with a special parameter for 'Live Configuration', 'LveCnf' in the Operator/System list.

⚠️ **Due care should be taken when changing the value of 'LveCnf'; it should NOT be left enabled.**

2.2.2. Configuration Mode

'Configuration' or 'Config' mode is intended for control strategy design, set-up and test. For this reason this mode permits complete alteration of blocks and wires. Configuration is easily performed from iTools from the 'Config' port or the Modbus network communications port. When in 'Config' mode the yellow indicator LED 'C' is illuminated.

Configuration mode can be entered by:-

▪ powering up with the 'Config' lead connected to a PC

▪ toggling the iTools access level icon

▪ setting the 'Instrument Mode' parameter to 2 with iTools

▪ any means over the network communications port

If the IOC has been put into configuration mode it will stay in 'config' even through power-cycle until it is explicitly set into operating mode.

In 'Config' mode digital outputs are disabled (logic 0 output), analogue outputs drive the level defined by the electrical low limit (IOL).

2.2.3. Configuration Key

The configuration key ensures that the IOC powers up in configuration mode. The key is fitted into the configuration port of the IOC and has the same effect as powering up the IOC with the config lead connected to a PC, see section 2.2.2.

It is recommended that the key is fitted, for example, when a new or spare IOC with unknown configuration program is used to replace another IOC in an on line system.

Figure 2-2:   Configuration Key Shown Fitted

2.2.4. Standby Mode

The 'Standby' mode is a transition mode normally invoked by the IOC when changing between Run and Config at start-up. A yellow LED 'S' on the front of the IOC is illuminated in 'Standby' mode.

This mode inhibits changes to parameters and forces output modules to electrical low levels.

This mode would not normally be required by users.

2.2.5. Fail Mode

'Fail' mode is only entered when the IOC detects a hardware fault during normal operation. This state is consequently rare. The red LED 'X' on the front of the IOC will blink rapidly in the 'Fail' mode.

On software versions V3.30 or V4.00 or higher the user can save the strategy as a clone file; the system can only be recovered by forcing a cold-start. This is a return-to-factory repair.

2.3.   CONFIGURATION PORT

The IOC configuration port ('Config' port) is provided on the front face of the IOC. This RJ11 socket supports EIA232 with a fixed 9600 baud rate, no parity, 8 bit data and 1 stop bit for extremely simple and reliable connection to a PC. Any PC based software supporting Modbus can thus communicate with the 2500 system - including the iTools package. A suitable interconnection cable is available, part 2500A/CABLE/CONFIG/RJ11/(PINDF/3M0.

Pin connections RJ11 into IOC	Pin connections 9 way D-type to PC
6 (no connection)	
5 (RX)	3 (TX)
4 (TX)	2 (RX)
3 (0V)	5 (0V)
2 (no connection)	
1 (24V (in))	
(Screen)	(Screen)

Table 2-1:   Connections for IOC to PC Link
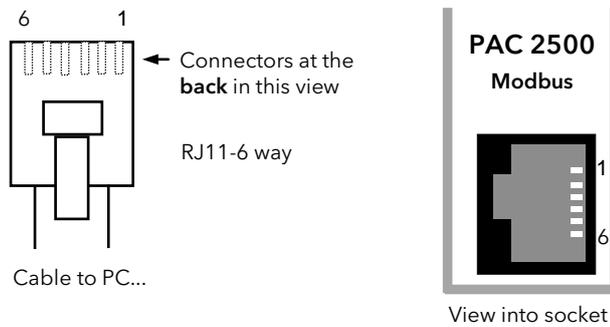
Figure 2-3:   RJ11 Configuration Pin Identification

When the IOC is powered up with a PC connected to the RJ11 configuration port, it will start in the 'Config' mode. The port always uses network address 255, overriding any address switch setting. When the 'Config' lead is in use the Terminal Unit network connections are disabled, whether Profibus, Modbus or DeviceNet. A plastic cover is supplied which must be fitted when the IOC is in normal operation.

2.4.   STATUS INDICATION

Five LED indicators show the status of an IOC module as follows:

LED	Colour	ON	ALL OFF
✶ S C	Green Yellow Yellow	Normal operation Standby (See Note 1) Configuration	Self test failed on power up
✶&C both on	As above	Normal operation with online IO reconfiguration enabled	Self test failed on power up

LED	Colour	ON	OFF
⌒	Yellow	IO network or configuration port communicating	

LED	Colour	ON (See also Note 1)	OFF
X	Red	1. Non-volatile RAM checksum failure 2. Custom linearisation checksum failure 3. I/O network watchdog (if configured) 4. Invalid base size detected 5. Module missing, faulty or wrong type	Normal operation

		Flashing	
X	Red	Power on self test failed	Refer to section 2.5
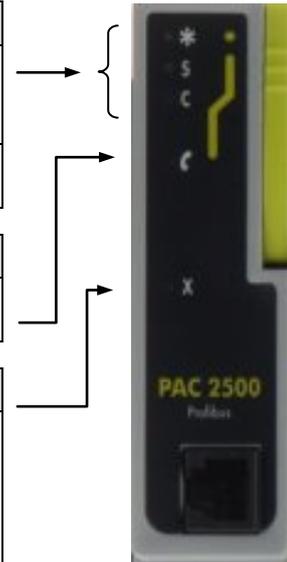
Figure 2-4:   IOC Status Indication

The *DeviceNet* health indicator is not shown; this lights red if the network side is unpowered or non-functional.

Note 1:

1. Non-volatile RAM checksum failure.

    Identified by the Non-Volatile Memory Failure Flag in Operator → SYSTEM → NVFail.

2. Custom linearisation checksum failure.

    Identified by Custom Linearisation Failure Flag in Operator → SYSTEM → ClinFl.

    Either condition 1 or 2 above will cause the red LED to flash and the system to go into fail safe mode.

3. I/O network watchdog.

    Identified by Custom I/O Network Watchdog Flag in Operator → SYSTEM → NWdged and indicates that network communication has not occurred for longer than the watchdog duration. The watchdog may be configured to recover automatically. This will clear the Nwdged flag when communications are restored. The flag can be cleared by writing 0 to the IO Network Watchdog Timeout Flag found in Operator → SYSTEM → IONwdg.

4. Invalid base size detected.

    Indicated by any value other than 0, 2, 4, 8, 10, 12 or 16 in the Base Size parameter found in Operator → SYSTEM → BaseSz. This indicates genuine hardware fault as the IOC does not recognise the hardware base size code being read from the backplane.

5. Any IO (channel or module) status bit set except the channel not used bit (bit 2 of the channel status).

    Indicated by the Global IO Status parameter found in Operator → SYSTEM → Iostat. The Global IO Status is an OR of all the module status parameters (found in IO → Module xx → MODxx → ModSta) in the most significant byte, and an OR of all the channel status parameters (found in IO → Modulexx → Mxx_Cy → ChStat) in the least significant byte.

    To clear this fault all modules and channels should be indicating no fault. For analogue inputs this may require a link on any unused input or configuring them as V to remove any spurious sensor break indications.

2.5. INITIALISATION AND POWER ON SELF TEST

The IOC goes through an initialisation sequence when power is applied, and will start in either 'Run' mode or 'Config' mode. The tests illuminate the indicators in a specific pattern.

Figure 2-5: LED Indication During Start Up

2.6.   MODBUS IOC AND TERMINAL UNIT

The Modbus IOC is identified by the front label and the order code printed on the side label. This IOC must be used with the Modbus Terminal Unit.

LED Status Indicators →

Configuration Port (RS232) →

→ I/O Module interconnection bus

→ Module connector

→ RS485/422 Links *

→ Address Switch

→ Digital Communications Ports RS485

→ 24V power supply terminals

+24V   0V
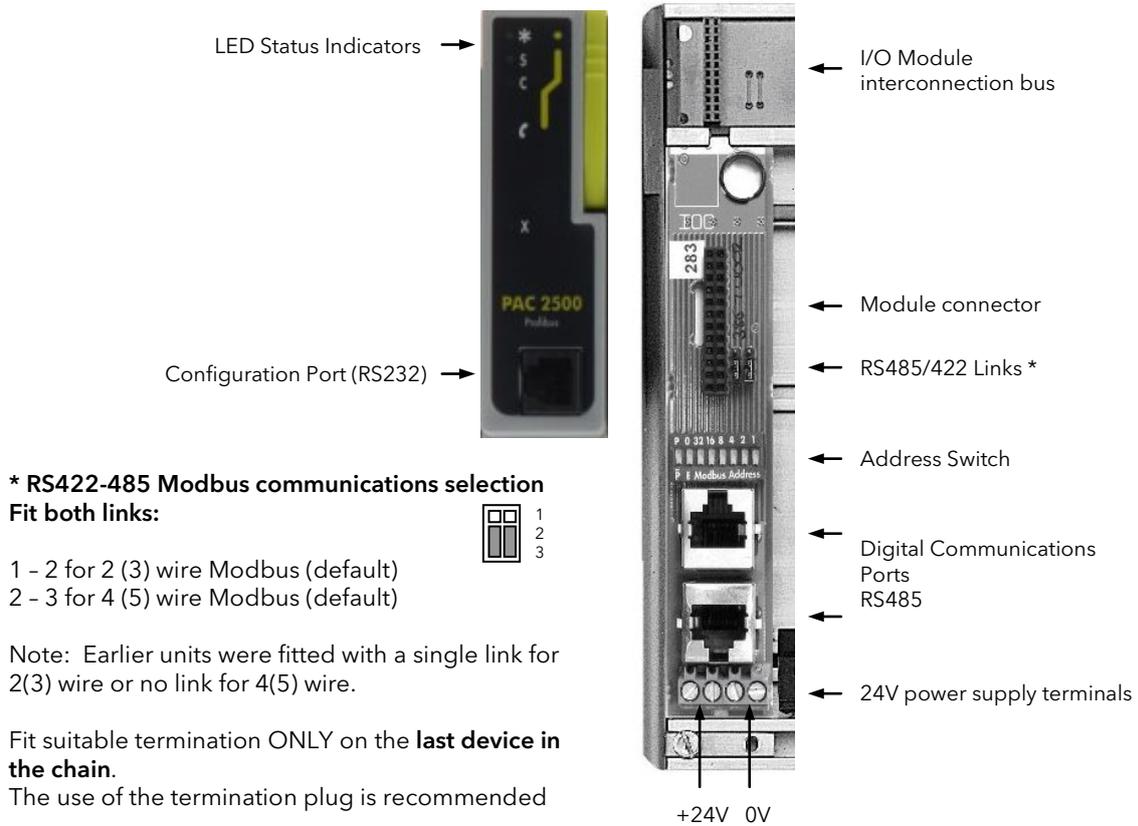
*** RS422-485 Modbus communications selection
Fit both links:**

1 – 2 for 2 (3) wire Modbus (default)
2 – 3 for 4 (5) wire Modbus (default)

1
2
3

Note: Earlier units were fitted with a single link for 2(3) wire or no link for 4(5) wire.

Fit suitable termination ONLY on the **last device in the chain**.
The use of the termination plug is recommended

Figure 2-6: Modbus IOC Module and Terminal Unit

The Modbus network connection and the 2500 system power connections are provided by the Terminal Unit; the latter with standard screw terminals, the former with RJ45 sockets.

The network connection is used for connection to an operator interface unit, a PC running iTools or 3rd party system, or to link further slave 2500 controllers or other Modbus equipment in a system.

The IOC can also be configured from the Modbus network if required.

2.6.1. Connections to the RJ45 Sockets

The two RJ45 sockets are parallel connected for network daisy-chaining, with the connections:

RJ45 pin	Colour	EIA-485	2 wire	4 wire
1	Orange / White	B	D-	TX-
2	Orange	A	D+	TX+
3	Green / White	Gnd	Gnd	Gnd
4	Blue	-	-	-
5	Blue / White	-	-	-
6	Green	Gnd	Gnd	Gnd
7	Brown / White	B	-	RX-
8	Brown	A	-	RX+
Screen	-	-	-	-

NOTE: Blue and Blue/White Wires are not used.

⚠ **CABLE COLOURS MAY CHANGE!**

Table 2-2: RJ45 Modbus Connections

Plastic covers are supplied which must be fitted when the system is in normal operation.

2.6.2. The RJ45 Modbus Line Terminator

All network communications lines must be terminated using appropriate impedance. To provide correct resistor values for CAT-5 cable and to match the RJ45 wiring the terminator order code 2500A/TERM/MODBUS/RJ45 should be used. This can be plugged into the free socket in the last 2500 base in the chain; it is presumed that the other end of the cable (usually at the network master) is likewise terminated.
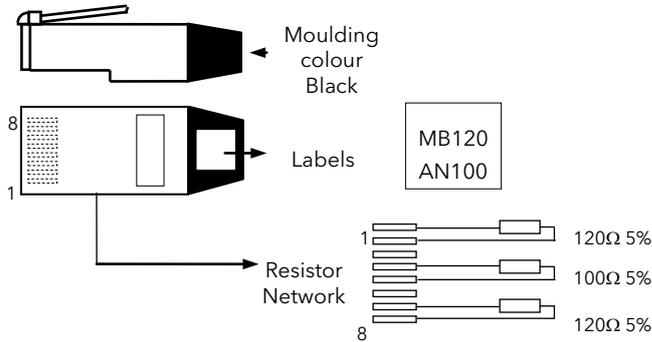
Figure 2-7:   Modbus IOC Module and Terminal Unit

2.6.3. The Modbus Address Switch

The base must be given a unique Modbus address when working in a Modbus network. The address can be set by switch, an 8-way DIP type mounted on the Terminal Unit. It allows addresses 1 to 63 to be set in a binary code with the right-most six switches, lsb to the right. The left two switches define parity (on/off, odd or even).

P   Parity On
P   Parity off
O   Odd Parity
E   Even Parity
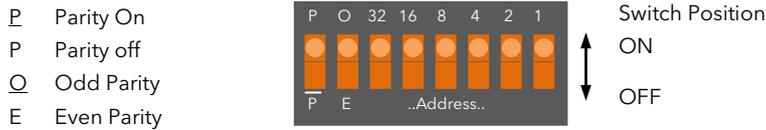
Figure 2-8:   The Modbus Address Switch

If the Address switch is set to 0 the IOC will use the software defined address in the parameter 'Addr'. This can be used for base addresses from 64 to 247.

2.6.4. Baud Rate

Baud rate is set using iTools. The default is 9600. The table below shows the rates that are supported in different software versions:

	Software version		
Baud rate	V1.XX	V2.XX	V3.26+
2400			✓
4800			✓
9600	✓	✓	✓
19,200	✓	✓	✓
38,400			✓

Table 2-3:   Baud Rates

2.7.   PROFIBUS IOC AND TERMINAL UNIT

The Profibus IOC is identified by the front label and the order code printed on the side label. This IOC must be used with a Profibus Terminal Unit. There are two TU options: a standard, a 9-Way D-Type and a dual RJ45 type as shown in Figure 2-9. The latter is similar to the Modbus terminal unit (Figure 2-6), but must not be confused; the Modbus unit includes capacitors that could affect high-speed data.

The IOC may be ordered for Profibus DP or Profibus DPv1. Note that for software versions later than v3.43 (and v4.10) DP/DPv1 may be configured within the IOC (see section 6.2.1).

LED Status Indicators

Configuration Port (RS232)

Module connector

* Termination Links

Address Switch

9-way D-Type Communications Connector

RJ45 Communications Connectors

24V power supply terminals

+24V   0V

+24V   0V
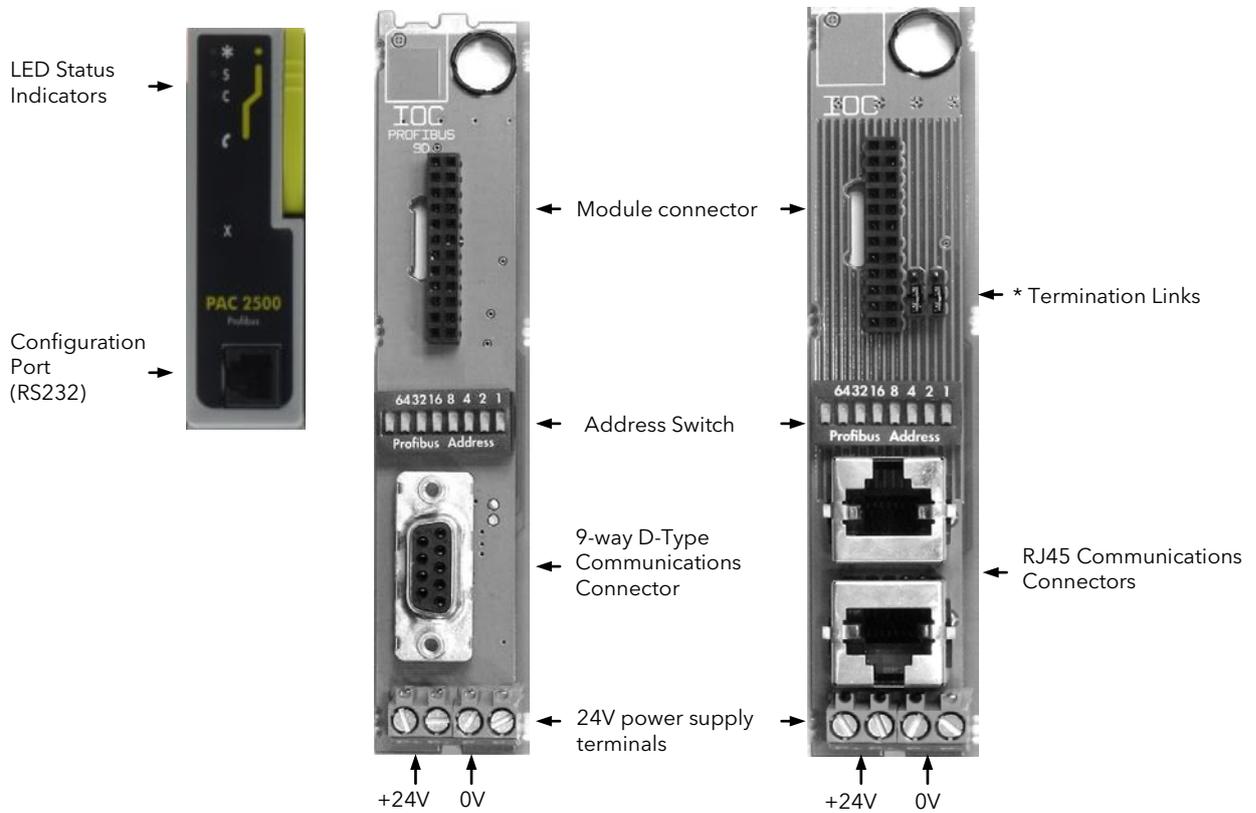
* Termination Links

Fit both links:

1
2
3

1 – 2 to terminate the Profibus network

2 – 3 no termination

Fit suitable termination ONLY on the **last device in the chain.**

Note: Earlier units were fitted with a single link. On these units this link has no function and the system should be terminated using the termination plug

On later units fit either the termination unit or both links in position 1 and 2.

Figure 2-9: ProfiBus IOC and Terminal Unit

2.7.1. Connections to the Network Connectors

The 9 pin D-Type connector is intended for installations using standard Profibus cables:

Pin No.	Signal Name	Meaning
1	Shield	Shield (ground)
2		Not used
3	RxD/TxD-P	Receive/Transmit – Data 'P'
4		Not used
5	DGND	Data ground
6	VP	Voltage – Plus
7		Not used
8	RxD/TxD-N	Receive/Transmit – Data 'N'
9		Not used

Table 2-4:   Profibus 9-pin D-TypeConnections

The two RJ45 sockets are parallel connected for network daisy-chaining, with the connections:

RJ45 pin	Colour	Signal
1	Orange / White	Data 'N'
2	Orange	Data 'P'
3	Green / White	Gnd
4	Blue	-
5	Blue / White	-
6	Green	+5V
7	Brown / White	-
8	Brown	-

⚠ **CABLE COLOURS MAY CHANGE!**

Table 2-5:   RJ45 Profibus Connections

2.7.2. The Profibus Address Switch

The address switch is mounted on the IOC terminal unit. Addresses from 1 to 127 can be set.
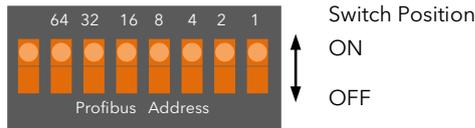
Figure 2-10:   The Profibus Address Switch

2.7.3. Profibus 9 pin Connector Line Termination

For 9-pin connectors standard Profibus cables should be used. These cables have special headers on the 9-pin D male connector which allow one or two cables to be connected inot them and have a small termination load built in with an ON'OFF switch, which is set to ON at the two ends of the links.

The Profibus standard states that two types of cable, 'Line A' and 'Line B' may be used. The termination details for these two types of cable are shown below.
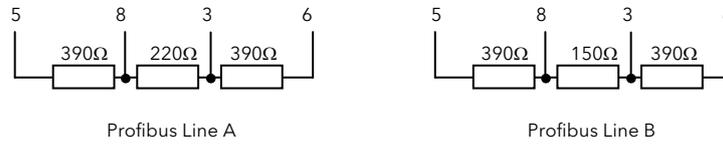
Figure 2-11: The Profibus 9-pin Connector Terminations

2.7.4. The RJ45 Profibus Line Terminator

The 9-way connector is not provided with terminators; termination is the responsibility of the network designer.

The RJ45 connector system can be used for local installations for ease of wiring. This requires special termination impedance (nominal 100Ω). This method of cabling is limited to 16 slaves and must not be directly connected to a "standard" Profibus cable.

The terminator part number 2500A/TERM/PROFIBUS/RJ45 is designed for this application. Network wiring and termination techniques are indicated in chapter 10.

Figure 2-12: The Profibus RJ45 Terminator

2.8.   DEVICENET IOC AND TERMINAL UNIT

The DeviceNet IOC is identified by the front label and the order code printed on the side label. This IOC must be used with the DeviceNet Terminal Unit.
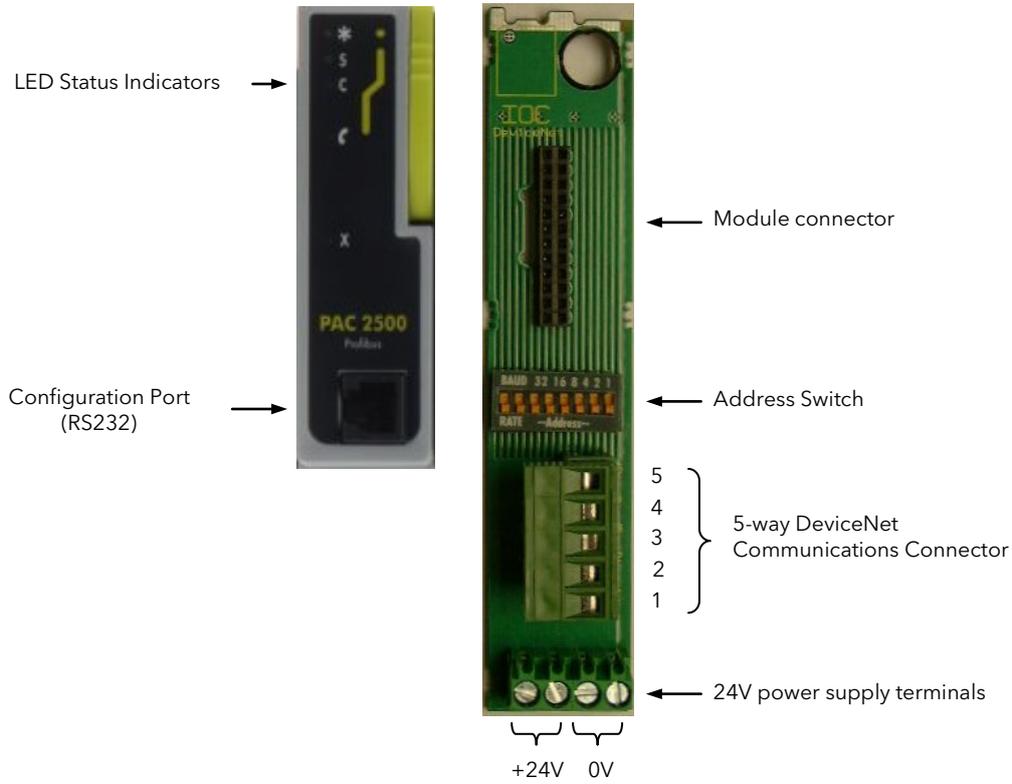
Figure 2-13:   DeviceNet IOC and Terminal Unit

2.8.1. Connections to the Terminal Unit

The DeviceNet Connector is selected to comply with the DeviceNet Open Connector specification (5-way, 5.08mm pitch).

The mating DeviceNet connector (female Open Connector) is supplied to facilitate screw-in user wiring. The pin functions are marked on the TU.

Pin Number	Function
1	V+
2	CAN_H
3	DRAIN
4	CAN_L
5	V-

Table 2-6:   5-Way Connector Pin Functions

2.8.2. DeviceNet Terminators

The DeviceNet specification states that the bus terminators should not be included as any part of a master or slave. They are not supplied as part of the 2500 DeviceNet termination assembly.

2.8.3. Power

The DeviceNet bus is powered form the system, the load being around 100mA.

2.8.4. The DeviceNet Address Switch

The address switch is mounted on the DeviceNet IOC terminal unit. Addresses from 0 to 63 can be set. The leftmost two switches may be used to set the DeviceNet baud rate and also to disable the switches, allowing the baud rate and address to be set by iTools.

Sw   Baud rate
0 0   125K
0 1   250K
1 0   500K
1 1   Baud and address set
         by iTools

BAUD 32 16 8 4 2 1   Switch Position

RATE   ..Address..   ON (1)
                                   OFF (0)

Figure 2-14:   DeviceNet Address Switch

2.9.   ETHERNET IOC AND TERMINAL UNIT

The Ethernet IOC is identified by the front label and the order code printed on the side label. This IOC must be used with the Ethernet Terminal Unit.

LED Status Indicators

Configuration Port (RS232)

Module connector

Address Switch

24V power supply terminals

+24V   0V
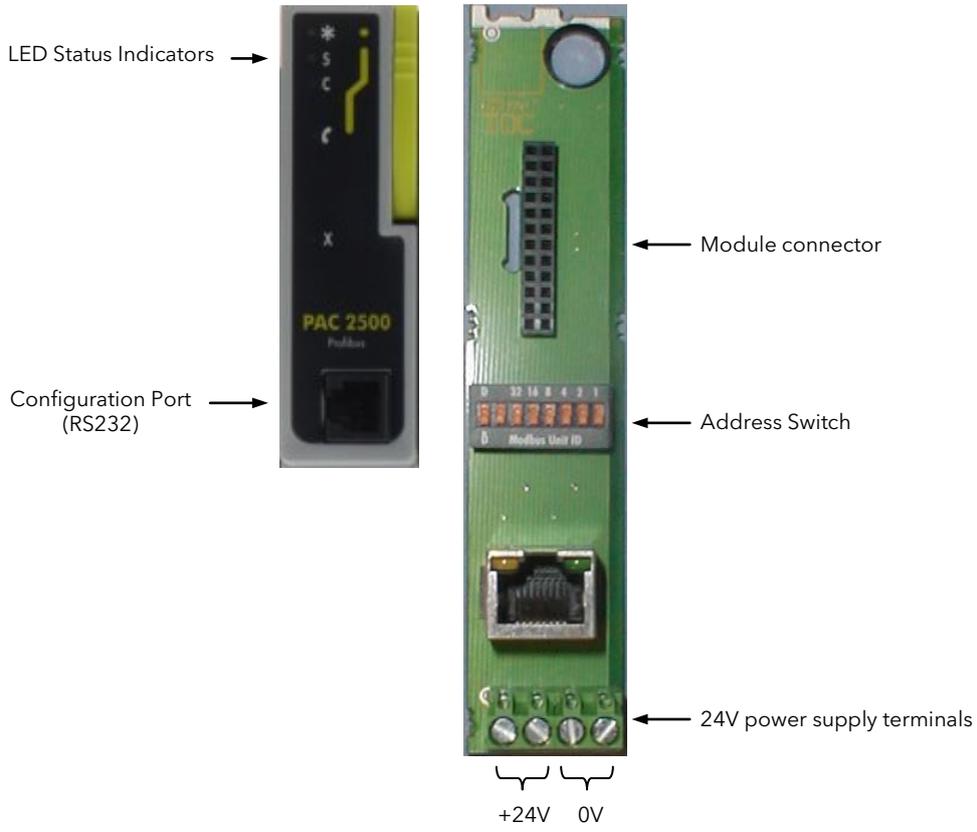
Figure 2-15:   Ethernet IOC and Terminal Unit

The Ethernet IOC supports 10BaseT to IEEE802.3 and uses the Modbus TCP protocol.

2.9.1. Connections to the RJ45 Socket

The RJ45 socket is connected according to the Ethernet standard.

RJ45 pin	Colour	Signal
1	Orange / White	TX+
2	Orange	TX-
3	Green / White	RX+
4	Blue	-
5	Blue / White	-
6	Green	RX-
7	Brown / White	-
8	Brown	-

⚠ **CABLE COLOURS MAY CHANGE!**

Table 2-7: RJ45 Ethernet Connections

2.9.2. The Modbus Address Switch

The address (Modbus TCP slave i.d.) switch is mounted on the Ethernet IOC terminal unit. Addresses from 1 to 63 can be set on the rightmost 6 switches. The leftmost switch may be used to enable DHCP Ethernet addressing.

If all switches are off, the Modbus address and DHCP enable will be determined by the value seen in the iTools Operator.COMMS list – see section 6.2.
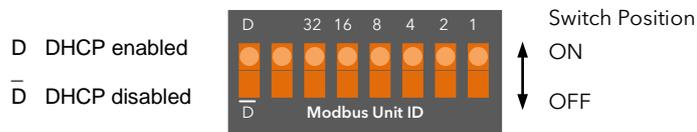
Figure 2-16: Modbus Address Switch

3. Chapter 3   iTools

3.1.   OVERVIEW

iTools is a Windows® based software package providing a user interface into the 2500 system (as well as other Eurotherm products). iTools provides tools to configure, commission and monitor any 2500.

iTools implements Modbus RTU communications via any serial port on personal computers under Windows® 95, 98, ME, 2000 or NT version 4.

NOTE: the minimum specification requirements for the PC depend to some extent on the operating system - for further details refer to the iTools "ReadMe" file. Any modern PC with at least a Pentium-166, 64M of RAM, 40M of hard disk space free and one serial port free should cope. This is the minimum specification if running Windows NT.

iTools is started in the conventional way either by double clicking the on screen icon or choosing iTools.exe in the appropriate folder.

3.2.   CONNECTING ANY 2500 TO A PERSONAL COMPUTER

There are three methods of connecting the 2500 system to a Personal Computer (PC) for configuration.

The simplest connection is through the 'Config' port. All versions of IOC support this port (see Chapter 2). The 'Config' port is RS232 compatible, so can be wired directly to any PC COM port with an appropriate adapter cable.

The other connection methods make use of the network communications port.

The Modbus version IOC requires a converter - RS232 to RS485.

The Ethernet IOC can be connected directly to the network card in the pc by use of a cross-over cable. Alternatively it can be connected to the same network as the pc using a normal cable.

3.2.1. To Connect a Single 2500 Controller to a PC

Connection of any 2500 to a PC can be made through the RS232 configuration port located on the front of the IOC module.

This cable plugs directly into the IOC and a COM port of the PC as shown below:
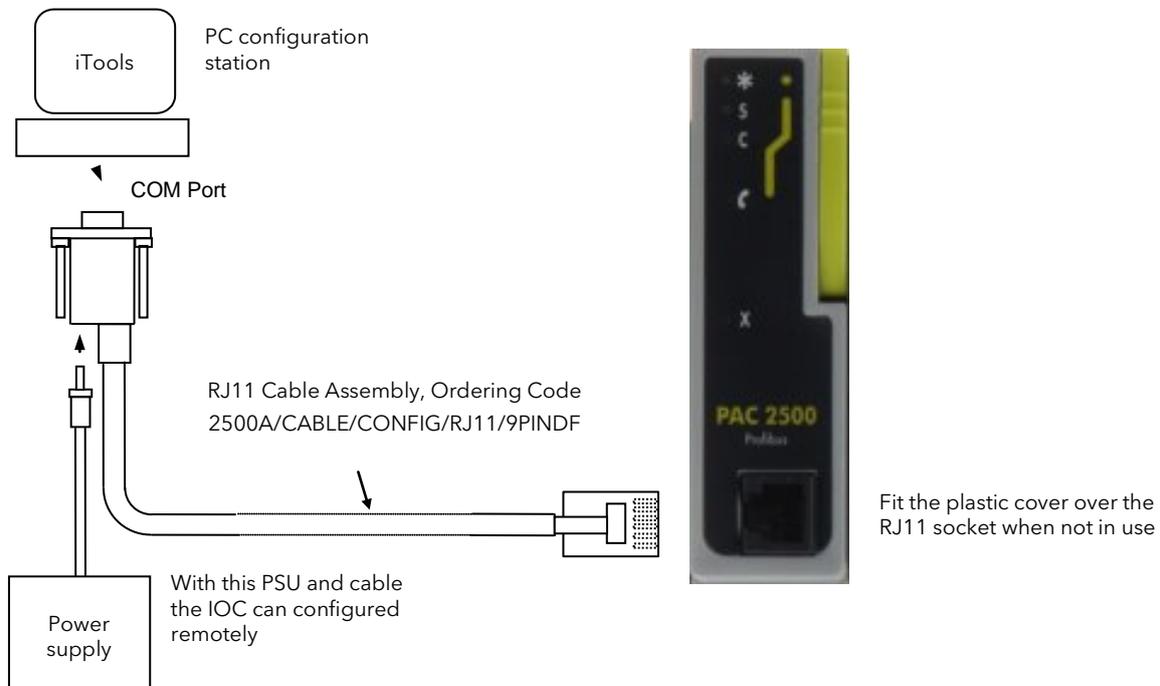
Figure 3-1: Connection between IOC and PC using the 'Config' Port

3.2.2. To Connect multiple 2500 Controllers to a PC

Modbus IOC

A number of Modbus 2500 controllers can be networked together and connected to a network master - iTools. As the IOC supports RS485 (either 3-wire or 5-wire) a converter is required at the PC COM port. The KD485 RS485/RS232 communications converter is suitable.

All network components (PC, 2500 and KD485) must be set up as appropriate and compatible for a network - each slave with a different address, each working with the same baud rate and parity settings, all components to work 5-wire (duplex) or 3-wire.
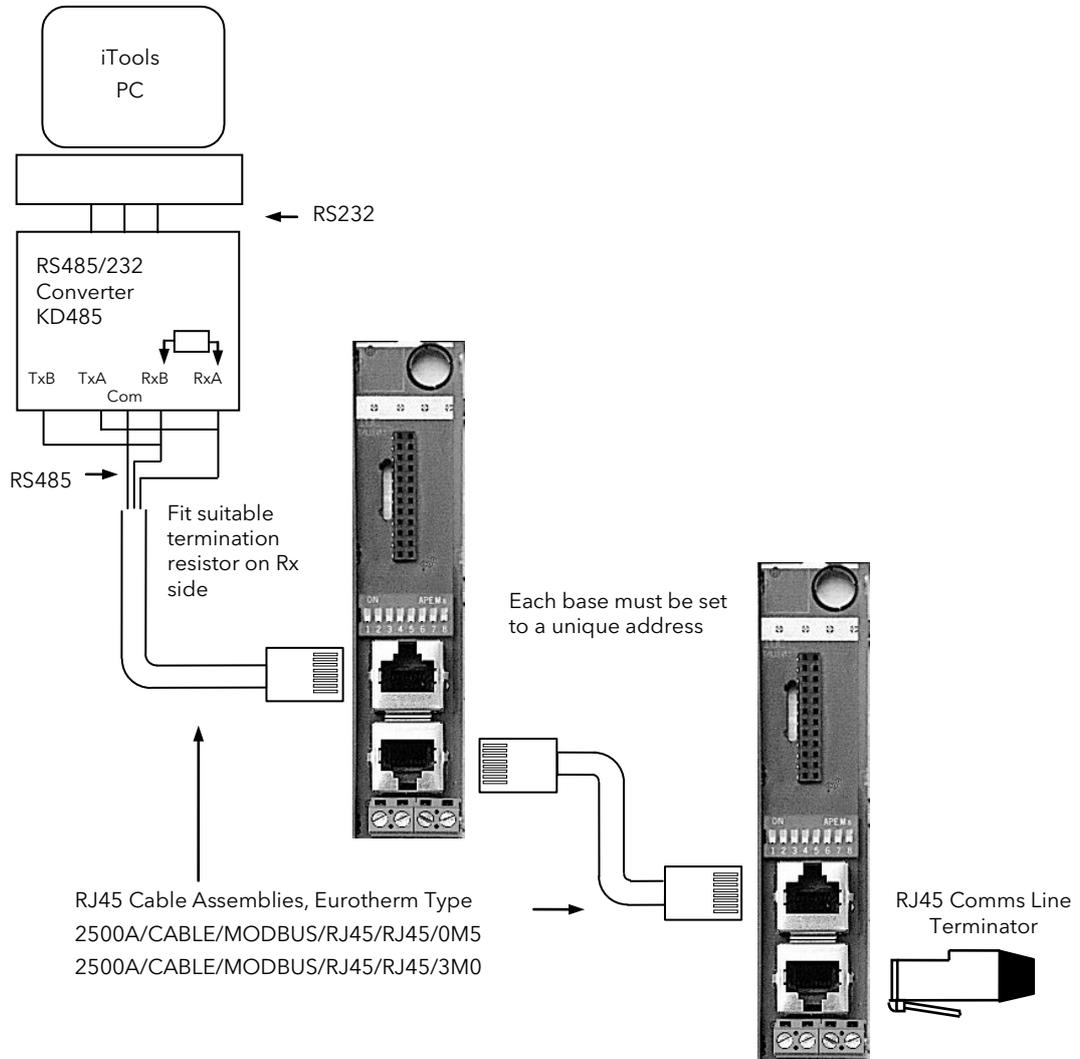
Figure 3-2: Connections for multiple Modbus instruments

Ethernet IOC

If the Ethernet IOC is connected directly to the pc using a cross-over cable, any IP address may be used. Alternatively, the Ethernet IOC must be configured for the network by obtaining a compatible fixed IP address and Subnet mask or by setting up DHCP – see your Network Administrator.
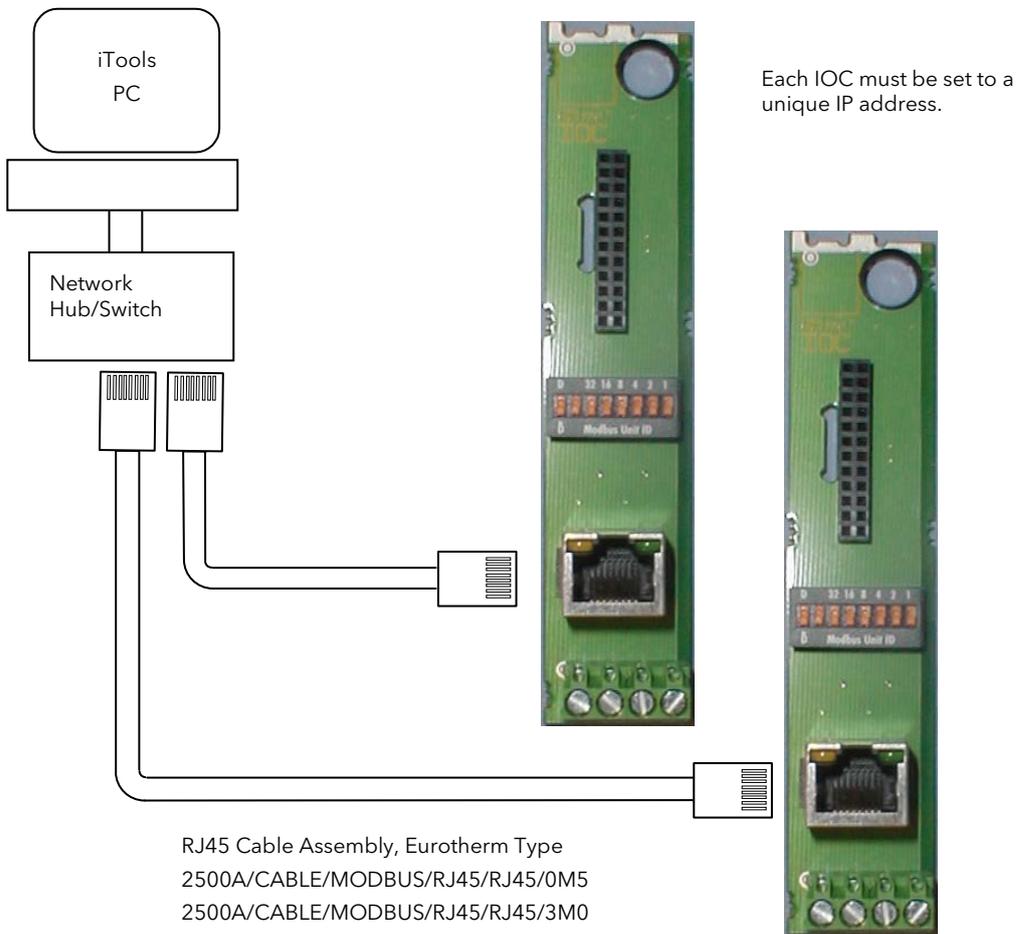
Figure 3-3: Connections for multiple Ethernet instruments

In order for iTools to be able to detect the Ethernet IOC, it may be necessary to set up the Modbus TCP ports on the EuroMBus server. To display the server from within iTools, select Options, Advanced, Show Server.

Within the EuroMBus server select Add, Ports then click on the TCP/IP tab:
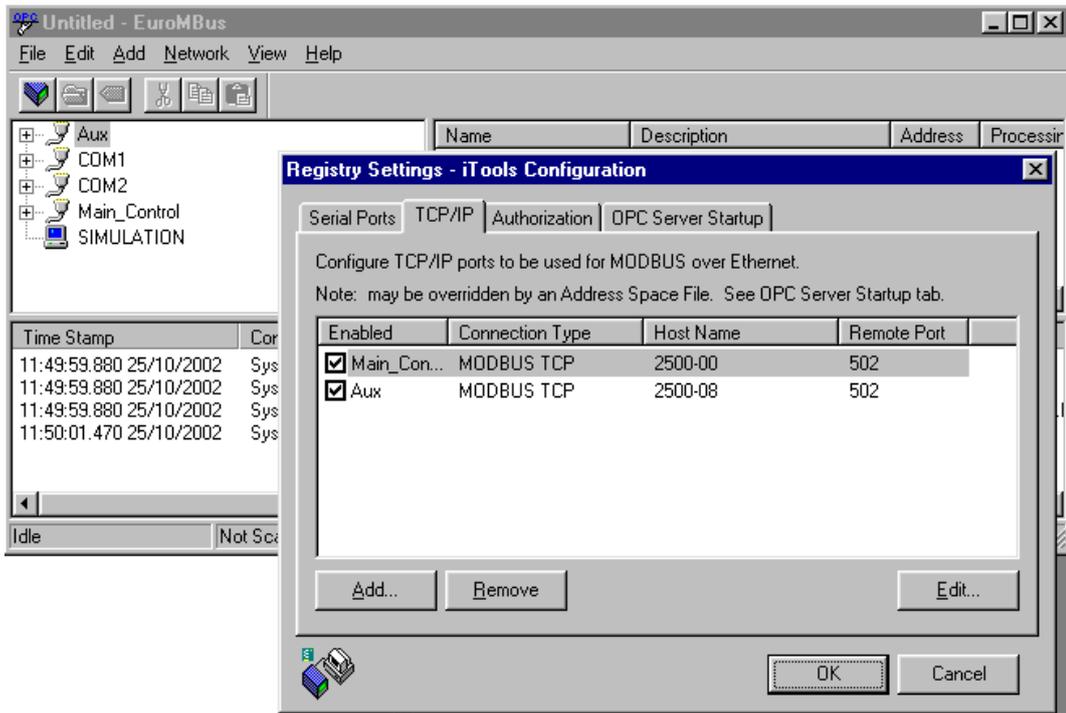
Click Add, or select one of the existing ports and click Edit.
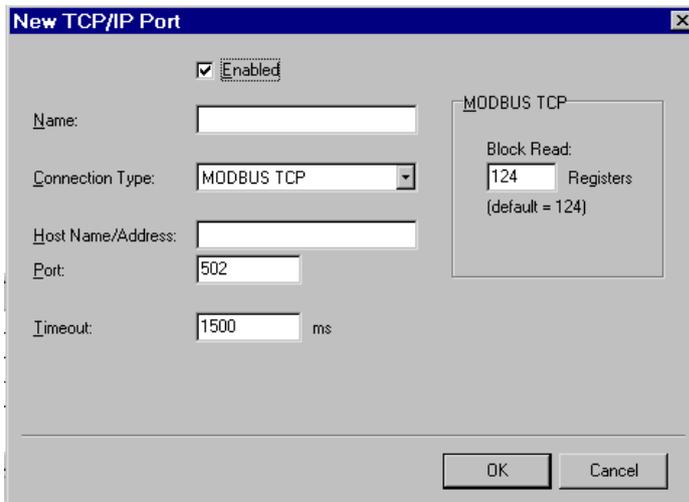
Enter a meaningful name in the Name field.

Enter the IP address in the Host Name/Address field.

Ensure the Enabled box is checked.

Click OK.

For fixed addressing, this address must be programmed into the Ethernet IOC using the configuration cable – see Section 3.2.2.

For DHCP addressing, your Network Administrator will allocate a Host name for the instrument. This should be entered into the Host Name/Address box above. The instrument should be set to DHCP by setting the DIP switch – see section 2.9.2.

iTools will now search this IP address when scanning for instruments (see section 3.3)

3.3. STARTING iTOOLS - DEVICE DETECTION

As "network master" iTools must identify any and all devices connected to the network - even if just one 2500 is connected through the 'config' port. On request iTools will automatically search for all devices with unique network base addresses.

To initiate the search, press the button: [Start Scan]

A dialogue might ask for a start address. For a single IOC connected from the 'Config' port leave the start at 255; for networking multiple systems save time by specifying the lowest address used.

When all connected instruments have been found appropriate icons are a displayed in the Panel window (assuming **Panel Views** has been checked in the **View** menu):
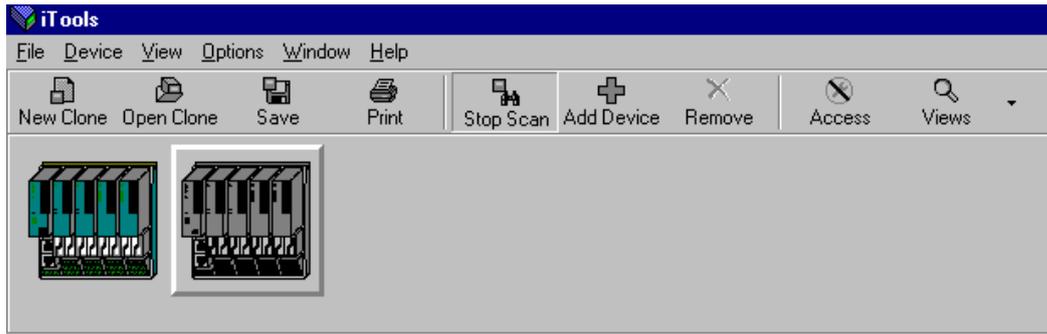
Figure 3-4: 2500 icons in the Panel View window

To save time (in a large network) it is possible to stop iTools scanning by pressing the **Stop Scan** button once all relevant bases have been identified**.**

To work with any particular base simply click the appropriate icon.

If working with a single IOC through the 'Config' port (and no other ports enabled) the network scan stops automatically and the device is automatically selected.

3.4. SETTING ACCESS LEVEL

The IOC can run in different modes, as discussed in Chapter 2 (section 2.2). The 'Operating' or 'Run' mode in particular limits access to features; the most important of which is that critical loop parameters are secured, to prevent accidental changes to an active process.

The 'Configuration' or 'Config' mode provides full access to parameters for set-up, but limits functions; in particular, output channels are limited to OFF (digital outputs) or electrical low (analogue outputs). Note this particularly when testing output channels.

3.4.1. Operating Mode

For most of its working life the IOC will be in 'Operating' or 'Run' mode, executing the programmed control strategy. In this mode inputs and outputs are active, PID loops and Toolkit Blocks operate and the internal database regularly updated. Any network master can use the communications link to access the database and the parameters.

iTools will indicate that any connected 2500 is in operating mode by displaying the 2500 icon with no additional symbols. On the IOC the top (green) indicator LED marked "★" is on.

3.4.2. Configuration Mode

'Configuration' or 'Config' mode is designed precisely for set-up of any 2500 system. The 2500 is shipped with a collection of useful tools but no strategy. To configure the 2500 for useful applications the user must define the needed I/O modules and "wire" the blocks together to perform the required task. Sometimes changes are made on-site; for this reason, when the 2500 is in configuration mode it is NO LONGER controlling. Outputs drive is effectively disabled.

When the 2500 is in configuration mode the iTools icon is displayed with a yellow wrench symbol. On the IOC the yellow indicator LED marked "C" is on.

3.4.3. Standby Mode.

'Standby' mode is normally a transient state that the IOC enters while changing modes or when a fault is detected. In Standby mode the IOC is not controlling but is also not in configuration mode. This mode should not be deliberately set by the user.

When the 2500 is in standby mode the iTools icon is displayed with a yellow hand symbol. On the IOC the yellow indicator LED marked "S" is on.

3.4.4. Changing Mode

There are several ways to change the IOC run mode.

▪ **To enter 'Config' mode directly from iTools:-**

1. Click the "Access" button on the Toolbar, or
2. Right click on the **Instrument View** (or the **device name** in the **Device Browser)**. From the pop up menu select **Set Access Level** ▸ **Configuration**, or
3. From the menu bar, click **Device** ▸ **Set Access Level** ▸ **Configuration**.

When changing from 'Run' to 'Config' mode a warning is displayed on iTools, but no password or security code is required.

Alternatively, simply power up the 2500 with iTools and the RJ11 'Config' connector plugged into the IOC 'Config' socket. This connection forces the 'Config' mode.

▪ **To enter 'Run' mode from iTools:**

1. Click the "Access" button on the Toolbar, or

2. Right click on the **Instrument View** (or the **device name** in the **Device Browser)**. From the pop up menu select **Set Access Level** ▸ **Operator**, or

3. From the menu bar, click **Device** ▸ **Set Access Level** ▸ **Operator**

3.5.   INSTRUMENT PARAMETERS

In the 2500 system "Parameters" are the numbers and values that represent the state of the machine. Each available parameter has a predefined address in the database. Parameters in iTools are organised into folders which are applicable to a particular subject. For example, to find a loop alarm setpoint go to Control → LOOP(number) → LO(number)ALM in the browser in iTools.

Parameter values are of just two type: **Real Values** or **Enumerated Values**. The former is altered from a dialogue window simply by typing in a new value. Enumerated values require a selection from predefined options from a pull down list. iTools displays each enumerated item with an integer value in brackets - the enumeration value. This is the value that would be used over network communications for reading or writing a new parameter value.

Parameters are given fixed attributes, so may be **Read Only** or **Read/Write**. **Read Only** parameters are displayed in **blue** and **Read/Write** parameters are shown in **black** in the parameter lists. Only Read/Write values can be changed, and some parameters, such as configuration parameters, can only be changed if the access level is appropriate.

iTools also allows irrelevant parameters to be hidden from view, reducing screen clutter.

Once iTools has detected a 2500 system it is ready to display Parameter Lists for operation, monitoring or configuration.

3.5.1. To Display Parameters

Parameters are collected into related lists. Controller Parameter Lists may be displayed in several ways:

1. Double click on the required instrument view (or the instrument name in the **Device Browser)**, or
2. Right click on the instrument view (or the instrument name in the **Device Browser**) and select <u>**Parameter List**</u> from the pop up window, or
3. Left click on the required instrument view. From the Toolbar click **Device Views** ▾ followed by **Parameter List**.

3.5.2. To Find a Parameter

If it is not known in which list the parameter resides, press the '**Find**' tab which is located at the at the bottom of the browser section.

You may search on

▪ Parameter Names
▪ Descriptions
▪ Addresses
▪ Comments

3.5.3. To Change Parameter Values

The first step is to invoke the parameter edit dialogue. There are several methods:-

1. From the **Parameter List** window double click on the selected parameter; or

2. From the **Parameter List** window right click on the selected parameter, and from the pop up menu select **Edit Parameter Value**; or

3. From the menu bar select **Parameter List** and from the pop up menu select **Edit Parameter Value**

A pop up window will appear:

Figure 3-5: Parameter value dialog

The edit method depends upon parameter type. If real (as in Figure 3-5 above) then simply type in the new value, then set by clicking the "<u>A</u>pply" dialogue button (if you want to use the same dialogue again), or click the "OK" button if finished with the dialogue.

If the parameter offers a list the dialogue looks more like:
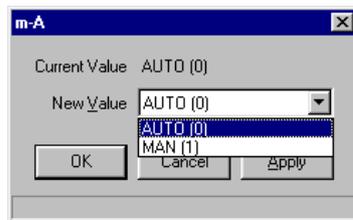
Figure 3-6: Enumerated value dialog

Select the desired value from the pull-down list and click "OK" or "<u>A</u>pply" as before.

Note that to change the above parameter example over network communications, say to AUTO, write the value 0 to the parameter address; for manual MAN write 1.

3.5.4. Example: To Set Baud Rate

1. From the Device Browser, click Operator → COMMS → Baud (in the right hand window)

2. Double click this parameter

3. From the pop up window click " ▼ "

4. Select the required baud rate, and click OK or Apply

The baud rate can only be changed if the 2500 is in Configuration Mode and it is appropriate to the Communication protocol

3.5.5. Failure To Write a New Value

If an attempt to write a new parameter value is unsuccessful the message **'Value Rejected by Device'** might appear.

This could happen if the controller is not in configuration mode and the parameter selected is a configuration parameter.

Alternatively, an incorrect condition has been requested. For example, if a module is configured as a Digital Input, selecting a parameter associated with any other type (AO, AI or DO) will be rejected.

Note that there are many situations, particularly in Configuration Mode, where a new value is not formally rejected, it is just ignored.

3.6.   PARAMETER AVAILABILITY AND ALTERABILITY

A very large number of parameters are pre-defined in the 2500 system.

The Navigation tree example shown, taken from the iTools browser, shows the top list of folders available on a 2500 with 4 way base.

iTools can hide folders and parameters that are not relevant to a particular set-up. In this list iTools knows it is a 4 way base and has removed the I/O folders for I/O modules 5 to 16. Note that this "list hiding" is delayed at start-up while the IOC communicates the parameter values and settings and synchronises its data base.

In the same way iTools will hide and expose parameters depending on the actual configuration of the 2500 Unit and its mode – whether it is in Operating mode, Configuration mode or in Standby

The List window will display the list associated with one of these folders - simply double-click on the folder to be viewed.

See Chapter 4

See Chapter 8

See Chapter 5

See Chapter 6

See Chapter 7

See Chapter 8

See Chapters 9, 10, 11 and 12
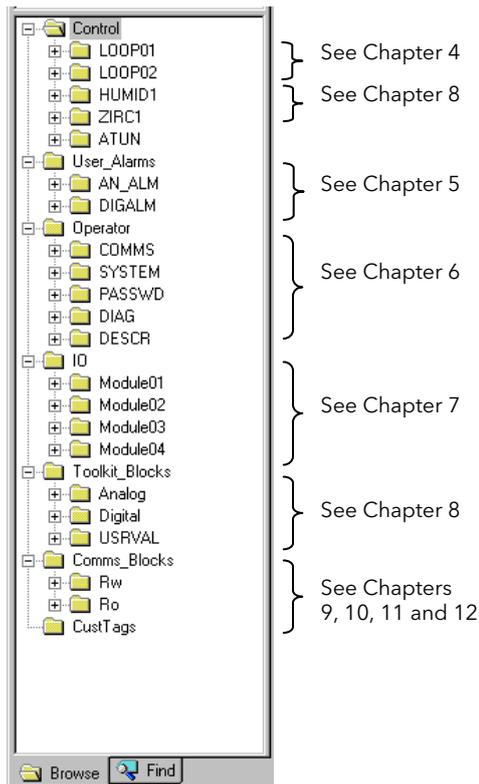
Figure 3-7: Browser view of 2500 folders

For example, a double-click on the LOOP1 folder (of Figure 3-6) will display a list perhaps similar to this:

Note: from the title bar the identifier COM1.ID255-2500-v222. This identifies the device completely through the network connection:

Figure 3-8: LOOP1 parameter list

COM1 - the port on the PC running iTools that is connected to the 2500

ID255 - the Modbus address, in this case via the IOC configuration port

2500 -   the product code

V222 - the software version number.

From the folder line below the title bar the path to the highlighted parameter on the navigation tree is:-

Control → LOOP01 → L01PID → PB (the PID loop proportional band).

By default only 'available' or relevant parameters appear on a page. For example, relative cool gain does not appear in a heat only controller, and integral time does not appear in an On/Off controller.

A parameter may be Read Only with the 2500 in operating mode, but Read/Write in Configuration mode. An example is thermocouple linearisation type.

Parameters coloured in **black** are Read/Write.

Parameters coloured in **blue** are Read Only.

Parameters in a **grey** banner are read only and depend upon the setting of another parameter. For example, 'SP Rate Limit Holdback Value' can only be altered if 'SP Rate Limit Holdback Type ≠ OFF.

3.7.   SETTING UP AN APPLICATION

The 2500 can be set up to provide a wide range of application solutions. To this end it offers I/O channel blocks, I/O module blocks, PID loop blocks, timer blocks, counter blocks... and more.

To create any control strategy the Applications Engineer can connect these blocks together using software 'wiring' in whatever way is needed to provide the required control functions.

3.7.1. What is a Function Block?

A function block is a software entity that performs a particular task upon 'input' data to compute 'output' values. The actual algorithm may be dependent upon other input settings.

For example, an input channel is a block - the terminal signal being the 'input', the reported PV the output. The parameter 'Channel Type' will modify the response. The COUNTER block is a purely computational block, producing a count value 'output' from and event 'input'. Note that there are usually several instances of each function block type; for example, there might be eight PID loop blocks.

3.7.2. Why use Function Blocks?

Function Blocks are tested building blocks intended to provide general purpose tools to allow speedy construction of complex systems. This methodology reduces problems and speeds up the design cycle while retaining the flexibility to produce different applications.

3.7.3. Function Block Wiring Example

To make use of function blocks the various inputs and outputs must be interconnected - "wired". This software "wiring" (not to be confused with electrical wiring!) is a method of passing an output parameter value to the input parameter of another block.

Consider the simple task below, to set up a temperature control loop:
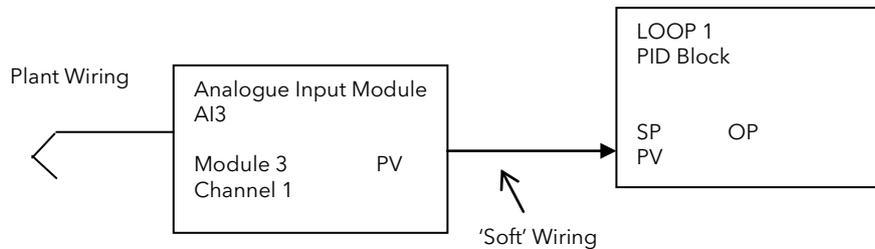
Figure 3-9: Example of function block wiring

To implement the temperature control loop a LOOP block is selected - here LOOP01. To make the loop dependant upon temperature the output value (PV) of the AI3 block must be wired to the PV input of the LO01 PID block.

Note in this example a temperature measurement device (thermocouple) is wired (literally, in the electrical sense) to the Channel 1 terminals of the AI3 Module, which is in the base slot 3.

To add the loop PV wire use the iTools 'Browse' pane to navigate to LOOP01 and double-click to show the parameter list, which might look something like Figure 3-10:

Note that the Process Variable (PV) and 'PVSrc' parameters are not wired by default. Note also the 'Address' column; every parameter in the 2500 has a unique Modbus address, and this address is used to identify each end of the 'wire'. In the window above the Process Value 'Source' has a value –1, which indicates no wire.

It is this parameter that we need to alter, defining the address of the PV value from the AI3.
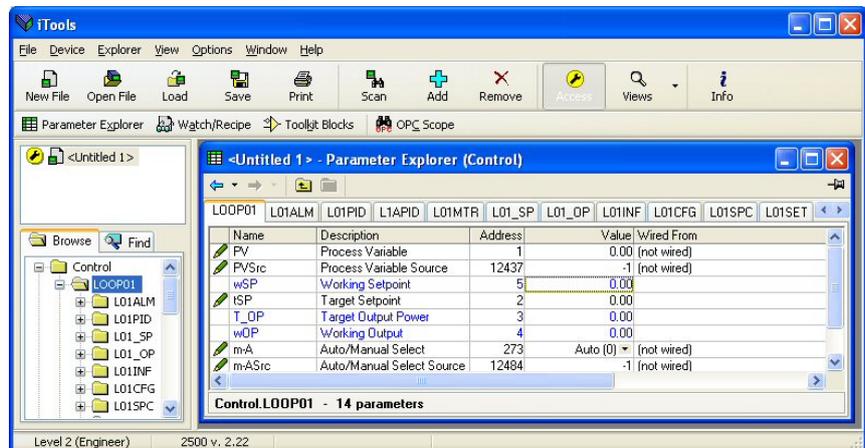
Figure 3-10: Loop parameter lists

We need to identify the AI3 channel output (PV) address; navigate as usual to that list:
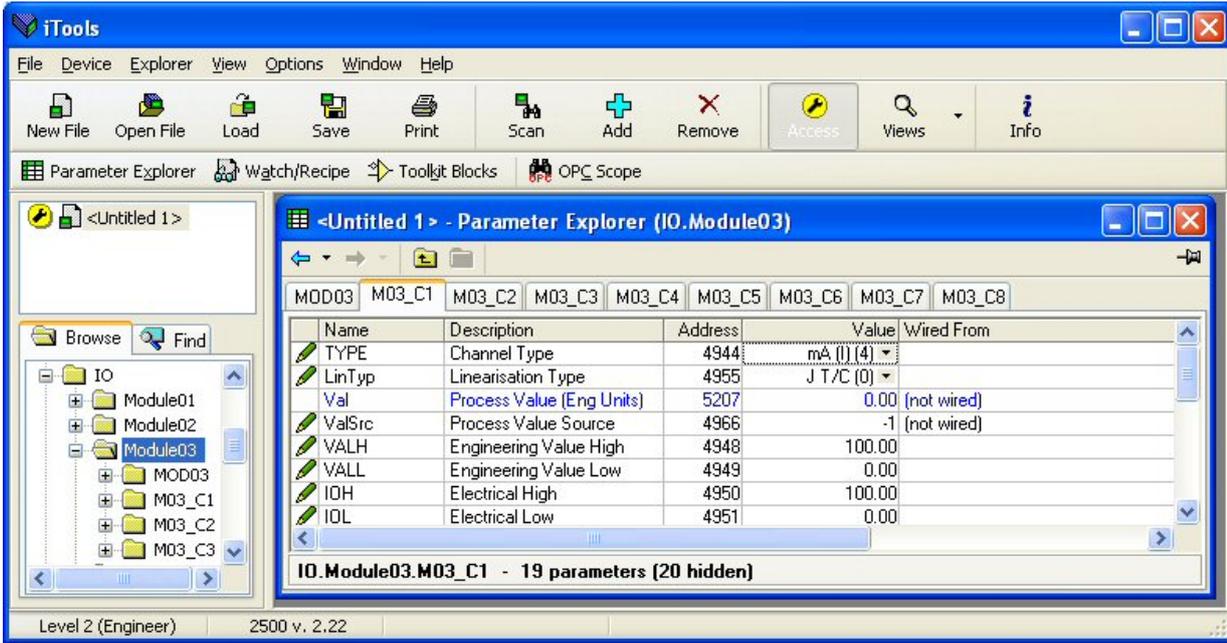
Figure 3-11: AI3 channel list

We can see the parameter 'Val' is at address 5207. We could have found this by looking up the published Modbus parameter information.

Reverting to the LOOP list (Figure 3-10), enter the new address (5207) into the PVSrc Value the new parameter will look like:
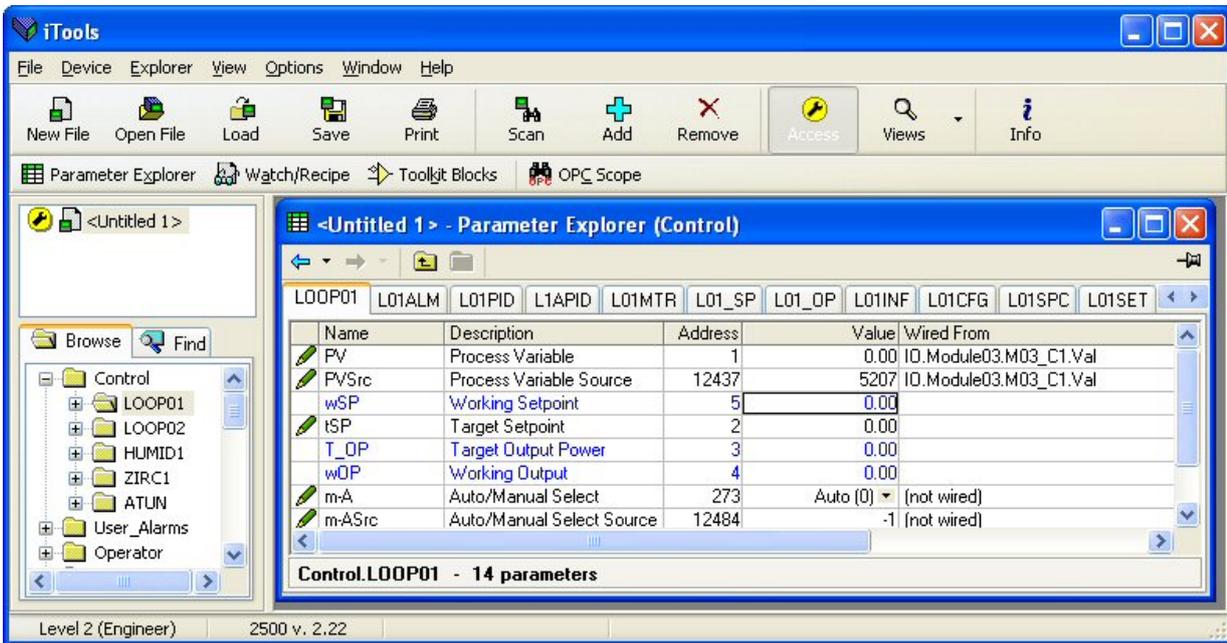
Figure 3-12:   PID Function Block View with Wiring

To extend this example further, the loop output should be wired to an output channel; the set point wired to a fixed value, or to a setpoint controller.

Complex systems can be constructed in a very short time using the above procedure.

3.8.   DECLARING I/O MODULES

Each type of 2500 I/O module is identified with a unique code. The IOC regularly scans every base slot for module type codes; thus can verify any software configuration against actual modules fitted. This system also allows for "hot swap" of modules in service.

The iTools I/O module lists show two parameters 'ReqID' and 'ActID'. The former must be set to define the needed module type, the latter confirms the type actually fitted. These parameters are found in **IO → Modulexx → MODxx.**

In the 2500 system EVERY required module must be declared and identified. If not declared (or the wrong type fitted) the module will not function. Note, the green indicator LED on I/O modules only lights if the module is correctly identified and initialised. If the IOC detects any miss-match the red "X" indicator illuminates.

To set the 'ReqID' parameter to match the I/O module navigate to the module block list as shown in the example in Figure 3-13:
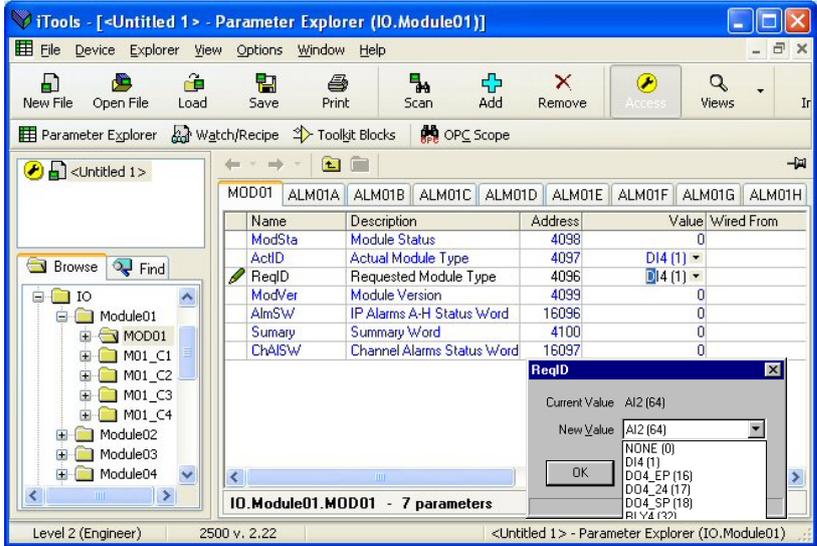
Figure 3-13: Selecting a module type

Double-click the 'ReqID' parameter and select the module type from the drop-down list in the usual way.

3.9.   THE WIRING EDITOR

Wiring can become quite complex in a large system. To help control wiring there is an editor in the Toolkit Block components that provides a view of all wiring connections within a 2500 controller. The editor also contains a full list of all the available Wireable Parameters and where they are wired from.

The **Block Wiring** Editor in Toolkit Blocks can be opened in a number of ways:-

1. From the toolbar click ▼ next to **Views**
2. From the **View** menu
3. Right click on the icon view or the device name in the **Device Browser**

This opens up a Window with 4 tabbed lists. The first three tabs are for the Toolkit Blocks which are covered in Chapter 8.

The fourth list is the 'Block Wiring', with all the wireable parameters and all their connections within the 2500. It is possible to do all the wiring using this editor alone.
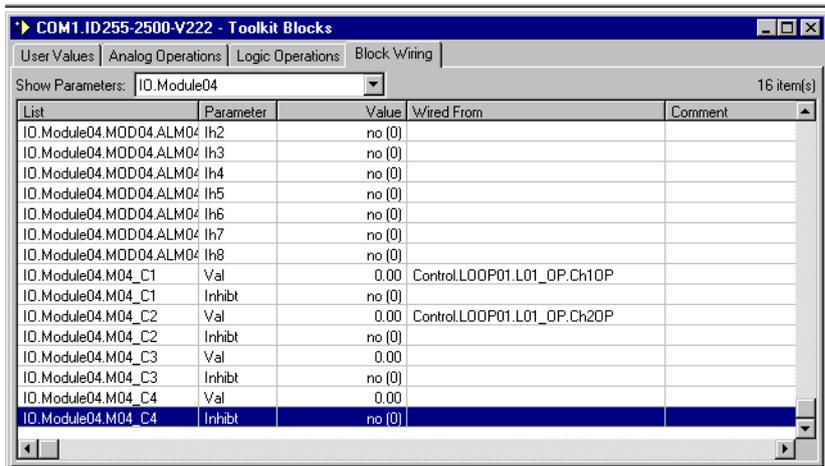
Figure 3-14: The wiring editor

Because there are potentially a very large number of wireable parameters in a 2500 the list is split up into sections and a pull down list "Show Parameters" is used for selection.

Wiring can be added as before, by double-clicking or right-clicking on the row required in the 'Wired From' column. Wiring can also be made by using Windows drag and drop; for example, taking the Control.LOOP01.L01_OP.Ch1OP parameter from the device browser (or from the Parameter List) and dropping it on the IO.Module04.M04C1.Val in the Block Wiring page above.

4. Chapter 4 Control

4.1. ABOUT THIS SECTION

The IOC fitted in the 2500 DIN Rail Controller has a number of options, such as 2, 4 or 8 loops of control and Toolkit Blocks depending upon the option ordered. This section applies to any number of loops. Toolkit blocks are described in Chapter 8.

The loop type can be configured as:

Loop Type	For further description see section:-
Single PID	4.4
Single On/ Off	4.3
Valve Position (Bounded or Boundless)	4.8.3, 4.8.4
Cascade pair	4.10
Override pair	4.11
Ratio	4.9

In its simplest form a Control Loop can be represented by the diagram below.

Tuning Parameters Section 4.5   Alarms Section 4.15

Setpoint Section 4.6   Loop Type Section 4.3   Output Section 4.8

Process Variable

Auto Tune Section 4.13   Diagnostics Section 4.14
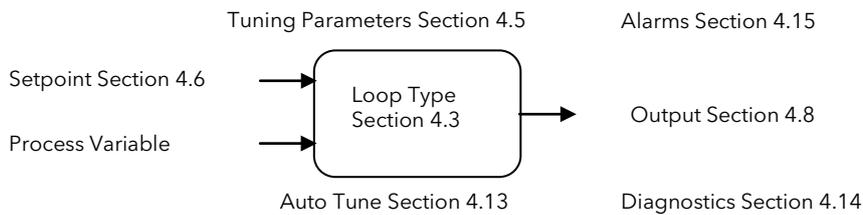
Figure 4-1: A PID Loop

The loop function block has inputs from a Setpoint Function block and a Process Variable measurement. Outputs from the loop function block may be wired to control plant actuators. Alarm conditions can be added to monitor plant conditions. Auto and Manual Tuning of the loop parameters can be made to suit the characteristics of the plant. This chapter describes these options and how to set them up, all based on **LOOP0x,** where x = 1 to 8.

Section 4.2	Standard 'view' of a loop in iTools
Section 4.3	Key configuration parameters 'Loop Type', 'Control Type'
Section 4.5	Sets of tuning parameters, 'gain scheduling'
Section 4.6	Setpoints and how to select setpoints
Section 4.8	Outputs, Dual outputs, output demand limit, Heat Cool
Section 4.9 4.10 4.11	Advanced Loops:- Ratio, Cascade, Override
Section 4.13	Auto tune
Section 4.14	Diagnostics
Section 4.15	Loop Alarms

4.2. LOOP VIEW

This is the top Parameter List of a Loop in iTools. In most configurations these parameters are Read Only and show how the loop is performing. The Process Variable would normally be wired to the analogue input requiring to be controlled. Target Setpoint and Auto Manual would be writeable in simple applications.
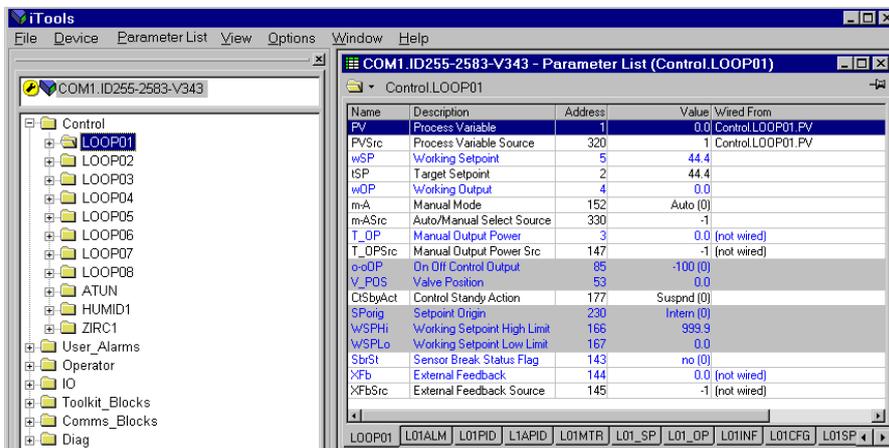
Figure 4-2: Loop Overview

4.2.1. Loop Overview Parameters

These parameters are in the **Control → LOOP0x list**.

Name	Description	Range	Status
▪ PV	**Process Variable.** The input process value to be controlled by the loop. The current value of the variable from the wired source, for example an Analogue Input module	·9	📖
▪ PVSrc	**Process Variable Source.** Modbus address of the parameter wired to the PV. -1 indicates NOT wired.		
▪ wSP	**Working Setpoint.** The Working Setpoint is the current value of the setpoint being used by the control loop. It may come from a number of different sources, such as an internal SP, Remote SP or Next Slave Instrument SP (see section 4.6)	·9	
▪ tSP	**Target Setpoint.** The Target Setpoint is the value of setpoint at which the control loop is aiming. It may come from a number of different sources, such as an internal SP, Remote SP or Next Slave Instrument SP (see section 4.6)	·9	
▪ T_OP	**Target Output Power.** The output demand the loop calculates is required before external limits are applied.	·%	📖
▪ T_OPSrc	**Process Variable Source.** Modbus address of the parameter wired to the T_OP. -1 indicates NOT wired.		
▪ wOP	**Working Output.** The current value of the output demand signal from the loop.	·%	
▪ m-A	**Auto/Manual Select**. If this is not wired this allows the output demand to be set for manual or automatic:-		
Auto (0)	**Automatic** The output demand is provided by the control loop		
mAn (1)	**Manual** The output demand can be set by the operator using the 'Target Setpoint' parameter. When changing from Auto to Manual the output demand will remain at the current value until it is raised or lowered by the operator. When changing from Manual to Auto the output demand will assume the previous manually set value then change in a controlled manner to the value demanded by the control loop. This is referred to as 'Bumpless Transfer'.		
▪ m-Asrc	**Auto/Manual Select Source.** This allows the Auto/Manual select to be wired to a parameter.		📖
▪ CtSbyAct	**Control Action in Standby**. The action the Control algorithm will take when in Standby mode.		
Suspnd (0)	Suspend the loop:		
Cont (1)	Continue running the loop.		
▪ SbrSt	**Sensor Break Status Flag**. Either hardware fault from input or linearised input PV out of range		
no (0)	Sensor working normally		
YES (1)	Sensor in a break condition. This may be open circuit or high impedance		
▪ XFb	**External (or Remote) OP Feedback.** Allows an external source of feedback to stop Integral wind-up	·9	📖
▪ XFbSrc	**External Feedback Source.** Modbus address of the parameter wired to the ExtFB. -1 indicates NOT wired.		

The following parameters may be hidden if not required for the operation of the instrument. To reveal uncheck the 'Hide Parameters' box in 'Options → Parameter Availability Settings'

Name	Description	Range	Status
▪ o-oOP	**On Off Control Output.** For ON/OFF control the actual output demand is:		
-100 (0)	Maximum 'Cool' demand (Full output demand for Direct acting loop)\		
0 (1)	No output demand		
+100 (2)	Maximum 'Heat' output demand (Full demand for Reverse acting loop)		
▪ V_POS	**Valve Position.** Actual position of potentiometer if connected or inferred position if no potentiometer fitted	·%	📖
▪ SPorig	Setpiont Origin. Defines where the PID Setpoint comes from:		📖
Intern (0)	the internal setpoint of the PID block		
Remote (1)	the Remote Setpoint\		
Progrm (2)	the Programmer Ramp Block		
▪ WSPHi	Maximum value allowed for the working setpoint	·9	📖
▪ WSPLo	Minimum value allowed for the working setpoint	·9	📖

4.3.   LOOP CONFIGURATION

This is the page used to set up or configure the way in which the loop is designed to operate. In Configuration Mode ALL these parameters are Read/Write, in Operating Mode ALL these parameters are Read ONLY.
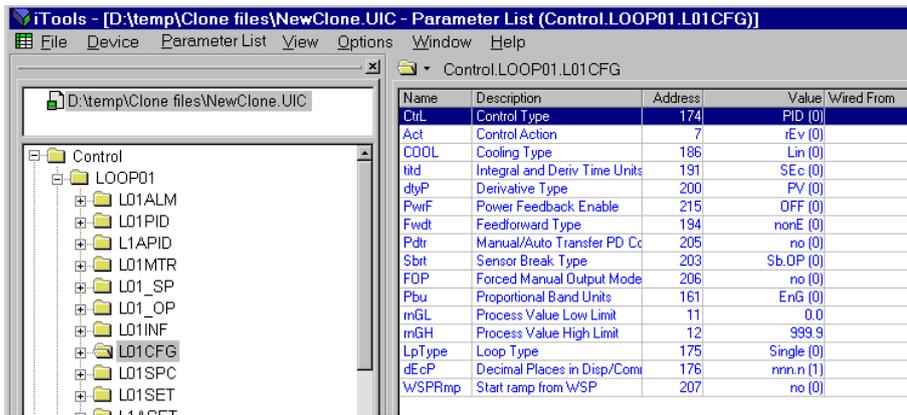
Figure 4-3:   Loop Configuration

4.3.1. Key Configuration Parameters.

These parameters are in the **Control → LOOP0x → L0xCFG** list.

The following four configuration parameters must be set to suit the application.

▪ **LpType**	**Loop Type**. This is first main selection and defines the structure of the loop.	
	Single (0)	Single Loop Control
	Cascde (1)	Cascade Control (See Section 4.10)
	Overid (2)	Override Control (See Section 4.11)
	Ratio (3)	Ratio Control (See Section 4.9)

▪ **Ctrl**   **Control Type**. This is the second main selection and defines the behaviour and outputs of the loop. A control loop may have a single channel output (eg Heat Only) or Dual channel (eg Heat/Cool). The control algorithm may be PID, or a raise/lower Valve Positioning algorithm. The Valve Position algorithm may be configured for use with position feedback from a potentiometer ('Bounded' or Position Mode control), or without position feedback ('Boundless' or Velocity Mode control).

Single outputs: Channel 1.   Numbers shown in ( ) are enumerated values

PID (0)	PID control
OnOff (1)	ON/OFF control
VPU (2)	Valve Control - boundless
VPB (3)	Valve control – bounded

Dual outputs:.   Channel 1   Channel 2

	Channel 1	Channel 2
PID1&2(4)	PID (Heat)	PID (Cool)
PID On(5)	PID	ON/OFF
On1&2(6)	ON/OFF	PID *see note*
OnVPU(7)	ON/OFF	Valve Control – boundless *see note*
OnVPB(8)	ON/OFF	Valve control – bounded *see note*
VPUOn(9)	Valve Control – boundless	ON/OFF
VPBOn(10)	Valve control – bounded	ON/OFF
PIDVPU(11)	PID	Valve Control – boundless *Next Phase*
PIDVPB(12)	PID	Valve control – bounded *Next Phase*
VPU1&2(13)	Valve Control – boundless	Valve Control – boundless *Next Phase*
VPUVPB(14)	Valve Control – boundless	Valve control – bounded *Next Phase*
VPB1&2(15)	Valve control – bounded	Valve control – bounded *Next Phase*
VPBVPU(16)	Valve control – bounded	Valve Control – boundless *Next Phase*

Note: Select Direct Control Action (below) and ON/OFF as Channel 2.

▪ **Act**   **Control Action**.   This applies to Channel 1, Channel 2 will be the opposite

rEv (0)	**Reverse action** - the output will increase positively if PV is below SP. (Eg Heat)
dir (1)	**Direct action** - the output will increase positively if the PV is above SP. (Eg Cool)

▪ **rnGH/L**   **Process Value High and Low Limits**.   These must reflect the active range of the controlled variable and will be used to scale the PID action, for example, to calculate the proportional band in %. Outside these limits the Sensor Break flag will be active

The remaining configuration parameters also affect how the loop is used and are taken in the order listed:

4.3.2. Other Loop Configuration Parameters

Name	Description	Range	Status
▪ COOL	**Cooling Type** This applies to the PID output on Channel 2		
Lin (0)	**Linear** The control output follows linearly the PID output signal, i.e. 0% PID demand = 0 demand output, 100% PID demand = 100% demand output.		
oiL (1)	**Oil, Water, Fan** The control output is characterised to compensate for the non-linear effect of the cooling medium - oil, water and blown air. Typically used in extrusion processes.		
H20 (2)			
FAn (3)			
ProP (4)	**Prop** Cooling output is proportional to error		
▪ titd	**Integral & Derivative Time Units** Usually seconds, but may be changed to minutes or hours	🕐	
▪ dtyP	**Derivative Type** Derivative on PV defines that derivative action responds to changes to PV only	🕐	
	Derivative on Error defines that derivative action responds to changes to differences between SP and PV, better for ramping setpoints		
▪ PwrF	**Power Feedback Enable** If the supply voltage changes the PID output is immediately modified to keep the output demand constant.		
	Power feedback is generally used in a heating application to compensate for supply voltage changes before the effect is seen in the temperature. For outputs controlling contactors or SSRs set power feedback to on. For outputs controlling analogue thyristor units PwrF would normally be set to OFF since the thyristor unit generally contains its own local compensation.		
OFF (0)	**Off** No power feedback		
on (1)	**On** Power feedback enabled		
▪ Fwdt	**Feedforward Type** Feedforward control is used typically to overcome time delays or to compensate for the effect of external influences such as control signals from other loops in the process. This is added directly to the output of the PID algorithm, before output limiting and dual output conversions are performed. Trim Limit applied to the PID calculated output is possible when Feedforward is enabled.		
▪ Pdtr	**Manual/Auto Transfer PD Control** Defines the control output behaviour for Manual/Auto transfer when there is no integral term:		
no (0)	**No** Manual to Auto transfer will bump		
YES (1)	**Yes** Manual to Auto transfer will be bumpless		
▪ Sbrt	**Sensor Break type**. On sensor break detection the output demand will revert to:-		
Sb.OP (0)	**Sb.OP** to a preset value set by 'oSbOP' in 'L0x_OP' list		
HoLd (1)	**Hold** to its current value		
▪ FOP	**Force Manual Output Mode**. Force Manual Mode allows you to select how the loop behaves on auto/ manual transfer		
no (0)	**Off** Transfer between auto/manual/auto takes place bumplessly		
trAc (1)	**Track** Transfer from auto to manual, the output reverts to the <u>previous</u> manual value. Transfer from manual to auto takes place bumplessly		
StEP (2)	**Step** Transfer from auto to manual, the output goes to a pre-set value **L01_OP.FOP**. Transfer from manual to auto takes place bumplessly		
▪ Pbu	**Proportional Band Units**. Units in which the Proportional band is set		
EnG (0)	**Eng** in engineering units		
% (1)	**%** as a percentage of the input range		
▪ dEcP	**Decimal Places in Disp/Comms**. Defines the resolution of the main PV and Setpoint as seen by digital communications		
nnnn (0)	No decimal places		
nnn.n (1)	One decimal place ie 123.4 is sent as 1234		
nn.nn (2)	Two decimal places ie 12.34 is sent as 1234		
▪ WSPRmp	**Ramp from WSP**. When ramping SP is enabled, this parameter determines the starting point of the ramp		
no (0)	Ramp from PV		
YES (1)	Ramp from WSP		

4.4.   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 set P, PI, PD or PID control.

4.4.1. Proportional Term

The proportional term delivers an output which is proportional to the size of the error signal. An example of this is shown in Figure 4-4, for a temperature control loop, where the proportional band is $10^{O}C$ and an error of $3^{O}C$ will produce an output of 30%.
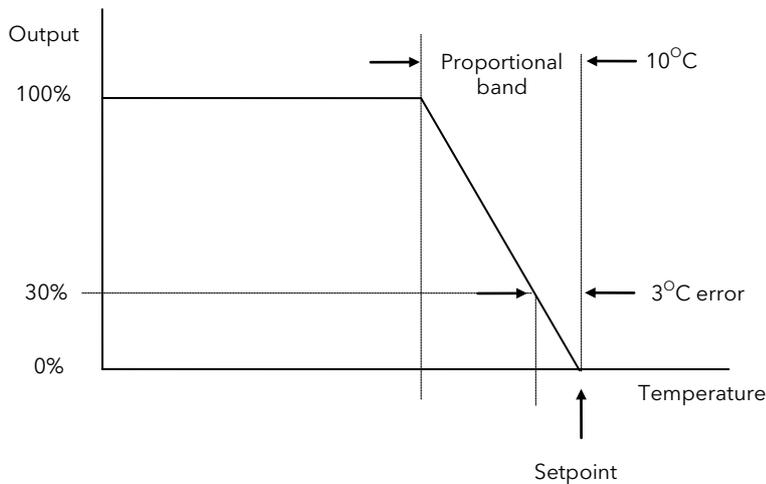
Figure 4-4: Proportional Action

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

4.4.2. 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.

4.4.3. 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, to 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.

4.4.4. 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 demand.
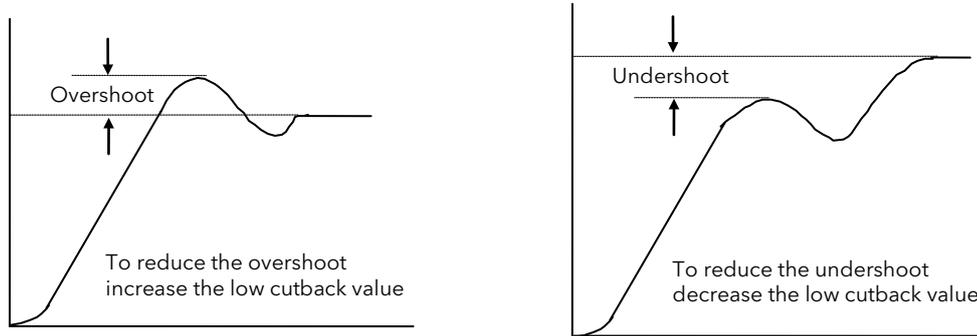
Figure 4-5: High and Low Cutback

4.4.5. PID Block Diagram
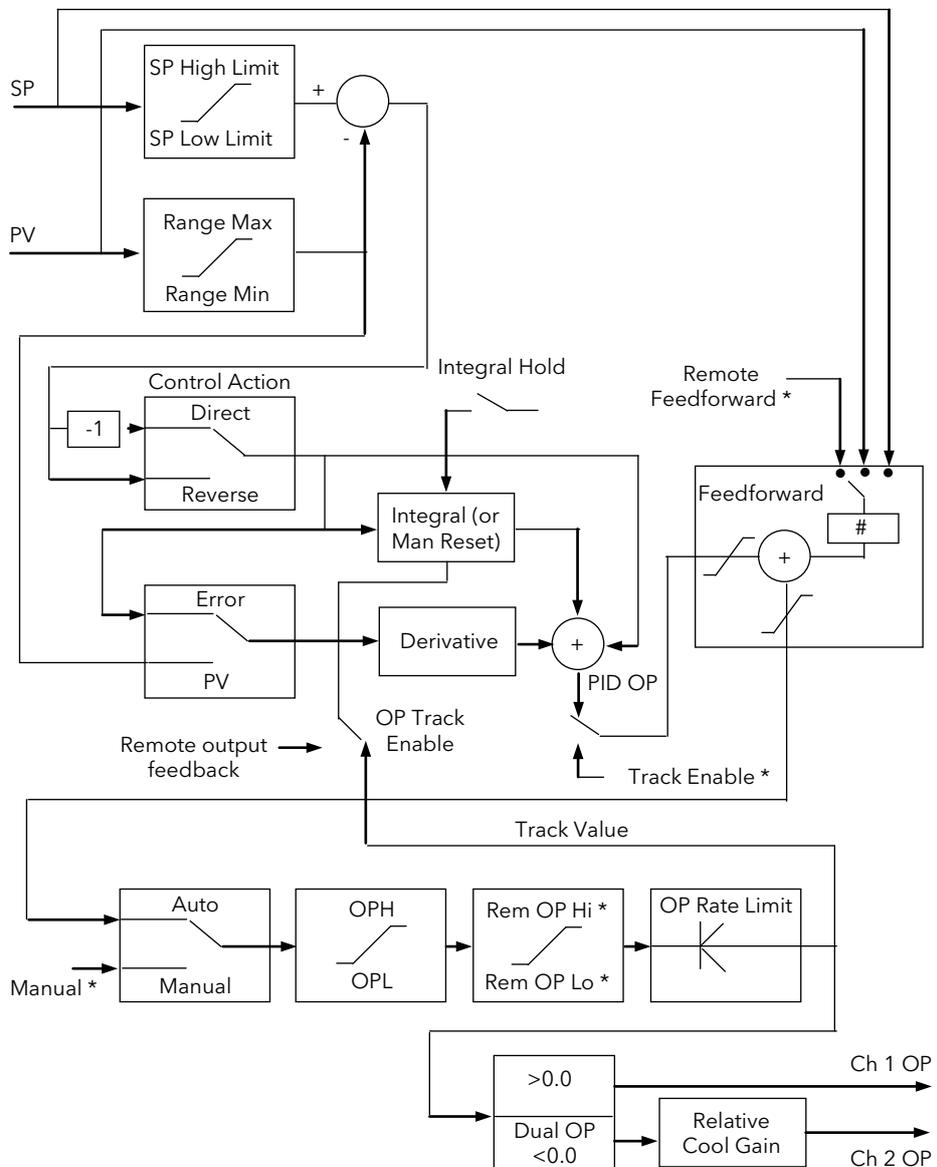
Figure 4-6: PID Block Diagram

4.4.6. PID Parameters

These parameters are in **Control → LOOP0x → L0xPID**.

The L0xPID List displays all the current working PID parameter values. These are all read only (coloured blue) and are set either following an **Autotune** (section 4.13) or adjusted manually (section 4.5.1 **'PID Sets'**). The PID terms have been described in previous pages.

Figure 4-7: PID Parameter List

Name	Description	Range	Status
▪ **PB**	The proportional band value the PID is using now. Units (Eng, %) are set in Control → LOOP0x → LoxCFG → Pbu		📖
▪ **Ti**	The integral time the PID is using now. Units (Sec, Min, Hour) are set in Control → LOOP0x → L0xCFG → titd		📖
▪ **Td**	The derivative time the PID is using now. Units (Sec, Min, Hour) are set in Control → LOOP0x → L0xCFG → titd		📖
▪ **rES**	The Manual reset value the PD controller is using now		📖
▪ **Hcb**	The cutback high value the PID is using now		📖
Auto (0)	**Auto** The cutback value is set by the PID Block		
Value	The cutback value set manually in Control → LOOP0x → L0xSET → Hcb1		
▪ **Lcb**	The cutback low value the PID is using now		📖
Auto (0)	**Auto** The cutback value is set by the PID Block		
Value	The cutback value set manually in Control → LOOP0x → L0xSET → Lcb1		
▪ **reL**	The Channel 1 Channel 2 Relative gain value the PID is using now		📖
▪ **SET**	**Working PID Set.** Selects which of the 3 sets of tuning parameters is being used. Selection is Manual or by Gain Scheduling (section 4.5.). Note that Control.LOOP0x → L0xSET → nSets must be a value > 1.		📖
▪ **SETSrc**	Modbus address of parameter value used as the working PID set		
▪ **FF**	**Remote Feedforward** Remote input value used as a feedforward. Feedforward must enabled in L01CFG → Feedforward type.		
▪ **FFSrc**	Modbus address of parameter value used as the remote feed forward -1 indicates NOT wired.		
▪ **Frz**	**Freeze Control Flag Value** Freeze Control flag may be set to suspend PID calculation and all the calculated values remain frozen. This parameter is wireable		
▪ **FrzSrc**	Modbus address of parameter value used as the freeze control flag		
▪ **LPBrk**	**Loop Break Status Flag.** PID loop detects that the output has remained on a limit and PV has not moved by half proportional band for > Loop Break Time		📖
no (0)	**No** Loop status is OK		
YES (1)	**Yes** Loop status is detected as broken - open loop		
▪ **Lb_t**	**Loop Break Time** Flag is set when the PID loop detects that the output has remained on a limit and the PV has not moved by half the proportional band during the Loop Break Time.		
▪ **I_Hold**	**Integral Hold Flag** Set to suspend the Integral calculation and hold constant the current integral contribution to the output value. This parameter is wireable		

Name	Description	Range	Status
▪ **I-HSrc**	Modbus address of the flag used to hold the Integral value -1 means not wired		
▪ **Debump**	**Debump Flag** Set to balance integral to maintain the same output demand. Flag resets itself		
▪ **Adc**	**Manual Reset Auto Calc Enable** With Integral Time OFF, setting **Adc** enables calculation of the Manual Reset. If **Adc** is not set Manual Reset must be set manually		

The following parameters may be hidden if not required for the operation of the instrument. To reveal uncheck the 'Hide Parameters' box in 'Options → Parameter Availability Settings'

▪ **FFPb**	Proportion of feed forward fed directly to the output - Default 100 decreasing value increases the effect		
▪ **FFtr**	Fixed offset value added to the feedforward signal		
▪ **FFdv**	SP and PV feed forward defines range of PID trim contribution. Feedforward is limited directly.		
▪ **MaxDsp**	For diagnostic use only		
▪ **MinDsp**	For diagnostic use only		
▪ **MnPosn**	For diagnostic use only		
▪ **MxTDTI**	For diagnostic use only		

4.5.   GAIN SCHEDULING

Gain scheduling is the automatic transfer of control between one set of PID values and another. Gain scheduling may be used in very non-linear systems where the control process exhibits large changes in response time or sensitivity, see Figure 4-8 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. Up to are three sets of PID values may be chosen -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.

The active set can be selected from:
1. A digital input
2. A parameter ' Working PID Set' in the L0xPID list
3. Or you can transfer automatically in gain scheduling mode.
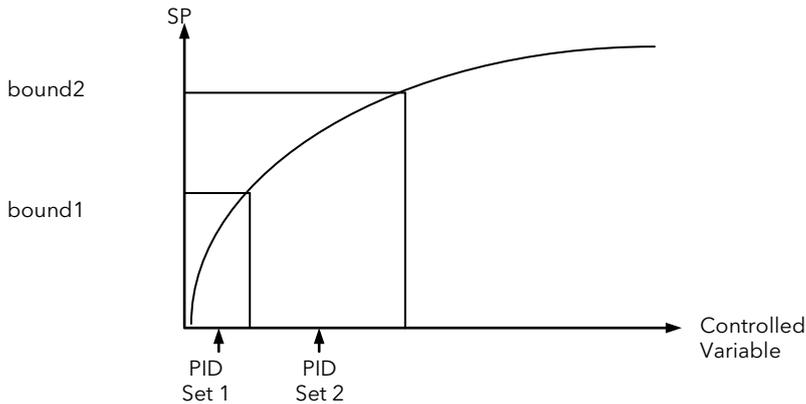
Figure 4-8:   Gain Scheduling in a Non-linear System

4.5.1. Gain Scheduling Parameters - PID Sets

These parameters are in the **Control → LOOP0x → L0xSET** list. They are not available if Control Type = OnOff in Control → LOOP0x → L0xCFG.

Figure 4-9: PID Parameter Sets

The default set up of the loop provides a single set of PID values – all Read/Write. There are 3 sets of PID values available and different strategies to select to change from one PID set to the next. These two parameters may only be changed in configuration level.

Name	Description	Range	Status
▪ nSets	**Number of PID sets to Use**. For Gain Scheduling	1, 2, 3	
▪ PidSch	**Scheduling Type**		
OFF (0)	**Off** SET 1 is used all the time		
SET (1)	**SET** No strategy, enabled sets may be selected using L0xPID.SET		
SP (2)	**SP** New set is selected when the Setpoint crosses the value of **bound1** and **bound2**		
PV (3)	**PV** New set is selected when the PV crosses the value of **bound1** and **bound2**		
ER (4)	**ER** New set is selected when the Error crosses the value of **bound1** and **bound2**		
OP (5)	**OP** New set is selected when the Output crosses the value of **bound1** and **bound2**		
RM (6)	**RM** New set is selected when the **Remote Scheduling Input** crosses the value of **bound1** and **bound2**		
WIRE (7)	**WIRE** Gain Scheduling is implemented by wiring to the PID terms using **XpSrc, TiSrc, TdSrc**.		
▪ RM	**Remote Scheduling Input.** The value used to control the active set when **Scheduling type** is set to **RM**.		
▪ RMSrc	**Remote Scheduling Input Source.** Modbus address of the parameter supplying the value for RM. –1 means it is not wired.		
▪ AnVal	The current analogue value selected form AnVal1 to AnVal3		
▪ bound1	Boundary for change from Gain Scheduling Set 1 to Set 2\nDepends on the Scheduling type selected		
▪ bound2	Boundary for change from Gain Scheduling Set 2 to Set 3\nDepends on the Scheduling type selected		
▪ XpSrc	**Proportional Band Source.** Modbus address of the parameter supplying the value for Prop Band when the **Scheduling type** is set to **WIRE**. –1 means it is not wired.		
▪ TiSrc	**Integral Time Source.** Modbus address of the parameter supplying the value for Integral Time when the **Scheduling type** is set to **WIRE**.. –1 means it is not wired.		
▪ TdSrc	**Derivative Time Source.** Modbus address of the parameter supplying the value for Derivative Time when the **Scheduling type** is set to **WIRE**.. –1 means it is not wired.		

Parameters PB1, Ti1, Td1, rES1, Hcb1, LcB1, rEL1 are the PID parameters for set 1. They are the same as those described in section 4.4.6. and are repeated for sets 2 and 3.

Parameters OPH1, OPL1 to OPH3, OPL3 are the output limit parameters for each set which are the same as those described in section 4.8.2.

Parameters AnVal1 to 3. are customisable parameters which provide additional flexibility when designing a control strategy. They are available for each set when gain scheduling has been configured and for each loop configured. They can be 'soft wired' to perform a specific function relevant to the particular process being controlled. Examples include: Output Power Limit, SP feedforward Trim, etc.

4.6.   LOOP SETPOINT

This page is used to configure parameters which define the setpoint to a control loop.
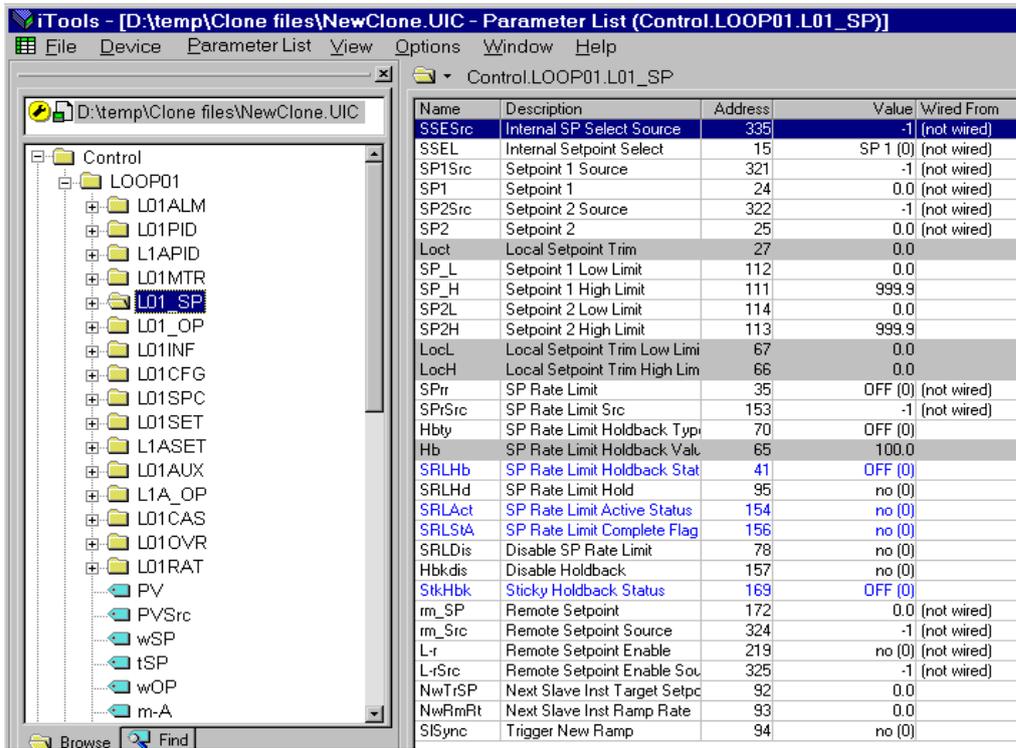
Figure 4-10: Loop Setpoint

The Working Setpoint is the setpoint used by the control loop and may be derived from a number of different sources.

4.6.1. Setpoint Parameters

These parameters are in the **Control → LOOP0x → L0x_SP** list.

Name	Description		Range	Status
▪ **SSESrc**	**Internal SP Select Source** Modbus address of the flag used to select SP1 or SP2 -1 means it is not wired			
▪ **SSEL**	**Internal Setpoint Select**. If this is not wired the setpoint can be selected from:-			
SP1 (0)	**Setpoint 1**	Internal setpoint 1		
SP2 (1)	**Setpoint 2**	Internal setpoint 2		
▪ **SP1/2Src**	Modbus address of the parameter supplying the value of SP1/2 -1 means it is not wired			
▪ **SP1/2**	Current value of SP1/2 Note Control → LOOPnn → Lnn_SP → L-r must not be set.			
▪ **SP_L**	Minimum value allowed on SP1		·%	
▪ **SP_H**	Maximum value allowed on SP1		·%	
▪ **SP_2L**	Minimum value allowed on SP2		·%	
▪ **SP_2H**	Maximum value allowed on SP2		·%	

4.6.2. Rate Limit and Holdback Parameters

These parameters are also in the **Control → LOOP0x → L0x_SP** list.

Holdback is used to stop the setpoint ramp when the Process Variable is unable to keep up with the changing setpoint. This is selected by:-

Name	Description		Range	Status
▪ **SPrr**	**SP Rate Limit**. To set the rate at which the setpoint changes			
OFF (0)	No setpoint rate limit			
Value	Setpoint rate of change is limited to this value			
▪ **SPrSrc**	Modbus address of the parameter supplying the value of SPrr -1 means it is not wired			
▪ **Hbty**	Sets the holdback strategy for setpoint ramps			
OFF (0)	No holdback			
Lo (1)	Setpoint ramp is held back when the PV is below the Setpoint by the Holdback value			
Hi (2)	Setpoint ramp is held back when the PV is above the Setpoint by the Holdback value			
bAnd (3)	Setpoint ramp is held back when the PV is below or above the Setpoint by the Holdback value			
▪ **SRLHb**	The SP ramp is currently:-			📖
OFF (0)	ramping			
HbAc (1)	on Hold			
▪ **SRLHd**	**SP Rate Limit Hold.** Stops the SP ramp			
no (0)	enabled			
YES (1)	on Hold			
▪ **SRLAct**	**SP Rate Limit Active Status.**			📖
no (0)	**no** Setpoint rate limit not active			
YES (1)	**Yes** Ramping			
▪ **SRLStA**	**SP Rate Limit Complete Flag.** SP ramp has			📖
no (0)	**no** NOT reached the Target SP			
YES (1)	**Yes** reached the Target SP			
▪ **SRLDis**	**Disable SP Rate Limit.** Select from:-			
no (0)	**no** Setpoint rate limit enabled			
YES (1)	**Yes** Setpoint rate limit disabled			
▪ **Hbkdis**	**Disable Holdback.** Select from:-			
no (0)	**no** Holdback enabled			
YES (1)	**Yes** Holdback disabled			
▪ **StkHbk**	**Sticky Holdback Status.** As the above flag could be set and reset very frequently as the PV tries to follow the SP, a second output - Sticky Holdback Status - is provided. This will remain permanently on if the PV is achieving at least half the rate of the setpoint. This output is used to give a consistent message over communications to show that Holdback has very recently been active			

4.6.3. Remote Setpoint Parameters

These parameters are also in the **Control → LOOP0x → L0x_SP** list.

Name	Description	Range	Status
▪ **rm_SP**	**Remote Setpoint**. A setpoint can be wired from a remote source to replace the local setpoint		
▪ **rm_Src**	**Remote Setpoint Source**. The source from which the remote setpoint is wired		
▪ **L-r**	**Remote Setpoint Enable**. Allows the 'Remote' setpoint to replace the Internal setpoint, or to act as a trim to the Internal Setpoint. Alternatively the Internal Setpoint can trim the Remote Setpoint. This is selected using the '**Remote Setpoint Configuration**' in the Loop SP Configuration List.		
no (0)	no SP1 or SP2 is being used by the PID		
YES (1)	Yes The remote setpoint is being used by the PID		
▪ **L-rSrc**	**Remote Setpoint Enable Source**. The source from which the remote setpoint enable is wired		

4.6.4. Control Setpoint – Ramp Parameters

These parameters are also in the **Control → LOOP0x → L0x_SP** list.

They are used to synchronise ramp segments over a number of 2500 controllers, using communications.

Name	Description	Range	Status
▪ **NwTrSP**	**Next Slave Instrument Target Setpoint**. The next setpoint to be loaded into the Rate Limit block		
▪ **NwRmRt**	**Next Slave Instrument Ramp Rate.** The next rate limit to be loaded into the Rate Limit block		
▪ **SlSync**	**Trigger New Ramp.** Load the next values into the ramp block		
no (0)	no New Ramp not triggered		
YES (1)	Yes New Ramp triggered		

The following parameters may be hidden if not required for the operation of the instrument. To reveal uncheck the 'Hide Parameters' box in 'Options → Parameter Availability Settings'

▪ **Loct**	**Local Setpoint Trim**. A fixed 'offset' value applied to the working setpoint	📖
▪ **LocL**	**Local Setpoint Trim Low Limit**. To set a high limit on the setpoint trim value	📖
▪ **LocH**	**Local Setpoint Trim High Limit**. To set a low limit on the setpoint trim value	📖
▪ **Hb**	**SP Rate Limit Holdback Value**. Sets the allowed error, in Engineering Units, between SP and PV before Holdback is invoked. Not available if SP Rate Limit Holdback Type = OFF. There is a separate Disable Holdback input	

4.7.   LOOP SETPOINT CONFIGURATION

These parameters set up or configure the way in which the loop setpoints are designed to operate.
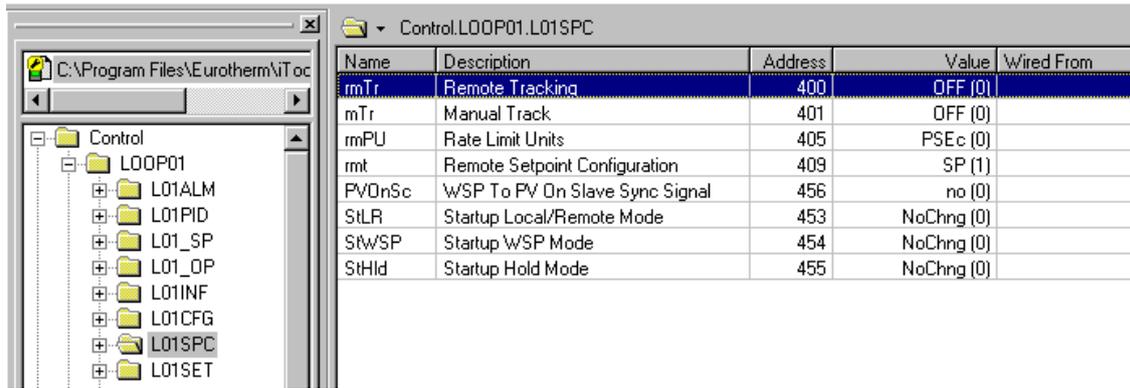
Figure 4-11: Loop Setpoint Configuration

4.7.1. Setpoint Function Block

The schematic diagram below shows how the setpoints are connected and selected and where the setpoint limits are applied.
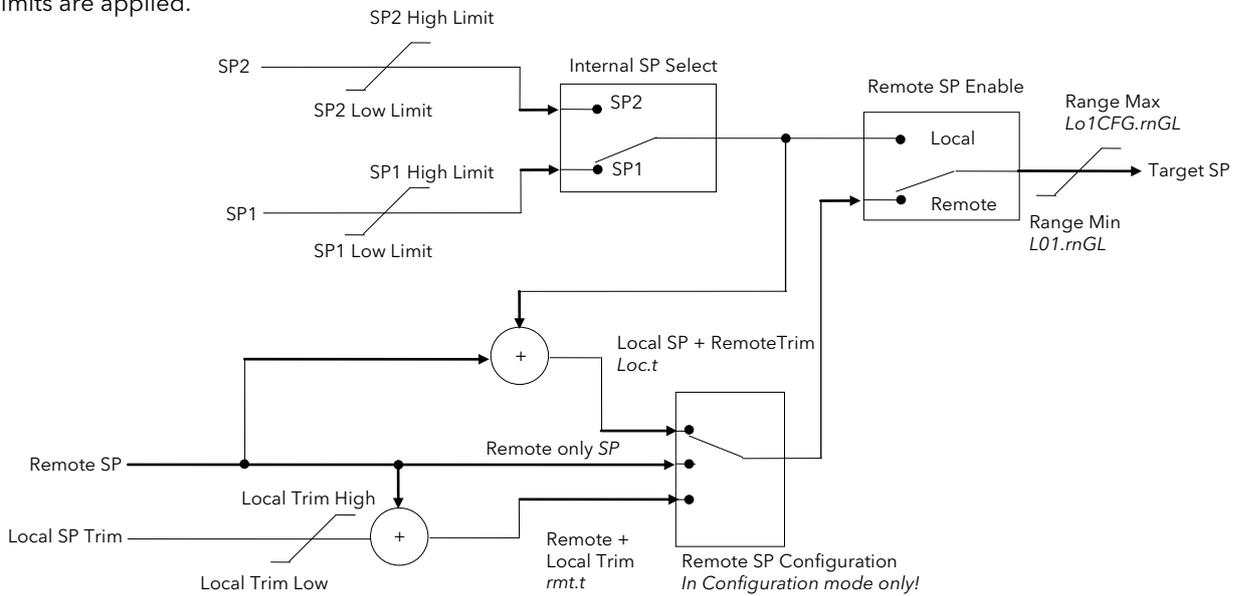
Figure 4-12:   Setpoint Function Block Schematic

The Remote Setpoint Configuration is in the Setpoint Configuration List (Control → LOOP0x → L0xSPC) and can only be changed in Configuration Mode. The other parameters appear in the Setpoint Parameter List (L0x_SP). This list will change depending on the Remote Setpoint Configuration selected.

The Target setpoint is then fed to a ramp block that applies a Rate Limit to setpoint of the PID. There is a rate limit enable/disable input.
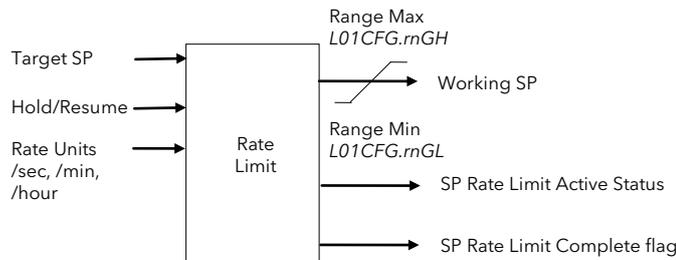
Figure 4-13:   Setpoint Rate Limit Schematic

Rate limit units are selected in Setpoint Configuration List.

4.7.2. Setpoint Configuration Parameters

These parameters are in the **Control → LOOP0x → L0xSPC** list.

Name	Description			Range	Status
▪ **rmTr**	**Remote Tracking.** Defines the local setpoint behaviour when changing from Remote to Local setpoint. Read only in Operator Mode.				
OFF (0)	**Off**	Active Local setpoint will remain unchanged			
trAc (1)	**Track**	Active local setpoint will track the value of the remote setpoint			
▪ **mTr**	**Manual Track.** Defines what the active local setpoint does in Manual Mode. Read only in Operator Mode				
OFF (0)	**Off**	Local setpoint will remain unchanged			
trAc (1)	**Track**	Local setpoint will track the value of the process variable (servo)			
▪ **rmPU**	**Rate Limit Units.** Sets the rate units – Operator or Configuration Modes			🕐	
PSEc (0)	**Per second**				
Pmin (1)	**Per Minute**				
PHr (2)	**Per hour**				
▪ **rmt**	**Remote Setpoint Configuration**. In remote mode the working setpoint is modified by:-				
none (0)					
SP (1)	**Remote Setpoint**				
Loc.t (2)	**Remote Setpoint + local trim**				
rmt.t (4)	Remote trim + local setpoint				
▪ **PVOnSc**	**WSP to PV On Slave Sync Signal.** Used by an external master to servo the working setpoint to the process variable				
no (0)	**No** No sync				
YES (1)	**Yes** Sync WSP to PV				
▪ **StLR**	**Startup Local/Remote Mode.** Defines the Setpoint Mode when the controller powers up				
NoChang (0)	**No Change**	Setpoint selection remains as it was when the controller powers down			
Local (1)	**Local**	Controller takes the local Setpoint when it powers up			
Remote (2)	**Remote** Controller takes the Remote Setpoint when it powers up				
▪ **StWSP**	**Startup WSP Mode.** Defines the setpoint strategy when the controller powers up				
NoChang (0)	**No Change** The setpoint remains the same as when the controller was last used				
GotoPV (1)	**Goto PV** The setpoint takes the same value as the process value				
Go TSP (2)	**Goto TSP**	The setpoint takes the value of the Target setpoint			
▪ **StHld**	**Startup Hold Mode** . Defines the HOLD strategy when the controller powers up				
NoChang (0)	**No Change** Hold remains the same as it was when the controller was last used				
Hold (1)	**Hold**	The controller powers up in HOLD			
NoHold (2)	**NoHold**	The controller powers up in the normal ramp mode NOT in Hold			

4.8. CONTROL OUTPUT

4.8.1. Output Function Block

This block diagram shows how the parameters and limits are used on the Output of a PID block.
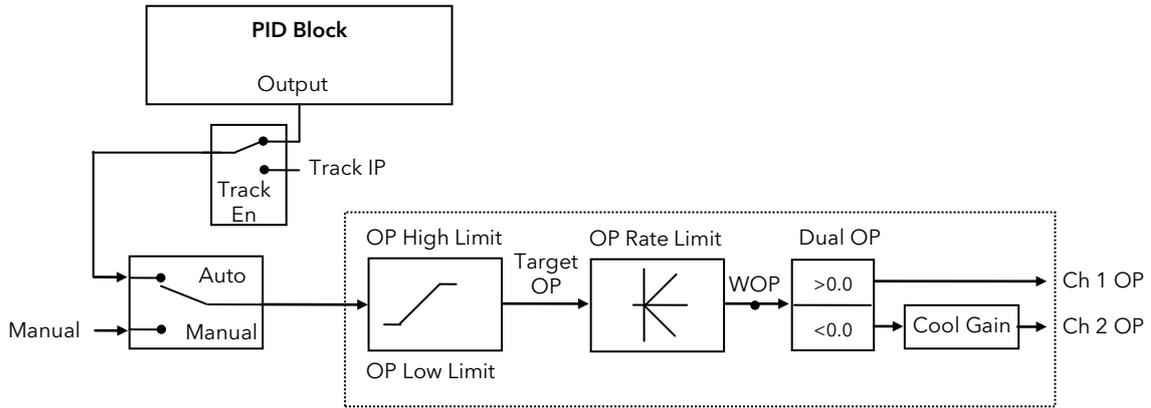
Figure 4-14: PID Output Schematic

4.8.2. Output Parameters

Figure 4-15: Output Parameters

These parameters are in the **Control → LOOP0x → L0x_OP** list.

Name	Description	Range	Status
▪ **Ch1OP**	**Ch1 Output.** The current value of channel 1 output	·%	📖
▪ **Ch2OP**	**Ch2 Output.** The current value of channel 2 output	·%	📖
▪ **OPLo**	**Low Power Limit.** Limits the minimum output demand (0 to 100%)	·%	
▪ **OPHi**	**High Power Limit.** Limits the maximum output demand (0 to 100%)	·%	
▪ **rOL**	**Remote Low Power Limit.** Limits the minimum remote output demand (-100 to 100%)	·%	
▪ **rOLSrc**	**Remote Low Power Limit Source.** Low demand limit can be wired to a parameter		
▪ **rOH**	**Remote High Power Limit.** Limits the maximum remote output demand (-100 to 100%)	·%	
▪ **rOHSrc**	**Remote High Power Limit Source.** High demand limit can be wired to a parameter		
▪ **ORL**	**Output Rate Limit Enable.** Enables the OPrr value to limit the rate of change of the Output.		
OFF (0)	**Off** The Output ramp rate is not limited.		
on (1)	**On** Enabled. The Output ramp rate will be limited by the OPrr value.		
▪ **ORLSrc**	**Output Rate Limit Enable Source.** Modbus address of the parameter used as the Output Ramp Limit Enable. –1 means not wired.		

Name	Description	Range	Status
▪ OPrr	**Output Rate Limit.** Sets the rate of change in output demand in seconds		
▪ OPrSrc	**Output Rate Limit Source.** Modbus address of the parameter used as the Output Rate Limit. –1 means not wired.		
▪ ont1	**Ch1 Output Minimum On Time.** Limits the switching rate of a relay or logic output	🕐	
▪ oSbOP	**Sensor Break Power.** Sets the demand output level in % in the event of the controlled variable being out of range	·%	
▪ TkEn	**Output Track Enable.** A feedback signal from the output is used for integral de-saturation. This signal may be derived internally or from an external source.		
no (0)	**No** Not enabled. The default internal OP is used for the integral calculation.		
YES (1)	**Yes** Enabled. The feedback signal is forced to a remote output feedback		
▪ TkESrc	**Output Track Enable Source.** The Output Track Enable Source allows an external source of output to stop integral wind up in some applications such as cascade control. The integral will calculate a PID output to match the external value when manual to auto bumpless transfer is activated		
▪ TrkIP	**Track Input.** The input value that the Output tracks when Control → LOOP0n → L0n_OP → TkEn is set to Track Enable Normally a feedback signal from the output used for integral de-saturation.		
▪ TrkSrc	**Track Input Source.** Modbus address of the parameter whose value is used as the Track input -1 means it is not wired		
PFFVal	**Power Feed Forward.** Monitors the demand supply to the controller and adjusts the output demand to compensate for changes in the supply. This parameter shows the current value of the power feed forward		📖
PFFSrc	**Power Feed Forward Source.** Provides a wireable source for the power feed forward measurement		

The following parameters may be hidden if not required for the operation of the instrument. To reveal uncheck the 'Hide Parameters' box in 'Options → Parameter Availability Settings'

▪ FOP	**Forced Output Level** Power level on transferring to Manual if the Forced Output Mode is selected in Control → LOOP01 → L01CFG → FOP		
▪ hYS1	**Hysteresis 1** Only available if Control Type set to OnOff in Control → LOOP0x → L0xCFG list. Channel 1 On Off Control \n0\tNo hysteresis or gap between output going OFF or coming ON\n>0\tGap in engineering units between the output going OFF and coming ON		
OFF (0)	**Auto** The cutback value is set by the PID Block		
Value	The hysteresis value is entered manually		
▪ hYS2	**Hysteresis 2**		
OFF (0)	**Auto** The cutback value is set by the PID Block		
Value	The hysteresis value is entered manually		
▪ ont2	**Ch2 Output Minimum On Time.** Limits the switching rate of a relay or logic output		
▪ oSbOP	**Sensor Break Power** Power applied in ON/OFF control when the sensor is detected as broken		
-100 (0)	Channel 2 fully ON		
0 (1)	Both Channels OFF		
100 (2)	Channel 1 fully ON		
▪ TkEn	**OP Track Enable** The integral is adjusted to make output track the TrkIP parameter in the L0x_OP folder		
no (0)	**No** tracking disabled		
YES (1)	Yes Output is made equal to the Track Input		
▪ TkESrc	**OP Track Enable Source** Modbus address of the flag used to enable Output Track mode -1 means it is not wired		
▪ AbPwrL	**Absolute Low Power Limit** Internal R/O parameter		📖

4.8.3. Valve Control Outputs

There are two types available Bounded or Boundless Mode. Bounded requires feedback from a potentiometer giving valve position. Boundless (sometimes known as Velocity or Unbounded mode) does not require position feedback.

Figure 4-16: Valve output Parameters

4.8.4. Valve Control Parameters

These parameters are in the **Control → LOOP0x → L0xMTR** list. This list only appears if 'Control Type' (L0xCFG List) is set to a valve position output.

Name	Description	Range	Status
tm	**Valve Travel Time.** Set to the time it takes for the valve to go from fully closed to fully open.	🕐	
Int	**Valve Inertia Time.** Set this time to the time that the motor carries on moving after the signal has ended.	🕐	
bAct	**Valve Backlash Time.** Set to compensate for any backlash in linkages	🕐	
mPt	**Minimum Pulse Time.** Sets the minimum on time of the device (normally a relay) which switches the motor	🕐	
PotHi	**Valve Positioner High Limit.** Set to the required output value with the valve at the high position.	·%	
PotLo	**Valve Positioner Low Limit.** Set to the required output value with the valve at the low position.	·%	

Sensor break action options are different for Velocity Mode (Boundless) and Position Mode.

▪ Vbr	**Boundless Sensor Break Action.**		

rESt (0)	**Rest**	remain in existing position
uP (1)	**Up**	drive valve fully open
dwn (2)	**Down**	drive valve fully closed

SbOP	**Bounded Sensor Break Action.** Set the value (in %) that the valve must move to in the event of sensor break.		
VP_OP	**VP Manual Output.** Output demand value when in manual. In manual set to 1 to raise or 2 to lower - operates for 1 minimum pulse length	·%	📖
PPos	**Pot Position.** Indicates the position of the valve from the feedback potentiometer.	·%	
PPoSrc	**Pot Position Source.** Modbus address of the parameter supplying the value of the pot position. -1 means it is not wired		
CalPot	**Pot Input Calibration Enable.**		

OFF (0)	**Off** Pot calibration disabled.
on (1)	**On** Pot calibration enabled.

4.9.   RATIO CONTROL

Ratio Control is a technique used to control a process variable at a setpoint which is calculated as a proportion of a second (lead) input. The ratio setpoint determines the proportion of the lead value that is to be used as the actual control setpoint. The ratio setpoint can be applied as either a multiplier or as a divisor to the second input.

A typical application is in gas fired furnaces where in order to achieve efficient combustion, the gas and air flow supplied to the burners needs to be maintained at a constant ratio.

4.9.1. Basic Ratio Control

Each loop in the 2500 contains a ratio control function block. Figure 4-17shows a block diagram of a simple ratio controller. The lead PV is multiplied or divided by the ratio setpoint to calculate the desired control setpoint. Prior to the setpoint calculation, the ratio setpoint can be offset by the ratio trim value and must obey the overall ratio setpoint operating limits.
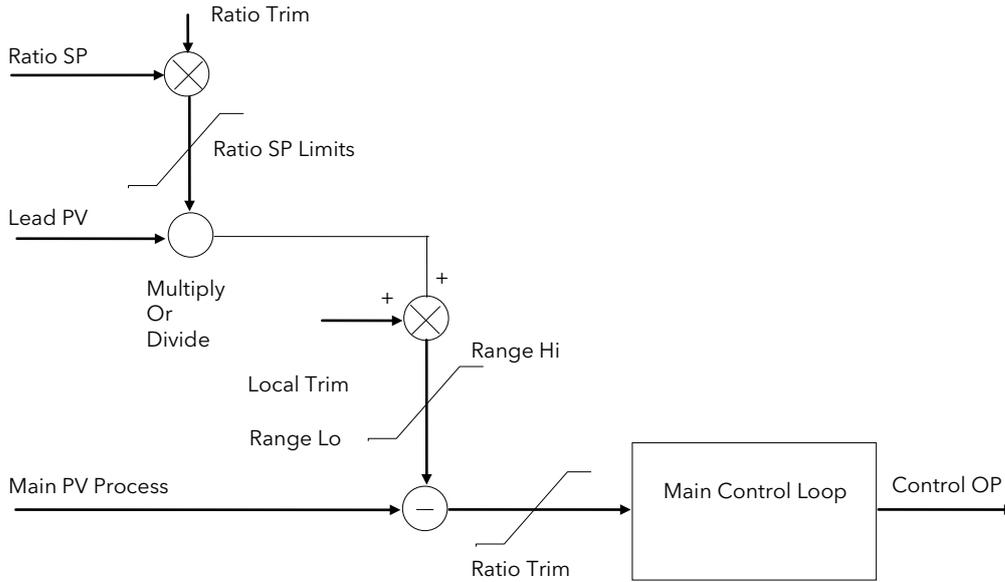
Figure 4-17:   Ratio Control Schematics

4.9.2. Ratio Parameters

Ratio control is selected by **'Loop Type'** = **'Ratio'**. This parameter is found in Control → LOOP0x → L0xCFG.

Figure 4-18:   Ratio Control Parameter List

Ratio parameters are found in **Control → LOOP0x → L0xRAT**

Name	Description	Range	Status
▪ SP	**SP** Setpoint generated by the ratio calculation in engineering units	·9	📖
▪ MRatio	**Measured Ratio** Continuous calculation of the actual measured ratio. It is calculated from the **Lead PV** and the **Process PV**.	·9	📖
▪ WRatSP	**Working Ratio SP.** The actual Ratio being using by the algorithm after limits and trim.	·9	📖
▪ RAType	**Ratio Type** Defines how the ratio is calculated. Can only be set in configuration level.		
Divide (0)	**Divide** Divides the lead PV by the working ratio setpoint		
Mult (1)	**Multiply** Multiplies the lead PV by the working ratio setpoint		
▪ RAL	**Ratio Setpoint Low Limit** Minimum range limit for the ratio setpoint	·%	
▪ RAH	**Ratio Setpoint High Limit** Maximum range limit for the ratio setpoint	·%	
▪ RatSrc	**Ratio Setpoint Source.** The modbus address of the parameter used for the ratio setpoint -1 means NOT wired		
▪ Rat_SP	**Ratio Setpoint** Adjustment of the ratio setpoint value.	·%	
▪ TriSrc	**Ratio Trim Source.** Modbus address of parameter used for the Ratio Trim SP -1 means it is NOT wired		
▪ Trim	**Ratio Trim** Adjustment of the ratio trim value.	·%	
▪ LeaSrc	**Lead PV source.** Modbus address of parameter used for the Lead PV -1 means it is NOT wired		
▪ LeadPV	**Lead PV** The measured parameter used to ratio the process variable.	·9	
▪ REn	**Ratio Enable** Ratio control may be switched off, eg, during commissioning		
OFF (0)	**Off** Ratio is not used – PID uses the local setpoint only. The parameter 'Ratio Valid' will show YES.		
on (1)	**On** Ratio is calculated and used. The parameter 'Ratio Valid' will show no.		
▪ REnSrc	**Ratio Enable source.** Modbus address of parameter used for the Ratio Enable. -1 means it is NOT wired		
▪ RatTrk	**Ratio Track Mode** Defines the ratio tracking strategy. Can only be set in configuration level.		
OFF (0)	**OFF** Ratio track is disabled		
on (1)	**ON** whenever '**Ratio Enable**' is set to 'Off' the **Ratio SP** will track the measured ratio. This feature allows the user to set the Ratio SP according to the current condition of the process.		
▪ RatVld	**Ratio Valid.**		📖
no (0)	Ratio is valid or disabled		
YES (1)	Ratio is enabled and no sensor break		

4.10. CASCADE

4.10.1. Overview

Cascade control is classified as an advanced control technique used, for example, to enable processes with long time constants to be controlled with the fastest possible response to process disturbances, including setpoint changes, whilst still minimising the potential for overshoot. It is a combination of two PID controllers, where the output signal from one (the master) forms the setpoint for the other (the slave). For cascade control to be effective the slave loop should be more responsive than the master.

4.10.2. Trim Mode

The 2500 controller uses trim mode cascade control an example of which is shown in Figure 4-19. The slave controls the temperature in a furnace. The master is measuring the temperature of the workpiece and controlling the setpoint of the slave. In this case the master trims the setpoint of the slave rather than controlling it directly. By limiting the amount of trim the temperature of the furnace will remain within bounds.

Feedforward allows either the master PV, master SP or a user defined variable (FF_Src) to be fed forward so that it directly influences the slave setpoint.

A typical application for SP feedforward could be in a heat treatment furnace, where it can be used to extend the life of heating elements by limiting their maximum operating temperature.

An application using PV feedforward could be in autoclaves or reactor vessels where it is sometimes required to protect the product from excessive temperature gradients (also referred to as Delta T Control). The effect of this is to limit the furnace temperature to a band around the target temperature.

Feedforward can also be a user defined variable in trim mode in the same way as full scale mode
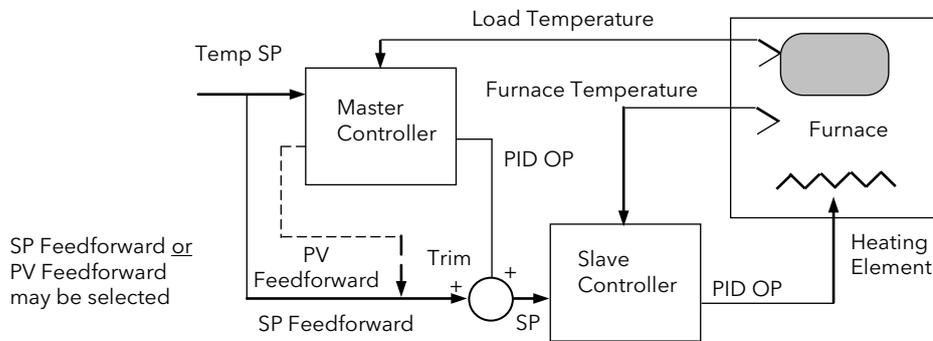
Figure 4-19: Cascade Trim Control

4.10.3. Auto/Manual Operation in Cascade

Auto/Manual operates on both master and slave loops.

When the controller is placed in manual the slave working setpoint will track the value of the slave process value continually, therefore ensuring bumpless transfer.

When cascade is deactivated the master loop will monitor the setpoint of the slave loop and provide a smooth transition of output demand when the loop moves back to cascade mode.

4.10.4. Cascade Controller Block Diagram
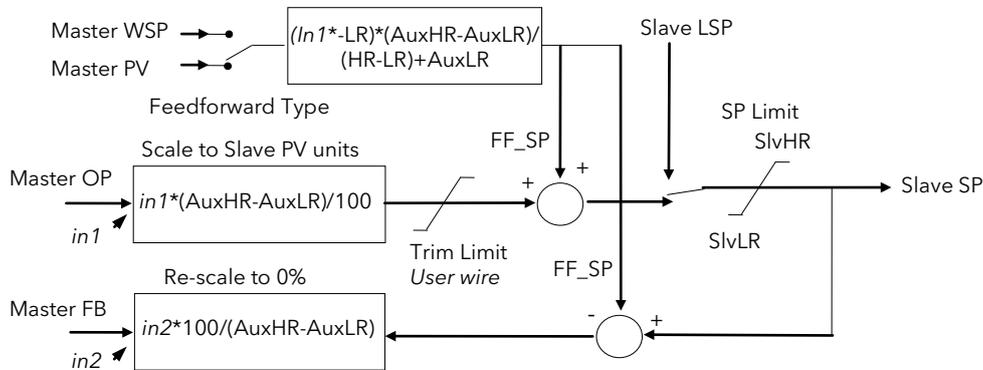
Figure 4-20: Cascade Controller in Trim Mode

In the 'L01CFG' Parameter list 'Feedforward Type' must be set to 'FEEd' and the 'Remote Feedforward' input value is displayed in 'L01PID'.

4.10.5. Cascade Parameters

Cascade control is selected by the **LoopType** = **Cascade** .
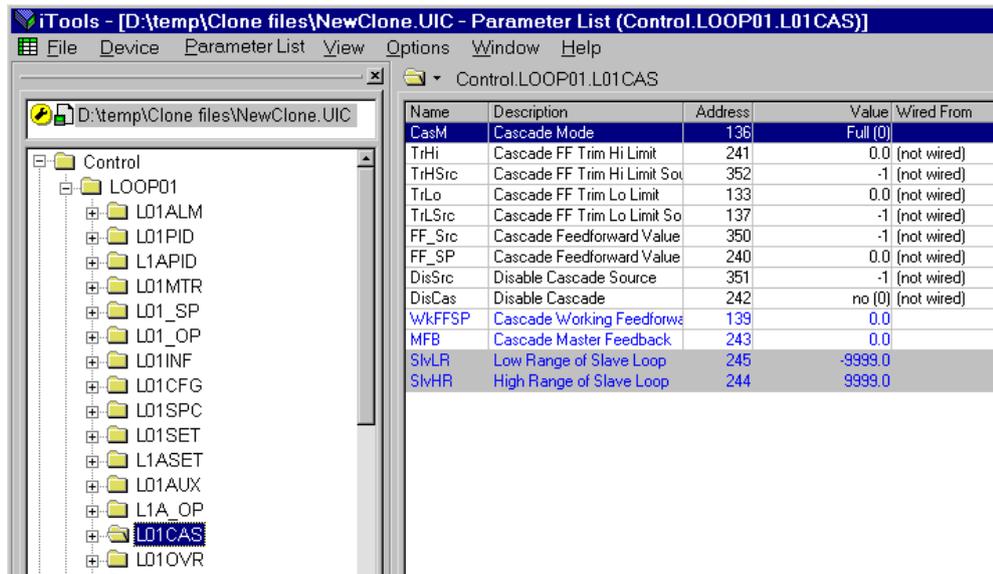
Figure 4-21: Cascade Control Parameter List

Cascade parameters are found in **Control → LOOP0x → L0xCAS**.

Name	Description	Range	Status
▪ **CasM**	**Cascade Mode.** Selected Cascade Mode		
Full (0)	Full scale Cascade mode		
Full FF (1)	Full scale feed forward mode		
SP.FF (2)	Setpoint feed forward mode		
PV.FF (3)	PV feed forward mode		
▪ **TrHi**	**Cascade Feedforward Trim High Limit.** The external analogue input being used as high limit for the PID contribution in Feedforward or the Cascade feedforward using remote input		·9
▪ **TrHiSrc**	**Cascade Feedforward Trim High Limit source** Modbus address of parameter used as the cascade Feed Forward Trim High Limit. -1 means it is NOT wired		
▪ **TrLo**	**Cascade Feedforward Trim Low Limit.** The external analogue input being used as low limit for the PID contribution in Feedforward or the Cascade feedforward using remote input		·9
▪ **TrLoSrc**	**Cascade Feedforward Trim Low Limit source** Modbus address of parameter used as the cascade Feed Forward Trim Low Limit. -1 means it is NOT wired		
▪ **FF_Src**	**Cascade Feedforward Value Source.** Modbus address of parameter used as the cascade Feed Forward -1 means it is NOT wired		
▪ **FF_SP**	**Cascade Feedforward Value.** The external analogue input being used for feedforward in the same eng units as PV		·9
▪ **DisSrc**	**Disable Cascade Source.** Modbus address of flag used to disable cascade. -1 means it is NOT wired		
▪ **DisCas**	**Disable Cascade.** It is sometimes useful to disable cascade when starting the process. This parameter provides a simple way to do this, particularly if it is wired using DisSrc. When disabled the auxiliary loop is turned off and the controller returns to single loop mode using the local setpoint		
no (0)	The cascade loops are both active		
YES (1)	Only the slave loop is active		
▪ **WkFFSP**	**Cascade Working Feedforward Value.** The working feed forward value after trim and limit.		·9
▪ **MFB**	**Master Feedback Value.** Cascade master PID feedback value.		·9

Name	Description	Range	Status
The following parameters may be hidden if not required for the operation of the instrument. To reveal uncheck the 'Hide Parameters' box in 'Options → Parameter Availability Settings'			
▪ **SlvHR**	**High Range of Slave Loop.** Maximum value of the PV of the auxiliary loop	·9	
▪ **SlvLR**	**Low Range of Slave Loop.** Minimum value of the PV of the auxiliary loop	·9	

4.10.5.1.   Auxiliary Loop

Note in the Browser section in Figure 4-21 there are folders for the Auxiliary loop:

L1APID	PID parameters
L1ASET	PID parameters Sets
L01AUX	Loop set up
L1A_OP	Loop output set up.

The master loop has to be configured in a similar manner to the slave loop. This is done in the same way as the main (slave) loop, though there are fewer parameters in each list.

4.11. OVERRIDE

Overview

Override Control allows a secondary control loop to override the main control output in order to prevent an undesirable operating condition. The override function can be configured to operate either in minimum, maximum or select mode.

A typical example can be implemented in a heat treatment furnace with one thermocouple attached to the workpiece, and another situated close to the heating elements. Control of the furnace during the heating up period is regulated by the override (heating element) temperature controller which provides a safeguard against overheating. Control of the furnace will switch over to the workpiece temperature controller at some point when the temperature is near to its target setpoint. The exact point of switchover is determined automatically by the controller, and will be dependent on the selected PID terms.

Simple Override

Override control is available with analogue, time proportioning and ON/OFF control outputs. It is not available with valve position outputs. Figure 4-22 shows a simple override control loop. The main and override controller outputs are fed to a low signal selector. The override controller setpoint is set to a value somewhere above the normal operating setpoint, but below any safety interlocks.

There is only one Auto Manual switch for both loops. In manual mode the control outputs of both loops track the actual output, ensuring bumpless transfer when auto is selected. The transfer between main and override PID control is also bumpless.
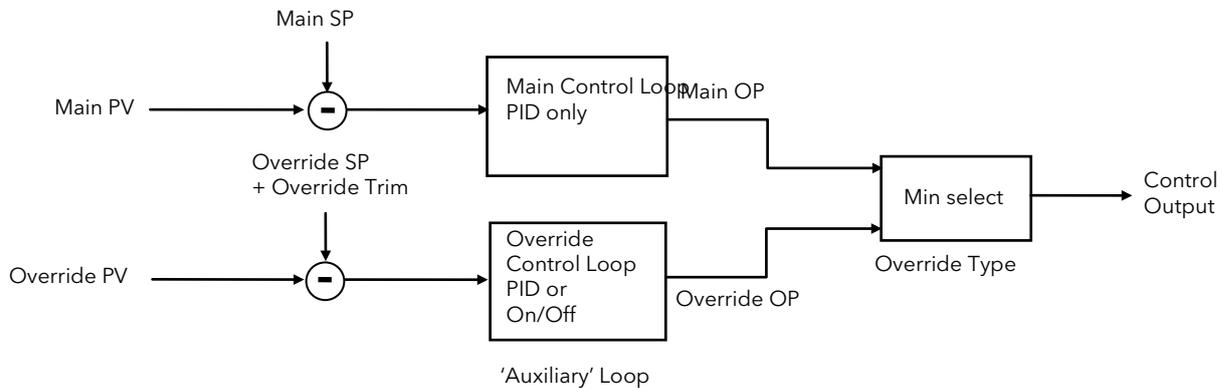
Figure 4-22: Override Control Schematic

4.11.1. Override Parameters

Override is configured by setting **L0xCFG → Loop Type** to **Override**.
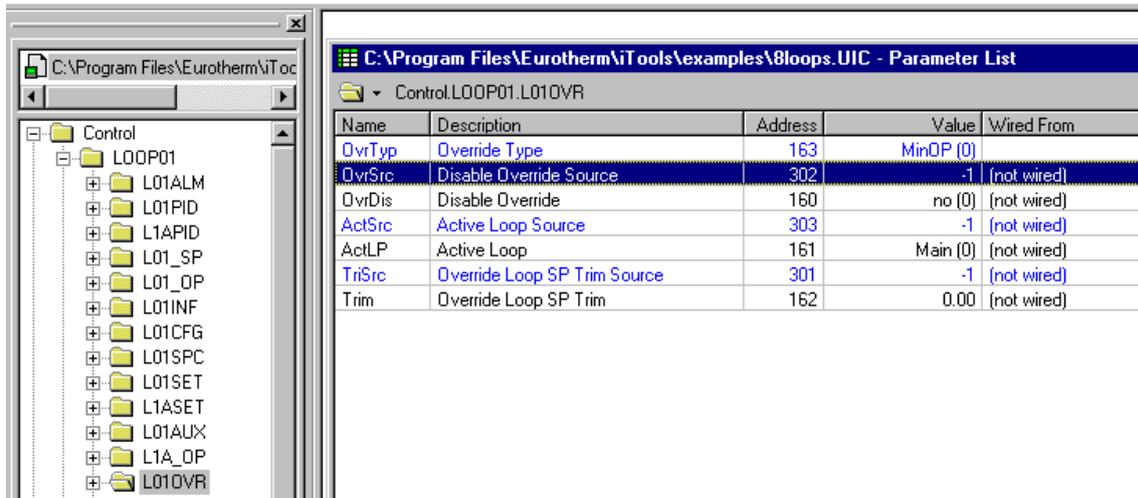
Figure 4-23: Override Control Parameter List

Override parameters are found in **Control → LOOP0x → L0xOVR**.

Name	Description	Range	Status
▪ OvrTyp	**Override Type.** Override Type Defines the strategy for Override Control		
MinOP(0)	The working output demand is the minimum of the Main and Aux output demands		
MaxOP(1)	The working output demand is the maximum of the Main and Aux output demands		
Select(2)	Select which loop is active using Control → LOOP0x → L0xOVR → ActLP		
▪ OvrSrc	**Disable override source.** Modbus address of flag used to disable the override control -1 means NOT wired		
▪ OvrDis	**Disable override.** It is sometimes useful to disable override when starting the process. This parameter provides a simple way to do this, particularly if it is wired using OvrSrc. When disabled the controller returns to single loop mode using the local setpoint		
no (0)	**no** Both Main and Auxilliary loops are active		
YES (1)	**YES** Only the main loop is active		
▪ ActSrc	**Active loop source.** Modbus address of parameter used to SELECT active loop -1 means it is NOT wired		
▪ ActLP	**Active Loop.** Indicates which loop is currently controlling the process or can be set if Control.LOOP0x → L0xOVR → OvrTyp is set to SELECT		
Main (0)	The main loop is active		
Aux (1)	The auxiliary loop is active		
▪ TriSrc	**Override Loop SP Trim source.** Modbus address of parameter used as the Override SP Trim -1 means it is NOT wired		
▪ Trim	**Override Loop SP Trim.** SP trim for the Override auxiliary loop	·9	

4.12.   TUNING

In tuning, you match the characteristics 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 Control → L0xPID list. This may be done manually or automatically. The following section describes automatic tuning.

4.13.   AUTOMATIC (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 during tuning, then the levels can be restricted by setting the '**Autotune High Power Limit'** (TnOH) and '**Autotune Low Power Limit**' (TnOL). These limits are only applied during the autotune process. However, the measured value *must* oscillate to some degree for the tuner to be able to calculate values.

Under normal control the output power limits may be set by '**Low Power Limit'** and '**High Power Limit**' found in Control → L0x_OP list. If these limits are set to a lower value than the autotune limits, then the autotune high and low power limits will be clipped to the output limits as soon as Autotune is run.

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.

4.13.1. Autotune Parameters

In the 2500 Loops do not have their own individual Autotune. There is a single tuning block available to be used on the loops one at a time. There is no configuration required.

Figure 4-24:   Auto Tune Parameter List

Autotune parameters are found in **Control → ATUN** list.

Name	Description	Range	Status
▪ tuning	**Tuning Active.** Set if the tuning block is active. Note that there is only 1 tuning block which has to be used to tune the internal loops one by one, using Control → ATUN → TnLpNr		📖
OFF (0)	Tuning Inactive		
on (1)	Tuning in progress		
▪ TnOL	**Auto tune low power limit.** Set this to limit the minimum output demand 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	·%	

Name	Description	Range	Status
▪ **TnOH**	**Auto tune high power limit.** Set this to limit the maximum output demand 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	·%	
▪ **TnStat**	**Tuning State.** Reports the state of the individual PID loop tuning		📖
OFF (0)	Not tuning		
Noise (1)	Monitoring noise		
Init (2)	Initialising		
Start (3)	Start tune at current setpoint		
Start (4)	Start tune at new setpoint		
NewSP (5)	Tune to new setpoint		
Min (6)	Find minimum		
Max (7)	Find maximum		
Store (8)	Store zero time		
Zero (9)	Set output to zero		
Calc (10)	Calculating PID values		
Abort (11)	Tuning aborted		
DONE (12)	Tuning complete		
▪ **CTStat**	**CascadeTuning State.** Reports the state of tuning a cascade loop. The auxiliary loop is tuned first followed by the main		📖
OFF (0)	Not tuning		
Init (1)	Initialising the auxiliary loop		
Aux PID (2)	Tuning the auxiliary loop		
Wait (3)	Wait		
Wait2 (4)	Wait again		
Init (5)	Initialising the main loop		
PID1 (6)	Tuning main PID		
▪ **TnOP**	Actual output demand that the tuner is requesting	·%	📖
▪ **TnLpNr**	**Tune Loop Number.** Choose the required loop. Autotune starts when the loop is chosen		
OFF (0)	Not tuning		
L01PID(11)	Tune loop 1		
L1APID(12)	Tune auxiliary loop 1		
L1CASC(13)	Tune cascade loop 1		

The above three parameters are repeated for as many loops as supplied up to a maximum of eight. Add '10' to the enumerated values shown above for each loop. For example L02PID has the value (21) and so on.

Name	Description	Range	Status
▪ **TnPID**	**Tune PID Number.** Reports which loop is being tuned		📖
OFF (0)	Tuning inactive		
L01PID (1)	Tuning loop 1		
L1APID (2)	Tuning auxiliary loop 1		

The above two parameters are repeated for as many loops as supplied up to a maximum of eight. The enumerated values become (3) and (4) for loop 2 and so on.

Name	Description	Range	Status
▪ **TnWSP**	**Working SP of Current Tune Stage.** Actual SP that the tuner is currently using.	·%	📖
▪ **STime**	**Current Tune Stage Time.** The time spent in the current tune stage.	🕐	📖

4.13.2. Cascade Tuning

When tuning a cascade loop it is necessary that both master and slave loops are tuned. It is recommended that each loop is tuned independently using the procedure below.

Because the slave loop is used by the master loop it must be tuned first.

4.13.3. Example: To Tune a Full Scale Cascade Loop

Step 1. Configure the loop as cascade full scale as follows:-

In L0xCNF	Set 'Loop Type' = Cascade
In L0xCNF	Set 'Feedforward Type' = FEEd
In L0xCAS	Set 'Disable CSD' = Yes
In L0x_SP	Set 'Setpoint 1' = the normal operating setpoint value for the main loop
In L0x_SP	Set 'Local SP' = the normal operating setpoint value for the slave loop (when cascade is disabled)

Step 2. Start the controller in Operator Level

Step 3. Set tune output high and low limits as follows:

Note: For the slave tune you may wish to restrict the ability of the tuner to disturb the process. Tune OH should, therefore, be set to a value that will only enable the tune to achieve the local setpoint which you have chosen.

In ATUNE	Set 'TnOL' to a value which will limit the minimum output demand during tuning. This may be 0.0 for a heat only loop.
	Set 'TnOH' to a value which will limit the maximum output demand during tuning.

Step 4. Start tune on the slave loop as follows:

In ATUNE   Set 'Tune Loop Number' to L1APID

Step 5. You may monitor the progress of the tune by viewing the following parameters:

In ATUNE	'TnStat'	This indicates which step is being performed
	'TnOP'	The output demand of the autotune. For a slave loop this will be the same as the working output demand.
	'CTStat'	The length of time this particular step has been running. The tune step will abort after two hours

Step 6. On completion of the slave loop tuning:

Keep the loop in Cascade Disabled, and allow the slave loop to control the process. You must allow the slave loop to control at its Local SP. Wait for the master loop to settle to a steady state value. (Note, it is unlikely that the master loop steady state is the same as the slaves).

When the master PV is at a steady value proceed with tuning the master loop. (Note, if the master loop has not settled satisfactorily you may not be able to tune the master loop at all, since it is necessary to restrict the disturbance of the slave when tuning the master.

Step 7. Tune the master loop

In ATUNE	Set 'TnOL' and 'TnOH'
	The values chosen should be symmetrical and chosen such that the slave stays in control (typically $\pm$ 0.5 * slave proportional band).
	This amount, however, may not be sufficient to disturb the master to achieve a successful tune. If the proportional band of the master is in engineering units, the tune hysteresis of the master will be $\pm$1 engineering unit. For a temperature loop, therefore, the master must be disturbed by at least 1 degree.
	TnOL and TnOH are set in %. Although it is the master which is being tuned, it is the slave working SP which has to be modified in order to achieve a change in the output and hence measure a disturbance in the master PV. Therefore, TnOL and TnOH relate to a percentage of the slave range by which the slave working SP will be changed.
	For example, if the slave has a range of –200 to +1372 the slave range is 1572 and TnOL and TnOH are 1%, then the slave working setpoint will be modified by $\pm$ 15.72 degrees.
In ATUNE	Set 'TnLpNr' to L0xPID
In L0xCAS	Set 'DisCas to 'No'
	This is to re-enable cascade mode and must be done before the time out period of 1 min

Step 8: Return to control

The slave and master loops should now be tuned. Try changing the main setpoint and observe the response. If the master PV response is oscillatory then you may not have restricted the disturbance of the slave enough. Try decreasing the values of 'TnOL' and TnOH' and retune the master.

To invoke tune select **Tune Loop Number** to the particular loop that requires to be tuned.

Loop Number	Tunes	Write Value via Comms
1	L01PID (Slave)	11
1	L1APID (Master)	12
1	L1 Cascade pair	13
2	L02PID (Slave)	21
2	L2APID (Master)	22
2	L2 Cascade pair	23
3	L03PID (Slave)	31
Etc	Etc	etc

Table 4-1: Tuning via Comms

Setting **Tune Loop Number** to 0 (OFF) will discontinue tuning.

If the sequence of tuning loops one by one is being handled by a supervisory system over communications, then the system should monitor the **Tuning Active** flag and wait for that to reset, or wait until **Tune Loop Number** is reset to 0, before setting **Tune Loop Number** to the value for the next Loop to be tuned.

The remaining parameters give diagnostic information about what the tuning block is doing.

Tuning	Cascade Tuning
OFF	OFF
Noise	Init
Init	AuxPID
Start	Wait
Start	Wait2
NewSP	Init
Min	PID1
Max	
Store	
Zero	
Calc	
DONE	

Table 4-2: Auto Tuning States

4.14. LOOP DIAGNOSTICS
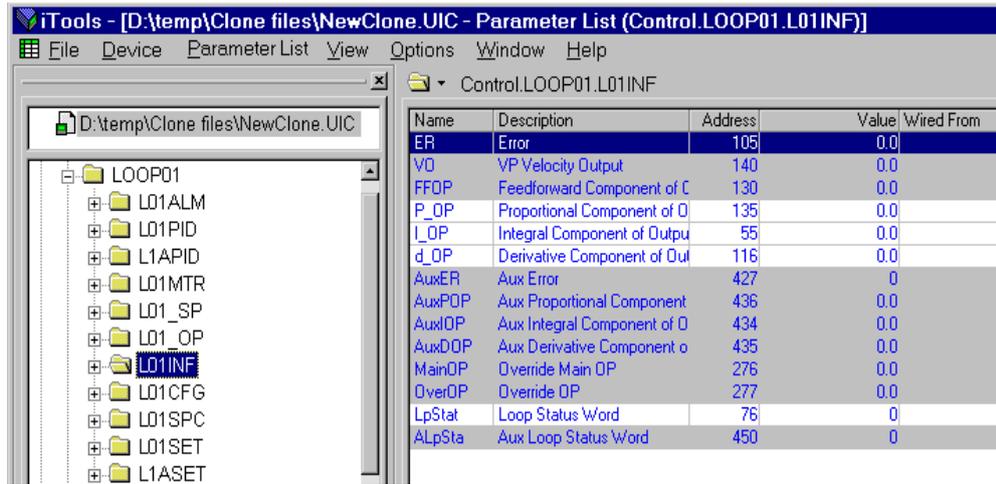
Figure 4-25: Loop Diagnostic Parameter List

All these parameters are read only and are mostly of use in diagnosing control problems.

4.14.1. Loop Status Word

The **Loop Status Word** (and the equivalent for the Auxiliary Loop) is useful for a supervisory system to read and to display loop status. Each of the 16 bits in the word represents a condition.

Bit	Value (Decimal)	Bit set
0	1	Hold
1	2	Sensor Break
2	4	SP ramp active
3	8	Remote SP selected
4	16	SP servo
5	32	Debump
6	64	Loop Break
7	128	Integral Hold
8	256	Remote SP fault
9	512	Direct Action
10	1024	Track
11	2048	Power Limit
12	4096	Autotune
13	8192	Adaptive tune
14	16384	Droop Tune
15	32768	Manual

Table 4-3: Loop Status Word

4.15. LOOP ALARMS

Each Loop has 4 alarms which apply to the Loop Process Variable. They may be set to Absolute High, Absolute Low, Deviation High, Deviation Low, and Deviation band. One of four alarms, Alarm 4, may also be set as a 'rate of change' alarm.

The alarm function blocks have many features. All the alarms in the 2500 use the same function block and are described in detail in Chapter 5.

5. Chapter 5   Alarms

5.1.   DEFINITION OF ALARMS AND EVENTS

Alarms are used to set a flag when a pre-set level has been exceeded (an analogue alarm) or an event has occurred (a digital alarm). The flag may be used to switch an output - usually a relay - to provide interlocking of the machine or plant or external audio or visual indication of the alarm. Using Toolkit blocks various alarm flags may be wired to a single relay output using the OR function.

Alternatively the Alarms flag may just be read over communications and the 2500 supervisory system will annunciate and take the action required.

Additional alarm options are to make the alarm '**Blocking**' where a pre-condition has to be met before the alarm is enabled, or '**Latching**' where the alarm must be acknowledged before the flag is cleared.

Events are just alarms but are generally defined as conditions that occur as part of the normal operation of the plant, and are required for information or to start the next phase of the process, etc. For the purposes of the operation of the 2500, alarms and events can be considered the same.

5.2.   TYPES OF ANALOGUE ALARM USED IN THE 2500

This section describes graphically the operation of different types of alarm used in the 2500 controller. For analogue alarms the graphs show measured value plotted against time.

5.2.1. Absolute High

This alarm (**AbSHi**) occurs when the Process Variable (PV) exceeds a set high level
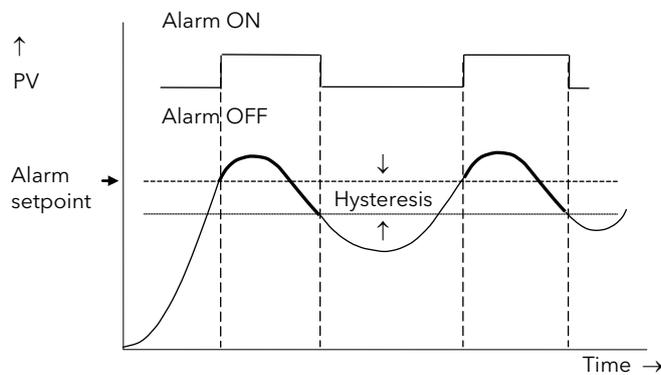
Hysteresis is the difference between the alarm ON value and the alarm OFF value. It is used to prevent relay chatter.

Figure 5-1: Absolute High Alarm

5.2.2. Absolute Low

This alarm (**ABSLo**) occurs when the Process Variable (PV) exceeds a set low level
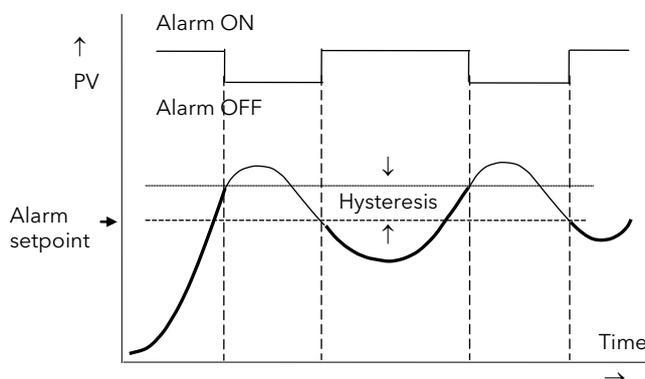
Figure 5-2: Absolute Low Alarm

5.2.3. Deviation High Alarm

This alarm (**devHi**) occurs when the difference between the process variable and the setpoint is positive by greater than the alarm setpoint.
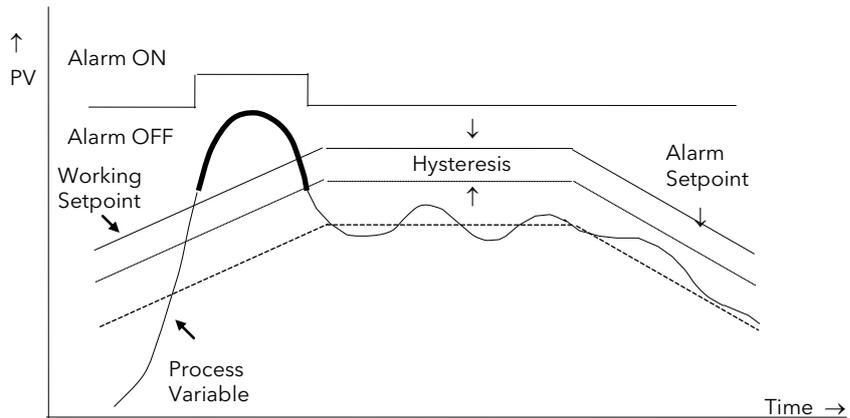
Figure 5-3:   Deviation High Alarm

5.2.4. Deviation Low Alarm

This alarm (**devLo**) occurs when the difference between the process variable and the setpoint is negative by greater than the alarm setpoint.
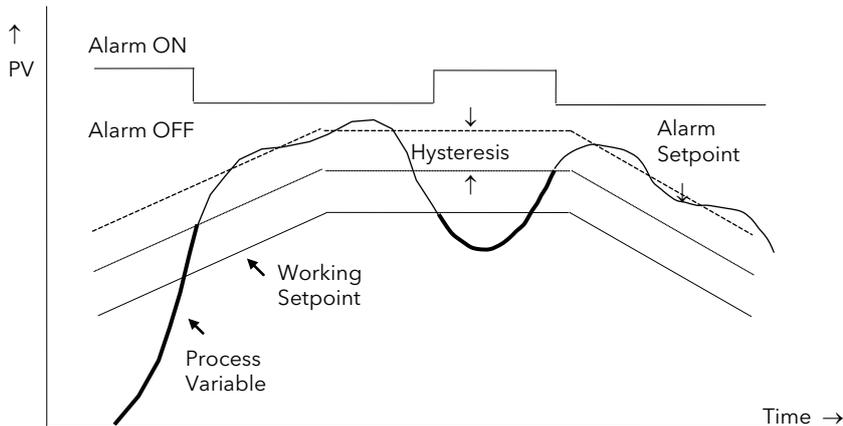
Figure 5-4:   Deviation Low Alarm

5.2.5. Deviation Band

A deviation band alarm (**dEvbnd**) monitors the process variable and the working setpoint and continuously compares the difference against the alarm setpoint. If the difference is either negative by less than, or positive by greater than the alarm setpoint, the alarm state will be active.
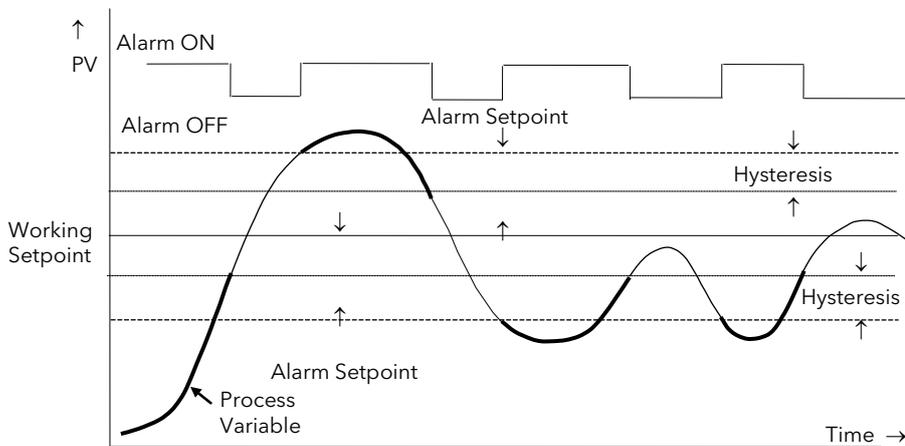
Figure 5-5:   Deviation Band Alarm

5.2.6. Rate Of Change Alarm

The Process Value falls faster than the alarm setting or rises faster than the alarm setting.
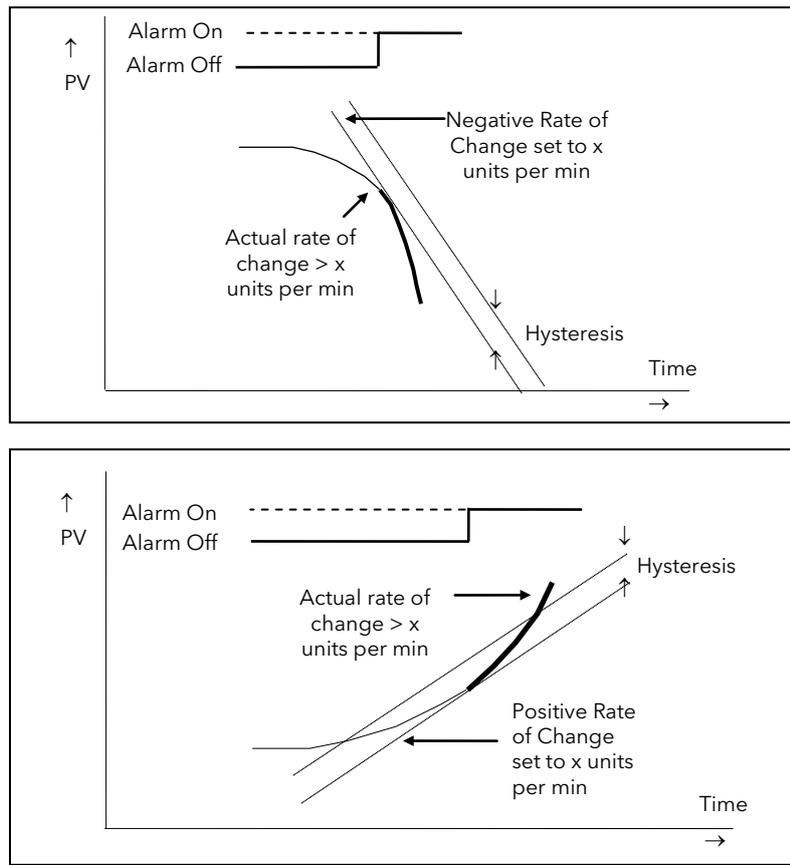
Figure 5-6:   Rate of Change Alarm

Notes:

1. The alarm is activated by excessive positive or negative rates of change
2. An alarm is indicated during the period that the actual rate of change is greater than the set rate of change.
3. There may be a small delay before the instrument displays an alarm condition since the instrument requires several samples. This delay increases if the set value and actual value are close together
4. A hysteresis value of, say, 1 unit per second will prevent the alarm from 'chattering' if the rate of change varies by this amount

5.3. TYPES OF DIGITAL ALARM USED IN THE 2500

This table describes the operation of different types of digital alarm used in the 2500 controller.

ITools List	Description
IstruE	Alarm output set when input is TRUE
ISFALS	Alarm output set when input is FALSE
GoTruE	Alarm output set when input changes from FALSE to TRUE
GoFALS	Alarm output set when input changes from TRUE to FALSE
ChAnGE	Alarm output set when input changes state

Table 5-1: Types of Digital Alarm

5.4. BLOCKING ALARMS

A Blocking Alarm only occurs **after** it has been through a start up phase. It is typically used to prevent alarms from being indicated until the process has settled to its normal working conditions.

5.4.1. Absolute Low With Blocking

The alarm only occurs **after** the start up phase when low alarm has first entered a safe state. The next time a low alarm occurs will cause the alarm to become active.
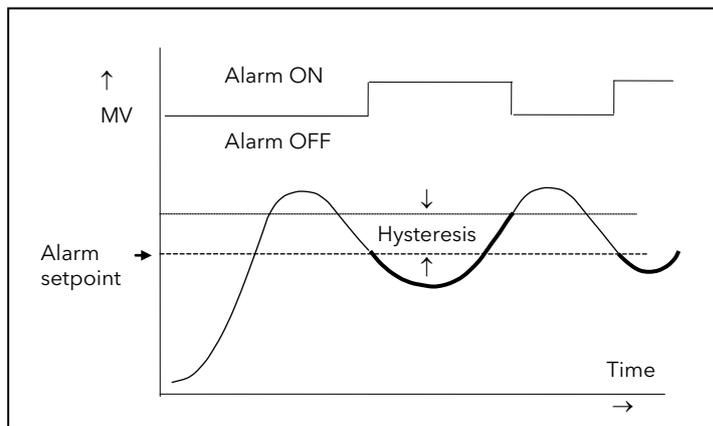
Figure 5-7: Absolute Low Blocking Alarm

5.4.2. Absolute High Alarm With Blocking

The alarm only occurs **after** the start up phase when high alarm has first entered a safe state. The next time a high alarm occurs will cause the alarm to become active.
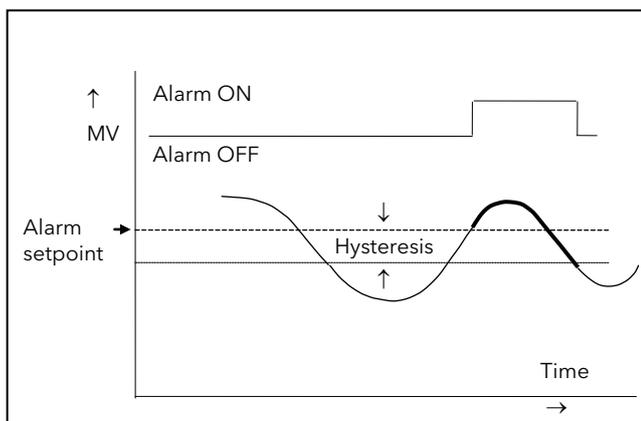
i.e. If the controller is powered up with PV > 'Hi Alarm SP' no alarm is indicated. The PV must reduce below the 'High Alarm SP' and increase again to > 'Hi Alarm SP'. The alarm condition will then be indicated.

If the controller is powered up with PV < 'Hi Alarm SP' an alarm is indicated as soon as PV > 'Hi Alarm SP'

Figure 5-8: Absolute High Blocking Alarm

5.4.3. Deviation Band With Blocking

The alarm only occurs **after** the start up phase when low deviation alarm has first entered a safe state. The next time an alarm occurs, whether high band or low band will cause the alarm to become active.

Figure 5-9: Deviation Band Blocking Alarm

5.5. LATCHING ALARMS

The alarm is indicated until it is acknowledged by the user. Acknowledgement of an alarm is by setting the Alarm acknowledge flag via communications or, using wiring, from a digital input.

To make an alarm latching there are two options, automatic (**Auto**), or manual (**mAn**).

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

2. **Manual Reset.** 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 alarm condition is removed.

These are shown below for an Absolute High Alarm

5.5.1. Latched Alarm (Absolute High) With Automatic Reset

The alarm is displayed until it is acknowledged

Figure 5-10: Latched Alarm with Automatic Reset

5.5.2. Latched Alarm (Absolute High) With Manual Reset

Acknowledging here will not reset the alarm
because it is still in an alarm condition

The alarm must first clear
before it can be reset.
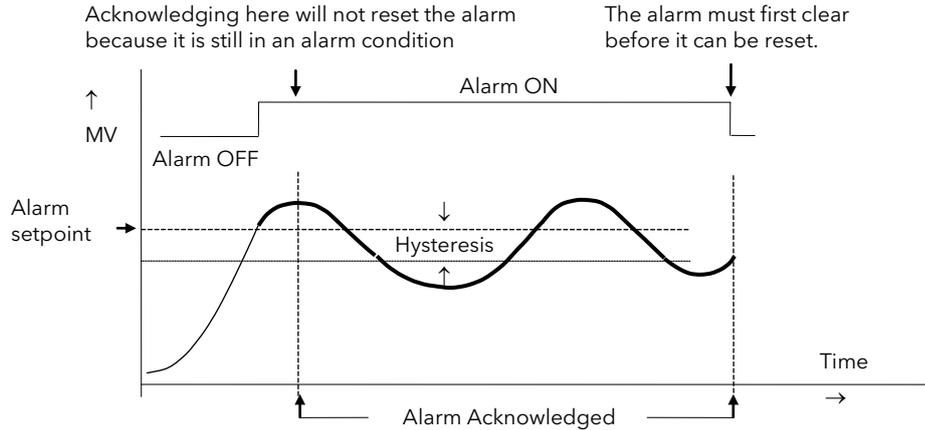
Figure 5-11:   Latched Alarm with Manual Reset

5.6.   GROUPS & ALARM STATUS WORD

All the alarms in the 2500 are in groups associated with a PID loop, an I/O channel, or are User defined alarms. All the alarm active flags and alarm acknowledged flags are also available within a 16 bit Alarm Status Word '**AlmSW',** in the following standard format.

Bit	Value (Decimal)	Set when:	
0	1	Alarm 1 (or A) active	
1	2	Alarm 1 (or A) acknowledged	
2	4	Alarm 2 (or B) active	
3	8	Alarm 2 (or B) acknowledged	Alarms can be acknowledged individually or as a group using the Group Acknowledge Flag **GrpAck**.
4	16	Alarm 3 (or C) active	
5	32	Alarm 3 (or C) acknowledged	
6	64	Alarm 4 (or D) active	
7	128	Alarm 4 (or D) acknowledged	
8	256	Alarm E active	
9	512	Alarm E acknowledged	Note:
10	1024	Alarm F active	**Operator → SYSTEM → AckAll** acknowledges all alarms on the base.
11	2048	Alarm F acknowledged	
12	4096	Alarm G active	
13	8192	Alarm G acknowledged	
14	16384	Alarm H active	
15	32768	Alarm H acknowledged	

Table 5-2: Alarm Status Word

5.7.   LOOP ALARMS

Every PID block in the 2500 includes a group of four alarms. All alarms use the PID block Process Variable as the alarm input and deviation alarms are with respect to the PID block setpoint.
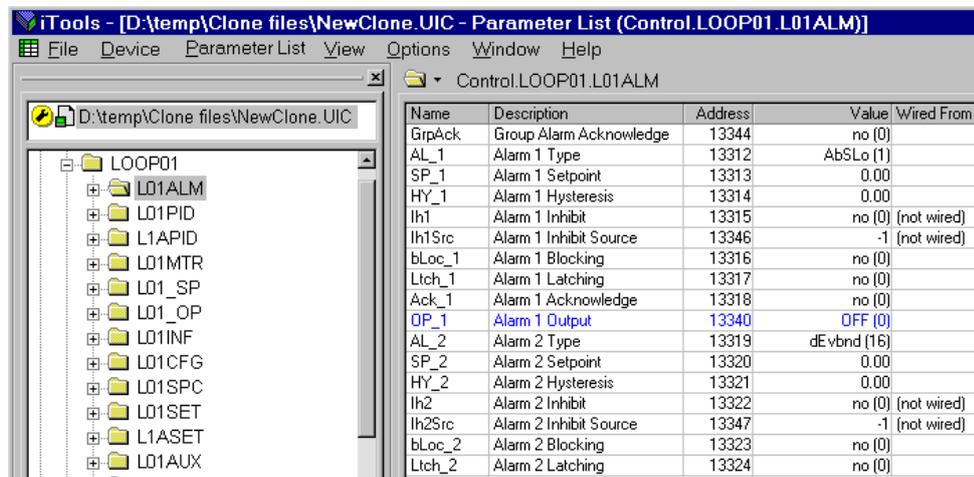
Figure 5-12: Loop alarms (Configuration mode)

5.7.1. Alarm Parameters

These are found in **Control** → **LOOP0x** → **L0xALM**

Name	Description	Range	Status
▪ **GrpAck**	**Group Acknowledge**. To acknowledge <u>all</u> alarms associated with this loop. The action which follows depends on the type of latching configured, see section 5.5.		
no (0)	**No** Unacknowledged		
YES (1)	**Yes** Select to acknowledge		
▪ **AL_1**	**Alarm 1 Type**. In configuration mode the four alarms may be set to any of the types listed below: (See also section 5.2)		
None (0)	Alarm not configured		
AbsLo (1)	Absolute Low		
AbSHi (2)	Absolute High		
dEvbnd (16)	Deviation Band		
devHi (17)	Deviation High		
devLo (18)	Deviation Low		
rAtE (64)	Rate of Change Alarm 4 only		
▪ **SP_1**	**Alarm 1 Setpoint**. To set the level at which the alarm operates	·9	
▪ **HY_1**	**Alarm 1 hysteresis.** 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 prevent relay chatter.	·9	
▪ **Ih1**	**Alarm 1 inhibit.** Inhibit prevents the alarm from being indicated. It can be wired to a source (such as a digital input) or if not wired can be set by the operator.		
no (0)	**No** Not inhibited		
YES (1)	**Yes** Inhibited		
▪ **Ih1Src**	**Alarm 1 inhibit source.** Allows In1 to be wired		
▪ **bLoc_1**	**Alarm 1 blocking.** In configuration mode the four alarms may be set to blocking, see section 5.4.		
no (0)	No blocking		
YES (1)	Blocking		
▪ **Ltch_1**	**Alarm 1 latching.** In configuration mode the four alarms may be set to latching, see section 5.5.		
no (0)	No latching		
Auto (1)	Automatic reset		
mAn (2)	Manual reset		
▪ **Ack_1**	**Alarm 1 acknowledge.** To acknowledge alarm 1. The action which follows depends on the type of latching configured, see section 5.5.		
no (0)	Unacknowledged		
YES (1)	Acknowledged		
▪ **OP_1**	**Alarm 1 output state.**		📖
OFF (0)	Alarm 1 off		
on (1)	Alarm 1 on		
▪ **RtUnit**	**Alarm 4 rate units** Alarm 4 only		
SEc (0)	Seconds		
min (1)	Minutes		
▪ **AlmSW**	**Alarm Status Word** See Table 5-2		📖

The above alarms are repeated for alarms 2 to 4.

5.8. USER ALARMS

The 2500 has four unassigned analogue alarms and four unassigned digital alarms.
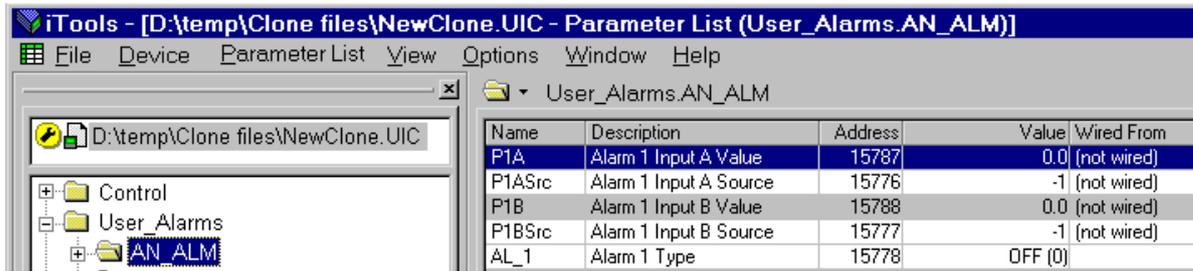
Figure 5-13: Analogue User Alarm (Configuration Level)

5.8.1. User Alarm Parameters – Analogue

These are found in **User_Alarms → AN_ALM**

Name	Description	Range	Status
▪ **P1A**	**Alarm 1 Input A Value.** To set the analogue value of alarm 1to input A		·9
▪ **P1ASrc**	**Alarm 1 Input A Source.** Allows P1A to be wired		
▪ **P1B**	**Alarm 1 Input B Value.** To set the analogue value of alarm 1to input A		·9
▪ **P1BSrc**	**Alarm 1 Input B Source.** Allows P1A to be wired		

The remaining parameters are the same as the loop alarms

Note:

1. The inputs to the alarm block are unassigned so **Input A** must be wired to the Value to be tested for the alarm condition (PV), and for deviation alarms **Input B** must be wired to the Value used compare with Value A for alarm condition (SP).

5.8.2. User Alarm Parameters – Digital

The input has to be wired to the Flag to be tested for the alarm condition. In configuration mode all four alarms may be set to any of the digital alarm types listed in section 5.3.

These are found in **User_Alarms → DIGALM**

Name	Description	Range	Status
▪ **P1**	**Alarm 1 Input Value.** To set the value to alarm 1 input		
▪ **P1Src**	**Alarm 1 Input Source.** Allows P1 to be wired		
▪ **AL_1**	**Alarm 1 Type**. In configuration mode the four alarms may be set to any of the types listed below: (See also section 5.2)		
None (83)	Alarm not configured		
IStrue (84)	Alarm output set when input is TRUE		
ISFALS (85)	Alarm output set when input is FALSE		
Gotrue (86)	Alarm output set when input changes from FALSE to TRUE		
GoFALS (87)	Alarm output set when input changes from TRUE to FALSE		
ChAnGE	Alarm output set when input changes state		

The remaining parameters are the same as the loop alarms

5.9.   I/O ALARMS

Each I/O module has 8 alarms (designated A to H) which are shared between the channels of the module. This sharing has a default setting but, in configuration mode, individual alarms may be reassigned to other channels.
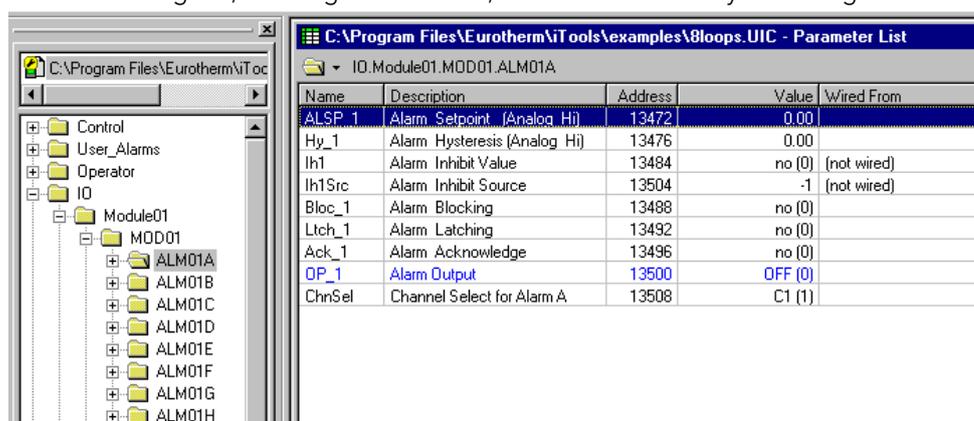
Figure 5-14:   I/O Alarms (Configuration Level)

5.9.1. I/O Alarm Parameters

These are found in **IO → Module 0x → MOD0x** and are essentially the same as Loop Alarms except that there is no Group Alarm Acknowledge. Plus:-

Name	Description	Range	Status
▪ **ChnSel**	**Channel select for alarm A**.		
C1 (1)	Channel 1		
C2 (2)	Channel 2		
C3 (3)	Channel 3		
C4 (4)	Channel 4		
C5 (5)	Channel 5		
C6 (6)	Channel 6		
C7 (7)	Channel 7		
C8 (8)	Channel 8		

5.9.2. Analogue Modules

The alarm types are fixed as shown below together with the default channel assignment.

Alarm	Type	AI2 Channel	AI3 Channel
A	AbsHi	1	1
B	AbsHi	2	2
C	AbsLo	1	1
D	AbsLo	2	2
E	AbsHi	1	3
F	AbsHi	2	4
G	AbsLo	1	3
H	AbsLo	2	4

Table 5-3:   Default Analogue I/O Alarms

5.9.3. Digital Modules

The alarm types are not fixed and in configuration mode may be set to any digital alarm type. The default channel assignments are shown below.

Alarm	Type	DI4 Channel	DI8 Channel
A	Any	1	1
B	Any	2	2
C	Any	3	3
D	Any	4	4
E	Any	1	5
F	Any	2	6
G	Any	3	7
H	Any	4	8

Table 5-4:   Default Digital I/O Alarms

5.10.   INSTRUMENT STATUS ALARMS

These are self diagnostic alarms provided to simplify fault finding. Bit masks are provided to allow only selected events to be reported in the appropriate alarm output.

Alarms are reported at the channel level, at the module level and at a system (IOC) level.

5.10.1.   Individual Channel Status

The **Status ChStat** is reported for every channel on every module and is found in **IO → Module0x → M0x_C1 to C8.**

Bit	Value (Decimal)	Bit set when
Bit 0	1	Sensor break detected
Bit 1	2	CJC failed
Bit 2	4	Channel not in use
Bit 3	8	Analogue output saturated
Bit 4	16	Initialising
Bit 5	32	Invalid Analogue Calibration data
Bit 6	64	Reserved / Analogue input saturated
Bit 7	128	Module fault (Module Status not zero)

Table 5-5: Channel Status Bits

An alarm is provided for this status word. The **Status Alarm Output** flag is set if any bit in the channel **Status** is set **AND** the corresponding bit in the **Status Alarm Bit Mask** is set.

To use the Alarm the **Status Alarm Bit Mask** must be set in Configuration Mode. If the bit mask is set to 255 (Bits 0 to 7 set) then any Channel Status bit will set the alarm output. If the mask is set to 1 (bit 0 set) then only Sensor Break detection will set the alarm output.

As with all alarms it may be configured to be latching or blocking. There is an alarm inhibit and an acknowledge.

5.10.2.   Status of All Channels in a Module

At the Module level all its channels are reported in the **Channel Alarms Status Word**. This has the same format as standard alarm status words.

Bit	Value (Decimal)	Set when:
0	1	Channel 1 Alarm active
1	2	Channel 1 Alarm acknowledged
2	4	Channel 2 Alarm active
3	8	Channel 2 Alarm acknowledged
4	16	Channel 3 Alarm active
5	32	Channel 3 Alarm acknowledged
6	64	Channel 4 Alarm active
7	128	Channel 4 Alarm acknowledged
8	256	Channel 5 Alarm active
9	512	Channel 5 Alarm acknowledged
10	1024	Channel 6 Alarm active
11	2048	Channel 6 Alarm acknowledged
12	4096	Channel 7 Alarm active
13	8192	Channel 7 Alarm acknowledged
14	16384	Channel 8 Alarm active
15	32768	Channel 8 Alarm acknowledged

Table 5-6: Channel Alarm Status Word

5.10.3. Status of All Channels in a System (IOC)

Operator → SYSTEM → IOStat is a **Global IO Status** word that consolidates all the IO status alarms into a single word. Bits 0 to 7 are the OR of all the **Channel Status** bits Table 5-5, bits 8 to 11 the OR of all the **Module Status** bits Table 5-8.

Bit	Value (Decimal)	Set when:
0	1	Any channel Sensor break detected
1	2	Any channel CJC failed
2	4	Any channel Channel not in use
3	8	Any channel Analogue output saturated
4	16	Any channel Initialising
5	32	Any channel Invalid Analogue Cal data
6	64	Reserved / Analogue input saturated
7	128	Any channel Module fault
8	256	Any Module is missing
9	512	Any Wrong Module fitted
10	1024	Any Unrecognised Module fitted
11	2048	Any Module Comms Error
12	4096	Reserved for future use
13	8192	Reserved for future use
14	16384	Reserved for future use
15	32768	Reserved for future use

Note that Bit 2 (value 4) will usually be set as there is likely to be an unused channel.

When **IOStat** has a value 4 (or zero) the red LED on the 2500 IOC will be off.

Table 5-7: Global IO Status Word

5.10.4. Module Status

Module01 → MOD01 → ModSta is the **Module Status** for the module fitted in slot one.

Bit	Value	Bit set when
0	0	Module is OK
1	1	Module is missing
2	2	Wrong Module fitted
3	4	Unrecognised Module fitted
4	8	Module Comms Error

Table 5-8: Module Status

Note that the Summary Word is not an 'alarm' word, it reflects the state of the I/O.

Bit 0 is set if the value of channel 1 is >0.5 for analogue or digital modules.

Bits 1 to 7 are for channels 2 to 8. See Chapter 7.

5.10.5. System (IOC) Status

Operator → SYSTEM → InstSt is the **Instrument Status** word and provides information about problems with the 2500 IOC.

Bit	Value	Set when:
0	1	In Config Mode
1	2	Running Slowly
3	4	NV ram fail
4	8	Bad Custom Lin
5	16	Bad base size
9	32	I/O network watchdog
10	64	IO controller cold started

Table 5-9: Instrument Status Word

An alarm is provided for this status word. The **Instrument Alarm Output** flag is set if any bit in the **Instrument Status** is set **AND** the corresponding bit in the **Instrument Alarm Bit Mask** is set.

To use the Alarm the **Instrument Alarm Bit Mask** must be set in Configuration Mode. If the bit mask is set to 2047 (Bits 0 to 10 set) then any Instrument Status bit will set the alarm output. If the mask is set to 1 (bit 0 set) then only 'in Configuration Level' will set the alarm output.

As with all alarms it may be configured to be latching or blocking. There is an alarm inhibit and an alarm acknowledge.

6. Chapter 6   Operator

This folder contains a number of system wide and diagnostic parameters.

6.1.   LINEARISATION TABLES

These parameters are found in **Operator → Lin Tables** and are provided to allow the customised linearisation to be checked. The list is only shown when 'Options' → 'Parameter Availability Settings' → 'Hide Parameters and Lists when Not Relevant' is not checked. They are used for cloning purposes only and under no circumstances should any attempt be made to change or enter the value of a parameter in this list.
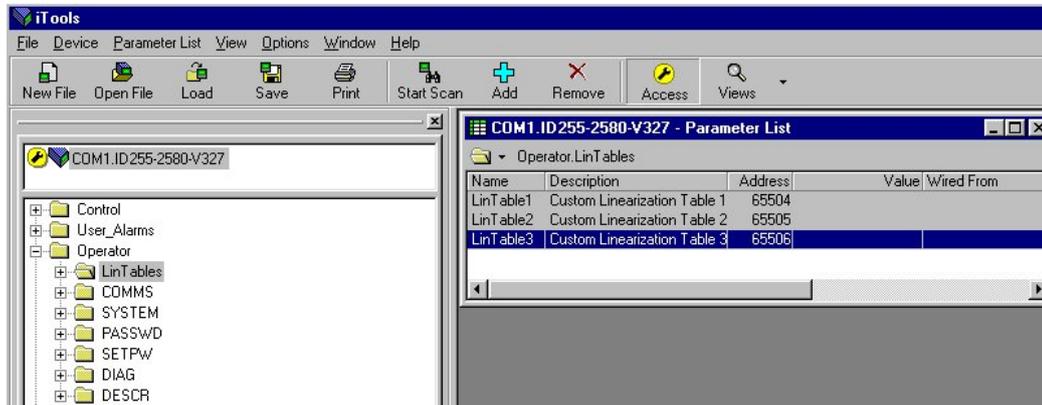
Figure 6-1:   Lin Tables

6.2.   DIGITAL COMMUNICATIONS

These parameters set up digital communications
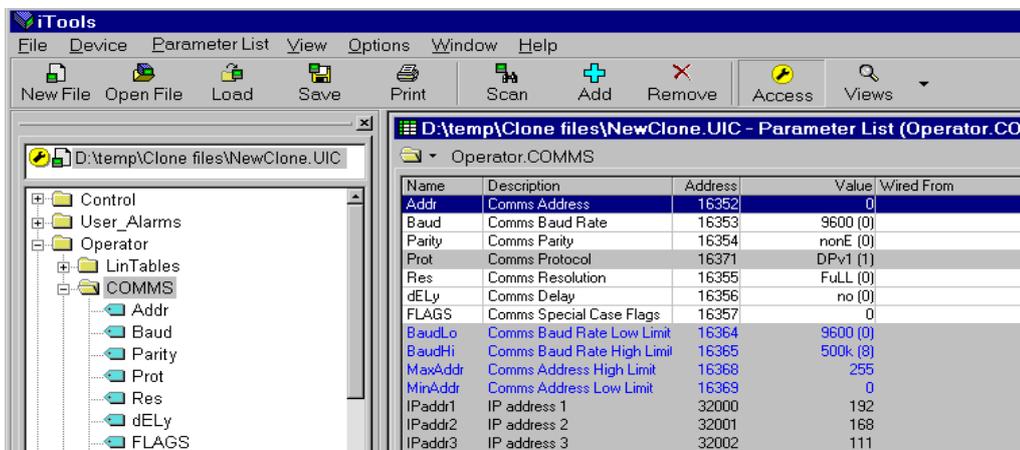
Figure 6-2:   Modbus Communications Parameters (Configuration Level)

6.2.1. Digital Communications Parameters

These parameters are found in **Operator → COMMS**. See also Chapters 9,10, 11 and 12 for further details.

Name	Description	Range	Status
▪ Addr	**Comms Address.** Unit address		
	Modbus:- normally taken from the IOC terminal unit digit switch (see section 2.6.3). The digit switch allows addresses of 1 to 63 to be set. If the address switch is set to zero, the 'Addr' parameter can be set in software. This software address is only used if unit addresses higher than 63 are required.		
	Profibus:- range 0-127. Address can be set on the IOC terminal unit digit switch or in software using this parameter.		
	Devicenet:- range 0-63. Address can be set on the IOC terminal unit digit switch or in software using this parameter.		
	Ethernet-Modbus TCP slave id: range 0-63. Value can be set on the IOC terminal unit digit switch or in software using this parameter.		
▪ Baud	**Comms Baud Rate.** Baud rate		
	Modbus:- range 9600 to 19200 see also note 1.		
	Profibus:- the parameter is read only		
	Devicenet:- Rates of 125, 250 or 500 can be set		
	Ethernet:- the parameter is not used, so is normally hidden		
▪ Parity	**Comms Parity.** Parity is available for Modbus, Profibus and Devicenet and must be set to suit the master.		
None (0)	**None**. No parity		
EvEn (1)	**Even**. Even parity		
Odd (2)	**Odd**. Odd parity		
▪ Res	**Comms Resolution.** Modbus only:- normally set to 'Full', giving all the digits available including those after the decimal point. The communications master must know how to interpret the number as set in LOOP0x → L0xCFG → dEcP.		
FuLL (0)	Full		
Int (1)	Integer. Setting 'Res' to 'Int' will only return the integer value.		
▪ dELy	**Comms Delay.** Modbus only: normally set to 'no'. It is only required if there is a problem, particularly with comms adaptors. The delay option leaves 10ms of quiet time after each transaction.		
no (0)	No delay		
YES (1)	Delay selected in ms (1 –100)		
▪ FLAGs	**Comms Special Case Flags.** This parameter is for special use only and may be changed in all modes, not only in configuration.		

The following parameters may be hidden if not required for the operation of the instrument. To reveal uncheck the 'Hide Parameters' box in 'Options → Parameter Availability Settings'

Name	Description	Range	Status
▪ Prot	**Profibus Protocol.** Select the Profibus protocol required.		
DP (0)	**DP**		
DPv1 (1)	**DPv1**		
▪ BaudLo	**Comms Baud Rate Low Limit**		📖
▪ BaudHi	**Comms Baud Rate High Limit**		📖
▪ AddLo	**Address Low Limit**		📖
▪ AddHi	**Address High Limit**		📖

The following parameters are only relevant to the Ethernet IOC:

- **IPaddr1** **IP Address 1:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the aaa field

- **IPaddr2** **IP Address 2:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the bbb field

- **IPaddr3** **IP Address 3:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the ccc field

- **IPaddr4** **IP Address 4:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the ddd field

- **Subnet1** **Subnet Mask 1:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the aaa field

- **Subnet2** **Subnet Mask 2:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the bbb field

- **Subnet3** **Subnet Mask 3:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the ccc field

- **Subnet4** **Subnet Mask 4:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the ddd field

- **Gateway1** **Default Gateway 1:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the aaa field

- **Gateway2** **Default Gateway 2:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the bbb field

- **Gateway3** **Default Gateway 3:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the ccc field

- **Gateway4** **Default Gateway 4:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the ddd field

- **PrefMst1** **Preferred Master 1:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the aaa field

- **PrefMst2** **Preferred Master 2:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the bbb field

- **PrefMst3** **Preferred Master 3:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the ccc field

- **PrefMst4** **Preferred Master 4:** in the standard Ethernet format, aaa.bbb.ccc.ddd, this is the ddd field

- **MACaddr1** **MAC Address 1:** in the standard Ethernet format, aa-bb-cc-dd-ee-ff, this is the aa-bb fields. 📖

- **MACaddr2** **MAC Address 2:** in the standard Ethernet format, aa-bb-cc-dd-ee-ff, this is the cc-dd fields. 📖

- **MACaddr3** **MAC Address 3:** in the standard Ethernet format, aa-bb-cc-dd-ee-ff, this is the ee-ff fields. 📖

- **DHCPen** **DHCP Enable:**

Fixed (0)	**Fixed**.	Fixed IP addressing – DHCP disabled.
DHCP (1)	**DHCP**.	Dynamic IP addressing – DHCP enabled.

- **NetStat** **Network Status:** for diagnostics purposes

- **IPChanged** **IP Changed:** for diagnostics purposes

- **LocalAddres** **Local Modbus Address:** for diagnostics purposes 📖

Note 1:- The table shows the baud rates supported in different versions:-

Modbus			
Baud Rate	**Software Version V1**	**V2**	**V3**
2400 (3)			✓
4800 (2)			✓
9600 (0)	✓	✓	✓
19,200 (1)	✓	✓	✓
38,400 (5)			✓

Profibus				
Baud Rate	**Software Version V1**	**V2**	**V3**	**V4**
Set by the master up to 12MB	✓	✓	✓	✓

Note:- Version 4 is Profibus only

Devicenet			
Baud Rate	**Software Version V1**	**V2**	**V3**
125K (6)			✓
250K (7)			✓
500K (8)			✓

Ethernet			
Baud Rate	**Software Version V1**	**V2**	**V3**
10BaseT			✓

6.3. SYSTEM

These parameters provide information about the system.

6.3.1. System Parameters

These parameters are found in **Operator → SYSTEM**.

Name	Description	Range	Status
▪ **ReqIM**	**Requested Instrument Mode.** The requested mode of the 2500 IOC		
Operat (0)	Operating: Normal use		
Stndby(1)	Standby: Input values still work but there are no calculations		
Config (2)	Configuration: the controller is being set up and is not functioning		
▪ **IM**	**Instrument Operating Mode.** The actual mode of the 2500 IOC		
Operat (0)	Operating: Normal use		
Stndby(1)	Standby: Input values still work but there are no calculations		
Config (2)	Configuration: the controller is being set up and is not functioning		
▪ **II**	**Instrument Identity.** A unique hex number for the 2500 product, displayed as decimal as follows:-		📖
	Code	**2500E**	**2500C**
	Modbus	2580 [9600]	2500 [9472]
	Profibus DP	2581 [9601]	2510 [9488]
	Profibus DPV1	2582 [9602]	2511 [9489]
	Devicenet	2583 [9603]	N/A
	Ethernet	2584 [9604]	N/A
▪ **AckAll**	**Global Alarm Acknowledge.** Set to acknowledge all alarms. It resets itself.		
no (0)	No acknowledge		
YES (1)	Choose 'Yes' to acknowledge		
▪ **AckIP**	**Global Alarm Ack Input.** Used to acknowledge all alarms.		
no (0)	No acknowledge (only if not wired)		
YES (1)	Choose 'Yes' to acknowledge (only if not wired)		
▪ **AckSrc**	**Global Alarm Ack Input Source.** Modbus address of flag used to acknowledge all alarms -1 means it is not wired Allows all alarms to be acknowledged by wiring to the address of a source (configuration level only)		
▪ **IOstat**	**Global IO Status.** Summarises all channels of all modules, see section 5.10.3.		📖
▪ **BaseSz**	**Base Size.** Size of the base as identified by the IOC.		📖
▪ **IOFail**	**I/O Fail Strategy.** Defines IO behaviour in fault condition		
Contin (0)	Continue – carry on as before		
EntSby (1)	Enter Standby - go into Standby Mode on failure and stay there		
Stndby (2)	Standby - Remain in Standby only whilst fault persists		
▪ **IONwdg**	**I/O Network Watchdog Timeout.** Set time before IO network watchdog is activated after failure is detected. On loss of Field communications for greater than a pre set time an action can be taken, either to go into standby or set the network watchdog flag. The latter mode is intended for use where a failure strategy is defined by the configuration of the IOC. This strategy is set by the next parameter 'NwdAct'. A value of 0 disables the watchdog. Setting to a positive value switches the function on.	h:m:s:ms	

Name	Description	Range	Status
▪ **IONrec**	**IO Network Recovery Time**		📖
▪ **NwdAct**	I/O Network Watchdog Timeout. Defines the instrument behaviour when the network watchdog is activated.		
EntSby (0)	**Enter Standby**. Go into Standby Mode on failure and stay there		
Flag (1)	Set the network watchdog flag only		
▪ **Nwdged**	**I/O Network Watchdog Flag.** Indicates IO network has failed		
▪ **StStby**	**Startup in Standby.** (Config only) Defines IOC behaviour on powering up		
no (0)	No - Operate normally		
YES (1)	Yes - Remain in Standby Mode		
▪ **STime**	**Sample Time.** Indicates the current sample time the IOC is achieving		📖
MaxST	Maximum Sample Time. The maximum sample time the IOC has used. If the IOC is failing to achieve the requested sample time this indicates what it can achieve.		
ReqST	Requested Sample Time. This is normally 110ms (0) but may be increased to 990ms (8) in steps of 110ms for bigger systems.		
SlowST	Running Slower than Requested Flag. Set if the IOC is failing to achieve the requested sample time.		📖
no (0)	IOC is achieving the requested sample time		
YES (1)	IOC is running slower than the requested sample time		
SOrCt	Slowed Down Counter. The number of times the 'SlowST' flag has been set.		
ColdSt	Cold Start Flag. Set after a non volatile RAM error has forced a re-initialisation to default parameter values.		📖
NVFail	Non-Volatile Memory Failure. The IOC non volatile RAM has failed and it will remain in Standby Mode whilst this condition persists.		📖
ClinFl	Custom Linearisation Failure. The IOC has detected failure in a custom linearisation curve and it will remain in Standby Mode whilst this condition persists		📖
InstSt	Instrument Status. A status word which combines a number of the above flags. See section 5.10.5. This is used for the Instrument Alarm.		
Units	Instrument Temperature Units. (Config mode) sets the temperature units		
°C (0)	Celsius		
°F (1)	Farenheit		
°k (2)	Kelvin		
Mask	Instrument Alarm Bit Mask. (Config mode) set to select which of the 'InstSt' bits are enabled (not masked) from the Instrument Alarm Status Word 'AlmSW'. See section 5.10.5.		
Inhibt	Instrument Alarm Inhibit. To inhibit 'AlmSW'		
InhSrc	Instrument Alarm Inhibit Source. Modbus address of the parameter used to inhibit the instrument alarm -1 means it is not wired		
Bloc	Instrument Alarm Blocking. (Config mode). After power up the alarm condition must be OK first, before the alarm is allowed to be active. See section 5.4.		
no (0)	No blocking		
YES (1)	Yes – set for blocking alarm operation		
Ltch	Instrument Alarm Latching. (Config Mode) Set to Auto the alarm will latch until the condition has cleared and it has been acknowledged. See section 5.5.		
no (0)	No latching		
Auto (1)	Automatic. The alarm continues to be active until both the alarm condition is removed AND the alarm is acknowledged		
mAn (2)	Set to Manual the alarm must clear first, then be acknowledged.		
Ack	Instrument Alarm Acknowledge. See section 5.5.		
no (0)	No acknowledge		

Name	Description	Range	Status
YES (1)	Yes – Set to acknowledge alarm		
OP	Instrument Alarm Output. Flag set if 'AlmSW' is not zero.		📖
OFF (0)	No alarm		
on (1)	Alarm flag set		
AlmSW	Instrument Alarm Status Word. Returns the bitwise AND of 'InstSt' and the bit mask 'Mask'.		📖

The following parameters are used by external masters to control the ramp blocks in the 2500:

Name	Description	Range	Status
GHd	Global SRL Hold Flag. Holds all ramps		
GHdSrc	Global SRL Hold Flag Source. (Config mode) Modbus address of flag used to hold ramps -1 means it is not wired		
GSSync	Trigger All Ramps. Triggers all ramps to provide a synchronised start.		
no (0)	Do not trigger ramps		
YES (1)	Global trigger active		
ActIM	Actual operating mode of the IOC. Only appears when 'Options' → 'Parameter Availability Settings' not checked		📖
Operat (0)	Operator mode – normal use		
Stndby (1)	Standby mode - I/P values still work but there are no calculations		
Config (2)	Configuration mode - the controller is being set up and is not functioning		
LveCnf	Enable IO Config in Operator mode. Enables changes to parameters and wires in IO areas <u>on line</u>. Care is needed when changing this value		
no (0)	Configuration parameters read only in Operator mode		
YES (1)	Configuration parameters read/write in Operator mode		
IS	Instrument Operating State. Displays the level of operation		📖
Operat (0)	Operator level		
Stndby (1)	Standby mode - I/P values still work but there are no calculations		
Config (2)	Configuration mode - the controller is being set up and is not functioning		
LveCnf (3)	Live Configuration mode. Similar to operating mode		
PaChgd	Parameter Changed Status Word. This is a bit mapped field indicating modules which have had parameters changed while in 'LveCnf'. The parameters are detailed in the list below:-		📖

ALM01 to 16 A to H	ALSP_1 to 8	Alarm SP
ALM01 to 16 A to H	Hy_1 to 8	Alarm hysteresis
M01 to 16_C1 to 8	SenS	Invert
M01 to 16_C1 to 8	VALH	Eng val high
M01 to 16_C1 to 8	VALL	Eng val low
M01 to 16_C1 to 8	IOH	Electrical high
M01 to 16_C1 to 8	IOL	Electrical low
M01 to 16_C1 to 8	SBDet	Sensor break bleed enable
M01 to 16_C1 to 8	FltAct	Fault action
M01 to 16_C1 to 8	LinTyp	Linearisation type

Bit 0 = module slot 1 ... bit 15 = module slot 16.
May be used over digital communications
It is possible to reset the bits to 0 but not set to 1

Name	Description	Range	Status
ApName	Application Name This is an 8 character field for the manual entry of a configuration name. E.g. the name of the clone file currently loaded.		
ApVers	Application Version. A 5 digit field for the manual entry of the application version. E.g. the clone file version.		
TStamp	Application Time Stamp. A 6 digit field to manually store the application date/time..		
CustabN1	Custom Table 1 Name. Name of the custom linearisation table downloaded with the linearisation data		📖
CustabN2	Custom Table 2 Name. Name of the custom linearisation table downloaded with the linearisation data		📖
CustabN3	Custom Table 3 Name. Name of the custom linearisation table downloaded with the linearisation data		📖

6.4.   PASSWORD ENTRY

These parameters allow the user to enter different levels of operation

6.4.1. Password Entry Parameters

These parameters are found in **Operator → PASSWD**

Name	Description	Range	Status
▪ **UserPW**	**User Calibration Password.** The correct value has to be entered to enable User Calibration. See Chapter 13.	0 -32767	
▪ **RefPW**	**Reference Calibration Password.** The correct value has to be entered to enable Reference Calibration. See Chapter 13.	0 -32767	

6.5.   PASSWORD SET UP

These parameters are in configuration level only and allow the user to set up the passwords for different levels of operation.

6.5.1. Password Set Up Parameters

These parameters are found in **Operator → SETPW**

Name	Description	Range	Status
▪ **DefUPW**	**User Calibration Password Configuration..** (Config mode only). The value used for the User Cal password	0 -32767	
▪ **DefRPW**	**Reference Calibration Password.** (Config mode only). The value used for the Reference Cal password	0 -32767	

6.6.   DIAGNOSTICS

These parameters are used to assess the cycle time that the 2500 unit can achieve. It is particularly useful for 2500 units with the 8 PID loops.

6.6.1. Diagnostic Parameters

These parameters are found in **Operator → DIAG**

Name	Description	Range	Status
▪ **Ctime**	**Control Task Duration in Ticks.** This is in 'ticks' of 1.83ms (1/60 of 110ms) and is the time taken to calculate all the PID loops.		
▪ **MaxCT**	**Maximum Control Task Duration.** This is the maximum number of 'ticks' used to calculate the PID loops. This can be reset to 0. **MaxCT** should not exceed the number indicated below:- Base Size MaxCT ticks 4 <56 8 <52 16 4		

If 'MaxCT' does approach or exceed this number the 'Operator.SYSTEM → Requested Sample Time' should be increased.

Other diagnostic parameters displayed give the high and low A/D conversion counts for each channel. These are for engineering purposes only.

6.7.   SYSTEM DESCRIPTIONS

These parameters provide descriptions of system parameters. They are found in **Operator → DESCR**

Name	Description	Range	Status
▪ **CC**	Company ID		📖
▪ **II**	Product ID		📖
▪ **VO**	Instrument Version Number		📖
▪ **SerialNo**	Instrument Serial Number		📖
▪ **PCode1**	Feature Pass Code 1. Used to set which features are available: number of loops, user calculations.		
▪ **PCode2**	Feature Pass Code 2. Used to set which features are available: number of loops, user calculations.		
▪ **FitA**	Feature Identifier Table Address		📖
▪ **PidCS**	Product ID Table Checksum		📖
▪ **nFID**	Number of Feature Identifiers		📖
▪ **F1**	Feature1: Indirect Modbus Address		📖
▪ **F1_1**	Address of Read Only Indirection Table		📖
▪ **F1_2**	Address of Read/Write Indirection Table		📖
▪ **F1_3**	Not Used		📖
▪ **F2**	Feature2: Modbus Word Ordering		📖
▪ **F2_1**	High order word in low reg. addr		📖
▪ **F2_2**	Not Used		📖
▪ **F2_3**	Not Used		📖
▪ **F3**	Feature3: Modbus Function Codes		📖
▪ **F3_1**	FCs 3;4;6;7;8 and 16 supported		📖
▪ **F3_2**	FCs 17-19 NOT supported		📖
▪ **F3_3**	FCs 70 and 71 supported		📖
▪ **F4**	Feature4: Analog Value Formats		📖
▪ **F4_1**	16 bit scaled & IEEE & 32 bit int		📖
▪ **F4_2**	Not Used		📖
▪ **F4_3**	Not Used		📖
▪ **F5**	Feature5: Ethernet Parameters		📖
▪ **F5_1**	Supported Ethernet parameters		📖
▪ **F5_2**	Ethernet Base Address		📖
▪ **F5_3**	Not Used		📖
▪ **nindRO**	Read Only Modbus indirect table size		📖
▪ **nindRW**	Read/Write Modbus indirect table size		📖

7. Chapter 7   I/O MODULES

7.1.   OVERVIEW

In the 2500 system, **I/O Modules** perform equipment interface functions to measure or generate raw voltage, resistance or current. Most transducer types can be connected straight into the I/O module via screw terminals.

Each I/O Module is dedicated to a particular function - analogue or digital, input or output. Channels on a module may be set for different functions; for example, channel 2 of an AI2 might be set to work with a Zircionia probe, and channel 1 set to a thermocouple range to measure the probe temperature.

Each channel can be considered as an instance of a design block (see section 3.7), capable of scaling, filtering, A-to-D or D-to-A conversions, de-bounce, linearisation, and more - within the reasonable limits of the channel type. Each channel has a set of parameters providing for each feature. These parameters can be displayed in lists and manipulated using iTools.

The I/O Module itself is also considered a design block, with identity and status parameters.

7.2.   I/O BLOCKS

Figure 7-1:   For maximum design flexibility all modules are packaged as plug in modules

Some modules (particularly the analogue input types) are supported with different Terminal Units, optimizing performance for specific input ranges.

Figure 7-2:   The plant wiring is accommodated by screw terminals in matching terminal units

7.3.   I/O MODULE INDICATOR LEDS

All modules support status indicator LED's to reflect I/O terminal status.

All I/O modules offer a green indicator. This is illuminated when the module is fitted and powered and when the IOC matches the 'ReqID' parameter for that base slot with the actual module type 'ActID'.

LED	ON	OFF
* Green	Normal operation	Fault Condition No power, IOC comms or unrecognised module type
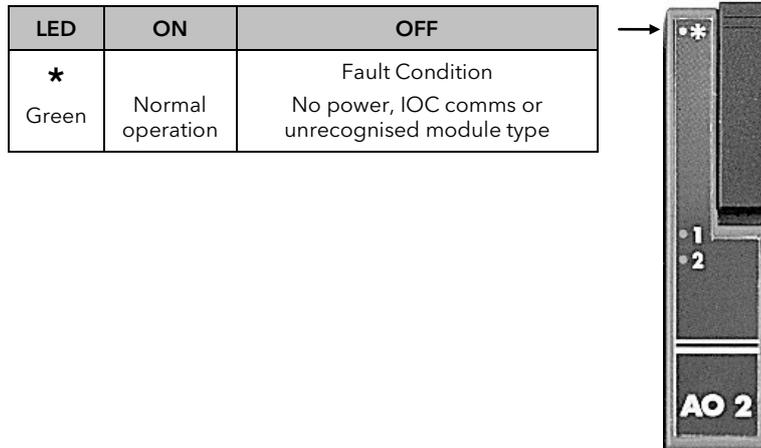
Figure 7-3: Module Status Indication

The green status LED should be steady; any flash or blink indicates a system or module hardware problem.

All Analogue I/O modules also support a channel status LED for each channel. These indicators are red and show channel status - illuminated if there is a channel problem.

LED	ON		OFF
Red	Initialising, or I/O overload		Normal operation
	Flashing	**Blinking**	
	Bad cal data	Calibrating	
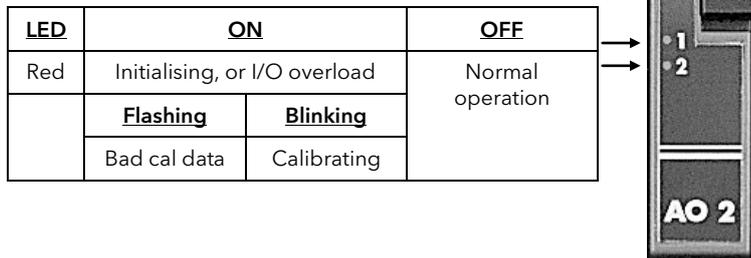
Figure 7-4: Analogue I/O Channel Status Indication

The Digital I/O modules (including the RLY4) all support an LED associated with each channel. These indicators are yellow and show channel status, lit for logic 1 (on).

LED	ON	OFF
Yellow	Digital input Logic 1, input voltage high, or contact closed. Digital output Logic 1, output voltage high, or (RLY4) contact closed.	Digital input Logic 0, input voltage low, or contact open. Digital output Logic 0, output voltage low, or (RLY4) contact open.
Note: Digital Output modules must have a 24V power supply connected to the terminal unit in order to drive the LEDs.		

Figure 7-5: Digital I/O Channel Status Indication

Note that the indicators in DI4, DI6 and DI8 modules track the processed data reported to the IOC, not the terminal condition. There could be a slight difference if the channel has a long de-bounce period specified, or when using the pulse detect channel type.

7.4.   CHANNEL ISOLATION

The 2500 is easy to use because transducers can be directly wired into any appropriate channel at the terminals. Such direct connection introduces safety implications, particularly risk of shock hazard. Electrical isolation minimizes such risks even when equipment goes faulty, and particularly when some transducers have to be run "live".

The system designer must also ensure I/O signal integrity, minimizing noise, interference and cross-talk effects. Electrical isolation makes it much easier to plan and implement system wiring.

With these considerations in mind, a very simple isolation strategy is implemented. There is a barrier separating all I/O channels in any I/O module from the rest of the 2500 system.

The isolation barrier means that a hazardous voltage on any I/O channel cannot introduce a hazard on any wiring on another I/O module, or put at risk the rest of the 2500.

Extending this principle, most 2500 modules - like the AI2, DI6 and so on - provide isolation channel-to-channel. This ensures safety and good signal quality on all channels, even running under high common-mode voltage conditions.

Figure 7-6 below shows the principle, using, for example, the AI2 with TC terminal unit
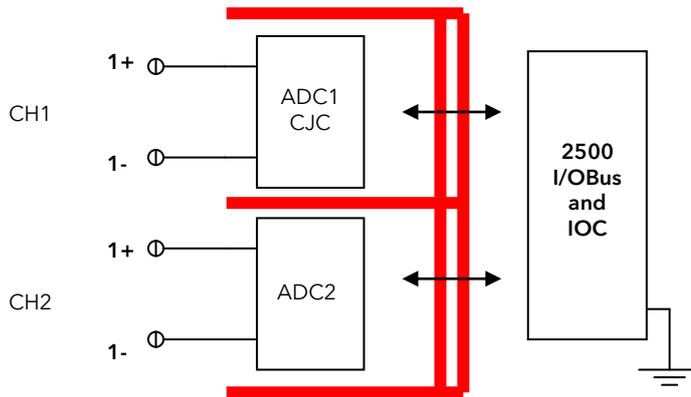
Figure 7-6: AI2 Isolation Barriers

Some I/O modules - like the AI3 - offer channels completely isolated for common-mode rejection, but are unlikely to be run at hazardous voltages. Still others - like DO4 - share one or more common terminals, so the individual channels are not isolated at all from each other.

The following sections describe each separate module including the isolation provided for each type.

⚠ Any installation must pay due regard to safety requirements. Sensors working at hazardous voltage levels must be adequately insulated and wired to appropriately isolated I/O in the 2500 base. Wiring on other channels in the same I/O Module could be at risk under fault conditions.

7.5.   CHANNEL STATUS AND ERRORS

Any control strategy and configuration of the 2500 must consider wiring and plant faults, errors and exceptions. Even simple faults may affect the safe running of the system.

The 2500 offers several levels of alarms and status indicators to help handle problems.

Section 5.10 describes the Instrument Status Alarms and how they can be set up. For I/O modules there is a Module Status byte:

- **ModSta**   **Module Status.** A bit field reporting the module status:

Bit	Value (decimal)	Set when
0	1	Missing Module
1	2	Wrong Module
2	4	Unrecognised Module
3	8	Module Comms (IOBus) Error

See section 7.6.1 for further details.

Each channel also supports a status byte:

- **ChStat**   **Channel Status.** This is a bit mapped field as follows:

Bit	Value (decimal)	Set when
0	1	Sensor break detected or value outside limits of linearisation table
1	2	CJC failed
2	4	Channel not in use
3	8	Analogue output saturated
4	16	Initialising
5	32	Invalid Analog input Cal data
6	64	Reserved / Analogue Input Saturated
7	128	Any Module fault (from ModSta)

See the module sections 7.7.11, 7.8.4, 7.9.12 and 7.10.10 for further details.

These all flag specific error conditions, so can be handled in the control strategy so as to take appropriate control action for a safe recovery or shutdown.

Note that sensor break and input "overload" are treated in the same way. This may result in unexpected actions - overload of mA input may force downscale-drive; "underload" of TC input may result in upscale drive. Special strategies can be applied to hold the "last good" Val parameter, or apply a pre-defined value.

7.6.   IO MODULE CONFIGURATION CONCEPTS

The IOC must be configured to recognise each module fitted to the base, and then configured to set up each and every I/O channel to work with the connected transducers.

The configuration methods are illustrated here using iTools, but any method of setting the appropriate Modbus parameters will achieve the same.

The methods for setting the "config" access mode from iTools and setting parameters are described in Chapter 3, particularly 3.4 and 3.5.
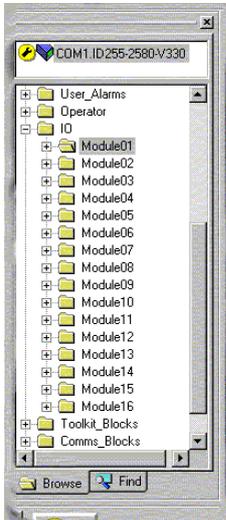
In iTools all I/O module lists are found under the folder "IO".

Each module is numbered according to slot position in the base.

Each module folder can be expanded to show sub-folders for the module block and for each channel block. Each folder contains just the relevant parameter lists. Parameters may be visible and alterable according to set design rules depending on context - this means that the display changes according to run mode, module type and display settings.

In this example the IO folder is expanded to show the IOModules available on a 16 slot base.

Figure 7-7:   Browser IO and Module Folders Example

On start-up iTools takes a short time to read all the system parameters. While "synchronising" all folders and lists are displayed. For example, the IO folder will show all 16 module folders, even with smaller bases. When correctly synchronised only the relevant folders are shown.

The lists illustrated below were obtained from iTools, with both boxes checked in the (Options) Parameter Availability settings. Parameter lists may differ with other settings.

7.6.1. Module Block Parameters

These parameters are found in **IO** → **Module0x** → **MOD0x**
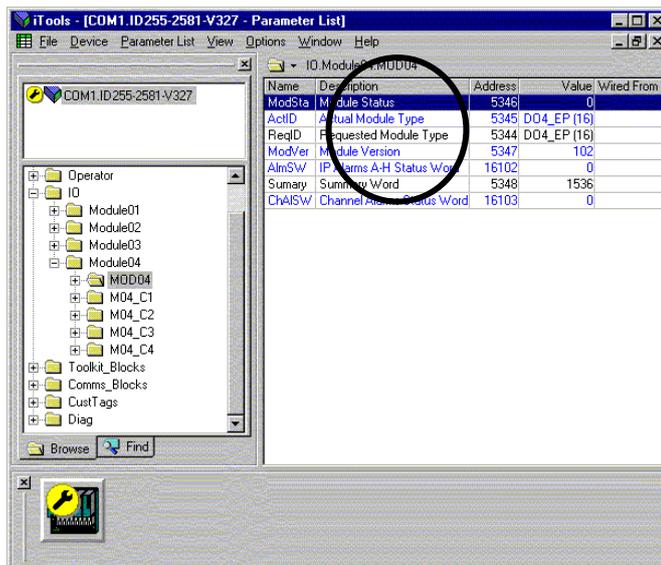
Figure 7-8:   Module Block Parameter List

To declare a module for use, select to the module block list (here MOD04), and set 'Requested Module Type' (ReqID) to match the needed I/O module (double-click the parameter and select from the list).

The IOC will interrogate any fitted module and report the type in 'ActID'. For the module to work these parameters must match, as shown in Figure 7-8 above.

Note that 'ReqID' will not change unless the 2500 is in "config" mode.

Module Status Parameters

Name	Description		Range	Status
▪ ModSta	**Module Status.** A bit field reporting the module status:			📖
	ModSta is 0 if module is OK and working.			

Bit	Value (decimal)	Set when
0	1	Missing Module
1	2	Wrong Module
2	4	Unrecognised Module
3	8	Module Comms (IOBus) Error

Name	Description	Range	Status
▪ ActID	**Actual Module Type.** Module type, as found by the IOC. The list of types is the same as the enumerations shown for the Requested Module Type below		📖
▪ ModVer	**Module Version.** Module version code (diagnostic aid)		📖

▪ ReqID	**Requested Module Type**
None (0)	No module required in this slot
DI4 (1)	Digital Input 4 channels (logic)
DI8_LG (4)	Digital Input 8 channels (logic)
DI8_CO (5)	Digital Input 8 channels (contact closure)
DI6_MV (6)	Digital Input 6 channels (ac mains input, 115V rms)
DI6_HV (7)	Digital Input 6 channels (ac mains input, 230V rms)
DO4_EP (16)	Digital Output 4 channels (externally powered, 10mA)
DO4_24 (17)	Digital Output 4 channels (externally powered, 100mA)
RLY4 (32)	Relay Output 4 channels (2 amp; 3 n/o, 1 change over)
AI2 (64)	Analogue Input 2 channels (universal; 3 terminal unit options)
AI3 (67)	Analogue Input 3 channels (4-20mA, with transmitter PSU)
AI4 (69)	Analogue Input 4 channels (TC, mV, mA terminal unit options)
AO2 (80)	Analogue Output 2 channels (0-20mA or 0-10V output)

Name	Description		Range	Status
▪ AlmSW	**Summary of alarm status.** This is a bit mapped field as follows:			📖

Bit	Value (decimal)	Set when
0	1	Alarm A active
1	2	Alarm A acknowledged
2	4	Alarm B active
3	8	Alarm B acknowledged
4	16	Alarm C active
5	32	Alarm C acknowledged
6	64	Alarm D active
7	128	Alarm D acknowledged
8	256	Alarm E active
9	512	Alarm E acknowledged

Name	Description	Range	Status

10	1024	Alarm F active
11	2048	Alarm F acknowledged
12	4096	Alarm G active
13	8192	Alarm G acknowledged
14	16384	Alarm H active
15	32768	Alarm H acknowledged

▪ ChAlSW	**Channel Alarm Status Word -** Summary of the Channel Status Alarms of all Channels in this module.	📖
	The required bits of each Status alarm (IO → Module0x → MNN_Cx → ChStat) must be enabled by setting the corresponding bits in the mask,	
	(IO → Module0x → MNN_Cx → Mask). Set mask to 255 to enable all alarms	
	The Status alarm must also not be inhibited IO → Module0x → MNN_Cx → Inhibt etc	

Bit	Value (decimal)	Set when
0	1	Channel 1 alarm active
1	2	Channel 1 alarm acknowledged
2	4	Channel 2 alarm active
3	8	Channel 2 alarm acknowledged
4	16	Channel 3 alarm active
5	32	Channel 3 alarm acknowledged
6	64	Channel 4 alarm active
7	128	Channel 4 alarm acknowledged
8	256	Channel 5 alarm active
9	512	Channel 5 alarm acknowledged
10	1024	Channel 6 alarm active
11	2048	Channel 6 alarm acknowledged
12	4096	Channel 7 alarm active
13	8192	Channel 7 alarm acknowledged
14	16384	Channel 8 alarm active
15	32768	Channel 8 alarm acknowledged

Status Summary Parameters

Name	Description	Range	Status
▪ **Summary**	**Summary Word.** Indicates the state of digital IO channels. Initialisation status is given by bits 8 to 15. The 'initialising' flag is only set during power up or if the channel type has been changed. The flag is fleeting, normally set for just one sample period. For Digital output modules this word can be written to set or reset outputs.		📖(DI)

Bit	Value (decimal)	Set when
0	1	Channel 1
1	2	Channel 2
2	4	Channel 3
3	8	Channel 4
4	16	Channel 5
5	32	Channel 6
6	64	Channel 7
7	128	Channel 8

For more information on the alarms, alarm folders and alarm status parameters refer back to chapter 5.

7.6.2. Module Channel Parameters

When the module is identified correctly the I/O channels can be set up.

These parameters are found in **IO → Module0x → M0x_Cy**
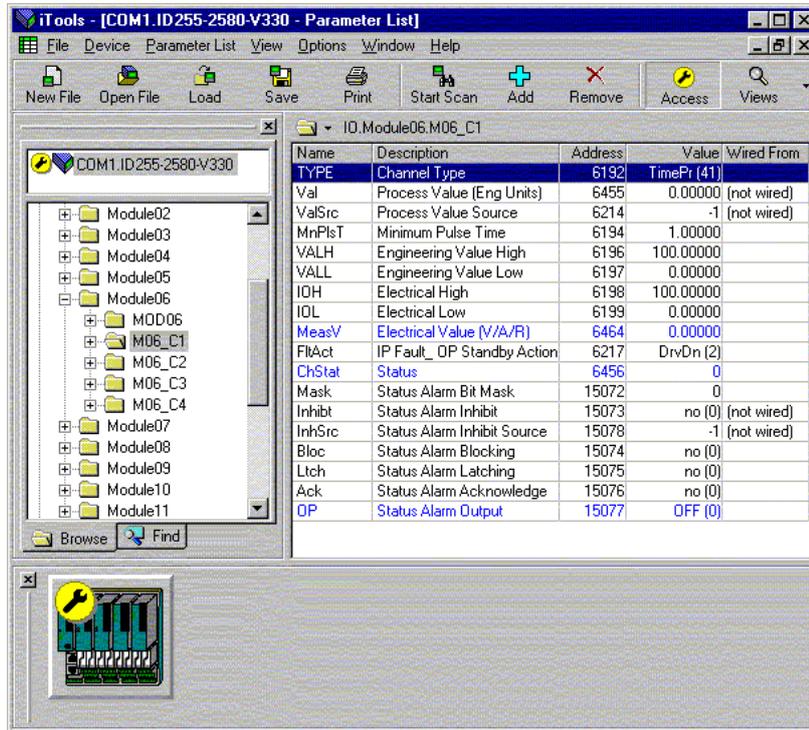
Figure 7-9:   Channel Parameter List Example

Figure 7-9 shows an example of a channel parameter list - in this case, for a DO4 module.

All I/O channels have a common set of parameters, but only a relevant sub-set are enabled and visible when working with any particular channel type (if iTools is set up appropriately).

The individual parameters are described below in the context of each module type.

7.7. ANALOGUE INPUT MODULES

There are three different analogue input modules - the AI2, the AI3 and the AI4. These are supported by a number of terminal units, each optimised for different input sensors.

All these modules and channels function the same way and with similar channel parameters, differing only in electrical interface options and characteristics.

Note that some terminal units exclude certain input ranges, and it is possible to configure the AI module to an unsupported range. Care should be taken to ensure that only relevant ranges are configured.

For module specification see Appendix A.

7.7.1. AI2 Isolation Barriers

Isolation channel-channel: Functional (basic insulation), 264Vac max

Isolation to system: Reinforced (double insulation), 264Vac max
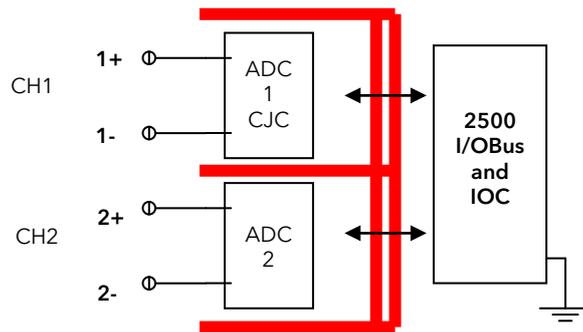
Figure 7-10: AI2 Isolation Barriers

7.7.2. AI2 Analogue Input Equivalent Circuits

The equivalent circuits below show details of analogue inputs, in particular sensor break circuits.

Thermocouple Input
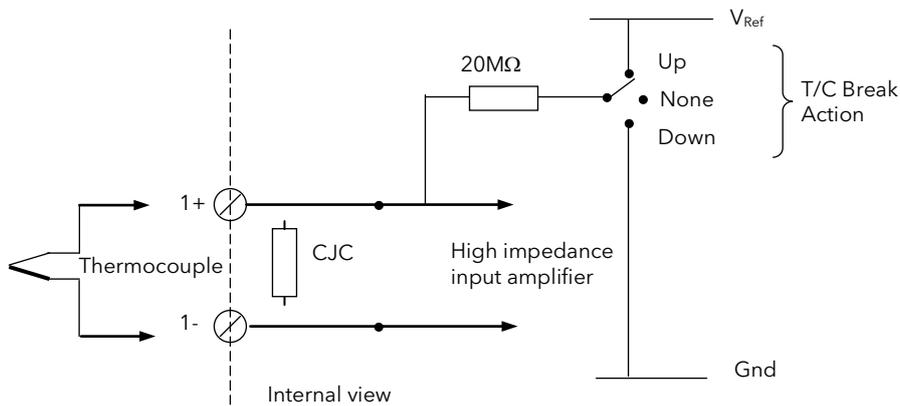
Figure 7-11: Thermocouple Input

3-Wire PRT Input
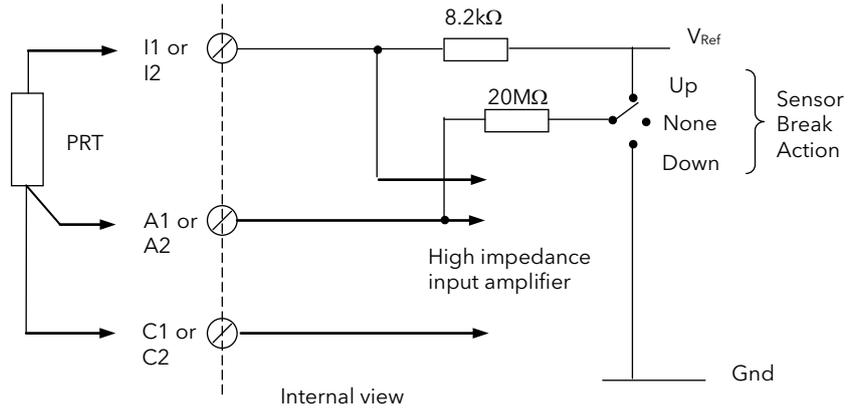
Figure 7-12:   3-Wire PRT Input

4-Wire PRT Input
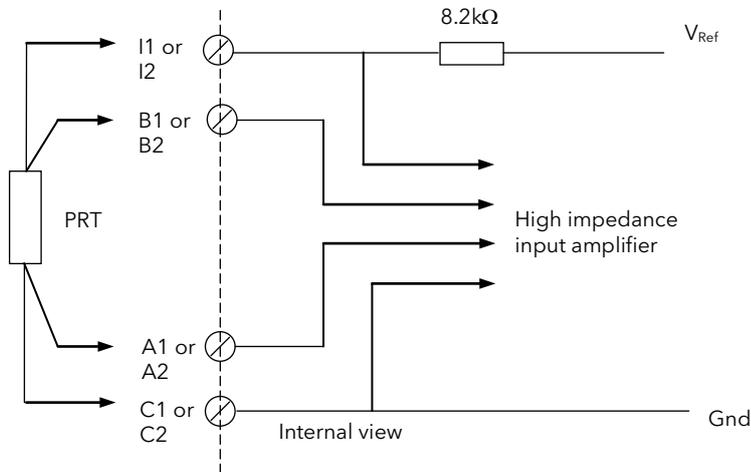
Figure 7-13:   4-Wire PRT Input

Pot Input
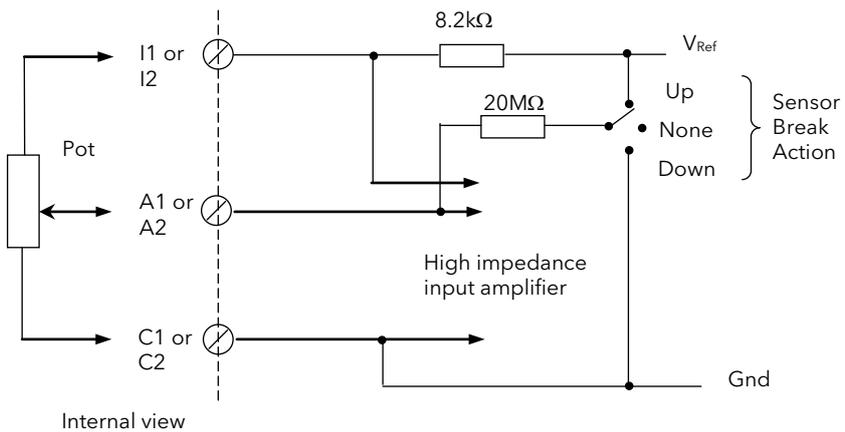
Figure 7-14: Pot Input

Milli-Volt Input
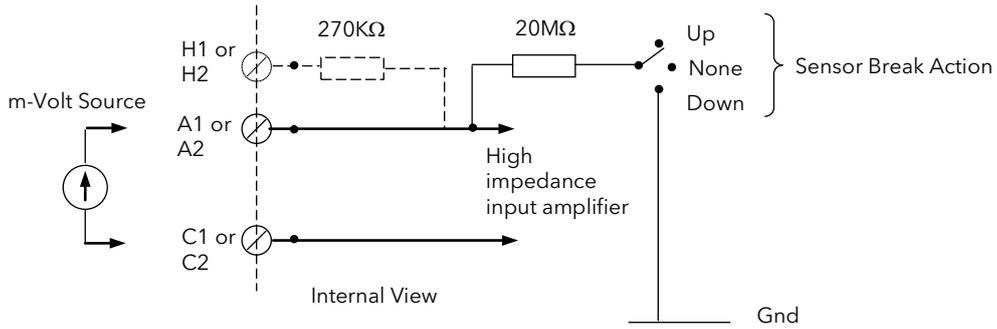
Figure 7-15:   mV Input

Volts Input
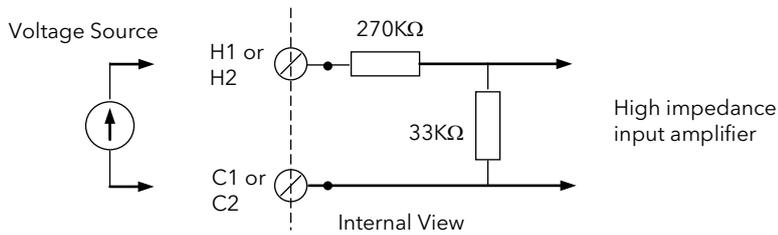
Figure 7-16:   Volts Input

Milli-Amp Input
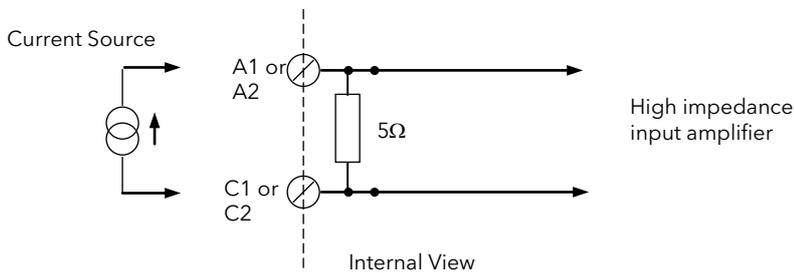
Figure 7-17:   mA Input

7.7.3. AI2 Terminal Connections

Thermocouple

The dual TC AI2 Terminal Unit provides 4 screw terminals for channel wiring:

1+	1-	2+	2-
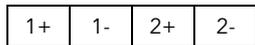
Other AI2 Terminals

Other AI2 Terminal Unit provides 12 screw terminals for channel wiring:

H1	B1	H2	B2

I1	D1	I2	D2

A1	C1	A2	C2
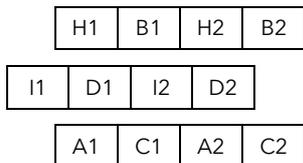
7.7.4. AI3 Isolation Barriers
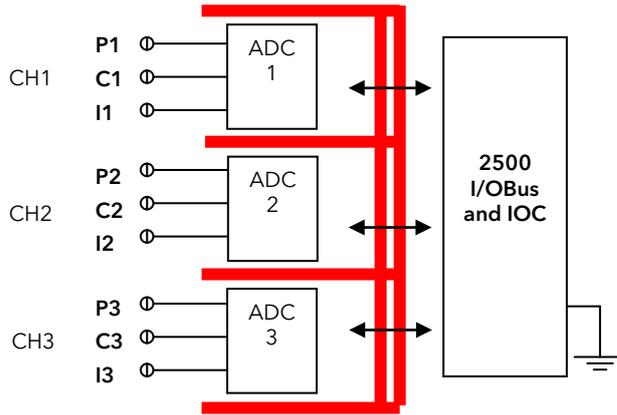
Figure 7-18:   AI3 Isolation Barriers

7.7.5. AI3 mA Input Equivalent Circuit
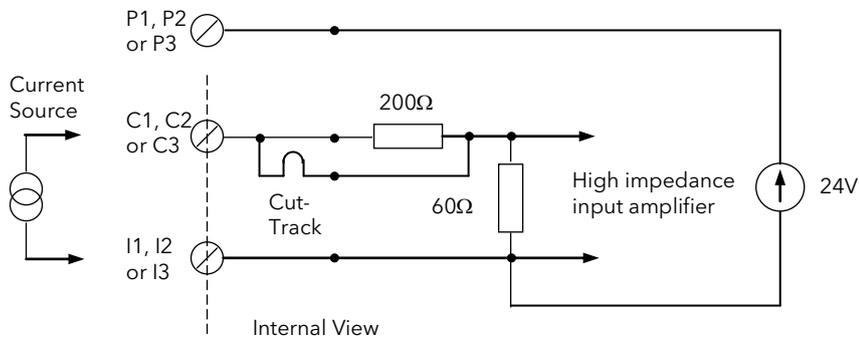
Figure 7-19:   mA Input AI3

7.7.6. AI3 Terminal Connections

AI3 Terminal Unit provides 12 screw terminals for channel wiring:
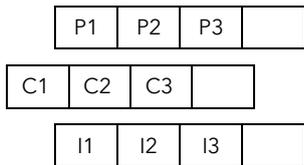
7.7.7. AI3 Analogue Input Module Hart Compatibility

The module does not directly support HART data extraction or injection functions.

The module is compatible with HART systems but with the following notes and provisos:

- The PSU is specified with a low AC impedance, so permitting normal HART connections (e.g., with master connected across the field device (near or far), or across the loop burden).
- Each channel offers full galvanic isolation, easing wiring and preventing HART signals from becoming interfering signals.
- Power Supply noise and ripple at HART frequencies are at very low amplitude, thus minimising risk of interference with HART signals.
- For HART loops where the main burden resistor is that provided by the AI3, the resistor must be padded with an external series resistor, normally by adding 190Ω in series with the C connection. This can be achieved by cutting the track as shown in the diagram above. The resistor can be wired using the spare terminals and wire-ended resistors. Such padding does not affect the specification, except in that the excess input voltage would reduce the headroom required to power external devices (as would all HART compliant loops).

7.7.8. AI4 Isolation Barriers
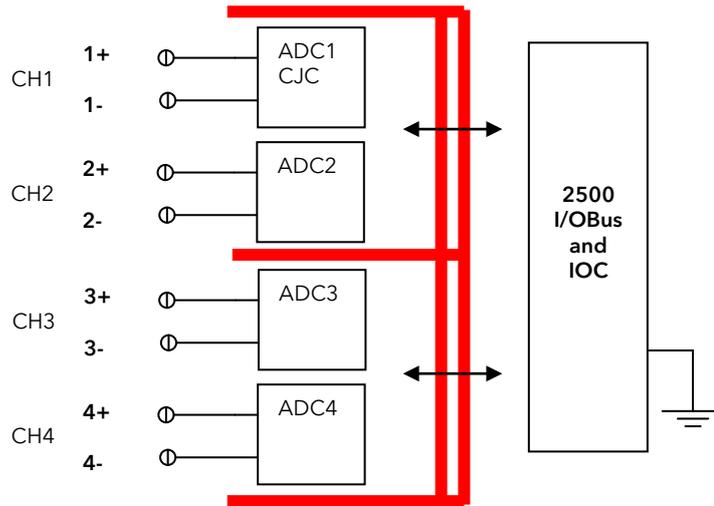
Figure 7-20: AI4 Isolation Barriers

7.7.9. AI4 Analogue Input Equivalent Circuits

The equivalent circuits below show details of analogue inputs, in particular sensor break circuits.

Thermocouple Input
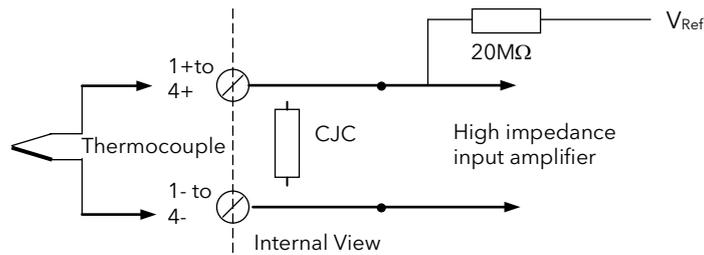
Figure 7-21: Thermocouple Input

Milli-Volt Input
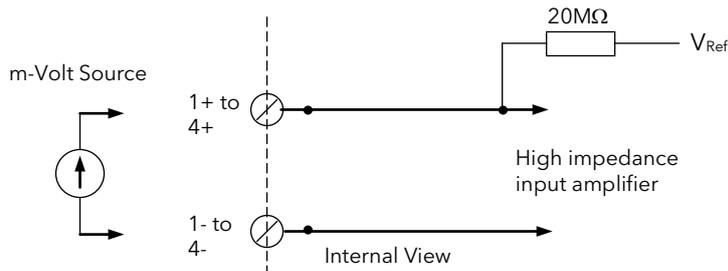
Figure 7-22: mV Input

Milli-Amp Input
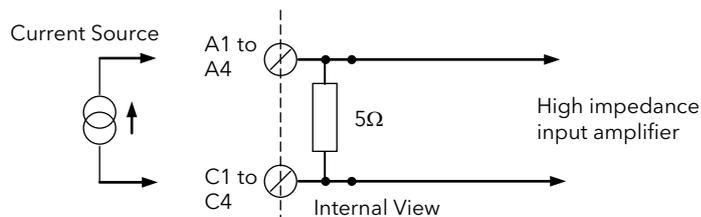
Figure 7-23: mA Input

7.7.10. AI4 Terminal Connections

The AI4 Terminal Unit provides 8 screw terminals for channel wiring:

2+	2-	4+	4-

1+	1-	3+	3-
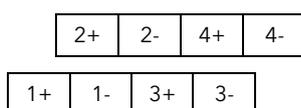
7.7.11. Analogue Input Parameters

Channel Type and Enumerations

Name	Description
▪ TYPE	Channel Type
RTD3 (0)	PT100 resistance thermometer – 3 wire
TC (1)	Thermocouple
PYRO (2)	Optical Pyrometer
mV (3)	Millivolt
mA (I) (4)	Milli amp input
V (I) (5)	Volt input
HiZ (6)	High impedance (zirconia) input
Ohms3 (7)	Ohms input – 3 wire
HiOhms3 (8)	High ohms input – 3 wire
Pot (9)	Potentiometer input
RTD4 (10)	PT100 resistance thermometer – 4 wire
Ohms4 (11)	Ohms input – 4 wire
HiOhms4 (12)	High ohms input – 4 wire

Analogue Input IO Parameters

These parameters are found in **IO → Module0x → MOD0x** and depend on the 'Channel Type' selected: If the parameter is greyed out on the PC screen it is not available for the Channel Type configured.

Name	Description	Range	Status
▪ LinTyp	**Linearisation Type.** The linearisation curve applied to convert the measured input to engineering units. Only available when an analogue input has been requested.		
J (0)	J type thermocouple		
K (1)	K type thermocouple		
L (2)	L type thermocouple		
R (3)	R type thermocouple		
B (4)	B type thermocouple		
N (5)	N type thermocouple		
T (6)	T type thermocouple		
S (7)	S type thermocouple		
PL2 (8)	Platinel type thermocouple		
C T/C (9)	Custom thermocouple		
PT100 (10)	Pt100 platinum resistance thermometer		
Linear (11)	Linear process input		
SqRoot (14)	Square root		
Cust 1 (20)	Custom curve Name 1		
Cust 2 (21)	Custom curve Name 2		

Name	Description	Range	Status
Cust 3 (22)	Custom curve Name 3		
▪ **Val**	The actual value of the channel in engineering units		📖
The next four parameters are used to calibrate process type (V/mV/mA inputs). They are not used for thermocouple, RTD or pyrometer inputs. See section 7.11.3.		
▪ **VALH**	**Engineering Value High**. The maximum value allowed for the channel Process Value. See also section 7.11.3.		
▪ **VALL**	**Engineering Value Low**. The minimum value allowed for the channel Process Value. See also section 7.11.3.		
▪ **IOH**	**Electrical High.** The maximum value allowed for the channel Measured Value. See also section 7.11.3.		
▪ **IOL**	**Electrical Low.** The minimum value allowed for the channel Measured Value. See also section 7.11.3.		
▪ **MeasV**	**Electrical Value (V/A/R).** The actual electrical signal value measured at the terminals of the channel		
▪ **Emiss**	**Emissivity**. To set pyrometer emissivity. Only applicable to pyrometer inputs		
▪ **CJC_Tp**	**CJC Type.** Cold Junction Compensation may be measured automatically by the instrument or use an external reference source. Only applies to thermocouple inputs		
Auto (0)	Automatic. Temperature is measured by a sensor mounted on the terminal unit and is used to compensate for the cold junction		
0C (1)	External reference at 0°C		
45C (2)	External reference at 45°C		
50C (3)	External reference at 50°C		
OFF (4)	No CJC		
▪ **CJtemp**	**CJC Temperature.** The actual temperature at the cold junction		📖
▪ **FltAct**	**Fault Action.** Defines the PV action on input failure		
UScale (0)	**Upscale.** PV is driven Upscale. This is the default setting.		
DScale (1)	**Downscale.** PV is driven Downscale.		
▪ **SBDet**	**Sensor Break Bleed Enable.** Feeds a tiny current through the sensor so that the input drifts upwards when the sensor goes open circuit		
on (0)	Default		
OFF (1)	Disabled		
▪ **Lead_R**	**RTD lead resistance.** Only available if RTD or Ohms configured		📖
▪ **FiltTm**	**Filter Time**. The input filter time constant. Set to a suitable value to reduce the effect of a noisy input signal. Can be set in hours, minutes, seconds or ms		
▪ **ChStat**	**Status.** This is a bit mapped field as follows:		📖

Bit	Value (decimal)	Set when
0	1	Sensor break detected or value outside limits of linearisation table
1	2	CJC failed
2	4	Channel not in use
3	8	Analogue output saturated
4	16	Initialising
5	32	Invalid Analog input Cal data
6	64	Reserved / Analogue input saturated
7	128	Module fault from IO → Module0x → MOD0x → ModSta – an 'or' of all the bits in the module status word

Name	Description	Range	Status
▪ UCAL	**User Calibration Enable.** Allows single offset calibration correction using the 'Offset' parameter for single point calibration offset or 'PointL' with 'OfsetL' and 'PointH' with 'OfsetH' for 2 point correction See also section 7.11.3.		
FAct (0)	Channel is using its original factory calibration values		
USEr (1)	Channel calibration is modified by the user		
▪ PointL	**User Cal Point Low (Eng).** Input value at which IO → Module0x → M0x_Cy → 'OfsetL' is added to provide the lower point of a two point calibration correction Must be enabled using IO → Module0x → M0x_Cy → 'UCAL'. See also Chapter 13 'Calibration'.		
▪ PointH	**User Cal Point High (Eng).** Input value at which IO → Module0x → M0x_Cy → 'OfsetH' is added to provide the upper point of a two point calibration correction Must be enabled using IO.Module0x → M0x_Cy → 'UCAL'. See also Chapter 13 'Calibration'.		
▪ OfsetL	**User Cal Offset Low (Eng).** Offset value added at input value IO → Module'nn' → M'nn'_C'n' → 'PointL' to provide the lower point of a two point calibration correction. See also Chapter 13 'Calibration'.		
▪ OfsetH	**User Cal Offset High (Eng).** Offset value added at input value IO → Module'nn' → M'nn'_C'n' → 'PointH' to provide the upper point of a two point calibration correction. See also Chapter 13 'Calibration'.		
▪ Offset	**Simple Cal Offset (Eng).** Adds a single offset calibration equally over the whole range of the input		
▪ Cal_st	**Calibration State.** Used to indicate the calibration status of the channel.		
Done (0)	Calibration complete		
Failed (1)	Calibration failed		
Idle (2)	Idle		
Cal Lo (3)	Calibration low		
Cal Hi (4)	Calibration high		
Restor (5)	Restore		
Sure? (6)	Confirm		
Go (7)	Start calibration		
Abort (8)	Calibration aborted		
Busy (9)	Calibration in process		
Fsave (10)	Save		
▪ Cal TrL	**AO Calibration Lo Trim (Counts).** Used to adjust the minimum output value of an AO2 module		
▪ Cal TrH	**AO Calibration Hi Trim (Counts).** Used to adjust the maximum output value of an AO2 module		
▪ Mask	**Status Alarm Bit Mask.** Used to select which of the channel status bits 'ChStat' should be used to set the channel alarm status IO → Module'nn' → MOD'nn' → ChAlSW Set to 255 will allow all alarms to be used.		
▪ Inhibt	**Status Alarm Inhibit**		
no (0)	No. Inhibits the status alarm		
YES (1)	Yes. The status alarm is active		
▪ InhSrc	**Status Alarm Inhibit Source. (**Config mode) Modbus address of flag used to inhibit the status alarm -1 means it is not wired		
▪ Bloc	**Status Alarm Blocking.** See also section 5.4.		
no (0)	No blocking		

Name	Description	Range	Status
YES (1)	Yes. Blocking is active		
▪ Ltch	**Status Alarm Latching.** See also section 5.5.		
no (0)	No blocking		
YES (1)	Yes. Blocking is active		
▪ Ack	**Status Alarm Acknowledge.** See also section 5.5.		
no (0)	No acknowledge		
YES (1)	Acknowledge is configured		
▪ OP	**Status Alarm Output.**		📖
OFF (0)	No Alarm		
on (1)	Alarm present		
▪ ClStLL ▪ ClStHL	**Calibration State Low and High Limit.** Defines the state of the channel calibration at the lower and upper points		📖
Done (0)	Calibration complete		
Failed (1)	Calibration failed		
Idle (2)	Idle		
Cal Lo (3)	Calibration low		
Cal Hi (4)	Calibration high		
Restor (5)	Restore		
Sure? (6)	Confirm		
Go (7)	Start calibration		
Abort (8)	Calibration aborted		
Busy (9)	Calibration in process		
Fsave (10)	Save		
▪ ChTpLo ▪ ChTpHi	**Low and High Limit for Channel Type.** Defines the lower and upper points based on the type of channel in use		
RTD3 (0)	PT100 resistance thermometer – 3 wire		
TC (1)	Thermocouple		
PYRO (2)	Optical Pyrometer		
mV (3)	Millivolt		
mA (I) (4)	Milli amp input		
V (I) (5)	Volt input		
Ohms3 (7)	Ohms input – 3 wire		
HiOhms3 (8)	High ohms input – 3 wire		
Pot (9)	Potentiometer input		
RTD4 (10)	PT100 resistance thermometer – 4 wire		
Ohms4 (11)	Ohms input – 4 wire		
HiOhms4 (12)	High ohms input – 4 wire		

7.8.   ANALOGUE OUTPUT MODULE

There is one Analogue Output Module (AO2) which provides two channels offering either voltage or current output drive. Each channel is independently software settable. Both channels work the same way, calculating the output drive value **'MeasV'** from the block parameters and the demanded **'Val'** value.

For module specification see Appendix A.

7.8.1. Analogue Output Isolation Barriers
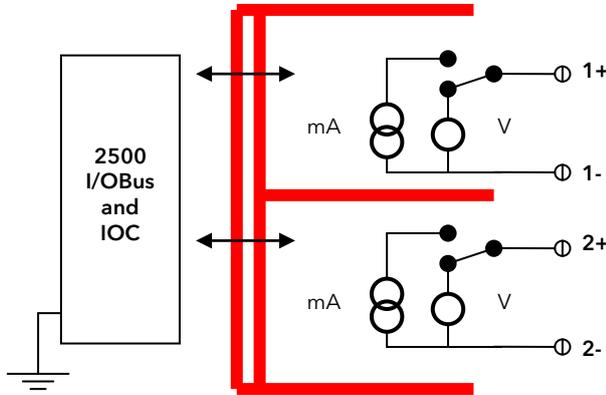
Figure 7-24:   AO2 Channel Isolation barriers

7.8.2. Analogue Output Equivalent Circuits
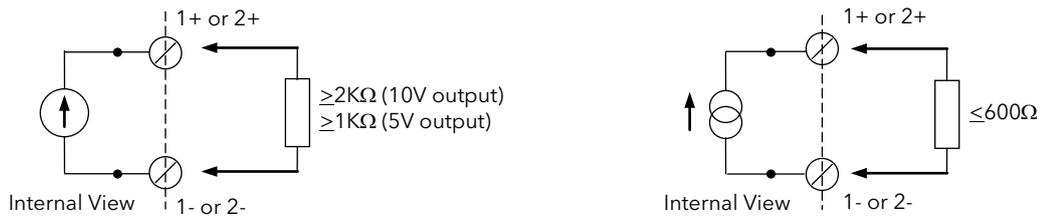
Figure 7-25:   Voltage Output   **Current Output**

7.8.3. AO Terminal Connections

The AO2 Terminal Unit provides 4 screw terminals for channel wiring:

1+	1-	2+	2-

No external power source is required, each channel supporting an isolated supply derived from the base 24V.

7.8.4. Analogue Output Channel Parameters

These parameters are found in **IO → Module0x → MOD0x**

AO2 Channel Type and Enumeration

Name	Description	Range	Status
▪ **TYPE**	**Channel Type**		
V (O) (30)	Volt output		
mA (O) (31)	Milliamp output		

AO2 Channel I/O Parameters

These parameters are found in **IO → Module0x → M0x_Cy**

Name	Description	Range	Status
▪ **Val**	**Process Value** (in Engineering Units) - controls the output drive.		
▪ **ValSrc**	**Process Value source** - Modbus address of the controlling parameter. Source address values of -1 indicate the parameter is not wired.		
▪ **VALH**	**Engineering Value High**. For TPO only, the maximum control value allowed.		
▪ **VALL**	**Engineering Value Low**. For TPO only, the minimum control value allowed.		
▪ **IOH**	**Electrical High.** For TPO types only, the maximum output proportion.		
▪ **IOL**	**Electrical Low.** For TPO types only, the minimum output proportion.		
▪ **MeasV**	**Electrical Value** - the electrical signal value measured at the terminals.		
▪ **FltAct**	**OP Standby Action** - behavior when in standby mode		
DrvDn (2)	Electrical output is forced to low limit.		
DrvUp (3)	Electrical output is forced to high limit.		
Cont (4)	Signal is maintained - held if the PV is not wired. If wired to a local PID loop control will be maintained.		

AO2 Status and Alarm Parameters

These parameters are found in **IO → Module0x → M0x_Cy**

Name	Description	Range	Status
▪ **ChStat**	**Status** - a bit mapped field, non-zero on error.		📖

Bit	Value (dec)	Set when
0	1	Sensor break detected
1	2	CJC failed
2	4	Channel not in use
3	8	Analogue output saturated
4	16	Initialising
5	32	Invalid Analog Cal data
6	64	Reserved / Analogue Input Saturated
7	128	Module fault from IO → Module0x → MOD0x → ModSta

Name	Description	Range	Status
▪ **Mask**	**Status Alarm Bit Mask** - selects which bits of 'ChStat' set the channel alarm status Set to 255 allows all alarms to be used		
▪ **Inhibt**	**Status Alarm Inhibit** -		
no (0)	Inhibits the status alarm		
YES (1)	The status alarm is active		
▪ **InhSrc**	**Status Alarm Inhibit Source -** Address of flag to inhibit the status alarm.		
▪ **Bloc**	**Status Alarm Blocking** - See also section 5.4.		
no (0)	No blocking.		
YES (1)	Blocking is active.		
▪ **Ltch**	**Status Alarm Latching**		
no (0)	No Latching.		
YES (1)	Latching is active		
▪ **Ack**	**Status Alarm Acknowledge**		
no (0)	No acknowledge		
YES (1)	Acknowledge is configured		
▪ **OP**	**Status Alarm Output**		📖
OFF (0)	No Alarm		
on (1)	Alarm present		

Analogue Output 2 Calibration Parameters

Calibration of the AO Module and associated parameters is described in Chapter 13.

7.9.   DIGITAL INPUT MODULES

There are five different digital "input" modules - the DI4, the DI6\115V, the DI6\230V, the DI8\Logic, and the DI8\Contact. These all behave in exactly the same way, with the same channel parameters, but with differences in the type and specification of the channel circuits.

7.9.1. DI4

The DI4 offers four logic channels for voltage input or for switch contact input. For the latter a 24V supply is required; for logic input the supply must be shorted. Note that this configuration determines the function for all four channels.

7.9.2. DI4 Channel Isolation Barriers
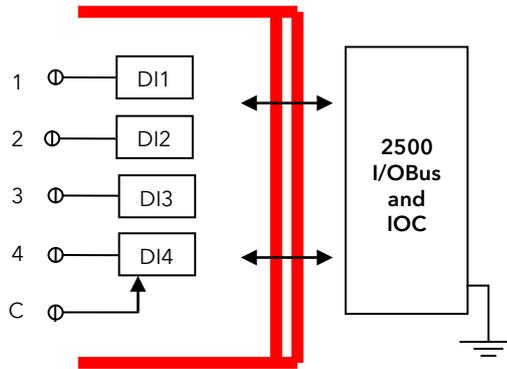
Figure 7-26:   DI4 Channel Isolation Barriers

7.9.3. DI4 Digital Input Equivalent Circuits

The following equivalent circuits show the input into the Digital Input Modules. These may be used for determining source conditions.
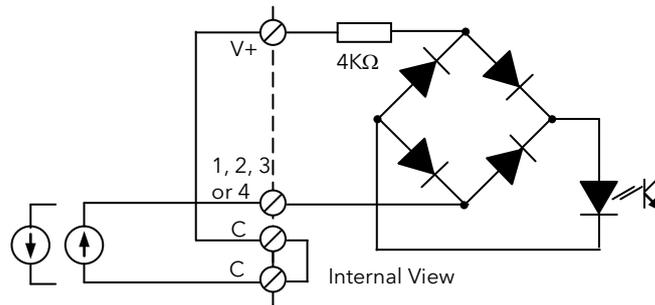
Figure 7-27:   Quad Digital Input Voltage Source Equivalent Circuit
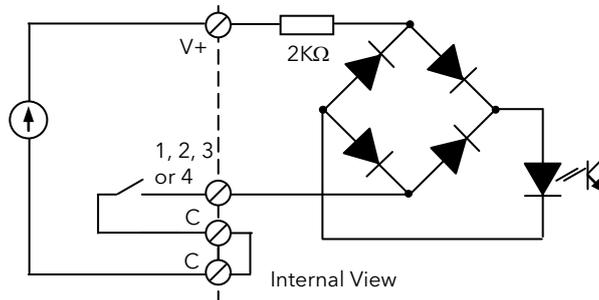
Figure 7-28:   Quad Digital Input Contact Closure Equivalent Circuit

7.9.4. DI4 Terminal Connections

The DI4 Terminal Unit provides 12 screw terminals for channel wiring:
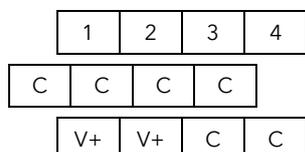
7.9.5. DI6 115V and 230V

The DI6 modules offer 6 logic input channels designed for direct ac supply.

7.9.6. DI6 Isolation Barriers
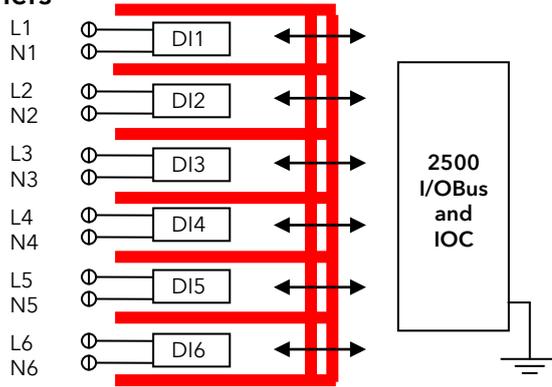
Figure 7-29:   DI6 Channel Isolation Barriers

DI6 Equivalent Circuits
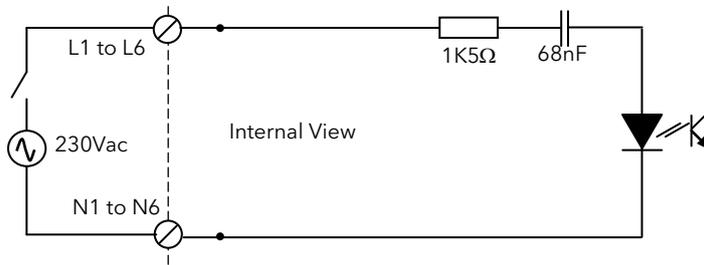
Figure 7-30:   230Vac Digital Input Equivalent Circuit
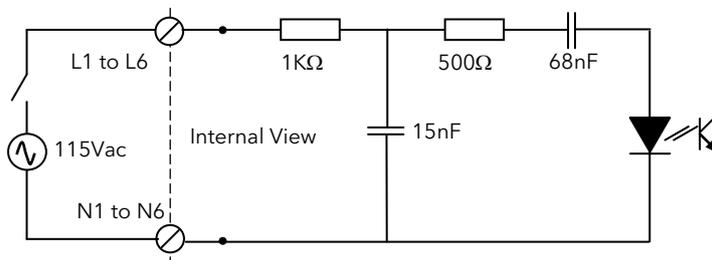
Figure 7-31:   115Vac Digital Input Equivalent Circuit

DI6 Terminal Connections

The DI6 Terminal Unit provides 12 screw terminals for channel wiring:

L5	N5	L6	N6

L3	N3	L4	N4

L1	N1	L2	N2

7.9.7. DI8 Logic

The DI8 offers 8 logic input channels. Unlike the DI4, the contact and logic input versions are order options, again fixing the channel function for the whole module.

7.9.8. DI8 Logic Input Isolation Barriers
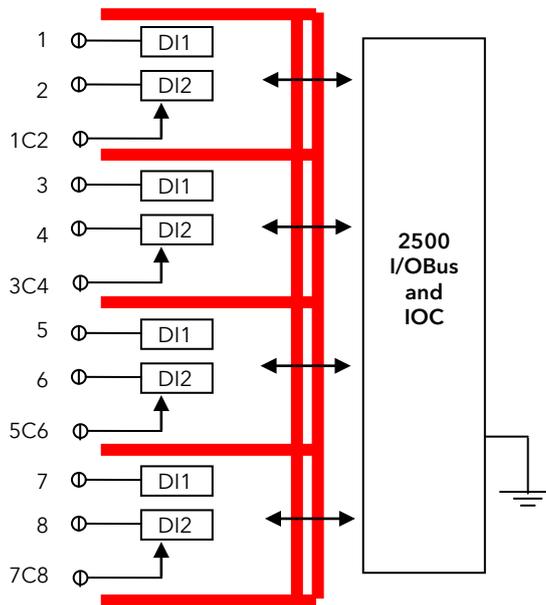
Figure 7-32:   DI8 Logic Input Isolation Barriers

7.9.9. DI8 Equivalent Circuits
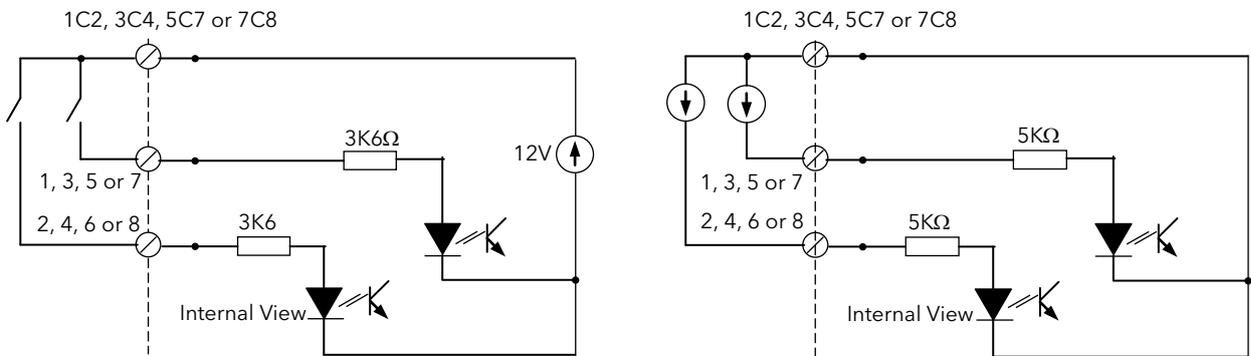
Figure 7-33:   Octal Digital Input Contact Closure Equivalent Circuit

Voltage Source Equivalent Circuit

7.9.10.   DI8 Terminal Connections

The DI8 Terminal Unit provides 12 screw terminals for channel wiring:

1	3	5	7
IC2	3C4	5C6	7C8
2	4	6	8
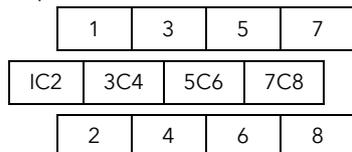
7.9.11.   DI8 Contact Input

This version of the DI8 supports switch contact inputs.

The channel configuration is exactly the same as for the logic input version; and the same terminal unit is used.

7.9.12.   Digital Input Parameters

Channel Type and Enumerations

These parameters are found in **IO → Module0x → M0x_Cy**

Name	Description		Range	Status
▪ TYPE	**Channel Type**			
OnOff (I) (50)	On/Off input. Used for logic or contact inputs which generally switch cleanly. The raw input is sampled every tick			
	Update rate	= 110ms (once per control cycle)		
	Min pulse width always detected	= 110ms		
Debnce (51)	**Debounced**. The input is debounced for the time specified in 'MinPlsT' and the debounced state is sampled every IOS tick. Min pulse width guaranteed to be detected.			
	Update Rate	= 110ms (once per control cycle)		
	Debounce time (MinPlsT) limits	= 0ms (off) to 2.55s		
	Debounce time (MinPlsT) resolution	= 10ms		
	Max pulse width guaranteed filtered out	'= MinPlsT'		
	Where 'MinPlsT' < 110ms	= 110ms		
	Where 'MinPlsT' > 110ms	= 'MinPlsT'+10ms		
	Min sampling delay	= 'MinPlsT'		
	Max sampling delay	= 'MinPlsT'+120ms		
Pulse (52)	**Pulse.** Detects pulses which are longer than the debounce 'MinPlsT'. For every edge of a pulse train to be detected the cycle time must be more than two IOS ticks.			
	Update Rate	= 110ms (once per control cycle)		
	Debounce time (MinPlsT) limits	= 0ms (off) to 2.55s		
	Debounce time (MinPlsT) resolution	= 10ms		
	Max pulse width guaranteed filtered out	= 'MinPlsT'		
	Min pulse width guaranteed to be detected	= 'MinPlsT'+10ms		
	Min time between pulses	= 220ms (two control cycles)		
	Min sampling delay	= 'MinPlsT'		
	Max sampling delay	= 'MinPlsT'+120ms		

Digital Input IO Parameters

These parameters are found in **IO → Module0x → Mox_Cy**

Name	Description	Range	Status
▪ **Val**	The actual value of the channel in engineering units		📖
on (0)	On		
OFF (1)	Off		
▪ **SEnS**	**Invert.** Change the polarity of the input signal		
no (0)	Signal is not inverted		
YES (1)	Signal is inverted		
▪ **MnPlsT**	**Minimum Pulse Time**. For a digital input in debounce mode it defines the time taken for an input signal to reach a steady state. Shorter transients will be ignored. For a digital input in pulse mode it should be set to detect the faster leading edges of a train of pulses with a minimum resolution of 10mS.		
▪ **MeasV**	**Electrical Value (V/A/R).** The actual electrical signal value measured at the terminals of the channel	1 or 0	📖
▪ **ChStat**	**Status.** This is a bit mapped field as follows:		📖

Bit	Value (decimal)	Set when
0	1	Sensor break detected or value outside limits of linearisation table
1	2	CJC failed
2	4	Channel not in use
3	8	Analogue output saturated
4	16	Initialising
5	32	Invalid Analog input Cal data
6	64	Reserved / Analogue Input Saturated
7	128	Module fault from IO → Module0x → MOD0x → ModSta – an 'or' of all the bits in the module status word

Name	Description	Status
▪ **Mask**	**Status Alarm Bit Mask.** Used to select which of the channel status bits 'ChStat' should be used to set the channel alarm status. IO → Module0x → MOD0x → ChAlSW Set to 255 will allow all alarms to be used.	
▪ **Inhibt**	**Status Alarm Inhibit**	
no (0)	No. Inhibits the status alarm	
YES (1)	Yes. The status alarm is active	
▪ **InhSrc**	**Status Alarm Inhibit Source. (**Config mode) Modbus address of flag used to inhibit the status alarm -1 means it is not wired	
▪ **Bloc**	**Status Alarm Blocking.** See also section 5.4.	
no (0)	No blocking	
YES (1)	Yes. Blocking is active	
▪ **Ltch**	**Status Alarm Latching.** See also section 5.5.	
no (0)	No blocking	
YES (1)	Yes. Blocking is active	
▪ **Ack**	**Status Alarm Acknowledge.** See also section 5.5.	
no (0)	No acknowledge	
YES (1)	Acknowledge is configured	
▪ **OP**	**Status Alarm Output.**	📖
OFF (0)	No Alarm	
on (1)	Alarm present	

7.10. DIGITAL OUTPUT MODULES

There are just three different digital "output" modules - the DO4\EP, the DO4\24, and the RLY4 module. All blocks work the same way, with the electrical output **'MeasV'** being processed from the demanded **'Val'** value. All modules offer the same channel parameters, differing only in the type and specification of the channel characteristics.

7.10.1. DO4 EP (External Power)

This module provides four simple logic output channels from current limited switches. Output power comes from a power supply connection at the terminal unit.

Channel Types:	On/Off, TPO, Valve Raise/Lower.
Output Types:	Logic (24Vdc).

7.10.2. DO4 EP Channel Isolation:

The blocks "I$_L$" indicate the current-limit mechanism.
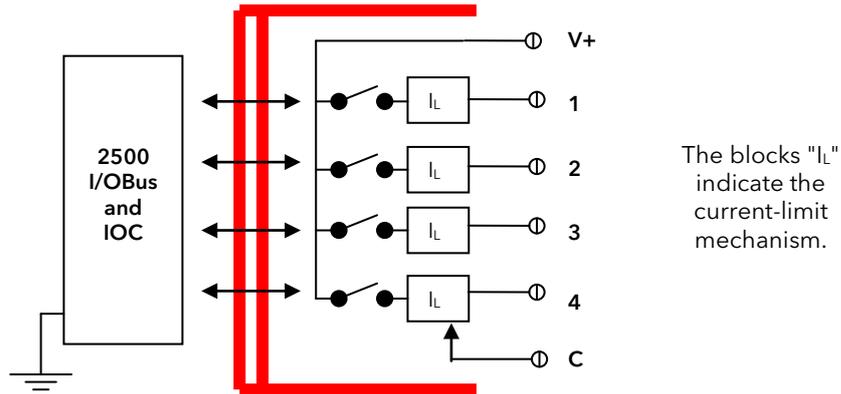
Figure 7-34: Isolation Barriers for DO4 Module

7.10.3. Digital Output Equivalent Circuits

The equivalent circuits below show the output drive from the Quad Digital Output Module for purposes of determining the load conditions.
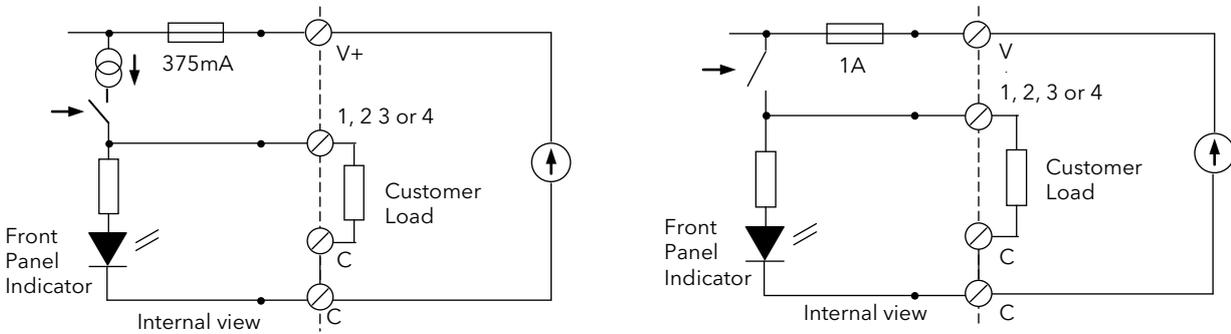
Figure 7-35: Quad Digital Output Current Source Equivalent Circuit (Logic)   Voltage Switch Equivalent Circuit (24V)

7.10.4. DO4 Terminal Connections:

The DO4 Terminal Unit provides 12 screw terminals for channel wiring:

1	2	3	4
C	C	C	C
V+	V+	C	C
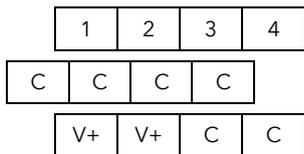
Power (nominal 24V) is wired into V+ and C on the lowest row, each duplicated to allow easy daisy-chaining. Channel wiring is simply to the appropriate numbered terminal and the C terminal underneath.

7.10.5. DO4 24V

The 24V version of the DO4 is identical to the EP, but with each channel capable of delivering 100mA. Thermal protection provides safe operation even with difficult loads.

7.10.6.   Relay Module RLY4

The RLY4 module "output" contains four power relay contacts capable of working at 2A, 250Vac. Otherwise, module operation is exactly the same as the other logic output modules.

Channel Types:	On/Off, TPO, Valve Raise/Lower
Number of channels:	3 N/O (normally open contact), 1 C/O (changeover contacts)

7.10.7.   RLY4 Isolation Barriers
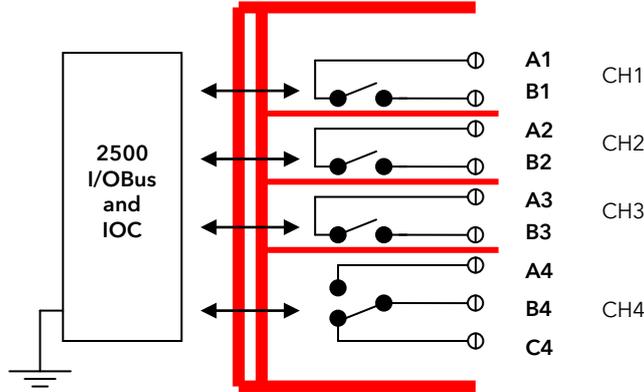
Figure 7-36:   Isolation Barriers for RLY4 Module

7.10.8.   RLY4 Terminal Connections

The RLY4 Terminal Unit provides 12 screw terminals for channel wiring:

1A	2A	3A	4A
1B	2B	3B	4B
			4C
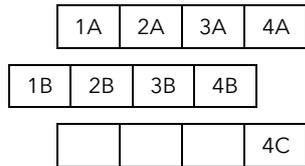
7.10.9.   RLY4 Snubber Circuits

Each relay is fitted with a 'snubber' (22nF + 100Ω) wired across the normally-open (N/O) contacts. These are to prolong contact life particularly when switching inductive loads.

In ac applications snubbers will pass a small current when the contacts are open - typically 1mA at 110V and 2mA at 240V. This current may be sufficient to hold in some relays with low coil current. The fitted snubbers may be removed and alternatives wired to the terminals.

Use the Terminal Unit Fuses to isolate live terminals if there is a need to "hot swap" the module. Take particular care when using the RLY4 for alarm or safety circuits.

7.10.10.   Digital Output Channel Parameters

DO Channel Type and Enumerations

These parameters are found in **IO → Module0x → M0x_Cy**

Name	Description	Range	Status
▪ TYPE	**Channel Type**		
OnOff (O) (40)	On/Off output		
TimePr(41)	TPO - Time proportioning output		
VlvRse (42)	Valve Raise output		
(VlvLwr (43))	(Valve Lower output) (Not selectable - automatic on VlvRse)		

▪ On/off may be used for control or for alarms and events and may drive indicator lamps or solenoid valves.

▪ TPO is used for control applications with variable pulse width adjusting output power.

▪ Valve Position types are also used for control using motorised valve actuators.

Note that specifying an odd channel type as "Valve Raise" will force the next (even) channel to be "Valve Lower".

DO Channel Control Parameters

These parameters are found in **IO → Module0x → M0x_Cy**

Name	Description	Range	Status
▪ **Val**	**Process Value** (in Engineering Units) - controls the output drive	·%	📖
▪ **ValSrc**	**Process Value source** - Modbus address of the controlling parameter. Source address values of -1 indicate the parameter is not wired.		
▪ **SEnS**	**Invert** - In 'OnOff' mode changes the polarity of the output		
no (0)	MeasV sense directly matches Val signal (0 output for Val=0)		
YES (1)	MeasV is inverse of Val signal (1 output for Val=0)		
▪ **MnPlsT**	**Minimum Pulse Time**. For time proportioning output channel types only, defines minimum on/off period in seconds. Both 0 and 1 pulses are constrained		
▪ **VALH**	**Engineering Value High**. For time proportioning output only, the maximum control value allowed	·9	
▪ **VALL**	**Engineering Value Low**. For time proportioning output only, the minimum control value allowed	·9	
▪ **IOH**	**Electrical High.** For time proportioning output types only, the maximum output proportion	·9	
▪ **IOL**	**Electrical Low.** For time proportioning output types only, the minimum output proportion	·9	
▪ **MeasV**	**Electrical Value** - the electrical signal value driven from the terminals		📖
▪ **FltAct**	**OP Standby Action** – behavior in Standby mode		
DrvDn (2)	Electrical output is forced off (logic 0)		
DrvUp (3)	Electrical output is forced on (logic 1)		
Cont (4)	Signal is maintained - held if the PV is not wired. If wired to a local PID loop control will be maintained		

DO Status and Alarm Parameters

Name	Description	Range	Status
▪ Mask	**Status Alarm Bit Mask** – Used to select which of the channel status bits 'ChStat' should be used to set the channel alarm status IO → Module'nn' → MOD'nn' → ChAISW Set to 255 will allow all alarms to be used		
▪ Inhibt	**Status Alarm Inhibit** -		
no (0)	Inhibits the status alarm		
YES (1)	The status alarm is active		
▪ InhSrc	**Status Alarm Inhibit Source -** Address of flag to inhibit the status alarm		
▪ Bloc	**Status Alarm Blocking** - See also section 5.4.		
no (0)	No blocking		
YES (1)	Blocking is active		
▪ Ltch	**Status Alarm Latching**		
no (0)	No Latching.		
YES (1)	Latching is active		
▪ Ack	**Status Alarm Acknowledge**		
no (0)	No acknowledge		
YES (1)	Acknowledge is configured		
▪ OP	**Status Alarm Output**		
OFF (0)	No Alarm		
on (1)	Alarm present		

7.11. CONFIGURATION EXAMPLES

The following are examples use key configuration parameters to configure different I/O modules.

7.11.1. Thermocouple or RTD Input

Fit an Analogue Input module into a suitable position on the base, for example AI2 in slot 03.

In IO → Module03 → MOD03	set 'ReqID' = AI2
In IO → Module03 → M03_C1	set 'TYPE' = TC (or RTD). Note, if the AI module is configured as thermocouple input on one channel and, say, mV on the other, then the thermocouple input must be on channel 1.
	set 'LinTyp' to the type of thermocouple in use, eg type K.
	set 'CJC_Tp' = Auto if internal compensation is to be used. This is the normal default case. Only if an external reference source is used should this parameter be changed.
	set 'FltAct' = 'UScale' (Up scale) to turn off output power in the event of a sensor break (or high impedance). This is the normal default for heating applications.
	'DScale' (Down scale). This is the normal default for cooling applications to turn off cooling demand.
	If the input is configured for RTD then 'CJC_Tp' is not applicable. RTD Lead Resistance, 'Lead_R', reads and compensates for the resistance of the wires connecting the RTD sensor to the module.

Figure 7-37: Analogue Input For TC (configuration level)

7.11.2. Pyrometer Input

Using the above example:

In IO → Module03 → M03_C1	set 'TYPE' = 'PYRO'.
	set 'LinTyp' to match the pyrometer curve. This may be Linear or a custom curve.
	set 'Emiss' to an appropriate value for the target surface.
	set 'FltAct' as above (note: it is unlikely that a pyrometer will be used in cooling applications)

7.11.3.   Analogue Input: mV, mA, V, ohms

Using the previous example:

1.   In IO → Module03 → M03_C1   a.   set 'TYPE' = 'mv'.

                                       b.   set 'LinTyp' to match the curve of the transducer in use.

It is now necessary to scale the input to match the displayed reading with the electrical output levels from the transducer. In the example given below an electrical input of 4-20mA corresponds to a scaling of 0.0 to 1000.0 engineering units.
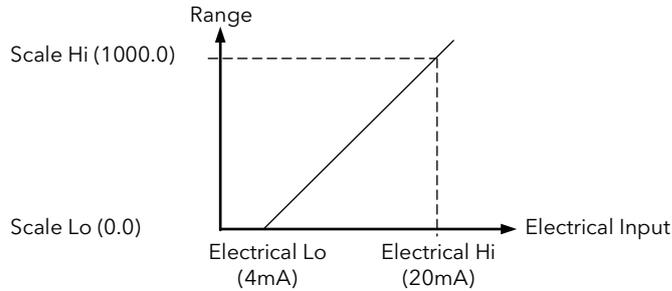
Figure 7-38:   Input Scaling

Four configuration parameters are used to scale the Electrical Input to the Process Value.

Figure 7-39:   Input Scaling Parameters

2.   In IO → Module03 → M03_C1   a.   set 'IOL' = '4.00'.

                                       b.   set 'IOH' = '20.00'

                                       c.   set 'VALL' = '0.00'

                                       d.   set 'VALH' = '1000.00'

7.11.4.   Analogue Output

Fit an Analogue Output module into a suitable position on the base, for example AO2 in slot 04.

1. In IO → Module04 → MOD04   set 'ReqID to 'Analogue Output' (AO2)
2. In IO → Module04 → M04_C1 (or 2)   set 'Channel Type' to 'mA or V

It is now necessary to scale the analogue output to adjust the output value to correspond with the demand from the control block output. In this example the analogue output is 0 to 10V for a PV of 0 to 100% (from the PID output).
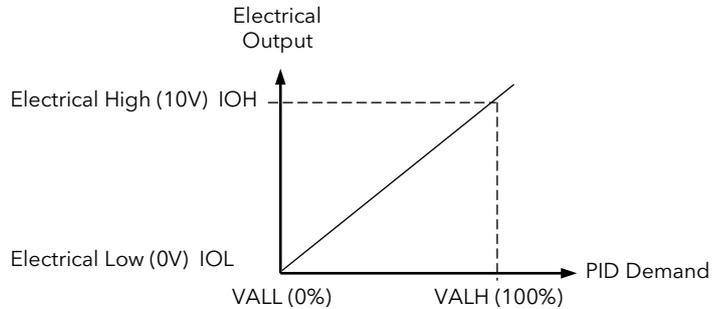
Figure 7-40: Output Scaling

Four configuration parameters are used to scale the Engineering Input to the Electrical Output:

COM2.ID255-2500-V222 - Parameter List

IO.Module04.M04_C1

Name	Description	Address	Value	Wired From
TYPE	Channel Type	5360	V (0) (30)	
Val	Process Value (Eng Units)	5623	50.00	Control.LOOP01.L01_OP.Ch1OP
VALH	Engineering Value High	5364	100.00	
VALL	Engineering Value Low	5365	0.00	
IOH	Electrical High	5366	10.00	
IOL	Electrical Low	5367	0.00	
MeasV	Electrical Value (V/A/R)	5632	5.00	

Figure 7-41: Analogue Output Parameters

3. In IO → Module04 → M04_C1 (or 2)
    a. set 'IOL' = '0.00'.
    b. set 'IOH' = '10.00'
    c. set 'VALL' = '0.00'
    d. set 'VALH' = '100.00'

7.11.5.   Digital Input

Fit a Digital Input module into a suitable position on the base, for example DI8 in slot 01.

1. In Module01 → MOD01   set 'ReqID to 'Digital Input' (DI8)
2. In IO → Module01 →   set 'Channel Type' to 'OnOff (or 'Debnce' or 'Pulse')
   M01_C1 (to 8)

OnOffI (50)	**On/ Off Input**. Used for logic or contact inputs which generally switch cleanly. The raw input is sampled every IOS tick. Update Rate = 110ms (once per control cycle) Min pulse width always detected = 110ms
Debnce (51)	**Debounced**. The input is debounced for the time specified in 'MinPlsT' and the debounced state is sampled every IOS tick. Update Rate = 110ms (once per control cycle) Debounce time (MinPlsT) limits = 0ms (off) to 2.55s Debounce time (MinPlsT) resolution = 10ms Max pulse width guaranteed filtered out '= MinPlsT' Min pulse width guaranteed to be detected. Where 'MinPlsT' < 110ms = 110ms Where 'MinPlsT' > 110ms = 'MinPlsT'+10ms Min sampling delay = 'MinPlsT' Max sampling delay = 'MinPlsT'+120ms
Pulse (52)	**Pulse.** Detects pulses which are longer than the debounce 'MinPlsT'. For every edge of a pulse train to be detected the cycle time must be more than two IOS ticks. Update Rate = 110ms (once per control cycle) Debounce time (MinPlsT) limits = 0ms (off) to 2.55s Debounce time (MinPlsT) resolution = 10ms Max pulse width guaranteed filtered out = 'MinPlsT' Min pulse width guaranteed to be detected = 'MinPlsT'+10ms Min time between pulses = 220ms (two control cycles) Min sampling delay = 'MinPlsT' Max sampling delay = 'MinPlsT'+120ms

See also section 7.6.2. 'Module Channel Parameters'.

7.11.6.   Digital Outputs

Fit a Digital Output module into a suitable position on the base, for example DO4 (or RLY4) in slot 02.

In Module02 → MOD02	set 'ReqID to 'Digital Output' DO4 (or RLY4)
In IO → Module01 → M01_C1 (to 4)	set 'Channel Type' to 'OnOff (or 'TimePr' or 'VlvRse' or 'VlVLwr')

OnOffO (40)	On/ Off Output. Used for on/off control, events or alarm outputs.
	The output will switch on and off, following the Process Value input. The output 'MeasV' is OFF if 'Val' is zero, and ON if 'Val' is not zero. The sense can be inverted using the Invert parameter 'SenS', but only in configuration level.
TimePr (41)	Time proportioning. Used for control outputs to switch contactors or SSRs
	This takes an analogue input which is converted into an ON time Off time ratio. At 50% power the ON and OFF time would be equal. This type is normally used to take a PID heat output to drive a (solid state) contactor. The Minimum Pulse Time is the minimum period in seconds that the output will be ON when the power goes down towards 0% power, or OFF as it rises towards 100%.
	This output can be scaled but the default settings of 0 to 100% in giving 0 to 100% out would normally be used.
VlvRse (42)	Valve Raise. Used for motor valve position output
VlvLwr (43)	Valve Lower. Used for motor valve position output
	This pair of outputs has to be configured together. Making Channel 1 (or 3) Valve Raise will automatically configure Channel 2 (or 4) to Valve Lower.

see also section 7.6.2. 'Module Channel Parameters'.

7.11.7.   Valve Position Controller

This example assumes:-

IO Module 01 is configured for PV input

IO Module 02 is configured for potentiometer input

IO Module 03 is configured for relay output

Loop 01 is configured for bounded valve position control

The wiring for this is shown below:-
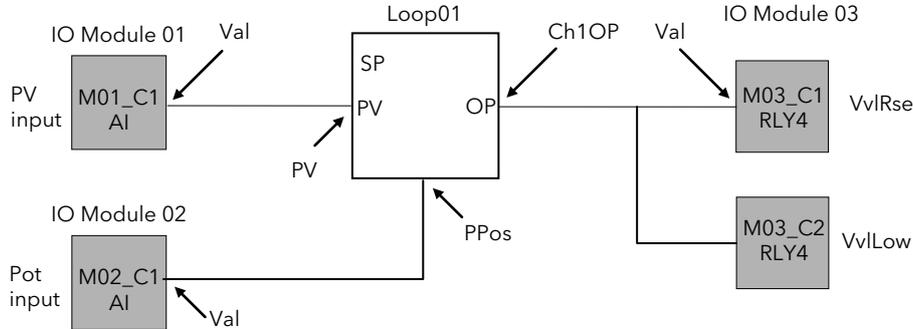
Figure 7-42:   Soft Wiring for VP

Configure Module Types

Configure Loop 1 for Bounded Valve Position control	HOW?	Enter configuration level by pressing 'Access' in the iTools toolbar In the browser select Control ∏ LOOP01 ∏ L01CFG In the parameter list select 'CtrL' = VPB
Configure Module02 for a potentiometer Analogue Input	HOW?	In Configuration level select IO ∏ Module02 ∏ MOD02 In the parameter list select 'ReqID' = AI2 (or AI3 or AI4) Select IO ∏ Module02 ∏ M02_C1 In the parameter list select 'TYPE' = Pot
Configure Module03 for valve drive output	HOW?	In Configuration level select IO ∏ Module03∏ MOD03 In the parameter list select 'ReqID' = RLY4 for relay output (or DO4 for digital output) Select IO ∏ Module03 ∏ M03_C1 In the parameter list select 'TYPE' = VlvRse Select IO ∏ Module03 ∏ M03_C2 In the parameter list select 'TYPE' = VlvLwr

Configure Wiring

Wire IO Module 01 for PV input	HOW?	Enter configuration level by pressing 'Access' in the iTools toolbar Select the parameter to be wired from ie Control ∏ LOOP01 ∏ PVSrc Double click in the Wired From column and select the parameter to be wired ie IO ∏ Module01 ∏ M01_C1 ∏ Val Press OK
Wire IO Module 02 for potentiometer input	HOW?	Select the parameter to be wired from ie Control ∏ LOOP01 ∏ L01MTR ∏ PPoSrc Double click in the Wired From column and select the parameter to be wired ie IO ∏ Module02 ∏ M02_C1 ∏ Val Press OK
Wire IO Module 03 for valve raise relay output	HOW?	Select the parameter to be wired from ie IO ∏ Module03 ∏ M03_C1∏ ValSrc Double click in the Wired From column and select the parameter to be wired ie Control ∏ LOOP01 ∏ L01_OP ∏ Ch1OP Press OK
Wire IO Module 03 for valve lower relay output	HOW?	Select the parameter to be wired from ie IO ∏ Module03 ∏ M03_C2∏ ValSrc Double click in the Wired From column and select the parameter to be wired ie Control ∏ LOOP01 ∏ L01_OP ∏ Ch1OP Press OK

Further information on wiring can be obtained from the iTools Handbook Part No HA026179, 'User Wiring'chapter, and in Chapter 3 'ITOOLS' in this handbook.

7.11.8.   To Calibrate a Potentiometer Input

When using the controller in bounded valve position control mode, it is necessary to calibrate the feedback potentiometer to correctly read the position of the valve. This is carried out using iTools.

For this example the conditions in example 7.11.7 are assumed:-

To calibrate the potentiometer input:-

Put the loop in manual mode	HOW?	Enter operator level. It is only necessary to do this if the controller is already in configuration level by pressing 'Access' in the iTools toolbar
		Select Control ∏ LOOP01
		In the parameter list select 'm-A' = mAn
Drive the valve to minimum position	HOW?	In operator level.
		Select Control ∏ LOOP01
		In the parameter list select 'T_OP' = 0

It is possible that the valve may not close fully. This might happen if, for example, it has not been calibrated previously for the pot in use. To ensure the valve is fully closed it may be nudged

First enable Pot Cal	HOW?	In operator level
		Select Control ∏ LOOP01 ∏ L01MTR
		In the parameter list select 'CalPot' = on. In this state the manual closed loop VP control is made open loop
Nudge the valve to minimum position	HOW?	Select Control ∏ LOOP01 ∏ L01MTR
		In the parameter list select select 'VP_OP' = 1 to nudge the valve closed or 'VP_OP' = 2 to nudge the valve open.
When the valve is fully closed set the Pot input Low Value to 0%	HOW?	Enter configuration level. Select IO ∏ Module02 ∏ M02_C1 In the parameter list select 'VALL' = 0.00.

In normal operation PPos will read 0.00 when the valve is in this position.

Now drive the valve fully open by repeating the above sequence

Set Pot Cal to off	HOW?	In operator level Select Control ∏ LOOP01 ∏ L01MTR In the parameter list select 'CalPot' = off.
Drive the valve to maximum position	HOW?	Select Control ∏ LOOP01
		In the parameter list select 'T_OP' = 100

It is possible that the valve may not open fully. To ensure the valve is fully open it may be nudged

Enable Pot Cal	HOW?	In operator level Select Control ∏ LOOP01 ∏ L01MTR
		In the parameter list select 'CalPot' = on. In this state the manual closed loop VP control is made open loop
Nudge the valve to maximum position	HOW?	Select Control ∏ LOOP01 ∏ L01MTR
		In the parameter list select select 'VP_OP' = 1 to nudge the valve closed or 'VP_OP' = 2 to nudge the valve open.
When the valve is fully open set the Pot input Low Value to 100%	HOW?	Enter configuration level. Select IO ∏ Module02 ∏ M02_C1 In the parameter list select 'VAL.H' = 100.00.

In normal operation PPos will read100.00 when the valve is in this position.

Set Pot Cal = Off, exit Manual mode and exit configuration level

8. Chapter 8   Toolkit Blocks

8.1.   OVERVIEW

Toolkit blocks are function blocks which can be customised by the user. They are used to calculate derived variables, to perform combinational logic and to trigger events when certain conditions are met. The constants in 'USRVAL' may be used as digital flags or analogue parameters. In the case of digital flags zero is interpreted as OFF, any other value is ON.
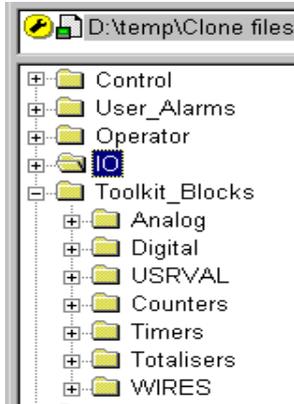
Toolkit Blocks are only available if the 2500 IOC is ordered with the Toolkit Blocks feature enabled.

Toolkit blocks provided in the 2500 are:

16* or 32 analogue calculation blocks in 'Analog'

16* or 32 digital calculation blocks in 'Digital'

8* or 16 constants in 'USRVAL'

8* Counters, 8* Timers, 8* Totalisers

1 Humidity control block in 'HUMID1'

1 Zirconia control block in 'ZIRC1'

The ability to wire between blocks in 'WIRES'

* earlier versions had less blocks and functions

Figure 8-1: Browsing Toolkit Blocks

8.2.   ANALOGUE BLOCKS

Analogue Blocks 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 as shown in Figure 8-2.

The parameters to use, the type of calculation to be performed and the acceptable limits of the calculation are determined in Configuration.

Up to 16 calculations may be performed.
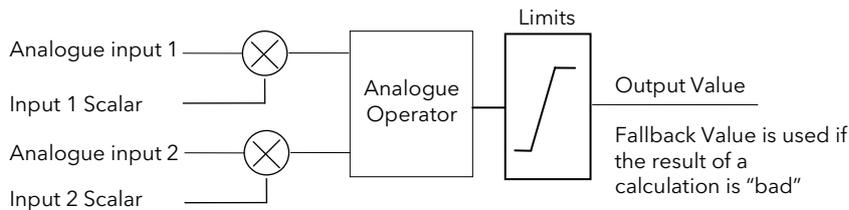
Figure 8-2: Analogue Blocks Schematic

The scalars and operators and limits may only be changed in configuration mode.

8.2.1. Analogue Operators

Up to 32 calculations are available. Operators may only be changed in configuration mode.

Operator	Description
None	The selected analogue operator is turned off
Add	The output result is the addition of Input 1 and Input 2
Sub	The output result is the difference Input 1 and Input 2 where Input 1 > Input 2
Mul	The output result is the multiplication of Input 1 and Input 2
Div	The output result is Input 1 divided by Input 2
AbsDif	The output result is the absolute difference between Input 1 and Input 2
Max	The output result is the maximum of Input 1 and Input 2
Min	The output result is the minimum of Input 1 and Input 2
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.
S/Hold	Normally input 1 will be an analogue value and input 2 will be digital. The output = input 1 when input 2 changes from 0 to 1. The output will remain at this value until input 2 again changes from 0 to 1. Input 2 can be an analogue value and must change from 0 to 100% to provide a sample and hold at the output.
Expt	The output is the value at input 1 raised to the power of the value at input 2, i.e. $\text{input } 1^{\text{input } 2}$
Sqrt	The output result is the square root of Input 1. Input 2 has no effect.
Log	The output result is the logarithm (base 10) of Input 1. Input 2 has no effect
Ln	The output result is the logarithm (base e) of Input 1. Input 2 has no effect
Exp	The output result is the exponential of Input 1, i.e. $e^{\text{input}1}$ Input 2 has no effect
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
Sel 1 Up to Sel 32	Logic Operator 1 to 32 is 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:-
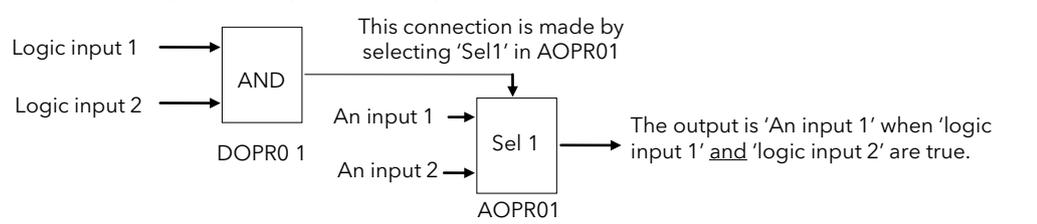
8.2.2. Analogue Block Parameters

These parameters are found in **Toolkit Blocks** → **Analog** → **AOPR01 to 32**

Figure 8-3: Analogue Blocks - Parameter List

The schematic view shown above is displayed in the usual parameter list format. However by invoking the Toolkit Block editor (View → Toolkit Blocks on the Menu bar) the same information is available in a more graphical format, as shown below.

Figure 8-4: Analogue Blocks – Editor

Name	Description	Range	Status
▪ Oper	**Operator. To** define the analogue operator type Use the Toolkit block editor for graphical explanation		
	For types of operator see section 0.		
▪ P1_Val	**Input 1 Value.** The parameter value used for Input 1		
▪ P1_Src	**Input 1 Source.** Modbus address of the parameter used for Input 1 -1 means NOT wired.		
▪ P1_Mul	**Input 1 Scalar.** Factor applied to Input 1 before calculation		
▪ P2_Val	**Input 2 Value.** The parameter value used for Input 2		
▪ P2_Src	**Input 2 Source.** Modbus address of the parameter used for Input 2 -1 means NOT wired.		
▪ P2_Mul	**Input 2 Scalar.** Factor applied to Input 2 before calculation		
▪ FallBk	**Fall Back Value.** The value given by the block if the results of the calculation are invalid This option must be enabled by the UseFBk parameter.		
▪ UseFBk	**Enable Fall Back.** Set to give a safe output value in the event of the result of the calculation being invalid. Fallback options allow a good result to be indicated when a fault condition occurs on the input. This feature can be used to break a bad status loop where User wiring has created a loop in the configuration. This feature can be set as an enumeration or graphically as shown in Figure 8-3 and Figure 8-4		
C Bad (0)	Indicate bad result and clip if outside limits, for other failures use fallback value.		
F Bad (1)	Indicate bad result and always use fallback value.		
C Good (32)	Indicate good result and clip if outside limits, for other failures use fallback value.		
F Good (33)	Indicate good result and always use fallback value.		
▪ HiLim	**Output High Limit.** High limit applied to the output		
▪ LoLim	**Output Low Limit.** Low limit applied to the output		
▪ RealCV	**Output Value.** The output of the Toolkit block after the calculation, fallback and limits		📖
▪ CVStat	**Status.** Set if the calculation itself gives an invalid output		📖
Good (0)	Status good		
Bad (1)	Status bad		

8.2.2.1. Example – To Add a User Value to Loop 01 Setpoint 2

This example is included to illustrate the principle of configuring Analogue Blocks using the Toolkit Block editor. This example could be used to add a fixed offset to an analogue variable, in this case Setpoint 2.

1. Under the User Values tab, select a user value, for example 'Usr1'. Double click on this and enter a value
2. Under the Analog Operations tab, click on the Input <u>1</u> ellipsis button. From the small browser window select Toolkit Blocks → USRVAL → Usr1. Press OK or double click on 'Usr1'.
3. Click on the Input <u>2</u> ellipsis button. From the small browser window select Control → LOOP01 → L01_SP → SP2. Press OK or double click on 'SP2'.
4. Type in the value for the input scalars if required
5. Select an Operator, in this example 'Add'
6. Limits are applied to the result of the initial calculation. If the calculation is invalid (eg divide by zero) then the 'Fallback' value is used. By checking the 'Fallback Overrides Limits' box, if the initial calculation is outside the limits, the fallback value will be used.

Notes
1. Figure 8-3 and Figure 8-4 show this example
2. Space is left for a comment to describe the purpose of the calculation.
3. To remove a value from the input, click in the box and press delete or press the ellipsis button and select a new parameter from the small browser
4. The parameter list view can be selected by pressing the Parameter List button

8.3. DIGITAL BLOCKS

Digital Blocks allow the controller to perform combinational logic 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.

Up to 32 separate calculations can be performed.
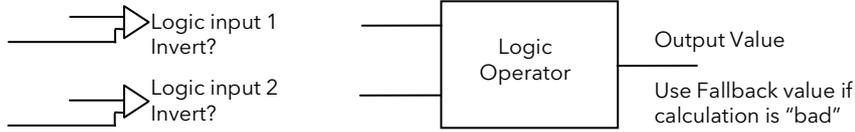
Note: 0 = OFF (or false)   Non 0 = ON (or true)

Figure 8-5:   Digital Block Schematic

8.3.1. Logic Operators

Up to 16 operations are available. Operators may only be changed in configuration mode.

Operator	Description
None	The selected logic operator is turned off
AND	The output result is ON when both Input 1 and Input 2 are ON
OR	The output result is ON when either Input 1 or Input 2 is ON
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.
Latch	The output is ON when input 1 turns ON. The output remains ON when input 1 turns OFF. The output is reset to OFF by turning input 2 ON.
= Equal	The output result is ON when Input 1 = Input 2
<> Not Equal	The output result is ON when Input 1 ≠ Input 2
> Greater	The output result is ON when Input 1 > Input 2
< Less than	The output result is ON when Input 1 < Input 2
>= Greater or Equal	The output result is ON when Input 1 $\geq$ Input 2
<= Less or Equal	The output result is ON when Input 1 $\leq$ Input 2

8.3.2. Parameters for Digital Blocks

These parameters are found in Toolkit Blocks → Digital → DOPR01 to 32.

Figure 8-6:   Digital Blocks - Parameter List

However by invoking the Toolkit Block editor (View → Toolkit Blocks on the Menu bar) the same information is available in a more graphical format as shown in the following view.
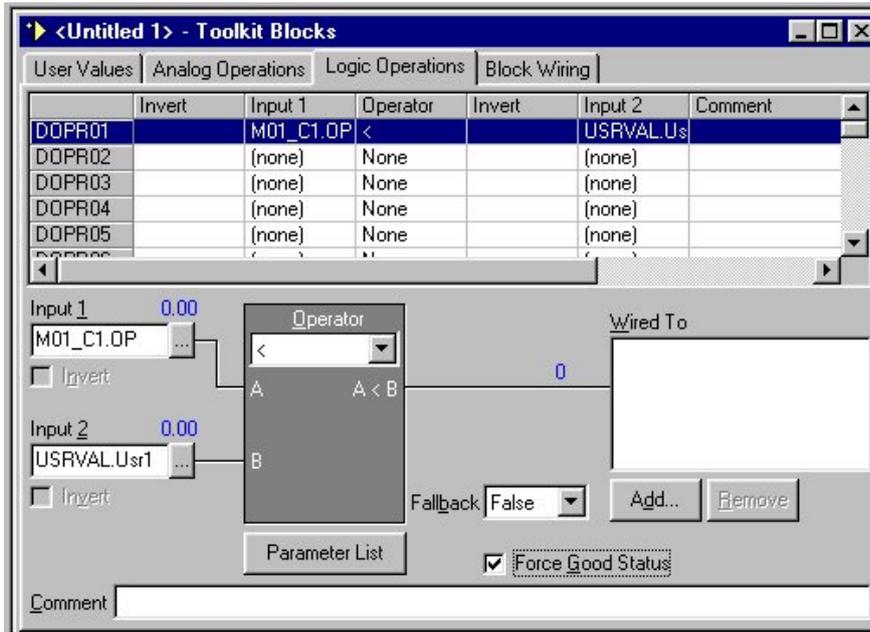
Figure 8-7:   Digital Blocks – Editor

The above views show the result of the configuration example in section 8.3.3.

Name	Description	Range	Status
▪ **Oper**	**Operator.** Defines the operation of the Digital Toolkit Block Use the Toolkit block editor for graphical explanation Note that inputs to the blocks may be analogue. The output is True/False		
	For types of operator see section 8.3.1.		
▪ **P1_Val**	**Input 1 Value.** The parameter value used for Input 1		
▪ **P1_Src**	**Input 1 Source.** Modbus address of the parameter used for Input 1 -1 means NOT wired.		
▪ **P2_Val**	**Input 2 Value.** The parameter value used for Input 2		
▪ **P2_Src**	**Input 1 Source.** Modbus address of the parameter used for Input 2 -1 means NOT wired.		
▪ **FallBk**	**Fallback Value.** The state given by the block if the results of the calculation are invalid		
F Bad (0)	Indicate bad result and return 0 (False)		
T Bad (1)	Indicate bad result and return 1 (True)		
F Good (32)	Indicate good result and return 0 (False)		
T Good (33)	Indicate good result and return 1 (True)		
▪ **InvMsk**	**Invert Inputs Mask.** Setting Bit 0 inverts Input 1 before the computation, Setting Bit 1 inverts Input 2 before the computation:		
None (0)	Neither input inverted.		
IP1 (1)	Input 1 only inverted		
IP2 (2)	Input 2 only inverted		
Both (3)	Both inputs inverted		
▪ **BoolCV**	**Output Value.** Output of the block True/false		📖
▪ **CVStat**	**Status.** Set if the logical computation gives an invalid output		📖
Good (0)	Status good		
Bad (1)	Status bad		

8.3.3. Example – To Produce a Logic Calculation Block

This example is included to illustrate the principle of configuring Digital Blocks using the Parameter List.

The example is a 'comparator' which compares the value of two inputs using the < (Less Than <) operator. The first input (input 1) in this example is taken from the output of an analogue input module. The second input (input 2) is an analogue User Value.

This type of application may be used to switch an alarm or event output or used in a decision making situation. A logic output is produced if Input 1 is less than input 2.

In this example Input 1 is taken from the channel 1 output of Analogue I/O module 'M01_C1' and input 2 is taken from a user variable 'USRVAL.Usr1'.

```
From output of AI module          Input 1  ┌─────────┐
        M01_C1.OP        ──────────────────►│ DOPR01  │
                                            ├─────────┤
From output of user value         Input 2   │    <    │────►
         function block    ─────────────────►│         │
        (USRVAL.Usr1)                       └─────────┘
```
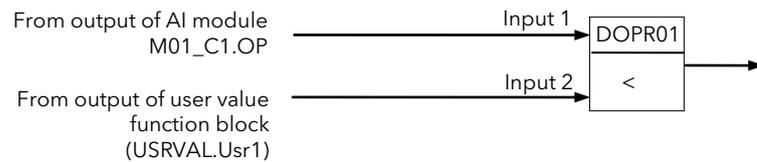
1. In Toolkit Blocks → Digital → DOPR01, set 'Oper' to < (8)
2. In IO → Module01 → M01_C1 press + (or double click M01_C1) to open the list of parameter tags
3. Drag 'OP' tag from M01_C1 to 'P1_Src' in the DOPR01 parameter list
4. In Toolkit Blocks → USRVAL, drag 'Usr1' tag to 'P2_Src' in the DOPR01 parameter list
5. Set fallback value to 0 for false or 1 for true

If the Logic Operations editor is opened it will be noticed that the above operations will have been transferred to this graphical editor.

8.4.   USER VALUES

A User Value is a variable which can be defined by the user and is available for derived calculations. They are found in **Toolkit Blocks → USRVAL.**

They may be used as analogue values or digital where any non zero value is considered 'True'

There are up to 16 user values which may be used as required in any analogue or logic calculations. To use a User value as a digital flag it takes the state OFF when the value is zero and ON when the value is not zero.
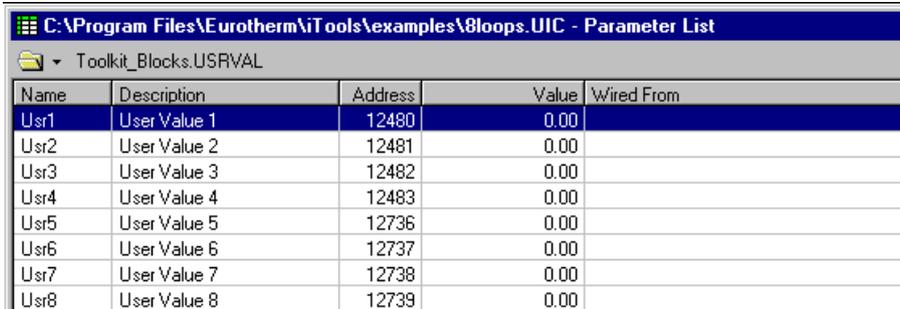
Name	Description	Address	Value	Wired From
Usr1	User Value 1	12480	0.00	
Usr2	User Value 2	12481	0.00	
Usr3	User Value 3	12482	0.00	
Usr4	User Value 4	12483	0.00	
Usr5	User Value 5	12736	0.00	
Usr6	User Value 6	12737	0.00	
Usr7	User Value 7	12738	0.00	
Usr8	User Value 8	12739	0.00	

Figure 8-8:   User Values - Parameter List

Note:

To set the user value, double click on the user value and enter the new value in the pop up box.

Alternatively, right click on the user value and select 'Edit Parameter Value' from the pop up window.

8.5. TIMER BLOCKS

Timer Blocks allow the controller to use time information as part of the control process. They can be triggered by an event and used to initiate an action. For example, an action may be delayed following a particular event. The Timer Blocks fitted in the 2500 controller are:

Timers   Up to eight Timer Blocks each having four modes of operation are explained in section 8.6. The timer type is set in Configuration level. The timer is activated by an event. The event is also defined in Configuration mode or it may be triggered by a parameter in the list. Timing continues for a set time period. The output can be 'wired' in configuration mode to operate a further event, see section 8.9.

Counters   Up to eight Counter Blocks are available. Each can be configured for Up or Down count. See section 8.7.

             The output can be 'wired' in configuration mode to operate a further event, see section 8.9.

Totalisers   Up to eight Totaliser Blocks may be configured to provide a running total of a parameter and give an output when a pre-set total is reached. An example might be to totalise the flow through a pipe. See section 8.8.

             Totaliser blocks can also be 'wired', in Configuration level, to any input parameter.

             The output can also be 'wired' in Configuration level to operate an event such as a relay, see section 8.9

8.6. TIMER TYPES

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

8.6.1. On Pulse Timer Mode (PULSE)

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 behaviour of the timer under different input conditions is shown below.
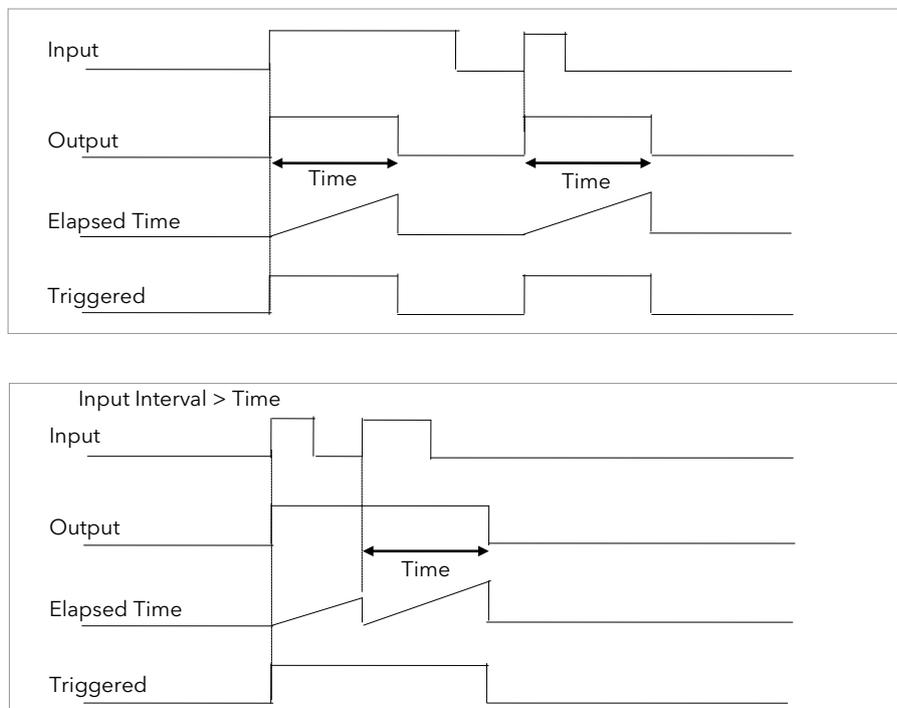
Figure 8-9: On Pulse Timer Under Different Input Conditions

8.6.2. Off Delay Timer Mode (DELAY)

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 behaviour of the timer under different input conditions is shown below.
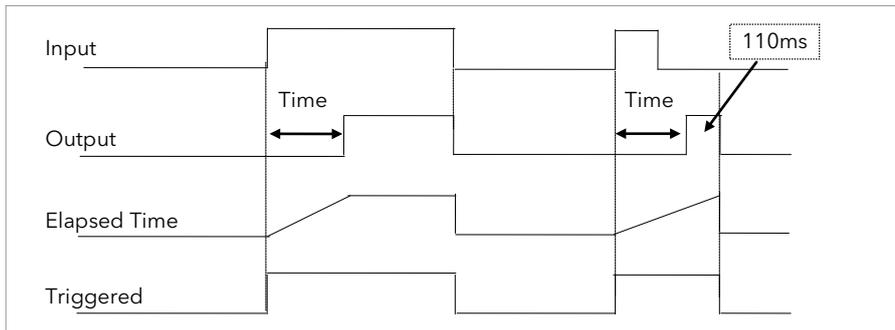
Figure 8-10:   Off Delay Timer Under Different Input Conditions

8.6.3. One Shot Timer Mode (1 SHOT)

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 Time reaches zero.

The behaviour of the timer under different input conditions is shown below.
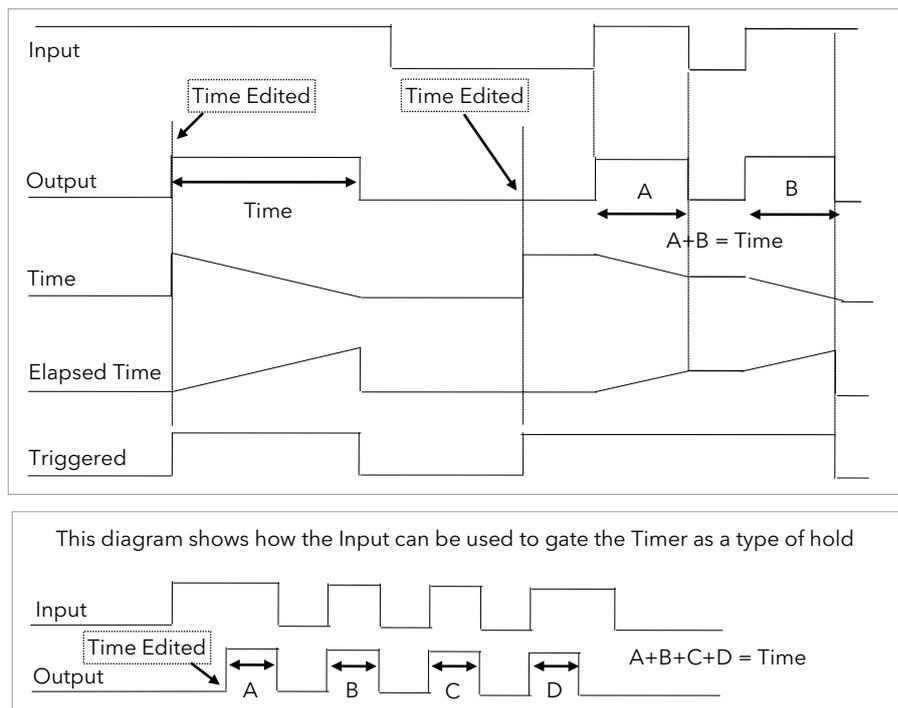
Figure 8-11: One Shot Timer

8.6.4. Minimum On Timer Mode (CMPRSS)

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 behaviour of the timer under different input conditions is shown below.
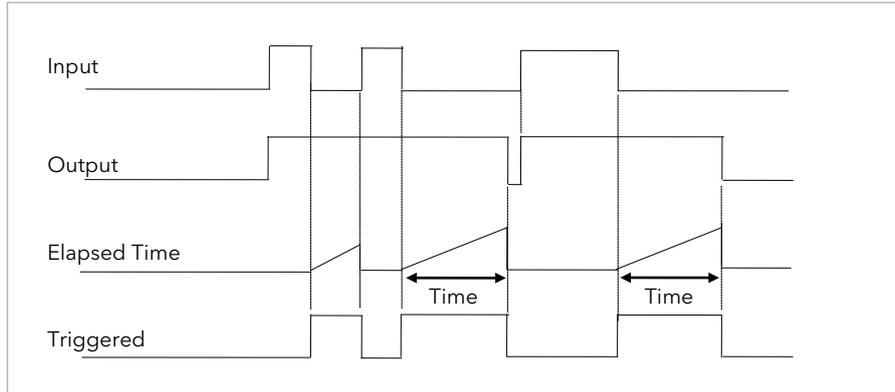
Figure 8-12: Minimum On Timer Under Different Input Conditions

8.6.5. Timer Parameters

These are found in **Toolkit Blocks → Timers → TMR1 to 8**.

Figure 8-13: Timers Parameter List

Name	Description	Range	Status
▪ **Type**	**Timer Type.** This selects the type of timer from those described in the previous sections		
OFF (0)	Timer not defined		
PULSE (1)	A single retriggerable pulse timer		
DELAY (2)	Off delay timer		
1 SHOT (3)	One shot timer		
CMPRSS (4)	Compressor or minimum on timer		
▪ **IP_Src**	**Timer Input Wire.** This allows the timer to be started from an external source. –1 indicates that no wire is made and the time can be set using the 'Time' parameter.		
▪ **IP_Val**	**Trigger/Gate Input.** This input triggers the timer to start.		
OFF (0)	Not timing. Trigger/gate input FALSE		
on (1)	Timing. Trigger/gate input TRUE		
▪ **Time**	**Timer Time.** Sets the period for which the timer will run	H:M:S:ms	
▪ **Trig**	**Timer Triggered.** The timer trigger will change from on to off depending on the timer type		📖
OFF (0)	Not timing. Trigger/gate output FALSE		
on (1)	Timing. Trigger/gate output TRUE		
▪ **OP**	**Timer Output.** The output will change from on to off depending on the timer type		
OFF (0)	Timer output FALSE		
on (1)	Timer output TRUE		
▪ **Elapse**	**Timer Elapsed Time.**		📖

8.7. COUNTERS

Up to eight Counter blocks are supported per IOC.

The counter provides a function to count transitions from 'OFF' to 'ON'

The counter can be set to two modes count 'UP' or 'DOWN', it has external wireable enable 'En', a reset 'Rst' and a clear overflow flag 'COv'

1. In 'UP' mode, when 'En' is set to one (Yes) the block increments the 'COUNT' from zero to the target 'Tgt'. On reaching the target the block will sustain the Ripple Carry output while 'Count = target', on the next count it will set the Overflow output 'Ovflow' to 1 (yes) and re set the count to zero

2. DOWN mode, when 'En' is set to one (Yes) the block decrements the 'COUNT' from the target 'Tgt' to zero. On reaching zero the block will sustain the Ripple Carry output while 'Count = zero', on the next count it will set the Overflow output 'Ovflow' to 1 (yes) and re set the count to target.

3. The Overflow output can be cleared by switching the Clear overflow 'COv' from 0 (no) to 1 (yes).

The Total is limited to a maximum count of 2,147,483,647.

A Ripple carry output 'RCarry' allows multiple Counter blocks to be concatenated extending this count if required. See example below:

The nominal quoted resolution for the counter block is nine digits i.e.999999999.
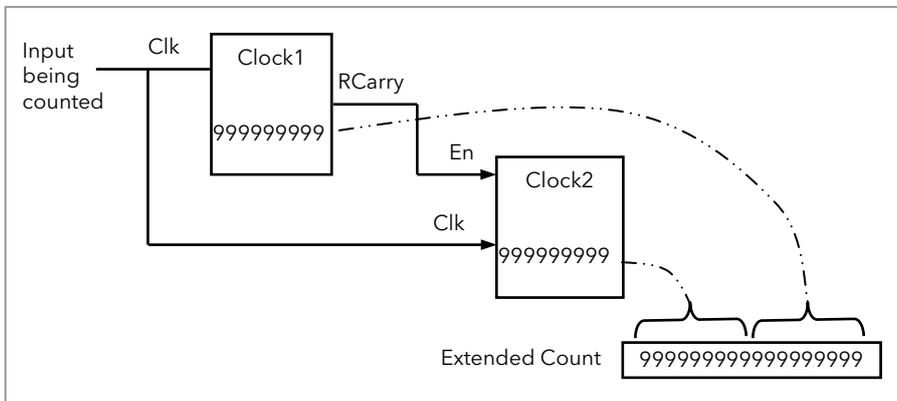
Figure 8-14: Counter Block

8.7.1. Counter Parameters

These are found in **Toolkit Blocks → Counters → CTR1 to 8.**

Figure 8-15: Counters Parameter List

Name	Description	Range	Status
▪ Dir	**Direction.** Defines the direction of count in response to clock pulses The Count is limited to a maximum count of 2,147,483,647.		
Up (0)	**Count up** In 'UP' mode, when 'En' is TRUE (Yes) the block increments the 'COUNT' from zero to the target 'Tgt'. On reaching the target the block will sustain the Ripple Carry output while 'Count = target'. On the next count it will set the Overflow output 'Ovflow' to 1 (yes) and reset the count to zero		
Down (1)	**Count down** In 'DOWN' mode, when 'En' is TRUE (Yes) the block decrements the 'COUNT' from the target 'Tgt' to zero. On reaching zero the block will sustain the Ripple Carry output while 'Count = zero'. On the next count it will set the Overflow output 'Ovflow' to 1 (yes) and re set the count to target.		
▪ Tgt	**Target.** Sets the value to which the counter is aiming		
▪ Count	**Count.** Current count value		
▪ Clk	**Clock.** Clock input: A FALSE to TRUE transition on this input will increment/decrement the count for Direction = Up/Down respectively.		
▪ ClkSrc	**Clock Source.** Modbus address of the source from which the Clock is derived. -1 indicates NOT wired		
▪ RCarry	**Ripple Carry.** Ripple Carry output: TRUE during a period determined by Direction: Direction = Up: when Count = Target. Direction = Down: when Count = 0. It will be FALSE otherwise.		
▪ Ovflow	**Overflow.** Overflow output: Becomes TRUE on the count after the ripple carry. It will remain TRUE until reset by the 'Cov' input..		
no (0)	No overflow		
YES (1)	Overflow active		
▪ Rst Src	**Reset Source.** Modbus address of the source from which the Reset is derived. -1 indicates NOT wired		
▪ Rst	**Reset.** Counter reset input. Setting this input TRUE will reset/load the count value as follows: Direction = Up: count goes to 0 Direction = Down: count goes to the target value. While the reset input is TRUE, the counter will ignore the clock input.		
no (0)	Reset input FALSE		
YES (1)	Reset input TRUE		
▪ COvSrc	**Clear Overflow Source.** Modbus address of the source from which the Clear Overflow input is derived. -1 indicates NOT wired		
▪ COv	**Clear Overflow.** Clear Overflow input: Setting this input TRUE will cause the Overflow output to become FALSE.		
no (0)	Clear overflow input FALSE		
YES (1)	Clear overflow input TRUE		
▪ EnSrc	**Enable Source.** Modbus address of the source from which the Enable input is derived. -1 indicates NOT wired		
▪ En	**Enable.** Enable Counter input: When TRUE the counter will count the Clock inputs. When FALSE, the counter will ignore the Clock input.		
no (0)	Clock input is ignored		
YES (1)	Clock inputs are counted		

8.8.   TOTALISERS

Totalisers are used to measure the total quantity of a measurement integrated over time (e.g. flow, power). There is a total of eight totaliser blocks in the 2500 controller. Outputs from the totaliser blocks are integrated values of the inputs. An alarm state and a pulse output is provided and can be wired to a counter block or external electromechanical counter to extend the upper range of totalisation.

In addition to the 'RUN', 'HOLD' and 'RESET' input parameters of a totaliser block, the following are provided:

- a 'LOW THRESHOLD cut-off for the Input signal
- an alarm set point
- a Pulse Set point for the Pulse output.

a.   In 'RUN' the totaliser will integrate its input and continuously test against an alarm set point.
b.   In 'HOLD' the totaliser and pulse output buffer will stop integrating the input but the block will continue to test for alarms.
c.   In 'RESET' the total will be reset to zero and the alarms cleared.

The Total is limited to a maximum of 99999 and minimum of -19999. This range can be extended by use of the pulse output wired to the Counter block.

8.8.1. Totaliser Parameters

These are found in **Toolkit Blocks → Totalisers → TOT1 to 8**
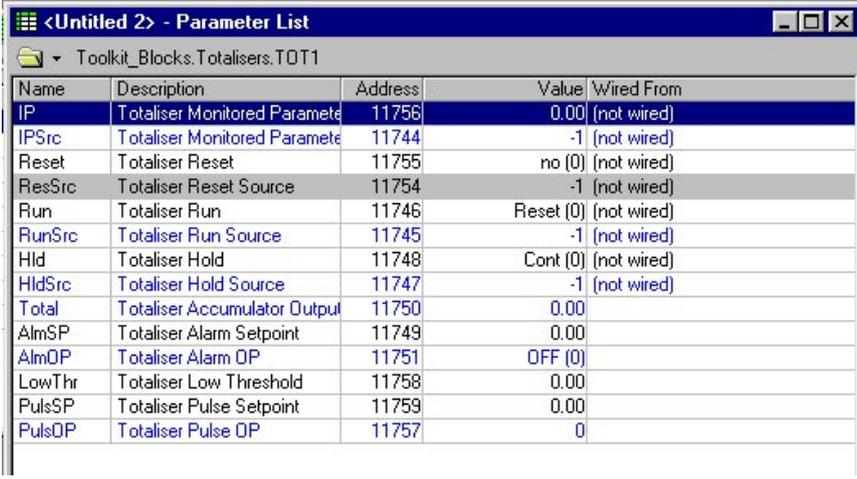
Name	Description	Address	Value	Wired From
IP	Totaliser Monitored Paramete	11756	0.00	(not wired)
IPSrc	Totaliser Monitored Paramete	11744	-1	(not wired)
Reset	Totaliser Reset	11755	no (0)	(not wired)
ResSrc	Totaliser Reset Source	11754	-1	(not wired)
Run	Totaliser Run	11746	Reset (0)	(not wired)
RunSrc	Totaliser Run Source	11745	-1	(not wired)
Hld	Totaliser Hold	11748	Cont (0)	(not wired)
HldSrc	Totaliser Hold Source	11747	-1	(not wired)
Total	Totaliser Accumulator Output	11750	0.00	
AlmSP	Totaliser Alarm Setpoint	11749	0.00	
AlmOP	Totaliser Alarm OP	11751	OFF (0)	
LowThr	Totaliser Low Threshold	11758	0.00	
PulsSP	Totaliser Pulse Setpoint	11759	0.00	
PulsOP	Totaliser Pulse OP	11757	0	

Figure 8-16:   Totalisers Parameter List

Name	Description	Range	Status
▪ IP	**Totaliser Monitored Parameter Value.** Current input value.	99999 to -19999	
▪ IPSrc	**Totaliser Monitored Parameter Source.** Modbus address of the source from which the Monitored Parameter is derived. -1 indicates NOT wired		
▪ Reset	**Totaliser Reset.** In Reset the totaliser will be zeroed, and alarms will be reset.		
no (0)	Totaliser Reset FALSE		
YES (1)	Totaliser Reset TRUE		
▪ ResSrc	**Totaliser Reset Source.** Modbus address of the source from which Reset is derived. -1 indicates NOT wired.		
▪ Run	**Run.** In Run the totaliser will integrate its input and continuously test against an alarm setpoint.		
Reset (0)	Totaliser not running		
Run (1)	Totaliser running		
▪ RunSrc	**Totaliser Run Source.** Modbus address of the source from which Run is derived. -1 indicates NOT wired		
▪ Hld	**Hold.** In Hold the totaliser will stop integrating its input but will continue to test for alarm conditions. 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.		
Cont (0)	Totaliser not held		
Hold (1)	Totaliser in hold		
▪ HldSrc	**Totaliser Run Source.** Modbus address of the source from which Hold is derived. -1 indicates NOT wired		
▪ Total	**Totaliser Accumulator Output.** The integrated value of the Monitored Parameter		📖
▪ AlmSP	**Totaliser Alarm Setpoint.** Sets the totalised value at which an alarm will occur		
▪ AlmOP	**Totaliser 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 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.		📖
OFF (0)	Alarm output off		
on (1)	Alarm output on		
▪ LowThr	**Totaliser Low Threshold.** Monitored Parameter low threshold: If the absolute value of the input is less than this value, it will be ignored. E.g. a LowThr value of 1.0 will cause inputs from -0.9 to +0.9 to be ignored.		
▪ PulsSP	**Totaliser Pulse Setpoint.** The amount of Total integrated for each PulsOP output. E.g. if Monitored Parameter is in m/s then setting PulseSP=10 (m) would give one pulse on PulsOP for every 10m integrated.		
▪ PulsOP	**Totaliser Pulse Output.** Set TRUE for one sample period for every PulseSP integrated. Maximum rate of pulses will be 2x sample period. If the PulseOP cannot keep up with the integrated value then pulses will not be lost but will be output at maximum rate until caught up.		📖

8.9.   WIRING

Soft Wiring (sometimes known as User Wiring) refers to the connections which are made in software between function blocks. This section describes the principles of soft wiring.

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 soft wired to the output from a preceding function block. Output parameters are usually soft wired to the input source of subsequent function blocks.

It is possible to wire from any parameter using its Modbus address. In practice, however, it is unlikely that you will wish to wire from many of the available parameters.

The function blocks used in this manual are drawn as follows:

1. Input parameters defined by 'Src' on the left of the function block diagram
2. Typically wired output parameters on the right hand side
3. Other parameters, which are not normally wired to, are shown as settings

A parameter which is not wired to can be adjusted through the iTools display provided it is not Read Only (R/O) and the correct access level is selected.

Figure 8-17 shows an example of how a PID function block (Loop 1) might be wired to other function blocks to produce a simple single loop controller. The LOOP01 → 'PVSrc' input is soft wired to the output of 'IO → Module01 → M01_C1 → Val'.

The channel 1 (heat) output from the PID block is soft wired to the input source ('Wire Src') of Module 1A, fitted as an output module.

Also in this example, a digital input to the 'Man Mode Src', allows the loop to be placed into manual depending upon the state of the digital input. The digital input is DIO1 connected to terminal D1 on the controller.

8.9.1. An Example of Soft Wiring
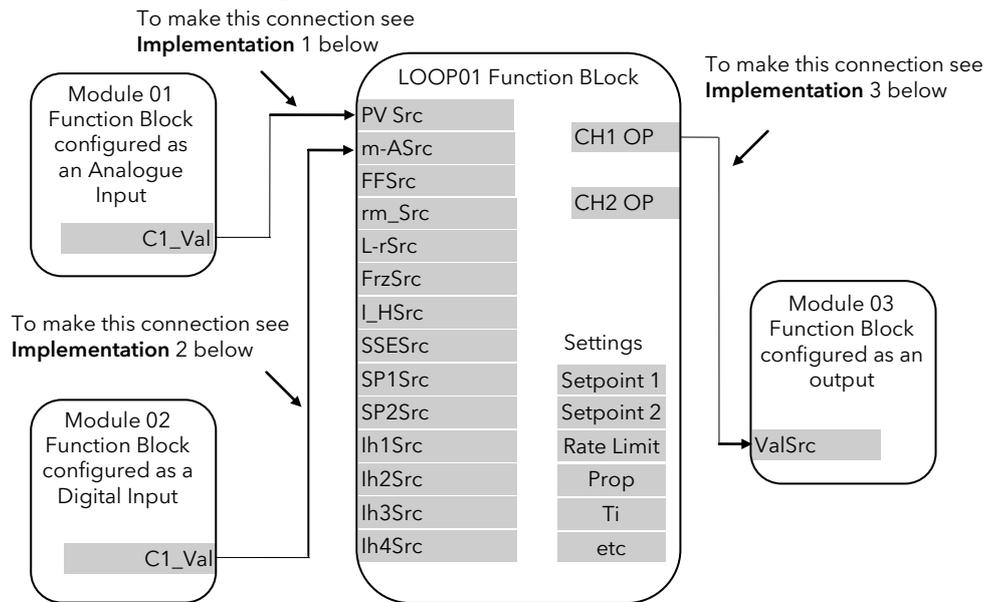
Figure 8-17:   A Simple Wiring Example of a PID Function Block

8.9.1.1. Implementation

1.   Wire Module 01 Output to Loop 01 PV Input
  a) In IO → Module01 → MOD01   Set 'ReqID' to AI2 (or AI3 or AI4)
  b) In IO → Module01 → M01_C1   Press + to open the list of parameter tags
  c) Drag the 'OP' tag to 'PVSrc' in Control → LOOP01

2.   Wire Module 02 Output to Loop 01 Auto/Manual Select Source
  d) In IO → Module02 → MOD02   Set 'ReqID' to DI4 (or DI8)
  e) In IO → Module02 → M02_C1   Press + to open the list of parameter tags
  f) Drag the 'OP' tag to 'm-ASrc' in Control → LOOP01

3.   Wire Loop 01 Channel 1Output to the input of Module 03
  g) In Control → LOOP01 → L01_OP   Press + to open the list of parameter tags
  h) In Module 03 → M02_C1   Set 'ReqID' to DO4 (or RLY4 or AO2)
  i) Drag the 'Ch1OP' tag to 'ValSrc' in Control → LOOP01 → L01_OP

4.   To remove a wire select the 'Src' parameter   right click Delete Wire

8.10.   POINT TO POINT WIRING

The user wiring system in earlier versions (up to V3.07) of the 2500 requires that all variables be 'wired to'. This requires that each variable that may be 'wired to' is allocated an additional Modbus address that contains the 'variable source' if 'wired to' and is unused if not.

All read/write variables can be written over communications. However, there are many read/write variables that are only sometimes wired.

An indirect 'WIRE' table is provided to facilitate writing to 16 variables not currently provided with a 'variable source' Modbus register

As an example if you require wiring to the input scalar in an analogue toolkit block this 'WIRE' block will provide connection.

8.10.1.   WIRES Parameters

These are found in **Toolkit Blocks → WIRES**

Figure 8-18:   WIRES Parameter List

Name	Description	Range	Status
▪ **Src1**	Point-to-point Wire Source -1 means NOT wired.		
▪ **Dst1**	Point-to-point Wire Destination. -1 means NOT wired.		
▪ **Stat1**	Wire status		📖
OK (0)	The wire is operating normally		
None (1)	The wire is not configured. Either source or destination are set to -1		
InvSrc (2)	The source address cannot be found		
Inv Dst (3)	The destination address cannot be found		
Fail (4)	The value has not been written due to being outside limits, not available or not alterable.		

The above parameters are repeated for 16 wires

8.11.   RELATIVE HUMIDITY

8.11.1.   Overview

Humidity (or altitude) control uses the traditional Wet/Dry bulb method. The Humidity toolkit block calculates the relative humidity (RH in %) and the Dew Point temperature and allows for compensation of atmospheric pressure and psychrometric constant.

As with any other transducer input, a 2500 analogue input may also be connected to a solid state sensor giving RH directly.

The derived Humidity value may be used for monitoring or may be wired to a PID control block and used to turn a refrigeration compressor on and off, operate a bypass valve, and possibly operate two stages of heating and/or cooling

8.11.2.   Humidity Parameters

Humidity parameters are found in **Control → HUMID1**
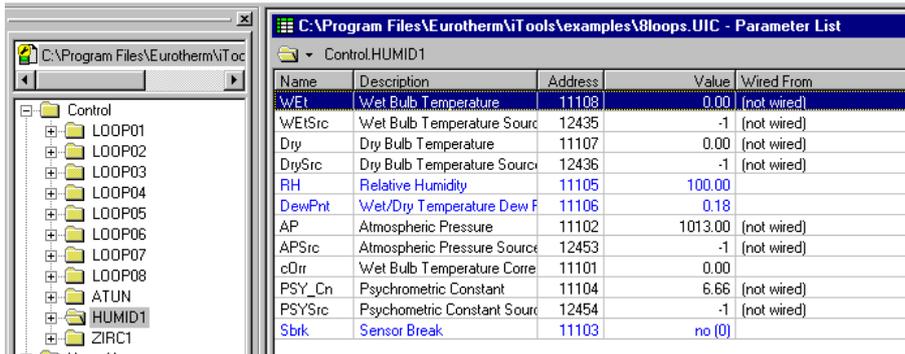
Figure 8-19: Humidity Parameters (configuration level)

The Wet and Dry bulb inputs must be wired to the appropriate PT100 analogue inputs.

Name	Description	Range	Status
▪ WEt	**Wet Bulb Temperature value**		
▪ WEtSrc	**Wet Bulb Temperature Source.** Modbus address of the parameter providing the wet temperature -1 indicates NOT wired.		
▪ Dry	**Dry Bulb Temperature value**		
▪ DrySrc	**Dry Bulb Temperature Source.** Modbus address of the parameter providing the dry temperature -1 indicates NOT wired.		
▪ RH	**Relative Humidity value.** The calculated RH in %		📖
▪ DewPnt	**Wet/Dry Temperature Dew Point**. The calculated Dew Point temperature		📖
▪ AP	**Atmospheric Pressure.** The atmospheric pressure used to compensate the RH calculation. The default is 1013 mBar		
▪ APSrc	**Atmospheric Pressure Source.** Modbus address of the parameter being used to provide the atmospheric pressure -1 indicates NOT wired - i.e. fixed at the default value		
▪ cOrr	**Wet Bulb Temperature Correction.** Allows an offset to be applied to the wet bulb temperature measurement		
▪ PSY_Cn	**Psychrometric Constant.** Default value 6.66. May be a constant or may be wired to a derived input using 'PSYSrc'.		
▪ PSYSrc	**Psychrometric Constant Source**. Modbus address of the parameter being used to provide the psychrometric constant -1 indicates NOT wired - i.e. fixed at the default value		
▪ Sbrk	**Sensor Break.** Sensor break status for RH control. Logical OR of the Wet and Dry input status'		📖
no (0)	Both sensors within limits		
YES (1)	One or both of the sensors is faulty		

8.12.   ZIRCONIA - CARBON POTENTIAL CONTROL

8.12.1.   Overview

An available option within the 2500 is the Zirconia function block. This feature is used to measure carbon potential, furnace dew point or oxygen concentration.

8.12.2.   Zirconia Probe Parameters

The key Zirconia configuration parameter is the actual equation used, 'ZrFn'. This depends on the type of probe, the range and the manufacturer. Depending on the option selected the Process Variable will be Carbon Potential, Dewpoint or Oxygen concentration. The PV is derived from the probe temperature 'TmpIP', the probe mV 'mV' and, for O_2 and Carbon, the local 'H-CO' or remote 'RmH-CO' gas reference input value. These must be wired to appropriate I/O input channels or derived values.

Zirconia parameters are found in **Control → ZIRC1.**

Figure 8-20:   Zirconia Parameters (configuration level)

Name	Description		Range	Status
■ **ZirPV**	**Zirconia Control Process Value**. The Zirconia PV - the Oxygen or Dew Point value derived from the gas reference inputs			📖
■ **ZiFn**	**Zirconia Probe Equation.**			
	MMI (0)	MMI - Carbon		
	MMI_DP (1)	MMI – Dew Point		
	AACC (10)	AACC		
	drAy (11)	Drayton		
	ACCU (12)	Accucarb		
	SSI (13)	SSI		
	mdu (14)	MacDhui		
	Oxy (15)	Oxygen		
	Log.O (16)	Log Oxygen		
	boSH (17)	Bosch		
	dw.P (18)	Dew Point		
	PmV (19)	Probe mV		
	boSC (20)	Bosch Carbon		
	BarCol (21)	Barber Colman		
■ **O2_Un**	**Oxygen Exponent.** Exponent of the Oxygen units eg set to 6 for ppm; set to 2 for %			

Name	Description	Range	Status
▪ H-CO	**Gas Reference.** Required value which defines the % carbon monoxide in the gas used for carburising. See also section 8.12.4		
▪ RmH-Co	**Remote Gas Reference.** Remote required value which defines the % carbon monoxide in the gas used for carburising. See also section 8.12.5		
▪ RmHSrc	**Remote Gas Reference Source .** Modbus address of parameter providing the Endothermic Gas correction. -1 means that it is not wired and must be set manually. See also section 8.12.5.		
▪ RmGEn	**Remote Gas Enable.** Set to enable remote gas reference for endothermic correction. See also section 8.12.5.		
Intern (0)	**Internal.** Use internal gas reference		
Remote (1)	**Remote.** Use remote gas reference		
▪ WkH-CO	**Working Gas Reference.** The current value of the reference gas.		📖
no (0)	No gas reference		
YES (1)	Working gas reference value		
▪ PF	**Process Factor.** The process factor is used by some probes (MMI) to provide compensation for varying degrees of carbon absorption. Only shown if 'Parameter availability settings' in the 'View' menu are not hidden.		
▪ ClnPrb	**Zirconia Clean Probe IP.** Zirconia Clean Probe IP Set to manually initiate a probe clean. See also section 8.12.7.		
OFF (0)	No probe clean.		
on (1)	Probe clean initiated		
▪ ClnSrc	**Zirconia Clean Probe IP Source.** Modbus address of the flag used to initiate a probe clean -1 indicates NOT wired		
▪ cYct	**Zirconia Probe Cleaning Interval.** Sets the interval between probe cleaning cycles. Default 4 hours.	h:m:s: ms	
OFF (0)	Zirconia probe cleaning off. Appears when the value is set to 0.		
_4h	Zirconia Probe Cleaning Interval		
▪ bot	**Zirconia Probe Cleaning Time.** The length of time the compressed air is applied to clean the probe. See also section 8.12.7.	h:m:s: ms	
▪ bort	**Maximum recovery time after purging.** The maximum time allowed for the probe to recover after cleaning Nominally 10 min. See also section 8.12.7.	h:m:s: ms	
▪ bmrt	**Minimum recovery time after purging.** The minimum time allowed for the probe to recover after cleaning	h:m:s: ms	
OFF (0)	Minimum probe recovery time. OFF appears when the value is set to 0.		
_0h	Minimum probe recovery time value		
▪ MinT	**Zirconia Minimum Calculation Temperature.** Set to the minimum temperature that will be allowed for the calculation to take place		
▪ OFFS	**Zirconia mV Offset**. Applies an offset to the probe reading		
▪ TOFS	**Zirconia Temperature Offset.** Sets the temperature offset for the probe		
▪ t2c	**Time To Next Cleaning.** Time remaining until the next clean is initiated	h:m:s: ms	📖
▪ Prob	**Zirconia Burn Off State.** Zirconia Burn Off State Defines the current state of the probe cleaning.		📖
idle (0)	Cleaning not in progress		
burn (1)	Cleaning in progress		
rcvy (2)	The probe is recovering having just been cleaned		
▪ boVLV	**Zirconia Clean Valve Output**. Displays the current state of the cleaning valve.		📖
OFF (0)	Cleaning not in progress		
on (1)	Cleaning in progress		
▪ PrbFlt	**Zirconia Bad Probe.** Set if the probe recovery time exceeds the Maximum recovery time. See also section 8.12.7.		
Good (0)	Probe clean completed OK		
Bad (1)	Probe due for refurbishment		
▪ ZirSBr	**Probe Sensor Break**. Set if the probe input is broken		📖

Name	Description	Range	Status
no (0)	Probe OK		
YES (1)	Probe out of limits		
▪ **SootAL**	**Zirconia Probe Sooting Alarm**. Alarm triggered when the atmospheric conditions are such that carbon will be deposited as soot on all surfaces inside the furnace. See also section 8.12.6.		📖
Good (0)	Conditions will not cause soot		
Bad (1)	Sooting conditions present		
▪ **mV**	**Zirconia Probe mV IP**. Zirconia probe input	-0.1 to 2.0	
▪ **mVSrc**	**Zirconia Probe mV Input Source.** Modbus address of the parameter providing the probe input mV -1 indicates NOT wired		
▪ **TmpIP**	**Zirconia Probe Temperature Input.** The actual temperature of the probe		
▪ **TmpSrc**	**Zirconia Probe Temperature Input Source.** Modbus address of the parameter providing the probe temperature -1 indicates NOT wired		
▪ **PVnVd**	**PV Invalid**. PV invalid		📖
no (0)	PV valid		
YES (1)	PV invalid		
▪ **PVFrz**	**PV Frozen.** Set whilst the probe is being cleaned or recovering afterwards Ensures the control loop is not disturbed by the cleaning		📖
no (0)	PV working normally		
YES (1)	PV Frozen during clean/recover cycle		

8.12.3.   Temperature Control

As well as the Carbon control the furnace temperature has to be controlled. 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 temperature PID block will provide a heating output that may will be connected to gas burners or to thyristors to control electrical heating elements. In some applications a cooling output may also be connected to a circulation fan or exhaust damper.

8.12.4.   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. This is set as the Gas Ref/Process Factor 'H-CO'.

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

Oxygen Units is the 'O2_Un' exponent of the oxygen units. This may be set to correspond to the units used, eg set to 6 for PPM; 2 for %, etc.

8.12.5.   Endothermic Gas Correction

A gas analyser may be used to determine the %CO concentration. If an analogue output is available from the analyser, it can be fed into the 2500 Zirconia block to adjust the calculated % carbon reading automatically. The analyser signal should be wired to the Remote Gas Ref/Process Factor 'RmH-CO' and the Remote Gas Enable 'RmGEn' set to Enable. If 'RmGEn' is disabled the value can be entered manually in 'H-CO'.

8.12.6.   Sooting Alarm

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

8.12.7.   Automatic Probe Cleaning

The 2500 zirconia block has a probe clean and recovery strategy. A short blast of compressed air is used to remove any soot and other particles that may have accumulated on the probe. The air blast continues for the time set in Probe Cleaning time 'bot'. Once the cleaning has been completed the time taken for the probe to recover is measured. If the recovery time is longer than the Max recovery time after purging 'bort', the probe is ageing and replacement or refurbishment is due and the output Zirconia Bad Probe 'PrbFlt' is set.

During the cleaning and recovery cycle, the %C reading is frozen to prevent the carbon PID reacting and ensuring continuous furnace operation. The cleaning cycle can be triggered manually by setting the input Zirconia Clean Probe IP 'ClnPrb' or it can be programmed to occur automatically at an interval set in Zirconia Probe Cleaning Interval 'cYct'.

The Zirconia block has various outputs to indicate the status of the block:

t2c   Time remaining to next cleaning

PVFrz   set when the PV output is Frozen

Prob   The probe burn off state set to idle, burn or recovery.

8.13.   ORDER IN WHICH CALCULATIONS ARE PERFORMED

The strategy is executed in the following order:-

1.   Point to point wires
2.   Digital calculations
3.   Analogue calculations
4.   Timers
5.   Totalisers
6.   Counters
7.   Humidity
8.   Zirconia
9.   Loops
10. User alarms
11. Loop alarms

9. Chapter 9   Modbus Communications

9.1.   OVERVIEW

The 2500 IOC and wiring for digital communications is described in Chapter 3.

To set up the parameters of the Modbus slave in the 2500 IOC. is described in Chapter 6.2.

NOTE:- When the configuration port is in use the Modbus network port is disabled.

9.2.   MODBUS ADDRESSES

9.2.1. Offset

The parameter addresses shown in iTools and in 2500 documentation is the actual register used. When setting up a true Modbus master the address must be increased by 1. This is not required for Jbus masters.

Parameter Address	Modbus Master Address	Jbus Master Address
01000	01001	01000

Table 9-1: Offset for Modbus

9.2.2. Parameter Addresses

All parameter addresses are available in iTools. They are in the Parameter Lists in the Address column. To see this column ensure that on the Menu Bar under Parameter List → Columns 'Address' is ticked. All the Parameter Lists shown in this handbook contain the address column.

Because there are many addresses within a 2500 and there is potentially a large variety of IOC type, Base size, I/O module type, channel setup etc. using iTools is the best way to determine the addresses of the parameters that are required in a particular system. They can be shown in decimal or hexadecimal from the menu bar 'Parameter List' → 'Address Display'.

In the case of enumerated values these are listed in preceding chapters of this handbook with the value of the enumeration shown in ( ) in the parameter lists. These can also be seen in iTools for a particular parameter by double clicking on the parameter, which opens the parameter value pop up window, then opening the enumerated list.

Take care not to inadvertently change this value in a working system.

9.2.3. Parameter Resolution

Normal Modbus Comms use a 16 bit word to transfer integer values. This has no decimal point so the magnitude of the number has to be known to the master. For example if two decimal places are required the number 12.34 is set as 1234 and the master has to be set up to divide this by 100. Each Loop has the option to define how many decimal places are included in the word. See section 4.3.2 and Control → LOOP01 → L01CFG → Decimal Places in Disp/Comms.

Since the value here is limited to 16 bits, the range is limited to +32767 to –32768. If the parameter is outside this range a value of –32768 (8000H) will be returned. In order to obtain a true reading in this case, the floating point address must be used.

9.2.4. Floating Point

All Modbus parameters are repeated in the Modbus address space above 32768 (8000hex) in 24 bit IEEE floating point format using two adjacent Modbus registers.

The floating point address of a parameter is its normal address x 2 and + 32768.

Taking Loop01.PV address as 2 then the floating point address is 2 X 2 + 32768 = 32772

The format used to transfer IEEE numbers is in Table 9-2

Lower Modbus address		Higher Modbus address	
MSB	LSB	MSB	LSB
Bits 31-24	Bits 23-16	Bits 15-8	Bits 7-0
Sign & Exponent	Fractional Value		

Table 9-2: IEEE Format

Most Modbus master protocols in SCADA packages will read this directly if the data type is set up as REAL or FLOAT.

9.3. COMMUNICATIONS BLOCKS

9.3.1. Block Communications

Modbus communications is made much more efficient by reading parameters in blocks rather than one by one. Actual data rates depend on many factors, but typically at 9600 bits/sec, read one by one, a data rate of about 30 parameters per second may be achieved. If blocks of 32 parameters are read at a time the data rate rises to a few hundred parameters per second. This gives a much better update response on a SCADA display, for example.

Parameters that may be required in a particular system are very unlikely to be in a block of contiguous addresses that can take advantage of block reading. To solve this a folder **Comms_Blocks** has been provided.

9.3.2. Indirection Tables

Two tables are provided, one for read/write 'Rw' and one for read only 'Ro' communications.

The Read Only table would usually be used with Process Variables which are changing continuously and it would be block read at a relatively fast rate.

The Read Write table is for parameters that do not change often, such as setpoints, and could be read at a much slower rate. The actual arrangements would vary depending on the requirements of the whole system.

The size of the two tables is defined in Operator → DESCR → nIndRO and nIndRW. The standard size is 127 parameters each.

9.3.3. Read Write Source Indirection Table

The 'Src' folder allows parameters to be entered into the indirection table.
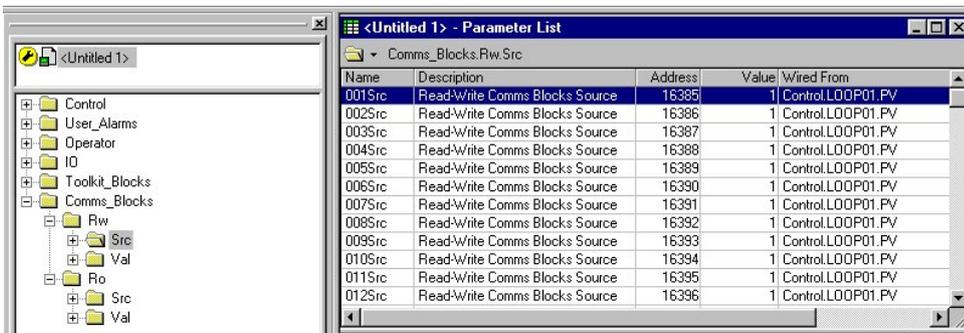
Figure 9-1: Read Write Indirection Table - Block Build

The parameters may be wired by dragging the parameter tag to the appropriate source parameter shown in the above table or by entering the parameter Modbus address in the value column. For example, parameter 001 has been wired to Loop01 PV.

9.3.4. Read Write Value Indirection Table

The 'Val' folder provides a convenient way to change the value of the parameter. This is in addition to changing its value in its normal folder. Note that, in this example, the PV may be changed by writing either to Modbus address 16512 or to the actual Control → LOOP01 → PV at address 1.
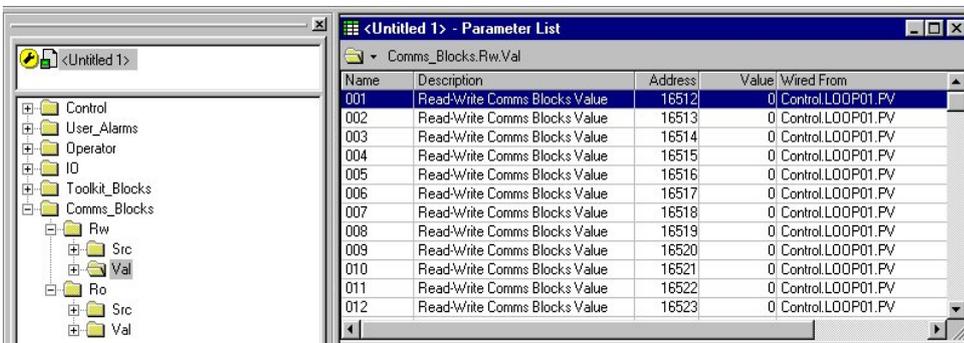
Figure 9-2: Read Write Indirection Table - Value Entry

9.3.5. Read Only Indirection Table

These are similar to the 'Rw' tables and are also available as 'Src' and 'Val' tables.

10.   Chapter 10   Profibus Communications

10.1. OVERVIEW

The 2500 IO Controller is available with Profibus DP and Profibus DPv1 communications. The 2500 can thus function as a Profibus **slave**, the network Master having read and write access to IOC database parameters. The 2500 will work with any Profibus Master - the Eurotherm T940, the Visual Supervisor and, of course, PC card types. It will work alongside any other slave - and obviously in large systems along with other 2500 bases.

There are four aspects considered here: the physical wiring of the network, the configuration of the 2500, the configuration of the network Master, and the creation and use of GSD files.

NOTE:- the Profibus IOC must be configured using iTools. When the configuration port is in use the Profibus network port is disabled.

10.2. PROFIBUS INSTALLATION

The DP and DPv1 options can be factory fitted, so the order code must include the appropriate field descriptor PROFIBUS (for Profibus DP) or PROFI DPv1 (for Profibus DPv1). Note that this option can be changed in configuration mode, see section 6.2.1.

The matching Terminal Unit must also be ordered. There are again two styles for different network connectors: a standard 9-Way D-Type, or a RJ45 type (not to be confused with the Modbus Terminal Unit, which looks very similar). The latter can only be used for small local systems where the advantage of easier wiring is appreciable. See also Chapter 2.

With the RJ45 version a network can be quickly built up using CATEGORY-5 cable; simply chain together all the bases to create a single serial run, all the way through the system up to the Master. The cable must be terminated at both the Master end and at the last slave; if this is a 2500 fit the two links on the terminal unit in the high position.

When connecting to a full Profibus network the D-Type connector must be used, via a short drop to the main network cable. Terminators are not required or supplied for 2500s in such a system. The pin-out conforms to the Profibus standard. The 5V supply pins are for network bias and termination only; do not load with more than 10mA.

10.3. CONFIGURATION OF THE 2500 FOR PROFIBUS

Each slave on the network must be provided with a unique address, 1 to 127, in no particular sequence. The Terminal Unit switches are used to set this address using binary code, lsb on the right, 1 in the up position (furthest from the power connector terminals), and 0 down. See section 2.7.2.

There are no software configuration requirements for the 2500.

10.4. A 'GSD' FILE

The Profibus network Master may be needed to work with many diverse slaves from different manufacturers and with different functions. Furthermore, instruments like the 2500 run thousands of parameters, most of which will not be required by the network master for a particular application.

The user must, therefore, define which parameters are to be available on the Profibus link. This may be done using the Windows configurator which is supplied as standard on the iTools CD. This configurator creates a 'GSD' file for the slave. The file <name>.GSD is a text file in predefined standardised format that may be imported into any proprietary Profibus master. The master may then map the selected device parameters into the PLC input/output registers, or, in the case of a supervisory (SCADA) package, to a personal computer.

Note that a GSD file for a particular 2500 may be used for a number of actual 2500 slave devices where the same parameter set is required. These bases will obviously have different unit addresses.

To use any slave the Master has to be set up appropriately in a two-step process:

1) The new slave has to be declared (using tools provided with the Master);

2) The GSD file(s) have to be imported and interpreted by the Master.

This is sufficient to establish communications. However, the Master still has to identify which parameter is which.

10.5.   TO CREATE A NEW GSD FILE

Profibus Parameters are defined as Input parameters or as Output parameters. Input parameters are read every Profibus cycle, output parameters are written to every cycle. This means, for example, that if the Profibus Master is writing to setpoint 'SP1' then any other attempt to change 'SP1' will just be overwritten on the next Profibus cycle. Using 'Demand Data' continual writing to Output parameters can be controlled by extra code in the PLC. See also the Profibus Handbook Part No. HA026290.

Do This	The Display You Should See	Additional Notes
1. Load the GSD file editor from the iTools CD and run it by double clicking the desktop icon.		
2. Set up the editor for the appropriate slave by clicking the icon (here, the 2500).		
3. Select the appropriate list of parameters from the drop down list of 'folders' or		These folders are in exactly the same order as they are displayed in iTools. Check '**Use Demand Data'** to allow continual writing to Output parameters controlled by the PLC Check '**Esuite/DPV1'** when using masters capable of Profibus DPV1 communications
4. Highlight the parameter to be <u>read</u> by the master and press the upper > button 5. Highlight the parameter to be <u>written</u> to the master and press the lower > button		Press '<u>D</u>elete' to remove the highlighted parameter Press '<u>C</u>lear' to remove all parameters in the list
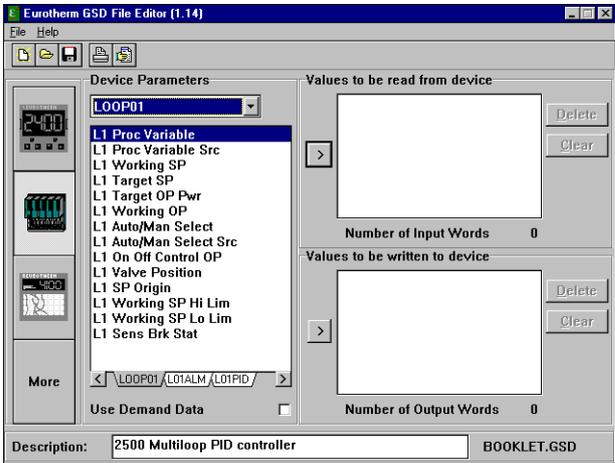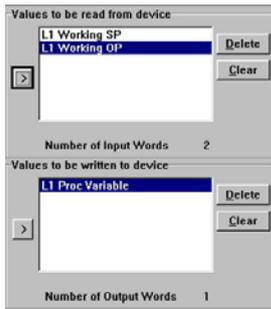
Continue adding to the Input and Output lists until all the required parameters have been added to the appropriate list. Parameters may be repositioned within a list by using the mouse to drag and drop a parameter within its list. This can be used to make the list more logical.

A maximum of <u>117</u> total input and output parameters is allowed in a Profibus DP slave. When this limit is reached, the configurator will not allow more parameters to be added into either the input or output lists until other parameters have been deleted.

It is advisable not to exceed 32 input and 32 output parameters in total, since some Profibus DP masters are unable to deal with more.

When satisfied with the content a useful comment may be added to the 'Description' field at the bottom of the window.

10.6.   TO SAVE THE GSD FILE

Once all the Input and Output parameter lists have been assembled as required press the diskette icon 'Save the current GSD file to disc' or the menu item File/Save and save the file as <name>.GSD.

An I/O Map may also be displayed or printed for a project folder again using the 'Display a report of Profibus IO Mapping' icon or from the file menu. An example is shown below:-
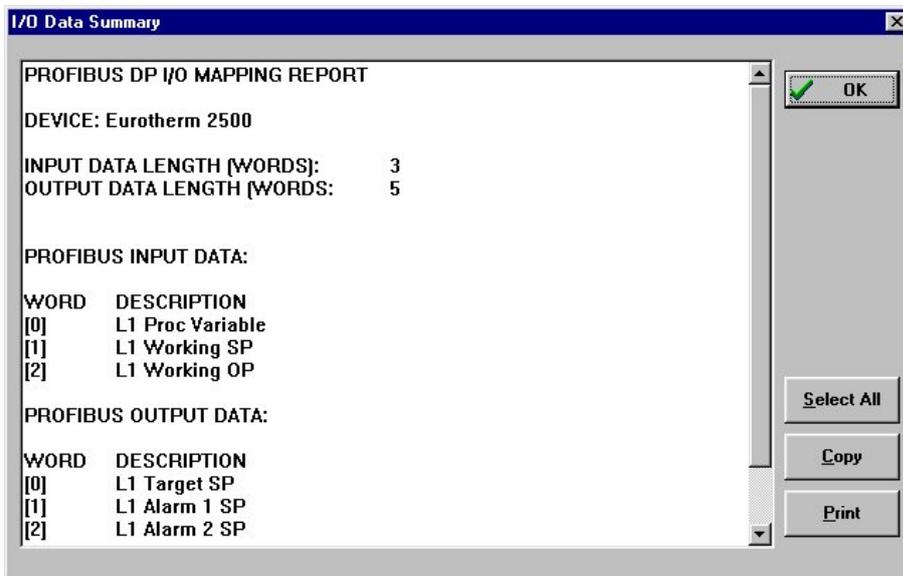
10.7.   OPERATING AND APPLICATION NOTES

▪ The Profibus Master needs the 2500 GSD file in order to establish a communications link. The configuration of the Profibus Master will vary according to the manufacturer. However, they will follow these basic steps.

1.   A new slave has to be declared and it has to be given a unit ID (base address).

2.   The required GSD file is then imported.

▪ A single GSD file may be used for a number of actual 2500 systems on the Profibus network if the same parameter set is of interest on each. If not a separate file must be produced for each different 2500.

▪ Some master devices limit the parameter count to 32 input and 32 output.

▪ Every parameter in the 2500 is treated as a WORD. The Master may consider the data as bytes and it is necessary to identify which bytes correspond to each parameter. An example from a configurator is shown below.

Tag Name   Address   Datatype

```
(* DP Input variables: *)
VAR_GLOBAL
    L1_PV                   AT %IW0.2.0!swap :   WORD;
    L1_WSP                   AT %IW0.2.2!swap :    WORD;
    L1_WOP                   AT %IW0.2.4!swap :    WORD;
    L1_ALM                  AT %IW0.2.6!swap :   WORD;
    L2_PV                   AT %IW0.2.8!swap :   WORD;
    L2_WSP                   AT %IW0.2.10!swap   :    WORD;
    L2_WOP                  AT %IW0.2.12!swap   :   WORD;
    L2_ALM                  AT %IW0.2.14!swap   :   WORD;
END_VAR

(* DP Output variables: *)
VAR_GLOBAL
    L1_TSP                  AT %QW0.2.0!swap :   WORD;
    L1_ASP                  AT %QW0.2.2!swap :   WORD;
    L2_TSP                  AT %QW0.2.4!swap :   WORD;
    L2_ASP                  AT %QW0.2.6!swap :   WORD;
END_VAR
```

The PLC Tag name is given during configuration.

Loop 1 PV (tag L1_PV) is Input Word (%IWO).the slave address(2).byte number (0)

The data type is WORD which takes bytes 0 and 1. The next parameter L1_WSP, therefore, starts at byte 2, and so on for the others.

Note that in this case the byte order has to be swapped to be interpreted correctly.

The output variables are handled in the same way.

Note also, that if 32 bits are read on a 16 bit system then a read of 8000Hex (32768dec) is returned.

11. Chapter 11   Devicenet Communications

11.1. OVERVIEW

The 2500 supports DeviceNet as a "Generic device type, Group 2 only server" with the following specifications:

- Support I/O messaging of up to 60 analog variables of Input data, and 60 analog variables of Output data. Actual I/O sizes can be chosen as required.

- Choose contents of I/O messages from any variable or value in the main application object, transferring only the information needed for an application and saving overall network capacity.

- Supports Polled I/O, Bit Strobe, Change of State, and Cyclic production.

- Supports Device Shutdown and Heartbeat messages

- "Application Variables" object provides direct access to 200 frequently used variables from each device type. In 2500 the object can itself be configured to contain specific variables needed for an application.

- Access to all other values in the instrument provided by a simple 'Tag Access' object, giving read or write access to blocks of data identified by a tag address. Used for recipe download.

- Analogue values can be returned either as 16 bit "scaled integer" values, or as 32 bit IEEE single precision floats.

- Operation at all DeviceNet baud rates. (up to 500K baud)

- maximum of 64 nodes on 100 metres of cable using the CAN physical signalling protocol

11.2. DEFAULT MAPPING

The 2500's factory default settings provide a "get you started" mapping that should be sufficient for many applications. The following parameters are stored in non-volatile memory in the 2500 IOC. If no custom mapping is made the IOC will load those parameters.

11.3. 2500 DEFAULT PARAMETER MAPPING

Input Parameter	Offset		Output Parameter	Offset
Process Variable (Loop 1)	0		Target Setpoint (Loop 1)	0
Working Setpoint (Loop 1)	2		Auto/Manual Select (Loop 1)	2
Alarm Status (Loop 1)	4		Alarm Group Ack (Loop 1)	4
Process Variable (Loop 2)	6		Target Setpoint (Loop 2)	6
Working Setpoint (Loop 2)	8		Auto/Manual Select (Loop 2)	8
Alarm Status (Loop 2)	10		Alarm Group Ack (Loop 2)	10
Process Variable (Loop 3)	12		Target Setpoint (Loop 3)	12
Working Setpoint (Loop 3)	14		Auto/Manual Select (Loop 3)	14
Alarm Status (Loop 3)	16		Alarm Group Ack (Loop 3)	16
Process Variable (Loop 4)	18		Target Setpoint (Loop 4)	18
Working Setpoint (Loop 4)	20		Auto/Manual Select (Loop 4)	20
Alarm Status (Loop 4)	22		Alarm Group Ack (Loop 4)	22
Process Variable (Loop 5)	24		Target Setpoint (Loop 5)	24
Working Setpoint (Loop 5)	26		Auto/Manual Select (Loop 5)	26
Alarm Status (Loop 5)	28		Alarm Group Ack (Loop 5)	28
Process Variable (Loop 6)	30		Target Setpoint (Loop 6)	30
Working Setpoint (Loop 6)	32		Auto/Manual Select (Loop 6)	32
Alarm Status (Loop 6)	34		Alarm Group Ack (Loop 6)	34
Process Variable (Loop 7)	36		Target Setpoint (Loop 7)	36
Working Setpoint (Loop 7)	38		Auto/Manual Select (Loop 7)	38
Alarm Status (Loop 7)	40		Alarm Group Ack (Loop 7)	40
Process Variable (Loop 8)	42		Target Setpoint (Loop 8)	42
Working Setpoint (Loop 8)	44		Alarm Group Ack (Loop 8)	44
Alarm Status (Loop 8)	46		Alarm Status (Loop 8)	46
TOTAL LENGTH	48		TOTAL LENGTH	48

11.4.   CUSTOM PARAMETER MAPPING

The DeviceNet interface uses the 2500s standard Modbus indirection table to parameterise its application specific Send and Receive tables. Custom mapping is done with iTools and is stored with the applications clone file.

11.4.1.   Indirection Tables

Two tables are provided, one for read/write **Rw** and one for read only **Ro** communications. The Read Only table would usually be used with Process Variables which are changing continuously and it would be block read at a relatively fast rate. The Read Write table is for setpoints that do not change often, and could be read at a much slower rate. The actual arrangements would vary depending on the requirements of the whole system.

11.4.2.   Read Write Indirection Table

Figure 11-1: Read Write Indirection Table

The parameters may be wired in the usual way See iTools manual for more details. In the read write table Parameter 001 has been wired to Loop01 target setpoint.

11.4.3.   Read Only Indirection Table

Figure 11-2: Read Only Indirection Table

The parameters may be wired in the usual way. In the read only table Parameter 001 has been wired to the PV of channel 1 of module 3.

12.   Chapter 12   Ethernet Communications

12.1. OVERVIEW

The 2500 I/O Controller (IOC) supports Ethernet using the Modbus/TCP protocol. This protocol embeds the standard Modbus protocol (see Chapter 9) within an Ethernet TCP layer.

A master device (iTools, PLC, SCADA, 6000 series recorders) using the Modbus/TCP protocol is required to access the 2500 Ethernet IOC parameters.

12.1.1.   Support for other Ethernet utilities

In addition to the MODBUS TCP protocol, the 2500 IOC supports the standard Ethernet 'ping' utility to assist in fault finding. Other interfaces such as http, ftp or telnet are not currently supported.

NOTE 1:- When the configuration port is in use, the Ethernet network port is disabled for general Modbus/TCP traffic. Support for the 'ping' utility is not affected and will still respond.

NOTE 2:- When changing processors be aware that the MAC address is not the same as the previous MAC address and it may take a few minutes to re-establish communications links.

12.2. CONFIGURATION OF THE 2500 FOR ETHERNET

12.2.1.   General

The 2500 IOC Ethernet capability is provided by an interface board installed within the IOC case. This interface board communicates to the IOC internally using a standard Modbus interface at 38400 baud. The Ethernet port is a 10baseT port and can be connected to a hub or switch with Cat5 cable via the standard RJ45 connector. Alternatively, an RJ45 cross-over cable may be used to connect direct to a PC 10baseT Network Interface Card.

As most parameters are saved in the IOC memory, the interface board must retrieve these values before it can start communicating on Ethernet. If the configuration cable is plugged in at power up, this retrieval will not take place and the interface board will not communicate over Ethernet.

The values seen by iTools via the configuration cable in this case will vary according to the instrument set-up:

1.   The MAC address will be returned as 0 in all fields.
2.   If DHCP is configured, the IP address, Subnet mask and Default gateway will contain the values last assigned by the DHCP server. These may change when the configuration cable is removed.

Changing any of the IP parameters will cause the interface board to reset in order to retrieve the new values.

Any socket left with no data traffic for 2 minutes will be disconnected and made available for new connections. This also applies to the preferred master socket (see section 12.3.5), except it will not be made generally available. Thus the preferred master will either have to send 'keep alive' data or periodically re-connect if it stops sending data.

Note that the 2500 may not respond if a DHCP server is not available - see section 12.3.7

12.2.2.   Setting the Instrument Address

The 2500 Ethernet IOC uses the Modbus/TCP protocol. This embeds the normal Modbus protocol within a TCP packet for transmission over an Ethernet network. The Modbus address is included as part of the Modbus/TCP protocol, where it is referred to as the 'Unit ID' and will need to be set in accordance with the Unit ID Enable parameter (12.3.1).

For normal Modbus (and other protocols) there is only the one address parameter that needs to be set. For the Ethernet instrument however, there are several more: IP address, subnet mask, default gateway and DHCP enable.

Changing any one of these parameters may immediately move the instrument to a new network address. For this reason, it is recommended that such changes are made offline, via the configuration port.

It is possible to safely make these changes via the Ethernet port since most of the parameters are in a contiguous block of addresses. The exception is the Unit ID – but the DIP switches may set this. Otherwise, the Ethernet parameters may be set by a single block write.

The format for Ethernet IP addresses is four groups of up to three decimal digits usually represented as: aaa.bbb.ccc.ddd. To enter these values into the 2500 Ethernet IOC, four separate parameters are used for each IP address style parameter. For example, IP address 1 is the 'aaa' value, through to IP address 4 for the 'ddd' value.

12.2.3.   DIP Switches

The following description views the DIP switches from the terminal side. 'Off' (0) is with the switch slider towards the terminal, 'On' (1) is with the slider away from the terminal.

The Unit ID Enable parameter decides how these switches are interpreted. If set to "Instr", each slave on the network must be provided with a unique slave id, 1 to 127. The Terminal Unit switches may be used to set this value using binary code, lsb on the right. See section 2.6.3.

The leftmost switch is used to set DHCP enable: 'off' selects 'Fixed' addressing, 'on' selects DHCP. See section 12.3.7.

As normal, if all switches are 'off', the values may be set by iTools – otherwise the values are read only.

12.3.   ETHERNET COMMUNICATIONS PARAMETERS

The 2500 Ethernet IOC address parameters may be found in the Operator.COMMS list.

	Name	Description	Address	Value	Wired From
✎	Addr	Comms Address	16352	1	
✎	UnitIDEn	Unit Ident Enable	32023	Instr (2) ▾	
✎	Res	Comms Resolution	16355	FuLL (0) ▾	
✎	IPaddr1	IP address 1	32000	149	
✎	IPaddr2	IP address 2	32001	121	
✎	IPaddr3	IP address 3	32002	129	
✎	IPaddr4	IP address 4	32003	181	
✎	Subnet1	Subnet mask 1	32004	255	
✎	Subnet2	Subnet mask 2	32005	255	
✎	Subnet3	Subnet mask 3	32006	248	
✎	Subnet4	Subnet mask 4	32007	0	
✎	Gateway1	Default gateway 1	32008	0	
✎	Gateway2	Default gateway 2	32009	0	
✎	Gateway3	Default gateway 3	32010	0	
✎	Gateway4	Default gateway 4	32011	0	
✎	PrefMst1	Preferred master IP add	32012	0	
✎	PrefMst2	Preferred master IP add	32013	0	
✎	PrefMst3	Preferred master IP add	32014	0	
✎	PrefMst4	Preferred master IP add	32015	0	
	MACaddr1	MAC address 1	32020	0	
	MACaddr2	MAC address 2	32021	0	
	MACaddr3	MAC address 3	32022	0	
✎	DHCPen	DHCP enable	32016	Fixed (0) ▾	
✎	NetStat	Ethernet status	32017	0	
✎	IPChanged	IP Parameter Changed	32018	1	
	LocalAddres	Local Modbus Address	32019	1	

Operator.COMMS - 26 parameters (9 hidden)

Figure 12-1: Communications Parameters

12.3.1.   Unit Ident Enable

This parameter controls how the instrument responds to the value in the Modbus TCP Unit Ident field. The following value options are available:-

0 = 'Strict'   The instrument will only respond to Unit Ident values of 255 (0xFF). Ignores values in the Addr – Comms address field.

1 = 'Loose' The instrument will respond to ANY Unit Ident value. Ignores value in Addr – Comms address field.

2 = 'Instr'   The instrument will only respond to Unit Ident values that match the Comms Address parameter. Uses the value in the Addr – Communications address field. This field is set by either the DIP switches on the terminal unit or by software if the DIP switches are set to zero.

12.3.2.   IP Address

With the DHCP Enable parameter set to 'Fixed', the values here become effective.

Your network administrator will issue you with a value compatible with your network.

The default IP address 'out of the box' is to 192.168.111.222.

Those parameters are in Operator → **COMMS list**

Name	Description		Range	Status
▪ **IPadd1**	**IP address 1**		255	
▪ **IPadd2**	**IP address 2**		255	
▪ **IPadd3**	**IP address 3**		255	
▪ **IPadd4**	**IP address 4**		255	
	IP address	000 . 000 . 000 . 000		

12.3.3.   Subnet Mask

This parameter defines which addresses are local to the network.

Your network administrator will issue you with a value compatible with your network.

Those parameters are in Operator → **COMMS list**

Name	Description		Range	Status
▪ **Subnet1**	**Subnet mask 1**		255	
▪ **Subnet2**	**Subnet mask 2**		255	
▪ **Subnet3**	**Subnet mask 3**		255	
▪ **Subnet4**	**Subnet mask 4**		255	
	IP address Subnet mask	000 . 000 . 000 . 000		
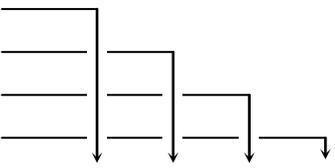
12.3.4.   Default Gateway

This parameter allows the 2500 Ethernet IOC to access devices that are not on the local network.

Your network administrator will issue you with a value compatible with your network.

Those parameters are in Operator → **COMMS list**

Name	Description		Range	Status
▪ **Gateway 1**	**Default Gateway 1**		255	
▪ **Gateway 2**	**Default Gateway 2**		255	
▪ **Gateway 3**	**Default Gateway 3**		255	
▪ **Gateway 4**	**Default Gateway 4**		255	
	IP address of default gateway	000 . 000 . 000 . 000		
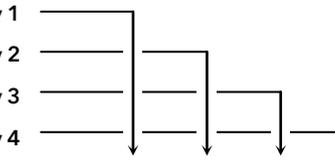
12.3.5.   Preferred Master - Multiple Connections

The 2500 Ethernet IOC is capable of providing information to up to four different Modbus/TCP masters simultaneously. Access to the four 'sockets' is normally available on a first come first served basis. Once all sockets are in use, further connections will be refused.

There are situations where a particular master needs guaranteed access to the 2500 IOC at all times. The 'preferred master' IP address can be used to ensure this availability. When this parameter(s) is configured with the appropriate master's IP address, only three sockets will be generally available, the fourth is reserved for a master with the matching IP address.

Setting the Preferred Master IP address to 0.0.0.0, the default setting, is a special case that disables the function and makes all four sockets available for general use.

Note that if the preferred master attempts to open a second socket while the first socket is connected, it will be given access to one of the 3 general sockets – if available. If no sockets are available, it will be refused additional connections.

Those parameters are in Operator → **COMMS list**

Name	Description		Range	Status
▪ **PrefMst1**	**Preferred Master 1**		255	
▪ **PrefMst2**	**Preferred Master 2**		255	
▪ **PrefMst3**	**Preferred Master 3**		255	
▪ **PrefMst4**	**Preferred MAster 4**		255	
	IP address Preferred Master	000 . 000 . 000 . 000		
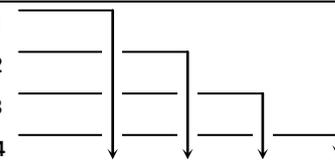
12.3.6.   MAC Address

Every device designed to connect to the Ethernet is allocated a unique address, the **M**edia **A**ccess **C**ontrol (MAC) address. Every Network Interface Card in every PC and every 'Internet Enabled' appliance is allocated its unique MAC address. The 2500 Ethernet IOC is no different.

Those parameters are in Operator → **COMMS list**

Name	Description				Range	Status
▪ **MACaddr1**	**MAC address 1**					📖
▪ **MACaddr2**	**MAC address 2**					📖
▪ **MACaddr3**	**MAC address 3**					📖
	MAC address	00-00	– 00-00	– 00-00		

The iTools representation of the MAC address is as three 16 bit signed values - MAC address 1 is the most significant. To convert this to the standard notation, each signed value must be converted to two hexadecimal bytes to give:

(MACaddr1 MSB) - (MACaddr1 LSB)
          - (MACaddr2 MSB) - (MACaddr2 LSB)
                    - (MACaddr3 MSB) - (MACaddr3 LSB)

where '-' is the standard MAC address separator.

The MAC address must be stored in the device that connects to the Internet - for the 2500 Ethernet IOC; this is the interface board. The MAC address value seen through iTools has to be read from the interface board. If the configuration cable is plugged in at power up, communications to the interface board is inhibited and the MAC address parameters seen by iTools will all be 0. In order to see the correct value(s), the configuration cable should be removed for a short period after the power up self-test sequence has completed.

Note that the MAC address will be available (read only) to iTools via the configuration port (but see section 12.2.1), regardless of the DHCP setting and will be retrieved before any wait for the DHCP server is invoked.

12.3.7.   Dynamic Host Configuration Protocol

DHCP Enable

DHCP is a protocol that enables a network server to dynamically allocate the IP address (and other parameters) of a client when it connects to the network. Note: Other protocols that automatically set the IP address, such as BOOTP or Link Local are not supported.

The DHCP parameter may be set to 'DHCP' or 'Fixed'. If the parameter is set to fixed see IP address above.

DHCP at power up: The instrument polls the network for a server to supply these parameters. Once received, they are copied to the IOC and may then be interrogated using iTools via the configuration cable. Until a valid IP address has been received, the IOC parameters will assume a value of 0.0.0.0 – seeing this value may be an indication that the DHCP server has not yet supplied any parameters.

Note that if the DHCP server does not respond (in common with other Ethernet appliances in this situation) the 2500 will not be accessible via the network.

An alternate way to view the IP address, assigned by the DHCP server, without using the configuration lead is to use the appropriate network tools to interrogate the server. For example, knowing the instrument MAC address (see below) the network command, 'arp –a' may provide a cross-reference from the MAC address to the assigned IP address.

Note: Changing any IP communication parameter will reset the interface board. With DHCP enabled this will trigger a new request to the DHCP network server and may result in new address values being assigned. When viewing the network addresses, it is recommended that no changes be made while reading the DHCP assignments via the configuration.

Those parameters are in Operator → **COMMS list**

Name	Description	Range	Status
▪ **DHCPen**	**DHCP enable:** Defines if a remote, suitably configured DHCP server, is allowed to automatically assign IP address, subnet mask and default gateway.		
	See your network administrator to set up this server.		
Fixed (0)	Allows manual entry of IP address, subnet mask and default gateway		
DHCP (1)	Allows the DHCP server to set the IP address, the subnet mask and default gateway.		

Note that this parameter may be set via the DIP switches (see section 12.2.3) – in which case it is read only here.

DHCP Leases

Leases must be issued for less than 24 days. Notify your network administrator

12.4.   MODBUS EXCEPTIONS

The 2500 Ethernet IOC will return all the usual Modbus exceptions with respect to normal transactions.

There are also two new conditions that will return exceptions.

- **BUSY (6):** this will be returned when the configuration cable is plugged in.
- **FAIL (4):** this will be returned if the connection from the interface board to the IOC experiences time-outs, or crc failures.

12.5.   COMMUNICATIONS INDICATORS

There are two levels of communication indication. The first dealing with Modbus communications between the Ethernet interface board and the IOC the second dealing with Ethernet communications.

12.5.1.   Modbus communications indicator

The yellow communications status LED on the top of the IOC module will reflect traffic on the IOC Modbus port. As such this will see the periodic status exchanges from the interface board (about 2 per second) as well as external network traffic. Note that this status exchange does not start until the power up initialisation is complete. In particular, with DHCP enabled if the server does not respond (or the network is not connected), this led will remain off after an initial exchange has completed.

12.5.2.   Ethernet communications indicators

Two LED's located on the RJ45 network connector that is mounted on the IOC termination unit have following uses:

- The yellow LED indicates receive activity. It will flash for ALL network activity on the local link – not just traffic addressed to the 2500 Ethernet IOC.
- The green LED indicates transmit activity. This will only flash when the 2500 Ethernet IOC is replying to received requests addressed to the instrument.

Those parameters are in Operator → **COMMS list**

Name	Description	Range	Status
▪ **NetStat1**	**Ethernet Status:** Diagnostic parameter		📖
▪ **IPChanged**	**IP Parameter Changed:** Shows a fleeting (1) while the Ethernet interface registers the change in IP parameter		📖

12.6.   NETWORK WATCHDOG

The Network Watchdog is triggered by external communications traffic that is addressed to the instrument only.

- If the preferred master is configured, only data addressed to the 2500 Ethernet IOC from that IP address will reset the watchdog.
- If the preferred master is not configured, any data addressed to the 2500 Ethernet IOC from the network will reset the watchdog.

See section 6.3.1 for further details.

13.   Chapter 13   Calibration

13.1. OVERVIEW

Analogue Input and Output modules are factory calibrated for life on every channel and on every range so as to meet quoted specifications. On occasion there may be good reason to alter this standard behaviour; either to compensate for some specific loop or sensor characteristic, or simply to extract maximum accuracy by eliminating residual transducer, wiring and measurement errors.

To support such corrections on analogue I/O channels the 2500 offers several levels of "user calibration":

- Simple Cal Offset correction (input channels);
- User Calibration, a two-point gain and offset correction (input channels);
- Reference Calibration, for extremely accurate electrical performance (all channels).

These are not to be confused with the Factory Calibration, which can always be restored from EEPROM memory in the I/O module. Note that there are other ways to alter channel behaviour - for example, by using the Custom Linearisation feature of input channels. It is also possible to use combinations of all these methods, but the simplest solution is always advised.

The Simple Offset is available in any run mode without restriction. User Calibration can only be changed in 'Config' mode and with the UserPW set. Similarly, Reference Calibration requires the password RefPW. Refer to Chapter 6 (OPERATOR) for more information about passwords.

Simple Offset and User Calibration corrections directly alter input channel reported PVs. The corrections are applied after linearisation (important if using TC mode or square-root linearisations). The full Reference Calibration is applied to the electrical interface (MeasV), thus before linearisation (AI modules) or altering the actual output (AO modules).

Note that all user-calibrations would require validation and possibly re-calibration if the module (or the connected transducer) is changed. This is not the case with Factory Calibration.

13.2. SIMPLE OFFSET

Offset correction may be used for any system where there is a systematic measurement or control offset term. Less obvious, perhaps, is that an offset may also be sufficient to correct complex errors in any system where the input (process monitoring) channel will operate over a very narrow working range.

Simple Offset correction is available on all AI2, AI3 and AI4 channels in both 'Run' mode and 'Config' mode. No password is required.

To carry out offset correction simply change the channel parameter 'Offset', with the required value as a floating point number in engineering units. The value is in the same units as the PV, applied directly and instantly. 'Offset' is found in IO $\rightarrow$ Module'nn' $\rightarrow$ C1 (to 4).
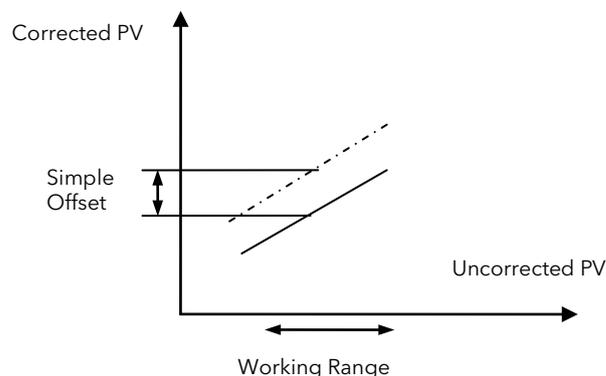
Figure 13-1: Offset directly affects PV

13.2.1.   To Perform Offset Calibration

In iTools navigate to the appropriate channel list, double-click the 'Offset' parameter and enter the correction factor:
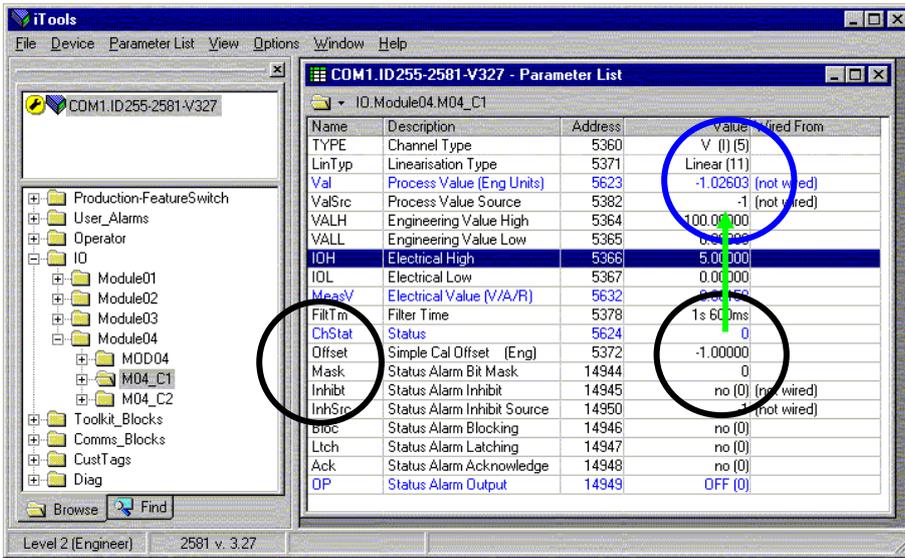
Figure 13-2:   Offset parameter in the IO Channel List

The IOL, IOH, VALL and VALH limits still apply to the uncorrected channel behaviour; note that the offset of -1.0 in the above example modifies the PV without problems, despite the VALL limit of 0.000.

13.3.   USER CALIBRATION

Sometimes the simple offset correction is not sufficient for an application - particularly when any compensation requires changes through the working range. If the "error" (as seen in the PV reported for an input channel) can be modelled with a gain term and an offset term we can use the AI2, AI3 and AI4 "user cal" facility to impose a straight-line correction.

This type of correction is defined by two PV offsets, 'OfsetL'& 'OfsetH', applied at two PV points, 'PointL' & 'PointH'. This can be shown graphically as follows:
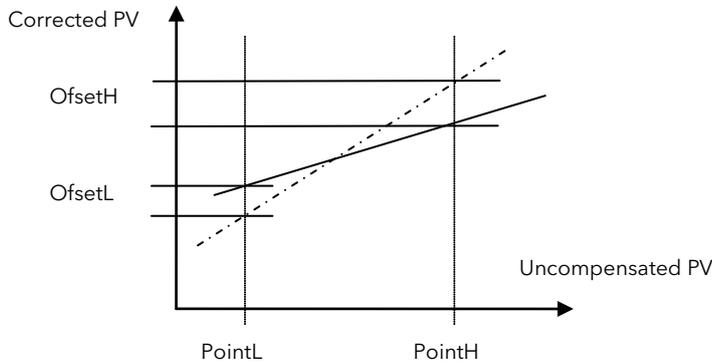
Figure 13-3:   Mapping Calculated PV to 'User Cal' PV

Here the uncorrected PV working range characteristic is shown by the solid line between the working range PV values 'PointL' and 'PointH' (it is best practice to use these extremes for the reference points). The dotted line shows the corrected PV when the shown 'OfsetL' (in this example a negative value) and 'OfsetH' (here positive) have been defined, and UCAL set.

Note that this correction is applied after any linearisation. This (for example) corrects the temperature reading when using a TC range.

The correction is enabled by setting the 'UCAL' parameter to 'USEr (1), normal operation is restored by changing UCAL to 'FAct (0)'. All these parameter should be visible and alterable only when the password 'UserPW' is set and the 2500 put into 'Config' mode.

☺ To find a parameter press the **'Find'** tab located at the bottom of the browser section in iTools.

13.3.1. To Perform User Calibration

1. Select 'UserPW' in Operator → PASSWD. Enter the password (factory default 12).

2. Navigate to the appropriate channel list

3. Double-click the 'PointL' parameter and enter the value at which the low offset is to be applied

4. Double click the 'OfsetL' parameter and enter the low offset value

5. Repeat 3. and 4. to apply a high offset

6. Set 'UCAL' to 'USER'
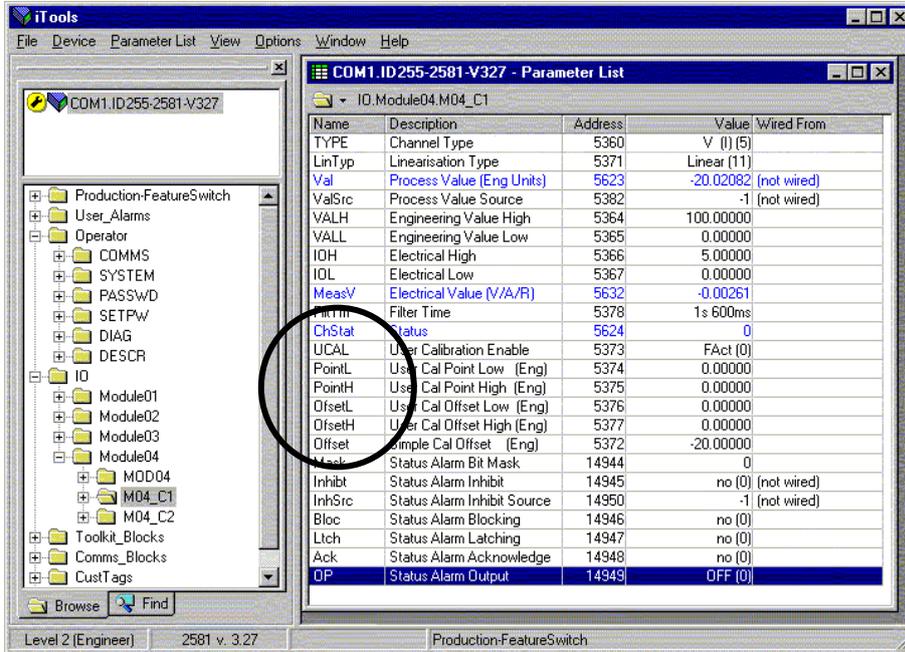
Figure 13-4: 'User Cal' Parameter List

☺

- If the correct password has been entered the parameters UCAL, PointL, PointH, OfsetL and OfsetH are available as shown by the background changing from grey to white.

- These parameters default to 0.00000.

- The parameter values are in engineering units, the same units as the PV. Corrections are applied directly and instantly when 'UCAL' is set to 'USEr (1)'.

- The IOL, IOH, VALL and VALH limits still apply to the uncorrected channel behaviour. The simple offset parameter is still effective, and is applied AFTER user calibration corrections.

13.4.   REFERENCE CALIBRATION

Reference calibration is particularly useful for eliminating residual system errors. It is another 2-point (straight line) method, but rather than altering the PV it directly changes the electrical signal conversion at the terminals. This calibration is used for small corrections - for example, to compensate for a known error in a characterised thermocouple. Note that all the calibration points are pre-defined, and large deviations (trying to force large corrections) are prohibited.

Partial calibration is quite acceptable. In the factory the AI2, for example, is calibrated at 16 points. Most applications use a single fixed range, so it would be wasted effort to calibrate anything other than the channel and 'Channel Type' used.

Factory Calibration can always be restored - see 13.4.3. below.

It is essential that the calibration procedure follows good practice, using accurate and traceable standards, allowing sufficient warm-up and settling times. Reference Calibration should not be performed if the system suffers from external noise interference, PSU problems or large swings in ambient temperature. Calibration cannot compensate for interference noise, non-linearity or temperature effects on the modules.

As any change to calibrated I/O modules (as for a service exchange, for example) will affect performance, it is suggested that any system calibrated modules are clearly labelled, particularly where accuracy is critical.

Before calibration you must set the password 'RefPW' in the Operator Password list, and you will need to set iTools to show more parameters and list options than usual. From the 'Options' menu select 'Parameter Availability Settings' and get the Parameter Availability dialogue:
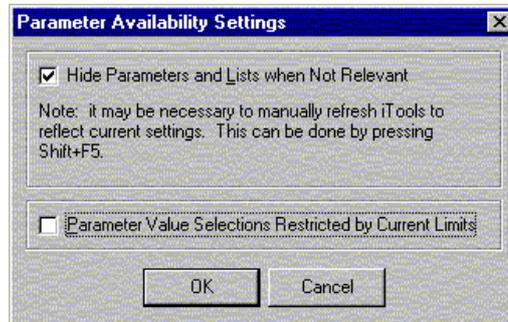
Figure 13-5: Parameter Availability Settings

Make sure the check-box 'Parameter Value Selections Restricted...' is not ticked.

13.4.1.   Analogue Input Calibration Procedure

Each module supports several 'Channel Types' - for mA, V, resistance and so on. Each such channel type can be calibrated at two points.

To perform the calibration at any one point a very accurate known signal (or resistor, for the resistance range) is connected to the input terminals. The 'Calibration State' parameter is then changed to start the calibration process; the 2500 samples the connected signal many times. Internal calculations are executed to normalise the measured data to match exactly the predefined expected value. This compensates for internal errors - for example, offset, gain, and lead resistance.

The table below identifies the input values required for each module and channel type:

Module	Channel Type	LOW Input	HIGH Input
AI2 / AI4	mV(3)	20.000mV	80.000mV
AI2	V(5)	2.0000V	8.0000V
AI2	Ohms(7)	200.00Ω	400.00Ω
AI2	HiOhms(8)	1200.0Ω	4800.0Ω
AI3	mA(4)	4.000mA	16.000mA

Table 13-1:   Analogue Input Calibration Points
Note: For resistance calibration, connect the reference using 4-wire connection.

Note that the AI2 Ohms, HiOhms and V ranges can only be calibrated in a -DC terminal unit. Do NOT try to recalibrate channel 1 Ohms range if <u>any</u> channel of the module is to be used for TC applications; any change will upset the cold-junction measurement apparatus.

The AI4 must be calibrated as an AI2. Force the Requested ID parameter to AI2(64):
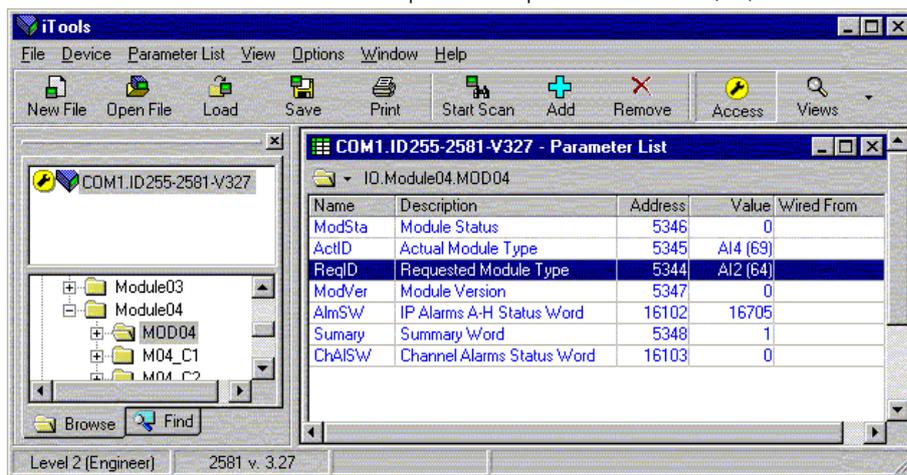
Figure 13-6:   AI4 Working as an AI2 for Calibration

The AI4 must not be recalibrated on the V, or Ohms 'Channel Types'.

The password 'RefPW' must be set and the 2500 in 'Config' mode.

To calibrate, use iTools to navigate to the channel to be calibrated.
In iTools set the channel 'TYPE', as appropriate. Connect the reference source (
1.   Table 13-1, above) to the appropriate channel input.
2.   Set the parameter 'Calibration State' Cal_st to 'CalLo (3)'. Set and make sure the input is at the LOW value specified in the table. Change Cal_st to 'Go (7)'
3.   Cal_st will change to 'Busy (9)' for about 30 seconds, then change to 'Idle (2)' or 'Done (0)' - that step has been completed.
4.   Set Cal_st to 'CalHI (4)'. Set and make sure the input is the HIGH value (from the table). Change Cal_st to 'Go (7)'
5.   Cal_st will change to 'Busy (9)' for about 30 seconds and then change to 'Idle (2)' or 'Done (0)' - channel calibration has been completed.
6.   Finally set 'Calibration State' to 'FSave (10)'. The calibration constants will be saved and 'Calibration State' will revert to 'Idle (2)'.

13.4.2.   Analogue Output Calibration Procedure

To calibrate an output channel on any particular range, the user must accurately verify two predefined output values. At each point the user has the option of entering a correction to force the output to the desired value. This is an iterative process at each point.

The AO2 supports just two 'Channel Types' with the TYPE parameter: 'mA (O)' (current output) and 'V (O)' (voltage output). The table below identifies the reference points for each channel type.

Channel Type	LOW Output	HIGH Output
V(30)	1.000V	9.000V
mA(31)	2.000mA	18.000mA

Table 13-2: Analogue Output Calibration Points

The password 'RefPW' must be set and the 2500 in 'Config' mode, with iTools Parameter Value Selections unrestricted to show all parameter options.

☺ Calibration tip: a calibration step value of 100 should affect the V output by about 35mV, and current output by about 75uA. The step size is affected only slightly by gain tolerances. If the changes appear to be non-linear there may be a hardware problem or a channel loading problem.

With iTools, navigate to the channel to be calibrated; if iTools has been correctly set up the channel list will show two extra parameters, 'AO Calibration Lo Trim' and 'AO Calibration Hi Trim'. To calibrate:

1.   Set the channel 'TYPE', as appropriate. Set the monitor equipment (DVM) on an appropriate range (20mA or 10V), and connect to the relevant channel output terminals.

2.   Set Cal_st to 'CalLo (3)'. The DVM should display something near the LOW cal value, as described in Table 13-2, above.

3.   If the output is in error, double-click the 'AO Calibration Lo Trim' parameter and alter the parameter value to increase or decrease the output. See the hint above for step size. Keep changing 'AO Calibration Lo Trim' until the output is correct.

4.   Set 'Calibration State' to 'CalHi(4)'.

5.   If the output disagrees with the value in Table 13-2, double-click the 'AO Calibration Hi Trim' parameter and alter the parameter value to increase or decrease the output. Keep changing the trim value until the output is exactly as required.

6.   Finally, set 'Calibration State' to 'FSave(10)'. The calibration constants will be saved and 'Calibration State' will revert to 'Idle(2)'.

13.4.3.   Restore Factory Calibration

Factory calibration may be restored at any time for any individual I/O channel. The procedure is similar to the reference calibration described above. To perform the restoration the 2500 must be in 'Config' mode, Parameter Value Selections must be unrestricted to display all options, and the Reference Calibration Password parameter 'RefPW' correctly set. No other equipment is required.

Use iTools to navigate to the parameter list of the channel to be restored. Double-click the parameter 'Calibration State' (Cal_st) and select 'Restor (5)'.
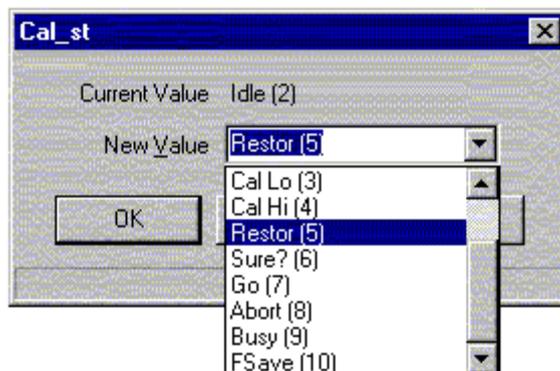
Figure 13-7: Cal_st list: 'Restor'

When you "OK" this selection 'Cal_st' will then change to 'Done (0)', and after a brief pause return to 'Idle (2)'.

14. Appendix A SPECIFICATION

A1 INSTALLATION CATEGORY AND POLLUTION DEGREE

This product has been designed to conform to BS EN61010 installation category II and pollution degree 2. These are defined as follows:

INSTALLATION CATEGORY II

The rated impulse voltage for equipment on nominal 230V ac mains is 2500V.

POLLUTION DEGREE 2

Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation shall be expected.

A2 GENERAL SPECIFICATION

Physical

Base unit dimensions	0 module:	35mm wide x 180 mm high x 132 mm deep (1.4in x 7.1in x 5.2in)
	2 module	86mm wide x 180mm high x 132mm deep (3.4in x 7.1in x 5.2in)
	4 module:	137mm wide x 180mm high x 132mm deep (5.3in x 7.1in x 5.2in)
	8 module:	239mm wide x 180 mm high x 132 mm deep (10.8in x 7.1in x 5.2in)
	10 module:	289mm wide x 180mm high x 132mm deep (11.4 in x 7.1 in x 5.2 in)
	12 module:	340mm wide x 180mm high x 132mm deep (13.4in x 7.1in x 5.2in)
	16 module:	442mm wide x 180 mm high x 132 mm deep (18.8in x 7.1in x 5.2in)
Base Unit fixing centres	0 module:	Not applicable
for panel mounting	2 module:	47mm (1.8in)
	4 module:	97mm (3.8in)
	8 module:	198mm (7.8in)
	10 module:	249mm (9.8in)
	12 module:	300mm (11.8in)
	16 module:	401mm (15.8in)

Weight

2-way:	No modules - 0.3kg (0.7 lb). Including all modules - 0.7kg (1.5 lb) max.
4-way:	No modules – 0.4kg (0.9 lb). Including all modules - 1.2kg (2.6 lb) max.
8-way:	No modules - 0.7 kg (1.5 lb). Including all modules - 2.0 kg (4.4 lb) max.
10-way:	No modules - 0.8 kg (1.8 lb). Including all modules - 2.4 kg (5.3 lb) max.
12-way:	No modules - 1.0 kg (2.2 lb). Including all modules - 2.8 kg (6.2 lb) max.
16-way:	No modules - 1.3 kg (2.9 lb). Including all modules - 3.6 kg (7.9 lb) max.

Electrical

Safety earth connections	Earth terminal strip at lower front flange of base unit
Supply voltage	24V dc (±20%)
Supply power (max.)	82 Watts (16 module base)
Surge current (max.)	8 Amps
Back-up supplies	3.3V ± 5% to source 10µA max.

> If the supply voltage falls below 19.2V dc during start up, the instrument can enter a continous cycle of attempted re-starts.

Environmental

Temperature	Storage:	-20 to +85°C
	Operation:	0 to + 55°C
Humidity	Storage/Operation:	5 to 95% RH (dewpoint 50°C) (See graph)
Atmosphere		Non-corrosive, non-explosive.
Altitude (max.)		2000m
Environmental protection Panel:		BS EN60529:IP20
RFI	EMC emissions:	BS EN61326-1:2006 Class A
	EMC immunity:	BS EN61326-1 :2006 Industrial locations
Electrical Safety Specification		BS EN61010-1: 2001 (see section 'A1', above); UL61010
Vibration / shock		To BS EN61131-2 (9 to 150Hz @ 0.5g; 1 octave per minute).
	Impact withstand	BS EN61010 (Corner drop test 100mm)
Packaging		BS EN61131-2
	Free fall:	BS EN60068-2-32, proc. 1 (five x 1 metre drops for each of six faces).
Flammability of plastic materials		UL746 UL V0
RoHS compliance		EU; China

Maximum RH with dewpoint of 50°C
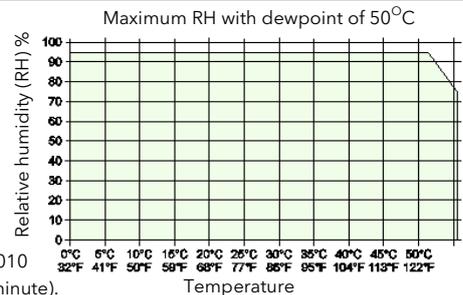
Approvals

CE; cUL (UL61010); GOST

Ethernet Communications

Connectors:	One RJ45 connector on the Terminal unit
	One RJ11 EIA232 configuration port on the Ethernet IOC module.
Network medium:	Ethernet Category 5 cables.
Protocols:	Modbus-TCP RTU slave.
Speed:	10 Mbps.
Network Topology:	Star connection to a hub.
Line length (max):	100 metres, extendable by repeater.
Allocation of IP address:	Manual, DHCP.
Isolation:	50V dc; 30V ac. (IEEE 802.3)

Modbus Communications

Connectors:	Parallel pair of RJ45 connectors on the Terminal unit.
	One RJ11 EIA232 configuration port on the Modbus IOC module
Network medium:	EIA485, link selectable as 3-wire or 5-wire.
Protocols:	MODBUS/JBUS RTU slave.
Isolation:	None.

Profibus Communications

Connectors:	Parallel pair of RJ45 connectors on the Terminal unit.
	Or 9-pin D-Type connector on Termianl unit. This is dependent on Terminal unit supplied.
	One RJ11 EIA232 configuration port on the Profibus IOC module

Devicenet Communications

Connectors:	5-way Devicenet screw connector on the Terminal unit.
	One RJ11 EIA232 configuration port on the Devicenet IOC module

A3 IOC SPECIFICATION

A3.1 TERMINAL UNIT

Physical

Dimensions (approx.)	26 mm wide x 125 mm high

Switches – 8 swich segments

Modbus:	Switches 1 to 32 Instrument Address, P – Parity On/Off, O – Parity Odd/Even
Profibus:	Switches 1 to 64 Instrument Address
Devicenet	Switches 1 to 32 Instrument Address, Baud rate set by remaining two segments
Ethernet	Switches 1 to 32 Instrument Address, D – DHCP enable/disable

Links LK1 and LK2

Modbus	Link pins 1 and 2 for three-wire communications; link pins 2 and 3 for five-wire (Figure 2-6)
Profibus	Link pins 1 and 2 to terminate the Profibus network; link pins 2 and 3 for no termination (Figure 2-9)

User Connectors

Supply power	One x four-way terminal block for supply power. Supplies separately monitored by the IOC modules.

A3.2 IOC MODULE

A3.2.1 Hardware

General

Dimensions	25 mm wide x 90 mm high x 81mm deep

LED Indicators

✵   Green – normal operation

S   Yellow – Standby mode

C   Yellow- Configuration mode

☍   Yellow – IO network or configuration port communicating

X   Red- failure of non-volatile RAM checksum, Custom linearisation checksum, I/O network watchdog, invalid base size detected, module missing, faulty or wrong type, power on self test failed.

Note: sections 2.4 and 2.5 give details of all IOC LEDs

A4 I/O MODULE SPECIFICATIONS

A4.1 AI2 MODULE

General specification, common to all variants

Power consumption	2W max.
Common mode rejection (47 to 63Hz)	>120dB
Series mode rejection (47 to 63Hz)	>60dB
Isolation Channel to channel:	300V RMS or dc (basic insulation).
to system:	300V RMS or dc (double insulation).
Max voltage across any channel	10.3V dc

A4.1.1 Thermocouple input variant

mV inputs, Thermocouple inputs

Input range	-150mV to + 150mV
Input impedance	>100MΩ (sensor break detect circuit 'Off')
Input leakage current	<100nA (sensor break detect circuit 'Off')
Calibration accuracy	± 0.1% of measured value ± 10µV
Noise	<28µV p-p with filter off: <4µV p-p with 1.6s filter (better with longer time constants).
Resolution	Better than 2µV with 1.6 second filter
Linearity	Better than 5µV
Temperature coefficient	<40ppm of reading per °C
Sensor break protection	Switchable as 'High', 'low' or 'Off'. Sensor current: 125nA

Cold Junction

Temperature range:	-10° C to +70° C
CJ Rejection:	>30:1
CJ accuracy:	±0.5°C typical (±1.0°C max.)
Sensor type	Pt100 RTD, located beneath the input connector

High impedance input (channel two only)

Input range	0.0V to 1.8V
Input impedance	>100MΩ (sensor break detect circuit 'Off')
Input leakage current	<100nA (sensor break detect circuit 'Off')
Calibration accuracy	± 0.1% of measured value ± 20µV
Noise	<100µV p-p with filter off: <15µV p-p with 1.6s filter (better with longer time constants).
Resolution	Better than 7µV with 1.6 second filter
Linearity	Better than 50µV
Temperature coefficient	<40ppm of reading per °C

A4.1.2 DC input variant

mV inputs

Input range	-150mV to +150mV
Input impedance	>100MΩ (sensor break detect circuit 'Off')
Input leakage current	<100nA (sensor break detect circuit 'Off')
Calibration accuracy	± 0.1% of measured value ± 10µV
Noise	<28µV p-p with filter off: <4µV p-p with 1.6s filter (better with longer time constants).
Resolution	Better than 2µV with 1.6 second filter
Linearity	Better than 5µV
Temperature coefficient	<40ppm of reading per °C
Sensor break protection	Switchable as 'High', 'low' or 'Off'. Sensor current: 125nA

High impedance input (channel two only)

Input range	0.0V to 1.8V
Input impedance	>100MΩ (sensor break detect circuit 'Off')
Input leakage current	<100nA (sensor break detect circuit 'Off')
Calibration accuracy	± 0.1% of measured value ± 20µV
Noise	<100µV p-p with filter off: <15µV p-p with 1.6s filter (better with longer time constants).
Resolution	Better than 7µV with 1.6 second filter
Linearity	Better than 50µV
Temperature coefficient	<40ppm of reading per °C

Voltage inputs

Input range	-10.3V to + 10.3V
Input impedance	303kΩ
Calibration accuracy	± 0.1% of measured value ± 2mV
Noise	<2mV p-p with filter off: <0.4mV p-p with 1.6s filter (better with longer time constants).
Resolution	Better than 0.2mV with 1.6 second filter
Linearity	Better than 0.7mV
Temperature coefficient	<40ppm of reading per °C

A4.1 AI2 MODULE (Cont.)

A4.1.2 DC INPUTS (CONT.)

Resistance inputs	
Input range	0Ω to 640Ω (includes support for 2-, 3- or 4-wire RTD connection)
Calibration accuracy	± 0.1% of measured value
Noise	<0.05Ω p-p with 1.6s filter (better with longer time constants).
Resolution	Better than 0.02Ω with 1.6 second filter
Linearity	Better than 0.05Ω
Temperature coefficient	<30ppm of reading per °C

High Resistance input	
Input range	0 to 7kΩ
Calibration accuracy	± 0.1% of measured value
Noise	<0.5Ω p-p with 1.6s filter (better with longer time constants).
Resolution	Better than 0.2Ω with 1.6 second filter
Linearity	Better than 0.1Ω
Temperature coefficient	<30ppm of reading per °C

Potentiometer inputs	
Input range	0 to 100% rotation
End-to-end resistance	100Ω (min.) to 7kΩ (max.)
Calibration accuracy	± 0.1% of measured value
Noise	<0.01% p-p with 1.6s filter (5kΩ pot.); <0.3% p-p with 1.6s filter (100Ω pot.)
Resolution	Better than 0.001% with 1.6 second filter and 5kΩ pot.
Linearity	Better than 0.01%
Temperature coefficient	<20ppm of reading per °C

A4.1.3 mA input variant

4 to 20 mA loop inputs	
Input range	-25mA to + 25mA with 5Ω burden resistor in terminal unit.
Calibration accuracy	± 0.25% of measured value plus ±2µA max offset.
Noise	<1µA p-p with 1.6s filter (better with longer time constants)
Resolution	Better than 0.5µA with 1.6 second filter
Linearity	Better than 1µA.
Temperature coefficient	<50ppm of reading per °C

A4.2 AI3 MODULE

Notes:
1.   The number of AI3 modules must be restricted such that the total, steady-state power consumption for all the modules in a base unit does not exceed 24 Watts for the eight module base or 48 Watts for the 16 module base.
2.   Sensor Break Protection is controlled using an associated AI_UIO block.

General specification		
Power consumption	Current i/p:	2.2W
	Three powered loops:	4W max.
Common mode rejection (47 to 63 Hz)		>120dB
Series mode rejection (47 to 63 Hz)		>60dB
Isolation	Channel to channel:	50V RMS or dc (basic insulation).
	to system:	300V RMS or dc (double insulation).
Hart Compliance		
		Cutting printed circuit links (one per channel) on the underside of the terminal unit places 250Ω resistors in the input circuits within the AI3 module (section 7.7.7.).

Channel inputs		
Input range		-28mA to + 28mA
Calibration accuracy		± 0.1% of measured value
Noise		<1µA p-p with 1.6s filter (better with longer time constants)
Resolution		Better than 0.5µA with 1.6 second filter
Linearity		Better than 1µA
Temperature coefficient		<50ppm of reading per °C
Burden resistor		60Ω nominal; 50mA maximum current
Channel PSU		20V to 25V
	PSU protection:	30mA (nom) current trip, auto resetting.

A4.3 AI4 MODULE

Note: Sensor Break Protection is controlled using an associated AI_UIO block. Channels 1 and 3 support sensor break actions 'Up', 'Down' and 'None'; channels 2 and 4 support 'Up' only.

General specification (applies to all AI4 variants)

Power consumption		2W max.
Common mode rejection (47 to 63 Hz)		>120dB
Series mode rejection (47 to 63 Hz)		>60dB
Isolation	Channel 1 to channel 2:	No isolation
	Channel 3 to channel 4:	No isolation
	Ch1 or Ch2 to Ch3 or Ch4:	300V RMS or dc (basic insulation).
	to system:	300V RMS or dc (double isolation).
Max. voltage across any channel		5V dc

A4.3.1 Thermocouple input variant

Thermocouple inputs

Input range	-150mV to + 150mV
Input impedance	>20MΩ (sensor break detect circuit 'Off')
Input leakage current	<125nA (sensor break detect circuit 'Off')
Calibration accuracy	± 0.1% of measured value ± 10µV
Noise	<28µV p-p with filter off; <6µV p-p with 1.6s filter (better with longer time constants).
Resolution	Better than 2µV with 1.6 second filter
Linearity	Better than 5µV
Temperature coefficient	<40ppm of reading per °C
Sensor break protection	Fixed pull-up. Sensor current: 125nA
Cold Junction	
Temperature range:	-10°C to +70°C
CJ Rejection:	>30:1
CJ accuracy:	±0.5°C typical (±1°C maximum)
Sensor type	Pt100 RTD, located beneath the input connector

A4.3.2 mV input variant

Thermocouple inputs

Input range	-150mV to + 150mV
Input impedance	>20MΩ (sensor break detect circuit 'Off')
Input leakage current	<125nA (sensor break detect circuit 'Off')
Calibration accuracy	± 0.1% of measured value ± 10µV
Noise	<28µV p-p with filter off; <6µV p-p with 1.6s filter (better with longer time constants).
Resolution	Better than 2µV with 1.6 second filter
Linearity	Better than 5µV
Temperature coefficient	<40ppm of reading per °C

A4.3.3 mA input variant

Input range	-25mA to +25mA
Calibration accuracy	± 0.25% of measured value plus ±2µA max offset.
Noise	<1µA p-p with 1.6s filter (better with longer time constants)
Resolution	Better than 0.5µA with 1.6 second filter
Linearity	Better than 1µA.
Temperature coefficient	<50ppm of reading per °C
Burden Resistor	5Ω ± 1% (fitted to terminal unit)

A4.4 AO2 MODULE

General specification

Power consumption		2.2W max.
Isolation	Channel to channel:	300V RMS or dc (basic insulation).
	to system:	300V RMS or dc (double insulation).

Current outputs

Output range	-0.1 to +20.5mA
Load limits	0 to 500Ω
Calibration accuracy	Better than ±0.1% of reading
Linearity	0.03% range (0.7µA)
Resolution	Better than 1 part in 10000 (1µA typical)

Voltage outputs

Output load limits

-0.1 to 10.1V range:	550Ω min.
-0.3V to +10.3V range:	1500Ω min.
Calibration accuracy	Better than 0.1% of reading
Linearity	0.03% range (0.3mV)
Resolution	Better than 1 part in 10000 (0.5mV typical)

A4.5 DI4 MODULE

Note: Inputs must be either all logic inputs (link 'V+' and 'C' terminals together) or all contact inputs (apply 24V supply across 'V+' and 'C' terminals).

General specification		
Power consumption		0.5W max.
Isolation	Channel to channel:	Channels share 'common' ('C') connections.
	to system:	300V RMS or dc (double insulation).
Voltage supply		24±6V dc external supply required for contact inputs.
Minimum pulse width		10ms, or de-bounce value whichever is longer.
Debounce time		0ms to 2.55s (as configured by the user).
Max. voltage across any channel		30V dc.

Logic inputs (see note above)	
Off (logic 0) voltage	-5V to +5V dc
On (logic 1) voltage	10.8V to 30V dc
Input current	2.5mA approx. at 10.5V; 10mA max. at 30V.

Contact inputs (see note above)	
Off (0) resistance	>7kΩ
On (1) resistance	<1kΩ
Wetting current	>8mA.
Wetting voltage	>9V (12V typical measured open circuit)

A4.6 DI6 MODULE

Note:

1.   This module is ordered either as a 115V version or as a 230V version. One type cannot be converted into the other.

2.   Each input is fitted with a 470pF capacitor for EMC purposes. This causes an earth leakage current of approximately 0.04 mA at 115Vac 60Hz or 0.08 mA 230Vac 60Hz

General specification		
Power consumption		0.5W max.
Detectable pulse width		Three mains cycles
Isolation	Channel to system:	300V RMS or dc (Double insulation)
	Channel to channel:	300V RMS or dc (Basic insulation)

A4.6.1 115V ac input variant

115V inputs		
Off (logic 0) voltage		0 to 35V ac.
On (logic 1) voltage		95V to 150V ac
Input current	Maximum:	8mA at 150V RMS
	Minimum:	2mA
Max voltage across any channel		150V RMS

The result of applying RMS voltages between 35V and 95V is not defined

A4.6.2 230V ac input variant

230V inputs		
Off (logic 0) voltage		0 to 70V ac.
On (logic 1) voltage		180V to 264V ac
Input current	Maximum:	9mA at 264V RMS
	Minimum:	2mA.
Max voltage across any channel		264V RMS

The result of applying RMS voltages between 70V and 180V is not defined

Voltage/current curves for 230V module

Voltage/current curves for 115V module
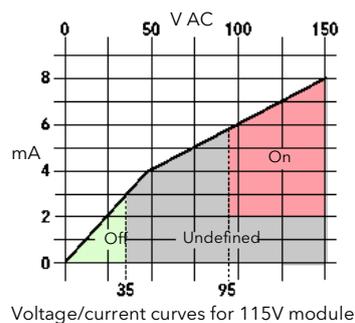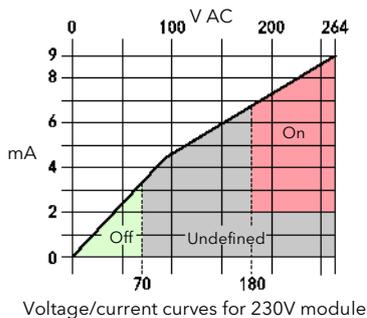
A4.7 DI8 MODULE

Note: This module is ordered either as a 'logic' version or as a 'contact closure' version. One type cannot be converted into the other.

General specification

Power consumption	Contact i/p:	1.9W max.
	Logic i/p:	0.6W max.
Isolation	Ch1 to Ch 2 :	Channels share 'common' ('1C2') connection.
	Ch3 to Ch 4 :	Channels share 'common' ('3C4') connection.
	Ch5 to Ch 6 :	Channels share 'common' ('5C6') connection.
	Ch7 to Ch 8 :	Channels share 'common' ('7C8') connection.
	Ch1/2 to other channels:	50V RMS or dc (Basic insulation).
	Ch3/4 to other channels:	50V RMS or dc (Basic insulation).
	Ch5/6 to other channels:	50V RMS or dc (Basic insulation).
	Ch7/8 to other channels:	50V RMS or dc (Basic insulation).
	to system:	300V RMS or dc (Double insulation).
Minimum pulse width		5ms (Task 1), or 10ms (Task 3), or de-bounce value whichever is longer.
Debounce time		0ms to 2.55s (as configured by the user).
Max. voltage across any channel		30V dc

A4.7.1 Logic input variant

Logic inputs (see note above)

Off (logic 0) voltage	-5V to +5V dc
On (logic 1) voltage	10.8V to 30V dc
Input current	2.5mA approx. at 10.5V; 8mA max. at 30V.

> The result of applying voltages between +5V and +10.8V is not defined

A4.7.2 Contact closure input variant

Contact inputs (see note above)

Off (0) resistance	>7kΩ
On (1) resistance	<1kΩ
Wetting current	4mA typical

> The result of applying contact resistances between 1kΩ and 7kΩ is not defined

A4.8 DO4

General specification

Power consumption		0.5W max.
Isolation	Channel to channel:	Channels share 'common' ('C') connections.
	to system:	300V RMS or dc (Double insulation).

Logic outputs

Voltage supply (VCS)	24±6Vdc.
Logic 1 o/p voltage	(Vcs - 3)V for a 5mA load.
Logic 0 o/p voltage	<1Vdc
Logic 1 o/p current	8mA per channel (current limited)
Off state leakage	<0.1mA

Voltage outputs

Voltage supply (VCS)	12V to 30Vdc.
Logic 1 o/p voltage	(Vcs - 3)V for a 5mA load.
Logic 0 o/p voltage	<1Vdc
Logic 1 o/p current	100mA per channel (current and temperature limited)

A4.9 RLY4 MODULE

Note: Snubber circuits (22nF+100Ω) are fitted internally to this module. They may be removed as described in Appendix C. Leakage across the snubber at 240V ac 60Hz = appox. 2mA

General specification

Power consumption		1.1W max.
Isolation	Channel to channel:	300V RMS or dc (Basic insulation).
	Channel to system:	300V RMS or dc (Double insulation).
Contact life (resistive load)	240Vac, 2A:	>6x10^5 operations
	240Vac, 1A:	>10^7 operations
Contact life (inductive load)		As per derating curves
Mechanical life		>3x10^7 operations

Relay specification

Contact material	AgCdO
Maximum current rating	2A at up to 240V ac; 0.5A at 200Vdc, increasing to 2A at 50V dc (resistive)
Minimum current rating	100mA at 12V

Contact format

Channels 1 to 3:	Common and normally open contacts. (Open circuit with relay not energised)
Channel 4:	Common, normally open and normally closed contacts. Common and normally closed contacts are short circuit with relay not energised

AC inductive load derating curves

DC inductive load breaking capacity derating curves
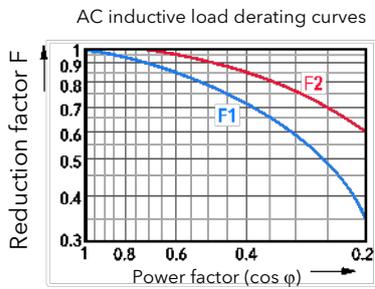
F1 = Measured results
F2 = Typical values
Life = Resistive life x reduction factor
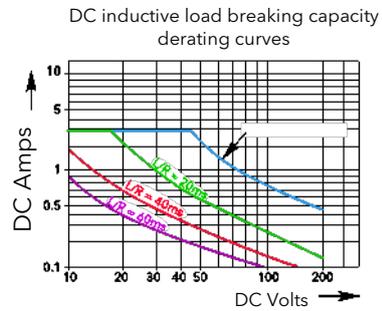
15.   Appendix B   The Ordering Codes

Base Units
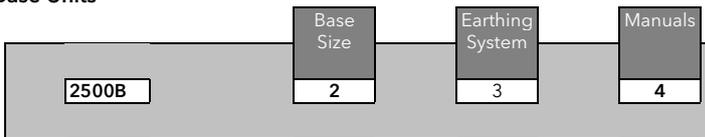
2	Base Size
S02	Single IOC base, 2 module positions
S04	Single IOC base, 4 module positions
S08	Single IOC base, 8 module positions
S10	Single IOC base, 10 module positions
S12	Single IOC base, 12 module positions
S16	Single IOC base, 16 module positions

3	Earthing system
NONE	Two earth clamps fitted
C02	Earthing Clamp for a 2 module base
C04	Earthing Clamp for a 4 module base
C08	Earthing Clamp for a 8 module base
C10	Earthing Clamp for a 10 module base
C12	Earthing Clamp for a 12 module base
C16	Earthing Clamp for a 16 module base

4	Manuals
ENG	English Manuals
FRA	French Manuals
GER	German Manuals
XXX	No Manuals

IOC
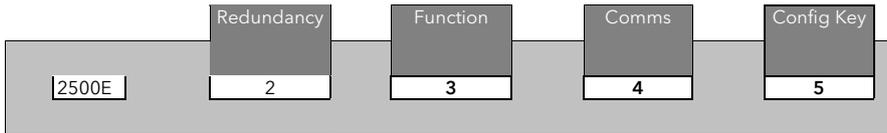
2	Redundancy Features
S	Remote IO acquisition

3	Functions
ACQIO	Remote IO acquisition
SYSIO	Remote IO acquisition (55msec scan)
UW	Toolkit Block + acquisition functions
4LOOP	Four local PID blocks + acquisition
4LOOPUW	Four local PID blocks + Toolkit & acquisition
8LOOP	Eight local PID Blocks + acquisition
8LOOPUW	Eight local PID Blocks + Toolkit & acquisition

4	Communications
MODBUS	Modbus communications
DEVICENET	DeviceNet communications
PROFIBUS	Profibus DP communications
PBUS DPv1	Eurotherm 'E' Suite communications. (Profibus DPv1)
ENET MBUS	Ethernet Modbus TCP communications

5	Start Up key
NONE	No Start up Key supplied
CFGKEY	RJ11 Start up Key - Forces IOC to Start In configuration mode after a power cycle

Modules
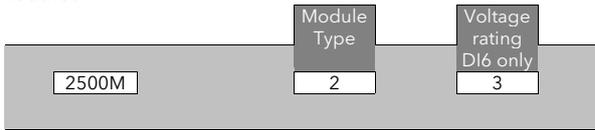
2	Module Type
AI2UNIV	Dual channel i- solated universal analogue input module
AI3	Three channel isolated 4-20mA analogue input module + 3 x isolated 24v Tx PSU
AI4UNIV	Four channel - non isolated T/C, mV, mA input module
AO2	Dual channel isolated analogue output module mA, volts
DI424V	Dual channel - isolated universal analogue input module
DI6HVAC	Six channel High voltage Logic input
DI8logic	Octal channel - non isolated Digital Input (Logic Inputs only)
DI8contact	Octal channel - non isolated Digital Input (Contact Inputs only)
DO4LOGIC	Quad digital output module Logic output 10mA max
DO424V	Quad digital output module 24d switched output
RLY4	Dual channel isolated analogue output module mA, volts

3	Power supply – DI424V and DO424V only
EXTPWR	External Power required

3	Voltage rating DI6 only
230v	230 volt ac. logic input
115v	115 volt ac. logic input

IOC termination units

2500T/ IOC/S	Comms Protocol 4	Comms Connector 5
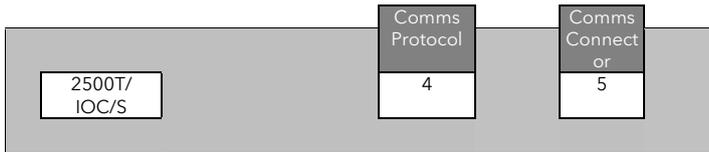
4	**Communications Protocol**
MODBUS	ModBus Communications
DEVICENET	DeviceNet Communications
PROFIBUS	ProfiBus or PbusDPv1 Communications
ENET MBUS	Ethernet / Modbus TCP
5	**Communications Connector Type**
RJ45	RJ45 connector for ProfiBus or ModBus
9Dtype	9 pin D connector for ProfiBus
DN	Standard DeviceNet screw connector
EN	Standard EtherNet terminal unit

Module termination units

2500T	Module Type 2	Voltage 3	Fuse / Disconnect 4
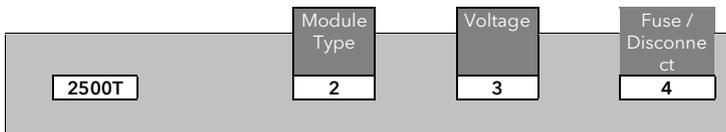
2 & 3	**Termination Type**
AI2 / TC	Two channel isolated TC with CJC
AI2 / DC	Two channel isolated mV
AI3 / UNIV	For 3 ch. isolated 4-20mA analogue input module
AI4 / TC	Terminal unit for 4 ch. isolated TC with CJC
AI4 / mV	Terminal unit for 4 ch. isolated mV
AI4 / mA	Terminal unit for 4 ch. isolated mA
AO2 / UNIV	Terminal unit for Dual Analogue Output
DI4 / UNIV	Terminal unit for Quad Digital Input module
DI6 / UNIV	Terminal unit for 6 ch. mains isolated digital input module
DI8 / UNIV	Terminal unit for 8 ch. digital input module
DO4 / UNIV	Dual channel isolated analogue output module mA, volts
RLY4	Dual channel isolated analogue output module mA, volts

4	**Volts mA option AI2 / DC only**
NONE	For PT100,.Hiz inputs
SHUNT	5 ohm shunt fitted for mA inputs

4	**Fuse / Disconnect Type**
NONE	Dummy cover fitted
DCONNECT	Disconnects

4	**Fuse / Disconnect Type**
NO FUSE	Dummy cover fitted
FUSE2A	4 off 3.15A fuses

2500A - Accessories items
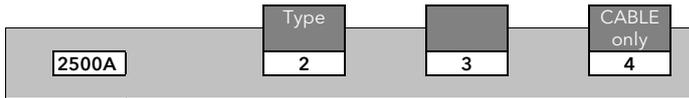
2	Type
CABLE	Communications cable
CFGPSU	24vdc Power supply for use with configuration lead
TERM	Terminator for end of RS 485 multi-dropped link.
CFGKEY	RJ11 start up key - Forces IOC to start in Configuration mode after Power cycle
BLANK	Blank Terminal Unit

3	Options with Cable only
CONFIG	Used for configuration of 2500C Termination for 2500C is RJ11 Termination for PC is 9 PIN D RS232
MODBUS	Modbus screened cable (Base to base multi-drop connection). RJ45 to RJ45 connection

3	Options with CFGPSU only
NONE	No mains lead supplied
UKLEAD	UK 5A Mains lead

3	Options with TERM only
MODBUS	Terminator for Modbus link - RJ45 only
PROFIBUS	Terminator for Profibus DP link - RJ45 only

4,5 & 6	Options with Cable ModBus or ProfiBus only
RJ45/RJ45/0M5	0.5m long
RJ45/RJ45 3M0	3.0 metres long

2500P - Power Supplies
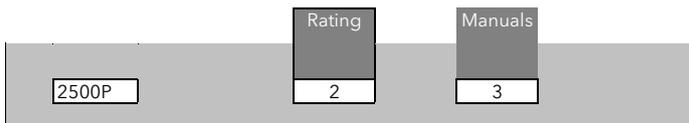
2	Rating
1A3	30 watt, 1.3 amp supply
2A5	60 watt, 2.5 amp supply
5A0	120 watt, 5.0 amp supply
10A	240 watt, 10.0 amp supply

3	Manuals
ENG	English Manuals
FRA	French Manuals
GER	German Manuals
XXX	No Manuals

Composite Ordering Codes

2500	Base Size 2	Earthing System 3	Function 4	Comms Protocol 5	Comms Connector 6	Application 7

I/O Slots - Module and Termination fill in			Configuration Tools
8	9 ----------------- 22	23	24
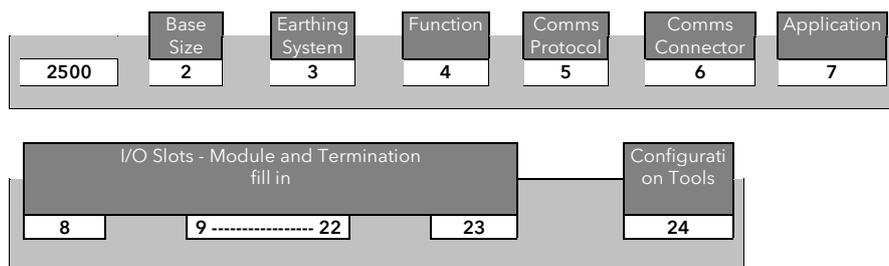
1	
2500	Product Code

2	**Base size**
S02	2 module positions
S04	4 module positions
S08	8 module positions
S10	10 module positions
S12	12 module positions
S16	16 module positions

3	**Earthing system**
NONE	Two earth clamps fitted
C02	Earthing Clamp for a 2 module base
C04	Earthing Clamp for a 4 module base
C08	Earthing Clamp for a 8 module base
C10	Earthing Clamp for a 10 module base
C12	Earthing Clamp for a 12 module base
C16	Earthing Clamp for a 16 module base

4	**Function**
ACQIO	Remote IO acquisition
SYSIO	Remote IO acquisition (55msec scan)
UW	Toolkit Block + acquisition functions
4LOOP	Four PID blocks + acquisition
4LOOPUW	Four PID blocks + Toolkit & acquisition
8LOOP	Eight PID Blocks + acquisition
8LOOPUW	Eight PID Blocks + Toolkit & acquisition

5	**Communications Protocol**
MODBUS	Modbus Communications
DEVICENET	Devicenet Communications
PROFIBUS	Profibus Communications
PBUS DPv1	Profibus DPv1 Communications
ENET MBUS	Ethernet Modbus TCP communications

6	**Communications Connector Type**
RJ45	RJ45 connector for Modbus or Profibus
9Dtype	9 pin D connector for Profibus
DN	Standard Devicenet screw connector
EN	Ethernet terminal unit

7	Application
NONE	No Application loaded
YYYXXX	Pre-configured application loaded
8 to 23	**Module & Terminations**
AI2-TC	2 ch. - isolated universal analogue input module with CJC
AI2-DC	2 ch. - isolated universal analogue input module For PT100,.Hiz inputs
AI2-MA	2 ch. - isolated universal analogue input module - 5 ohm shunt fitted for mA inputs
AI3	3 ch. - isolated 4-20mA analogue input module with 24v Tx PSU
AI3-DT	3 ch. - isolated 4-20mA analogue input module with 24v Tx PSU - Disconnects
AI4-TC	4 ch. - non isolated T/C, with CJC
AI4-MV	4 ch. - non isolated mV input module
AI4-MA	4 ch. - non isolated mA input module
AO2	2 ch. - isolated analogue output module mA, volts
AO2-DT	2 ch. - isolated analogue output module mA, volts with Disconnects
DI424	4 ch. - digital input module
DI424-DT	4 ch. - digital input module with Disconnects
DI6-230V	6 ch. - 230 volt ac. logic input
DI6-115V	6 ch. - 115 volt ac. logic input
DI8L	8 ch. - non isolated Digital Input (Logic Inputs only)
DI8C	8 ch. - non isolated Digital Input (Contact Inputs only)
DO4L	4 ch. - digital output module Logic output 10mA max
DO4L-DT	4 ch. - digital output module Logic output 10mA max with Disconnects
DO424	4 ch. - digital output module 24 volt dc switched output
DO424-DT	4 ch. - digital output module 24 volt dc switched output with Disconnects
RLY4	4 ch. - isolated relay output module Rated 2A ac
RLY4-FUSE	4 ch. - isolated relay output module Rated 2A ac, with 4 off 3.15A fuses
BLANK	Blank Terminal unit
NONE	No terminal unit or blank fitted

24	Configuration Tools
NONE	CD including Manuals and latest version of iTools - No iTools product key
iTools	CD including Manuals, iTools & STD iTools product key and 2500 configuration cable

16.   Appendix C   To Remove Snubber Circuits From The Relay Module

Each relay is fitted with a 'snubber' (22nF + 100Ω) wired across the contacts. The snubbers are used to prolong contact life and to suppress interference particularly when switching inductive loads such as mechanical contactors and solenoid valves.

Snubbers pass a small current typically 1.0mA at 110V 60Hz and 1.7mA at 240V 50Hz, which may be sufficient to hold in high impedance loads as, for example, found in some relay coils.

If this is found to be the case, the snubber can be removed by cutting all or any one of the snubber resistors from the printed circuit board.

The procedure below may be followed

1. Remove the rear cover from the module:

1.   Open the module retaining lever

2.   Gently ease the rear cover out of the module by inserting a small screwdriver in the slots ← at the top and bottom of the cover

3.   Gently ease the rear cover over the module retaining catch. It may be necessary to use the screwdriver in positions ↑ to gently lever the cover over the catch.
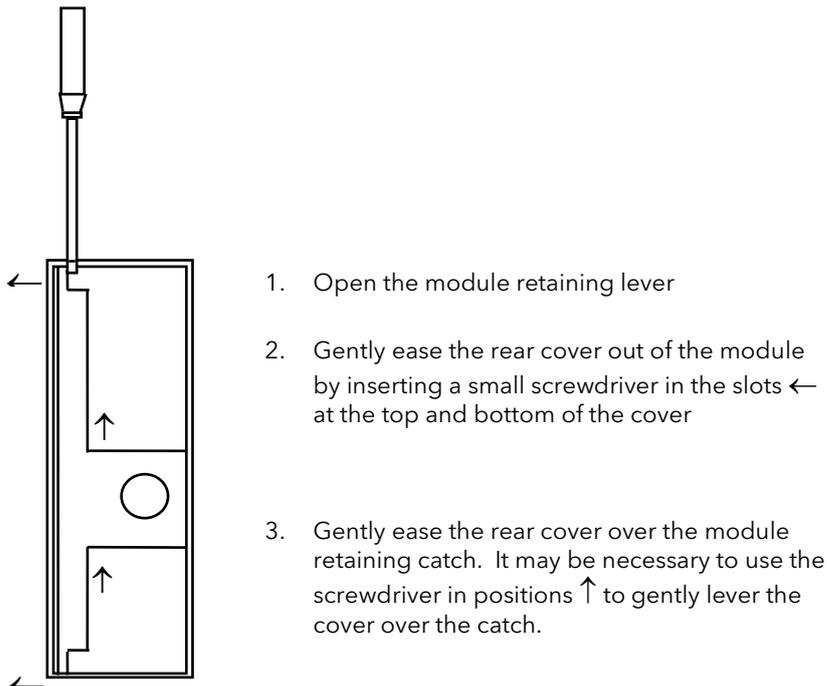
Figure C-1:   Removing the Rear Cover from the Relay Module

2. Remove the printed circuit board from module case as follows:

1. Invert the module and support it securely on a bench or table top

2. Squeeze the sides of the module so that the edge of the module bows outwards

3. Very carefully insert a screwdriver into the slot in the edge of the module.

Take care that the screwdriver does not slip which may cause injury

4. Gently ease the PCB out of module case.

5. Using a suitable pair of wire cutters, snip out and remove the 100Ω resistor to remove the required snubber circuit.
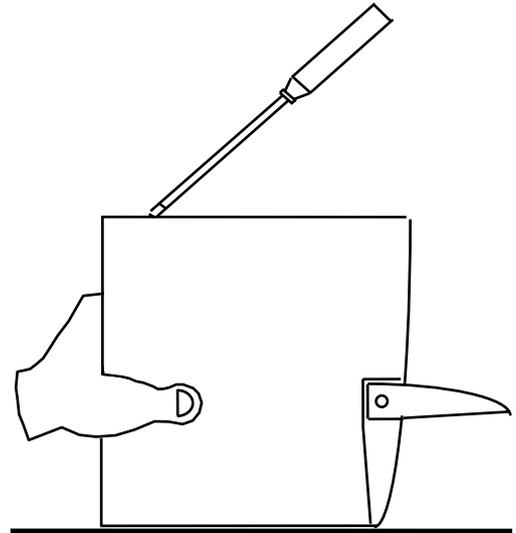
Figure C-2: Removing the Case from the Relay Module

3. Remove the snubber resistors

6. Record the removal of the snubber resistor on the side of the module in the place provided. This will provide easy identification of which snubbers have been removed in the event that the module needs to be replaced.
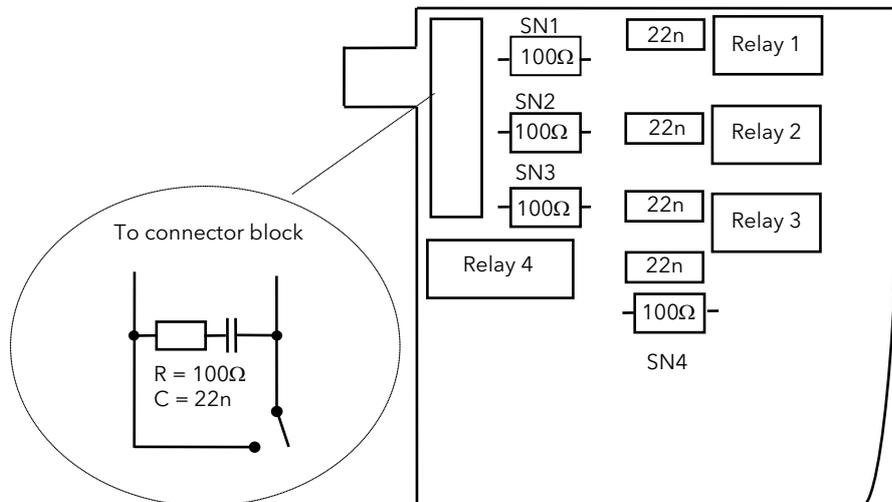
Figure C-3: Removing Snubbers from the Relay Module PCB

17.   Appendix D   Glossary of Terms

Clone/Cloning	Cloning allows the configuration and parameter settings from one instrument to be copied to another of the same type. It allows new or spare instruments to be rapidly set up from a standard source.
Config	Short for configuration or configuration mode
Config Mode	A security level in the 2500 in which Configuration Mode Parameters are made alterable
Configuration	*1.* The operation and inter-action of the 2500 functional elements *2.* The act of defining the operation and inter-action of the 2500 functional elements by means of selecting parameters and adjusting parameter values
Config Mode Parameters	A subset of the configuration parameters which can only be altered in Config Mode. *NB c.f. configuration parameters*
Configuration Parameter	A parameter which defines part of the Configuration of the 2500 *NB c.f. config mode parameters*
Configuration Port	A comms port intended for configuration of the 2500
CJC	Cold Junction Compensation
Series 2000 or 240x	Eurotherm Controls instrument range. 240x refers particularly to the 2400 range.
DIN	Deutsche Industrie Normand
EM	Electro-magnetic, as in EMC ~ Compliance
Enumeration(s)	Some parameters offer a list of options, each assigned an arbitrary integer value for discrimination. In iTools meaningful enumeration text is displayed, with the enumeration value shown in brackets. The enumeration value is the data that would be read or written over any communications link for that parameter.
On/Off control	The control output switches on when the setpoint is above process variable and off when the setpoint is below
Hysteresis	The difference between the on and off points normally applied to an output relay. Used to prevent relay 'chatter'.
I/O	Input or Output; general term for the plant interface to the 2500.
ICP	Industrial Control Package. This is a combination of the T2900 and 2500 DIN rail controller
IOBase	The complete mechanical 2500 assembly - DIN rail mount, base etc.
IOBus	Internal controller to I/O module interface
IOC	Input/output controller (the 2500 central processor module).
I/O Module	A 2500 plug-in module dedicated to plant Input or Output.
ION	Internal low-level input/output network
Parameter	In the 2500 'Parameters' are all the variables associated with blocks, channels, loops and so on, stored in a database at specific addresses.
Parameterised	Made accessible as a parameter
PID	Proportional + Integral + Derivative. Also called three term control
Program	Provide a list of general instructions to define operation
Programmable	Able to be programmed
PSU	Power Supply Unit
PRT or RTD	Abbreviation for Platinum Resistance Thermometer or Resistance Temperature Detector
SE	Strategy Engine (generic), or specific: the ISE (industrial) and PSE (process)
Snubber	A resistor and capacitor in series, connected across relay contacts, used to prolong contact life and reduce interference
SSR	Solid State Relay
TBD.	To be defined
TC or T/C	Abbreviation for thermocouple
Time proportioning	The control output (digital) switches with a variable on to off time
TU(s)	Terminal Units; provide the plant side wiring connections for I/O.

18.   Index

Parameter Index – By Mnemonic

Mnemonic	Description	Function Block	Section
AbPwrL	Absolute Low Power Limit	Output	4.8.2
Ack	Instrument Alarm Acknowledge	System	6.3.1
Ack	Status Alarm Acknowledge	Analogue Input	7.7.8
Ack	Status Alarm Acknowledge	Analogue Output	7.8.1
Ack	Status Alarm Acknowledge	Digital Input	7.9.5
Ack	Status Alarm Acknowledge	Digital output control	7.10.4
Ack_1	Alarm 1 acknowledge	Alarm	5.7.1
AckAll	Global Alarm Acknowledge	System	6.3.1
AckIP	Global Alarm Ack Input	System	6.3.1
AckSrc	Global Alarm Ack Input Source	System	6.3.1
Act	Control Action.	Key Configuration	4.3.1
ActID	Actual Module Type	Module Block	6.7
ActIM	Actual operating mode of the IOC	System	6.3.1
ActLP	Active Loop	Override	4.11.2
ActSrc	Active loop source	Override	4.11.2
Adc	Manual Reset Auto Calc Enable	PID	4.4.6
AddHi	Address High Limit Profibus	Digital Communications	6.2.1
AddLo	Address Low Limit Profibus	Digital Communications	6.2.1
Addr	Address	Digital Communications	6.2.1
AL_1	Alarm 1 Type	Alarm	5.7.1
AL_1	Alarm 1 Type	User Alarm - Digital	5.8.2
AlmOP	Totaliser Alarm Output	Totalisers	8.8.1
AlmSP	Totaliser Alarm Setpoint	Totalisers	8.8.1
AlmSW	Alarm Status Word	Alarm	5.7.1
AlmSW	Instrument Alarm Status Word	System	6.3.1
AlmSW	Summary of alarm status	Module Block	6.7
AnVal	The current analogue value selected form AnVal1 to AnVal3	Gain Scheduling	4.5.1
AP	Atmospheric Pressure	Humidity	8.11.2
ApName	Application Name	System	6.3.1
APSrc	Atmospheric Pressure Source	Humidity	8.11.2
ApVers	Application Version	System	6.3.1
bAct	Valve Backlash Time	Valve Control	4.8.4
BaseSz	Base Size	System	6.3.1
Baud	Baud Rate	Digital Communications	6.2.1
BaudHi	Comms Baud Rate High Limit Profibus	Digital Communications	6.2.1
BaudLo	Comms Baud Rate Low Limit Profibus	Digital Communications	6.2.1
Bloc	Instrument Alarm Blocking	System	6.3.1
Bloc	Status Alarm Blocking	Analogue Input	7.7.8
Bloc	Status Alarm Blocking	Digital Input	7.9.5
Bloc	Status Alarm Blocking	Digital output control	7.10.4
Bloc	Status Alarm Blocking	Analogue Output	7.8.1
bLoc_1	Alarm 1 blocking	Alarm	5.7.1
bmrt	Minimum recovery time after purging	Zirconia	8.12.2
BoolCV	Output Value	Digital block	8.3.2
bort	Maximum recovery time after purging	Zirconia	8.12.2
bot	Zirconia Probe Cleaning Time	Zirconia	8.12.2
bound1	Boundary change 1/2	Gain Scheduling	4.5.1
bound2	Boundary change 2/3	Gain Scheduling	4.5.1
boVLV	Zirconia Clean Valve Output	Zirconia	8.12.2
Cal TrH	AO Calibration Hi Trim (Counts)	Analogue Input	7.7.8

Mnemonic	Description	Function Block	Section
Cal TrL	AO Calibration Lo Trim (Counts)	Analogue Input	7.7.8
Cal_st	Calibration State	Analogue Input	7.7.8
CalPot	Pot Input Calibration Enable	Valve Control	4.8.4
CasM	Cascade Mode	Cascade	4.10.5
CC	Company ID	System Descriptions	6.7
Ch1OP	Ch1 Output.	Output	4.8.2
Ch2OP	Ch2 Output.	Output	4.8.2
ChAlSW	Channel Alarm Status Word	Module Block	6.7
ChnSel	Channel select for alarm A	I/O Alarm	5.9.1
ChStat	Status	Analogue Output	7.8.1
ChStat	Status	Digital Input	7.9.5
ChStat	Status.	Analogue Input	7.7.8
ChTpHi	High Limit for Channel Type	Analogue Input	7.7.8
ChTpLo	Low Limit for Channel Type	Analogue Input	7.7.8
CJC_Tp	CJC Type	Analogue Input	7.7.8
CJtemp	CJC Temperature	Analogue Input	7.7.8
ClinFl	Custom Linearisation Failure	System	6.3.1
Clk	Clock	Counter	8.7.1
ClkSrc	Clock Source	Counter	8.7.1
ClnPrb	Zirconia Clean Probe IP	Zirconia	8.12.2
ClnSrc	Zirconia Clean Probe IP Source	Zirconia	8.12.2
ClStHL	Calibration State High Limit	Analogue Input	7.7.8
ClStLL	Calibration State Low Limit	Analogue Input	7.7.8
ColdSt	Cold Start Flag	System	6.3.1
COOL	Cooling Type	Key Configuration	4.3.2
cOrr	Wet Bulb Temperature Correction	Humidity	8.11.2
Count	Count	Counter	8.7.1
COv	Clear Overflow	Counter	8.7.1
COvSrc	Clear Overflow Source	Counter	8.7.1
Ctime	Control Task Duration in Ticks	Diagnostics	6.6.1
Ctrl	Control Type	Key Configuration	4.3.1
CtSbyAct	Control Action in Standby	Loop Overview	4.2.1
CTStat	CascadeTuning State	Autotune	4.13.1
CustabN1	Custom Table 1 Name	System	6.3.1
CustabN2	Custom Table 2 Name	System	6.3.1
CustabN3	Custom Table 3 Name	System	6.3.1
CVStat	Status	Analogue block	8.2.2
CVStat	Status	Digital block	8.3.2
cYct	Zirconia Probe Cleaning Interval	Zirconia	8.12.2
Debnce	Debounced	Digital Input	7.9.5
Debnce	Debounced	Digital Input	7.11.5
Debump	Debump Flag	PID	4.4.6
dEcP	Decimal Places in Disp/Comms.	Key Configuration	4.3.2
DefRPW	Reference Calibration Password	Password set up	6.5.1
DefUPW	User Calibration Password Configuration	Password set up	6.5.1
dELy	Delay	Digital Communications	6.2.1
DewPnt	Wet/Dry Temperature Dew Point	Humidity	8.11.2
DHCPen	MAC Address 4 Ethernat	Digital Communications	6.2.1
Dir	Direction	Counter	8.7.1
DisCas	Disable Cascade	Cascade	4.10.5
DisSrc	Disable Cascade Source	Cascade	4.10.5
Dry	Dry Bulb Temperature value	Humidity	8.11.2
DrySrc	Dry Bulb Temperature source	Humidity	8.11.2

Mnemonic	Description	Function Block	Section
Dst1	point to point wire destination	Wires	8.10.1
dtyP	Derivative Type	Key Configuration	4.3.2
Elapse	Timer elapsed time	Timer	8.6.5
Emiss	Emissivity	Analogue Input	7.7.8
En	Enable	Counter	8.7.1
EnSrc	Enable Source	Counter	8.7.1
F1	Feature1: Indirect Modbus Address	System Descriptions	6.7
F1_1	Address of Read Only Indirection Table	System Descriptions	6.7
F1_2	Address of Read/Write Indirection Table	System Descriptions	6.7
F1_3	Not Used	System Descriptions	6.7
F2	Feature2: Modbus Word Ordering	System Descriptions	6.7
F2_1	High order word in low reg. addr	System Descriptions	6.7
F2_2	Not Used	System Descriptions	6.7
F2_3	Not Used	System Descriptions	6.7
F3	Feature3: Modbus Function Codes	System Descriptions	6.7
F3_1	FCs 3;4;6;7;8 and 16 supported	System Descriptions	6.7
F3_2	FCs 17-19 NOT supported	System Descriptions	6.7
F3_3	FCs 70 and 71 supported	System Descriptions	6.7
F4	Feature4: Analog Value Formats	System Descriptions	6.7
F4_1	16 bit scaled & IEEE & 32 bit int	System Descriptions	6.7
F4_2	Not Used	System Descriptions	6.7
F4_3	Not Used	System Descriptions	6.7
F5	Feature5: Ethernet Parameters	System Descriptions	6.7
F5_1	Supported Ethernet parameters	System Descriptions	6.7
F5_2	Ethernet Base Address	System Descriptions	6.7
F5_3	Not Used	System Descriptions	6.7
FallBk	Fall Back Value	Analogue block	8.2.2
FallBk	Fall Back Value	Digital block	8.3.2
FF	Remote Feedforward	PID	4.4.6
FF_SP	Cascade Feedforward Value	Cascade	4.10.5
FF_Src	Cascade Feedforward Value Source	Cascade	4.10.5
FFdv	SP and PV feed forward defines range of PID trim contribution	PID	4.4.6
FFPb	Proportion of feed forward fed directly to the output	PID	4.4.6
FFSrc	Modbus address of parameter used as the remote feed forward	PID	4.4.6
FFtr	Fixed offset value added to the feedforward signal	PID	4.4.6
FiltTm	Filter Time	Analogue Input	7.7.8
FitA	Feature Identifier Table Address	System Descriptions	6.7
FLAGs	Flags - special case comms	Digital Communications	6.2.1
FltAct	Fault Action	Analogue Input	7.7.8
FltAct	OP Standby Action	Analogue Output	7.8.1
FltAct	OP Standby Action	Digital output control	7.10.4
FOP	Force Manual Output Mode.	Key Configuration	4.3.2
FOP	Forced Output Level	Output	4.8.2
Frz	Freeze Control Flag Value	PID	4.4.6
FrzSrc	Modbus address of parameter used as the freeze control flag	PID	4.4.6
Fwdt	Feedforward Type	Key Configuration	4.3.2
Gateway1	Gateway 1 Ethernet	Digital Communications	6.2.1
Gateway2	Gateway 2 Ethernet	Digital Communications	6.2.1
Gateway3	Gateway 3 Ethernet	Digital Communications	6.2.1
Gateway4	Gateway 4 Ethernet	Digital Communications	6.2.1

Mnemonic	Description	Function Block	Section
GHd	Global SRL Hold Flag	System	6.3.1
GHdSrc	Global SRL Hold Flag Source	System	6.3.1
GrpAck	Group Acknowledge	Alarm	5.7.1
GSSync	Trigger All Ramps	System	6.3.1
Hb	SP Rate Limit Holdback Value	Remote Setpoint	4.6.1.3
Hbkdis	Holdback Disable	Rate Limit and Holdback	4.6.1.1
Hbty	holdback strategy for setpoint ramps	Rate Limit and Holdback	4.6.1.1
Hcb	Cutback high	PID	4.4.6
H-CO	Gas Reference	Zirconia	8.12.2
HiLim	Output High Limit	Analogue block	8.2.2
Hld	Hold	Totalisers	8.8.1
HldSrc	Totaliser Hold Source	Totalisers	8.8.1
HY_1	Alarm 1 hysteresis	Alarm	5.7.1
hYS1	Hysteresis 1	Output	4.8.2
hYS2	Hysteresis 2	Output	4.8.2
I_Hold	Integral Hold Flag	PID	4.4.6
Ih1	Alarm 1 inhibit	Alarm	5.7.1
Ih1Src	Alarm 1 inhibit source	Alarm	5.7.1
I-HSrc	Modbus address of the flag used to hold the Integral value	PID	4.4.6
II	Instrument Identity	System	6.3.1
II	Product ID	System Descriptions	6.7
IM	Instrument Operating Mode	System	6.3.1
Inhibt	Instrument Alarm Inhibit	System	6.3.1
Inhibt	Status Alarm Inhibit	Analogue Input	7.7.8
Inhibt	Status Alarm Inhibit	Analogue Output	7.8.1
Inhibt	Status Alarm Inhibit	Digital Input	7.9.5
Inhibt	Status Alarm Inhibit	Digital output control	7.10.4
InhSrc	Instrument Alarm Inhibit Source	System	6.3.1
InhSrc	Status Alarm Inhibit Source	Analogue Input	7.7.8
InhSrc	Status Alarm Inhibit Source	Analogue Output	7.8.1
InhSrc	Status Alarm Inhibit Source	Digital Input	7.9.5
InhSrc	Status Alarm Inhibit Source	Digital output control	7.10.4
InstSt	Instrument Status	System	6.3.1
Int	Valve Inertia Time	Valve Control	4.8.4
InvMsk	Invert Inputs Mask	Digital block	8.3.2
IOFail	I/O Fail Strategy	System	6.3.1
IOH	Electrical High	Analogue Input	7.7.8
IOH	Electrical High	Analogue Output	7.8.1
IOH	Electrical High	Digital output control	7.10.4
IOL	Electrical Low	Analogue Input	7.7.8
IOL	Electrical Low	Analogue Output	7.8.1
IOL	Electrical Low	Digital output control	7.10.4
IONrec	IO Network Recovery Time	System	6.3.1
IONwdg	I/O Network Watchdog Timeout	System	6.3.1
IOstat	Global IO Status	System	6.3.1
IP	Totaliser Monitored Parameter Value	Totalisers	8.8.1
IP_Src	Timer Input Wire	Timer	8.6.5
IP_Val	Trigger/Gate Input	Timer	8.6.5
IPaddr1	IP Address 1 Ethernet	Digital Communications	6.2.1
IPaddr2	IP Address 2 Ethernet	Digital Communications	6.2.1
IPaddr3	IP Address 3 Ethernet	Digital Communications	6.2.1
IPaddr4	IP Address 4 Ethernet	Digital Communications	6.2.1
IPChanged	IP Changed Ethernet	Digital Communications	6.2.1

Mnemonic	Description	Function Block	Section
IPSrc	Totaliser Monitored Parameter Value Source	Totalisers	8.8.1
IS	Instrument Operating State	System	6.3.1
Lb_t	Loop Break Time	PID	4.4.6
Lcb	Cutbacl low	PID	4.4.6
Lead_R	RTD lead resistance	Analogue Input	7.7.8
LeadPV	Lead PV	Ratio	4.9.2
LeaSrc	Lead PV source	Ratio	4.9.2
LinTyp	Linearisation Type	Analogue Input	7.7.8
LocalAddres	Local Modbus Address Ethernet	Digital Communications	6.2.1
LocH	Local Setpoint Trim High Limit	Remote Setpoint	4.6.1.3
LocL	Local Setpoint Trim Low Limit	Remote Setpoint	4.6.1.3
Loct	Local Setpoint Trim	Remote Setpoint	4.6.1.3
LoLim	Output Low Limit	Analogue block	8.2.2
LowThr	Totaliser Low Threshold	Totalisers	8.8.1
LPBrk	Loop Break Status Flag	PID	4.4.6
LpType	Loop Type	Key Configuration	4.3.1
L-r	Remote Setpoint Enable	Remote Setpoint	4.6.1.2
L-rSrc	Remote Setpoint Enable Source	Remote Setpoint	4.6.1.2
Ltch	Instrument Alarm Latching	System	6.3.1
Ltch	Status Alarm Latching	Analogue Input	7.7.8
Ltch	Status Alarm Latching	Analogue Output	7.8.1
Ltch	Status Alarm Latching	Digital Input	7.9.5
Ltch	Status Alarm Latching	Digital output control	7.10.4
Ltch_1	Alarm 1 latching	Alarm	5.7.1
LveCnf	Enable IO Config in Operator mode	System	6.3.1
m-A	Auto/Manual Select.	Loop Overview	4.2.1
MACaddr1	MAC Address 1 Ethernat	Digital Communications	6.2.1
MACaddr2	MAC Address 2 Ethernat	Digital Communications	6.2.1
MACaddr3	MAC Address 3 Ethernat	Digital Communications	6.2.1
Mask	Instrument Alarm Bit Mask	System	6.3.1
Mask	Status Alarm Bit Mask	Analogue Input	7.7.8
Mask	Status Alarm Bit Mask	Analogue Output	7.8.1
Mask	Status Alarm Bit Mask	Digital Input	7.9.5
Mask	Status Alarm Bit Mask	Digital output control	7.10.4
m-Asrc	Auto/Manual Select Source	Loop Overview	4.2.1
MaxCT	Maximum Control Task Duration	Diagnostics	6.6.1
MaxDsp	For diagnostic use only	PID	4.4.6
MaxST	Maximum Sample Time	System	6.3.1
MeasV	Electrical Value	Analogue Output	7.8.1
MeasV	Electrical Value	Digital output control	7.10.4
MeasV	Electrical Value (V/A/R)	Analogue Input	7.7.8
MeasV	Electrical Value (V/A/R)	Digital Input	7.9.5
MFB	Master Feedback Value	Cascade	4.10.5
MinDsp	For diagnostic use only	PID	4.4.6
MinT	Zirconia Minimum Calculation Temperature	Zirconia	8.12.2
MnPlsT	Minimum Pulse Time	Digital Input	7.9.5
MnPlsT	Minimum Pulse Time	Digital output control	7.10.4
MnPosn	For diagnostic use only	PID	4.4.6
ModVer	Module Version	Module Block	6.7
mPt	Minimum Pulse Time	Valve Control	4.8.4
MRatio	Measured Ratio	Ratio	4.9.2
mTr	Manual Track	Setpoint Configuration	4.7.2

Mnemonic	Description	Function Block	Section
mV	Zirconia Probe mV IP	Zirconia	8.12.2
mVSrc	Zirconia Probe mV Input Source	Zirconia	8.12.2
MxTDTI	For diagnostic use only	PID	4.4.6
NetStat	Network Status Ethernet	Digital Communications	6.2.1
nFID	Number of Feature Identifiers	System Descriptions	6.7
nindRO	Read Only Modbus indirect table size	System Descriptions	6.7
nindRW	Read/Write Modbus indirect table size	System Descriptions	6.7
nSets	Number of PID sets to Use	Gain Scheduling	4.5.1
NVFail	Non-Volatile Memory Failure	System	6.3.1
NwdAct	I/O Network Watchdog Timeout	System	6.3.1
Nwdged	I/O Network Watchdog Flag	System	6.3.1
NwRmRt	Next Slave Instrument Ramp Rate	Remote Setpoint	4.6.1.3
NwTrSP	Next Slave Instrument Target Setpoint	Remote Setpoint	4.6.1.3
O2_Un	Oxygen Exponent	Zirconia	8.12.2
OFFS	Zirconia mV Offset	Zirconia	8.12.2
Offset	Simple Cal Offset (Eng)	Analogue Input	7.7.8
OfsetH	User Cal Offset High (Eng)	Analogue Input	7.7.8
OfsetL	User Cal Offset Low (Eng)	Analogue Input	7.7.8
On1&2(6)	ON/OFF	Key Configuration	4.3.1
OnOff (1)	ON/OFF control	Key Configuration	4.3.1
OnOffI	On/ Off Input	Digital Input	7.11.5
OnOffO	On/ Off Output	Digital output control	7.11.6
ont1	Ch1 Output Minimum On Time	Output	4.8.2
ont2	Ch2 Output Minimum On Time	Output	4.8.2
OnVPB(8)	ON/OFF	Key Configuration	4.3.1
OnVPU(7)	ON/OFF	Key Configuration	4.3.1
o-oOP	On Off Control Output.	Loop Overview	4.2.1
OP	Instrument Alarm Output	System	6.3.1
OP	Status Alarm Output	Analogue Input	7.7.8
OP	Status Alarm Output	Analogue Output	7.8.1
OP	Status Alarm Output	Digital Input	7.9.5
OP	Status Alarm Output	Digital output control	7.10.4
OP	Timer Output	Timer	8.6.5
OP_1	Alarm 1 output state	Alarm	5.7.1
Oper	Operator	Analogue block	8.2.2
Oper	Operator	Digital block	8.3.2
OPHi	High power limit	Output	4.8.2
OPLo	Low power limit	Output	4.8.2
OPrr	Output Rate Limit	Output	4.8.2
OPrSrc	Output Rate Limit Source	Output	4.8.2
ORL	Output Rate Limit Enable	Output	4.8.2
ORLSrc	Output Rate Limit Enable Source	Output	4.8.2
oSbOP	Sensor Break Power	Output	4.8.2
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19.   Index - Key Words

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