Eurotherm®

by Schneider Electric

T2750 FOXBORO PAC
User Guide

T2750 FOXBORO PAC
Version 8

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T2750

AI2	AI8	DI8	DO8	RLY4	T2750 IOC
AI3	AO2	DI16	DO16	RLY8	T2750 Backplane
AI4	DI6	DO4	FI2	ZI	

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This certificate relates to the product models mentioned above. The data shown here is related to the following version of the China RoHS 2.0: Administrative Measures for the Restriction of Hazardous Substances in Electric Appliances and Electronic Products" released January 21st 2016.

部件名称 Part Name	有害物质 - Hazardous Substances					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr (VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
金属部件 Metal parts	X	O	O	O	O	O
塑料部件 Plastic parts	O	O	O	O	O	O
电子件 Electronic	X	O	O	O	O	O
触点 Contacts	O	O	X	O	O	O
线缆和线缆附件 Cables & cabling accessories	O	O	O	O	O	O

本表格依据SJ/T11364的规定编制。
O: 表示该有害物质在该部件所有均质材料中的含量均在GB/T 26572规定的限量要求以下。
X: 表示该有害物质至少在该部件的某一均质材料中的含量超出GB/T 26572规定的限量要求。

This table is made according to SJ/T 11364.
O: indicates that the concentration of hazardous substance in all of the homogeneous materials for this part is below the limit as stipulated in GB/T 26572.
X: indicates that concentration of hazardous substance in at least one of the homogeneous materials used for this part is above the limit as stipulated in GB/T 26572

Signed (Kevin Shaw, R&D Director): K Shaw Date: 30th June 2016

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ASSOCIATED DOCUMENTS

HA082375U003	LIN Blocks reference manual
HA082429	ELIN User guide
HA028014	Communications manual
HA028988	Modbus tools help manual (printable version of the on-line Modbus tools help system)
HA029881	Store and Forward user guide
HA263001U055	LIN Help manual (printable version of the on-line LINtools help system)
HA030272	PAC Systems alarm suppression user guide
HA030511	Raw Comms user guide

Information is also to be found in the help systems associated with the various software tools used with the product.

SOFTWARE EFFECTIVITY

This manual relates to units with software version 3.0.

T2750 Controller

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SAFETY NOTES

WARNING

Any interruption of the protective conductor inside or outside the apparatus, or disconnection of the protective earth terminal is likely to make the apparatus dangerous under some fault conditions. Intentional interruption is prohibited.

Note: in order to comply with the requirements of safety standard BS EN61010, the instrument shall have one of the following as a disconnecting device, fitted within easy reach of the operator, and labelled as the disconnecting device.

a. A switch or circuit breaker which complies with the requirements of IEC947-1 and IEC947-3
b. A separable coupler which can be disconnected without the use of a tool
c. A separable plug, without a locking device, to mate with a socket outlet in the building.

1. Before any other connection is made, the protective earth terminal shall be connected to a protective conductor. The mains (supply voltage) wiring to the PSU must be terminated in such a way that, should it slip, the Earth wire would be the last wire to become disconnected.
2. The protective earth terminal must remain connected (even if the equipment is isolated from the mains supply), if any of the I/O circuits are connected to hazardous voltages*.
3. Fuses are not user replaceable. If it is suspected that the fuse is faulty, the manufacturer's local service centre should be contacted for advice.
4. Whenever it is likely that protection has been impaired, the unit shall be made inoperative, and secured against accidental operation. The manufacturer's nearest service centre should be contacted for advice.
5. Any adjustment, maintenance and repair of the opened apparatus under voltage, should be avoided as far as possible and, if inevitable, shall be carried out only by a skilled person who is aware of the hazard involved.
6. Where conductive pollution (e.g. condensation, carbon dust) is likely, adequate air conditioning/filtering/sealing etc. must be installed in the recorder enclosure.
7. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment might be impaired.
8. In order to comply with the requirements of BS EN61010 the voltage applied across I/O terminals may not exceed the isolation voltage for those terminals. For terminals specified as having 'no isolation', the maximum permissible voltage is 30V ac or 50V dc.
9. Under extreme shock along the axis of the backplane, the IOC is liable to reset. Following this reset, the behaviour of the instrument is dependent upon the configuratin switches on the terminal unit. These switches determine whether the instrument is allowed to reboot, and whether it should attempt to run the strategy. See section 2.4.2 for details on the LIN Options Switch.

* A full definition of 'Hazardous' voltages appears under 'Hazardous live' in BS EN61010. Briefly, under normal operating conditions, hazardous voltages are defined as being > 30V RMS (42.2V peak) or > 60V dc.

I/O ISOLATION STRATEGY

Isolation is implemented in the form of a double insulation (300V) barrier separating all the I/O channels in a module from the rest of the system.

This prevents hazardous voltages on any one I/O channel from introducing hazards on wiring associated with any other I/O module, or from putting the rest of the system at risk.

Modules which provide channel-to-channel isolation further ensure safety and good signal quality on all channels within such modules. Refer to the relevant section of "Appendix A SPECIFICATION" on page 137 for more details.

EMC

This instrument conforms with the essential protection requirements of the EMC Directive 89/336/EEC, amended by 93/68/EEC. It also satisfies the emissions and immunity standards for industrial environments.

The earthing strip at the lower edge of the backplane also provides termination facilities for EMC, cable screens, etc.

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

If the backplane is mounted on a DIN rail, the DIN rail must be in good electrical contact with a grounded metal (aluminium or steel) sheet which is part of the enclosure. If this contact is not possible, the ends of the DIN rail must be connected at each end to the enclosure by two substantial earth braids (10mm x 2mm) not more than 100mm in length.

If the backplane is mounted directly onto a panel, it must be in good electrical contact with a grounded metal (steel or aluminium) sheet which is part of the enclosure. If this contact is not possible, the safety earth connections at the ends of the backplane must be connected to the enclosure by two substantial earth braids (10mm x 2mm) not more than 100mm in length.

If these connections are not practical, ferrite clamps should be clipped over the input leads, as near the terminal unit connector as possible. It is not necessary to have one clamp for each input pair - several input pairs may be inserted through a single clamp. Each clamp should have a minimum 200Ω impedance at 100 MHz. A suitable clamp is Richco MSFC-13K.

General guidance	For general guidance refer to the EMC Installation Guide (Part no. HA025464).
Relay outputs	When using relay outputs it may be necessary to fit a filter suitable for suppressing conducted emissions. The filter requirements will depend on the type of load.
Routing of wires	To minimise the pick-up of electrical noise, low voltage DC connections and sensor input wiring should be routed away from high-current power cables. Where it is impractical to do this, shielded cables should be used.
Power supply	The instrument must be powered from a local power supply and must not be connected to a DC distribution network. The power supply must be earthed according to manufacturers instructions in order to give best EMC performance for the system.

SYMBOLS USED ON THE INSTRUMENT LABELLING

One or more of the symbols below may appear as a part of the instrument labelling.

	Refer to the user guide for instruction
	Protective conductor terminal (safety earth)
	Precautions against electrostatic discharge must be taken before handling this unit or any electronic component of it.
	This unit is RoHS compliant
	For environmental reasons, this product must be recycled before its age exceeds the number of years shown in the circle.
	Underwriters Laboratories listed mark for the United States and Canada
	This unit is CE compliant
	This unit is ACMA compliant
	Risk of electric shock

I/O ISOLATION STRATEGY

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Modules which provide channel-to-channel isolation further ensure safety and good signal quality on all channels within such modules. Refer to the relevant section of Appendix A for more details.

T2750 Foxboro PAC user guide

1 INTRODUCTION

The T2750 is a modular I/O controller which can be used either as a stand alone unit, or as part of a complete control system. Modbus and Raw communications protocols are supported, allowing simple connection with PCs, and other instruments. Profibus master functionality is supported by using the optional netHOST gateways.

The control strategy is set up using LINTools software running on a PC.

1.1 PHYSICAL STRUCTURE

The unit consists of one or two Input/Output Controller (IOC) modules and a number of Input/Output (I/O) Modules each of which clips into its own individual terminal unit which provides termination for user wiring. The terminal units themselves are located in a base unit which is mounted on a DIN rail or on a panel, as required. Base units are available in different sizes to accommodate different numbers of I/O Modules (maximum 16).

The lower front of the unit is covered by a removable flap which protects the wiring, but leaves the status LEDs open to view.

Profibus master functionality, if required, is provided by the use of external netHOST gateway units. Up to two netHOSTs are required, depending on whether one of two IOC modules are installed.

1.2 MODULES AVAILABLE

AI2	Two universal analogue input channels
AI3	Three analogue input channels used for current loops, either self powered or externally powered
AI4	Two pairs of isolated analogue input channels. Terminal unit variants are available for particular applications (thermocouples, mA or mV inputs).
AI8	High density analogue input module. Terminal unit variants are available for eight channels of mA inputs (fast or standard polling), eight channels of thermocouples with cold junction compensation (also accepts mV inputs), or four channels for platinum resistance thermometers (RTD).
AO2	Two analogue output channels supplying 0 to 20mA or 0 to 10V signals
DI4	Four digital input channels (logic inputs)
DI6HV	Six digital input channels (mains input 230VRMS)
DI6MV	Six digital input channels (mains input 115VRMS)
DI8CO	Eight digital input channels (contact closure inputs)
DI8LG	Eight digital input channels (logic inputs)
DI16	16 digital input channels (universal inputs)
DO4LG	Four digital output channels (0 to 10mA), externally powered
DO424	Four digital output channels (0 to 100mA), externally powered
DO8	Eight digital output channels (0 to 500mA per channel- maximum 4 Amps per module), externally powered
DO16	16 digital output channels (0 to 700mA per channel)
FI2	Two frequency input channels (logic, magnetic and contact closure up to 40kHz)
RLY4	Four output relays arranged as one changeover relay and three Normally Open relays
RLY8	Eight Normally Open relays
ZI2	One high impedance input channel and one thermocouple input channel suitable for use with Zirconia oxygen probes

1.3 FEATURES

1.3.1 LIN Communication

The unit is a Local Instrument network (LIN) instrument, where the 'Local Instrument Network' is a collection of LIN instruments, that together form a control system. The network communicates using 'LIN Communication' which is a proprietary system used to connect each LIN instrument in the network.

1.3.2 ELIN Communication

ELIN Communication is LIN communication via Ethernet allowing peer-to-peer communications between instruments and with the wider network via a standard Ethernet infrastructure.

1.3.3 Profibus Master Communication

Profibus Master support is provided using the optional, externally mounted, netHOST gateways. Interface from the netHOST to the T2750 is via IP over Ethernet. Up to two netHOSTs are required depending on the number of IOCs installed into the T2750's base unit.

1.3.4 Redundant working

REDUNDANT POWER SUPPLY CONNECTION

Two sets of power connections allow two Power Supply Units (PSUs) to be connected so that the system can continue to run should one of the supplies fail. The system monitors the supply voltages allowing alarms to be triggered should either or both supply voltages drop below an acceptable value.

REDUNDANT INSTRUMENTS

When operating in redundant mode, a high speed data link between the primary and secondary control modules provides exact tracking of the control database, allowing bumpless automatic changeover to the secondary module should the primary module fail. There is no loss of I/O states and no need to re-initialise I/O points. Revalidation of all attached LIN nodes is automatic.

Live replacement of a failed control module can be carried out, without wiring disconnections. Full hardware and software status indication allows rapid verification and diagnostics. In Redundant mode operation either module can be removed leaving the remaining module to drive the I/O modules. When a replacement control module is fitted, it loads the control strategy and current status from the running control module.

1.3.5 Battery backup

An internal 'supercap' supports hot start data, and the Real-Time Clock, for a minimum of 1 hour. An external battery (3.3V ± 15%, 10µA max) can be connected in order to extend this period. An option exists for the T2750 to contain a 3V 'coin-cell' style battery, mounted on a small board, fitted on the inside of the plastic side panel adjacent to the IOC.

1.3.6 Configuration

Continuous strategies and Sequences are configured, downloaded and monitored using LINtools.

The instrument is capable of creating its own LIN Database automatically (_auto.dbf and _auto.run), this database including all the necessary module and I/O Function Blocks based on the I/O modules detected.

Automatic Configuration is attempted after the instrument has determined the Hot/Cold Start switch settings. If neither cold start nor hot start is selected, the instrument detects the installed I/O, and then creates an operational database and runs automatically.

SETPOINT PROGRAM

Allows a setpoint program (.uyy file) to be configured using the LIN Programmer Editor. The Programmer Wizard (available from LINtools Engineering Studio) is then used, automatically to insert and to link all the blocks needed to produce the generated Setpoint Program.

SEQUENTIAL FUNCTION CHART (SFC)

The Sequential Function Chart (SFC) is the graphical way LINtools represents a LIN Sequence (.sfc file). A Sequence is employed when the process being controlled by the LIN Database can adopt several distinct states - e.g. 'Starting Up', 'Full Running', 'Shutting Down', etc.

1.3.6 CONFIGURATION (Cont.)

LADDER CONFIGURATION

A ladder diagram is a type of 'Action' represented graphically by a column of 'rungs'. Rungs are equivalent to program statements, with icons along them representing digital or analogue fields, constants, and logical or arithmetic functions. Each rung has only one 'output' or 'objective' - at its right-hand end - which is either a coil (digital field), variable (analogue field), or a 'jump' to another labelled rung. Rungs can include any number of input elements and use any complexity of wired or explicit functions to perform the rung operation - subject only to screen space limitations.

Note: A single rung that evaluates TRUE or FALSE can also be used for a Sequence Transition.

SEQUENTIAL TEXT (ST) USER ALGORITHMS

Special Action blocks support user-algorithms written in Structured Text (ST).

SOFTWARE BLOCKS

Continuous strategies are built up using function blocks selected from a library of analogue and logic elements. Diagnostic blocks are also available, for hardware and software status reporting (see section 11). The LIN Blocks Reference manual contains descriptions of each block.

Blocks are 'license protected' into categories that define control levels (Appendix C gives a full list):

1. Foundation blocks include I/O and Communications blocks, amongst others.
2. Standard blocks include control, timing, basic maths and logic blocks.
3. Control blocks include control loop, advanced maths and sequence control blocks.
4. Advanced blocks are natural gas concentration and AGA8 calculation blocks.

Note: Generally, a combination of Standard license blocks can be used to provide a level of instrument control equivalent to a single Control license block, but this has an impact on the total number of available blocks remaining.

1.3.7 Data recording

Data archive (.uhh) files are saved in the unit's flash memory (as configured in LINtools) ready for automatic archiving to a host computer via FTP. Review software can be used to display this data in chart or spreadsheet form. If 'Store and Forward' software is fitted at the host pc, then these dtat recording files can be interrogated to read any data missing from the database as a result of a break in transmission.

1.3.8 Store and forward software

If there is a break in the transmission line, or if any other communications problem arises, then data for the period of the break will be missing from the database. The data remains in the instrument memory, and if the instrument is configured to archive automatically to a 'Review' database, then 'Store and Forward' allows the missing data to be retrieved from the Review database, once communications have been restored. (It may take some time to download all the files, depending on the duration of the break.)

More details are to be found in the 'Store and Forward User Guide.

1.3.9 Time Localisation Support

TIME ZONE

Provides a means of configuring the instrument to use the local time zone.

SIMPLE NETWORK TIME PROTOCOL (SNTP)

Allows the instrument to receive time and date from an SNTP server over the Ethernet connection.

1.3.10 Health monitoring

Automatic health checks, self-testing, and initialisation on power-up, with continuous checking of I/O status and external communications.

1.3.11 Watchdog

A Watchdog switch on the control module allows the user to initiate a restart in the event of a watchdog failure. If required, the Watchdog Relay connections can be wired as shown in section 2.3.1.

Note: The watchdog relay can also be switched by the strategy, using the 'Options.UsrAlm' bit in the Tactician Header block. For synchronised systems, both primary and secondary relays are switched.

1.3.12 IP (Intellectual Property) Protection

Specific application file types can be password protected. This prevents the loss of the Intellectual Property to mis-use and duplication, e.g. using files on an instrument for which they were not originally intended and the copying of files for use with another instrument or process.

1.3.13 Front panel indicators

Status LEDs are provided to indicate communications and module I/O status. Control switches are fitted on each control module.

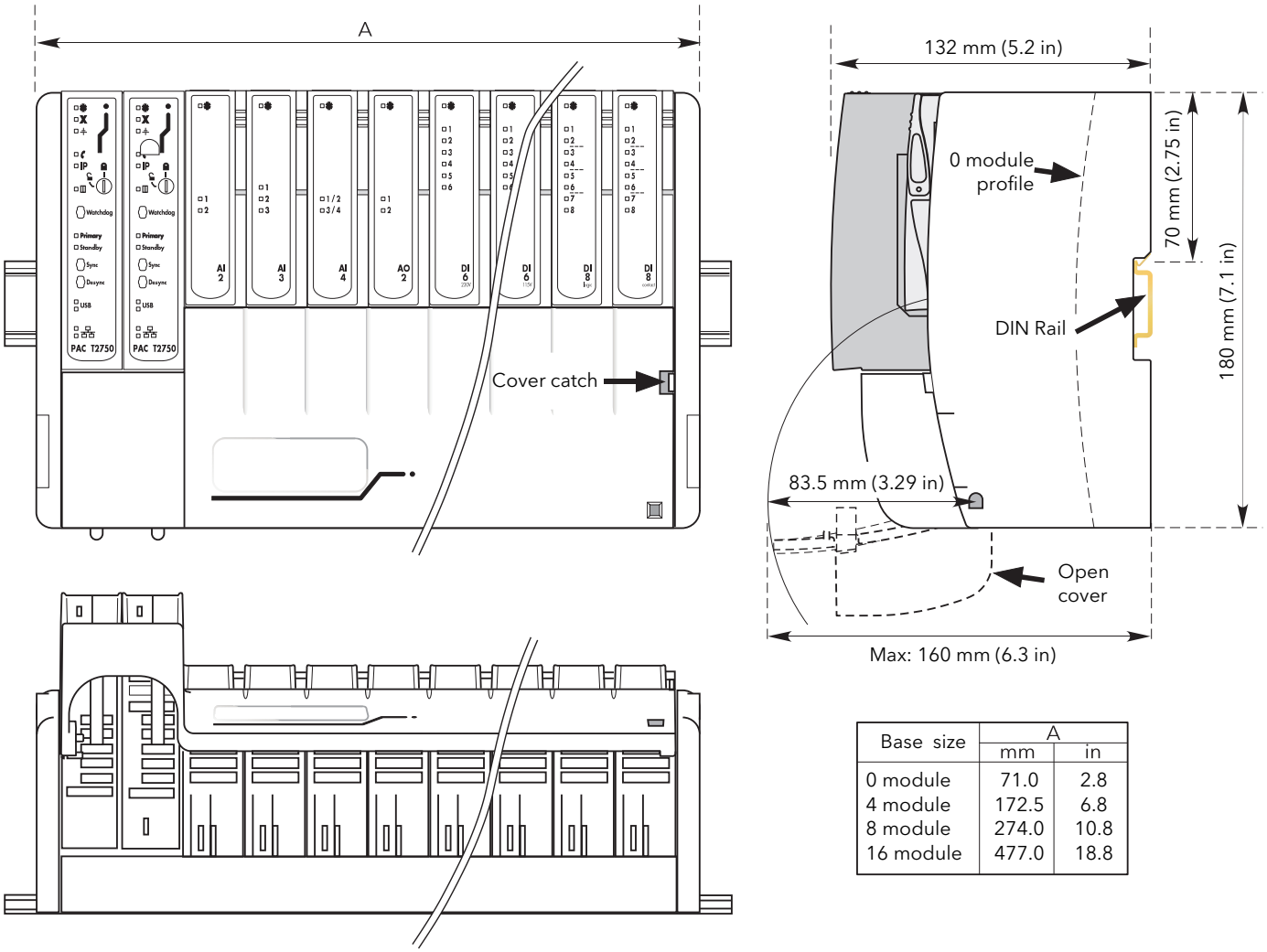
2 INSTALLATION

2.1 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.

2.2 MECHANICAL INSTALLATION

Figure 2.2a gives dimensional details; figure 2.2b gives fixing details.



Base size	A	
	mm	in
0 module	71.0	2.8
4 module	172.5	6.8
8 module	274.0	10.8
16 module	477.0	18.8

Figure 2.2a Overall dimensions

2.2 MECHANICAL INSTALLATION (Cont.)

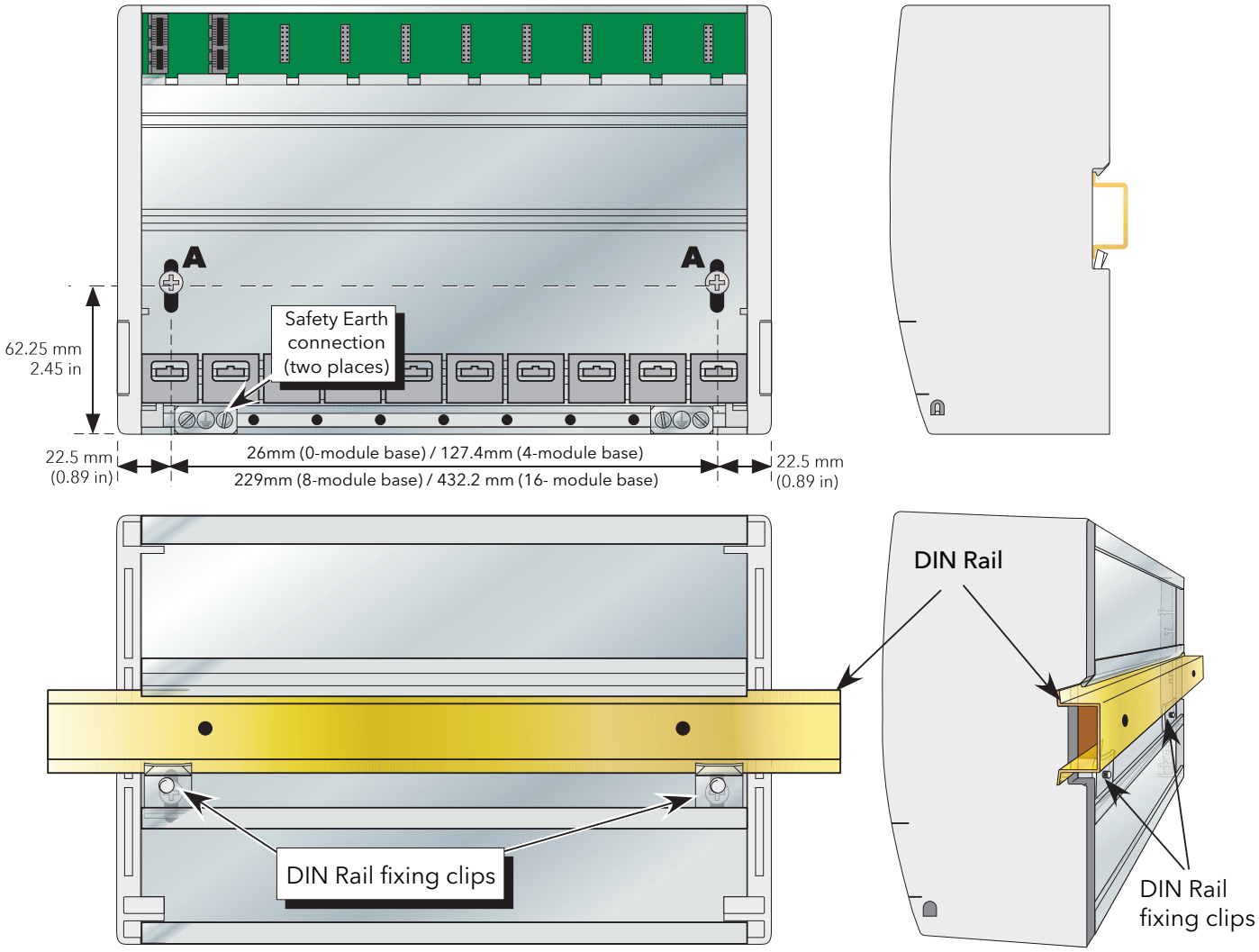


Figure 2.2b Fixing details

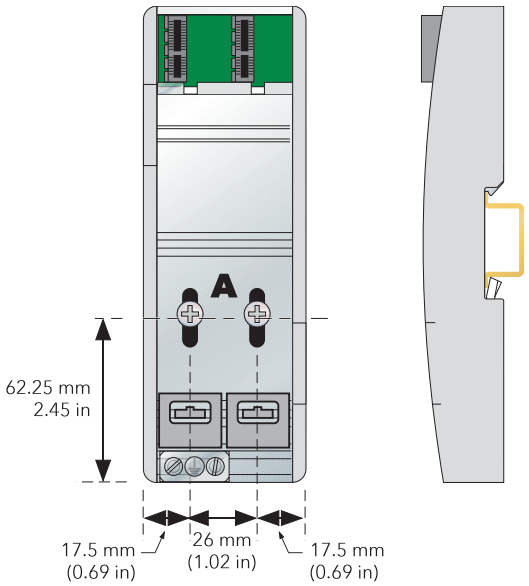


Figure 2.2c No-module base details

2.2.1 Base unit mounting

This Base Unit is intended for DIN rail or bulkhead mounting within an enclosure, or for IOCs at status level B2 or higher, in an environment suitable for IP20-rated equipment.

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 to 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.

DIN RAIL MOUNTING

For DIN rail mounting, symmetrical, horizontally-mounted 35×7.5 or 35× 15 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 2.2b/c) 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 on to the DIN rail such that the top edge of the rail fits into the slot on the underside of the support bar (see figure 2.2b/c).
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.

PANEL MOUNTING

WARNING

Bolt 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 2.2b/c) 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.

COMPLIANCE WITH EUROPEAN EMC DIRECTIVE

Please refer to the instructions given in the SAFETY NOTES - EMC section at the front of this manual which describe precautions which should be taken to conform with the directive.

2.2.2 Terminal unit installation

1. Insert the tag at the top of the terminal unit printed circuit board into the relevant slot in Base Unit (action 'B' in figure 2.2.2).
2. 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

TERMINAL UNIT REMOVAL

1. Remove the terminal unit's I/O module, if fitted (section 2.2.3, below).
2. If necessary, remove all wiring from the terminal Unit.
3. Press the retention clip at the bottom of the terminal Unit and lift the terminal unit out (action 'D').

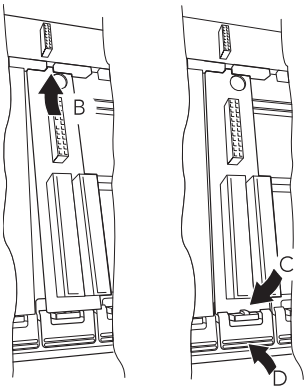


Figure 2.2.2 Terminal unit installation/removal

2.2.3 Module installation

Notes:

1. It is recommended that the module's channel blocks be placed in 'Manual' mode (using LINtools) before an I/O module is replaced in a 'live'system.
2. Polarising keys prevent modules being fitted to unsuitable terminal units.

1. Pull the module retaining lever forwards into the unlocked position as shown in figure 2.2.3.
2. Offer the module up to the terminal unit and the backplane, and push home.
3. Return the retaining lever to the locked position.

MODULE REMOVAL

1. Pull the module retaining lever forwards into the unlocked position as shown in figure 2.2.3
2. Disengage the module from the backplane connector and lift the module out of the base unit.

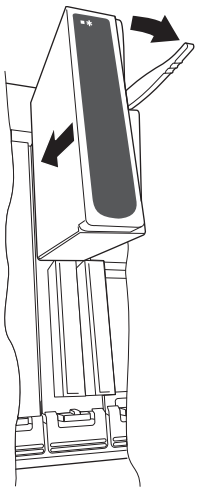


Figure 2.2.3 Module installation

2.2.4 Module identification

The inside of the cover contains locations ('slots') for labels which can be used to identify the module fitted 'above' each slot.

A document template is supplied on the DVD which allows the user to print onto a precut adhesive sheet (GA030486, supplied with the instrument). Once printed, the relevant labels can be peeled-off the backing sheet and attached to the relevant slots.

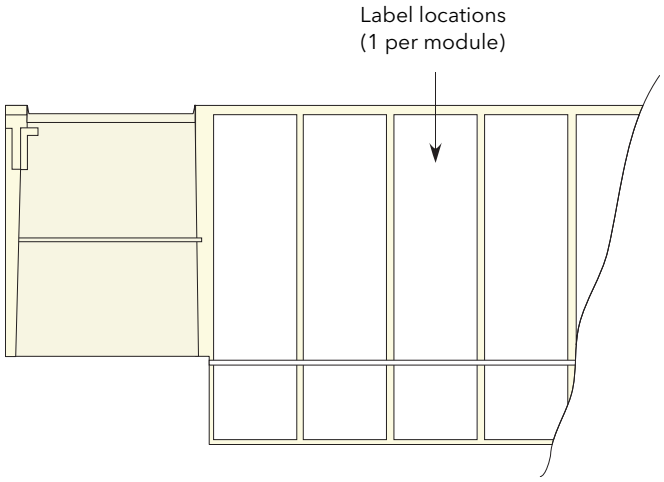


Figure 2.2.4 Inside cover

2.2.5 Installing the optional netHOST gateways

The optional netHOST gateways, which provide Profibus master functionality to the T2750, are associated to an individual IOC installed on the T2750's base unit. If only one IOC is installed, only one netHOST is required. Similarly, if the T2750 is configured with a redundant pair of IOCs, two netHOSTs are required.

Figure 2.2.5a shows the dimensions of the netHOST.

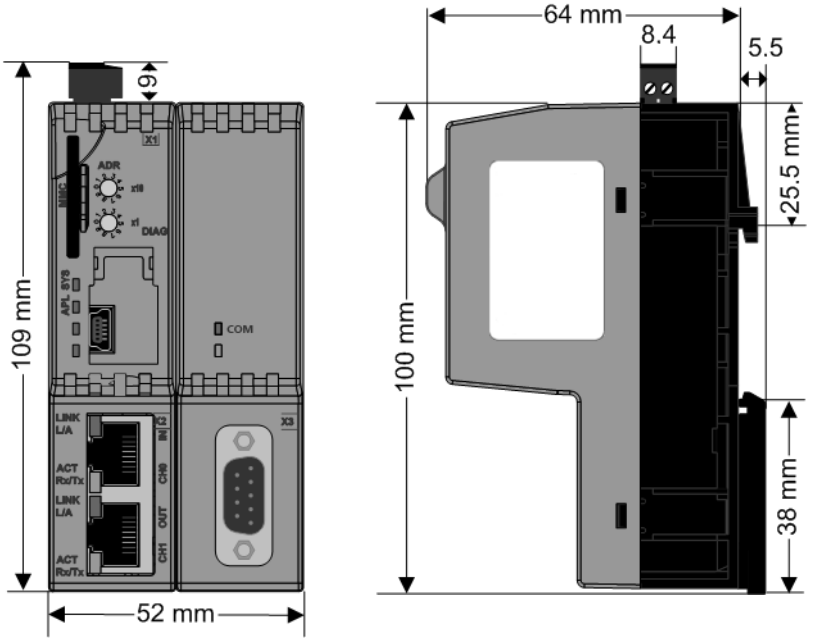


Figure 2.2.5a netHOST dimensions

It is recommended that the netHOSTs are mounted next to the T2750, although close proximity is not enforced as communication between the T2750 and netHOST is via standard Ethernet.

Mount the netHOST on a horizontally mounted DIN rail. The top hat rail must be connected with the potential equalisation conductor (PE). With reference to figure 2.2.5b, push the netHOST onto the top hat rail from above (1), and then press against the mounting surface (2).

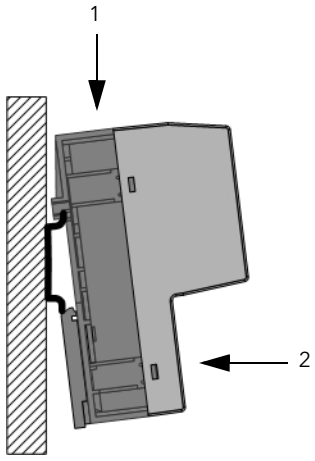


Figure 2.2.5b netHOST mounting

It is good practise to mount the two netHOSTs together, with the left netHOST being associated with the left IOC, and the right netHOST being associated to the right IOC.

2.3 ELECTRICAL INSTALLATION

2.3.1 Controller module (IOC) terminal unit

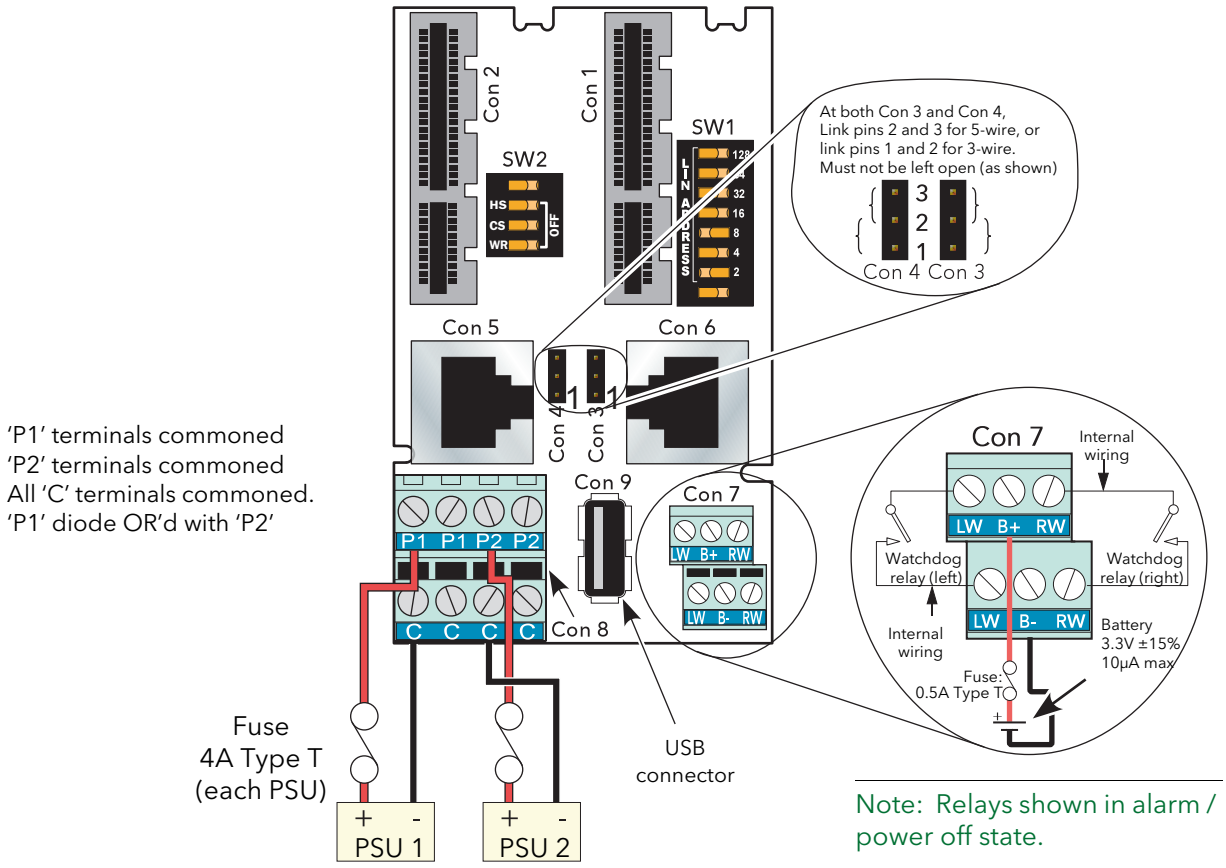


Figure 2.3.1a Wiring and hardware configuration details for the IOC terminal unit

Caution

1. Input current must be limited to 4A or the IOC supply connector (CON8) may overheat and be damaged.
2. If more than eight FI2 modules are fitted, and if these have an output channel load of more than 5mA each, then an external power supply (additional to the main power supply unit(s) shown above) must be used in order to avoid damage to the backplane tracking.

2.3.1 CONTROLLER MODULE TERMINAL UNIT (Cont.)

SUPPLY WIRING

Caution

Neither supply line may be allowed to rise above 30 Volts with respect to safety earth.

Note: should the supply voltage fall below 19.2V during startup, the instrument will not start successfully and will attempt repeatedly to restart.

The instrument supply voltage is 24Vdc ± 20%.

Typical power requirement is 150mA (3.6W) per control module, plus 1 Amp (24W) for an eight-module unit or 2 Amps (48W) for a 16-module unit.

An external battery (3.3 ± 15%) may be connected in order to maintain power for the SRAM and the real time clock when supply power is not available. Typical drain current is 10µA maximum. An option exists for the T2750 to contain a 3V 'coin-cell' style battery, mounted on a small board, fitted on the inside of the plastic side panel adjacent to the IOC.

Figure 2.3 shows the control module terminal unit with wiring details for the supply and for the battery. A suitable battery and charger are available from the manufacturer under part number LA030830.

FUSES

All positive supply lines must incorporate a fuse. Suitable types are 4A Type T for 24 Volt supplies and 0.5A Type T for an external battery.

WIRE SIZES

Supply wiring: 0.25mm^2 to 2.5mm^2 (20 AWG to 14 AWG)

External battery: 0.14mm^2 to 1.5mm^2 (25 AWG to 16 AWG)

Note...The above diameters relate to the total cross sectional area of the conductor(s) inserted into the terminal.

TERMINAL DETAILS

Recommended screwdriver type: Supply power connector (Con8): 3 mm flat blade. Watch dog/battery connector (Con7): 2.5 mm flat blade.

Maximum tightening torque: 0.6Nm for supply power terminals; 0.25Nm for battery terminals

Maximum current carrying capability: 5A per pin for supply power terminals; 2A per pin for battery terminals.

Caution

The maximum current carrying capacity should be considered when 'daisy chaining'.

SAFETY EARTH

Figure 2.2b above, and associated text gives safety earth details.

WATCHDOG RELAYS

Each control module (IOC) includes a 'watchdog' relay. At power up, for each IOC, the relay remains de-energised (contacts open) until a number of health checks have been completed successfully and a strategy has been loaded and is running, at which point the relay is energised and the contacts close. If during operation one or more health check fails, or if the strategy is stopped, the watchdog relay reverts to its de-energised (contacts open) state.

Note The watchdog relays can also be controlled by the 'Options.UsrAlm' bit in the Tactican header block.

2.3.1 CONTROLLER MODULE TERMINAL UNIT (Cont.)

Figure 2.3.1b, below, shows typical watchdog wiring. When wired in parallel, both IOCs have to fail, before the alarm becomes valid. When in series, the alarm becomes valid if either module fails. Figure 2.3.1b shows the relays wired in series to a 24V dc 'healthy' lamp, and wired in parallel, using an auxiliary relay to display both healthy and fail states. The contact ratings (resistive loads) for the watchdog relays are 30V ac/60V dc at 0.5A.

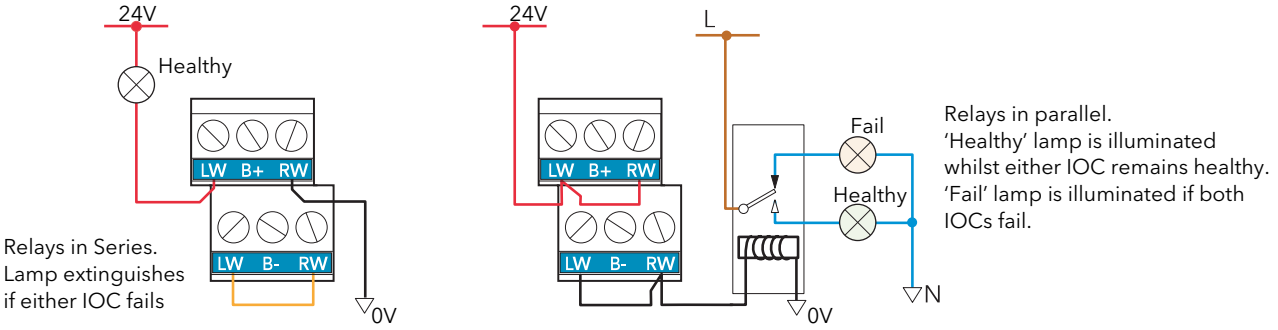
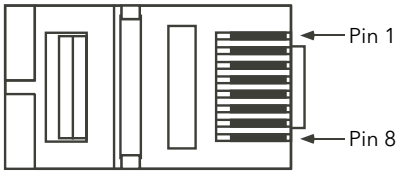


Figure 2.3.1b Typical watchdog relay wiring

Note: If the watchdog relay outputs are routed outside the cabinet in which the unit is mounted, a clip- on ferrite should be fitted round all watchdog leads, and positioned as closely as possible to the instrument. A suitable ferrite is available from the manufacturer under part number CO025698

COMMUNICATIONS CONNECTORS

A pair of parallel-wired RJ45 connectors, are used for EIA485 serial communications. Figure 2.3.1c gives the pinout. Master / slave status is defined in 'Modbus tools' supplied as a part of LINtools.



RJ45 plug: View on underside

Pin	5-wire Master	5-wire Slave	3-wire Master/Slave
1	RxB	TxB	B
2	RxA	TxA	A
3	Common	Common	Common
4	NC	NC	NC
5	NC	NC	NC
6	Common	Common	Common
7	TxB	RxB	NC
8	TxA	RxA	NC

Figure 2.3.1c RJ45 pinout (EIA485)

Note: The screen of the cable is connected to earth via the RJ45 connectors. Best RFI performance is achieved if the screen is also earthed at its other end

WARNING

If the screen is earthed at both ends, it must be ensured that the earth potentials at the ends of the cable are equal. If such is not the case, very large currents can flow through the screen, causing the cable to become hot enough to harm personnel who come into contact with it, and/or to cause fire.

USB CONNECTOR

A single Type-A USB connector, for redundant USB2.0 host communications, is located on the IOC terminal unit between the supply power connector and the battery/watchdog connector (figure 2.3.1a).

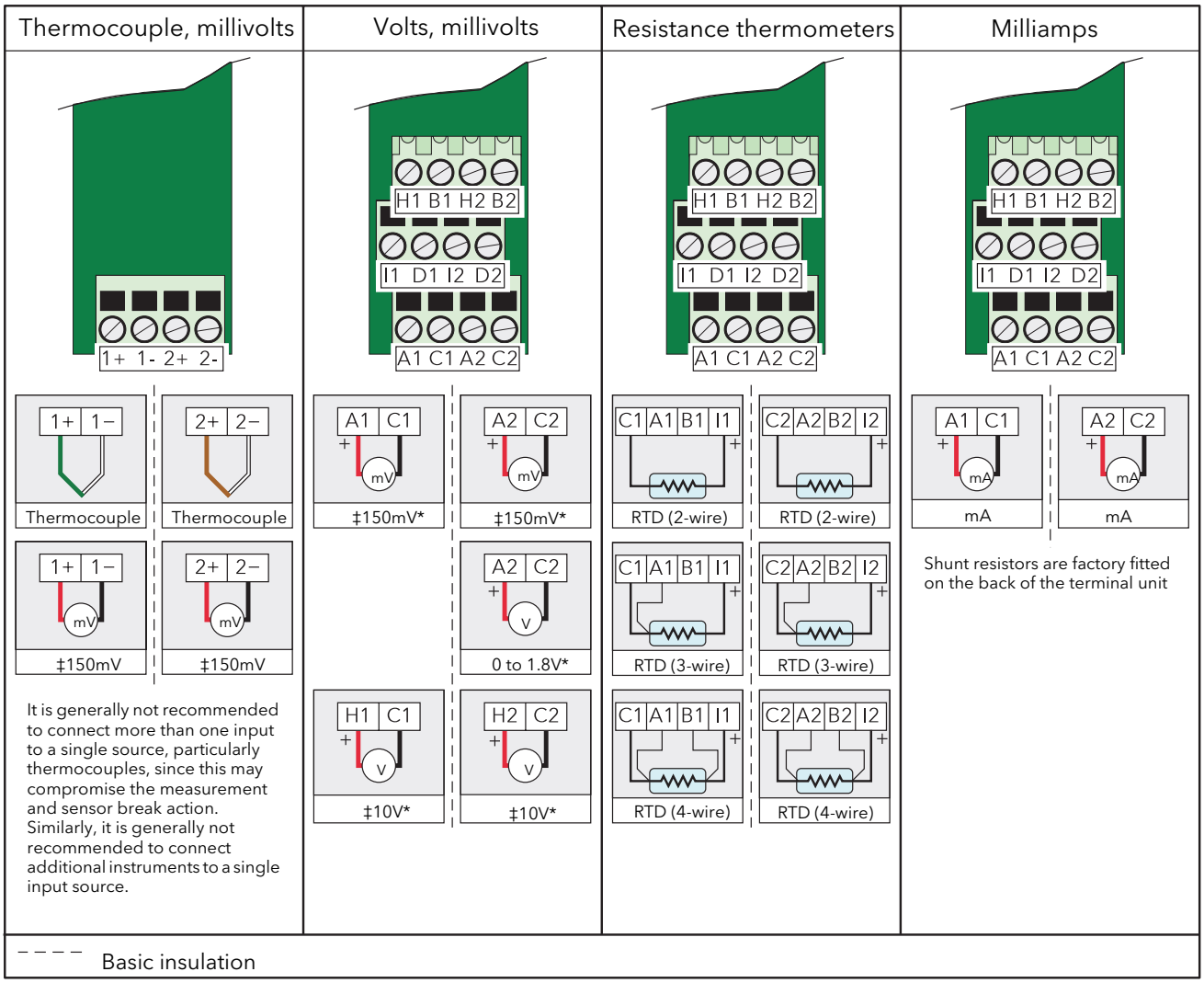
The connector is intended for use with USB memory sticks, and can supply up to 500mA. Attempts to draw more than 500mA causes the current limiting circuitry to shut the USB power down until the fault is removed.

The IOC module contains a USB fuse which prevents the entire supply power system from being affected in the unlikely event of a catastrophic failure in the USB electronics. The fuse is not user replaceable, so if it fails, the relevant IOC Primary must be returned to the supplier for service.

Note: If a USB extension cable is used to expose the USB port remotely, the maximum length of this cable must not exceed 1.5m when the T2750 is configured with a redundant pair of IOCs.

2.3.2 Two-channel analogue input (AI2)

This module can be ordered as one of a number of variants to measure thermocouple inputs, resistance thermometer inputs, Volts/mV or mA. Figure 2.3.2a gives pinout details



* When an input is configured as Volts or millivolts, the input circuit / terminal connections are selected based on the configured range parameters HR_in and LR_in as shown in the table.

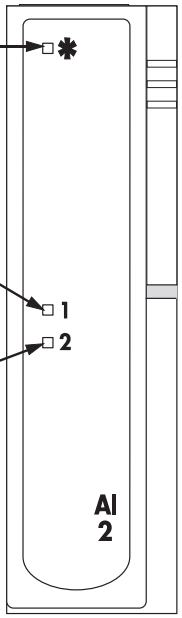
Figure 2.3.2a AI2 module pinout

STATUS INDICATORS

On green	Normal operation
Off	No power, No communications Incorrect module type

Off	Normal operation
On red	Ch1 sensor break Ch1 initialising
Flashing red/off	Ch1 CJC fail Ch1 bad cal data
Blinking red/off	Ch1 Calibrating

As above but for channel 2



Note:
Flashing = 0.5 secs on, 0.5 secs off
Blinking = 0.2 secs on, 1.8 secs off

Figure 2.3.2b AI2 Status indicators

2.3.3 Three-channel analogue input (AI3)

This module provides three isolated mA input channels. An isolated 24V (nom) supply is available across the 'P' and 'C' terminals for powering the current loop. If the current loop is self powered, the 'C' and 'I' terminals should be used. Figure 2.3.3a shows the pinout.

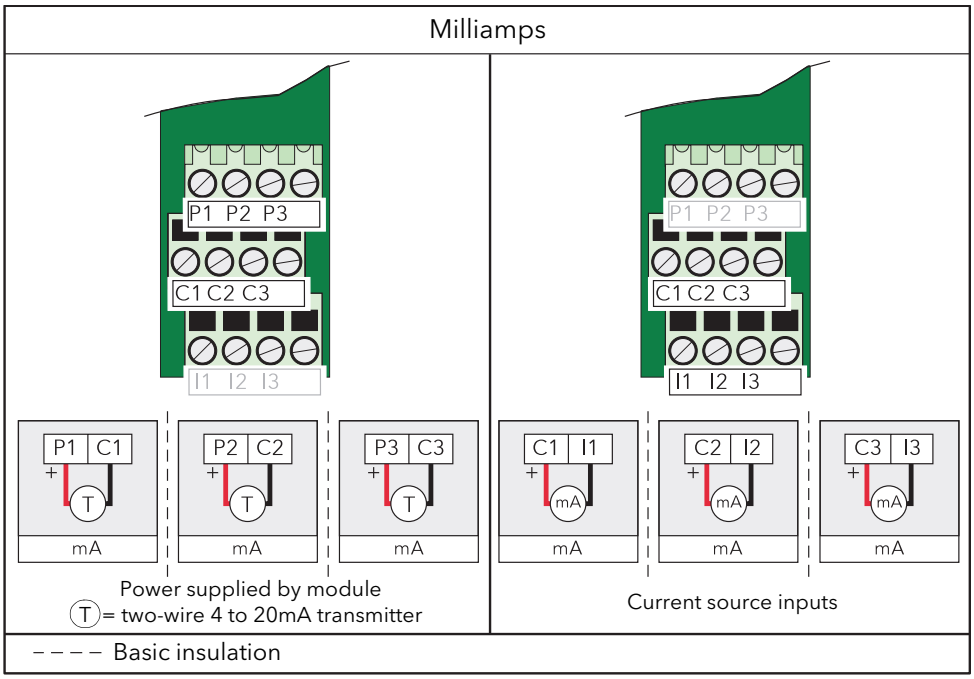
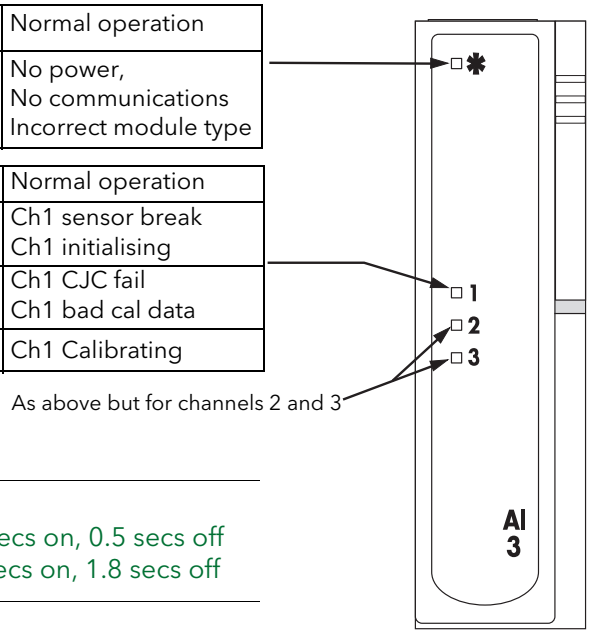


Figure 2.3.3a AI3 module pinout

STATUS INDICATORS

On green	Normal operation
Off	No power, No communications Incorrect module type

Off	Normal operation
On red	Ch1 sensor break Ch1 initialising
Flashing red/off	Ch1 CJC fail Ch1 bad cal data
Blinking red/off	Ch1 Calibrating



Note:
Flashing = 0.5 secs on, 0.5 secs off
Blinking = 0.2 secs on, 1.8 secs off

Figure 2.3.3b AI3 Status indicators

Note: 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.

2.3.3 THREE CHANNEL ANALOGUE INPUT MODULE (Cont.)

HART COMPATIBILITY

For each channel a 220 Ohm resistor is fitted in the input circuitry to the amplifier. Normally, these resistors are by-passed by printed circuit links on the underside of the terminal unit. In order to make the module Hart compatible, these links can be cut, placing the resistors in series with the amplifier input.

Figure 2.3.3c shows the module equivalent circuit, and figure 2.3.3d shows the location of the links on the underside of the terminal unit.

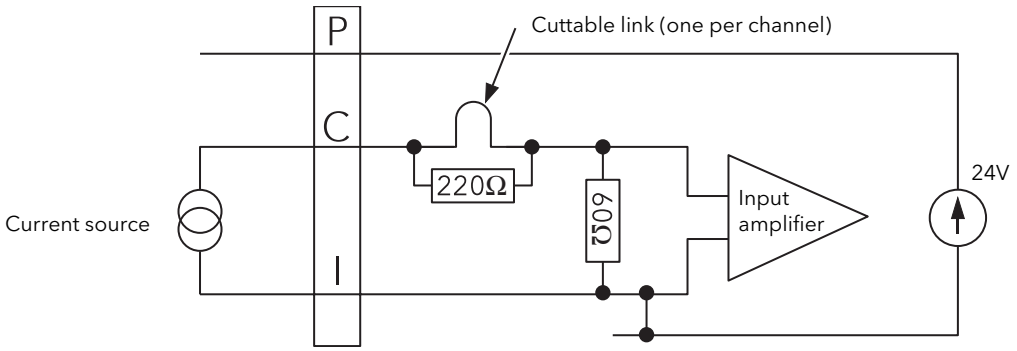


Figure 2.3.3c AI3 module equivalent circuit

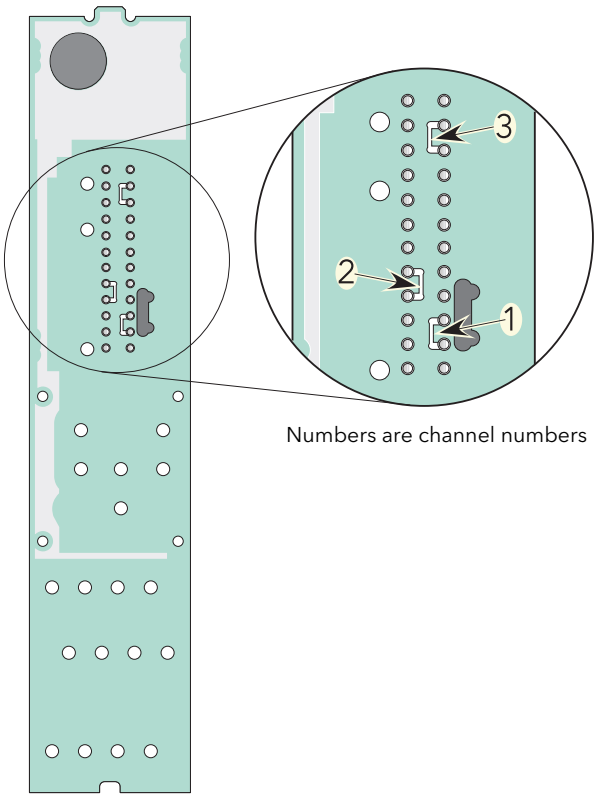


Figure 2.3.3d Link locations on underside of terminal unit

2.3.4 Four-channel analogue input (AI4)

This module can be ordered as one of a number of variants to measure thermocouple inputs, Volts/mV or mA. Figure 2.3.4a gives pinout details.

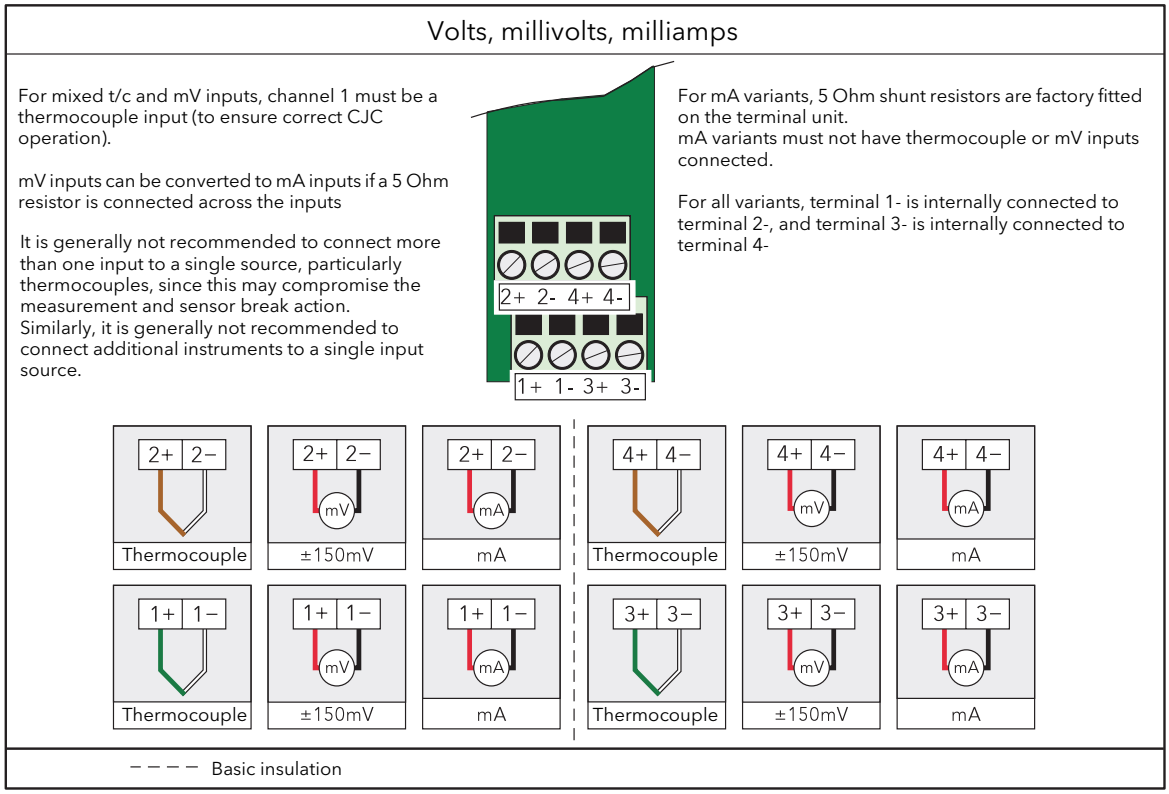


Figure 2.3.4a AI4 module pinout

STATUS INDICATORS

On green	Normal operation
Off	No power, No communications Incorrect module type

Off	Normal operation
On red	Ch1/2 sensor break Ch1/2 initialising
Flashing red/off	Ch1/2 CJC fail Ch1/2 bad cal data
Blinking red/off	Ch1/2 Calibrating

As above but for channels 3/4

Note:
Flashing = 0.5 secs on, 0.5 secs off
Blinking = 0.2 secs on, 1.8 secs off

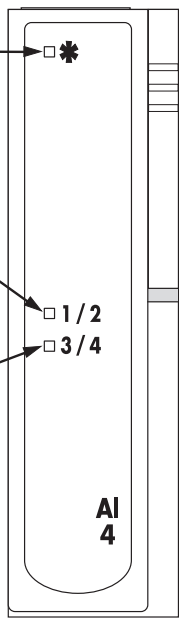


Figure 2.3.4b AI4 status indicators

2.3.5 High density analogue input (AI8)

This module can be ordered as one of four variants (each of which has a different terminal unit):

- **AI8-RT** – four channels of isolated platinum resistance thermometer (RTD) inputs, standard polling rate. See figure 2.3.5a for terminal pin-out details.

For the following three variants, the channels are isolated in pairs.

- **AI8-MA** or **AI8-FMA** – eight isolated channels of current (mA) inputs, standard polling rate and fast polling rate, respectively. See figure 2.3.5b for terminal pin-out details.
- **AI8-TC** – eight channels of thermocouple inputs (with cold junction compensation) or voltage (mV) inputs, standard polling rate. See figure 2.3.5b for terminal pin-out details.

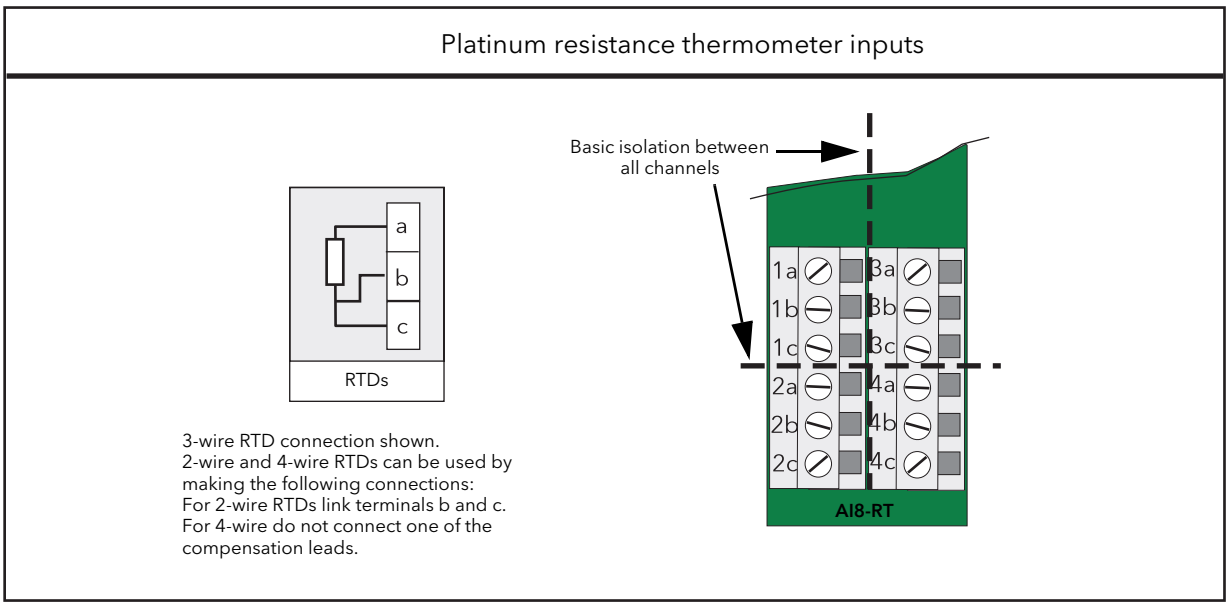


Figure 2.3.5a AI8-RT terminal unit

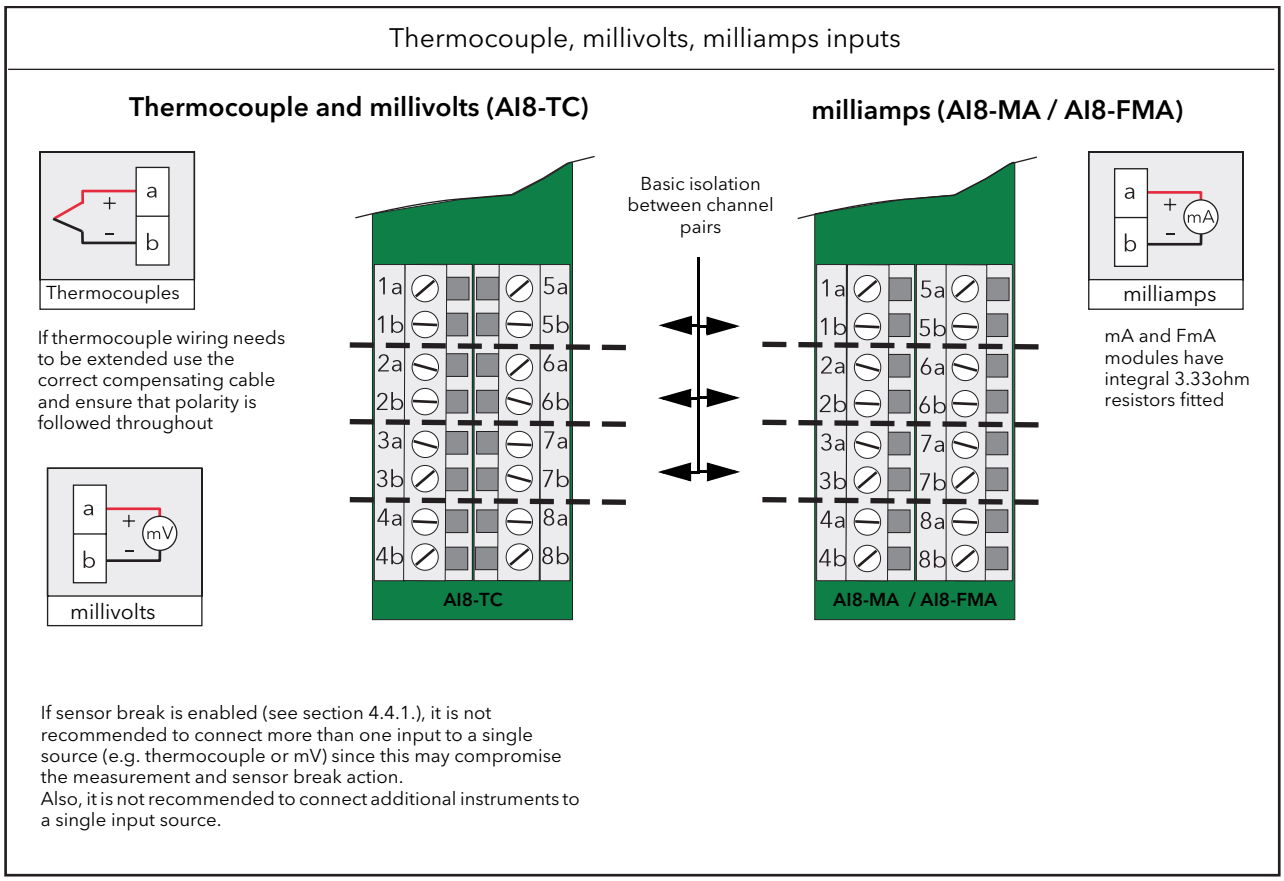


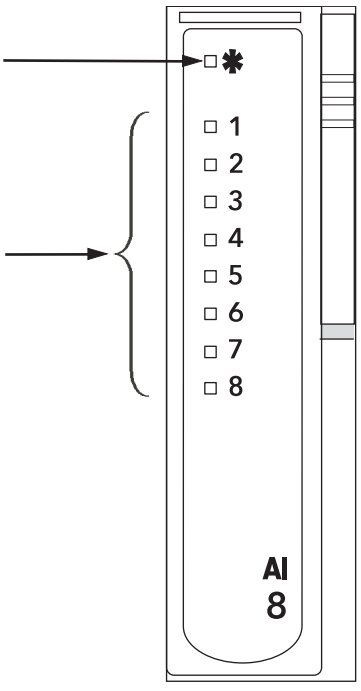
Figure 2.3.5b Module pinout for thermocouple, mV and mA inputs

STATUS INDICATORS

As shown in the Figure 2.3.5d below, the AI8 module's status is shown by a single green LED, whilst the status of each individual channel is shown by a red LED.

Off	No power unexpected module
On green	normal operation - module being polled
Flashing green	error condition

Off	normal operation
On red	error condition. For example, sensor break, over/ under hardware range, bad calibration.
Repeated for each channel	
For the RTD version only, LEDs 1 to 4 are used. LEDs 5 to 8 are unused.	



2.3.5 Two-channel analogue output (AO2)

This module provides two isolated output channels which can be configured independently (in software) as voltage or current source outputs. The specified voltage output range (0 to 10V) can be expanded slightly (-0.3V to +10.3V) by limiting the load to a minimum value of 1500 Ohms. Figure 2.3.5a gives the module pinout.

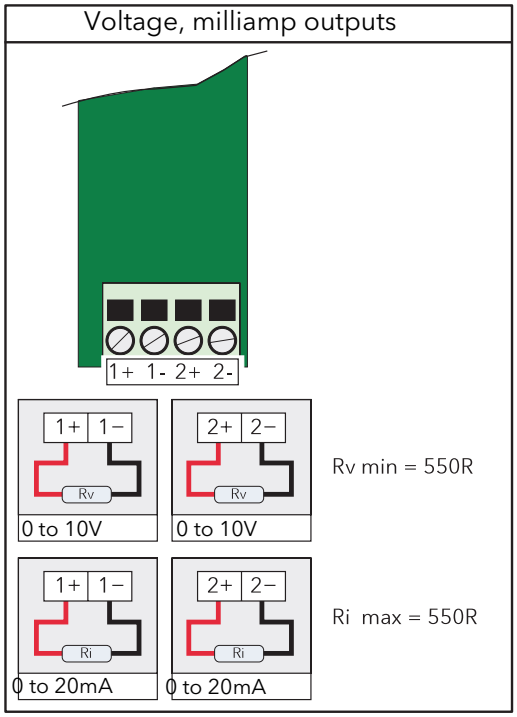


Figure 2.3.5a AO2 module pinout

STATUS INDICATORS

On green	Normal operation
Off	No power, No communications Incorrect module type

Off	Normal operation
On red	Ch1 saturated Ch1 initialising
Flashing red/off	Ch1 bad cal data
Blinking red/off	Ch1 Calibrating

As above but for channel 2

Note:
Flashing = 0.5 secs on, 0.5 secs off
Blinking = 0.2 secs on, 1.8 secs off

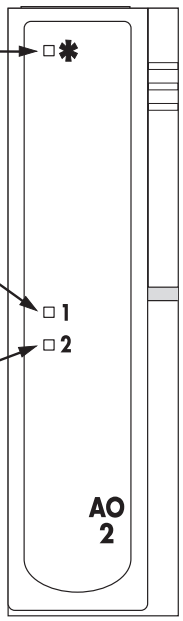


Figure 2.3.5b AO2 module status indicators

2.3.6 Four-channel digital input (DI4)

This module provides four digital inputs which support logic or contact closure inputs. Types cannot be mixed in one module.

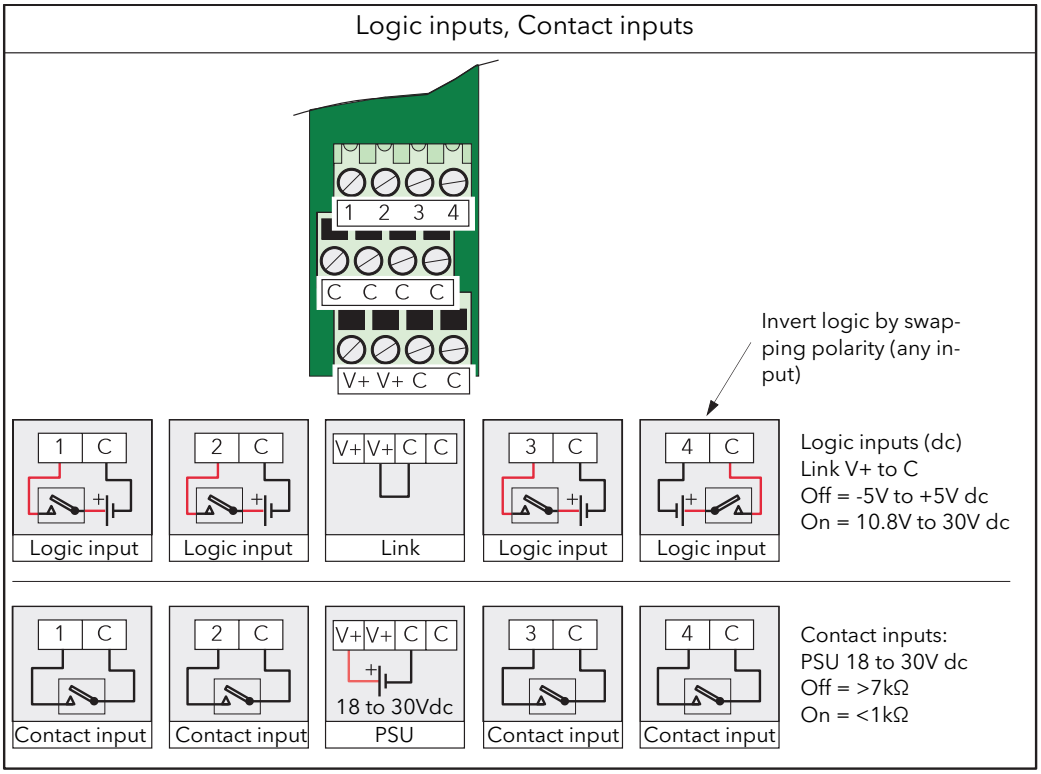


Figure 2.3.6a DI4 module pinout

STATUS INDICATORS

On green	Normal operation
Off	No power, No communications Incorrect module type

Off	Relevant input Off
On yellow	Relevant input On

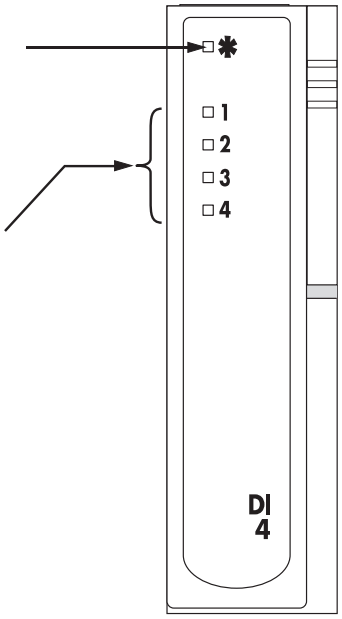


Figure 2.3.6b DI4 module status indicators

2.3.7 Six-channel digital input module (DI6)

This module provides six isolated ac logic input circuits. The module is available in two versions, one suitable for nominal 230V RMS, the other for nominal 115V RMS. It is not possible for the user to change version.

Using the 115V version with 230V inputs causes power consumption higher than specified, which can lead to overheating and eventual failure.

Using the 230V version with 115V inputs may cause intermittent switching as 115V lies outside both the off and the on switching voltage ranges.

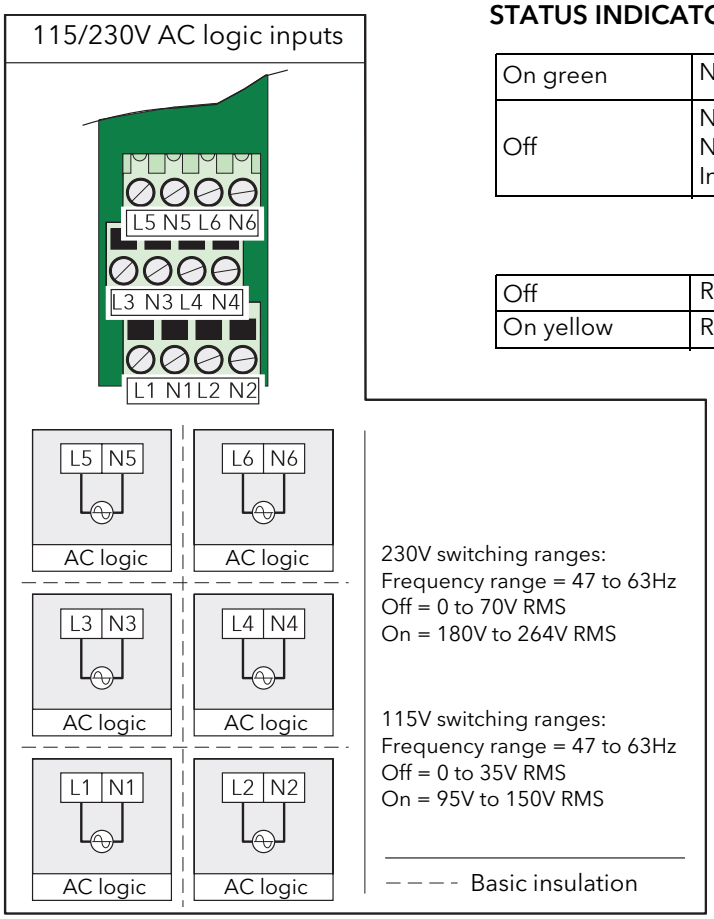


Figure 2.3.7a DI6 module pinout

STATUS INDICATORS

On green	Normal operation
Off	No power, No communications Incorrect module type

Off	Relevant input Off
On yellow	Relevant input On

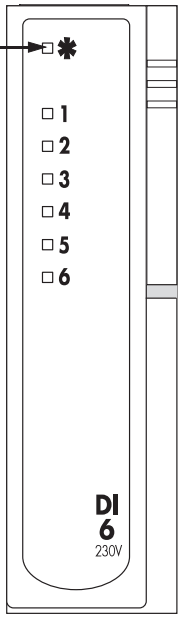


Figure 2.3.7b DI6 module status indicators (230V version shown; 115V version similar)

2.3.8 Eight-channel digital input module (DI8)

This module provides eight digital inputs which support either logic inputs (DI8LG) or contact closure (DI8-CO) inputs as specified at time of order.

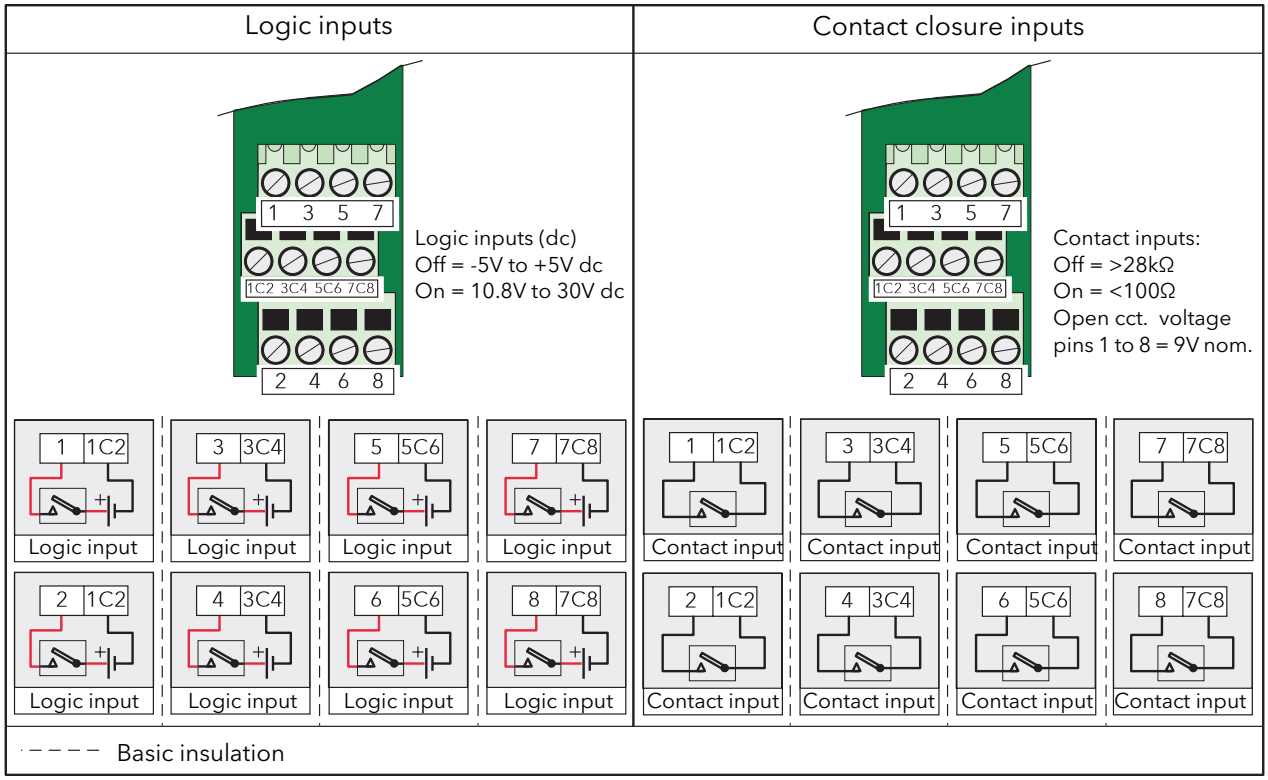


Figure 2.3.8a DI8 module pinout

STATUS INDICATORS

On green	Normal operation
Off	No power, No communications Incorrect module type

Off	Relevant input Off
On yellow	Relevant input On

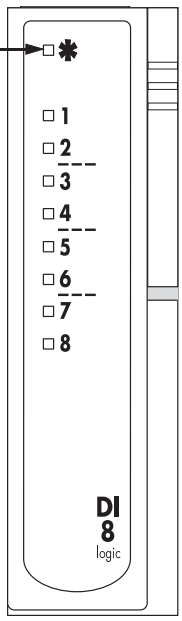


Figure 2.3.8b DI8 module status indicators

2.3.9 16-Channel digital input module (DI16)

This module provides 16 digital inputs which support either logic inputs or contact closure inputs. Both input types may be freely mixed on each DI16 module.

Note: The 'P' terminals are internally connected together and the 'C' terminals are internally connected together.

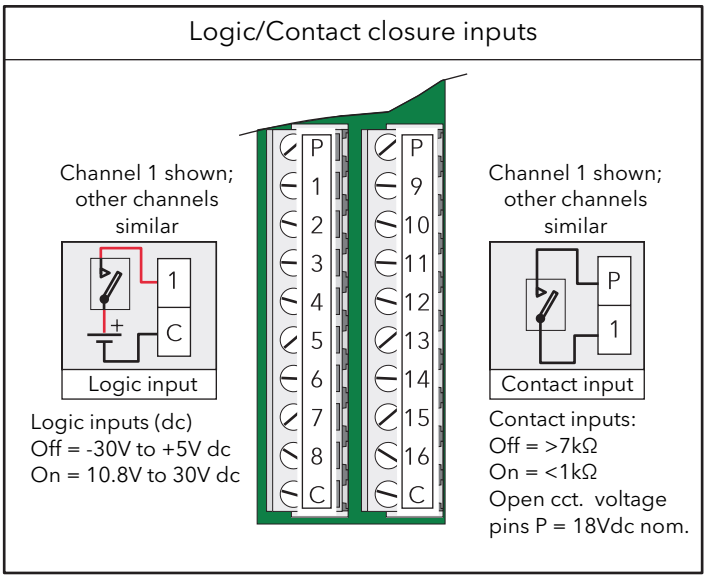


Figure 2.3.9a DI16 module pinout

STATUS INDICATORS

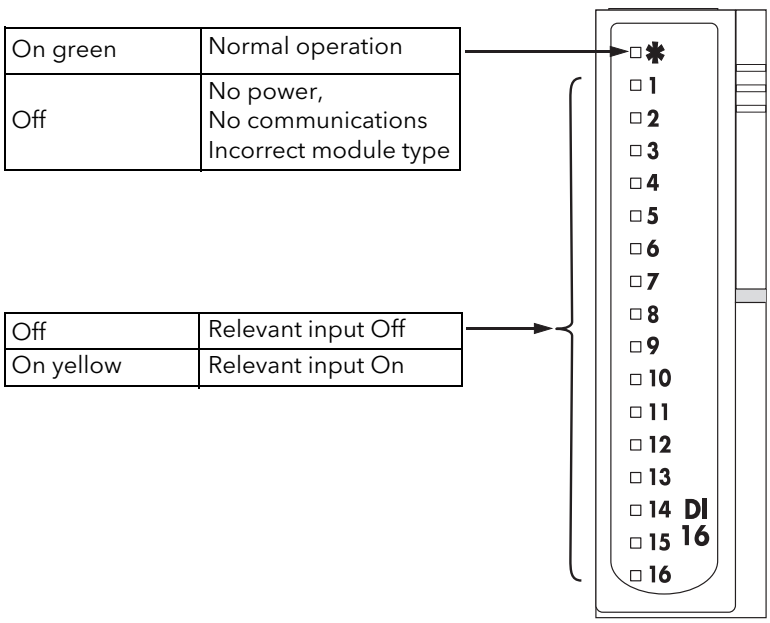


Figure 2.3.9b DI16 module status indicators

2.3.10 Four-channel digital output module (DO4)

This module provides four digital outputs. The module is available in two versions: 'DO4 logic' which can supply up to 8 mA, and $DO4_{24}$ which can supply up to 100 mA.

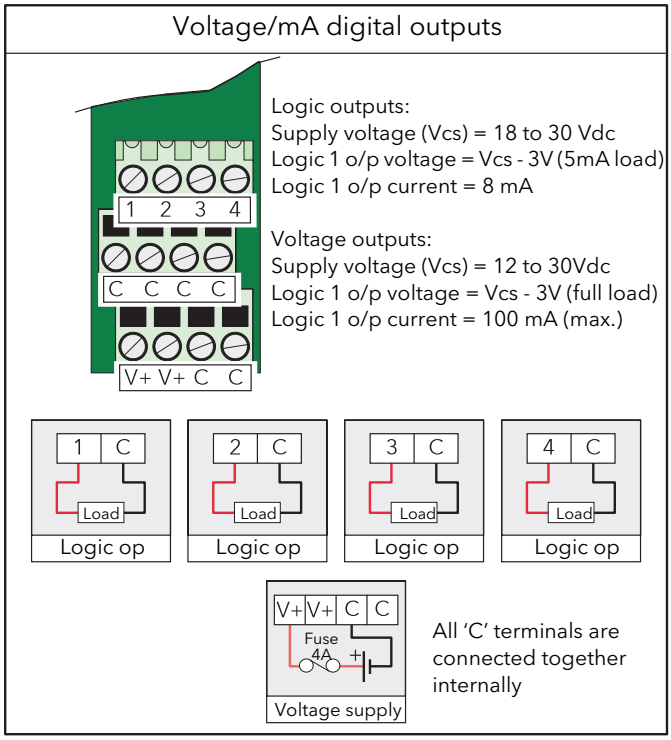


Figure 2.3.10a DO4 module pinout

STATUS INDICATORS

On green	Normal operation
Off	No power, No communications Incorrect module type

Off	Relevant output Off
On yellow	Relevant output On

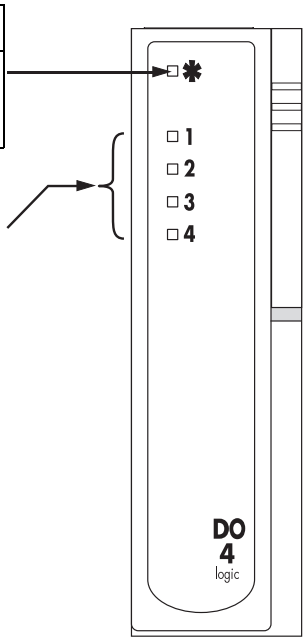


Figure 2.3.10b DO4 module status indicators

2.3.11 Eight-channel digital output module (DO8)

This module provides eight high-current logic drive outputs.

Caution

1. If the module is inserted into a powered base unit, the outputs might turn on fleetingly (up to 100ms). The DO8 module should not be inserted into a powered base unit where such fleeting outputs could be damaging to the process being controlled.
2. The maximum cumulative current for all eight channels must not exceed 4A.

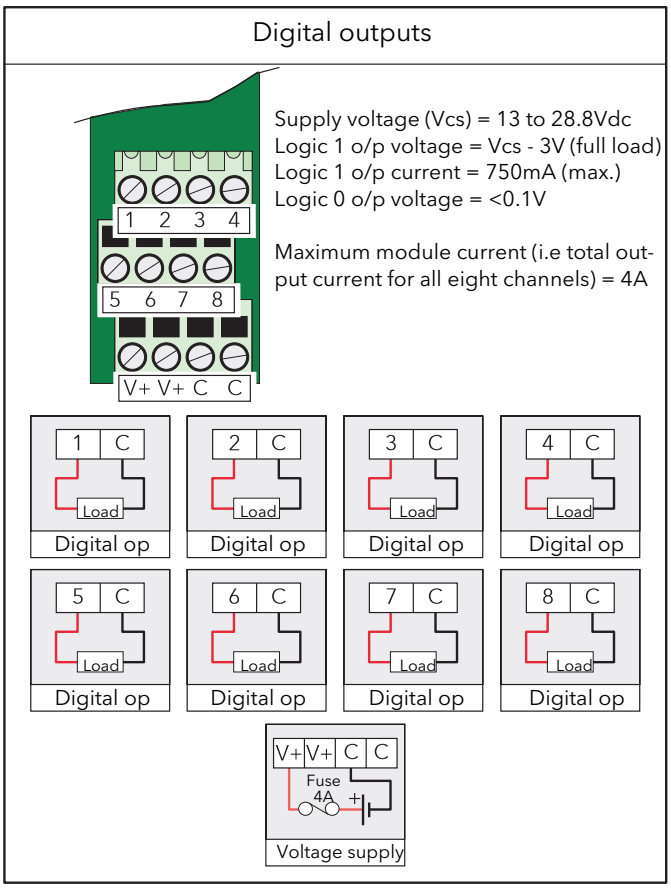


Figure 2.3.11a DO8 module pinout

2.3.11 EIGHT-CHANNEL DIGITAL OUTPUT MODULE (DO8) (Cont.)

STATUS INDICATORS

On green	Normal operation
Off	No power, No communications Incorrect module type

Off	Relevant output Off
On yellow	Relevant output On

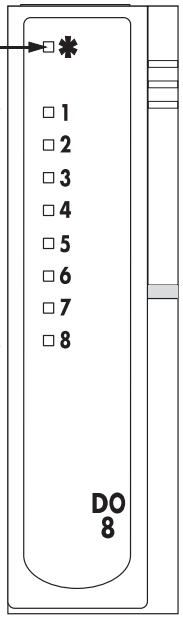


Figure 2.3.11b DO8 module status indicators

2.3.12 16-Channel digital output module (DO16)

Caution

If the module is inserted into a powered base unit, the outputs might turn on fleetingly (up to 8ms). The module should not be inserted into a powered base unit where such fleeting outputs could be damaging to the process being controlled, unless the wiring has first been disconnected.

Note: Any 'plant-side' power supply connected to a DO16 module must be capable of supplying an inrush current of 30A for 100µs.

This module provides 16 digital outputs of up to 700mA each. Two sets of power supply inputs are included, with the 'C' terminals being internally connected. (The 'P' terminals are not internally connected.)

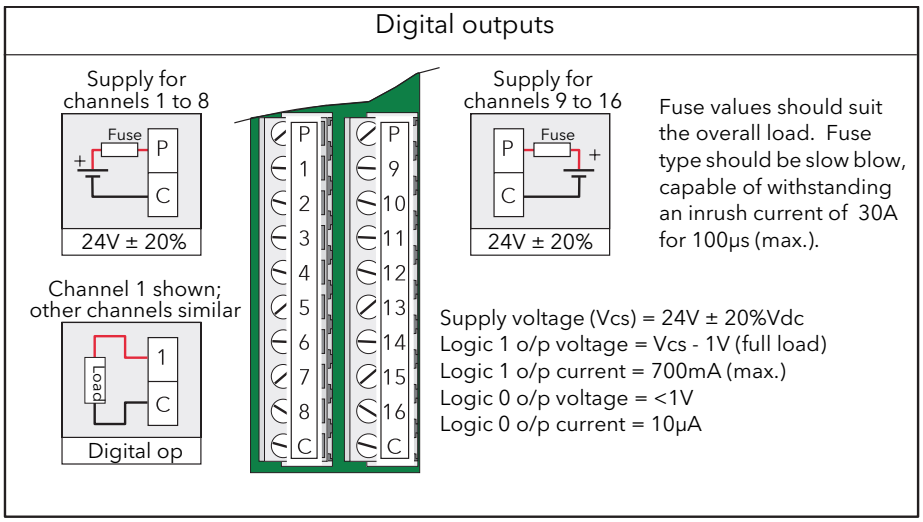


Figure 2.3.12a DO16 module pinout

STATUS INDICATORS

On green	Normal operation
Off	No power, No communications Incorrect module type

Off	Relevant output Off
On yellow	Relevant output On

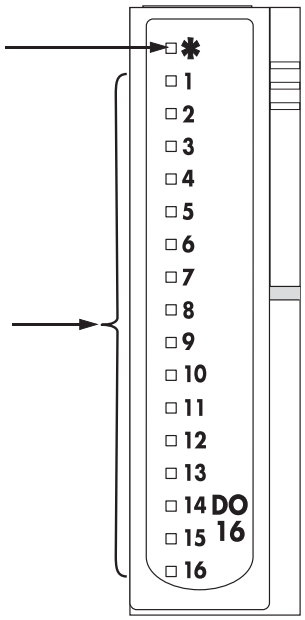


Figure 2.3.12b DO16 module status indicators

2.3.13 Two-channel frequency input module (FI2)

This module provides two isolated input channels used with a number of common plant sensors.

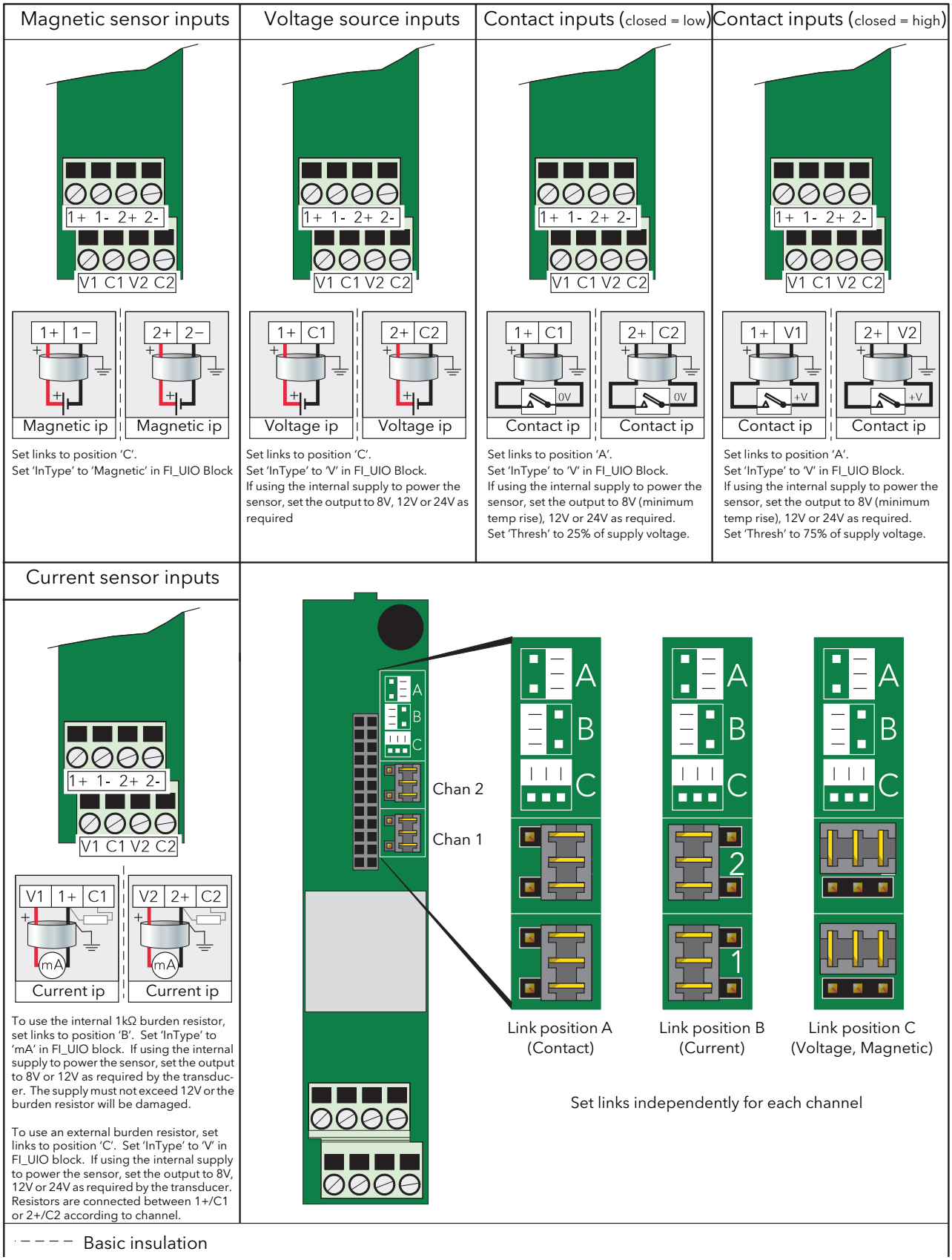


Figure 2.3.13a FI2 module pinout (see also Figure 2.3.13c and associated cautionary note, below)

2.3.13 TWO-CHANNEL FREQUENCY MODULE (FI2) (Cont.)

Note: 'InType', 'Burden', 'Thresh' are parameters associated with the LINtools FI_UIO function block. The PSU value is also set in LINtools, using the 'PSU' parameter, and this sets, for each channel independently, the voltage appearing across terminal pairs V1/C1 and V2/C2.

STATUS INDICATORS

On green	Normal operation
Off	No power, No communications Incorrect module type

Off	No activity Channel 1
Flashing yellow	Activity Channel 1

Off	Ch 1 Normal operation or frequency under range
On red	Ch 1 hardware fault (Status.HwFlt) Ch1 invalid software config. (Status: BadSetup) Ch1 invalid hardware config. (Status: BadHWSet)
Flashing red	Ch 1 sensor break or short circuit
Fast flashing red	Ch 1 frequency over range

Note:
Flashing = 500ms on, 500ms off
Fast flashing = 100ms on, 100ms off

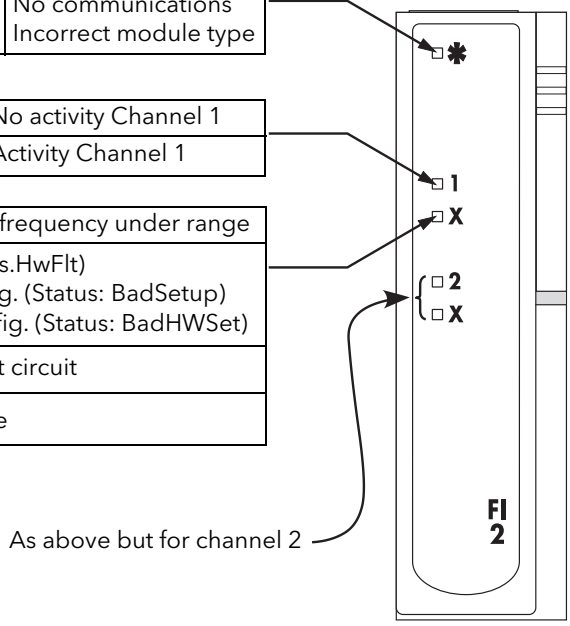


Figure 2.3.13b FI2 status indicators

Caution

If more than eight FI2 modules are fitted, and if these have an average output channel load of more than 5mA each, then an external power supply must be used to power the transducer (figure 2.3.13c). Otherwise, if the internal supply is used, damage will be caused to the base unit backplane tracking.

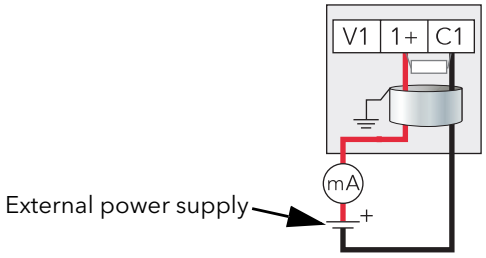


Figure 2.3.13c External power supply wiring example

For more details of the Frequency input, see section C1

2.3.14 Four output relay module (RLY4)

This module provides four relay outputs, one with changeover (common, normally open, normally closed) contacts, the remainder with common/normally open contacts.

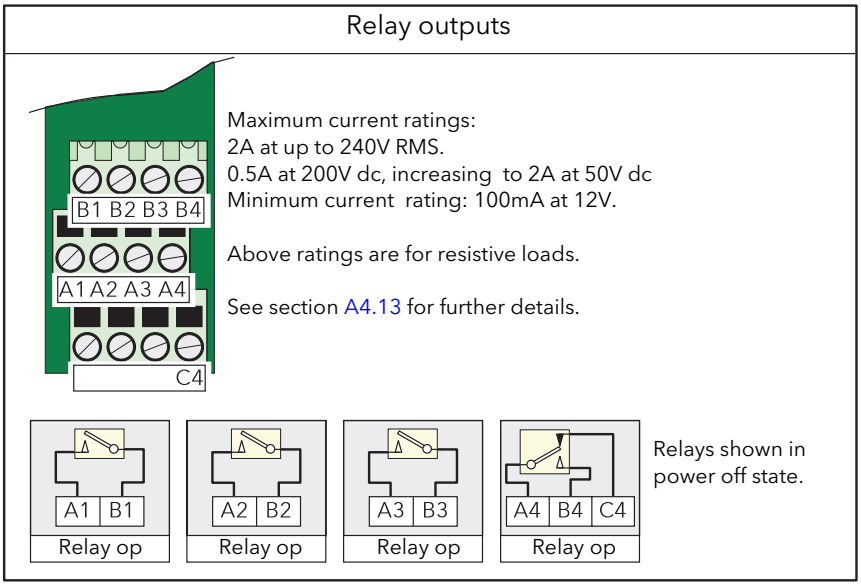


Figure 2.3.14a RLY4 module pinout

STATUS INDICATORS

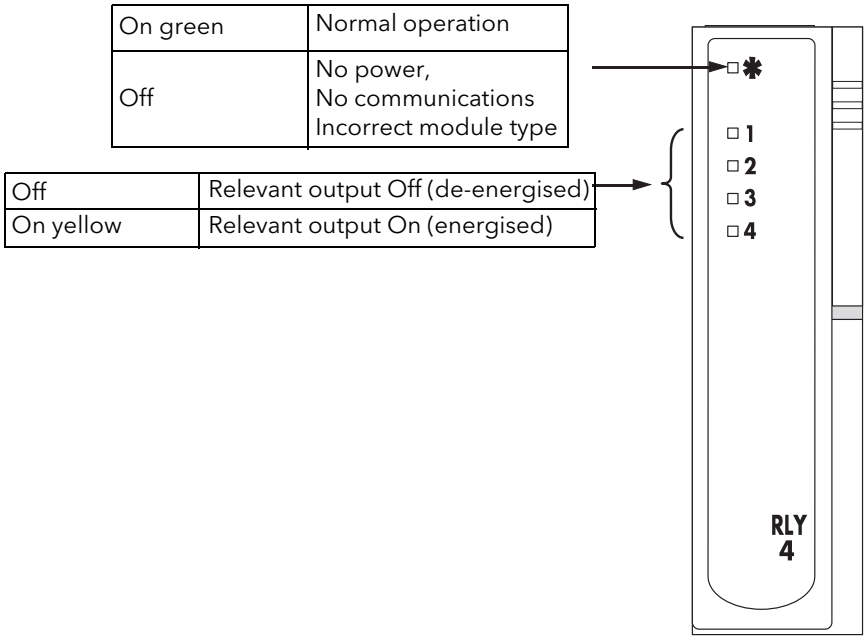


Figure 2.3.14b RLY4 status indicators

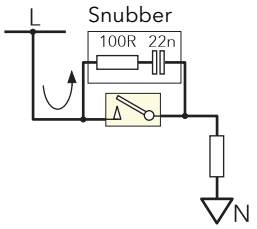
2.3.14 FOUR OUTPUT RELAY MODULE (RLY4) (Cont.)

SNUBBER CIRCUITS

Each set of relay contacts has an associated snubber circuit (a 22nF capacitor in series with a 100 Ohm resistor) to prolong relay life and to reduce radiated emissions when switching inductive loads (e.g. solenoid coils).

This circuit passes a small current (approximately 1mA at 115V 60Hz; 2mA at 240V 60Hz) which can be sufficient to cause problems when switching high impedance loads off.

In order to obviate such problems, the resistor can be removed, rendering the snubber open circuit.



Caution

Taking this action may shorten the life of the module, and may cause the system to fail to meet CE requirements for radiated emissions.

SNUBBER CIRCUIT REMOVAL

Note: Suitable precautions against damage due to static electrical discharge should be taken before the board is removed from the module.

1. Remove the module from its terminal unit.
2. With the module locking lever in the unlocked position*, use a small screwdriver, inserted at points 'A' (figure 2.3.14d), to lever the card retaining strip gently out of the module case. Attempting this with the lever in the locked position may result in damage being caused to the module case.
3. Lift the board latch 'B' and pull gentlyon the lug 'C' to remove the circuit board from the module moulding.

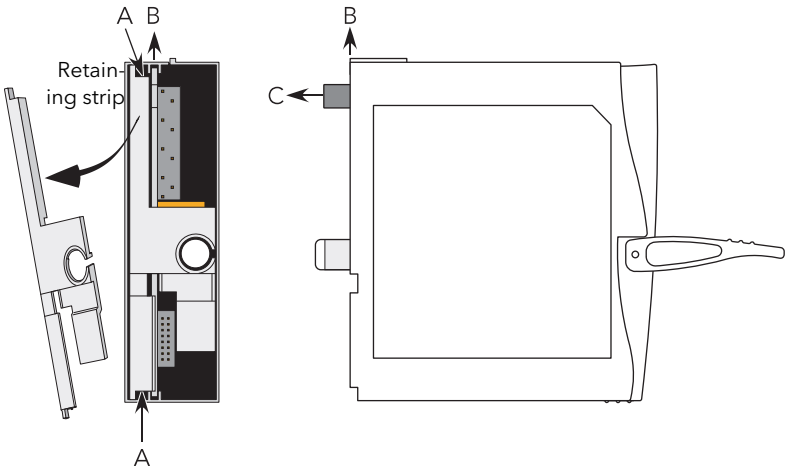


Figure 2.3.14d Removal of the relay board from the module

4. Once the board has been removed, and placed in a suitable static safe area, the relevant resistor leads can be cut, using a suitable pair of side cutters or similar. Figure 2.3.14e shows the locations of the relevant resistors numbered according to their associated relay. The snubber circuits are also identified on the circuit board.
5. When all the appropriate resistors have been removed, the board can be returned to the moulding, ensuring that it engages with the board guides. The retaining strip should then be refitted (module locking lever unlocked) and the module returned to its terminal unit.
6. Ensure that the module label is marked appropriately.

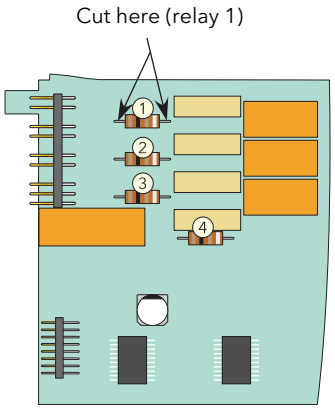


Figure 2.3.14e
Snubber resistor locations

2.3.15 Eight output relay module (RLY8)

This module provides eight relay outputs with common/normally open contacts. No snubber circuitry is built into this module so it is the responsibility of the user to incorporate such circuit elements as are necessary to protect the relay contacts from undue wear, and to maintain CE compliance for the system.

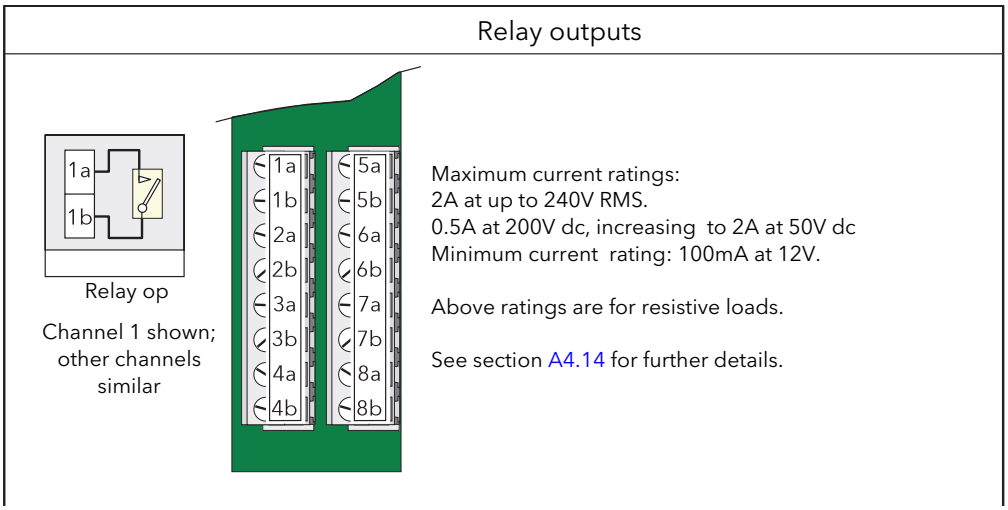


Figure 2.3.15 RLY8 module pinout

STATUS INDICATORS

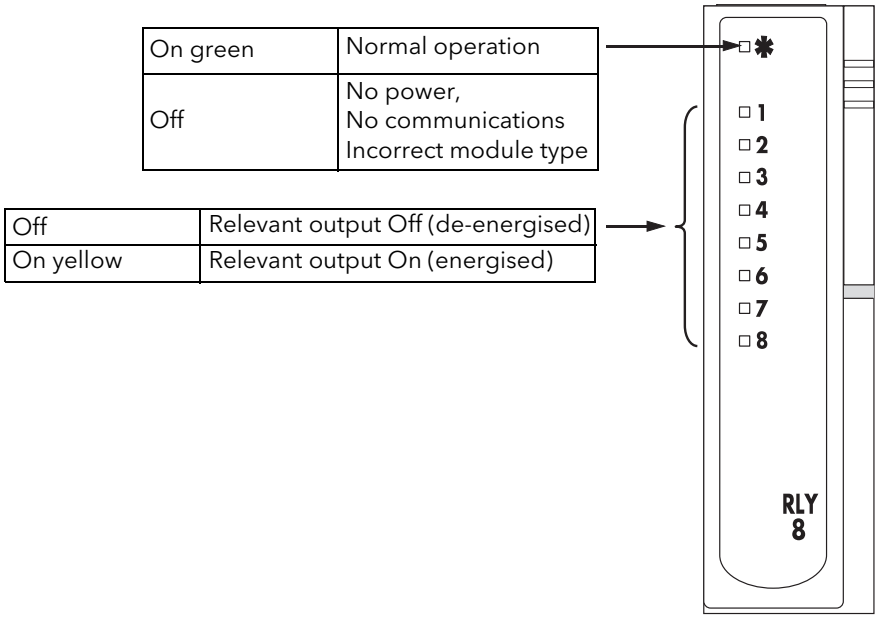


Figure 2.3.15b RLY8 status indicators

2.3.16 Zirconia input module (ZI)

This module consists of two input channels isolated both from each other and from the system electronics, used to measure the zirconia probe temperature (thermocouple input to channel one) and the zirconia probe output signal (channel two). The cold junction compensation for the thermocouple input is provided by a resistance temperature detector (RTD) mounted on the terminal unit.

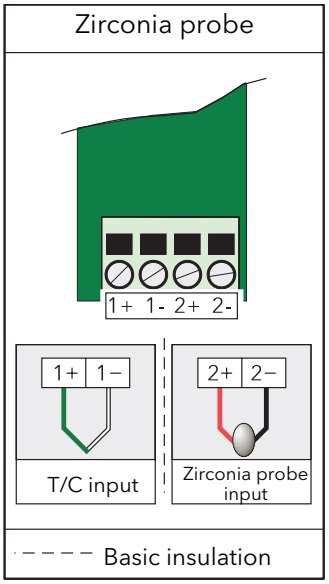


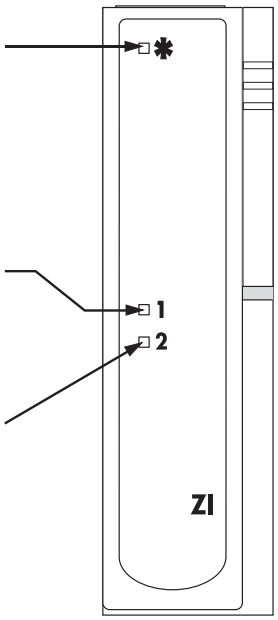
Figure 2.3.16a ZI Module pinout

STATUS INDICATORS

On green	Normal operation
Off	No power, No communications Incorrect module type

Off	Ch 1 Normal operation
On red	Ch1 sensor break, or initialising
Flashing red	Ch1 CJC fail or bad cal. data
Blinking Red	Ch1 calibrating

As above but for channel 2



Note:
Flashing = 50 ms on, 50ms off
Blinking = 0.2 secs on, 1.8 secs off

Figure 2.3.16b ZI module status indicators

For further details of the Zirconia probe and its applications, see section C2

2.3.16 netHOST Profibus Master gateway

SUPPLY WIRING

The netHOST voltage and power requirements are sufficiently low that typically the power can be obtained from the T2750's power supply. However, always check that sufficient capacity exists in the T2750's power supply if this option is chosen.

The netHOST supply voltage is 24Vdc.

Typical power requirements for a single netHOST is 130mA (260mA for two).

ETHERNET WIRING

The netHOST communicates with the T2750 using standard 100Mbps Ethernet through either one of the integrated two-port switch RJ45 connectors. Consideration to redundancy on the Ethernet network should be given when designing the system.

A typical configuration for Ethernet is shown in figure 2.3.16a below. To implement this setup, a total of four network feeds would be required – one for each of the netHOSTs, and one for each IOC card on the T2750.

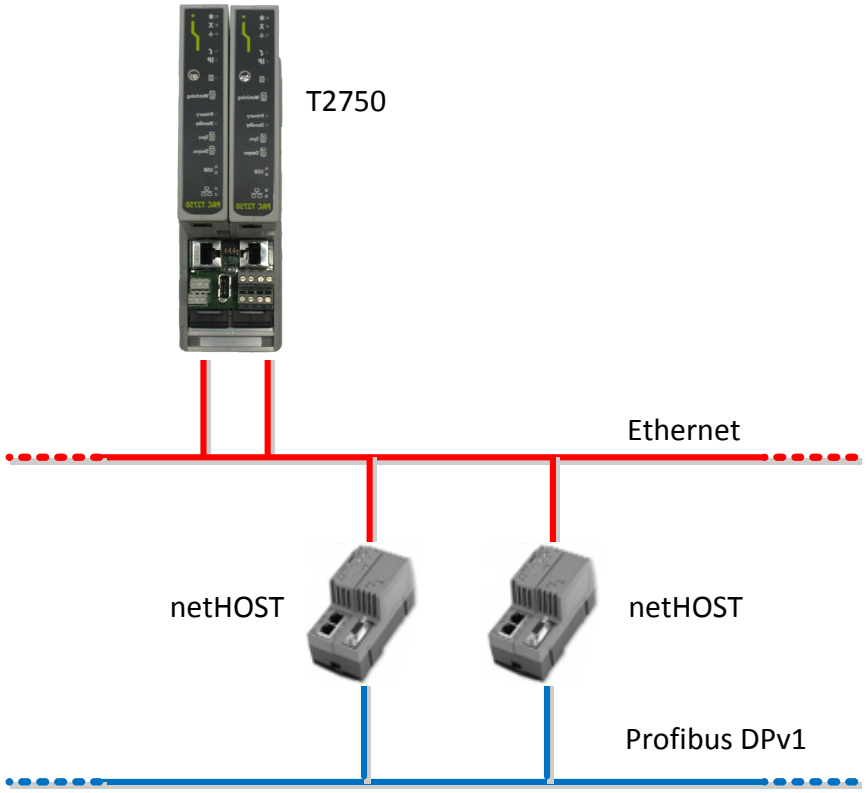


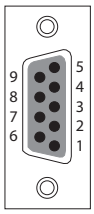
Figure 2.3.16a Typical netHOST Ethernet wiring

If the number of Ethernet feeds is severely limited, the netHOST's integral switch can be used to distribute a single feed to the netHOST and a single T2750 IOC.

Note: Using the netHost's built-in 2-port switch to distribute an incoming Ethernet feed introduces a single-point-of-failure and is therefore not recommended practice.

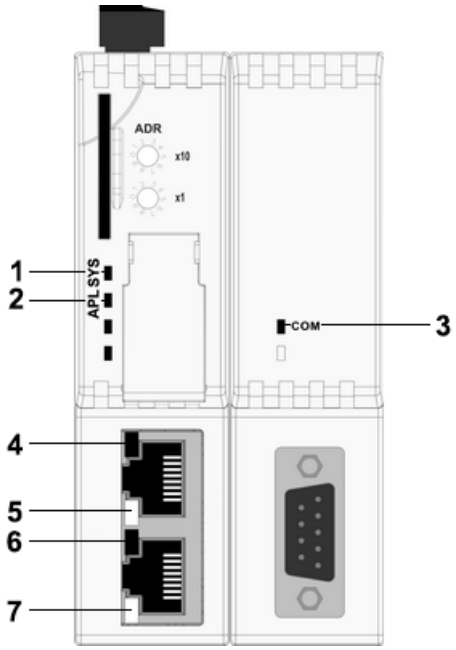
PROFIBUS WIRING

The netHOST's Profibus port is a single 9-way female D-connector. The pin out details for this connector is shown in the following table.

Profibus 9-way D	Pin	Signal	Description
	3	Rx/Tx +	Receive / Transmit data positive
	4	CNTR-P	Control signal (direction control)
	5	ISO GND	Data ground
	6	VP	Powers supply +5V for terminating resistor. Max current 100mA.
	8	Rx/Tx -	Receive / Transmit data negative
	Shield	PE	Metal shell on PE

STATUS INDICATORS

Seven LEDs are situated on the front of a netHOST to show the current status, as shown below.



1. SYS LED
2. APL LED
3. COM (Profibus DP Master) LED
4. Ethernet link channel 0 established (green)
5. Ethernet activity at channel 0 (yellow)
6. Ethernet link channel 1 established (green)
7. Ethernet activity at channel 1 (yellow)

Figure 2.3.16c netHOST status LEDs

The meaning of the SYS, APL and COM LEDs are outlined in the following tables.

SYS LED Description

Colour	State	Description
Green	On	netHOST is running in a healthy state
Yellow	On	The netHOST is starting up. This can take one minute or longer. If this LED remains yellow permanently, then a hardware failure is possible.
Yellow	Flashing	Hardware failure
Yellow/Green	Flashing yellow/green	Hardware failure
Off	Off	Power supply for the device is missing or hardware failure

APL LED Description

Colour	State	Description
Green	On	Ethernet configured and Profibus communications running.
Green	Flashing	Ethernet configured, but Profibus not running.
Red	On	Configuration files are missing.
Red	Flashing	Configuration files in error, or not loaded.

Com LED Description

Colour	State	Description
Green	On	Profibus communication established to all slaves.
Green	Flashing irregularly	Configuration error.
Green	Flashing regularly	Profibus is configured, but communications not yet started (this should only be a transient condition as the T2750 starts up).
Red	Flashing	Profibus communication to at least one or more slaves is disconnected.
Red	On	Profibus communications to all slaves is disconnected.

2.4 HARDWARE CONFIGURATION

2.4.1 LIN address

Each LIN instrument must have an address which is unique to the network. This address is configured by means of a DIL switch (SW1) located on the IOC terminal unit.

Setting an address at this switch automatically sets a pair of contiguous addresses where the set address (e.g. 7A) is associated with the primary unit and the next address (7B in this example) is associated with the secondary module. The primary always takes the even address.

Figure 2.4.1 shows the detail.

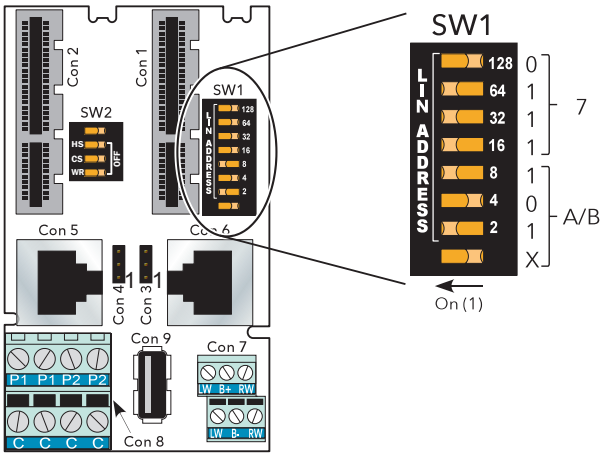


Figure 2.4.1 LIN Address setting

2.4.2 LIN option switch

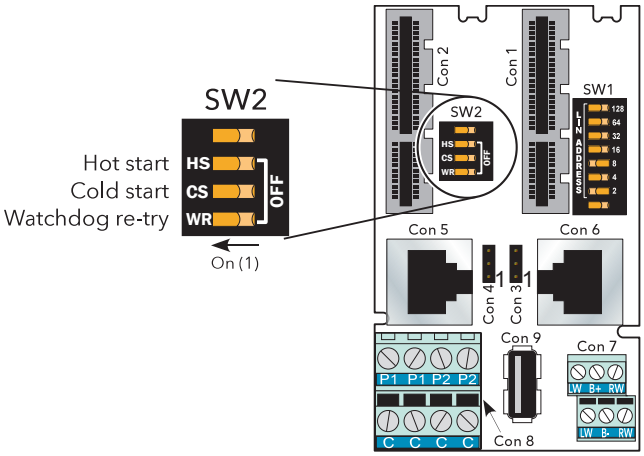


Figure 2.4.2 LIN option switch

A second DIP switch (SW2) on the IOC terminal unit allows the following settings:

START UP STRATEGY

This is set by the Hot Start (HS) and Cold start (CS) elements, as shown in table 2.4.2, below.

HS	CS	
Off	Off	Automatically generate new database at each start-up.
Off	On	Attempt cold start. Halt if unsuccessful.
On	Off	Attempt hot start. Halt if unsuccessful
On	On	Attempt hot start. If unsuccessful attempt cold start. Halt if unsuccessful.

Table 2.4.2 Start up strategy setting switches

2.4.2 LIN OPTION SWITCHES (Cont.)

START UP STRATEGY (cont.)

Cold start	The instrument attempts to start up from a previous database, using default parameter values.
Hot start	The instrument attempts to start from where it stopped running.

WATCHDOG RETRY

Setting this switch element 'On', causes the instrument to try to start again, after a watchdog failure. Setting the switch 'Off' means that the instrument must be restarted manually after any watchdog failure.

2.4.3 IP Address setting

Each instrument must have an IP address set which is unique to the communications network. The address is set using LINtools, and can be fixed, or automatically allocated by the network. Each instrument uses a one-to-one mapping of LIN node number and IP address, as defined in a file called the 'network.unh' file.

It is normally necessary for the user to get advice from his or her IT department, or network administrator before attempting to set IP addresses, as setting duplicate addresses can cause severe communications problems.

MANUAL

The IP Address is explicitly defined in the 'network.unh' file. It is not recommended to edit this file directly. Instead, use LINtools or the Instrument Options Editor to make changes to this file. Refer to "SETTING PROCEDURE" on page 45 for further details.

DHCP

A DHCP server is required that has been configured to respond correctly to IP address requests. This configuration depends on the company network policy.

DHCP is a method whereby the instrument requests an IP Address from a DHCP server. This happens at start-up, but can be repeated during operation. DHCP includes the concept of 'leases' (i.e. the assigned value will 'expire').

Using DHCP extends the processor restart time because it takes some time for the DHCP server to respond.

BOOTP

BootP or Bootstrap Protocol is used by a network computer to obtain an IP Address and other network information such as server address and Default Gateway. Upon startup, the client station sends out a BOOTP request to the BOOTP server, which returns the required information. A BootPtimeout period can be configured. If this period elapses before the IP Address, Subnet mask, and Default Gateway address are obtained, the values are automatically reset to 0.0.0.0.

LINK-LOCAL

Link-Local is used as a fallback to either DHCP or BootP, or can be used on its own as the only IP Address configuration method. Link-Local always assigns an IP Address in the range 169.254.X.Y. This IP Address range is reserved for use by Link-Local and is explicitly defined as private and non-routable.

The Link-Local algorithm ensures that an instrument (IP host) on a network chooses a unique IP Address from the Link-Local range.

To make a direct connection between a PC and the T2750 using Link-Local, the PC's network port must be configured to obtain an IP address automatically using the standard Windows control panel.

2.4.3 IP ADDRESS SETTING (Cont.)

SETTING PROCEDURE

It is assumed that LINtools has been started and a suitable project folder and instrument folder have been created. It is also assumed that communications have been successfully established between the instrument and the host PC. If this is not the case (for example, a brand new instrument with no project or instrument folder defined), refer to the next section, "SETTING PROCEDURE (FIRST USE)" on page 45.

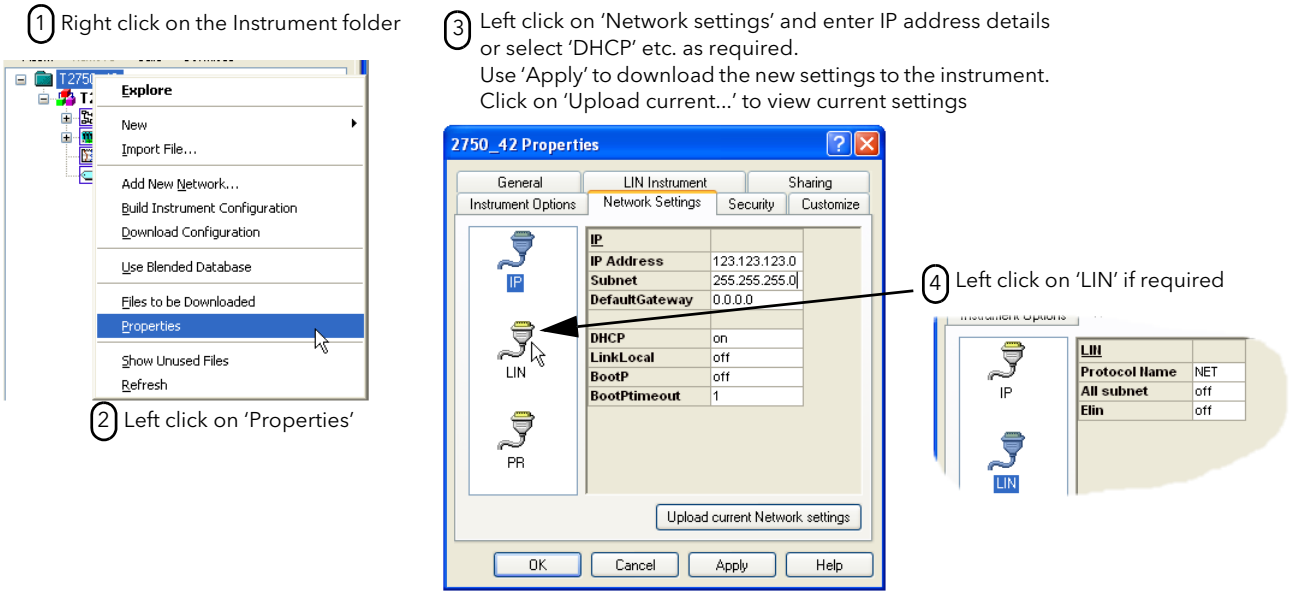


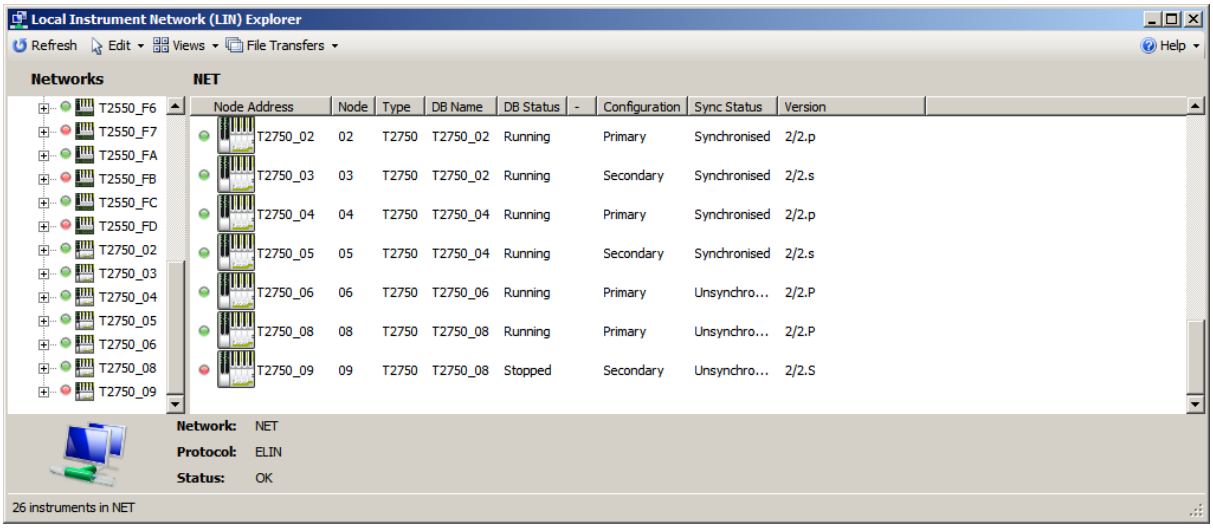
Figure 2.4.3 Access to IP address setting in LINtools

SETTING PROCEDURE (FIRST USE)

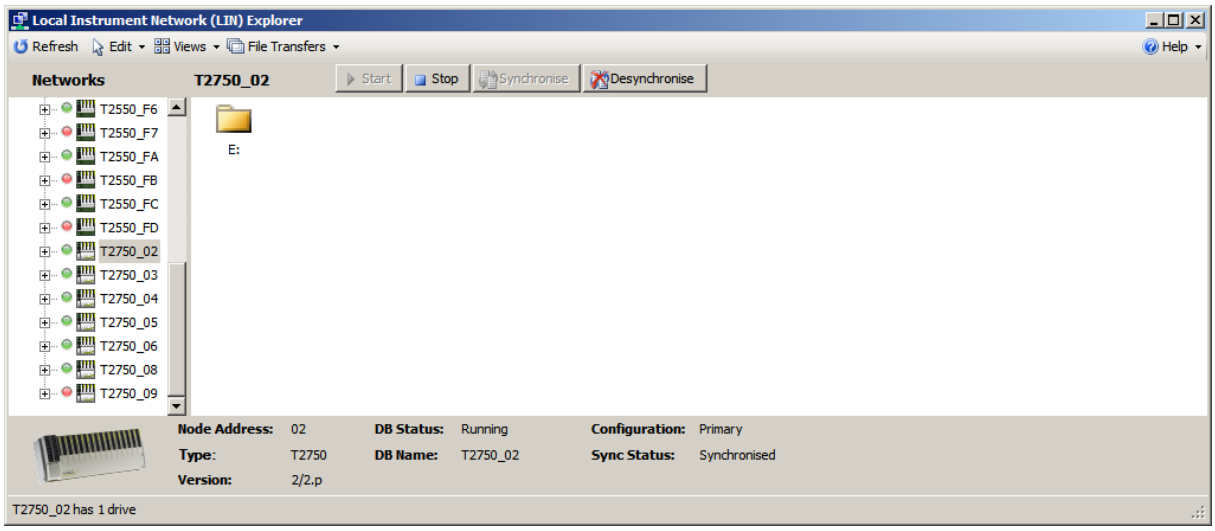
If the T2750 has not been used before and communication has not been established, an alternative method of bringing up the Instrument Options Editor should be followed, as outlined below.

If the T2750 is new, the default network settings (DHCP with Link-Local as a fallback) will be been set at the factory. If DHCP is an acceptable method of initially assigning the instrument with an IP address, then a DHCP server will be required to assign an IP address. Ensure your PC is on the same network that the DHCP server will assign in the instrument. Alternatively, the instrument can be connected directly to the PC and the use of a Link-Local connection can be employed. If using the DHCP and/or Link-Local method of communication, ensure the PC's network port is set to obtain an IP address automatically. Next, follow these steps shown in the next few pages.

1. Launch the LIN Network Explorer tool located in the Start menu. After a short delay, the connected instruments should be displayed. An example is shown in the following figure.

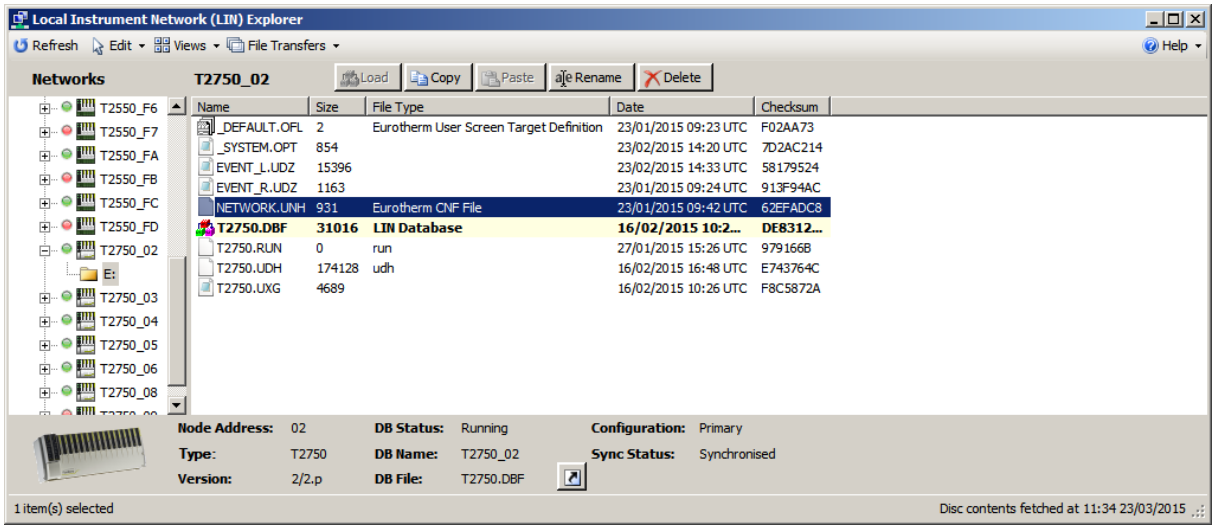


2. Click on the instrument in the left column to be configured to reveal the instrument's E: drive. An example is shown in the following figure.

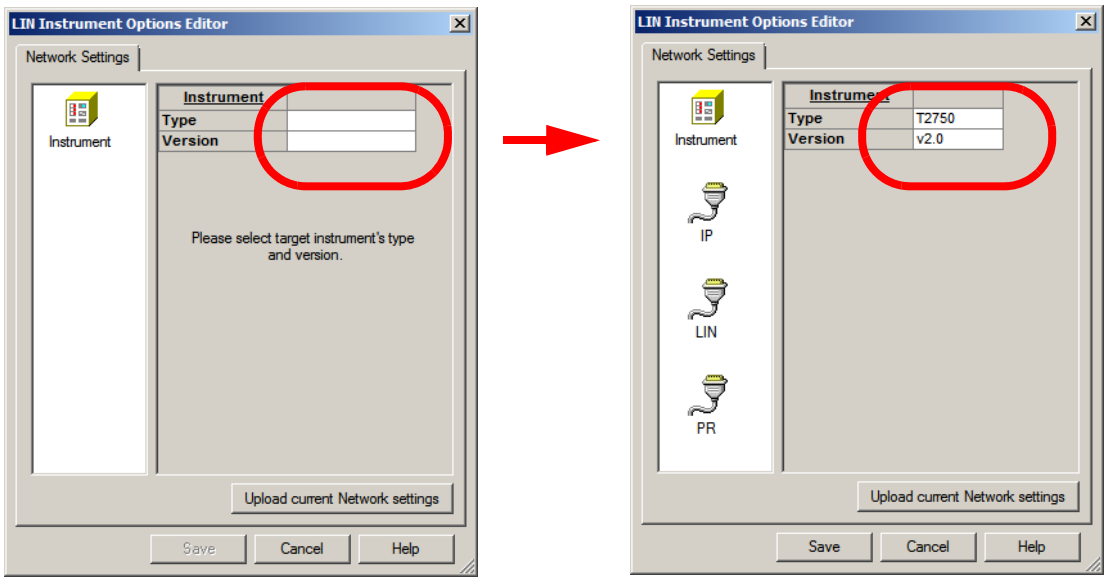


3. Double=click on the E drive folder for the instrument to view the contents of the drive.

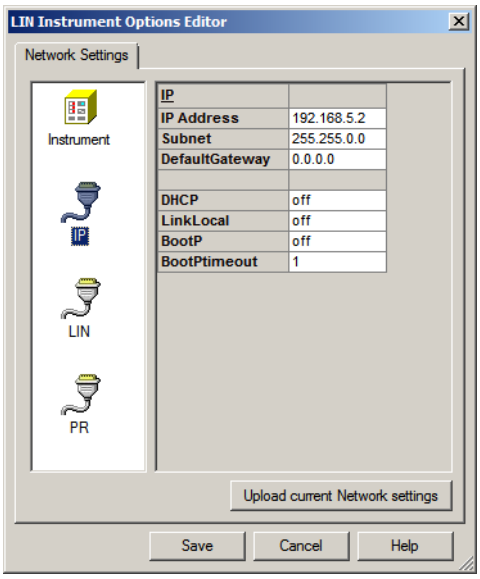
4. Locate the network.unh file and drag the file to your computer desktop (or other memorable location).



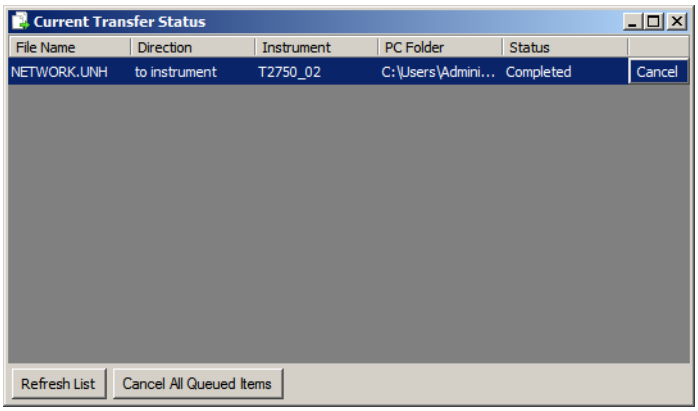
5. Double-click on the network.unh file copied to your computer to launch the Instrument Options Editor. Select the appropriate Instrument Type and Version. An example of this is shown in the following figure.



6. Select the IP tab, and enter the network settings accordingly. An example is shown in the following figure.



7. Select the LIN tab and edit the LIN Protocol name if required.
8. Click the Save button and select No to the offer to download the new settings to the instrument.
9. Drag the network.unh file from your computer to the instrument's E: drive within the Network Explorer tool, overwriting the existing version on the instrument. A Current Transfer Status window displays the status of the file transfer (an example is shown in the following figure).



After the above steps have been completed, power-cycle the T2750 for the changes to take effect. Adjust the PC's network configuration to match the new settings.

RECOVERY FROM AN UNKNOWN IP ADDRESS CONFIGURATION

To recover from an unknown IP address configuration, follow the procedure shown in this section.

The IP Address and Subnet Mask for an instrument can be forced to a known value by setting all of the LIN Address switches (SW1) "on" at the IOC terminal unit. Refer to "2.4.1 LIN address" on page 43 for further details.

This sets the IP address of the left-hand IOC to 192.168.111.222, and of the right-hand IOC (if installed) to 192.168.111.223, with a subnet mask of 255.255.255.0.

A computer with a fixed IP address on this Subnet can now be connected directly to the Ethernet port of the instrument and used to inspect and edit the IP Address of each IOC module using the T2750's terminal interface, which is accessed using Telnet. Any Telnet client will suffice, provided it can support VT-100 emulation. Follow the procedure outlined below.

1. Telnet to the left or the right IOC. A welcome page showing the current configuration is displayed (an example is shown in the following figure).)

```
Eurotherm T2750 3/0      69643 at  330 MHz
(Software Build: Mar 21 2015, 00:12:36)
(Hardware Build: RS485 - 2017Kbyte SRAM fitted at 0xA000000)
Serial Number = 115112
Ethernet (MAC) address = 00:0A:8D:01:C1:A8
IP address = 192.168.1.114
Subnet mask = 255.255.255.0
Default gateway = 0.0.0.0
POST result (0000) = SUCCESS
Hotstart failed because: Coldstart time was exceeded
Last shutdown because: Successful Power Down

T2750 3/0 (C) E8      69643

1 ANSI-CRT
>>>
```

2. Press '1' to bring up the initial menu (an example is shown in the following figure).

```
INIT      Choose option
(Running)


                      >DATABASE - General configuration

                       GATEWAY  - MODBUS configuration
```

3. Press the Enter key to select the database main menu. An example is shown in the following figure.

```
MAIN MENU Select option
(Running)


                        MAKE     - Create block

                        COPY     - Copy block

                        DELETE   - Delete block

                        INSPECT  - Inspect block

                        NETWORK  - Network setup

                       >UTILITIES- Engineering utilities

                        ALARMS   - Current alarms

                        ALARM LOG- Alarm History Log
```

4. Use the cursor keys to scroll down to **UTILITIES** and press Enter to bring up the utilities menu. An example is shown in the following figure.

```
UTILITIES Select option
(Running)

                        START    - Start runtime system
                        STOP     - Stop runtime system
                        SAVE     - Save database
                        LOAD     - Load database
                        FILE     - File page
                        TRY      - Try Changes
                        UNTRY    - Untry Changes
                        APPLY    - Apply Changes
                        UNDO     - Undo Changes
                       >ELIN     - Elin Setup
                        DEBUG    - Debug LIN Node
                        SERVICES - Available services
```

5. Use the cursor keys to scroll down to ELIN and press Enter to bring up the configuration page for IP address. An example is shown in the following figure.

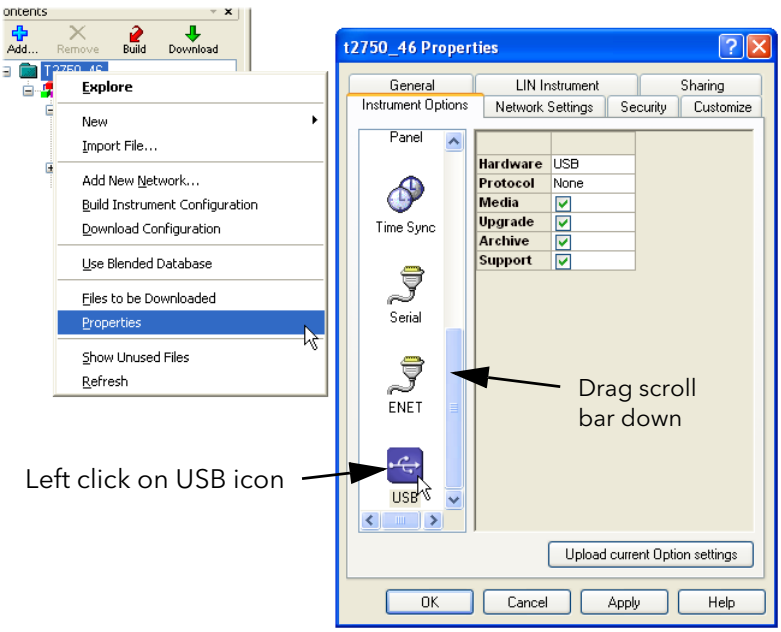
```
Elin Setup (network.unh file)
------------------------------------------------------------------------
----------
                                        |
 LIN PROTOCOL SETUP                     | REMOTE SUBNET NODE LIST
  Protocol Name      NET                |
  All Subnet Enable  OFF                |
  Elin Only Enable   OFF                |
 LOCAL IP SETUP                         |
  Get Address Method Fixed              |
  IP Address         192.168.1.114      |
  Subnet             255.255.255.0      |
  Default Gateway    0.0.0.0            |
 ELIN PARAMETERS                        |
  Unack Timeout          200 msec       |
  Rmt Unack Timeout     1000 msec       |
  No of retries            5            |
  EDB Timeout Used        5   sec       |
  EDB Timeout Unused     20   sec       |
  DBM Timeout TX conf    2000 msec       |
                                        |
                                        | TELNET
                                        |  Login Id
                                        |  Password     ********
                                         Timeout          0       Secs
```

6. Enter the required configuration using the fields provided. When complete, press the ESCAPE key. A pop-up will ask you to confirm the changes. Press **Y** if you want to save the changes, or **N** if not.
7. Once you have confirmed the changes, turn off the T2750. The LIN Node address should then be re-stored at SW1 on the IOC terminal unit. Finally, re-power the T2750 for the IP address changes to take effect.

2.4.4 USB Configuration

The USB memory stick application can be set up as follows:

1. Access the instrument properties page as described in steps 1 and 2 above.
2. Click on 'Instrument Options', and use the scroll bar to locate the USB symbol.
3, Left click on the USB icon to reveal the configuration page and click on the required items.



USB PARAMETERS

Media	If ticked, the USB stick is supported; if not, none of the following items is configurable.
Upgrade	If enabled, then the instrument performs an upgrade if the correct files are found on the memory stick, when inserted. The upgrade takes effect after the next power cycle.
Archive	If enabled, all history files are archived to the memory stick when it is inserted.
Support	A support file is generated and saved to the memory stick when it is inserted. The support file contains .udd and .udz files as a minimum and can be used by the supplier as a diagnostic tool.

2.4.4 netHOST Profibus Master configuration

The optional netHOST gateways provide the T2750 with Profibus master functionality. Where the T2750 runs in a duplex mode, one netHOST is assigned to each processor (left and right). If the T2750 runs only in Simplex mode (a single IOC card), a single netHOST is assigned to the processor.

A netHOSTs identity consists of two parts:

- The "ADR" setting. This is the value set on the netHOST's front panel decade rotary switches. This value must be unique on the local subnet. Set the netHOST's front panel switches to match the value expected by the T2750.
- The IP address assigned to the netHOST (which must be unique and on the same local subnet as the T2750). Note that this is not the T2750's IP address, but a unique address assigned to the netHOST.

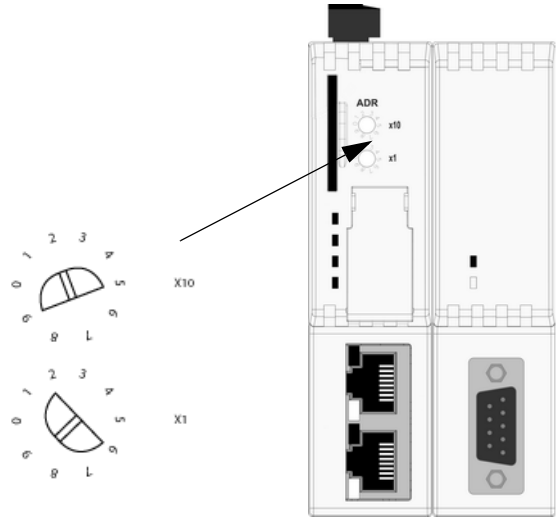
When the T2750 first starts the database file (DBF), it scans for all netHOSTs on the local subnet. From the responses, it identifies the netHOST(s) with the correct ADR setting and confirms the IP address is correct. If the IP address is unconfigured, the T2750 will automatically configure the IP address as it starts up.

SETTING THE ADR DECADE SWITCHES

The netHOST's address (ADR) is set using the two decade switches on the front of the netHOST. The value set must be unique on the local IP subnet. Use a small flat-bladed screwdriver to set the ADR switches.

The decade switches' pointer is that shown by the slot at the *flat* end of the dial. Thus, in the example on the right, the figure shows the decade switches set to 74.

The T2750 must be set with the same ADR details so it can locate and associated the physical netHOST. Refer to the next section, Setting the netHOST's IP address for details.



SETTING THE netHOST's IP ADDRESS

The T2750 must be associated with a physical netHOST by means of physically setting the address (using the ADR decade switches on the netHOST), and by defining it in the T2750's configuration. At the same time, the T2750 should be configured to assign a specific IP address to the associated netHOST.

Both of these settings are performed using the Instrument Options Editor, which can be invoked by right-clicking on the T2750's instrument folder and selecting Properties (and then clicking on the **Instrument options** tab), or from within LINtools (and clicking on the instrument name and selecting **Instrument Options**).

The Instrument Options editor allows the Profibus settings to be configured. An example is shown to the right and shows that the identity of both associated netHOSTs can be defined through the fields:

ADR: the netHOST instrument number. Set this to the same unique number as physically set on the netHOST's front-panel decade switches (00-99). Ensure this setting is unique across all netHOSTs on the same IP subnet.

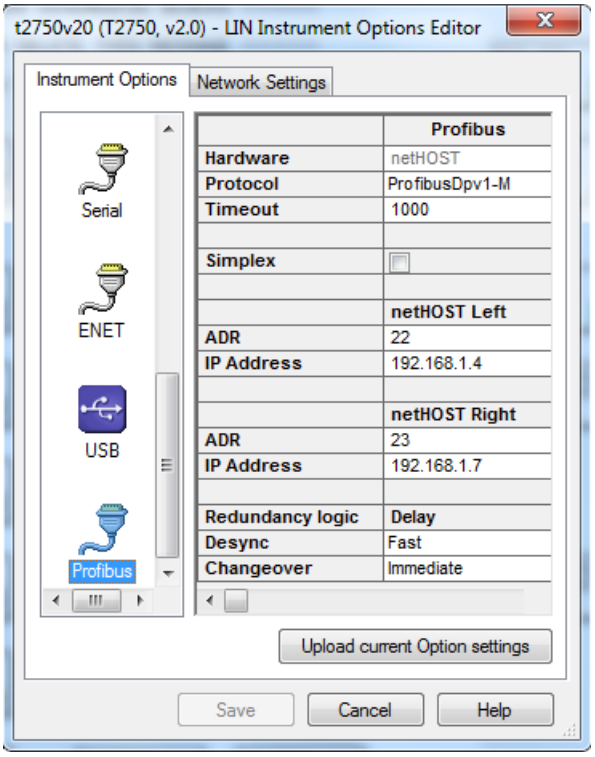
IP Address: Sets the IP address of the netHOST associated with the left or right IOC. The netHOST is automatically assigned this IP address, which must be on the same TCP/IP subnet as the T2750. Ensure this IP address is unique on the network.

In addition, the **Timeout** field specifies the maximum time (in milliseconds) before a lack of response is treated as a communication failure.

The Simplex checkbox specifies the T2750 has only one IOC, and disables the **netHOST Right** fields.

The Redundancy logic field are discussed in the following section.

Refer to the section below for information on the **Redundancy logic**, **Desync** and **Changeover** fields.



SETTING THE REDUNDANCY LOGIC

The behaviour of how the T2750 deals with Profibus health issues is definable using the Redundancy Logic section of the Instruction Options Editor. Settings allow the user to define how quickly (if at all) a Desync or Changeover occurs due to Profibus communication failures. Further information can be found in the section, "PROFIBUS (netHOST) REDUNDANCY DECISIONS" on page 63.

Desync: This field determines how the T2750 reacts if the secondary IOC has a worse view of the Profibus network than does the primary and when desync will occur. This is only applicable in duplex IOC configurations (that is, if the Simplex field is ticked, this field will not be editable). The three options are:

- 'Disable'. The T2750 ignores the situation (the IOCs never desync due to a Profibus health issue).
- 'Fast'. This is the default operation. The T2750 desyncs if the situation persist for 1800mS. This allows the status of the secondary to be checked prior to desynchronising. Selecting 'Fast' prioritises Profibus health over ELIN health for desync decisions.
- 'Slow'. The T2750 desyncs if the situation persists for 8000mS. Selecting 'Slow' prioritises ELIN health over Profibus health for desync decisions. Care should be taken when setting the Desync option to 'Slow' if Profibus I/O is an essential part of the strategy.

Changeover: This field determines how the T2750 reacts if the Primary cannot see any of the configured nodes on the Profibus network and when an IOC changeover will occur. This is only applicable in duplex IOC configurations (that is, if the Simplex field is ticked, this field will not be editable). The four options are:

- 'Disable'. The T2750 ignores the situation (the IOCs never changeover due to a Profibus health issue).
- 'Immediate'. This is the default operation. The primary IOC effects a changeover as soon as it can no longer communicate to any of the configured Profibus slaves, without checking whether the secondary IOC has a better view of the Profibus network.
- 'Fast'. If the primary IOC is unable to communicate with any of the configured Profibus slaves and the secondary IOC cannot view the primary on the Profibus network, then the IOCs will changeover if this situation lasts for 250mS. This prioritises Profibus health over ELIN health for changeover decisions.
- 'Slow'. If the primary IOC is unable to communicate with any of the configured Profibus slaves and the secondary IOC cannot view the primary on the Profibus network, then the IOCs will changeover if this situation lasts for 8000mS. This prioritises ELIN health over Profibus health for changeover decisions. Care should be taken when setting the changeover option to 'Slow' if Profibus I/O is an essential part of the strategy.

3 OPERATOR INTERFACE

3.1 INTRODUCTION

Figure 3.1,shows the IOC front panel LEDs and switches. Other modules' LEDs are described in section 2.3, above.

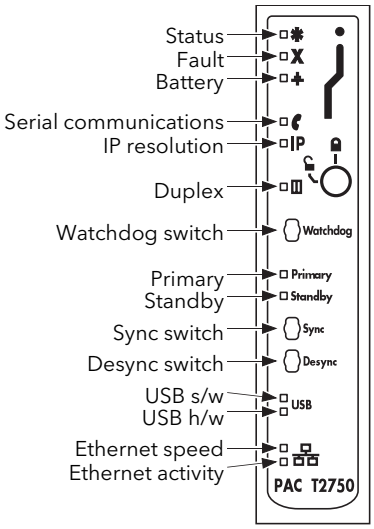


Figure 3.1 IOC LEDs and switches

3.1.1 LED interpretation

See also Section 11.4 which describes Power On Self Test (POST) failure LED patterns

LED	Function
Status (green)	On: Main power input valid Off: Main power input failed
Fault (red)	On: Module missing/faulty; incorrect type/base; any H/W fault. Watchdog Failure if all other LEDs are extinguished. Flashing: Database file unsaved, missing, or faulty. A '*.dbf' and corresponding '*.run' file do not exist on the instrument Off: No H/W faults detected
Battery (green)	On: Battery OK Flashing: battery failed or not fitted
Communications (yellow)	On: Instrument transmitting field communications Off: Instrument not transmitting field communications
IP Resolution (yellow)	On: IP address resolved successfully Flashing: IP address being resolved, or cable broken/disconnected Off: IP address cannot be resolved. Invalid IP address or DHCP failure.
Duplex (green)	On: Primary and secondary modules are coupled Flashing: Primary and secondary modules are not coupled Off: Operating in simplex mode.
Primary (green)	On: The module is the primary module and it is running a strategy. Flashing: The module is the primary module and is either loading a strategy, or is idle. Off: The module is not the primary module.
Standby (yellow)	On: The module is the secondary module and it is synchronised, ready to take over. Flashing: Primary and secondary modules are synchronising. Off: The module is not an active secondary module.

3.1.1 LED INTERPRETATION (Cont.)

LED	Function
USB s/w (green)	On: USB being written to. USB device must not be removed. Flashing: Write failure has occurred. USB device may be removed. Off: USB device idle and may be removed.
USB h/w (yellow)	On: an attempt is being made to draw too much current (>500mA) from the USB socket. USB activity suspended. Off: No hardware failure reported.
Ethernet speed (green)	On: 100MB Off: 10MB
Ethernet activity (yellow)	On: Connected to a live Ethernet network Flickering; Network traffic detected Off: Ethernet connection invalid
All LEDs	Flashing: A license violation has occurred within the current loaded strategy. Modify the strategy to comply with your license level, or contact your supplier to request an additional license. Refer to Appendix C for details of function block licence levels.

3.1.2 Switches

Watchdog	If the unit is in operating normally, or if the watchdog retry switch (section 2.4.2) is set to 'On', then this switch has no effect. Otherwise, if the 'fault' LED is on, operating this push-button switch causes the module to reset and attempt to restart.
Sync switch	If primary and secondary modules are synchronised: Operation of the primary module 'Sync' switch has no effect. Operation of the secondary module 'Sync' switch causes the primary and secondary modules to swap. If primary and secondary modules are not synchronised: Operation of the primary module 'Sync' switch causes the modules to start synchronising. Operation of the secondary module sync switch has no effect.
Desync switch	Operation of the primary module 'Desync' switch causes synchronised modules to de-synchronise, the Primary module remaining in control. Operation of the secondary module 'Desync' switch for longer than 3 seconds causes the secondary module to shutdown. When successfully shutdown (all LEDs extinguished), the module can be safely removed from the Terminal Unit.

SYNCHRONISATION

Synchronisation means the transfer of all relevant data from the primary module to the secondary module, followed by the continuous maintenance of this data. This allows the primary and secondary modules to change over should the primary module fail.

This synchronisation process takes place automatically if both modules are powered-up together, and have previously been run as a redundant synchronous pair. Should either of the above conditions not be met, then, at power-up the primary and secondary modules adopt unsynchronised states and the secondary module cannot change over to the primary in the event of failure. To synchronise the modules, the primary module 'Sync' switch must be operated.

Once synchronisation has been achieved, the modules are said to be in primary synchronised state and secondary synchronised state and the secondary can take over the primary functions if required.

TIME TO SYNCHRONISE

The time taken to complete the synchronisation process varies according to the complexity of the control strategy and on how heavily the file system is being used. Typically, the 'Load and Run' part of the procedure takes a number of seconds, but if the primary and secondary file systems are identical, synchronisation is almost instantaneous. During the synchronisation period, the primary runs the control process as normal.

4 START-UP

4.1 REDUNDANCY MODES

Two IOC modules (primary and secondary) are fitted and act in such a way that the secondary can take over from the primary in case of failure. The left-hand module is usually the 'primary' and the other the 'secondary'. The secondary continuously 'tracks' the primary so that it can take over with minimum disturbance to the controlled system. It also monitors communications to other nodes and the input/output modules.

If there is only one IOC module, it acts in Duplex unsynchronised mode.

4.2 START-UP MODES

The required start-up mode is selected using the 'Options' switch (SW2), described in section 2.4.2, above. This allows 'Hot', 'Hot/Cold', or 'Cold' to be selected, using two elements of the switch. Figures 4.2.1a/b, below, shows a simplified flow diagram for the different modes.

4.2.1 Hot start

Hot start means that the instrument restarts from where it stopped running. A suitable time period (Cold Start Time) is configured in the 'Header' block of the control database, and if this period is exceeded after the database stops running, then a hot start is not permissible. The Cold Start Time for any process can be defined as: A pre-set duration, following power off or power failure (database stopped), after which a Hot Start is not possible, and a Cold Start must be initiated instead.

A brownout time can be set in the 'Header' block, and if power to the instrument is lost for this duration or longer, the brownout alarm is set (also in the 'Header' block). This brownout time can be defined as an indication that a power variation or partial power failure longer than the defined Brownout Time has occurred. Any power variation or partial power failure shorter than the defined Brown out Time allows the instrument to continue operating without interruption.

If the Hot start fails (because the database is corrupted or because the Cold Start Time has been exceeded) the database is cleared and the instrument enters an 'Idle' state and remains there until physically restarted. See also section 4.2.3 (Hot/cold start).

4.2.2 Cold start

Cold start means that the instrument re-starts with the previous database loaded, but with all parameter values set to starting values appropriate to the process (that is, re-initialised). If the cold start fails the database is cleared and the instrument enters an 'Idle' state and remains there until physically restarted.

COLD START PARAMETER FILE

In the event of a cold start, the instrument searches for a file with the same name as the .dbf file just loaded, but with the extension .cpf, and if such a file is found it is executed. This file is a parameter overlay file storing values that are initialised when a cold start occurs. It is created using any text editor, and uses Structured Text (ST) style comment lines, e.g. (* Comment *) and assignment statements (one complete statement per line of text) that

1. Allocate the current cold start parameter values to database block fields
2. Define the Reset Data Set (see below)

```
(* Production plant Cold Start Initialisation --- .CPF file *)
(* Ensure no automatic control until started *)
PIC-023.Mode := "Manual";
XCV-124.Mode := "Manual";

(* Ensure vent valves open *)
XCV-124.Demand := "False"; (* Open *)
XCV-123.Demand := "False"; (* Open *)

(* Reset profile to default *)
Profile.A0 := 23.4; (* Start temp Deg C *)
Profile.A1 := 34.5; (* First target temp Deg C *)
Profile.A2 := 2.0; (* Ramp rate Deg C / min *)

(* Initialise totalisation block *)
>COUNT-01.NTotal := 10;
>COUNT-01.NTotFrac := 0.5;
```

Note: LINtools can interrogate this file to determine the cold start parameters. An alarm is asserted in the instrument header block if any problem is encountered when executing the .cpf file.

4.2.2 COLD START (Cont.)

COLD START PARAMETER FILE (Cont.)

If the ResetOfl alarm is enabled, it is asserted if one of these are TRUE:

1. The .cpf file is missing, or
2. the maximum of 2560 parameters in the Reset Data Set supported by the .cpf file has been exceeded.

The only syntaxes that are supported by the .cpf file are:

1. `Block.Field[.Subfield]:=Value;`
   These are the defined default values used each time the instrument cold starts. The instrument uses the specified value and overlays it on the defined (sub)field regardless of what the (sub)field value is in the database, e.g. forcing a PID to start in manual mode.

2. `>Block.Field[.Subfield]:=Value;`
   This is used in the same manner as above but overlays a value on a (sub)field which is normally read-only, e.g. setting a totalisation to a specific value. The defined value is only used during the first scan of the database, after which the (sub)field is updated at each block execution.

3. `Block.Field[.Subfield];`
   This syntax adds the subfield to the Reset Data Set for this instrument. It is only used during runtime and prevents the defined subfield being saved when Options.SaveDBF in the header block is set TRUE. When the instrument next cold starts, the value of the defined (sub)field will be read from the database in the SD card.

4. -Block.Field[.Subfield];
   This syntax removes the subfield from the Reset Data Set for this instrument. It is only used during runtime to allow the value from the defined sub(field) to be saved from RAM to SD card when Options.SaveDBF in the header block is set TRUE.

Example
If the syntax reads -PIC-023.SL; the online value is saved from RAM to SD card if Options.SaveDBF in the header block is set TRUE during runtime.

RESET DATA SET

The Reset Data Set is a list of parameters that remain unaltered in the database when Options.SaveDBF in the header block is set TRUE during runtime. Any parameter in the Reset Data Set can be omitted by preceding the parameter with '-' (negative symbol). The Reset Data Set supports a maximum 2560 parameters but 3 parameters are retained for Date, Time and Checksum, and used to validate the data. The local setpoint (SL), Mode (MODE) and output (OP) from all PID, PID_LINK or PID_CONN blocks in the database are allocated by default, but additional parameters can also be added to the .cpf file. This also applies to LOOP_PID block but additional default parameters are included, i.e. AutoMan, SP1, SP2, AltSPEn, ManOP and ReStrtOP.

> Note: ReStrtOP is a hidden non-volatile parameter from which the volatile output parameters are derived on power up. It is generally saved to the database with value zero.

4.2.3 Hot/cold start

This setting causes the instrument to attempt a hot start. If the hot start fails, however, instead of going straight into idle state as with 'hot start', the instrument attempts to carry out a cold start. If the cold start fails the database will be cleared and the IOC Modules enter an 'Idle' state and remain there until physically restarted.

Note: If the SD card is changed, a Hot Start for the current running database will not be possible.

4.2.4 Startup flowchart

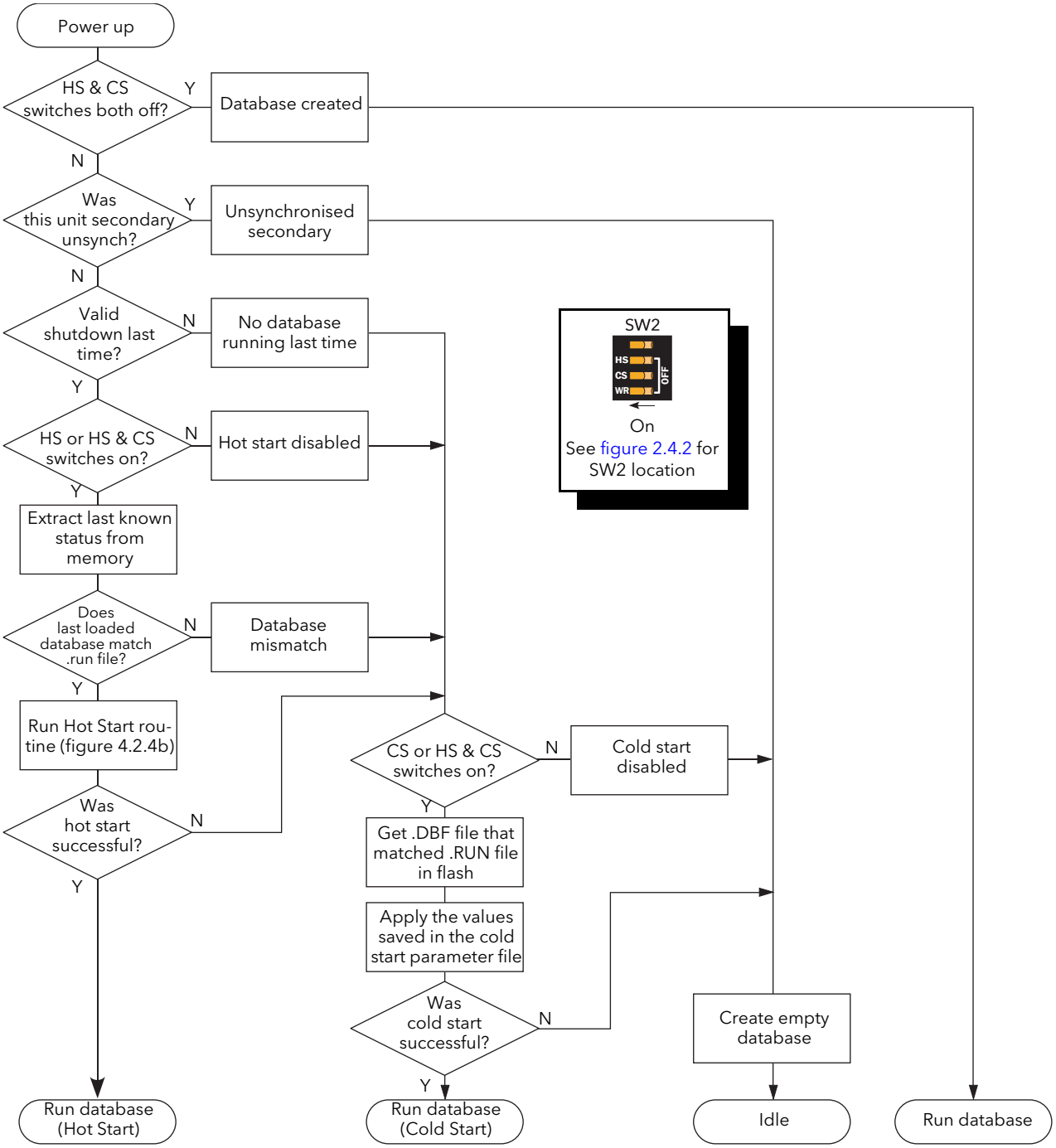


Figure 4.2.4a Simplified start-up flow diagram

4.2.4 STARTUP FLOWCHART (Cont.)

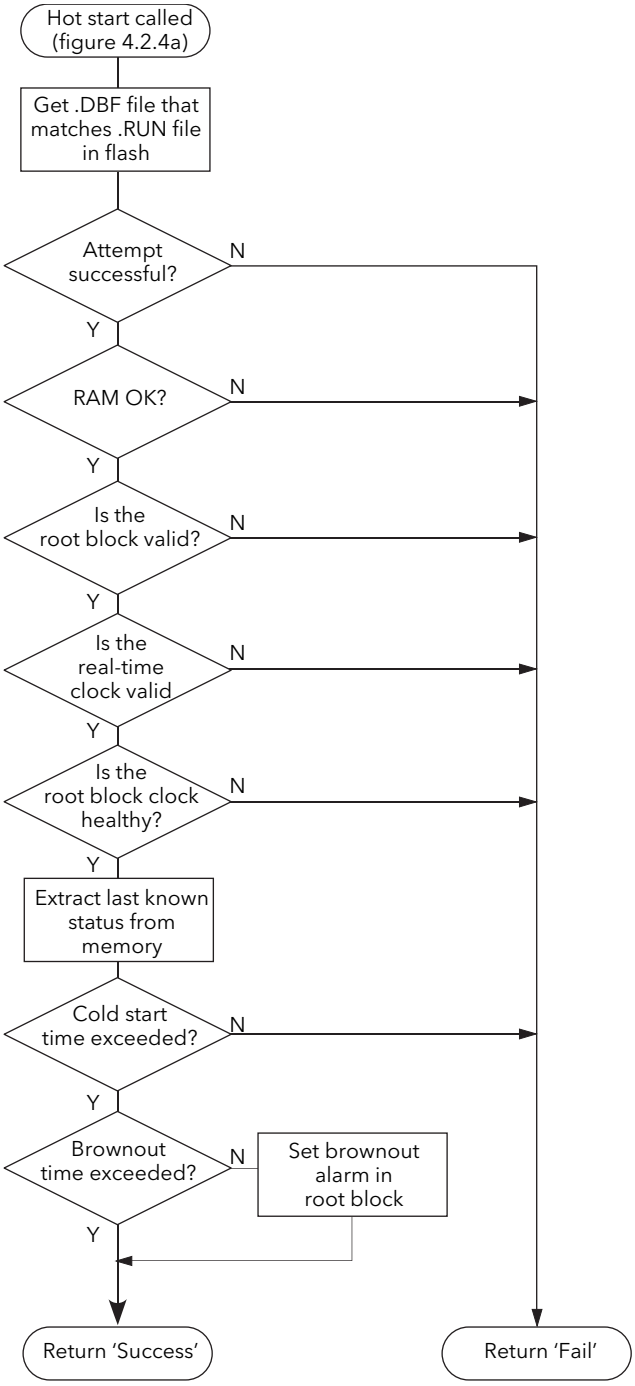


Figure 4.2.4b Hot or Hot/Cold start flowchart

4.3 STARTING THE IOC MODULES

Note: It is always possible to insert a second IOC module next to a simplex module to convert the system into a duplex (redundant) system.

4.3.1 Start-up routine

The Start-up routine is subject to the successful completion of the Power On Self Tests (POSTs) (see section 11.4 for details).

OFF STATE

In the Off state, all LEDs are extinguished.

STARTING STATE

When power is applied, the relevant 'Status' LED illuminates green immediately.

The 'Primary' and 'Standby' LEDs flash intermittently until the modules are initialised, at which point the 'Primary' LED is illuminated continuously on the primary module, and the 'Standby' LED is illuminated continuously on the secondary module.

The start-up procedure concludes with the establishment of Ethernet (ELIN) communications. During this period, the 'Primary' LED flashes on (600ms) and off (600ms).

OPERATING STATE

When the start-up sequence is complete, then as a minimum, the 'Status' LED is illuminated continuously green.

The 'Primary' ('Standby') LED is also illuminated green continuously if a database is running, or it flashes if a database is loading or if the Module is idle.

The 'Communications' LEDs are illuminated yellow if the associated communications links are operating correctly and flash intermittently when receiving messages.

The other LEDs operate as described in section 3.1.1.

WATCHDOG RELAYS

The Watchdog relays remain in their alarm state until the software has initialised.

4.3.2 Power-up decisions

Figure 4.3.2 shows the states possible with a pair of modules in Redundant mode.

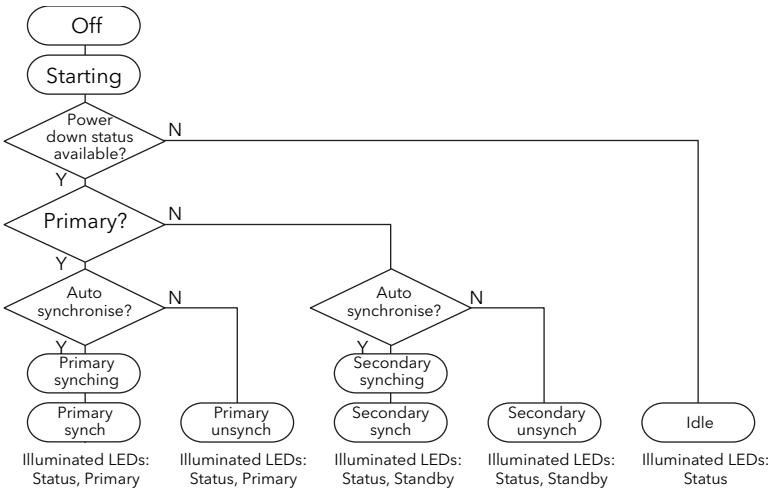


Figure 4.3.2 Power-up in redundant mode

Caution

If replacing an IOC module on a powered-down system (for example, during an intentional site shut-down), there is a risk that an unwanted strategy on the new IOC module will automatically run upon power-up. For this reason, always ensure when replacing an IOC module from a stock of spare IOCs, that the run file (*.run) is deleted from the device prior to installation on a production system. Caution should also be taken if replacing both the primary and secondary IOC modules at the same time.

PRIMARY/SECONDARY CRITERIA

When operating in redundant mode, it is necessary that one IOC module be defined as the primary; the other as the secondary. As described in section 4.1 (Redundancy modes), above, the primary initially assumes control and the secondary tracks the primary such that it can assume control should the primary module fail.

Decisions as to which module starts up as primary are made using information held in battery-backed memory, relating to which module was the primary prior to the last power off. If both modules power-up as they last powered down, then they attempt to power up with the same primary and secondary assignments. If the power down information in the two modules is conflicting, or not available, because the battery is not connected, both processor modules will enter an idle state (decoupled), and will not load or run a LIN Database. The power down state is initialised so that the modules start with default primary and secondary assignment at the next power cycle.

REDUNDANCY DECISIONS

Normal redundant operation will take place only if the primary module believes that it and the secondary module have an equal view of the ELIN network.

When acting as a redundant pair, the primary and secondary modules independently derive a communications status (indicated by the 'IP Resolution' LED).

The decision to remain synchronised, to desynchronise or to changeover, is always made by the current primary module, and then only if the two units are synchronised. The decision depends on which module has the best 'view' of the network. For example:

1. If the primary module believes that both modules hold the same outlook of the network, the primary and secondary modules remain synchronised.
2, If the primary module believes that it holds a better outlook of the network than the secondary, then the primary and secondary modules desynchronise and a changeover does not occur.

3. If the primary module believes that the secondary module holds a better outlook of the network, the modules desynchronise and a changeover occurs.

If the communications status is unstable, the decision is deferred to prevent spurious desynchronisations or changeovers occurring whilst faults are introduced to or removed from the network.

PROFIBUS (netHOST) REDUNDANCY DECISIONS

T2750 strategies that include Profibus I/O utilise the netHOST to communicate with the Profibus network. Using the Instrument Options Editor, basic configuration can be defined for both the identity of the netHOST and the redundancy logic. As mentioned on page 52, each T2750 can be configured to handle redundancy for the Profibus network with user-definable settings for desync and changeover logic. Refer to “SETTING THE REDUNDANCY LOGIC” on page 52 for details on how to change these settings.

The default behaviour of the Desync and Changeover settings make Profibus health very high priority. This matches the functionality of the T940 and T940X in that a changeover is immediate. If the Profibus I/O is an important element of your control strategy, then this default behaviour is probably the most suitable. It has the disadvantage, however, that if all Profibus slaves fail, the IOCs will changeover (because it does not wait to check the secondary's view of the Profibus network). This operation may not be desirable for control strategies where the Profibus health is not top priority.

Setting both the Desync and Changeover settings to 'fast' will defer the desync/changeover decision until the secondary's Profibus view can also be checked. This avoids a changeover if the Profibus slaves will sill be unreachable after a changeover. Note that 'fast' prioritises Profibus health over ELIN health for desync/changeover decisions (if Profibus and ELIN health monitoring would result in opposite decisions, the Profibus will "win" and thus still treating Profibus as very important).

Selecting 'Slow' has the effect of making ELIN health a higher priority than Profibus health. This setting is only applicable where the Profibus I/O is not an essential part of the strategy. Note that 'Slow' introduces a delay in the detection of the primary Profibus Master failing, and there will be several seconds during which Profibus is not operating before the changeover occurs.

Finally, selecting 'Disable' stops all desync and changeover decisions based on the health of Profibus. This should only be used where the Profibus is used for I/O associated with very low priority monitoring, in cases where Profibus failures may be not that important.

4.3.3 Autosynchronisation

Once the primary/secondary status of the modules has been determined, the system must decide if synchronisation of the primary and secondary should be automatic or if it should be initiated manually by means of the 'Sync' switch (section 3.1.2). This decision is made as follows:

If the modules are powered-up within a short time of each other, and they were running as a synchronised pair prior to power-down (data held in memory), then synchronisation will take place without operator intervention.

If either of the above conditions is not met (or if the data held in memory is not available) then both units will enter unsynchronised states in which case the secondary cannot take over from the primary. This state will continue until the 'Sync' switch on the primary module is operated.

SYNCHRONISATION

During synchronisation (automatic or manual), the primary module:

1. Copies all the primary module's strategy files to the secondary module.
2. Instructs the secondary module to load the relevant database.
3. Transfers current block data to the secondary module.

During the synchronisation process, the 'Standby' LED on the secondary module flashes. Once synchronisation is complete, the 'Standby' LED is continuously illuminated yellow, the 'Duplex' LED on the primary module is illuminated green and redundant operation starts with the IOC Modules in their synchronised states.

> In redundant operating mode, the secondary module does not permit any LIN database messages or any attempted writes to its filing system. It responds to all other messages.

TIME TO SYNCHRONISE

The time taken to complete the synchronisation process depends on the complexity of the control strategy and on how heavily the file system is being used. If the primary and secondary file systems are identical, synchronisation is almost instantaneous. If not, the 'Load and Run' part of the procedure can take a number of seconds, during which period the primary runs the control process as normal.

Where primary and secondary filing systems have substantial differences (e.g. when attempting synchronisation for the first time), multiple synchronisations may be required to copy all the files to the secondary module. (The 'Red_Ctrl' block 'sync' fields can be viewed to determine the synchronisation status.)

5 CONFIGURATION

5.1 TOOLS: THE AUTOMATIC I/O BUILD AND CONFIGURATION TOOLS

Most configuration will have been done before despatch but, at start-up, a basic LIN Database and the communications parameters can be automatically generated by setting the hot start (HS) and cold start (CS) elements of the LIN option switch to 'Off' (section 2.4.2).

LINtools also allows the creation of new LIN Databases, and the editing of existing configurations on-site and on-line*, usually to accompany modifications to the processing plant. LINtools Help should be referred to for details of the reconfiguration procedures using the LINtools program.
The LIN Blocks Reference Manual gives full details of the software function blocks available for control strategies, and how to configure their parameters.

*Note: On-line reconfiguration is not permitted if the IOC Modules are synchronised.

All processed data in the LIN Database can be transferred via Modbus communications protocol (see Communications Manual). Modbus Tools (part of LINtools) is used to configure the Modbus parameters.

5.2 AUTOMATIC I/O BUILD

If the hot and cold start switches are off, then at power up, the instrument detects which I/O modules are fitted in the base unit. This information is used to create the appropriate I/O channel blocks in a LIN Database, and configure them to match the real hardware. This automatically generated LIN Database does not result in a complete, usable, control strategy, because most I/O channel blocks require further configuration, (e.g. thermocouple type requires a millivolt range).

Notes:

1. All existing '*.run' files are deleted.
2. The 'FAULT' LED (red) flashes whilst an unsaved LIN Database or changes to a LIN Database exist in the instrument.
3. The Database name must be a unique 8-character string (it is recommended that the name consists of the Instrument Type and the LIN Address, i.e. T2750_0F.
4. Each automatically generated I/O channel block is configured to match the real hardware and is assigned a unique, meaningful 8-character name as shown in Table 5.2.
5. I/O channel blocks are assigned to the slowest I/O User Task, User Task 3.

Block Type	Naming Convention	Description
Header	T2750_xx	xx = LIN node address (hexadecimal)
Module	Modyy_xx	Mod = Module type; yy = module site number; xx = LIN node address
Diagnostic	[block template name]_xx	xx = LIN node address
Calibration	CALn_xx	n = Task number; xx = LIN node address
Analogue i/p channel index	yyMzz_xx	yy = Module site number; xx = LIN node address; zz = channel number
Analogue o/p channel index	yyPzz_xx	yy = Module site number; xx = LIN node address; zz = channel number
Digital i/p channel index	yyXzz_xx	yy = Module site number; xx = LIN node address; zz = channel number
Digital o/p channel index	yyYzz_xx	yy = Module site number; xx = LIN node address; zz = channel number

where site and channel numbers start at 1, and node addresses less than 10 include a leading '0'

Table 5.2 naming convention used by automatic I/O build

5.2.1 Preparing for the Automatic I/O Build

Before the Automatic I/O Build can be started, all power to the unit must be isolated, the IOC Terminal Unit HS and CS switches must be 'off', as described in section 2.4.2, and all required I/O modules must be fitted in the appropriate slots. Only then should power be applied to the instrument, initiating the automatic generation of a LIN Database, and a corresponding '_auto.run' file. The automatically generated LIN Database includes appropriate Header, Module, Calibration, I/O, and Diagnostic (section 11.5) function blocks.

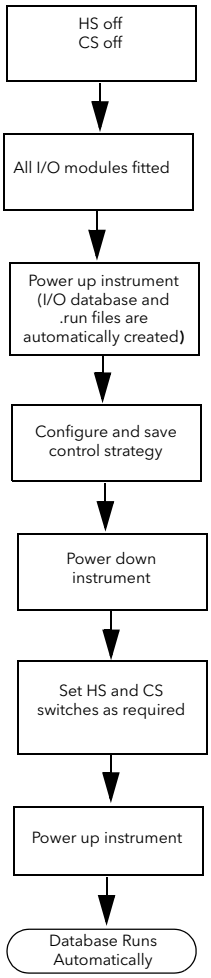
The LIN Database runs automatically. The database is unnamed until

1. automatically saved, if the Options.SaveDBF bit in the TACTICIAN header block is set
2. the 'Save as' command at the instrument level of the 'Network Explorer' is used
3. the LIN Database is open in LINtools and attached to the instrument via the 'Online Reconfiguration' command (see section 5.5.3 Uploading the instrument control strategy', below). The 'Save' command can then be used to save the instrument LIN Database.

Block names are in the format '03X02_1A', where:

03 represents the I/O Module location (slot 3 in this example).
X defines the channel type
(M = analogue input; P = analogue output; X = digital input; Y = digital output; F = frequency input)
02 represents the channel number within the module (the second digital input in this example).
1A is the LIN address for the base unit.

AUTOMATIC I/O GENERATION FLOW DIAGRAM



See section 2.4.2 for Hot start (HS) and Cold start (CS) switch configuration.

Figure 5.2.1 Automatic I/O generation routine

5.3 LINTOOLS

LIN databases are edited using LINtools software. This provides:

1. A view of the instrument configuration
2. Build and Download functions
3. LIN names and node addresses for external databases (EDBs) (i.e LIN databases running in other LIN instruments).
4. On-line Reconfiguration to a running LIN Database.

The strategy components can include one or more instances of the following items, depending on the process being controlled:

1. I/O Modules Database file (file extension .dbf)
2. Database file(s) (Function Block Diagram - FBD, file extension .dbf)
3. Sequences (Sequential Function Chart - SFC, file extension .sdb)
4. Action block methods (Structured Text - ST, and Ladder, file extension .stx and .sto)
5. Data Recording (file extension .uxg)
6. Setpoint Programs (Programmer Editor: file extension .uyy)
7. Modbus Gateway configurations (file extension .ujg and .gwf).

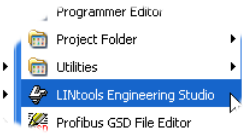
5.3.1 Starting LINtools

It is not within the scope of this document to describe the LINtools software in depth; full details are to be found in the LINtools help system and in the LINBlocks reference manual. If the user is already familiar with LINtools, the section may be ignored.

The following sections guide the user through the LINtools start-up, showing how to create the required project folders, networks and instrument folders from scratch. It is assumed that LINtools has already been installed successfully.

> Note: For convenience, it is suggested that a 'shortcut' is created on the desktop.

Press Start/All Programs/..../LINtools Engineering studio....

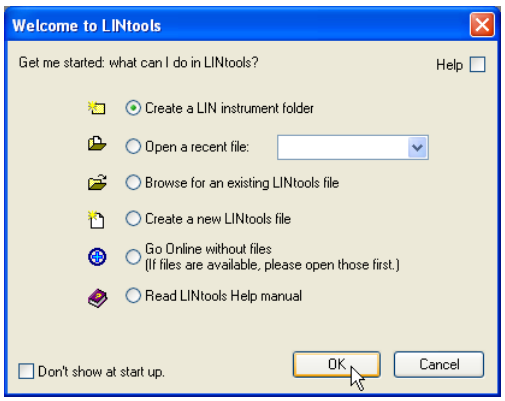


....or double-click on the desktop short cut.



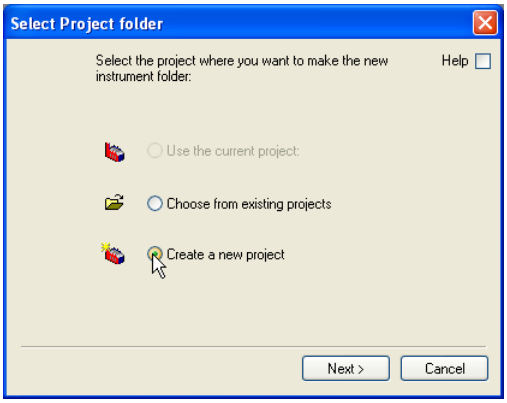
LINtools starts

Click on 'Create a LIN instrument folder', then Click on 'OK'.



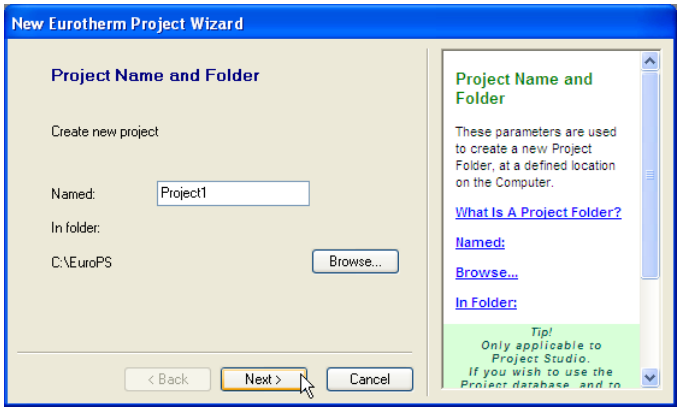
5.3.1 STARTING LINTOOLS (Cont.)

Click on 'Create a new Project', then on 'Next'



Enter a project name, and if necessary, browse for a file location at which to store it.

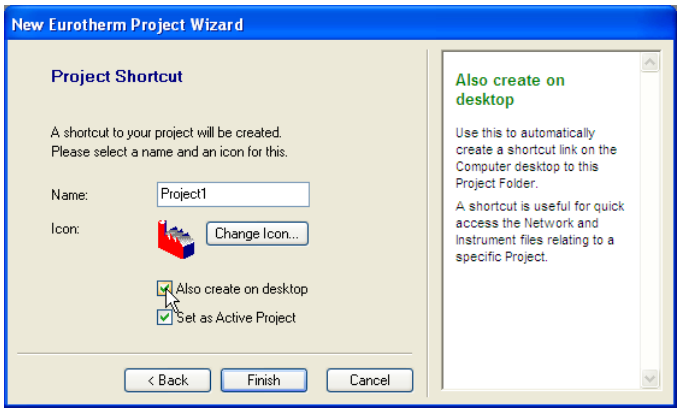
Click on 'Next'



It is recommended that 'Also Create on Desktop' is clicked on so that a short cut to the project appears on the desktop.

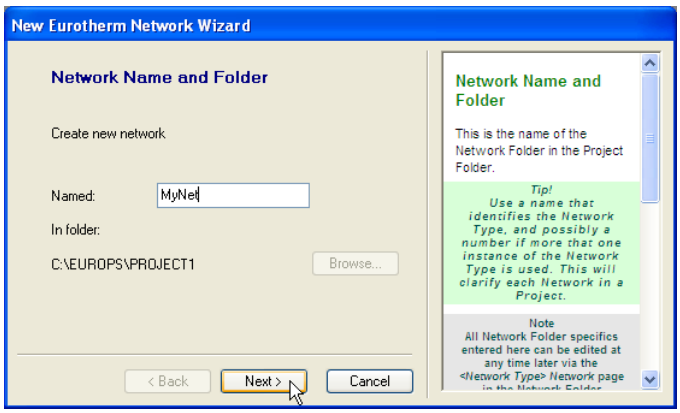
Select a different icon from the drop-down menu, if so desired.

Click on 'Finish'



Enter the name of the network on which this instrument is to reside.

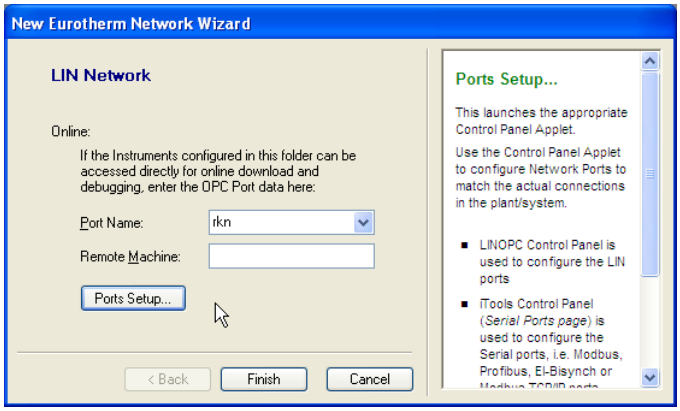
Click on 'Next'



5.3.1 STARTING LINTOOLS (Cont.)

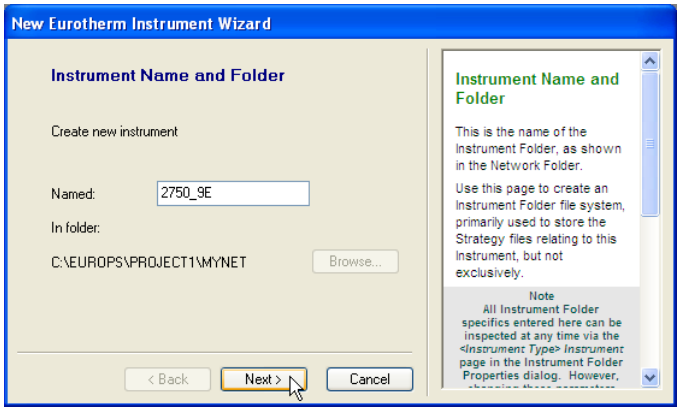
Select the port name for this network. (If it doesn't yet exist, it can be created by clicking on 'Port set-up...' and Adding the new port.)

Click on 'Finish'



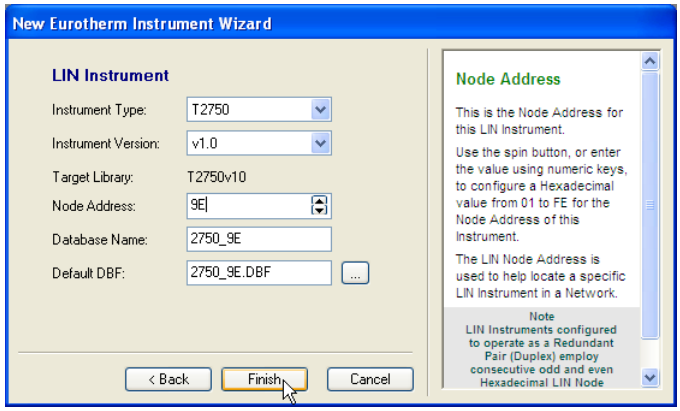
Enter an instrument name

Click on 'Next'



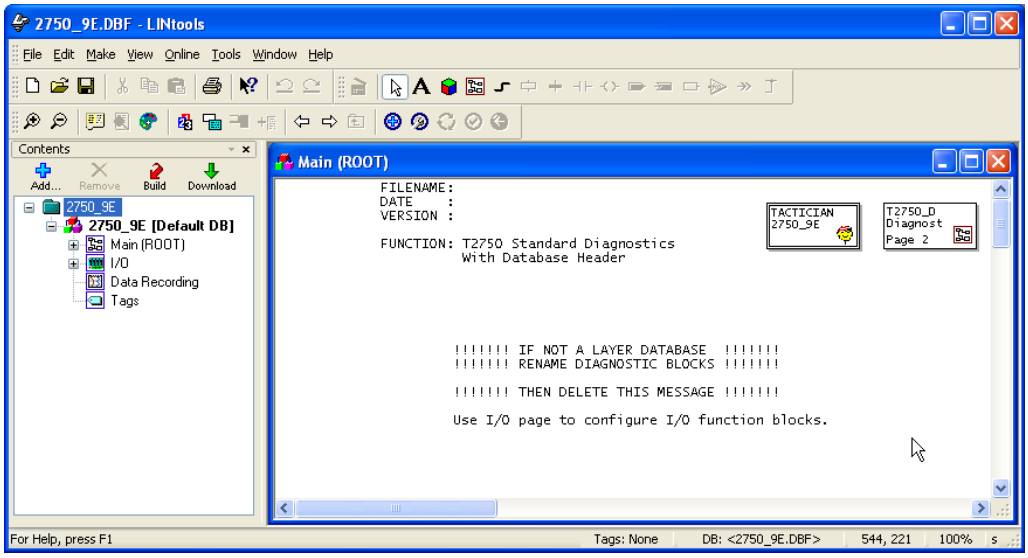
Select an instrument type from the pull-down menu, then wait a few seconds for the instrument version to be displayed. (If this not the required version, select the required version from the drop-down menu.)
Fill-in the remaining instrument details.

Click on 'Finish'



5.3.1 STARTING LINTOOLS (Cont.)

The LINtools worktop opens, allowing the user to configure a strategy as required.



CONNECTING TO A COMPUTER

The instrument can be accessed over the Ethernet network via an Ethernet hub/switch connected between the Ethernet Communications port on the underside of the IOC modules and the Ethernet port on the Computer.

Note that the correct LIN address must be set up on the instrument, as described in section 2.4.1.

5.4 MODBUS TOOLS

5.4.1 Introduction

This instrument may be configured as a Modbus Master or as a Modbus Slave, and the application supports up to three Modbus Gateway configurations.

Modbus configuration data is defined in a Modbus GateWay File (.gwf), downloaded with the LIN Database file into a LIN instrument. The data in the Gateway file is used to define the transfer of data between LIN and Modbus instruments.

This data includes:

1. The operating mode (i.e. Master or Slave)
2. The serial line set-up (or TCP)
3. The mapping between fields in function blocks and the registers of a Modbus instrument
4. Modbus functions, Modbus register addresses and the format in which data is to be transferred.

CONNECTING TO A COMPUTER

The instrument can be accessed over the Ethernet network via an Ethernet hub/switch connected between the Ethernet Communications port on the underside of the IOC modules and the Ethernet port on the Computer.

5.4.2 Running Modbus Tools

Refer to Modbus Tools Help for details of Modbus Configuration procedures using Modbus Tools.

An empty Modbus Tools window can be started

1.from the LINtools 'Tools' menu,

2.via the Start > ... > LINtools Advanced > MODBUS Tools command.

The 'Open' command is used to open a browse window to help locate the required .ujg file.

Alternatively, double-click the LIN MODBUS Database file (.ujg) from the required Instrument folder.

5.4.3 Configuring Modbus-TCP Slave Communications

When this instrument is configured as a redundant pair and is communicating as a Modbus-TCP Slave, the IP Addresses of the primary and secondary modules must be entered in the 'TCP properties' configuration of whichever instrument is the master.

With the relevant master's ujg file open in the Modbus Tools window, click on the TCP button to display the TCP Properties page and enter the IP Address of each Modbus-TCP Slave which is to communicate with the Modbus-TCP Master.

The figure shows the IP Addresses of both the primary and secondary modules of an instrument configured as a redundant pair (the primary module taking the odd address; the secondary the next highest address).

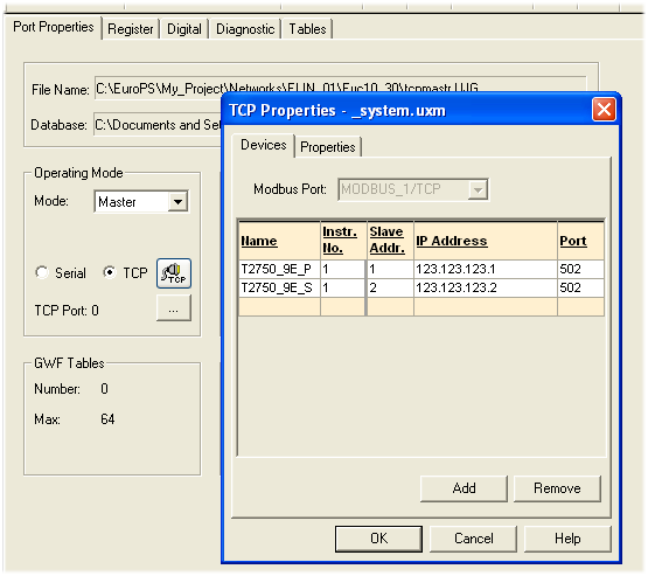


Figure 5.4.3 TCP properties

6 CONTROL LOOPS

6.1 INTRODUCTION

The instrument can be configured to control and tune a control loop, via LINtools Engineering Studio. This section discusses the use of the LOOP_PID block, but similar Proportional Band, Integral Time, and Derivative Time, PID, principles are also applicable to the 3_Term block and PID block.

Details of each block are to be found in the LIN Blocks Reference Manual.

Each control loop contains two outputs, Channel 1 and Channel 2, that can be configured for PID, On/Off or Valve Position (bounded or unbounded) control. In a temperature control loop Channel 1 is normally configured for heating and Channel 2 for cooling. Descriptions given here generally refer to temperature control but can also apply to other process loops.

6.1.1 Temperature control loop example

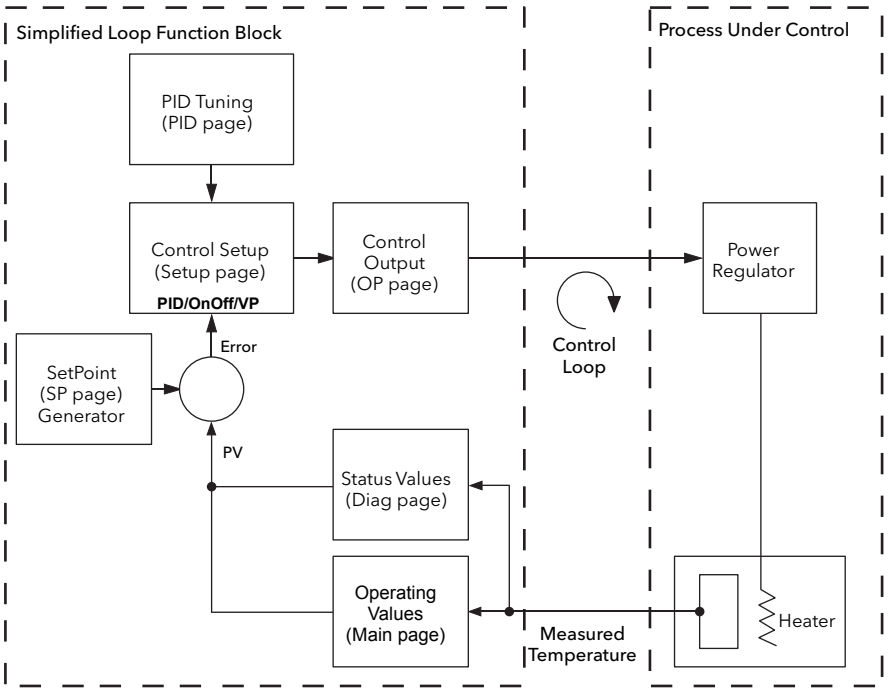


Figure 6.1.1 Single Loop, Single Channel Control Loop Block schematic

The measured temperature (or Process Variable (PV)), is connected to a suitable analogue input module. The PV is compared with the SetPoint (SP, or required temperature). The difference between the SP and the PV (the error) is calculated and a suitable heating or cooling demand output is generated, depending on the process being controlled.

The output(s) from the instrument are connected to devices in the plant/system which heat or cool the process, resulting in a change in the PV, that is again compared with the SP, and the process is repeated continuously. This is referred to as closed loop control.

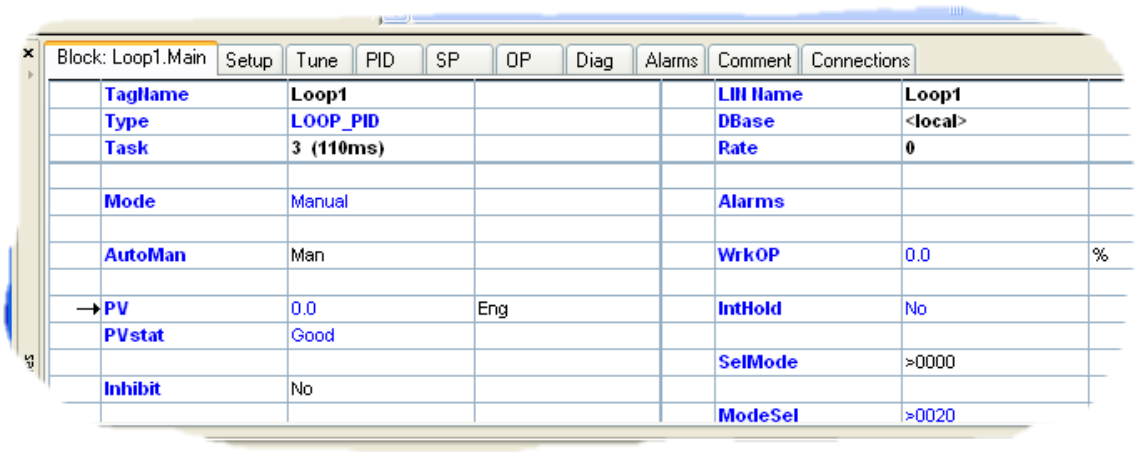
In this instrument it is possible to select PID, On/Off, and Valve positioning (Boundless or Bounded) algorithms.

6.2 THE LOOP PID FUNCTION BLOCK 

Note: Refer to the LIN Blocks Reference Manual for full block parameter details.

The instrument control loop is configured using the Loop function block and up to seven additional Tune_-Set blocks, allowing a total of eight sets of tuning parameters for an individual control loop.

Each set of PID tuning parameters provides specific tuning at different temperatures so that (for example) initial heating can take place as quickly as possible (set 1), followed by a controlled heating (set 2) and cooling (set 3) process, followed by a rapid cooling period (set 4).



The LOOP_PID block parameters are divided into the following 'tabbed' sections'.

Main	Sets up the operating parameters of the Control Loop such as Auto/Manual select, current PV, current output demand, selected SP value and working SP value. See section 6.2.1 for more details.
Setup	Configures control type for each channel of the selected loop (section 6.2.2)
Tune	Set up and initiate the Auto Tune function (section 6.2.3)
PID	Configures 3-term, Proportional Band, Integral Time, and Derivative Time (PID) control parameters (section 6.2.4)
SP	Select and adjust setpoint values, limits, and rates of change (section 6.2.5).
OP	Set up output parameters such as limits, sensor break conditions (section 6.2.6)
Diag	Control Loop status (section 6.2.7)
Alarms	Alarm configuration (section 6.2.8)

Parameters are software 'wired' using the LINtools Engineering Studio.

See section 6 of the LINBlocks reference manual for full details of this block

6.2.1 Main Page

The Main page of the Loop block provides an overview of parameters used by the overall control loop. It allows the user:

1. To select 'Auto' or 'Manual' operation
2. To stop the loop from controlling, for commissioning purposes
3. To hold the integral action
4. Read PV and SP values

AUTOMATIC MODE

Automatic indicates that PV is continuously being monitored and compared with the SP. The output power is calculated and used to minimise any difference.

If a sensor break occurs whilst the control loop is in automatic mode, a configured sensor break output power (OP.SbrkOP or OP.SafeOP, if Main.Inhibit is configured), can be output. The user can also switch to manual mode allowing the user to edit the output power. When 'Automatic' is returned-to, the controller again checks for sensor break.

MANUAL MODE

In manual mode:

1. If 'On/Off' control is configured, the output power may be edited by the user but the only values available are: +100% (heat on, cool off) for positive value entries; 0% (heat off, cool off) for zero entry or -100% (heat off, cool on) for negative entries.
2. If PID control is selected, the output may be edited between =100% and (if cool is configured) -100% but the actual output is subject to limiting (both absolute value and rate-of-change of value).
3. For valve position control, the position of the valve can be adjusted by contact closure inputs into a digital input module, driving the output relays directly, or by using OP.NudgeUp or OP.NudgeDn. This control can also be achieved over serial communications.

Caution

Manual control of valve position should be used with discretion, because, unless some position feedback mechanism has been installed to provide an indication of valve position, the operator is working 'blind', and might inadvertently leave the valve in the fully open position.

During manual operation, the loop continues to be monitored, allowing a smooth change when Automatic mode is subsequently selected.

If Auto Tune is enabled (Tune.Enable = Yes) it will remain in a reset state ('Tune.Stage' shows 'Reset'), until the control loop is switched to automatic control, initiating the Auto Tune process.

To provide a strategy that allows both sensor break action (normally supported only in Auto mode) and the ability to write to the output (only supported in manual mode) 'ModeSel.FManSel' can be wired to 'SelMode.SelMan'. Then, if a sensor break occurs the instrument operates in Forced Manual mode ('ModeSel.FManSel' is 'True' and 'Mode' is 'F_Man') and the required output can be written to OP.ManOP.

6.2.1 MAIN PAGE (Cont.)

'MAIN' TAB PARAMETERS

AutoMan	Sets the operating mode of the loop as automatic or manual
Inhibit	No: Loop operates normally. Yes stops the loop and sets the output to a 'safe' value (SafeOP), this value being entered as a part of the Output configuration (section 6.2.6). If an output rate limit is set, then the output ramps to the safe level at that rate, otherwise it performs a step change. If setpoint or manual tracking is enabled (in setpoint configuration (section 6.2.5), Inhibit overrides tracking.
IntHold	Select 'Yes' or 'No'. 'Yes' freezes the integral term at its current value. IntHold ensures that the power is reapplied smoothly after the loop has been broken for service reasons, for example.
ModeSel	Read only value used to show requested modes. (Bit 0 is at the top of the list.) TrackSel. Bit 2 True = Loop output tracking is requested (OP.TrackEn = On). RemSel. Bit 3 True = Use alternative setpoint request (SP.AltSpEn = Yes). AutoSel. Bit 4 True = Automatic mode is requested (Main.AutoMan = Auto) ManSel. Bit 5 True = Manual mode is requested (Main.AutoMan = Man) FmanSel. Bit 7 True = Forced manual mode is requested because PV status is 'Bad' (Main.PVstat = Bad) TuneSel. Bit 8 True = Autotune selected (Tune.Enable = On) PCalSel. Bit 9 True = Potentiometer calibration requested (OP.PotCal = On) InhibSel. Bit 10 True = Stop the loop running and output a safe value (OP.SafeOP)
PV	The value of the process variable input
PVStat	'Good' indicates that the PV is displaying a trusted value derived from the process via an input block. 'Bad' indicates that there has been a hardware failure or that the relevant I/O module is missing.
SelMode	Bitfields used to select controller modes via digital inputs from the strategy. (Bit 0 is at the top of the list.) EnaRem. Bit 3 True = Enable remote mode operation SelAuto. Bit 4 True = Automatic mode unless SelMan = True. SelMan. Bit 5 True = Manual mode selected
TargetSP	Target setpoint. This is the expected operating setpoint value for the loop.
WrkOP	The actual working output value before being split into channels 1 and 2.
WSP	Working Setpoint. The current setpoint being used by the loop.

ALARMS

See section 6.2.8 for a description of the alarms tab.

Combined	Asserted if any block alarm is active.
DevHi, DevLo	Asserted if the error signal value is greater than DevHi or less than DevLo. Remains active until the signal returns withing the DevHi-DevLo band by more than the hysteresis value. (DevHi and DevLo set in the Alarms tab.
Hi	The alarm goes active if the PV value is greater than the 'Hi' value set in the Alarm tab and remains active until the value is less than 'Hi' - 'Hyst'.
Lo	The alarm goes active if the PV value falls below the 'Lo' value set in the Alarm tab and remains active until the value exceeds 'Lo' + 'Hyst'.
HiHi (LoLo)	As for Hi and Lo, above but use the HiHi and LoLo values in the alarm tab.
LpBreak	Active if Diag.LpBreak is 'Yes'
SensorB	Asserted if Diag.SensorB is 'Yes'
Software	Checksum error in the block's RAM data

6.2.2 Set Up tab

Set Up configures the type of control required for each channel.

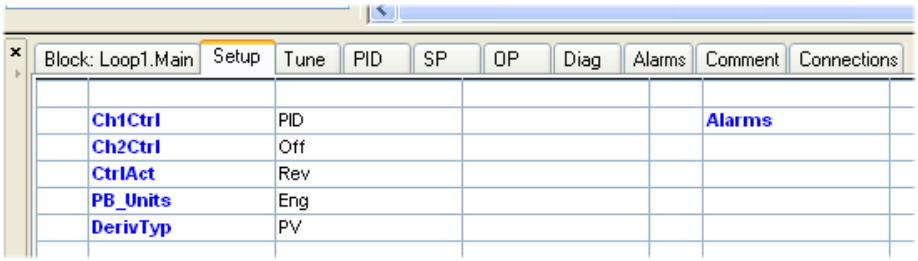


Figure 6.2.2a Setup tab

ON/OFF CONTROL

This form of control turns heating power on when the process value is below the setpoint, and turns it off when it is above the setpoint. If cooling is configured, cooling power is turned on when the process value is above the setpoint, and turned off when it is below the setpoint.
In Direct Acting mode, the behaviour is inverted.
Because of the thermal inertia of the load, a certain amount of oscillation takes place, and this can affect the quality of the product. For this reason, On/Off control is not recommended for critical applications.

Depending on the nature of the process being controlled, some hysteresis may have to be included to prevent continuous operation (chatter) in the controlling device.

PID CONTROL

Also known as 'three term control', this type of control continuously adjusts the output demand, in order to control the process as closely as possible to requirements. PID provides more stable control than On/Off control but is more complex to set up as the parameters must match the characteristics of the process under control.

The three major parameters are: Proportional band (PB), Integral time (Ti) and Derivative time (Td), the output from the controller being the sum of these three terms. This output is a function of the size and duration of the error value and the rate-of-change of the process value.

It is possible to disable the integral and/or derivative terms and control on proportional only, on proportional plus integral (PI) or proportional plus derivative (PD).

PI control is often used when the PV is noisy and/or subject to rapid variations, where derivative action would cause the output power to fluctuate wildly.

PROPORTIONAL BAND (PB)

The proportional band (PB) delivers an output which is proportional to the size of the error signal. It is the range over which the output power is continuously adjustable in a linear fashion from 0% to 100% (for a heat only controller). Below the proportional band the output is full on (100%), above the proportional band the output is full off (0%) as shown in figure 6.2.2b.

The width of the proportional band determines the magnitude of the response to the error. If PB is too narrow (high gain) the system oscillates; if it is too wide (low gain) control is sluggish. The ideal situation is when the proportional band is as narrow as possible without causing oscillation.

Figure 6.2.2a also shows the effect of narrowing proportional band to the point of oscillation. A wide proportional band results in straight line control but with an appreciable initial error between setpoint and actual temperature. As the band is narrowed the temperature gets closer to setpoint until eventually, it becomes unstable.

The proportional band may be set in engineering units or as a percentage of the controller range.

6.2.2 SETUP TAB (Cont.)

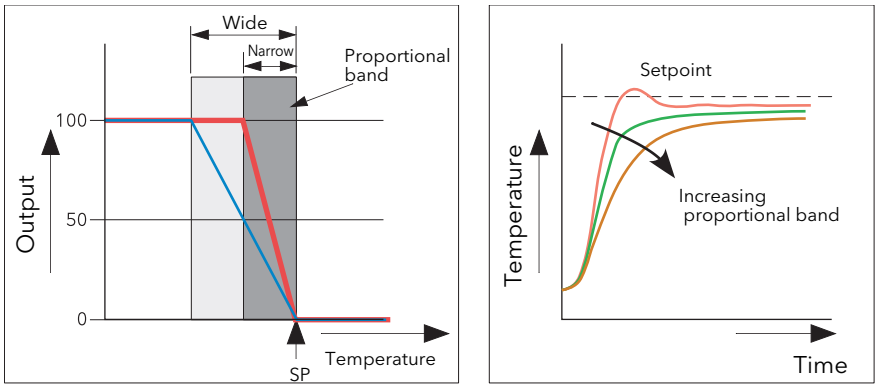


Figure 6.2.2a Proportional band action (reverse acting)

INTEGRAL TERM (TI)

In a proportional only controller, as seen in the previous section, an error must exist between setpoint and PV in order for the controller to deliver power. Integral is used to achieve zero steady state control error.

The integral term slowly modifies the output level as a result of any error between setpoint and measured value. If the measured value is below setpoint the integral action gradually increases the output in an attempt to correct the error. If it is above setpoint integral action gradually decreases the output or increases the cooling power to correct the error.

Figure 6.2.2b shows proportional plus integral action.

The integral term is set in seconds. The longer the integral time constant, the more slowly the output is modified and the more sluggish the response. Too small an integral time causes the process to overshoot, and perhaps to start oscillating. The integral action may be disabled by setting its value to Off.

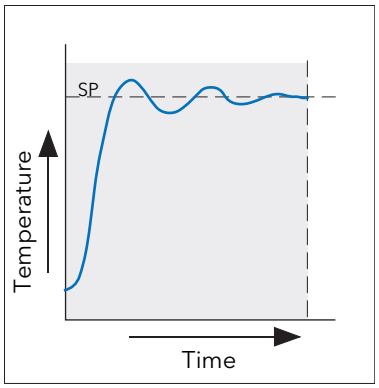


Figure 6.2.2b
Proportional + Integral Control

DERIVATIVE TERM (TD)

Derivative (or rate) action provides a sudden change in output linked to the rate of change in error, whether this is caused by PV alone (derivative on PV) or by a change in the SP as well (derivative on error selection). If the measured value falls quickly, derivative provides a large change in output in an attempt to correct the perturbation before it goes too far. It is most beneficial in recovering from small perturbations.

Derivative is used to improve the performance of the loop. There are, however, situations where derivative may be the cause of instability. For example, if the PV is noisy, then derivative can amplify that noise and cause excessive output changes, in these situations it is often better to disable the derivative and re-tune the loop.

Derivative should not be used to curb overshoot in situations when the output is saturated at Op High or Op Low for extended periods, such as process start up, since to do so degrades the steady state performance of the system. Overshoot inhibition is best left to the approach control parameters, High and Low Cutback.

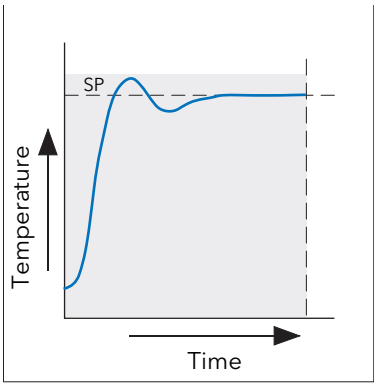


Figure 6.2.2c
Proportional + Integral +
Derivative Action

If Derivative is set to Off, no derivative action will be applied.

Derivative can be calculated on change of PV or change of Error. If configured on error, then changes in the setpoint will be transmitted to the output. For applications such as furnace temperature control, it is common practice to select Derivative on PV to prevent thermal shock caused by a sudden change of output as a result of a change in setpoint.

In addition to the PID terms described above other parameters that determine the control loop performance include Cutback terms, Relative Cool Gain and Manual Reset.

6.2.2 SETUP TAB (Cont.)

VALVE POSITION CONTROL

Valve Position Control is designed specifically for controlling motorised valves and can be specified either as boundless (VPU) or as bounded (VPB) mode.

Boundless VP (VPU) is a velocity mode algorithm that directly controls the direction and velocity of the movement of the valve in order to minimise the difference between the SP and the PV. It uses triac or relay outputs to drive the valve motor.

A feedback potentiometer is not required for VPU control, but can be used to provide indication of the valve position.

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

Control is performed by delivering a 'raise' pulse, a 'lower' pulse or no pulse in response to the control demand signal via relay or triac outputs.

MANUAL MODE

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

In boundless mode the algorithm is a velocity mode positioner. When manual is selected then the up and down arrow produce +100% or –100% velocity respectively for the duration of the key press.

In boundless mode it is essential that the motor travel time is set accurately in order to allow the integral time to calculate correctly. Motor travel time is defined as (valve fully open – valve fully closed). This is not necessarily the time printed on the motor since, if mechanical stops have been set on the motor, the travel time of the valve may be different.

Every time the valve is driven to its end stops the algorithm is reset to 0% or 100% to compensate for any changes which may occur due to wear in linkages or other mechanical parts.

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

Motorised Valve Output configuration automatically configures the second channel once the first has been setup, e.g. if 'OP.Ch2Outpt' is wired and configured as cooling, then 'OP.Ch1Outpt' is automatically wired and configured as heating.

SETUP TAB PARAMETERS

Ch1Ctrl	Select Off/On, PID, VBU or VPB from the pull down table for channel 1.
Ch2Ctrl	As above, but for channel 2
CtrlAct	'Rev' = Reverse acting. This is the normal negative feedback mode of operation for heating, where the output is increased when the PV is below SP. Dir = Direct acting. This positive feedback mode is the opposite of reverse acting, the output being decreased when the PV is below SP.
PB Units	Select 'Eng' or 'Percent'.
DerivTyp	Select 'PV' or 'Error'. for 'PV' the loop calculations occur only when PV changes. For 'Error', the calculations occur when either of PV or SP changes.

6.2.3 Tuning tab

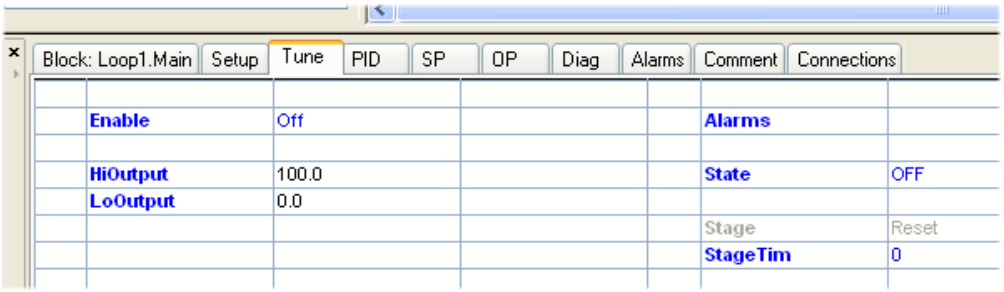


Figure 6.2.3a Tuning tab

The balancing of the P, I and D terms varies from process to process. In a plastics extruder, for example, there are different responses to a die, casting roll, drive loop, thickness control loop or pressure loop. In order to achieve the best performance from an extrusion line all loop tuning parameters must be set to their optimum values.

Tuning involves setting the following PID tab parameters (section 6.2.4):

Proportional Band (PB), Integral Time (Ti), Derivative Time (Td), Cutback High (CBH), Cutback Low (CBL), and Relative Cool Gain (R2G - applicable to heat/cool systems only).

The recorder/controller is shipped with these parameters set to default values and in many cases the default values give adequate, stable, straight-line control, but the response of the loop may not be ideal. Because process characteristics vary it is often necessary to adjust the control parameters to achieve best control. To determine the optimum values for any particular loop or process it is necessary to carry out a procedure called loop tuning. If significant changes are later made to the process which affect the way in which it responds it may be necessary to retune the loop.

Users have the choice of tuning the loop automatically or manually. Both procedures require the loop to oscillate and both are described in the following sections.

Before the Tuning process begins, it is recommended:

1. the tuning process is always started when PV and SP are not in close proximity. This allows start up conditions to be measured and CutBack High (CBH), and CutBack Low (CBL) values to be calculated more accurately.
2. tuning should be attempted only during dwell periods and not during ramp stages. If a control loop is tuned automatically, set 'Main.IntHold' to Yes during each dwell period while Auto Tune is active. It may be worth noting that tuning, carried out in dwell periods that are at different extremes of temperature can give different results owing to non linearity of heating or cooling. This can provide a convenient way of establishing Gain Scheduling values.
3. the 'OP.OutputHi' and 'OP.OutputLo' parameters are configured, as required. These overall output limit parameters apply both during tuning and during normal operation.
4. the 'Tune.HiOutput' and 'Tune.LoOutput' parameters are configured, as required. These output power limit parameters apply during the Auto Tune function.

> The 'tighter' power limit will always apply, e.g. if 'Tune.HiOutput' is set to 80% and 'OP.OutputHi' is set to 70%, the output power will be limited to 70%. The measured value must oscillate to some degree for the tuner to be able to calculate values: the limits must be set so as to allow oscillation about the SP.

6.2.3 TUNING TAB (Cont.)

LOOP RESPONSE

Ignoring loop oscillation, there are three categories of loop performance: Under damped, Critically damped and Over damped:

UNDER DAMPED

In this situation the parameters are set to prevent oscillation but lead to an overshoot of the Process Value (PV) followed by decaying oscillation until the PV finally settles at the Setpoint. This type of response can give a minimum time to Setpoint but overshoot may cause problems in certain situations and the loop may be sensitive to sudden changes in PV, resulting in further decaying oscillations before settling once again.

CRITICALLY DAMPED

This represents an ideal situation where noticeable overshoot to small step changes does not occur and the process responds to changes in a controlled, non oscillatory manner.

OVER DAMPED

In this situation the loop responds in a controlled but sluggish manner which results in a non-ideal and unnecessarily slow loop performance.

INITIAL SETTINGS

In addition to the tuning parameters listed above, there are a number of other parameters which can affect loop response. These parameters must be correctly configured before tuning is initiated. Parameters include, but are not limited to:-

SETPOINT

Before tuning, the loop conditions should be set as closely as practicable to the actual conditions which will be met in normal operation. For example, in a furnace or oven application a representative load should be included, an extruder should be running, etc.

OUTPUTHI, OUTPUTLO

These OP tab heat and cool limits define the overall maximum and minimum power which may be delivered to the process by the control loop. For a heat only controller the default values are 0 and 100%. For a heat/cool controller the defaults are -100 and 100%. Although most processes are designed to work between these limits there may be instances where it is desirable to limit the power delivered to the process.

REMOPL, REMOPH

If these Remote Output Limits parameters (OP tab) are used, they are effective only if they lie within the Heat/Cool Limits above.

HEAT/COOL DEADBAND

Heat/Cool Deadband If a second (cool) channel is configured, a parameter 'OP.Ch2DeadB' is also available in the Output tab which sets the distance between the heat and cool proportional bands. The default value is 0% which means that heating will cease to be available at the same time as cooling becomes available. The dead band may be set to ensure that there is no possibility of the heat and cool channels operating together, particularly when cycling output stages are installed.

MINIMUM ON TIME

If either or both of the output channels is fitted with a relay or logic output, the parameter 'Min On Time' appears in the output menu. This is the cycling time for a time proportioning output and should be set correctly before tuning is started.

RATESP

Sets the maximum PID rate-of-change. The output rate limit is active during tuning and can affect the tuning results. RateSP is useful in preventing rapid changes in output from damaging the process or heater elements. The parameter is found in the 'SP' tab (section 6.2.5) .

6.2.3 TUNE TAB (Cont.)

INITIAL SETTINGS (Cont.)

CH1TRAVT, CH2TRAVT

Valve Travel Time. If the output is a motor valve positioner the 'Ch1TravT' and Ch2TravT' Output tab parameters must be set correctly. The valve travel time is the time taken for the valve to travel from 0% (closed) to 100% (open). This may be different from the motor travel time limits because the mechanical linkage between the motor and the valve, setting of limit switches etc. can modify behaviour.

OTHER TUNING CONSIDERATIONS

If a process includes adjacent interactive zones, each zone should be tuned independently with the adjacent zones at operating temperature.

It is recommended that a tuning process be initiated when the PV and setpoint are far apart. This allows start up conditions to be measured and cutback values to be calculated more accurately. Cutback is not set for 'Tune at setpoint'.

In a programmer/controller tuning should only be attempted during dwell periods and not during ramp stages. If a programmer/controller is tuned automatically the controller should be placed in 'Hold' during each dwell period whilst autotune is active.

Note: Tuning, carried out in dwell periods which are at different extremes of temperature may give different results owing to non linearity of heating (or cooling). This may provide a convenient way to establish values for Gain Scheduling.

If an auto tune is initiated two further parameters ('High Output' and 'Low Output') which must be set.

High Output	Sets a high output limit to be imposed during autotune. Must be ≤ Output High, set in the Output menu.
Low Output	Sets a low output limit to be imposed during autotune. Must be ≥ Output Low, set in the Output menu.

The above values must be set correctly, otherwise sufficient power to achieve SP might not be available during tuning, and the tune will eventually fail.

AUTOTUNE

Autotune automatically sets the following PID tab parameters (section 6.2.4):

PB	Proportional band.
Ti	Integral time. If previously set to 'Off' Ti will remain off after an autotune.
Td	Derivative time. If previously set to 'Off' Td will remain off after an autotune.
CBH, CBL	Cutback high and low values. If either is set to 'Auto', it will remain so after auto tuning. In order that Autotune set the cutback values for the user, a value other than 'Auto' must be selected before Autotune is initiated. Autotune never returns cutback values less than 1.6 × PB
R2G	Calculated only if the unit is configured as Heat/Cool. Following an Autotune, R2G lies between 0.1 and 10. If the calculated value lies outside this range, a 'Tune Fail' alarm is set. See 'Relative Cool Gain' (section 6.2.4) for more details.
LBT	Loop break time. Following an autotune, LBT is set to 2 × Ti (if Ti was not previously set 'Off'), or to 12 × Td (if Ti was previously set to 'Off').

6.2.3 TUNE TAB (Cont.)

AUTOTUNE (Cont.)

Autotune 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 unsatisfactory (because its characteristics have changed), it may be necessary to tune again for the new conditions.

The auto tune algorithm reacts in different ways depending on the initial conditions of the plant. The explanations given later in this section are for the following example conditions:-

1. Initial PV is below the setpoint and, therefore, approaches the setpoint from below for a heat/cool control loop
2. As above, but for a heat only control loop
3. Initial PV is at the same value as the setpoint (tune at setpoint). That is, within 0.3% of the range of the controller if 'PB Units' (Setup tab) is set to 'Percent', or ±1 engineering unit (1 in 1000) if the 'PB Units' is set to 'Eng'. Range is defined as 'Range High' – 'Range Low' for process inputs or the thermocouple or RTD range defined in section A3 for temperature inputs. If the PV is just outside the range stated above the autotune will attempt a tune from above or below SP.

AUTOTUNE AND SENSOR BREAK

When the controller is autotuning and sensor break occurs, the autotune aborts and the controller outputs the sensor break output power 'Sbrk OP' set up in the OP tab (section 6.2.6). Autotune must be re-started when the sensor break condition is no longer present.

AUTOTUNE AND INHIBIT

If the controller is in autotune when 'Inhibit' is asserted, the tune goes to the Off state (Stage = Reset). On inhibit being released the controller will re-start autotune.

AUTOTUNE AND GAIN SCHEDULING

When gain scheduling is enabled and an autotune is performed, the calculated PID values are written into the PID set that is active, on completion of the tune. Therefore, the user may tune within the boundaries of a set and the values will be written into the appropriate PID set. However, if the boundaries are close (because the range of the loop is not large), then, at the completion of the tune, it cannot be guaranteed that the PID values will be written to the correct set particularly if the schedule type is PV or OP. In this situation the scheduler ('Sched Type') should be switched to 'Set' and the 'active set' chosen manually.

INITIAL CONDITIONS

Configure the parameters described above.

Notes:

1. The 'tighter' power limit applies. For example, if 'Tune.HiOutput' is set to 80% and 'OP.OutputHi' is set to 70% then the output power will be limited to 70%
2. The PV must oscillate to some degree to allow the tuner to calculate the relevant values. The limits must be set so as to allow oscillation about the setpoint.

INITIATING THE AUTOTUNE

In the Loop Tune tab for the relevant loop, set 'TuneEn' to 'On'.

6.2.3 TUNE PAGE (Cont.)

TUNING FROM BELOW SP (HEAT/COOL CONTROL LOOP)

The point at which automatic tuning is performed (Tune Control Point), is designed to operate just below the Target SP (LOOP_PID block - Main.TargetSP) - the expected operating value of the process. Using a Tuning Control Point configured below the Target SP ensures the process is not significantly overheated or overcooled and is calculated as,

Tune Control Point = Initial PV + 0.75 (Target SP – Initial PV) where the initial PV is the PV measured after a settling period of 1 minute.

Example

If Target SP = 500°C and Initial PV = 20°C, the Tune Control Point is calculated at 380°C.

If Target SP = 500°C and Initial PV = 400°C, the Tune Control Point is calculated at 475°C.

Any overshoot is likely to be smaller in the second example because the process temperature is already close to the Target SP.

When automatically tuning a heat/cool control loop and the Initial PV is below the SP, a number of cycles are run to calculate the PID tuning parameters.

1. Auto Tune is started, 'Tune.Enable' is set 'On' (A), but both heating and cooling power remain off for 1 minute (A - B) to allow the algorithm to establish steady state condition. Initial PV is then calculated.
2. First heat/cool cycle (B - D) establishes the first overshoot used to calculate 'PID.CBL' if it is not set to Auto.
3. Two cycles of oscillation (B - F) are produced to measure the peak to peak response, the true period of oscillation, and calculate the PID terms.
4. An extra heat stage (F - G) is applied and all power is turned off to allow the plant to respond naturally. During this period the 'PID.R2G' is calculated, then 'PID.CBH 'is calculated using the sum 'PID.CBL x PID.R2G'.
5. Auto Tune is complete ('Tune.Enable' is set 'Off ') (H). The control loop is now operating at the Target SP using the automatically tuned PID term values.

Note: This operation also applies if the Initial PV is above SP, but in this case the process starts with full cooling applied from (B), and not full heating.

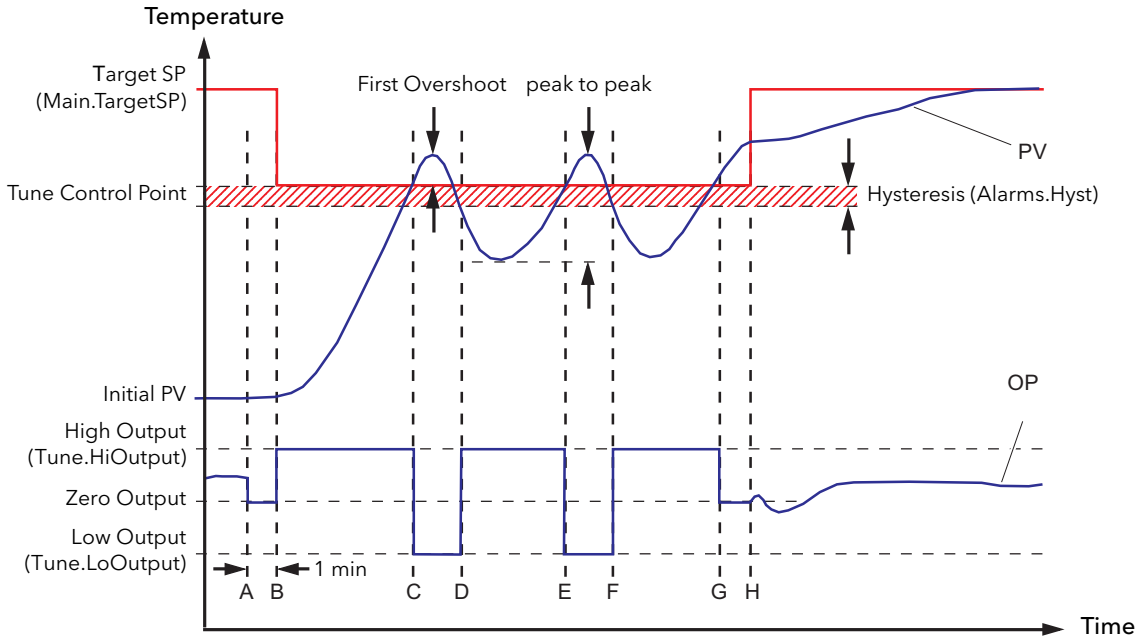


Figure 6.2.3b Tuning from below SP - Heat/Cool control loop

6.2.3 TUNE PAGE (Cont.)

TUNING FROM BELOW SP (HEAT ONLY CONTROL LOOP)

When automatically tuning a heat only control loop and the Initial PV is below the SP, a number of cycles are run to calculate the PID tuning parameters. The operation is similar to the heat/cool control loop, but because a cooling channel does not exist, it completes prematurely, ignoring the PID.R2G (set to '1' for heat-only control loops).

1. Auto Tune is started ('Tune.Enable' set 'On') (A) but heating power remains off for 1 minute (A - B) to allow the algorithm to establish steady state condition 'Initial PV' is then calculated.
2. First heat cycle (B - D) establishes the first overshoot used to calculate 'PID.CBL' (if it is not set to Auto). 'PID.CBH' is set to the same value.
3. Two cycles of oscillation (B - F) are produced to measure the peak to peak response and the true period of oscillation. The PID terms are then calculated.
4. Auto Tune is complete ('Tune.Enable' is set 'Off') (F). The control loop is now operating at the Target SP using the automatically tuned PID term values.

Note: This operation also applies if the Initial PV is above SP, but will start with full cooling applied from (B), instead of full heating. 'PID.CBH' is calculated (not PID.CBL), and 'PID.CBL' is set to the same value as 'PID.CBH'.

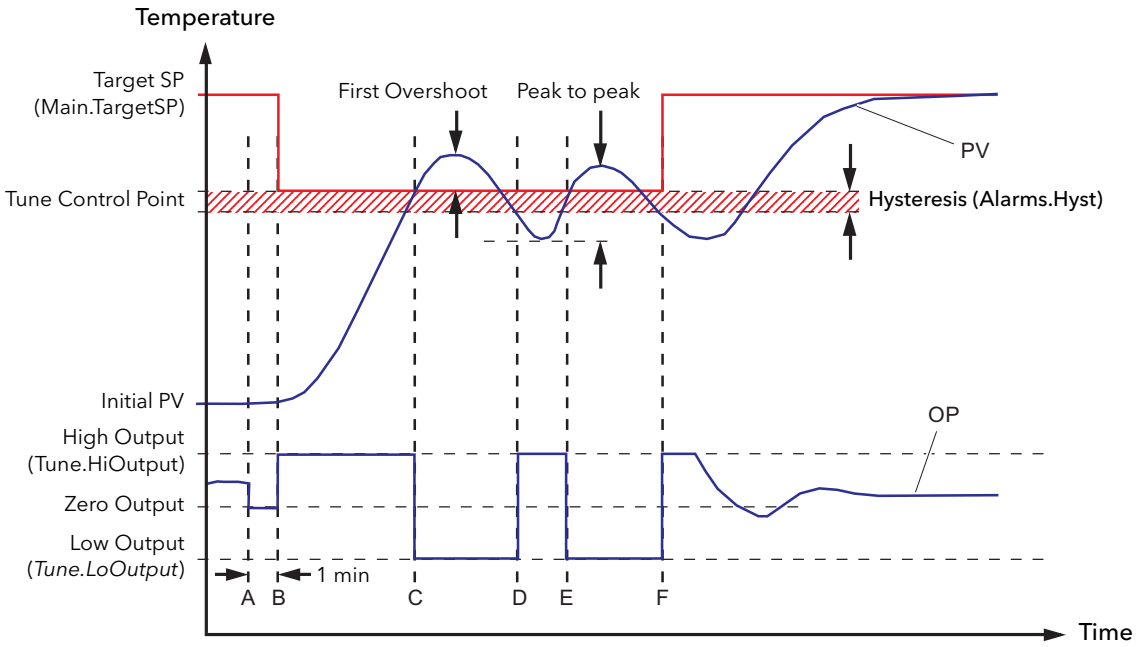


Figure 6.2.3c Tuning from below SP - Heat only control loop

6.2.3 TUNE PAGE (Cont.)

TUNING AT SP (HEAT/COOL AND HEAT ONLY)

When automatically tuning either type of control loop and the Initial PV is configured at the same value as the SP, a number of oscillations are produced to calculate the PID tuning parameters. This operation does not calculate 'PID.CBH' and 'PID.CBL' because there is not an initial start up response to the application of heating or cooling.

Note: 'PID.CBH' and 'PID.CBL' will never return a value less than 1.6 x PB.

1. Auto Tune is started ('Tune.Enable' set 'On') (A). The output is frozen at the current value for 1 minute (A - B), and the SP must remain within 0.3% of the range of the control (if Setup.PB_Units is set to %), or ± 1 engineering unit (if set to 'Eng'). Range is defined using the 'SP.RangeHi', and 'SP.RangeLo' parameters. If during this period the PV drifts outside these conditions Auto Tune is aborted, and resumed from above or below SP depending on which way the PV has drifted.
   A Tune Control Point is not used because the loop is already at SP.
2. Cycles of oscillation (C - G) are produced by switching the output between the output limits. The peak to peak response and the period of oscillation are measured, and the PID terms are calculated.
3. An extra heat stage (G - H) is applied and all power is turned off (H) to allow the plant to respond naturally. During this period 'PID.R2G' is calculated.
4. Auto Tune is complete ('Tune.Enable' set 'Off') (I). The control loop is now operating at the Target SP using the automatically tuned PID term values.

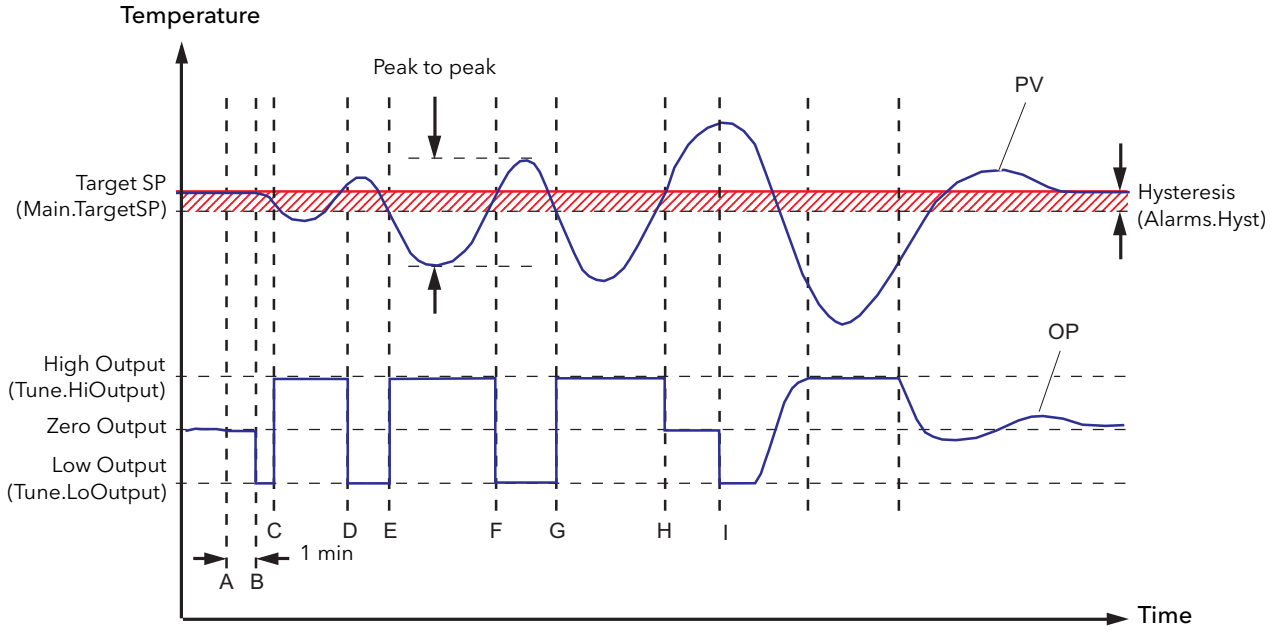


Figure 6.2.3d Tuning from below SP - Heat/Cool and Heat only control loop

6.2.3 TUNE TAB (Cont.)

MANUAL TUNING

If, for any reason, automatic tuning gives unsatisfactory results the controller can be tuned manually. There are a number of standard methods for manual tuning, the Zeigler-Nichols method being described here:

1. Adjust the setpoint to its normal running conditions (assumed to be above the PV so that 'heat only' is applied.
2. Set the integral and derivative times (PID.Ti and PID.Td) to 'Off'
3. Set High and Low cutback (PID.CBH and PID.CBL) to 'Auto'.
4. If the PV is stable (not necessarily at the setpoint), reduce the proportional band (PB) such that the PV just starts to oscillate, leaving time between adjustments to allow the loop to stabilise. Make a note of the PB at this point (PB′), and also note the oscillation period ('T').
   If the PV is already oscillating measure the oscillation period ('T') and then gradually increase PB to the point at which oscillation just ceases. Make a note of the PB at this point (PB′).
5. If the controller is fitted with a cooling channel, enable this now.
6. Observe the oscillation waveform and adjust 'PID.R2G' until a symmetrical wave form is observed (Figure 6.2.4e).
7. Set 'PID.PB', 'PID.Ti' and 'PID.Td' according to table 6.2.3

Control type	PID.PB	PID.Ti	PID.Td
Proportional only	2 × PB′	Off	Off
P + I	2.2 × PB′	0.8 × T	Off
P + I + D	1.7 × PB′	0.5 × T	0.12 × T

Table 6.2.3 Calculate parameter values

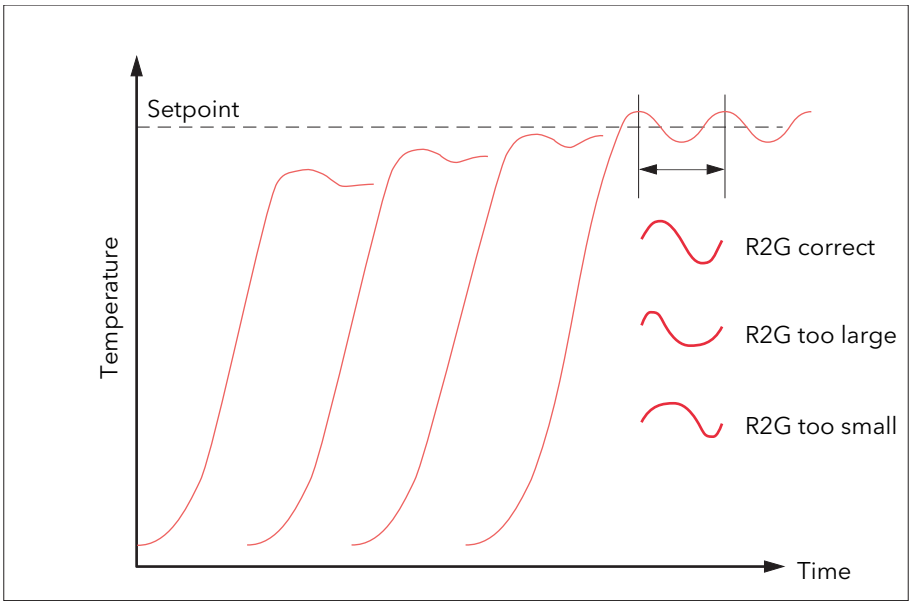


Figure 6.2.3e Relative Cool Gain waveform tuning

6.2.3 TUNE TAB (Cont.)

CUTBACK VALUES

The PID terms calculated from Table 6.2.3, above, should be entered before the cutback values are set.

The above procedure sets up the parameters for optimum steady state control. If unacceptable levels of overshoot or undershoot occur during start-up, or after large step changes in PV, then the cutback parameters should be set manually, as follows:

1. Initially set the cutback values to one proportional bandwidth converted into display units. This can be calculated by taking the value in percent that has been installed into the parameter 'PID.PB' and entering it into the following formula:

   PB/100 × Span of controller = Cutback High and Cutback Low
   For example, if PB = 10% and the span of the controller is 0 to 1200°C, then
   Cutback High = Cutback Low = 10/100 × 1200 = 120
2. If overshoot is observed following the correct settings of the PID terms increase the value of 'PID.CBL' by the value of the overshoot in display units. If undershoot is observed increase the value of the parameter 'PID.CBH' by the value of the undershoot in display units.

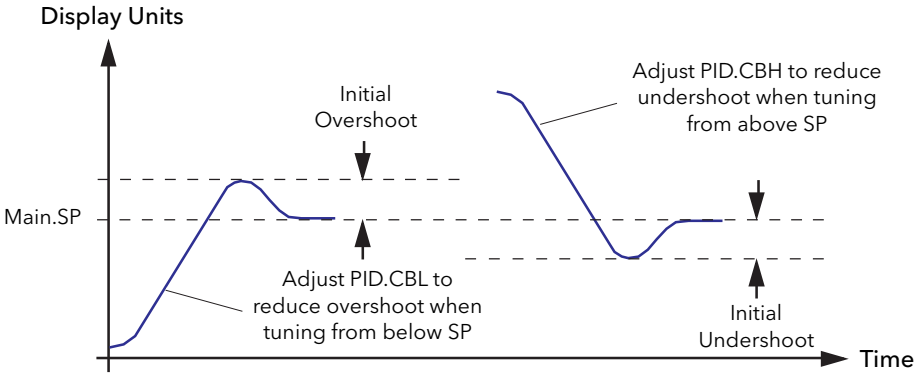


Figure 6.2.3f CutBack High (PID.CBH) and CutBack Low (PID.CBL) manual tuning

TUNE TAB PARAMETERS

See section 6 of the LINblocks reference manual for full details.

Enable	'On' initiates the autotune process.
HiOutput	Specifies the maximum allowable percentage power level to be output during the tuning process.
LoOutput	Specifies the minimum allowable percentage power level to be output during the tuning process.
State	Shows the status of the autotune as Off, Running, Ready, Complete,Timeout, Ti_limit or R2G limit
Stage	Shows the progress of the autotune as: Reset, None, Monitor, CurrentSP, NewSP, ToSP, Max or <in.
StageTim	Shows the time since the latest change in 'Stage' occurred.

6.2.4 PID tab

The PID parameters are used to optimise the control of the loop.

If the loop is configured for On/Off Control, only the PID.LBTn is available.

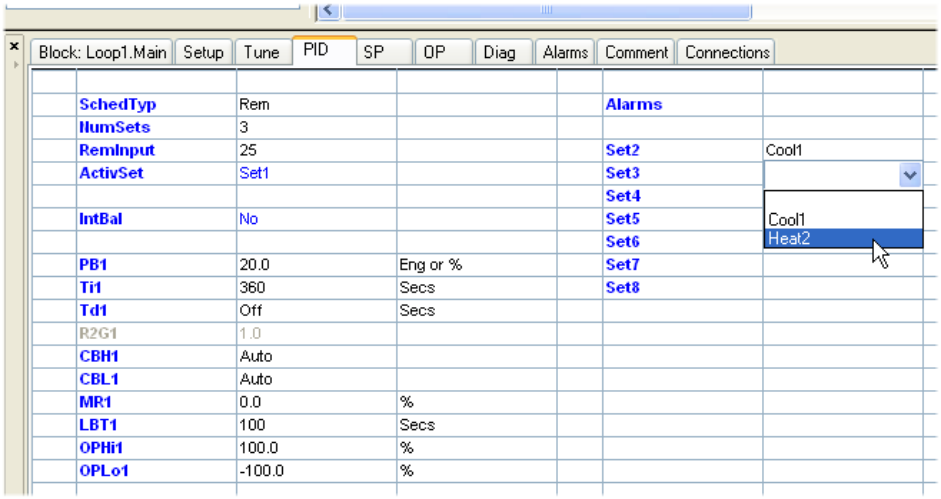


Figure 6.2.4a PID tab

PID TAB PARAMETERS

Note: In the following list, the parameters with suffix '1' refer to PID set 1. The identical parameters for other PID sets are to be found in the associated 'Tune_Set' blocks, as is the parameter 'Bound' which sets the transition value from the previous set.

ActivSet	Shows which PID set is currently being used.
CBH1, CBL1	Cutback high and cutback low are values that modify the amount of overshoot, or undershoot, that occurs as a result of a large step change in PV (under start-up conditions for example). They are independent of other PID terms which means that the PID terms can be set for optimal steady state control, leaving it up to the cutback values to control any overshoot. Described in more detail, below.
IntBal	'On' means that the integral balance calculation is applied to prevent abrupt changes in output power.
LBT1	Loop Break Time. A loop break is deemed to have occurred if the PV does not respond to a change in output power within the Loop Break Time.
MR1	Manual Reset. The output power setting required to eliminate steady-state errors from proportional control mode operation. This value is introduced into the output to force the PV to equal the setpoint.
PB1	Specifies the proportional band value (section 6.2.2) for Set 1.
OPHi1, OPLo1	Maximum and minimum output limits for set 1.NumSetsSpecifies the number of PID sets to be used (maximum eight). Each additional set is configured in an individual Tune_Set block and is associated using Set2 to SetN (where N = NumSets value) A TuneSet block called 'Heat2' is being associated with Set3 in the figure above). The relevant Tune_Set blocks ('Cool1' and 'Heat2' in our example) must exist before 'NumSets' parameters can be edited.
R2G1	For loops where cooling has been configured, this 'Relative Cool gain' value compensates for the different heating and cooling efficiencies of the process plant. Described in more detail below.
RemInput	If SchedTyp (above) is set to 'Rem', then this 'RemInput' value is used to determine which PID set is to be used.

6.2.4 PID TAB (Cont.)

SchedTyp	Specifies a method for transferring from one PID set to the next.	
	Off	A PID set is not used.
	Manual	The required PID set is selected by the operator
	SP	Selection of the PID set is controlled by the value of the working setpoint value (Main.WSP). An internal hysteresis value of 0.1% of loop span is included.
	PV	Selection of the PID set is controlled by the value of the process variable value (Main.PV). An internal hysteresis value of 0.1% of loop span is included.
	Error	Selection of the PID set is controlled by the difference between the values of the working setpoint (Main.WSP) and the process variable value (Main.PV). An internal hysteresis value of 0.1% of loop span is included.
	OP	The PID set selection is derived from the working output value (Main.WrkOP) and includes an internally defined hysteresis of 0.5% of output span
	Rem	PID set selection is derived from the value of a remote input parameter (PID.RemInput). An internally defined hysteresis of 0.1% of loop span is included.
Ti1	Integral time (Section 6.2.2) for Set 1. Off = integrative action disabled	
Td1	Derivative time (Section 6.2.2) for Set 1. Off = derivative action disabled	

RELATIVE COOL GAIN (R2G))

Relative Cool Gain (R2G) is a tuning parameter corresponding to the gain of channel 2 control output, relative to the channel 1 control output.

R2G compensates for the different quantities of power available to heat, as opposed to that available to cool, a process, e.g. water cooling applications might require an R2G value of 0.25 because cooling is four times more effective than the heating process.

R2G is set automatically when the Autotune process is performed.

HIGH AND LOW CUTBACK (CBH AND CBL)

The CutBack High (PID.CBH), and CutBack Low (PID.CBL), are values that modify the amount of overshoot, or undershoot, that occurs during large step changes in PV (under start-up conditions for example). Cutback is independent of the PID terms, which means that the PID terms can be set for optimal steady state response, while the CBH and CBL are used to modify any overshoot that may be present.

Cutback involves moving the PB towards a cutback point nearest the measured value whenever the latter is outside the PB and the power is saturated (at 0 or 100% for a heat only controller). The PB moves downscale to the lower cutback point and waits for the measured value to enter it. It then escorts the measured value with full PID control to the SP. In some cases it can cause a 'dip' in the measured value as it approaches SP, see below, but generally decreases the time needed to bring the process into operation.

The action described above is reversed for falling temperature.

If PID.CBH and PID.CBL are set to Auto, the values are automatically configured to 3 x PB..

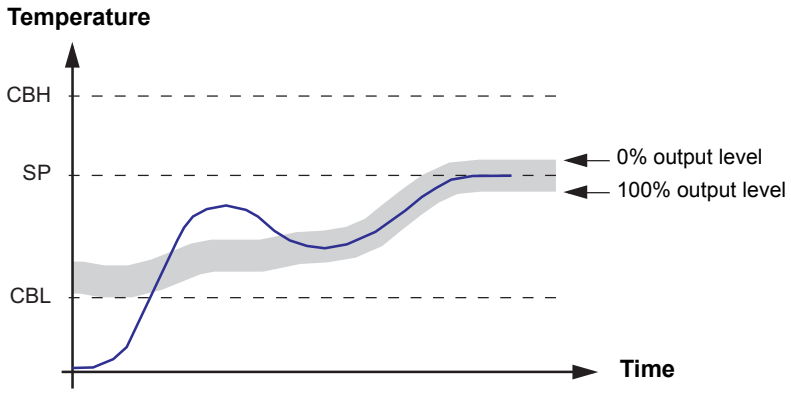


Figure 6.2.4b High and Low Cutback (CBH and CBL) configuration

6.2.4 PID TAB (Cont.)

MANUAL RESET (MR)

In a PID control, 'Ti' automatically removes the steady state error from the SP. If the PID control is changed to PD control, 'Ti' is set to 'OFF' and under these conditions the measured value may not settle precisely at SP. The MR parameter represents the value of the power output that will be delivered when the error is 0 (zero). To remove the steady state error, the MR value must be configured manually.

LOOP BREAK

Loop Break attempts to detect loss of restoring action in the control loop by checking the control output, the process value and its rate of change. Since response times vary from process to process, the Loop Break Time (LBT) parameter allows a time to be set before a Loop Break Alarm (LpBreak - see section 6.2.7 'Diagnostics tab') becomes active. LBT is set automatically in Autotune.

The Loop Break Alarm parameter has no direct effect on control. In order to define behaviour under Loop Break conditions, the parameter must be wired, for example, to a relay, which can then activate an external indicator.

It is assumed that, so long as the requested output power is within the output power limits of a control loop, the loop is operating in linear control and is therefore not in a loop break condition. If, however, the output becomes saturated then the loop is operating outside its linear control region. If the output remains saturated at the same output power for a significant duration, then this might be symptomatic of a fault in the control loop. The source of the loop break is not important, but the loss of control could be catastrophic.

Since the worst case time constant for a given load is usually known, a worst case time can be calculated over which the load should have responded with a minimum movement in temperature. By performing this calculation the corresponding rate of approach towards setpoint can be used to determine if the loop can no longer control at the chosen setpoint. If the PV was drifting away from the setpoint or approaching the setpoint at a rate less than that calculated, the loop break condition would be met.

If an autotune is performed the loop break time is automatically set to Ti × 2 for a PI or PID loop, or to 12 × Td for a PD loop. For an On/Off controller loop break detection is based on loop range settings as 0.1 × Span where Span = Range High – Range Low. Therefore, if the output is at limit and the PV has not moved by 0.1Span in the loop break time a loop break will occur.

If the loop break time is 0 (off) the loop break time can be set manually. Then, if the output is in saturation and the PV has not moved by >0.5 × Pb in the loop break time, a loop break condition is considered to have occurred.

Note: If the time configured in LBTn is 0(off), loop break detection is disabled.

6.2.4 PID TAB (Cont.)

GAIN SCHEDULING

In some processes the tuned PID set may be different at low temperatures from that at high temperatures particularly in control systems where the response to the cooling power is significantly different from that of the heating power, or when changes in the process have occurred. Gain scheduling allows a number of PID sets to be stored and provides automatic transfer of control between one set of PID values and another. For this instrument, the maximum number of sets is three which means that two boundaries are provided to select when the next PID set is used. When a boundary is exceeded the next PID set is selected bumplessly. Hysteresis is used to stop scheduling oscillation at the boundaries.

Gain scheduling is basically a look up table which can be selected using different strategies or types. Auto tune tunes to the active scheduled PID set.

The following Gain Scheduled types are offered from parameter 'SchedTyp':

Set	Required set selected by the user. Alternatively soft wiring may be used to control the PID set selection
Setpoint	Transfer between sets is dependent on the setpoint value
PV	Transfer between sets is dependent on the process value
Error	Transfer between sets is dependent on the Error value
Output	Transfer between sets is dependent on the output demand value
Remote	A remote parameter may be wired into the scheduler. The PID set is then selected according to the value of this input.

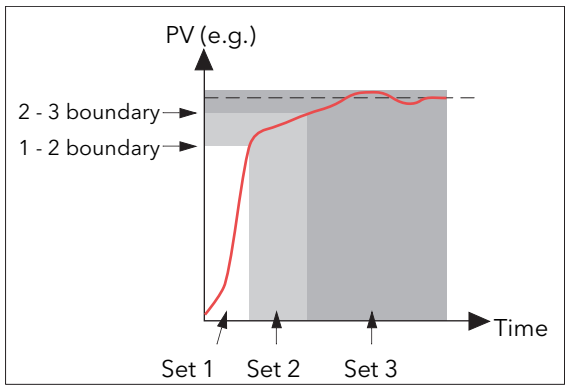


Figure 6.2.4c gain scheduling

6.2.5 SP tab



RangeHi	1372.0	Eng	Alarms		
RangeLo	-200.0	Eng			
			SPTrim	0.0	Eng
SPselect	SP1		SPTrimHi	0.0	Eng
			SPTrimLo	0.0	Eng
SP1	100.0	Eng			
SP2	0.0	Eng	ManTrack	Off	
SPHiLim	1372.0	Eng	SPTrack	Off	
SPLoLim	-200.0	Eng			
			TrackPV	0.0	Eng
AltSPEn	No		TkPVstat	Good	
AltSP	0.0				
			TrackSP	0.0	Eng
RateSP	20.0	Eng/Min			
			SPIntBal	Off	
RateDone	No				
SPRateDs	Yes				
ServToPV	Yes				

Figure 6.2.5a SP tab parameters

The SetPoint (SP) tab provides parameters for configuring the control loop setpoint. The control SP, defined as the Working SetPoint (Main.WSP), is the value used to control the PV in a control loop, and can be:

1. SP.SP1 or SP.SP2 (configured by the user and switched into use by an external signal or via a user interface).
2. SP.AltSP, an external (remote) analogue source

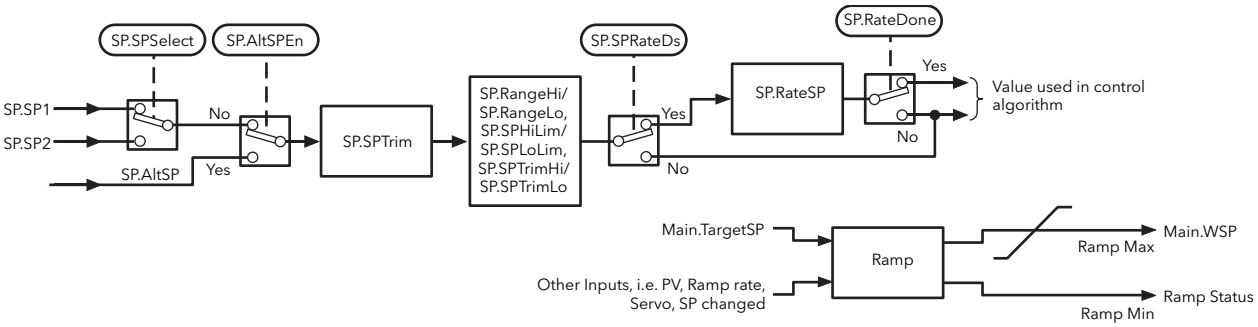


Figure 6.2.5b Set Point page block diagram

When the control loop is configured, changes to the Target setpoint can cause abrupt changes to the output value. By configuring Setpoint Integral Balance ('SP.SPIntBal'), abrupt changes, can be prevented, and the output power gradually changed in accordance with the demand by a user via a User Screen.

This page also provides the facility to limit the rate of change of the setpoint before it is applied to the control algorithm and provides upper and lower setpoint limits ('SP.SPHiLim' and 'SP.SPLoLim'), for the local setpoints 'SP.SP1' and 'SP.SP2'.

'SP.RangeHi' and 'SP.RangeLo' provide range information for the control loop in the control calculation to generate the Proportional Bandwidth (Span = SP.RangeHi - SP.RangeLo). These parameters affect all SP values.

User configurable methods for tracking are available, providing smooth transfers between SP values and between operational modes

6.2.5 SP TAB (Cont.)

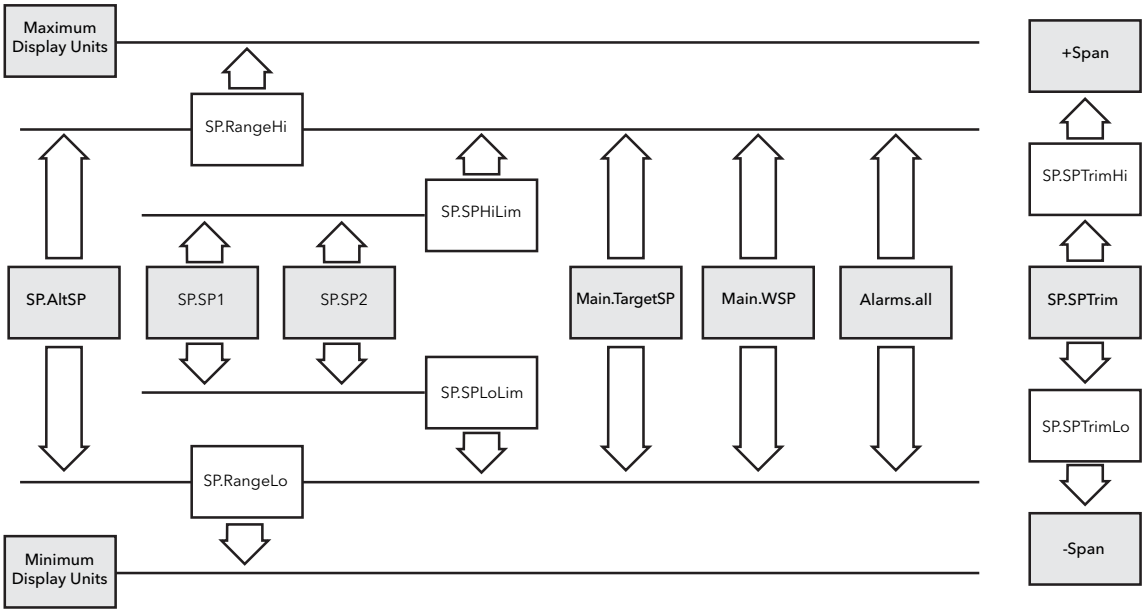


Figure 6.2.5c Setpoint Limits

SETPOINT RATE LIMIT ('RATESP')

'RateSP', allows the rate of change of setpoint to be limited to prevent step changes in the setpoint. The parameter is a symmetrical rate limiter including any configured Setpoint Trim (SPTrim) applied to the Working SP (Main.WSP).

RateSP' is enabled by the Setpoint Rate Limit Disable parameter 'SPRateDS'. If 'RateSP' is set Off, any change made to the SP will be effective immediately, but when a value is set, any change in the SP will be take place at ta maximum rate of RateSP. (in units per minute). 'RateSP' applies to 'SP1', 'SP2' and 'AltSP'.

When 'RateSP' is active 'RateDone' will display 'No'. When the setpoint has been reached the value configured in this parameter, 'RateDone' will change to 'Yes', but will reset to 'No' if the Target Setpoint, (TargetSP), is changed.

When 'RateSP' is set to a value other than Off, 'SPRateDS' can be used to enable/disable 'RateSP', thus avoiding the necessity to switch this parameter between Off and a value.

Setpoint rate limiting is suspended and 'Main.WSP' is set to zero if the PV is in sensor break, ('Diag.SensorB' set 'Yes' and 'Alarms.SBreak' set 'True'. When the sensor break is cleared, 'Main.WSP' returns to the defined setpoint at the rate configured in 'RateSP'.

SETPOINT TRACKING ('SPTRACK')

Setpoint Tracking ensures that the Local setpoint (SSP1 or SSP2), follows the Alternative Setpoint value ('AltSP'), whilst 'AltSP' is selected. This ensures a bumpless transfer when returning to 'SP1' or 'SP2'. Bumpless transfer does not take place when changing from Local to Remote.

If a setpoint rate limit value is configured, the change in setpoint value will take place at the value set (in units per minute) when changing from 'SP1' or 'SP2' to 'AltSP'.

6.2.5 SP TAB (Cont.)

SETPOINT TRACKING (Cont.)

The setpoint used by the control can be:

1. Local setpoint 'SP1' or 'SP2', selected using 'SPSelect', via serial communications or by a digital input. SP1 and SP2 may be used, for example, to switch between normal running conditions and standby conditions. If 'RateSP' is set OFF, the new setpoint value is adopted immediately when the switch is changed.
2. A remote analogue source. The source could be an input to an analogue input module wired to 'AltSP' or it might be a User Value wired to 'AltSP'. The Alternate Setpoint is used when the 'AltSPEn' is set to 'Yes'.

MANUAL TRACKING

When the control loop is operating in manual mode the currently selected setpoint ('SP.SP1' or 'SP.SP2') tracks the PV. When the control loop resumes automatic control there will be no step change in the resolved setpoint. Manual tracking does not apply to the Alternate Setpoint ('SP.AltSP').

SERVO TO PV

After power cycling the instrument, the time taken to obtain the 'Main.WSP' can be increased by configuring 'SP.ServToPV'. When 'SP.ServToPV' shows 'On', the measured PV ('Main.PV'), is used as a start point for the Main.WSP. This decreases the time required for the WSP to arrive at the TargetSP.

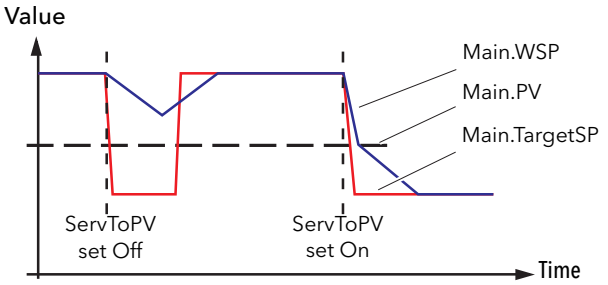


Figure 6.2.5d PV starting point

SP TAB PARAMETERS

AltSP	The value derived from the Alternative (remote) setpoint, wired into the loop via an analogue input channel.
AltSPEn	When 'Yes', the setpoint is taken from 'AltSP' input.
ManTrack	'On' enables manual tracking, allowing the currently selected SP1 or SP2 to follow the value of the PV, so there is no step change when automatic control resumes. 'Off' disables manual tracking.
Range Hi (Lo)	High (Low) range limits for all setpoints within the control loop
RateDone	'Yes' indicates that the setpoint rate limit has achieved its target (i.e. the working setpoint has reached the target setpoint). 'No' implies that ramping is continuing.
RateSP	Specifies the maximum rate-of-change for the setpoint.
ServoToPV	When 'Yes', the measured PV is used as the starting point for the working setpoint. When 'No', the working setpoint is reset and restarted.
SPRateDS	'Yes' allows the working setpoint to carry out step changes. When 'No', the maximum rate-of-change is limited to the RateSP value.
SPSelect	Allows SP1 or SP2 to be selected as the current setpoint. Read only if wired.
SP1 (2)	Setpoint 1 (2) value
SPHiLim, SPLoLim	Maximum and minimum values allowable for the setpoints.
SPIntBal	When 'On', the setpoint integral balance calculation is applied when TargetSP is changed in order to ensure a smooth response. when 'off' the calculation is not applied.
SPTrack	'On' enables setpoint tracking, allowing the currently selected SP1 or SP2 to follow the value of the alternative setpoint, so there is no step change when switching from the alternative setpoint to the local setpoint. 'Off' disables setpoint tracking.
SPTrim	An offset value that can be applied to the setpoint.
SPTrimHi (Lo)	The maximum and minimum values for 'SPTrim'
TrackPV	The tracked PV value when tracking enabled.

6.2.5 SP TAB (Cont.)

TkPVStat — The tracked PV status. 'Good' indicates that the PV is displaying a trusted value derived from the process via an input block. 'Bad' indicates that there has been a hardware failure or that the relevant I/O module is missing.

6.2.6 OP tab

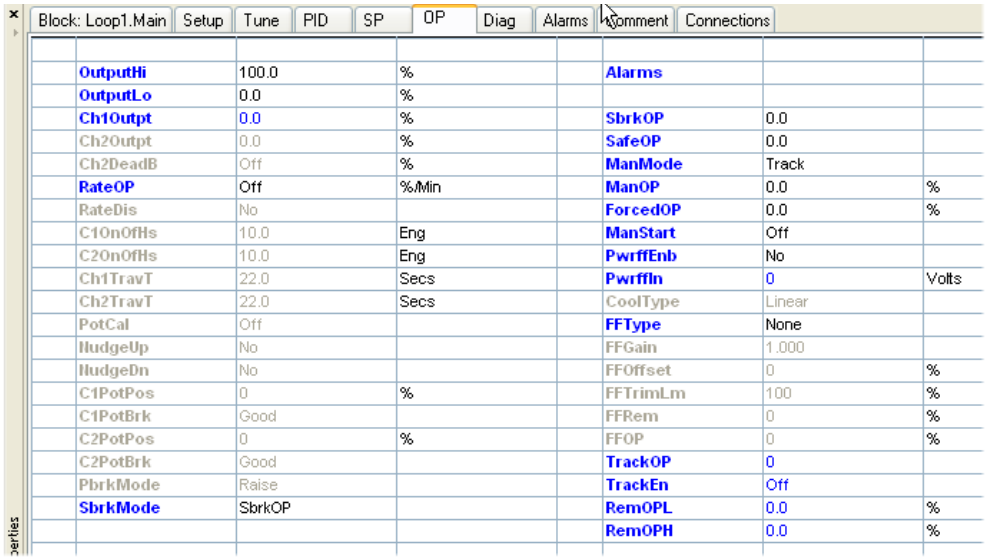


Figure 6.2.6a Output (OP) tab

The Output (OP) function selects the correct output sources to be used, determines whether to heat or to cool and then applies power feed forward, non-linear cooling and limit values.

The outputs, 'OP.Ch1Outpt' and 'OP.Ch2Outpt', are normally connected to an output module and converted into an analogue or time proportioned signal for electrical heating, cooling or valve movement. These parameters are limited using the upper and lower output limits 'OP.OutputHi' and 'OP.OutputLo'. The following additional configuration may also be required,:

1. Individual output limits can be configured for each set of PID parameters when gain scheduling is used.
2. 'Diag.SchdOPHi' and 'Diag.SchdOPLo' can be set to values that override the gain scheduling output values.
3. Limits ('OP.RemOPH' and 'OP.RemOPLo') can be applied from an external source These parameters are wireable, e.g. they can be wired to an analogue input module so that a limit can be applied through an external strategy. However, if these parameters are not wired, ±100% limit is applied every time the instrument is powered up.
   The 'tightest' set, out of Remote and PID, is applied to the output if an overall limit is applied using parameters 'OP.OutputHi' and 'OP.OutputLo'.
4. 'Diag.WrkOPHi' and 'Diag.WrkOPLo' are read-only parameters showing the overall working output limits.

Notes:

1. Tune limits are a separate part of the algorithm and are applied to the output during the tuning process. The overall limits OP.OutputHi and OP.OutputLo always have priority.
2. Each 'OPHin' and 'OPLon' is derived from a Tune_set block identified by the 'n', where 'n' equals the PID set number.

6.2.6 OP TAB (Cont.)

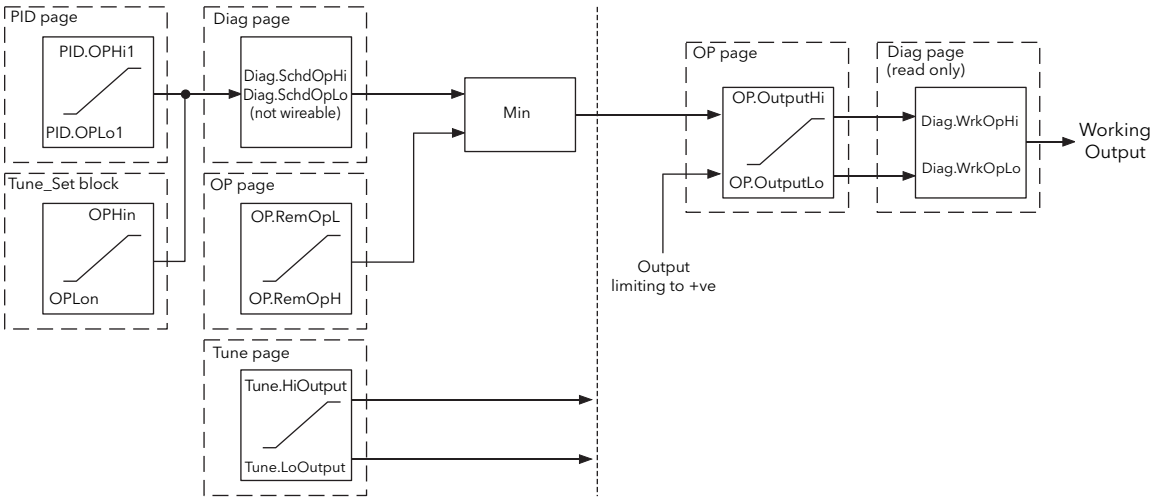


Figure 6.2.6b Output Limits

OUTPUT RATE LIMIT ('OP.RateOP')

Output Rate Limit, allows the rate of change of output to be controlled in order to prevent step changes in the output value. The limit is a symmetrical rate limiter applied to the Working output ('Main.WrkOP'), and is active in both auto and manual modes. The limit is performed by determining the direction the output is changing, and incrementing or decrementing the Working Output until it is equal to the required Target Output.

The incremental or decremental value is calculated based on the sampling (update) rate of the algorithm, i.e. 100ms, and the configured OP.RateOP value. Any change in output less than the rate limit increment will take effect immediately. The direction and size of increment is calculated on every execution of the rate limit, so if the rate limit is changed during execution, the new value takes effect immediately. If the output is changed while rate limiting is taking place, the new value takes effect immediately in the direction of the rate limit.

The limit is self-correcting so that if the increment is small and is lost in the floating point resolution, the increment will be accumulated until it takes effect.

'OP.RateOP' is switched on and off by the Output Rate Limit Disable parameter 'OP.RateDis'. If the limit is disabled (Off), any change made to the output takes effect immediately, but when a value other than 'Off' is set, any change in the output will take place at the set rate, in % per second.

When the limit is set to a value other than 'Off', 'OP.RateDis' can be used to disable and enable the limit avoiding the necessity to switch the parameter between Off and a value.

SENSOR BREAK MODE (SBRKMODE)

The Sensor Break Mode parameter determines the response of the control loop when a Sensor Break is detected by the measurement system. When a sensor break is detected, the output can be configured to adopt a pre-set value ('OP.SbrkOP'), or to remain at its current value ('OP.SbrkMode' set to 'Hold').

When 'OP.SbrkMode' = 'SbrkOP', the output ramps to the preset value at the rate defined in 'OP.RateOP', (unless 'OP.RateOP' = 'Off', in which case output steps to the preset value. When 'OP.SbrkMode' = 'Hold', the output of the loop remains at its last good value. If an 'OP.RateO'P value other than 'Off', has been configured, a small step might be seen, because 'Main.WrkOP' limits to the two-second-old value.

When a Sensor Break has been cleared, the power output ramps from the current value and transfers smoothly to the control value.

6.2.6 OP TAB (Cont.)

FORCED OUTPUT (FORCEDOP)

This feature enables the user to specify what the output of the loop should do when moving from automatic control to manual control. The default is that the output power is maintained but it is then adjustable by the user.

If Manual Mode is set to 'Step', the user can set a manual output power value and on transition to manual the output will be forced to that value.

If Manual Mode is set to 'Track' the output steps to the forced manual output and then subsequent edits to the output power are tracked back into the manual output value.

If Manual Mode is set to 'Last Man. Out' then when moving from automatic to manual mode, the output adopts the last manual output value.

POWER FEEDFORWARD

Power feed forward (PFF) is used when driving an electrical heating element. It monitors the line voltage and compensates for fluctuations before they affect the process temperature, providing better steady state performance when the line voltage is not stable.

PFF is mainly used for digital type outputs which drive contactors or solid state relays. Because it only has value in this type of application it can be switched off using the parameter 'OP.PwrffEnb'. It should be disabled for any non-electric heating process.

Example

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

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

Power FeedForward should not be confused with Feed Forward described below.

COOL TYPE

Cooling methods vary from application to application. For example, an extruder barrel may be cooled by forced air (from a fan), or by circulating water or oil around a jacket. The cooling effect will be different depending on the method. CoolType is used to accommodate different types of cooling methods as follows:

Linear	The cooling algorithm may be set to linear where the controller output changes linearly with the PID demand signal.
Oil	'OP.CoolType' = 'Oil'. As oil is essentially non-evaporative, oil cooling is pulsed in a linear manner.
Water	If the area being cooled is running well above 100°C, then the first few pulses of water flash into steam giving greatly increased cooling due to the latent heat of evaporation. When the area cools, less (or even no) evaporation takes place and the cooling is less effective. Setting 'OP.CoolType' to 'Water' delivers much shortened pulses of water for the first few percent of the cooling range, when the water is likely to be flashing into steam. This compensates for the transition out of the initial strong evaporative cooling.
Fan	'OP.CoolType' = 'Fan'. Fan cooling is much gentler than water cooling and not so immediate or decisive (because of the long heat transfer path through the process mechanics). With fan cooling, a cool gain setting of three upwards is typical. Delivery of pulses to the blower is non linear, this non-linearity being caused by a combination of forced air movement and fan efficiency as a function of air velocity (e. g. the efficiency of a fan when producing a low speed (laminar) air flow is different from its efficiency when producing a high-speed, turbulent flow.

6.2.6 OP TAB (Cont.)

FEEDFORWARD

Feed forward is a method of adding an extra scalable component to the PID output, before any limiting. It can be used, for example, in the implementation of cascade loops and constant head control or it can be used to pre-load the control signal with a value close to that which is required to achieve the setpoint, thus improving system response. Feed forward (FF) is applied such that the PID output is limited by trim limits (OP.FFTrimLim) and acts as a trim on the FF value (OP.FFOP). This value is derived either from the PV or setpoint by scaling the PV or SP by the 'OP.FFGain' and 'OPFFOffset'. Alternatively, if OP.FFOP = Remote, a remote value may be used for the FF value, but this is not subject to any scaling. The resultant FF value is added to the limited PID OP and becomes the PID output as far as the output algorithm is concerned. The feedback value then generated must then have the OP.FFOP contribution removed before being used again by the PID algorithm. The diagram below shows how feed forward is implemented..

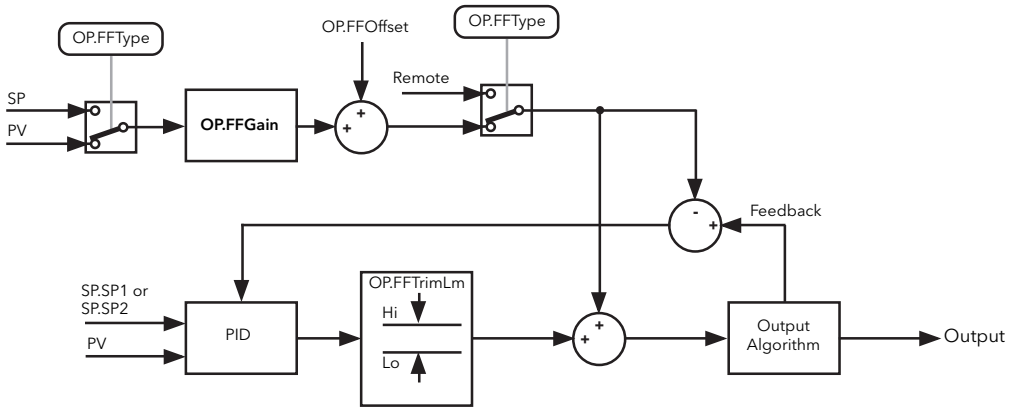


Figure 6.2.6c FeedForward block diagram

OP TAB PARAMETERS

C1OnOfHs	Channel 1 hysteresis value in PV units.
C1PotBrk	A potentiometer input module must be fitted, and the channel 1 wiper value wired directly to OP.C1PotPos. 'Good' shows that the input signal is valid. 'Bad' indicates that a break has been detected in the circuit.
C1PotPos	The value from a valve positional feedback potentiometer associated with channel 1.
C1TravT	Channel 1 valve travel time in seconds from closed (0%) and fully open (100%).
C2OnOfHs	Channel 2 hysteresis value in PV units.
C2PotBrk	A potentiometer input module must be fitted, and the channel 2 wiper value wired directly to OP.C2PotPos. 'Good' shows that the input signal is valid. 'Bad' indicates that a break has been detected in the circuit.
C2PotPos	The value from a valve positional feedback potentiometer associated with channel 2.
C2TravT	Channel 2 valve travel time in seconds from closed (0%) and fully open (100%).
Ch1Outpt	The output value of channel 1
Ch2Outpt	The output value for channel 2. When operating as a part of a heat/cool process, this negative value is inverted to give a positive value for driving a time-proportioning or dc output.
Ch2DeadB	Deadband percentage value specifying the gap between channel one going off, and chanel 2 coming on, and *vice-versa*. Used to ensure that heating and cooling are not on simultaneously. For on-off control, the value is a percentage of the hysteresis value.
CoolType	The type of cooling mechanism used in the process, as described above. Select from 'Linear', 'Oil', 'Water' or 'Fan'

6.2.6 OP TAB (Cont.)

OP TAB PARAMETERS (Cont.)

FFGain	A scaling factor for the feedforward signal.
FFOffset	An offset value for the feedforward signal.
FFOP	Shows the calculated feedforward signal.
FFRem	An alternative value to be applied as the feedforward signal. Gain and offset are not applied to this input.
FFTrimLim	Defines symmetrical limits about the PID output which are applied to the scaled feed-forward signal.
FFType	Feedforward type: None Feedforward disabled. Remote The feedforward input comes from a remote source. SP The feedforward value is derived from the working setpoint, scaled by FF-Gain and FFOffset. PV The feedforward value is derived from the process variable, scaled by FF-Gain and FFOffset.
ForcedOP	The output power value to be adopted in manual mode operation when man-Mode=Step.
ManMode	Specifies the power output during manual mode: Track The output is derived from last control output. Step The output is the value set in 'ForcedOP'. LastMOP the output is the value last configured by the operator in 'ManOp'.
ManOP	Manual output power. Used in manual mode when ManMode = LastMOP or Track. ManOp follows the control output in Auto mode.
ManStart	If 'On', then Auto/Man (Main tab) is set to Man at startup. If 'Off' Auto/Man remains as configured.
NudgeUp (Dn)	Used to open (NudgeUp) or close (NudgeDn) a valve by one minimum on time, allow-ing the valve position to be controlled over a serial link, or by contact closure inputs to a digital input module.
OutputHi (Lo)	The maximum output power values delivered by channels one and two. 'Outputlo' would normally be set to 0% for heat only processes.
PBrkMode	Defines the action to be taken in a bounded valve positioning system if the feedback potentiometer status is 'Bad'. Raise The output raises the actuator. Lower The output lowers the actuator. Rest The actuator remains where it is. Model The output uses a model to predict actuator position.
PotCal	Controls automatic calibration of the specified channel position input. A potentiometer input module must be fitted, and the wiper values wired directly to OP.C1PotPos for channel 1 or to OP.C1PotPos for channel 2. Off: Automatic pot calibration disabled. CalibrateCh1. Automatic calibration of channel 1 pot enabled. CalibrateCh2. Automatic calibration of channel 1 pot enabled.
PwrffEnb	Enables Power Feed forward. Must be disabled for any load other than electric heaters. Power feed forward allows fluctuations in line voltage to be compensated for before they can affect the process.
PwrffIn	Instantaneous value of the supply voltage. See 'Power feed forward', above.
RateOP	Output rate limiting. The maximum rate at which the PID output may change in % per minute. Effective only if 'OPRateDis' is 'Off'. Can be disabled by setting its value to zero.

6.2.6 OP TAB (Cont.)

OP TAB PARAMETERS (Cont.)

RateDIS	Enables/disables output rate limiting.
RemOPH, REMOPL	The high and low limits for loop output, derived from a remote source or calculation.
SafeOP	Defines the output power to be adopted if 'Inhibit' is enabled in the Main tab (section 6.2.1).
SbrkMode	Defines the output action if the PV is 'bad'.
	SbrkOP The output adopts the value entered in SbrkOP.
	Hold The output is maintained at the last good PV value.
SbrkOP	Specifies the output value to be adopted if a sensor break is detected, and 'SbrkMode' = SbrkOP.
TrackEn	When 'On', the loop output follows the track output value.
TrackOP	Shows the current tracked value if TrackEn = On.

6.2.7 Diag tab

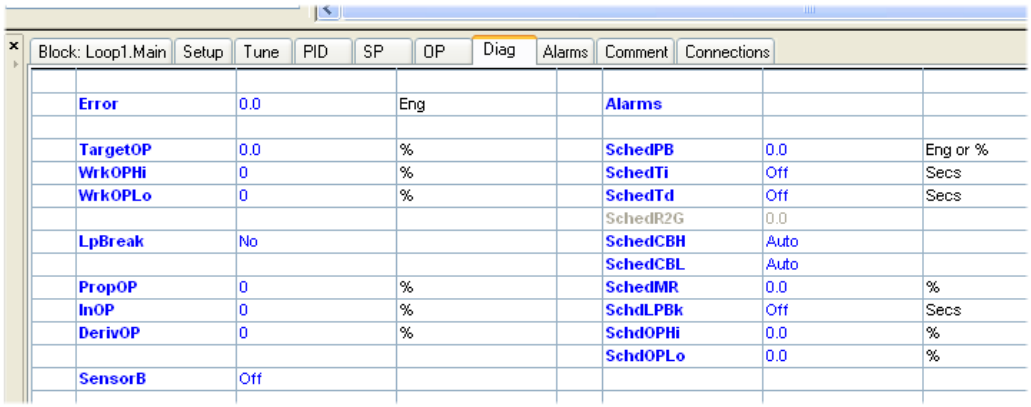


Figure 6.2.7 Diag tab

The Diagnostic tab provides parameters that assist in the commissioning of the control loop. The parameters are generally read only, but can be wired from to produce an application specific strategy. For example, 'Diag.LpBreak' can be wired to an output module to produce a physical output if the Loop Break Time, 'PID.LBT', is exceeded.

Additional gain scheduling parameters are also provided. These display the current values of the control time constants as set by the active PID list and determined by Gain Scheduling.

DIAG TAB PARAMETERS

DerivOP	The percentage contribution that the derivative term is making to the control output.
Error	The calculated error signal showing the difference between the working setpoint and the PV.
InOP	The percentage contribution that the integral term is making to the control output.
LPBreak	Yes = a loop break has occurred (i.e. the PV has not responded to a change in output withing the Loop break time for the current PID set). No = a loop break has not occurred.
PropOP	The percentage contribution that proportional band is making to the control output.
SchdLPBrk	The loop break time value for the current PID set.
SchdOPHi (Lo)	The current output high and low values for the current PID set.
SchedCBH (CBL)	Cutback High and Low values for the current PID set. 'Auto' = 3 x proportional band.
SchedMR	The manual reset value for this PID set.
SchedPB	The proportional band setting for the current PID set.
SchedR2G	The relative cool gain value for the current PID set
SchedTd	The derivative time for the current PID set.
SchedTi	The integral time for the current PID set
SensorB	'Yes' = sensor break has been detected.
TargetOP	The requested control output.
WrkOPHi (lo)	High and low power output limits.

6.2.8 Alarms tab

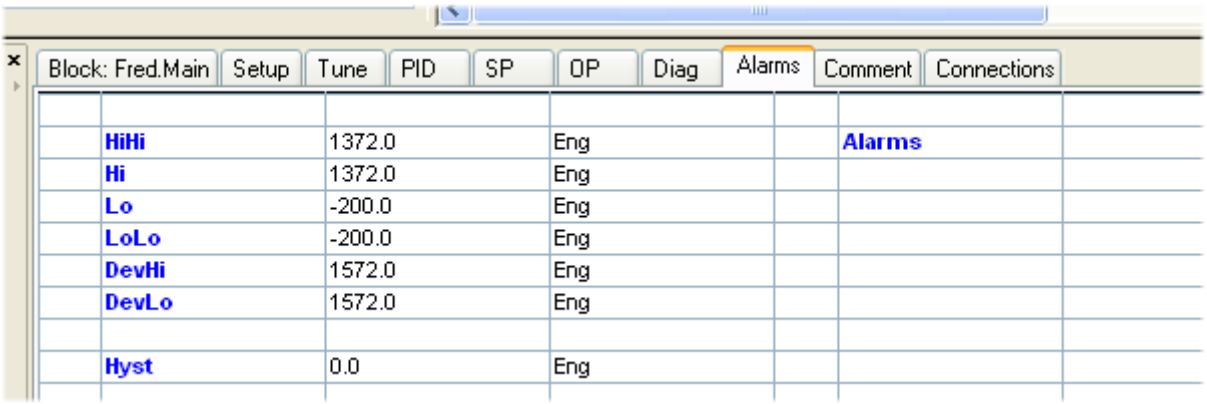


Figure 6.2.8 Alarms tab

The Alarms tab of the Loop block provides parameters that define the alarm limits applied during the operation of the control loop.

ABSOLUTE ALARMS

The following absolute alarm types are available:

1. High High Absolute (Alarms.HiHi). HiHighAl = True when PV>'HiHigh'
2. High Absolute (Alarms.Hi). HighAl = True when PV>'High'
3. Low Absolute (Alarms.Lo). LowAl = True when PV<'Low'
4. Low Low Absolute (Alarms.LoLo). LoLowAl = True when PV<'LoLow'

The action of these four multipurpose parameters depends on which type of alarm function is selected (via the Type parameter):

An alarm is not reset immediately that PV returns to a 'safe' value - the PV must be inside the level by a margin equal to the hysteresis parameter (Alarms.Hyst) before the alarm resets. Hysteresis permits clean transitions into and out of the alarm condition. The configured Hysteresis value will be applied.

DEVIATION ALARMS

The following deviation alarm types are available:

1, High Deviation (Alarms.DevHi) HighAl = True when PV-Setpoint >'High'
2. Low Deviation (Alarms.DevLo) LowAl = True when Setpoint -PV >'Low'

The high alarms are set when the positive deviation exceeds the defined levels. The low alarms are set when the negative deviation exceeds the levels:.

Hysteresis is applied to deviation values as it is to PV in absolute alarms.

HYSTERESIS

A hysteresis value (Alarms.Hyst) in engineering units, is applicable to the High Absolute and Low Absolute Alarm limits and the High Deviation, Low Deviation Alarm limits. This value provides a band that defines when the alarm limits are set TRUE. Once an alarm has been annunciated, it is not cleared until the value causing the alarm has returned inside the limit by an amount specified by this parameter.

6.3 EFFECT OF CONTROL ACTION, HYSTERESIS AND DEADBAND

6.3.1 Control Action

When configuring temperature control, the parameter 'Setup.CtrlAct' should be set to 'Rev'. If using PID control this means the heater power decreases as the PV increases, but if using on/off control, output 1 (usually heat), is full on when PV is below the SP and output 2 (usually cool), is full on when PV is above the SP.

6.3.2 Hysteresis

Hysteresis (Alarms.Hyst) applies to on/off control only and is configured in the units of the PV. In heating applications the output turns off when the PV is at SP and turns on again when the PV falls below SP by the hysteresis value, see below.

Hysteresis is used to prevent the output from repeatedly switching on and off as the PV drifts around the control SP. If Hysteresis is set to 0, any change in the PV, when operating at SP, will change the output, possibly causing unacceptable chatter. Hysteresis should be set to a value that provides acceptable life for the output contacts, but does not cause unacceptable oscillations in the PV.

Note: If this performance is unacceptable, it is recommended that PID control be attempted instead.

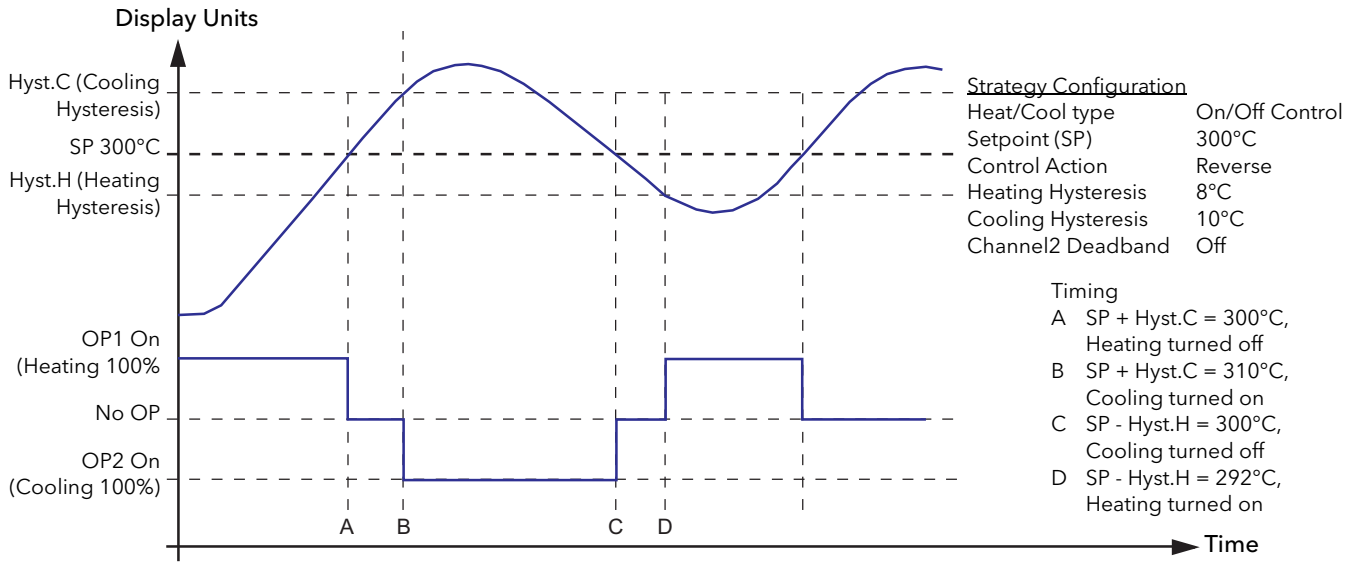


Figure 6.3.2a Hysteresis applied, Deadband not applied

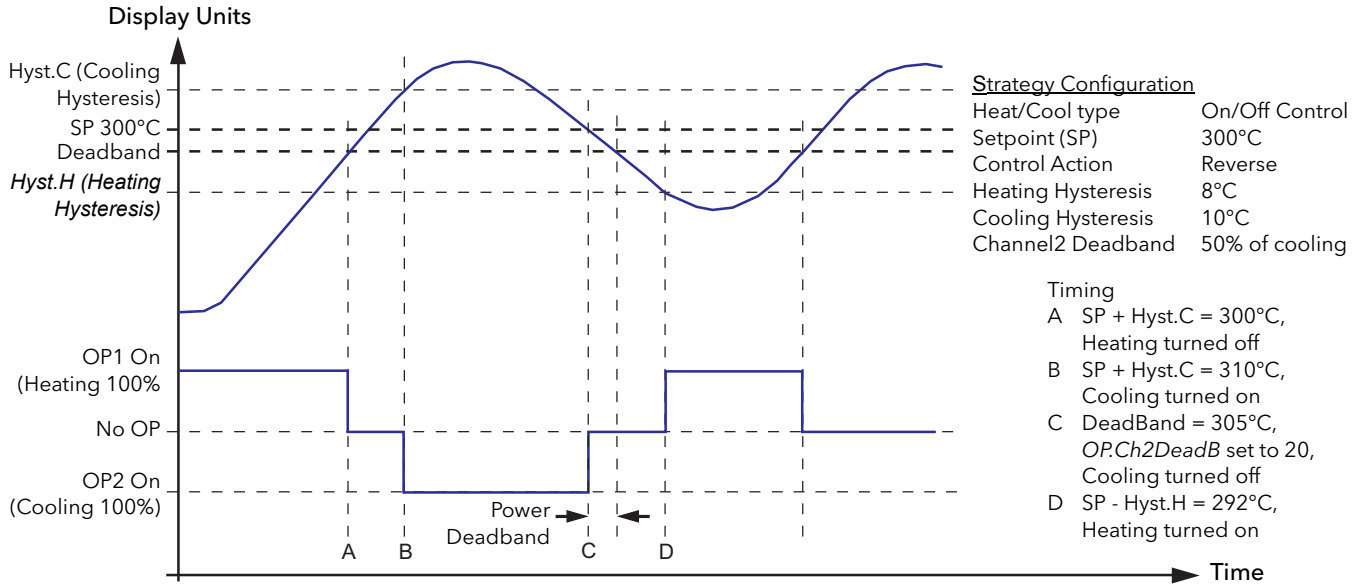


Figure 6.3.2b Hysteresis applied at 5%, Deadband applied at 50%

6.3.3 Channel two deadband

Channel 2 Deadband (OP.CH2DeadB) can operate in both on/off control or PID control to wide the period when no heating or cooling is applied. However, in PID control its effect is modified by both the PID.Ti and PID.Td parameters.

Channel two deadband would normally be used in on/off control only. It can, however, be used in PID control, in the situation where actuators take time to complete their cycle, to ensure that heating and cooling are never applied at the same time, see previous diagram.

7 TASK ORGANISATION

7.1 TASK SCHEDULING

All in-built and user-programmed instructions are performed serially (i.e. one after the other).

7.1.1 Tasks

A Task is a unit of software that is responsible for carrying out particular duties at certain times, usually while the Database is running. There are 24 recognisable Tasks in the instrument. Most Tasks are fixed and cannot be varied by the user. Others, the user tasks, are programmable, as described in 'USER TASKS 1 TO 4', below.

7.1.2 Priorities

Each task has a priority based on its importance to efficient and safe operation. Priorities are numbered from 1 (highest) to 24 (lowest). A task, once started, will run to completion unless it is interrupted at any time by a task of higher priority. In such a case, the lower priority task suspends activities until the higher priority task has finished, at which point it resumes running. These interruptions are hierarchical; several tasks may be suspended by higher priority tasks at any one time.

7.1.3 Functions

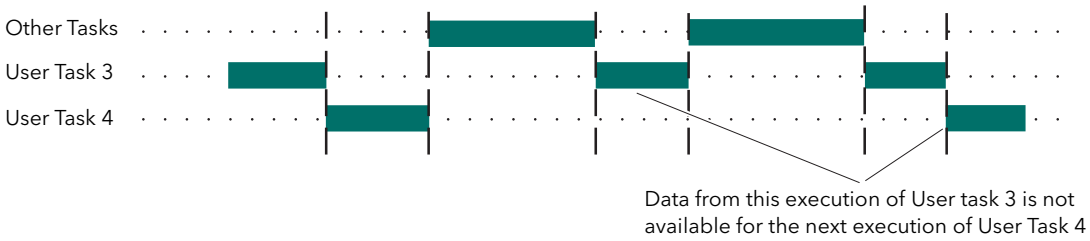
A list of Task functions is given in table 7.1.3a, below.

The following 6 tasks are the block servers and are under the control of the configuration engineer.

USER TASKS 1 TO 4

User Task 1, Fast I/O task (10ms) and User Task 3, Slow I/O Task (110ms) are synchronised with the I/O modules and are module type specific (Table 7.1.3b, below). The associated I/O blocks can be assigned to User Task 1 or User Task 3, as applicable.

Any blocks added to the database are automatically assigned to User Task 3 by default. If the SFC_CON block (and associated Sequences) were assigned to operate on User Task 4, the configured strategy must take into account that data may be missed when reading and writing values between Sequences and the I/O blocks. For example, consider the case where User Task 3 is updated at 110ms intervals and User Task 4 is updated at 250ms intervals. A possible order of task execution is,



CACHE SYNC SERVER

This Task is used to maintain synchronisation of cached blocks. The task is repeat driven every 110 msec, but this may be extended depending on the amount of CPU time remaining after User Tasks have been serviced.

CACHE CONN SERVER

This Task is responsible for processing LIN field writes into and out of cached blocks. The task is repeat driven every 110 msec, but this may be extended depending on the amount of CPU time remaining after User Tasks have been serviced.

7.1.3 TASK FUNCTIONS (Cont.)

	Task	Schedule	Function
1	Tick	Every 5ms	Provides system check
2	Rx_ICM	Event driven	Processes messages received over the ICM
3	Rx_LIN	Event driven	Processes messages received over the LIN
4	ICM_Mgr	Every 50ms	Monitors ICM link low level status. Applies timeouts to transmitted messages. Re-programs ICM hardware if errors detected.
5	PRMT	Event driven <100ms	Process redundancy management task. Responsible for effecting and maintaining synchronisation between redundant processors.
6	Pr_Px	Every 100ms (approx.)	Processes messages received using port resolution protocol (PRP) over ELIN
7	EDBserv (X2)	Every 10 ms (approx.)	Manages ELIN communications with external databases via cached blocks.
8	Network	Event driven	'Housekeeping' for all LIN transactions
9	File sync	Event driven	Responsible for maintaining synchronisation of filing systems on redundant systems
10	Mod_Rx	Event driven	Processes messages received via Modbus Gateway
11	ModServ	Periodic	Modbus database management
12	User task (x4)	Every TskRptn secs	Runs User task 1 and User task 3 synchronised with fast and slow I/O task modules respectively. Both user tasks 1 and 3 run at integer multiples of the repeat rate. That is User task one runs at multiples of 10ms and user task 3 runs at multiples of 110ms. User tasks 2 and 4 run at the repeat rate set in the header block.
13	Cache Sync Server	Min default 100ms	Maintains synchronisation of cached blocks
14	Cache Conn Server	Min default 100ms	Responsible for LIN field writes into cached blocks
15	LLC	Every 100ms (approx.)	Monitors LIN link low-level status. Applies timeouts to transmitted messages. Re-programs LIN hardware if errors are detected.
16	NFS	Event driven	Network Filing System. Processes LIN filing requests.
17	TTermcfg	Event driven	Runs the terminal configurator accessed via a Telnet session
18	Pr_Maint	Every 500 ms (approx.)	PRP database management
19	Load	Event driven	Loads a database as a result of a remote request
20	Panel	Event driven	Runs the operator interface
21	Config	Event driven	Runs the terminal configurator via the serial port
22	BatLoad	Event driven	Responsible for batch load operations (e.g. loading/unloading SFCs)
23	Bgnd (scan)	Event driven	Collates alarm information. Performs database checksum testing
24	Idle	Event driven	'Null' task. Provides an environment for CPU execution whilst no other tasks run.

Table 7.1.3a Task scheduling

Module type	Slow task rate (110ms)	Fast task rate 10ms	Module type	Slow task rate (110ms)	Fast task rate 10 ms
AI2	yes	no	DO4	yes	yes
AI3	yes	no	DO8	yes	yes
AI4	yes	no	DO16	yes	yes
AO2	yes	yes	RLY4	yes	yes
DI4	yes	no	RLY8	yes	yes
DI6	yes	no	FI2	yes	yes
DI8	yes	yes	ZI	yes	no
DI16	yes	yes			

Table 7.1.3b Module task rate applicability

7.2 USER TASKS

7.2.1 Terminology

USER TASK

A User Task is a defined set of function blocks in a database that are updated at a specific tick rate. The blocks are normally associated with instrument control.

BlOCK SERVER

A Block Server is a fixed software task, within this instrument, that executes a User Task, or processes cached blocks.

7.2.2 Execution times

User Task execution times are repeat driven. User Task 1, and User Task 3 are synchronised to the fast and slow I/O task modules respectively. Both run at an integer multiple of the repeat rate, i.e. User Task 1 runs at N × 10ms, and User Task 3 runs at M × 110ms, where N and M are integers.

User tasks 2 and 4 run at rates defined in the header block.

User task 1 has the highest priority, followed (in descending order) by User Task 2, User Task 3 and User Task 4 (lowest priority).

Note: All I/O blocks must be configured to User Task 1 or User Task 3.

Each of the 4 User Tasks has a 'requested repeat rate'. This can be configured using LINtools (Task n Period) or the Terminal Configurator (Block Full Description page).

Each function block has a Task field used to allocate it to one of the four available User Tasks. This field can also be used to configure the 'requested repeat rate' of the User Tasks. If the 'requested repeat rate' is changed via a function block allocated to a particular User Task, this change is made to the User Task, not the function block, and it affects all other function blocks assigned to that User Task.

If using the LINtools Database Editor, selecting the Task field from the function block Object Properties Pane reveals the Task dialogue which permits changes to the Task Number associated with the function block. To enable changes to the Task Period (i.e. to the 'requested repeat rate'), click the right (next) arrow button to display the Task Period dialogue.

If the requested repeat rate is not configured (LINtools Task n Period dialogue or Terminal Configurator Rate ms field set to 0) the default request repeat rate is applied i.e.10ms for User Task 1 and User Task 2, and 110ms for User Task 3 and User Task 4.

Note: Tasks must not be configured to use a faster requested repeat rate than any higher priority task. Any such configuration will be ignored by the instrument, but will be run according to the rules stated in section 7.3.1, below.

7.2.3 User task block servers

BLOCK SERVER INTERACTIONS

There are six block servers in this instrument, one for each of the User Tasks, and two for the cached blocks (see table 7.1.3). The block servers are prioritised, repeat-rate driven, and fully coherent, (see Section 7.4, below) . The instrument's block structured LIN Database supports cached blocks by showing local 'image' of a remote function block, i.e. a function block running in another instrument on the LIN. The cached function block allows interaction with the remote function block. In a cached function block, the DBase field specifies the name of the remote LIN Database containing the 'real' function block.

Block Server 1 has the highest priority, and block server 6 the lowest. Interruption of one block server by another of higher priority (see section 7.1.2, above). The User Task block servers will only start at intervals specified by the corresponding Task repeat rate. If the task continues beyond the task repeat time, it will be suspended until the next task repeat time, e.g. User Task 1 is set to repeat every 10 ms, but lasts 10.25 ms, it will start again at the next scheduled repeat time.

Figure 7.2.3a shows how the block servers interact with one another according to their priorities. The darker bars represent running tasks and the paler bars represent suspended tasks.

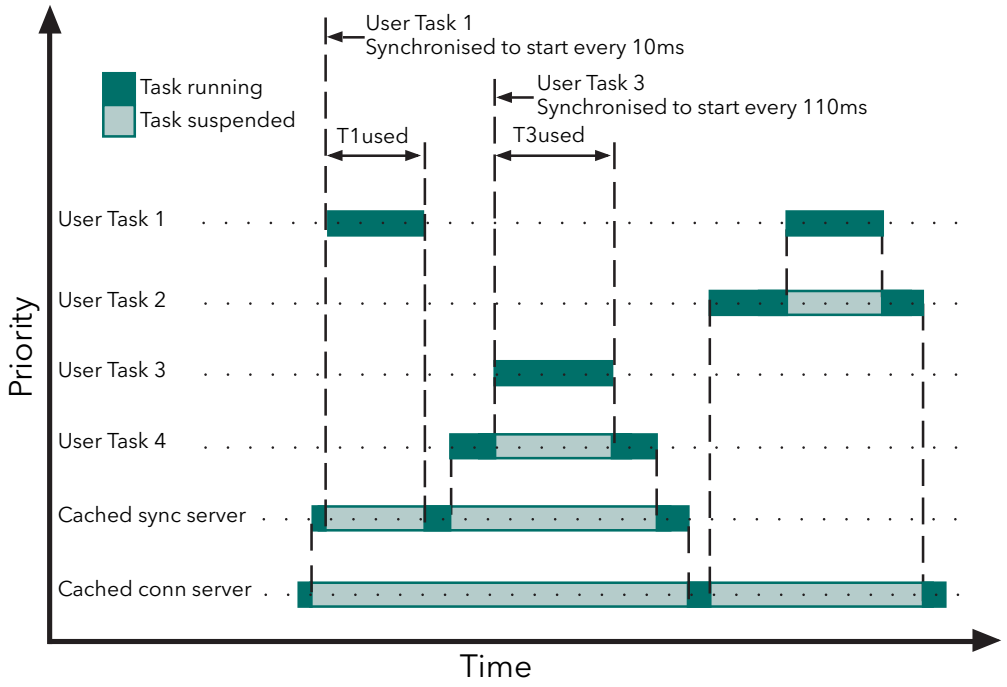


Figure 7.2.3a User task block server interactions

7.2.3 USER TASK BLOCK SERVERS (Cont.)

USER TASK BLOCK SERVER OPERATION

A higher priority user task block server always interrupts the running of a lower priority user task block server. Thus, whenever a given user task is running, all higher priority user tasks must have run to completion.

Figure 7.2.3b shows, schematically, the sequence of events that occurs during the running of a user task block server. These are as follows:

1. The user task is marked as 'busy'. During this 'busy' period lower priority tasks are suspended.
2. All connections sourced from higher priority tasks are copied into their destination blocks in this user task. This occurs as a single, indivisible, operation.
3. The blocks and their associated intra-task connections are then executed in order.
4. All connections sourced from this user task are now copied into their destination blocks in all higher priority user tasks, as a single, indivisible, operation.
5. The task 'busy' flag is removed.

This structure results in the least work being carried out by the highest priority task.

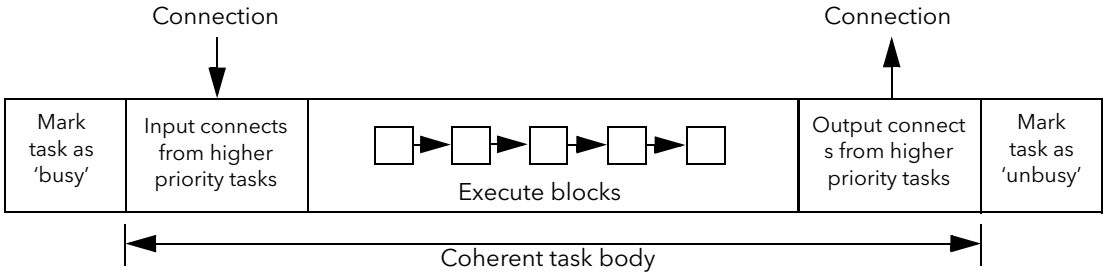


Figure 7.2.3b User task block server operation

7.3 USER TASK TUNING

At Database start-up, various checks are performed on the requested task repeat rates. Starting with the highest priority task, each block server check to ensure that:

1. Any requested repeat rate is not higher than any higher priority block server task. Any lower priority block server task configured with a higher repeat rate is adjusted to match the next highest priority task.
2. The repeat rate for the I/O synchronised block servers (User Task 1 and User Task 3) is an integer multiple of the I/O repeat rate (10ms for task 1; 110ms for task 3).

7.3.1 USERTASK block

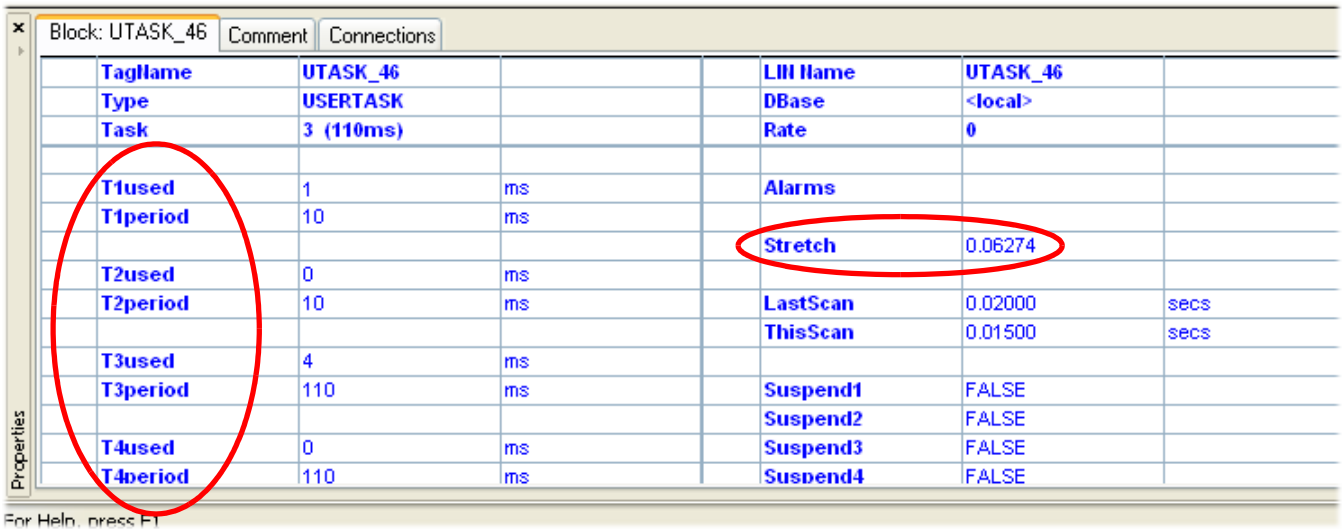


Figure 7.3.1 USERTASK block

In order to ensure smooth running, the amount of time used in executing all the blocks in all the tasks must not exceed 90% of the time available, otherwise there is insufficient time for non-task events (e.g. ftp transfers) to take place.

The LINtools USERTASK diagnostic block includes two read only parameters for each task: 'T1used' to 'T4 used' and' T1period' to 'T4 period'. When online to an instrument, these allow the user to calculate the percentage useage for each task and then to add them together. In the example above, task 1 is used for 1ms out of 10 ms (10%) and task 3 for 4ms out of 110ms = approximately 3.6%, giving a sum total of something less than 14%

If the usage is more than 90%, the user has two choices - either to move some blocks to slower tasks, or to increase the repeat period for the relevant task.

STRETCH

If the above precautions are not taken, and the usage time attempts to exceed 90% of the time available, the period is automatically extended by a stretch factor, to ensure block execution can be achieved within 90% of the adjusted period.

Notes:

1. The stretch factor is applied only when it is >1 (i.e for stretch values of ≤ 1, the tasks run at their configured rates).
2. The 'Stretch' parameter should ideally be 0.5 or less

7.4 DATA COHERENCE

7.4.1 Data flow between tasks

Data coherence is an important aspect of those control strategies which involve more than one user task. Data flow is defined as being coherent if, during any single execution of a task, the data input to it from outside the task is a 'snapshot' - unchanging during the execution of the task - and represents the values output from other tasks that have completed their execution.

Data coherence, by definition, refers to connections that are 'remote' (i.e. linking different tasks). Connections that are limited to within a task (i.e. 'local'), are copied from source to destination immediately before executing the destination function block.

For any task, there are three types of remote connection. These types, and the way in which data coherence is ensured, are as follows.

CONNECTIONS FROM OTHER TASKS IN THE SAME INSTRUMENT (NODE)

In order to ensure that multiple uses (in this task) of the same value (from another task) always use the same iteration of the value, such values are copied prior to the execution of all the executable blocks of this task - i.e. a 'snapshot' is taken of all values external to this task.

Two types of connection apply - those from higher priority tasks to lower priority tasks, and those from lower priority tasks to higher priority tasks:

1. Higher to lower priority. For coherence, whenever connections out of a task are used, all their values must result from the same iteration of that task. Owing to the priority structuring of the tasks, any connections from a higher priority task into a lower priority task meet this requirement because a lower priority task cannot interrupt a higher priority task, which therefore always runs to completion. Hence, these connections are dealt with by a 'snapshot' copying at the start of the lower priority task.
2. Lower to higher priority. A low priority task may be interrupted by a higher priority task before completion, and so be 'caught' with an incoherent set of output values. To avoid such invalid values being passed on, the last action of task execution is for the lower priority task to copy its set of coherent connections as a 'snapshot' to the higher priority task. In this way, the values passed on are always the last set of coherent values from a complete task execution.

CONNECTIONS FROM TASKS IN ANOTHER INSTRUMENT)

Connections between nodes are effected by the use of cached blocks. The process of cached block transmission, and reception at the destination end, is coherent for all the data within that function block.

At the destination end, the cached block exists on a cached block server. Connections from this cached block to other blocks effectively become inter-server connections within the same node, the coherence of which is guaranteed (as described in 'Connections into tasks...', immediately above).

CONNECTIONS OUT OF THIS TASK TO ANOTHER INSTRUMENT

This type of connection results in data flow that is not coherent, because the data is transmitted across the network as individual field writes, rather than complete block updates. If coherence is required, the block(s) can be cached in the opposite direction, via an AN_CONN block for example. This is illustrated in Figure 7.4.1, where block A coherently connects to block B across the LIN via the AN_CONN block (bold lines), but the connection is non-coherent when routed via cached block B.

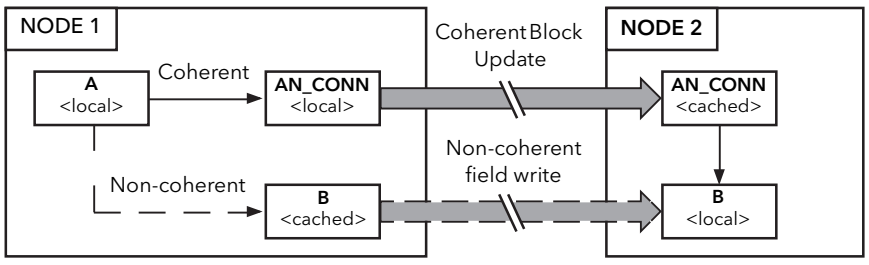


Figure 7.4.1 Coherent and non-coherent data flow across network

8 EVENT LOG

The Event Log records and store individually time stamped (real-time clock and instrument internal time) events generated in the instrument, and provides an indication of the impact of an event on the system. The log may be used to assist in diagnosing problems in the system.

8.1 THE EVENT LOG

Event records are stored in a ASCII text file, using a single line for each event. An I/O Subsystem with provision for two Processors use two Event Log files, 'event_l.udz' and 'event_r.udz' for left and right processors respectively. The 'event_l.udz' file is also used in Simplex I/O Subsystem. Eventually, as more event records are automatically added, the oldest event records are removed from the file. The file indicates the impact of the event on the system using the '!' character. Status, Warning, Error, and Major Error, are represented by 0, 1, 2 or 3 '!' characters respectively.

Figure 8.1 shows part of a typical event log.

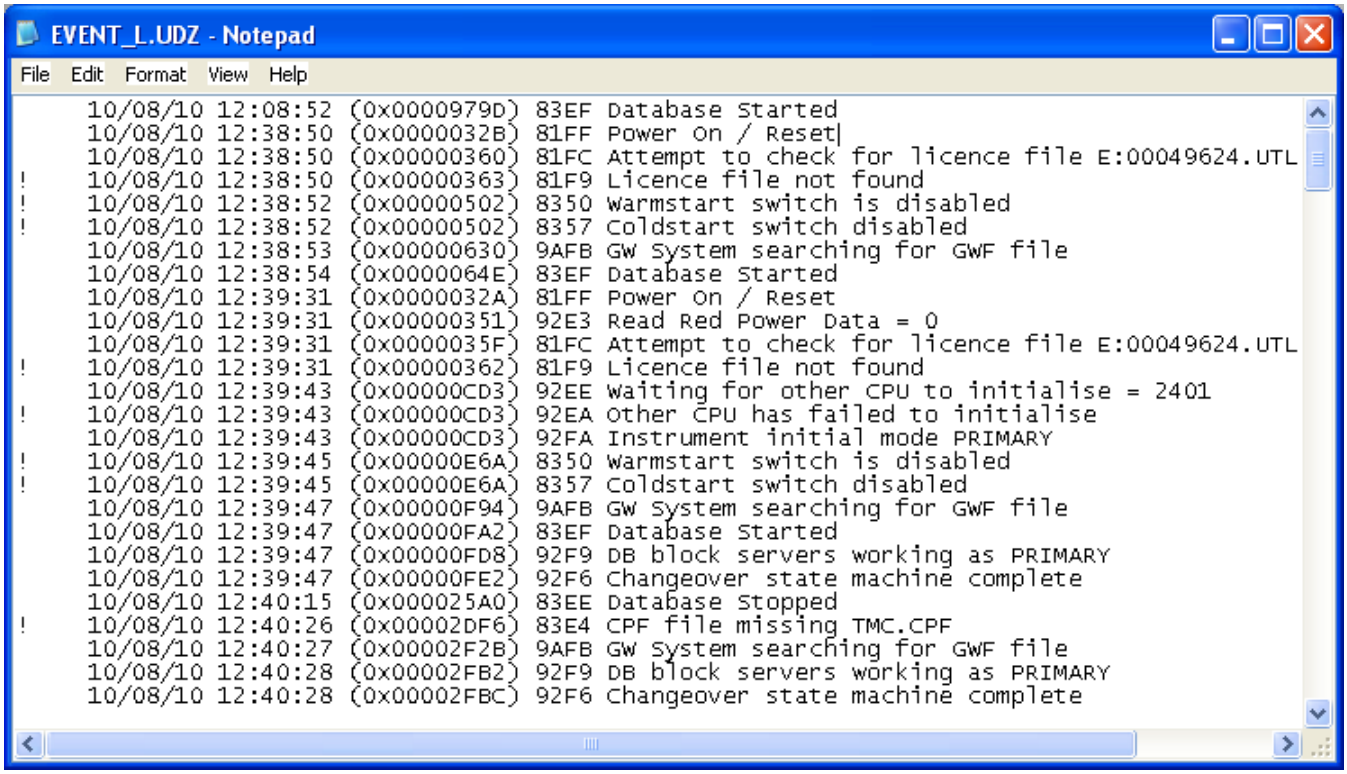


Figure 8.1 Event log example

Note: The failure to Hot Start event record is a 'Warning', but Desync event record due to the disconnected LIN cable is an 'Error'.

8.1 THE EVENT LOG (Cont.)

8.1.1 Status

The Event Log file, supports the recording of the following events:

NO '!' CHARACTERS

This indicates normal operation events such as: power up, database start, database stop, Online Reconfiguration operations, normal synchronisation of a redundant pair, etc.

ONE '!' CHARACTER (WARNING)

Single '!' characters indicate minor abnormalities, e.g. hot start fails due to power off time exceeded, controlled changeover of a redundant pair, etc.

TWO '!' CHARACTERS (ERROR)

Double '!' characters indicate real faults on the system, for example, automated changeover of a redundant pair due to a detected fault, or the running of serial communications on unsupported versions of this instrument causing corruption of communications bus on power-up.

If any Error is written to the Event Log file, the 'Alarms.EventLog' and 'Status.EventLog' fields of the database Tactician header block are set True and this provides an output that can be linked to a display to provide immediate identification of a problem that can have an effect on the system.

THREE '!' CHARACTERS (MAJOR ERROR)

Three '!' characters, indicate real faults in the execution of the instrument that must be investigated before continuing. If any Major Error is written to the Event Log file, the 'Alarms.EventLog' and 'Status.EventLog' fields of the database header block are set True and this provides an output that can be linked to a display to provide immediate identification of a problem that can have an effect on the system.

9 DATA MANAGEMENT

Data Management records selected parameters' values derived during run-time and saves them as .uhh files in the flash memory of the instrument. These files can then be archived automatically to a maximum of three FTP (File Transfer Protocol) Servers, or if the USB application is so configured (section 2.4.4), to a memory stick inserted into the USB connector on the I/O controller module terminal unit (figure 2.3.1).

Data recording is configured using LINtools and this configuration is downloaded to the instrument along with the database (.dbf) file.

Instrument flash memory problems can be investigated by inspecting the 'RMEMDIAG' block. Archiving problems may be investigated by inspecting the 'RARCDIAG' block. Both of these blocks are described in section 9 of the LINBlocks reference manual.

9.1 DATA RECORDING

9.1.1 Data Recording (.uhh) File

The .uhh file is an electronic tamper-resistant file that is used to record the values derived from the instrument. The file is saved in a proprietary format, that can be interpreted only by 'Review' software. Review can be configured to display files from different groups and different instruments on the same 'chart' or spreadsheet.

9.1.2 Data Recording Groups

Data Recording Groups provide a method of organising recorded data. For example, a single group can be created for each individual area of a plant/system. Each relevant LINblock field is assigned to a group, identified by an 'RGROUP' block, each group recording the configured field value at a specified rate. Fields may be assigned to multiple groups, allowing them to be recorded at different rates.

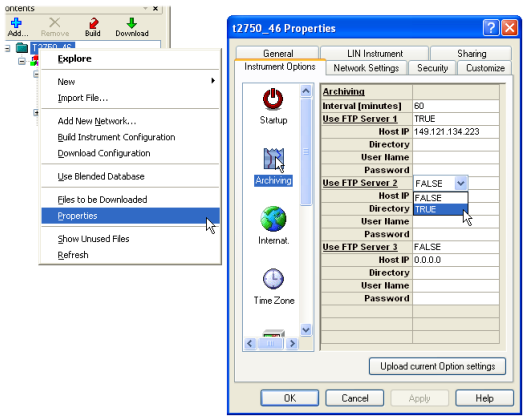
It is possible to record up to eight groups simultaneously, i.e. one 'RGROUP' block per recording group, with a maximum of 127 data values per group.

9.2 Data Archiving

Data archiving is the process of copying recorded data from the internal flash memory to up to three FTP Servers or to a USB memory stick. The archived .uhh file can then be replayed using an off-line tool ('Review' software).

FTP servers are configured as follows:

1. Right click on Instrument folder
2. left click on 'Properties'
3, Left click on the Instrument options tab
4. Left click on the 'Archiving' icon.
5. Click in the 'False' field and select 'True' from the pull-down menu.
6. Click in the 0.0.0.0 field and type-in the IP address of the relevant host computer.
7. Fill in the remaining Directory, user name and password information as required.

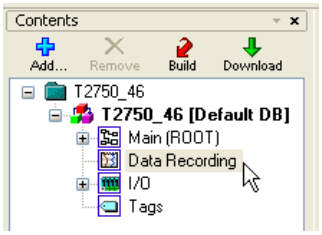


9.2.1 File Transfer Protocol (FTP)

File Transfer Protocol (FTP) is a commonly used Server/Client transfer mechanism. It allows the instrument to act as a FTP client to up to three FTP Servers for the purpose of transferring recorded files from the flash memory to a remote computer. When multiple FTP Servers can be configured to provide a back-up service for archiving, and in such cases, the .uhh files are archived to all defined FTP Servers.

It is necessary that each relevant host computer be configured to act as an FTP server and the services of the user's IT department or the Network Administrator may be needed in order to achieve this, particularly if there are company 'fire walls' or other security systems in place.

9.3 DATA MANAGEMENT CONFIGURATION



Data Management is configured using LINtools. Groups of recorded fields are defined in the instrument database, and can be individually customised using the Data Recording Configurator accessed by clicking on 'Data Recording' in tree view. Configuring individual fields provides a clear identification of each recorded field when displayed in Review.

To configure data management,

1. Define the data recording configuration using LINtools. There must be as many 'RGROUP' blocks on the worktop as the required number of groups.
2. Define the data archiving configuration using the Instrument Properties in LINtools.
3. Define the data visualisation configuration using Review.
4. Configure the FTP server(s)

Note: Review can import files directly from the instrument, as configured in the 'Review' Auto-Backup + Transfer facility. A User Name, ('history'), and a Password ('history') are required.

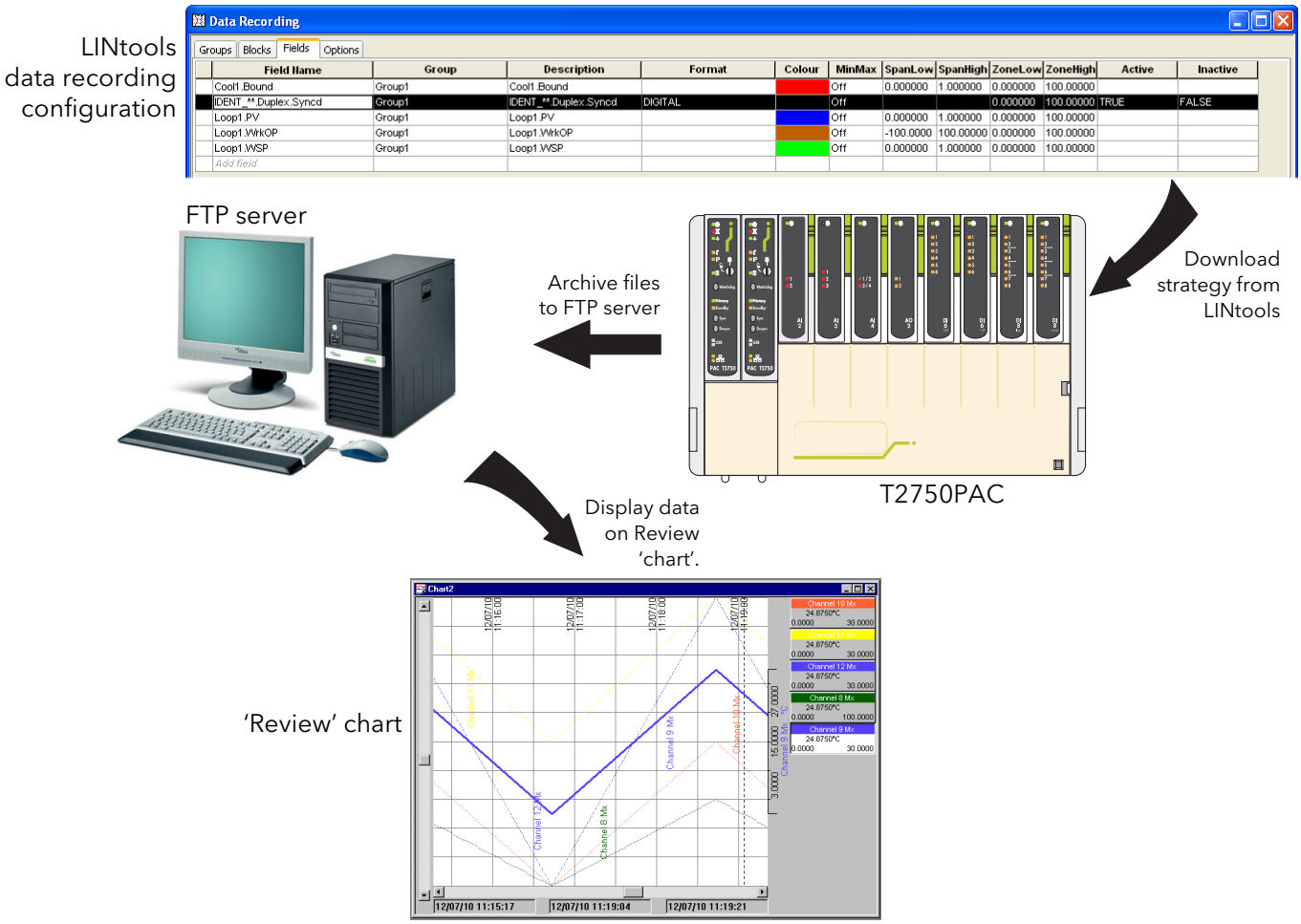


Figure 9.3 Data management overview

10 SETPOINT PROGRAMMER

The Setpoint Programmer creates a profile consisting of Ramp and hold segments. The output or current setpoint (PROGCHAN.Monitor.CurrSP) of the channel is the demand value, and should be wired to the setpoint of a control loop, e.g. LOOP_PID.SP.AltSP, together with the loop PV itself, so the loop can control an output, typically via an AO_UIO block, to drive the process.

A program template is first created using the 'Programmer Wizard', accessed from the LINtools 'Tools' menu. This contains basic information such as the number of Channels and their names, the number of Digital Events, Wait Conditions, Exit Conditions, User Values, the maximum number of segments the channels are to have etc.

Once the program template has been created, a Program file can be generated, using the Programmer Editor, which allows the user to enter segment details.

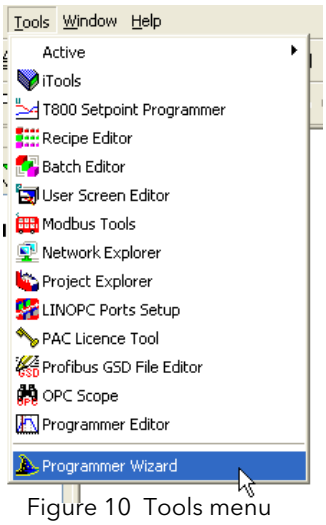


Figure 10 Tools menu

10.1 PROGRAM TEMPLATE CREATION

As mentioned above, program template (.uyw) files are created using the Programmer Wizard. Once created, such files may be edited only via the wizard.

The wizard creates a PROG_WIZ compound in the database file, containing:

1. One PROGCTRL block, used to control the overall execution of the Setpoint Program
2. Up to eight PROGCHAN blocks, one for each profiled setpoint in the compound,
3. Up to eight SEGMENT blocks per channel, each SEGMENT block offering 4 program segments

The wizard can also be used to specify the maximum number of digital event outputs, user values and segments allowed in the Program. The total number of digital event outputs, user values and Wait/Exit conditions is limited by the size of the Database file and the remaining number of PROGCHAN blocks available. Additional PROGCHAN blocks are automatically created if more than 16 digital event outputs and four user values are requested, but a maximum of eight PROGCHAN blocks can exist in a PROG_WIZ compound.

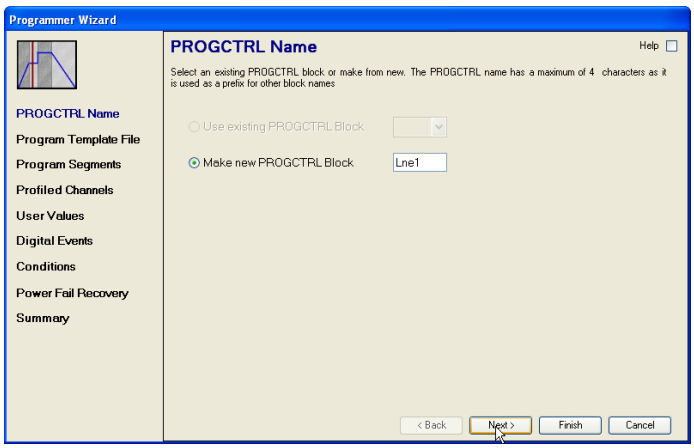
The Program Template file can be referenced by a local instrument or any other instrument on the same network allowing the same file to apply to multiple instruments.

10.1.1 Template creation

The following sequence illustrates the creation of a simple setpoint program template, with three channels having a maximum of eight segments each. The screen 'Help' has been disabled in order to save space.

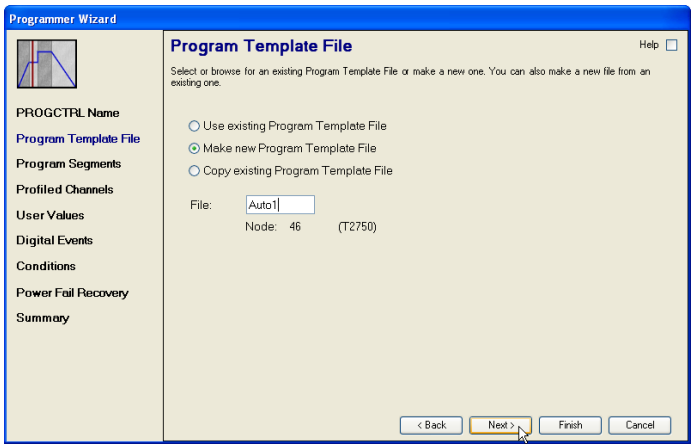
1. With LINtools running, click on the Tools menu, then on 'Programmer wizard' (figure 10, above).

2. The PROGCTRL Name display page appears. Enter a four-character name for the block and click on 'Next'



10.1.1 TEMPLATE CREATION (Cont.)

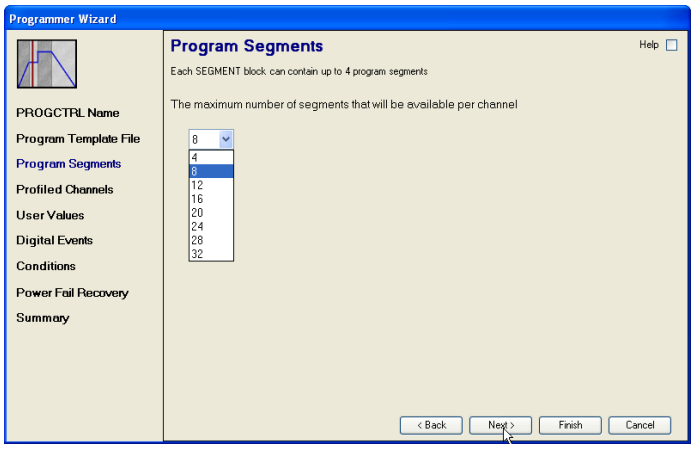
3 The 'Program Template' File page appears. Enter a name for the Program template, and click Next.



4 The 'Program Segments' page appears.

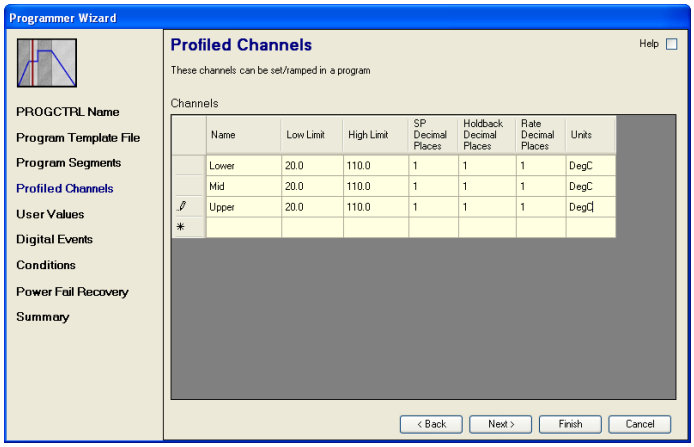
Select a value for the maximum number of segments the program is to have. There are four segments per block, so the available values are in increments of four.

Click on 'Next'.

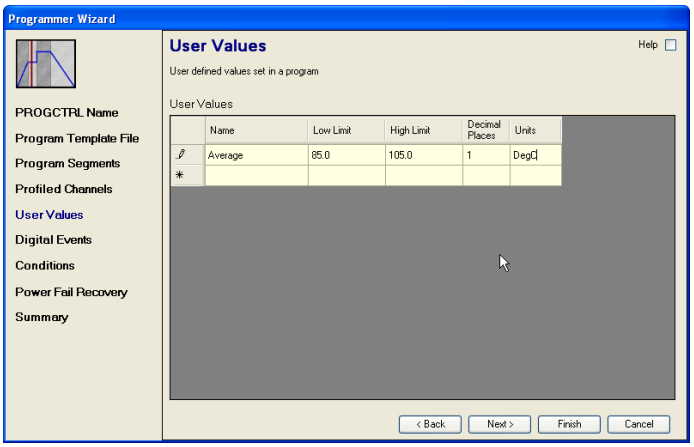


5. The 'Profiled Channels' page appears, allowing details of the required channels to be entered.
For this example, we have entered three channels: 'Lower', Mid' and 'Upper'.

Click on 'Next'

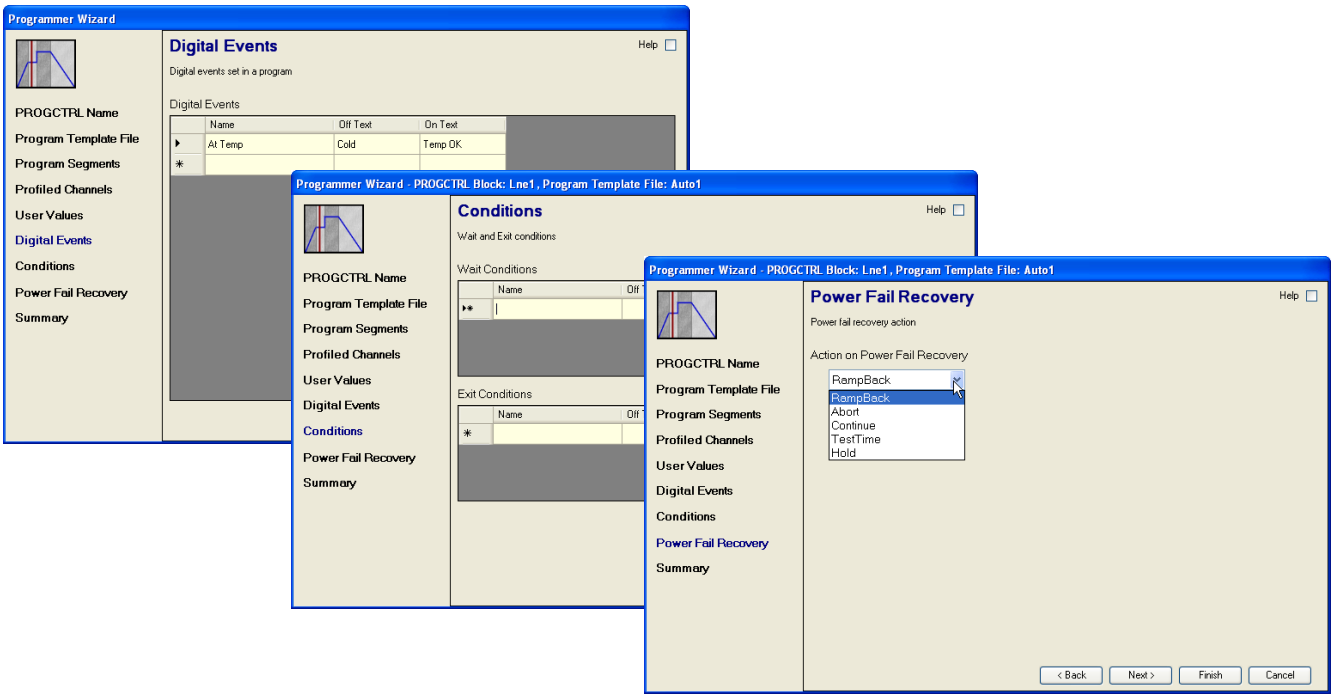


6. Enter any necessary user values and click on 'Next'
   User values (and digital events - below) can be associated with particular segments, such that they are output to a wired destination when that segment becomes active.

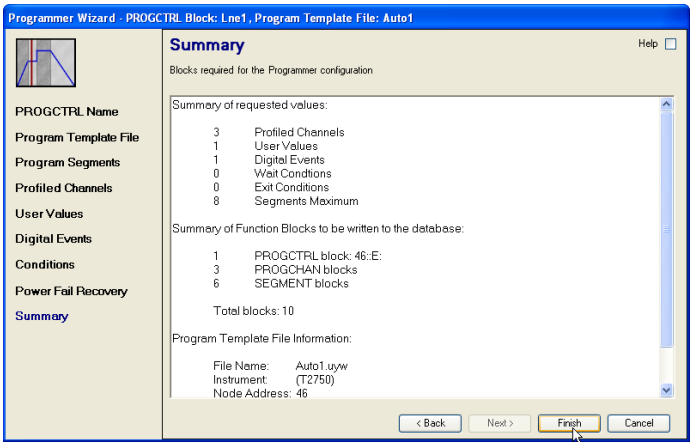


10.1.1 TEMPLATE CREATION (Cont.)

7. In a similar way, enter any Events, Wait Conditions, Exit Conditions and Power Fail recovery action. User values (above) and digital events can be associated with particular segments, such that they are output to a wired destination when that segment becomes active.
   Wait conditions must be fulfilled before the next segment can be advanced-to.
   Exit conditions must be fulfilled before the program can terminate.



8 The configuration can be checked by viewing the Summary page, before clicking on 'Finish'.



Note: The 'quicklink' headings on the left side of the pages can be used to jump to the relevant page.

10.2 PROGRAM EDITOR

10.2.1 Introduction

The Chart pane in the Programmer editor shows a maximum of three Profiled Channels, the first two showing the first two Profiled Channels the third being the channel currently selected in the Segment grid. The lowest Chart position can also show a Digital Event Output, or User Values by selecting it from the Properties pane

Any Program Template file can be used to construct many different Programs that can be run by each Programmer instance.

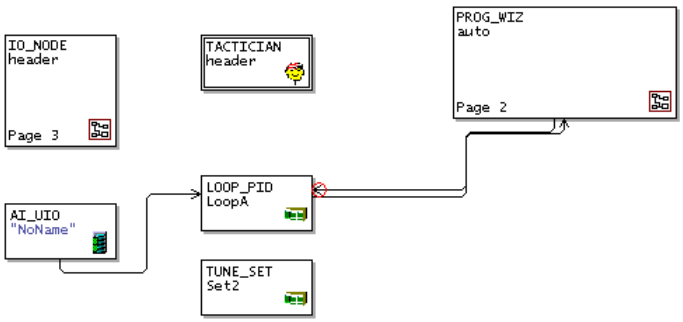
To configure a Setpoint Program:

1. In LINtools, create (edit) the instrument Program Template file using the Programmer Wizard as described in section 10.1.1, above,
   To prevent erroneous template file configurations only the wizard may be used to edit the blocks in the PROG_WIZ compound. Changing the number of Profiled Channels, Digital Events, or User Values invalidates any Program file created with the previous version.
2. Wire the control loop configuration (LOOP_PID block) to the Programmer configuration (PROGCHAN block) and return the current setpoint from the Programmer configuration (PROGCHAN block) to the control loop configuration (LOOP_PID block). This provides the setpoint control for the control loop configuration. Wire the input values (AI_UIO.PV) from the plant/system to the control loop (LOOP_PID.Main.PV).
3. Wire any Digital Events and User Values to appropriate output blocks.
4. Wire to the required Wait conditions and Exit conditions from appropriate input blocks.
5. When wiring is complete, save the Database file. Add the Program Template file and the Program file to the List of files to be Downloaded.

6 Create and/or open a Program file. This can be done either by using the context menu available when selecting the 'PROGCTRL.File.ProgFile (block.page.field)' in the LINtools Object Properties pane, after providing the Program name, or by opening the Programmer Editor, and selecting File > New (Open), and choose the Program Template file that matches the blocks of a PROG_WIZ compound in the database.

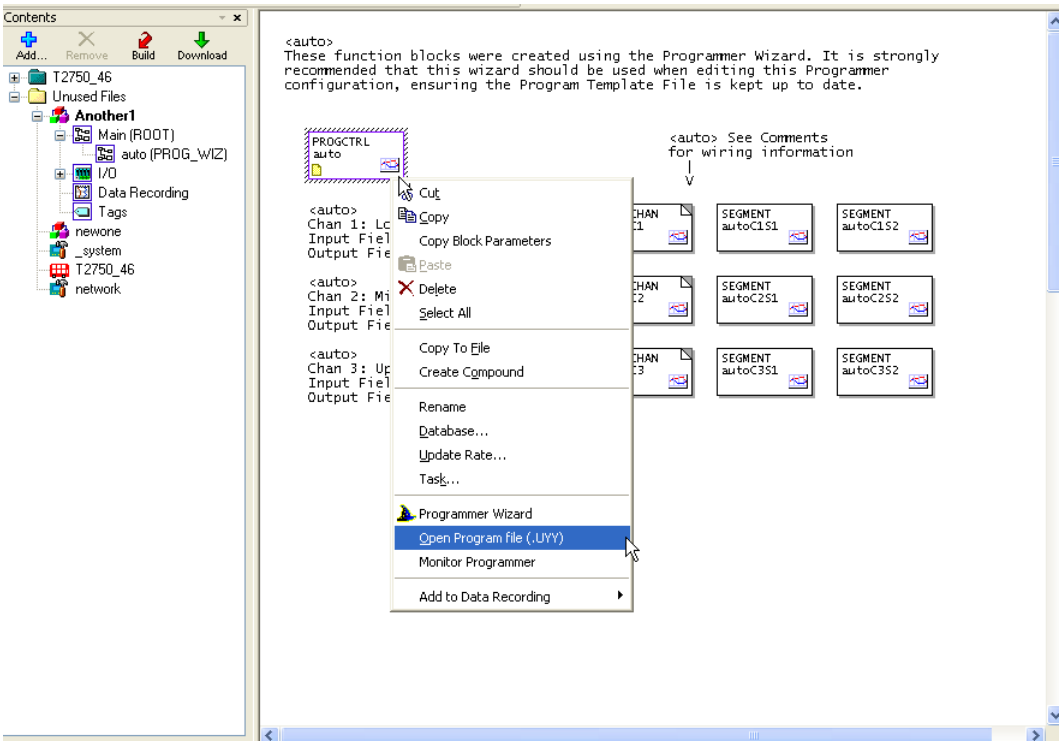
7 Configure the Program, setting each Segment type, Duration, and Target Setpoint in the Segment grid as required. Then configure the Digital Event Outputs, User Values, Exit and/or Wait conditions in the Program Properties Pane.

8 Download all relevant files to the instrument from the Programmer Editor to control the running Program.



10.2.2 Editing procedure

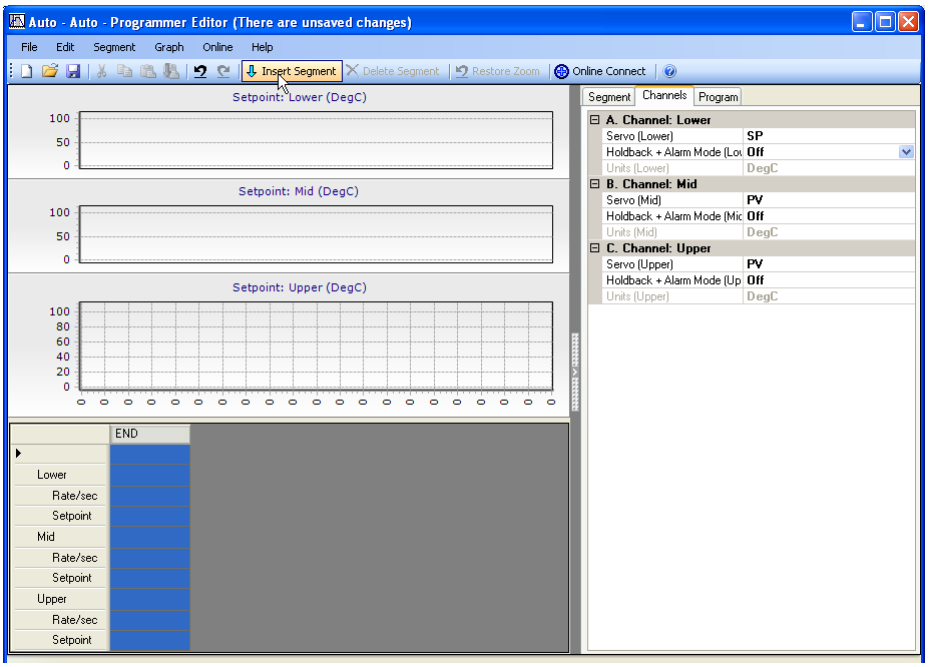
The following sequence shows typical steps in an imaginary segment creation procedure. Section 2 of the PAC Tutorial user guide should be referred to for fuller details.



One way of opening the program editor is to right-click on the PROGCTRL block on the LINtools work area, and selecting 'Open program File (UYY)' from the pull-down menu. Another way, for existing files, is to select 'Program Editor' from the LINtools 'Tools' menu', and using the browser to search for the program file (must have been saved previously).

If this is a new file, the program editor page opens, with an empty program display, based on the program template settings. If the file is pre-existing, then the previous configuration appears, but this part of the manual is concerned only with new files.

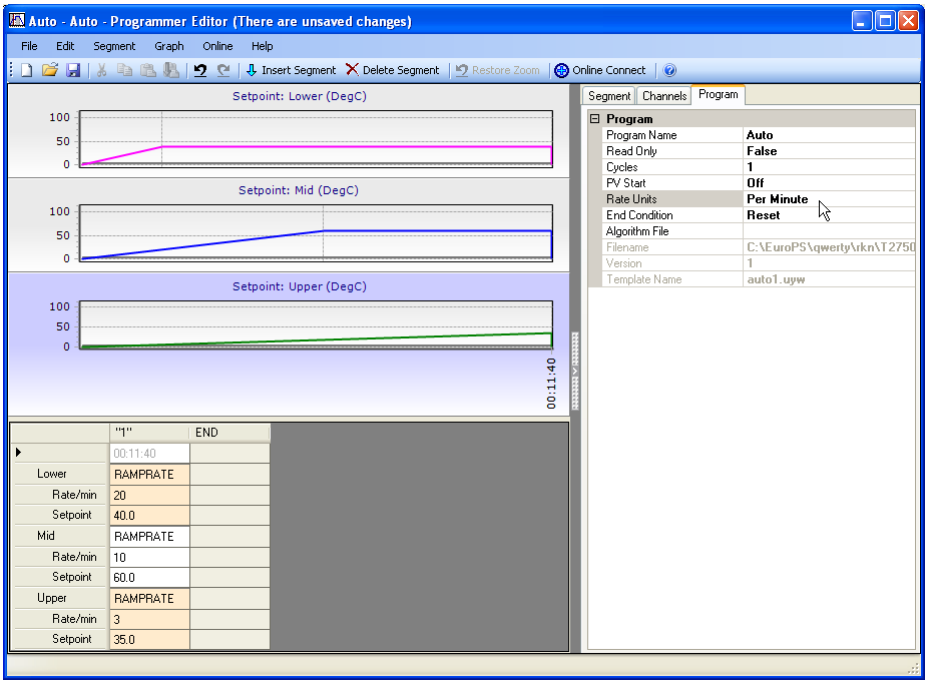
1. Click on the 'End' segment; then on 'Insert segment'



10.2.2 EDITING PROCEDURE (Cont.)

2. A new (dwell) segment appears. Edit the values as required. The traces respond to the new values.

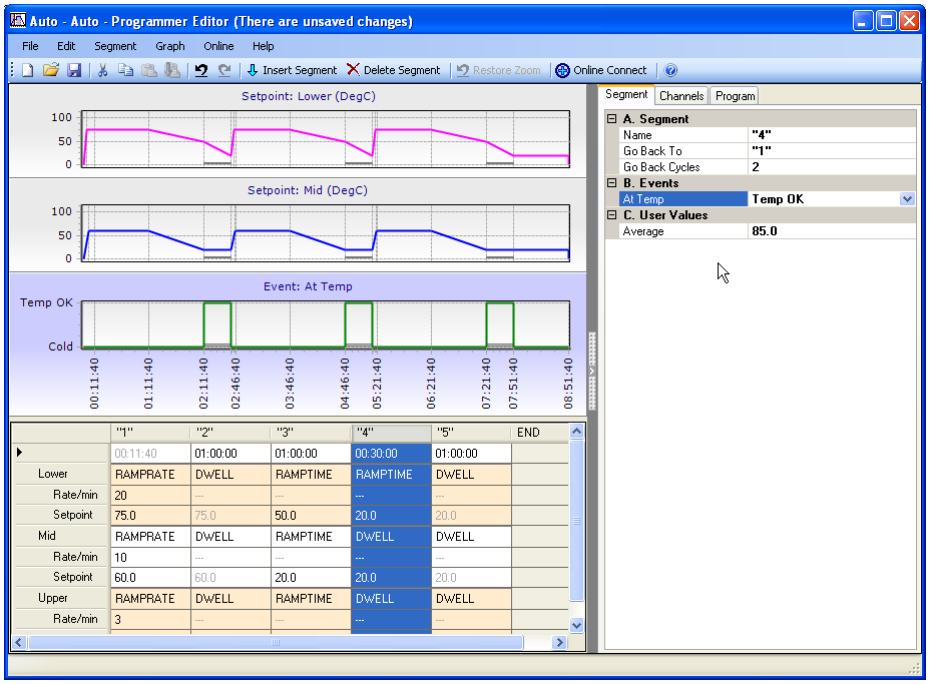
3. In the right hand pane, edit program parameters as required



4. Continue to add new parameters, by highlighting the parameter to the right of where the new parameter is to be located, then clicking on 'Insert Segment'.

5 When all the segments have been correctly entered, and all wait conditions, digital events, user values etc. correctly allocated, save the file, and close the editor.

6. Carry out a 'Build' and Download the program.



11 ERROR CONDITIONS AND DIAGNOSTICS

This chapter describes the various ways to tell if a fault has occurred in the PAC instrument, (not in the process being supervised).

The various subsections are:

1. Error indication types (section 11.1)
2. LED error displays (section 11.2)
3. Power-up failures (section 11.3) ()
4. Power On Self Tests (POSTs) (section 11.4)
5. Diagnostic blocks (section 11.5)
6. netHOST Profibus master troubleshooting (section 11.6)

11.1 ERROR INDICATION TYPES

Error indications include:

LEDs.	The LEDs are the most immediate source of error and instrument status information concerning Basic I/O System (BIOS) start, watchdog functions and normal running. During BIOS start, the LEDs are momentarily illuminated to indicate the BIOS status. If an IOC Module start fails, the pattern that these LEDs adopt prior to the failure is helpful to service engineers, so it is recommended that this pattern is recorded (along with the unit serial number) before a service call is made.
POSTs.	The results of Power On Self Tests (POSTs) can be used to pinpoint error conditions in the instrument. Refer to Power On Self Tests (POSTs) And Error Numbers section.
Diagnostic blocks.	A range of function blocks can be included in the running Strategy Database to provide diagnostic information on various topics, including the redundancy mechanism, the ICM (Inter-processor Communications Mechanism), the I/O interface, and others.

11.2 LED displays

The IOC LEDs are the primary method of displaying error, and an overview description is to be found in section 3 (Operator interface).

Additional information is included in the following subsections.

11.2.1 Instrument failure modes

The LEDs directly indicate the following IOC Module failure or potential failure modes:

1. Loss of Power
2. Watchdog
3. Communications failure
4. Loss of primary status
5. Decoupling
6. Desynchronisation

When either or both IOC modules, running as one of a redundant pair, fail, it usually changes its redundancy state in response to the failure, e.g. from primary to secondary, or from synchronised to desynchronised and sometimes, coupled to decoupled.

11.2.2 Power failure

In the event of a power failure, the IOC Modules enter a 'Power fail' state and the 'Status' LED on the Module is extinguished. Hot Start and Real-Time Clock data are maintained if a back-up battery is fitted. An internal 'supercap' also maintains this data (for approximately 1 hour) should power fail without a working backup battery being fitted.

11.2.3 Watchdog failure

In the event of a Watchdog failure, the affected IOC Module enters a 'Watchdog fail' state. Initially, the 'Fault' LED flashes, but becomes permanently illuminated after some seconds.

If the Watchdog Retry switch (section 2.3.2) is set ON, the IOC module automatically attempts to restart the CPU. If the Watchdog Retry switch is set Off, the CPU will atempt to restart only after an operation of the 'Watchdog' switch (figure 3.1 shows the switch location).

On watchdog failure in redundant mode, the surviving IOC module adopts (or maintains) the PRIMARY UN-SYNCHRONISED state. The database can run only if the modules were synchronised before changeover, otherwise, the database halts.

11.2.4 ICM failure

An ICM failure is not associated with any single IOC Module, and so is not classed as either primary or secondary fault.

An Inter-processor Communications Mechanism (ICM) failure occurs when the primary and secondary modules can no longer communicate with each other across the internal link, making database synchronisation impossible to maintain. An ICM failure causes the primary and secondary modules to decouple, but does not permit a changeover.

ACTION IN THE EVENT OF ICM FAILURE

In the event of an ICM failure, the IOC Module decouples (indicated by the flashing of the 'Duplex' LEDs on both IOC modules). See section 11.2.6 for details of decoupling. The process strategy must be designed to send the supervisory system an appropriate alarm to annunciate this ICM failure state, (e.g. use the 'RED_CTRL' block's 'PrHWstat.ICM_Ok' and 'SeHWstat.ICM_Ok' bits).

If the ICM does fail, the cause of the failure should be eliminated by replacing the secondary module. If this solves the problem the modules should be resynchronised by use of the primary 'Sync' button.

If the fault persists, the primary module is the most likely cause and should be replaced and the original secondary should be re-fitted as it is unlikely also to be faulty.

If appropriate, the existing database should be restarted by powering down and then up again. Otherwise, a 'default' database should be loaded and started in the new primary.

This last option is a Cold Start and requires manual supervision of the plant during the transition.

Note: A fault in the Terminal Unit is also a possible cause of ICM failure.

11.2.5 LIN failure

A LIN failure occurs when an IOC Module is not communicating over the LIN, perhaps because the cable is damaged or disconnected or because there is a hardware (electronics) failure or there is a network communications failure. A LIN failure causes the relevant 'Ethernet (Activity)' LED associated with the affected IOC Module to extinguish and the yellow 'IP' LED to flash.

A LIN failure in a synchronised primary Module causes primary/secondary changeover and loss of synchronisation, i.e. Primary synchronised adopts Secondary unsynchronised, and Secondary synchronised adopts Primary unsynchronised.

If an unsynchronised primary module suffers a LIN failure no changes of state occur.

If a LIN failure occurs in a synchronised secondary module, the module adopts the Secondary unsynchronised state ('Standby' LED off), and the primary module desynchronises to the Primary unsynchronised state. If the secondary was unsynchronised at the time of the failure, no change of state occurs.

11.2.5 LIN FAILURE (Cont.)

EFFECT OF LIN FAILURE ON REDUNDANCY MODE CONTROL

LIN failure affects the ability of Primary and Secondary modules to synchronise. For example, a LIN-failed secondary IOC module cannot be synchronised successfully with the primary by pressing the primary's 'Sync' switch. Attempts so to do are inhibited by the redundancy control software as indicated by the 'Stand-by' LED's lack of response.

11.2.6 Decoupled Instruments

Decoupling occurs when communication between unsynchronised primary and secondary modules is aborted because of a conflict regarding the unsynchronised state. This causes the IOC modules to become decoupled. Such decoupling can be caused by a number of faults, but generally it is due to a serious error, causing the modules to assume they should be more than unsynchronised.

A decoupled state is indicated by the 'Duplex' LED flashing on both IOC modules. Such a state can occur on power up if the two IOC modules conflict in their outlook of how they both powered down, i.e., if the two modules power down, both as synchronised secondary modules, when powered up together, they may de-couple - because the dual power up cannot resolve the differences between them.

The strategy must be designed to send the supervisory system an appropriate alarm to annunciate this state, using, for example, the 'RED_CTRL' block's 'PrSWstat.Decoupld' and 'SeSWstat.Decoupld' bits.

In the event of the primary and secondary modules becoming decoupled, the IOC modules are already un-synchronised. This can be rectified by operation of the 'Sync' switch on the primary module, and if this is successful, both 'Duplex' LEDs illuminate continuously. Should the decoupled modules not re-synchronise after using the 'Sync' switch, further investigation must be made in order to locate and rectify the cause of the fault.

11.2.7 Desynchronisation

Desynchronisation is generally caused when the database in the primary module stops running: the 'Primary' LED flashes and the two IOC modules desynchronise. No changeover occurs and attempts to resynchronise are inhibited by the redundancy control software until the primary module starts running again.

Only when the decision to changeover has been accepted, can the secondary IOC module assume control. Before the changeover occurs, the yellow 'Standby' LED of the secondary module is extinguished, and the green 'Primary' LED starts to flash whilst the strategy is loaded from the primary module. When the strategy has finished loading the previously secondary module assumes control, this state being indicated by the green 'Primary' LED being continuously illuminated. The changeover is complete when the database on the previously primary module is stopped.

11.3 POWER-UP FAILURE

11.3.1 Start-up routine

A number of error conditions can occur during the power-up phase. This start-up routine is described earlier (section 4), and should be referred-to for detailed information. Various messages are generated by the IOC Module during power-up and these messages can be displayed by running a 'Telnet' session on a Computer via the ELIN network.

11.4 POWER ON SELF TESTS (POSTs)

At switch on, the Basic I/O system (BIOS) checks that the Central Processor Unit is operating correctly. This stage of power-up is apparent by the lighting of all LEDs on the front of the IOC (shown in figure 3.1).

The start-up process initiates the Power On Self Tests (POSTs) with the loading of the application and system code from the SDHC card on the underside of the IOC Module.

Firstly the Boot ROM is checked, running each POST to ensure the SDHC Card is functioning correctly.

If all LEDs are dimly lit, this indicates a boot ROM failure, and the IOC must be returned to the factory for repair.

Then the IOC Module is checked, again running each POST to ensure the application is operating correctly.

Should any POST fail, the LEDs display a pattern (see below). The pattern is displayed for approximately 11 seconds before the instrument enters a watchdog state. The location of the POST failure is indicated by the 'Standby' LED. If illuminated, an Application POST has failed, whereas if it remains extinguished a Boot ROM POST has failed.

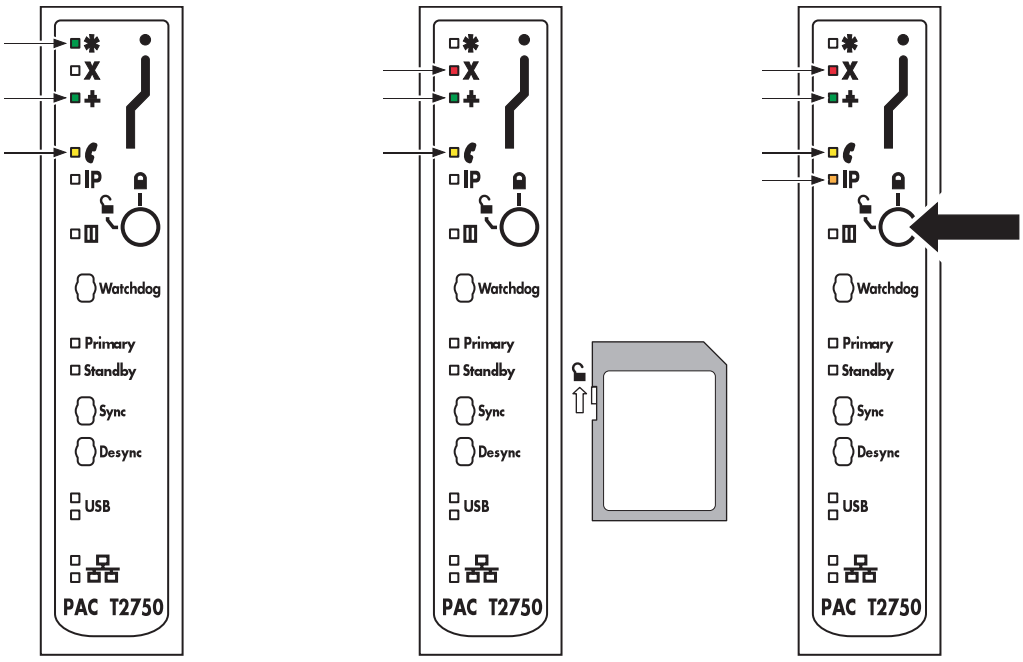
If the POSTs are concluded successfully, the instrument attempts to start the software. The primary/secondary status of each module is decided according to the criteria described in section 4.4.1, using 'signature' data relating to last-time's power down, automatic synchronise states and so on.

A check is made to ensure that the ICM communications are valid, and if so, the primary module continues its power up sequence, according to the mode selected. If synchronisation is permitted the 'Standby' LED starts flashing on and off when the primary module starts to download data to the secondary.

If the ICM test fails, or if non-redundant working is required, the module continues the power up sequence, according to the mode selected.

11.4.1 POST Failure LED patterns.

As mentioned above, if the POST procedure fails, a 'pattern' of LEDs is illuminated at front of the relevant IOC. The three patterns shown below are the only failure modes that the user can correct. All other modes require that the IOC be returned to the factory for repair.



Code 13: No SDHC card fitted:
Fit SD card (section 12.2)

Code 14: SDHC card write protected:
Slide write protect tab to 'unlocked' position.

Code 30: IOC not fully pushed home and secured:
Ensure that the module is correctly fitted and secured using the 1/4 turn fastener.

Figure 11.4.1 POST failure LED displays

11.5 DIAGNOSTIC BLOCKS

Several diagnostic function blocks are available from the DIAG category, that can be installed in the LIN Database at configuration time to help in diagnosing any error conditions that may arise in the running strategy. The LINtools program can then be used, via the LIN network, to investigate these fields.

Table 11.5 shows a list of diagnostic blocks that are generated as part of the automatically created LIN Database, when the Options switches are set correctly (section 2.4.2).

Note: All function blocks are described in the LIN Blocks Reference Manual.

Block	Function
DB_DIAG	Database diagnostic block. Shows actual and maximum resource levels of the database being used by the current application. Displayed parameter values are valid only at run time.
EDB_DIAG	External database diagnostics block. Shows connection information relating to an external database running in remote instruments, and monitors the cached block update rate tuning algorithm.
EIO_DIAG	Ethernet I/O system diagnostic block. Shows the current state (Healthy or Unhealthy) of the expected and actual I/O modules at each site. A maximum of 16 I/O sites can be displayed on one screen.
ELINDIAG	ELIN diagnostics block. Statistics on the operation of the Ethernet Local Instrument Network.
GWProfM_CON	Profibus master gateway block. Provides gateway diagnostics and standard Profibus communication diagnostic parameters for a device at a defined slave address. Only relevant if Profibus master functionality is used.
ICM_DIAG	ICM diagnostics block. Statistics related to the numbers and types of message passing between redundant IOC modules.
IDENTITY	IDENTITY diagnostics block. Identifies the instrument containing this block.
LIN_DEXT	LIN high-level diagnostics extension block. Statistics relating to operation of the Local Instrument Network (LIN).
NETHOST	netHOST diagnostic block containing information regarding the associated netHOST Profibus gateway. Only relevant if Profibus master functionality is used.
OPT_DIAG	Options/License control system diagnostics block. This block shows the user system attributes that may impose some limit of operation, or cause a license violation alarm. The block is not essential to the running of the LIN database, and can be added whilst on line, if required.
RED_CTRL	Redundancy Control Block. If redundant systems are configured, this block shows Processor Redundancy Management Task (PRMT) parameters. The block can also be used to trigger processor module synchronisation and primary/secondary swap.
SFC_DIAG	Sequential Flow Chart diagnostics block. If SFC is enabled, this block shows actual and maximum resource levels of the sequence used by the current application. Displayed parameter values are valid only at run time.
TACTTUNE	Tactician Tuning Block. System task monitoring in priority order.
USERTASK	User task diagnostic block. Strategy task performance monitoring.

Table 11.5 Typical diagnostic blocks

11.6 netHOST PROFIBUS MASTER TROUBLESHOOTING

When the T2750 first starts the database file (.dbf), it scans for all netHOSTs on the local subnet. From the responses, it identifies the netHOST with the correct ADR setting and confirms the IP address is correct. If the IP address is unconfigured, the T2750 will automatically configure the IP address as it starts up.

There are several potential failures:

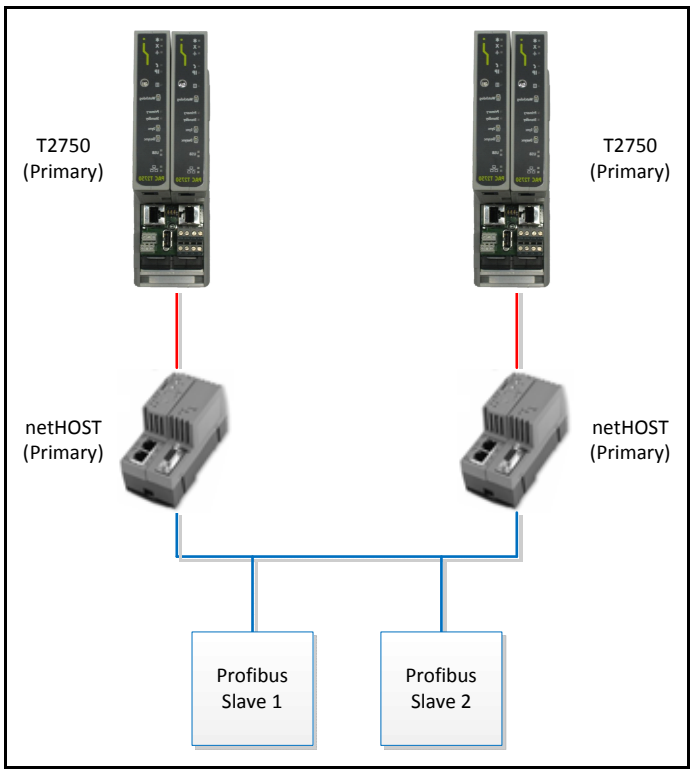
1. No netHOST with the correct ADR found
2. A netHOST with the correct ADR is found, but it is already assigned a different IP address to that expected (implying another T2750 may be using it).
3. A netHOST with the correct ADR is found but no IP address assigned and netIdent fails to correct set the IP address.

These failures can be diagnosed by any of the following:

- Alarm and status data in the GWProfM_CON block
- Status data in the NETHOST diagnostics block
- Error messages written to the UDZ file. This is a text file and can be copied from the instrument's drive using the Network Explorer tool
- Status LEDs on the front of the netHOST gateway (refer to page 41).

11.7 netHOST FAULT SCENARIOS

This section considers various fault scenarios that could occur on a redundant Profibus system using T2750 and netHOST devices. The scenarios are described in terms of this example system:

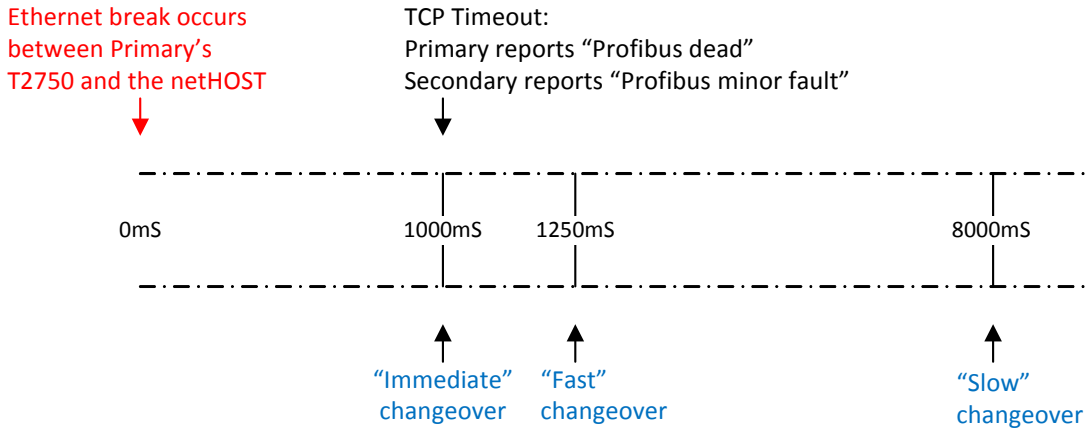


Note: This section does not consider the failure of a T2750, as failures of this nature are detected elsewhere and cause the surviving T2750 to adopt an isolated, unsynchronised primary state virtually immediately, with no impact from the Profibus health monitoring.

The action taken during a fault scenario depends upon the redundancy logic defined for the T2750. Refer to the "SETTING THE REDUNDANCY LOGIC" on page 52 for details.

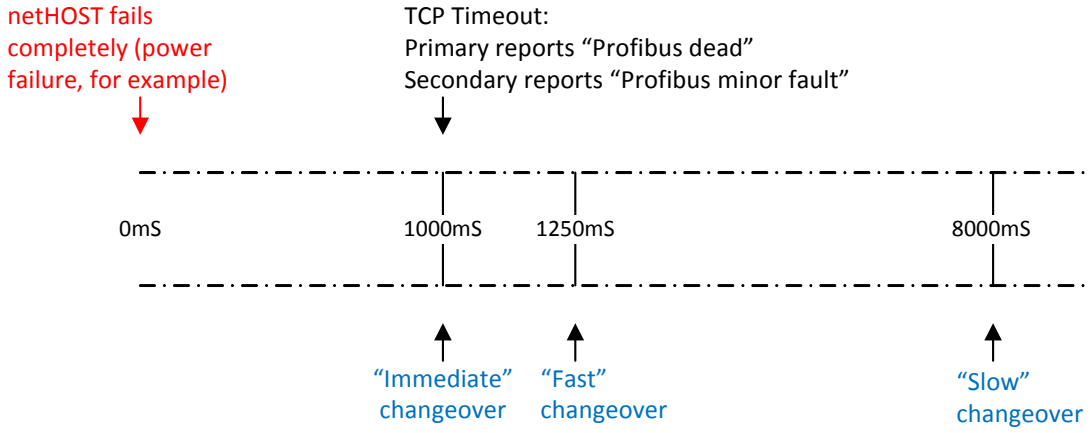
11.7.1 Fault Scenario 1: Ethernet Break between Primary's T2750 and netHOST

In this scenario, the Ethernet connection between the Primary T2750 and its netHOST breaks. The secondary T2750 therefore has a better view of the Profibus network (because the primary has no view at all of the Profibus network). The figure below shows a timeline of the events which will result in a changeover of the T2750s. If the redundancy logic for Changeover events is set to "Disable", then the T2750 will not changeover due to Profibus failures.



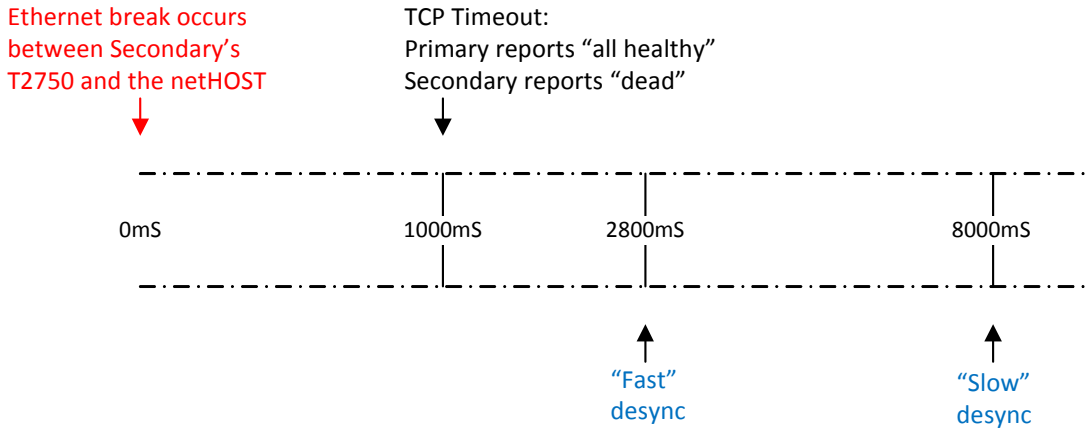
11.7.2 Fault Scenario 2: Total failure of Primary's netHOST

In this scenario, the Primary's netHOST fails completely (a power failure, for example). In this scenario, clearly the secondary T2750 has a better view of the Profibus network (because the primary has no view at all of the Profibus network). The figure below shows a timeline of the events which will result in a changeover of the T2750s. If the redundancy logic for Changeover events is set to "Disable", then the T2750 will not changeover due to Profibus failures.



11.7.3 Fault Scenario 3: Ethernet break between Secondary's T2750 and netHOST

In this scenario, the Ethernet connection between the Secondary T2750 and its netHOST breaks. The primary T2750 therefore has a better view of the Profibus network (because the secondary has no view at all of the Profibus network). The figure below shows a timeline of the events which will result in a desync of the T2750s. If the redundancy logic for desync events is set to "Disable", then the T2750 will not desync due to Profibus failures.



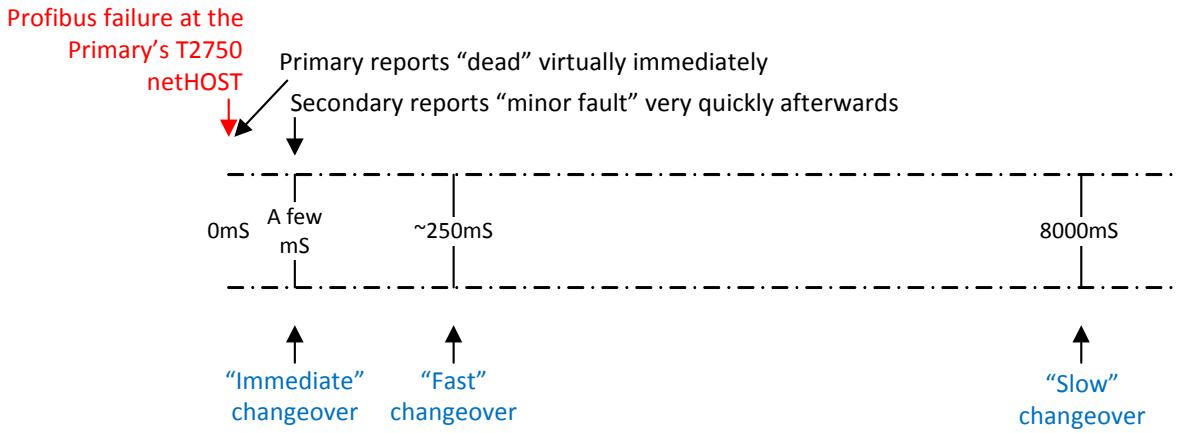
11.7.4 Fault Scenario 4: Total failure of Secondary's netHOST

In this scenario, the Secondary's netHOST fails completely (a power failure, for example). Clearly the primary T2750 has a better view of the Profibus network (because the secondary has no view at all of the Profibus network). The behaviour is identical to those to that for an Ethernet break between the Secondary's T2750 and associated netHOST (see "11.7.3 Fault Scenario 3: Ethernet break between Secondary's T2750 and netHOST" on page 131).

11.7.5 Fault Scenario 5: Profibus break at Primary's netHOST

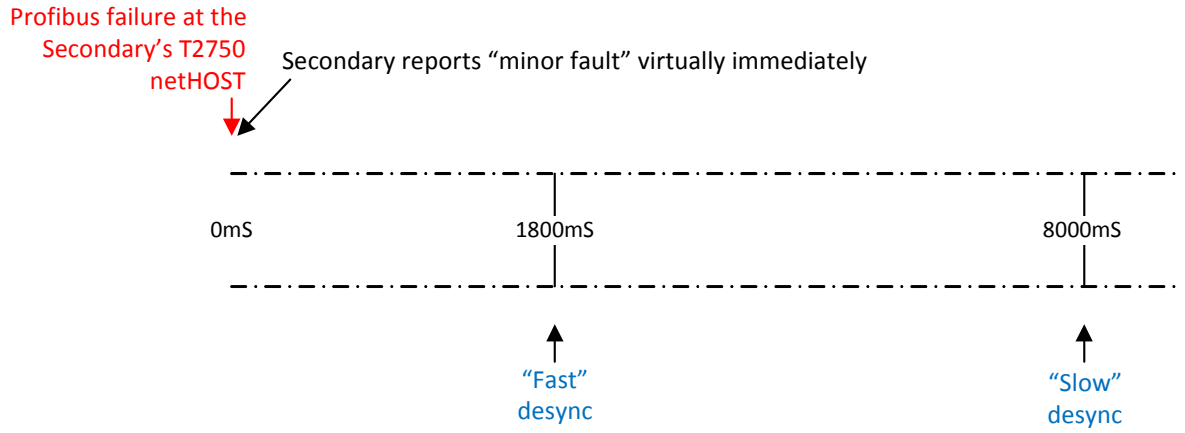
In this scenario, the Profibus connection fails at the Primary's netHOST. Clearly the Secondary's T2750 has a better view of the Profibus network (because the primary has no view at all of the Profibus network). The primary T2750 will report "dead" virtually immediately as it has lost contact with all the Profibus slaves.

The secondary T2750 will report "minor fault" almost immediately. However, it takes a small, but finite, time for this information to propogate from the secondary to the primary. The figure below shows a timeline of the events which will result in a changeover of the T2750s. If the redundancy logic for changeover is set to "Disable", then the T2750 will not changeover due to the Profibus network failure.



11.7.6 Fault Scenario 6: Profibus break at Secondary's netHOST

In this scenario, the Profibus connection fails at the Secondary's netHOST. Clearly the Primary's T2750 has a better view of the Profibus network (beacuse the seconday has no view at all of the Profibus network). The secondary T2750 will report "minor fault" virtually immediately because it has lost contact with the Primary. The figure below shows a timeline of the events which will result in a desync of the T2750s. If the redundancy logic for desync is set to "Disable", then the T2750 will not desync due to the Profibus network failure.



11.7.7 Fault Scenario 7: Profibus break in the middle of the Profibus network

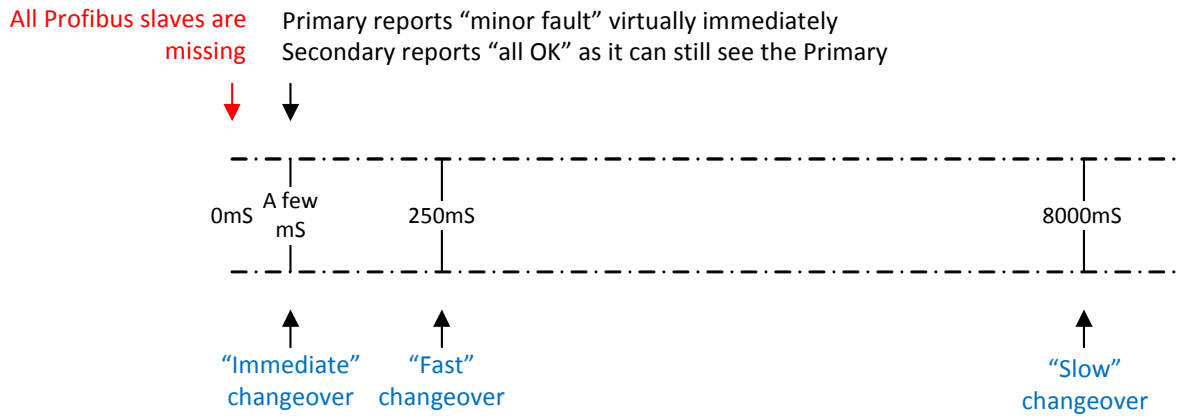
In this scenario, the Primary's netHOST is connected to some of the Profibus slaves, and the Seconday's netHOST is connected to the remaining Profibus slaves. The profibus link between the Primary and Secondary is broken.

There is no count of the number of slaves connected to each netHOST, so there is no way of knowing whether the Primary or Secondary has the "better" view of the Profibus network.

Both the Primary and Secondary T2750 will report "minor fault", but a desync or changeover will not occur.

11.7.8 Fault Scenario 8: Profibus failure of all slaves

In this scenario, the Primary and Secondary's netHOSTs are still connected via the Profibus network, but all slaves are missing. The figure below shows a timeline of the events which will result in a changeover of the T2750s. If the redundancy logic for changeover is set to "Disable", then the T2750 will not changeover due to the Profibus all-slave failure.



12 SERVICE

This section describes the regular preventive changing of back-up batteries etc., and shows how to replace the IOC SD card and live operating Modules.

For details of how to update and change the instrument's system software, boot ROM and libraries, please contact the manufacturer's nearest service centre.

CAUTION



All circuit boards associated with this unit are susceptible to damage due to static electrical discharges of voltages as low as 60V. All relevant personnel must be aware of correct static handling procedures.

12.1 PREVENTIVE MAINTENANCE SCHEDULE

The following periods are recommended to guarantee maximum availability of the instrument, for use in what the manufacturer considers to be a normal environment. Should the environment be particularly dirty, or particularly clean, then the relevant parts of the schedule may be adjusted accordingly.

Whenever preventive maintenance is performed, it is recommended that a visual inspection of the instrument be made, and any deposits of dirt or dust removed using a low-pressure compressed 'air duster' such as are available from most electronics distributors.

12.2 REPLACEMENT PROCEDURES

12.2.1 Software/Firmware upgrade

The T2750 software/firmware can be upgraded by putting an upgrade file onto the T2750 and cycling the power. There are three ways to do this, as outlined in this section.

Note: If the system being upgraded is configured as a duplex system, refer to the section, "Upgrading Duplex Systems" on page 134 first, and then determine which of the three upgrade options to follow.

Option 1 – Upgrading by copying onto the SD card

Perform the following steps to perform an upgrade by copying the upgrade files directly onto the SDHC card within the instrument:

1. Extract the files from the upgrade zip file. The zip file contains upgrade.tgz, upgrade.bat and upgrade.txt.
2. With the power off, remove the SD card form the T2750 (refer to the "SD CARD REPLACEMENT PROCEDURE" on page 134 for details).
3. On a PC with a suitable card reader, copy the upgrade.tgz file into the root folder on the SD card.
4. Replace the SD card in the T2750.
5. Power up the T2750. Once the power has been restored, the upgrade will be applied and the LEDs on the T2750 will cycle. Please be patient as this takes some time to complete. At the end of the upgrade, the T2750 will reset by means of a watchdog.
6. If the watchdog reset switch is in the off position, then it will be necessary to manually reset the T2750 by pressing the watchdog switch once the red fault light (X) is on constantly, indicating that the upgrade is complete.

Option 2 – Upgrading over a network

Perform the following steps to perform an upgrade using FTP (assuming the T2750's IP address is known).

1. Extract the files from the upgrade.zip file. The zip file contains upgrade.tgz, upgrade.bat and upgrade.txt
2. Copy the upgrade.tgz file onto the SD card using FTP by issuing the command "upload <ip_address>" where <ip_address> is the IP address of the T2750 to be upgraded.
3. Power cycle the T2750.

4. Once the power has been restored, the upgrade will be applied and the LEDs on the T2750 will cycle. Please be patient as this takes some time to complete. At the end of the upgrade, the T2750 will reset by means of a watchdog.
5. If the watchdog reset switch is in the off position, then it will be necessary to manually reset the T2750 by pressing the watchdog switch once the red fault light (X) is on constantly, indicating that the upgrade is complete.

Option 3 – Upgrading using a USB memory stick

In order to upgrade using a USB memory stick, the T2750 must be configured to enable upgrades via USB. Refer to "2.4.4 USB Configuration" on page 51 for details. Then perform the following steps:

1. Extract the files from the zip file. The zip file contains upgrade.tgz, upgrade.bat and upgrade.txt.
2. Copy the upgrade.tgz file onto the root of a compatible USB memory stick.
3. Plug the memory stick into the USB connector on the T2750 terminal unit. The green USB LED should illuminate indicating that the file is being copied. Once the green LED has gone out, the USB memory stick can be removed. If the amber USB LED illuminates, there is an error trying to read the USB memory stick.
4. Power cycle the T2750.
5. Once the power has been restored, the upgrade will be applied and the LEDs on the T2750 will cycle. Please be patient as this takes some time to complete. At the end of the upgrade, the T2750 will reset by means of a watchdog.
6. If the watchdog reset switch is in the off position, then it will be necessary to manually reset the T2750 by pressing the watchdog switch once the red fault light (X) is on constantly, indicating that the upgrade is complete.

Note: If a USB extension cable is used to expose the USB port remotely, the maximum length of this cable must not exceed 1.5m when the T2750 is configured with a redundant pair of IOCs.

Upgrading Duplex Systems

To upgrade a duplex configured system, upgrade options 2 and 3 above can be followed without interrupting control. To do this, the following additional instructions should be followed:

1. Begin by de-synchronising the processors by pressing the Desync button on the primary controller.
2. Follow the above instructions (option 2 or option 3) up to, but not including the power cycling.
3. Press and hold the Desync button on the secondary until all but the Ethernet LEDs go out.
4. Remove and the replace the secondary processor into the backplane.
5. Continue following the instructions (option 2 or option 3) above, from after the power cycling step.
6. Synchronise the processors by pressing the Sync button on the primary controller.
7. Changeover primary and secondary by pressing the Sync button on the secondary controller.
8. Wait for the secondary to re-synchronise, indicated by the Standby LED being steady on.
9. Repeat the process to upgrade the other processor by repeating steps 1-7 in this procedure.

SD CARD REPLACEMENT PROCEDURE

Figure 12.2.1 shows the location of the SDHC card. The replacement procedure allows databases, user configurations, IP address and Network name, to be transferred from one module to another, allowing the 'Mean Time to Replace' to be reduced to a minimum.

Note: The Node address is set using the base unit switches and is therefore not transferred when replacing the SD card.

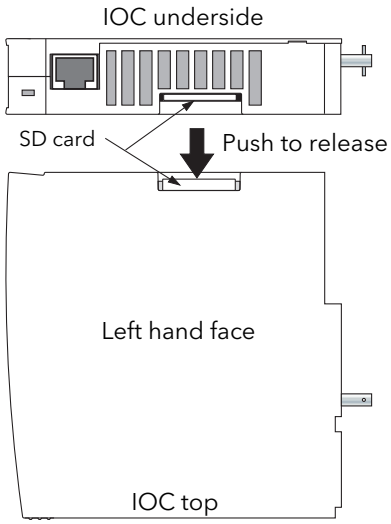


Figure 12.2.1a SD card replacement

1.For convenience, remove the relevant IOC module as follows:
a.Disconnect the Ethernet cable from the relevant IOC module.
b.Release the module by rotating its 1/4 turn fastener 90 degrees anti-clockwise.
c.Pull the IOC Module away from its Terminal Unit.
2.At the underside of the IOC Module, push on the edge of the SD card, to release it, then carefully pull it out of its connector.
3.Ensure that the replacement card is not write protected (figure 12.2.1b), then isert it into the slot and gently push it home.
4.Re-fit the Module to its terminal unit and secure it by turning the 1/4 turn fastener 90 degrees clockwise. Refit the Ethernet cable.

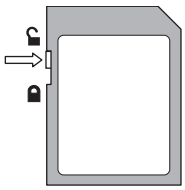


Figure 12.2.1b Write protect tab

SD CARD PRECAUTIONS

The following 'rules' should be observed to protect user databases etc:

1. Folders and / or system files must not be deleted.
2. The card must not be removed from the reader without the correct removal procedure having first been followed. This procedure varies according to the version of Windows being used.
3. It is recommended that a backup copy of all files and folders be made so that they may be restored in the event of accidental removal.

The SD card is a high-capacity card (SDHC) which might not be readable with older (SD) readers.

Note: If the SD card is changed, a Hot Start for the current running database will not be possible.

12.2.2 Live IOC Module replacement

Note: It is recommended that a backup of the strategy is made before replacing any IOC module.

Live replacement of a failed IOC Module can be carried out, without wiring disconnections. When operating in Redundant mode, either of the IOC modules can drive the I/O modules allowing the replacement module to load its strategy and status from the current primary Module.To replace the module:

1. Ensure the IOC Module to be replaced is not the current primary module. If the failed Module is the primary, press the 'Sync' switch to initiate the synchronisation process. This will ensure that both modules are synchronised allowing the primary and secondary modules to changeover.
   On occasions, it may be necessary to operate the primary module's 'Desync' switch in order to desynchronise the modules and ensure the failed module is operating as the secondary.
2. Shutdown the secondary module by pressing its 'Desync' switch for longer than 3 seconds.

3. When successfully shutdown (all LEDs are extinguished), the module can be safely removed from its Terminal Unit.
4. Fit the replacement module. When the module has automatically initialised, press the 'Sync' switch on the primary module to resynchronise the modules.

12.2.3 Powered-down IOC Module replacement

Replacement of a failed IOC Module can be carried out, without wiring disconnections, on a powered-down system. It is, however, recommended that this not be done without first ensuring that the replaced IOC Module has no RUN file on it (*.run). This is because the RUN file dictates which strategy is loaded upon power-up, and this may not be the same strategy that was previous running on the IOC Module just removed.

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:	61.25mm wide x 180 mm high x 132 mm deep (2.41in x 7.1in x 5.2in)
	4 module:	172mm wide x 180 mm high x 132 mm deep (6.79in x 7.1in x 5.2in)
	8 module:	274mm wide x 180 mm high x 132 mm deep (10.8in x 7.1in x 5.2in)
	16 module:	477mm wide x 180 mm high x 132 mm deep (18.8in x 7.1in x 5.2in)
Base Unit fixing centres	0 module:	26mm (1.023in)
	4 module:	127.4mm (5.02in)
	8 module:	229mm (9.016 in)
	16 module:	432.2mm (17.016 in)
Weight		
	0-way	0.7 kg (1.54 lb), including controller module.
	4-way:	No modules = 0.7 kg (1.54 lb). Including 2 x IOC and 4 x I/O modules = 1.65 kg (3.64 lb) max.
	8-way:	No modules = 0.98 kg (2.16 lb). Including 2 x IOC and 8 x I/O modules = 3.1 kg (6.83 lb) max.
	16-way:	No modules = 1.6 kg (3.53 lb). Including 2 x IOC and 16 x I/O Modules = 5.24 kg (11.55 lb) max.

See figures 2.2a/b for dimensional details

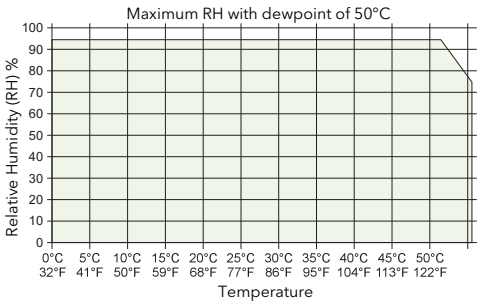
Electrical

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) 80 Watts (8 module base) 34 Watts (4 module base) 18 Watts (0 module base)
Surge current (max.)	8 Amps
Back-up supplies	3.3V ± 15%, 10µA max. (Figure 2.3.1a)

If the supply voltage falls below 19.2V dc during startup, the instrument can enter a continuous 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). 15g static shock
	Impact withstand	BS EN61010 (Corner drop test 100mm)
Packaging		BS EN61131-2 section 2.1.3.3
	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



Approvals

CE; cUL (UL61010); GOST

Ethernet Communications

Connectors:	One RJ45 connector on the underside of each IOC Module.
Network medium:	Ethernet Category 5 cables.
Protocols:	LIN over Ethernet / IP (ELIN), Modbus-TCP RTU slave, FTP.
Speed:	100 Mbps.
Network Topology:	Star connection to a hub.
Line length (max):	100 metres, extendable by repeater.
Allocation of IP address:	Manual, DHCP, Link-Local or BootP.
Isolation:	50V dc; 30V ac. (IEEE 802.3)

Modbus Communications

Connector:	Parallel pair of RJ45 connectors on the Terminal unit.
Network medium:	EIA485, link selectable as 3-wire or 5-wire.
Protocols:	MODBUS/JBUS RTU master and slave.
Isolation:	None.

A3 IOC SPECIFICATION

A3.1 TERMINAL UNIT

Physical	
Dimensions (approx.)	50 mm wide x 110 mm high
Weight (approx.)	0.1kg
Switches	
SW1, segment 2 to 8:	Instrument Address
SW2, segment 3:	Hot start switch
SW2, segment 2:	Cold start switch and Automatic Database Generation
SW2, segment 1:	Watchdog retry (trip and try again mode)
Links	
LK1 and LK2	Link pins 1 and 2 for three-wire communications; link pins 2 and 3 for five-wire. (Figure 2.3.1a)
User Connectors	
Supply power	Two x four-way terminal block for supply power. Supplies separately monitored by the IOC modules.
Watchdog Relay	Two x three-way terminal block, shared with back-up battery.
Backup battery	Shares connectors with Watchdog relays.
Modbus	Two RJ45 sockets, wired in parallel
USB	Type A connector.
USB	
Connector type	Type A located on IOC terminal unit (figure 2.3.1a)
USB standard	USB2.0 host communications
Source current	500mA max (current limited)
Fuse	Within primary IOC. Non-user replaceable.
USB extension cable length	Maximum 1.5m permissible with redundant IOCs

A3.2 IOC MODULE

A3.2.1 Hardware

General	
Dimensions	25 mm wide x 114.3 mm high x 110mm deep
Flash memory	32 MByte
SDHC card	Factory formatted. Removable from underside of the IOC module.
LED Indicators	
	Status (24V dc nom - Main supply), Fault indicator, Battery, Communications, IP Resolution, Duplex (redundant mode), Primary processor, Standby processor, Ethernet (speed), Ethernet (activity), USB hardware and USB software
Control switches	
	Watchdog Reset Synchronise/changeover Desynchronise
User Connections	
Ethernet Communications	One RJ45 connector mounted on the underside of each IOC module.

Note: Section 3 gives details of all IOC LEDs and control switches

A3.2.2 Software

LIN BLOCK LIBRARIES

Batch:	Sequencing recipe/record and discrepancy checking
Communications:	Instrument Communication blocks. Specific blocks MUST be included in the database to permit communications
Conditioning:	Dynamic signal-processing and alarm collection
Configuration (Header):	Instrument identity (Header) blocks
Control:	Analogue control, simulation and communications
Convert:	Convert dissimilar database field types, particularly enumerated values
Diagnostic:	Diagnostics
I/O:	Analogue and digital input output manual override
Logic:	Boolean, latching, counting and comparison
Maths:	Mathematical functions and free-format expressions
Organise:	Organise system screens and grouping data for logging
Programmer:	Control, monitor and schedule programs generated by the SetPoint Programme Editor
Recorder:	Control and manage data recording
Selector:	Selection, switching, alarm and display page management
Timing:	Timing, sequencing, totalisation and events

Continuous database resources

Number of function blocks (maximum)	2048
Number of templates (maximum)	170
Number of template libraries (max.)	32
Number of EDBs (maximum)	32
Number of FEATTs (maximum)	4096
Number of TEATTs (maximum)	1024
Number of server tasks (maximum)	6
Number of field-to-field connections	4096
Control database size (maximum)	800 kByte

Sequence Control Resources

Program data:	400 kBytes
N° of independent sequence tasks:	136 simultaneously active
SFC Roots:	31
Steps:	420
Action associations:	1680
Actions:	840
Transitions:	630

Modbus

Configuration Tools:	The Serial parameters of the instrument must be configured using 'Modbus Tools' software. The instrument parameters can be configured using 'Instrument Properties'.
Memory Size:	14 kBytes
Maximum Tables:	80 Diagnostics Registers = 16 general purpose registers + 1 register for each table
Operating Mode:	Master, Slave
Transparent Modbus Access (TMA/TalkThru):	Via Modbus Gateway file
Format:	Direct 32 bit, Reverse 32 bit (D, and S)
Tick Rate:	5ms
Number of facilities:	3 Modbus Gateway facilities
Redundancy:	Full control
Interface:	Serial interface can communicate with a maximum of 64 slave devices, one per register in the gateway file. TCP can communicate with 16 slave devices and 16 additional master devices, via the ENET3 and ENET4 ports.

I/O Block non supported software features

Some features are valid only in certain block configurations, and in such cases, unavailable options are 'greyed out' (non-editable). In addition to these, the following general exclusions apply.

AI_UIO block	Alarms.OctDel not supported
	Options.OCDelSt not supported
	Options.OCDelEnd not supported
	Status.BrkDtctd not supported
AO_UIO block	Alrms.OvrDrive not supported
	Status.OvrDrive not supported
DI_UIO block	All status bits and alarms are supported
DO_UIO block	Alarms.CctFault not supported.
	Status.OverTemp supported only by DO16 module.
FI_UIO	All status and alarm bits supported.
TPO_UIO block	Status.OverTemp supported only by DO16 module.
VP_UIO block	Status.OverTemp supported only by DO16 module.

A4 I/O MODULE SPECIFICATIONS

A4.1 AI2 MODULE

Note: Sensor Break Protection is controlled using an associated AI_UIO block.

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

A4.1.1Thermocouple 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

A4.1.4 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 220Ω resistors in the input circuits within the AI3 module (section 2.3.3).

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 ± 0.1% (fitted to terminal unit)

A4.4 AI8 MODULE

General specification (applies to all AI8 variants)

Number of channels		8 (4 for RTD)
Module power consumption		<1.8W
Common mode rejection (47 to 63 Hz)		
w.r.t. system, i.e. across galv. isolation		>140dB
Series mode rejection (47 to 63 Hz)		>60dB
Isolation	To system:	Reinforced for <300V ac/dc mains networks - Installation category II
	Between channels:	Galvanic isolation in pairs (channels 1 & 5, 2 & 6, 3 & 7 and 4 & 8) Basic isolation for <300V ac/dc mains networks - Installation category II Differential isolation within ±1V range between two channels of each pair in thermocouple, mV, mA and FmA modules. RTD provides basic isolation (<300V ac/dc) between channels

A4.4.1 mV input variant

Suitable transmitter types	mV sources with output impedance <1KΩ (floating or grounded)
Input range	±80mV
Input impedance	10MΩ differential, 2.5MΩ common
Input leakage current	±25nA (@ < 1V common)
Calibration accuracy	± 0.1% of mV reading for values outside -8mV to +8mV (full ambient temperature range) ±8µV for values inside -8mV to +8mV (full abient temperature range)
DC common mode rejection (w.r.t. other channels of same pair)	>105dB for source impedance mismatch <100Ω
Resolution/Noise	>17 bit with 1.6s filter (±1.5µV) 16 bit of span with no filter (±3µV)
Linearity	10ppm of input range
Temperature coefficient	<±30ppm per °C
Zero offset	<±3µV
Offset drift	<20pV/°C
Sensor break detection	within 250ms using 25µA pulse. Thresholds >50kΩ

A4.4.2 Thermocouple input variant

Thermocouple inputs		
Suitable thermocouples		B, C, D, E, G2, J, K, L, N, R, S, T, U, NiMo/NiCo, Platinel, Ni/NiMo, Pt20%Rh/Pt40%Rh
As mV input, with:		
Calibration accuracy		as for mV input, divided by chosen thermocouple sensitivity (mV/temperature unit) at measurement temperature
Linearity of linearisation		±0.1°C (deviation from defined curves)
Sensor break detection		within 250ms using 25µA pulse. Thresholds >50kΩ
Cold Junction	CJ Rejection	>50:1 typical (depending upon thermocouple sensitivity)
	Internal CJ accuracy	±0.8°C typical

Example.
Calibration accuracy using type K thermocouple at 500°C
500°C = 20.644mV
±0.1% of 20.644mV = ±20.644µV
Thermocouple sensitivity at 500°C = 43µV per °C
Calibration error is ±20.644/43 °C = ±0.48°C

A4.4.3 mA input variant

Suitable transmitter types	4-20mA sensors (floating or grounded)
As mV input, with:	
Input range	±24mA with 3.33Ω burden resistors fitted in the terminal unit
Calibration accuracy	±0.15% of mA reading for values outside -2.4mA to +2.4mA (full ambient temperature range)
Resolution/Noise	>17bit with 1.6s filter (±0.5µA) 16bit of span with no filter (±1.0µA)
DC common mode rejection (w.r.t. other channels of the same pair)	>105dB for source impedance mismatch <100Ω
Linearity	10ppm of span
Temperature coefficient	<±40ppm per °C (using 10ppm burden resistor)
Zero offset	<±1µA
Offset drift	<±8pA / °C)
Sensor break detection	Not detectable in hardware (software can detect under range current)

A4.4.4 RTD input variant

Connection scheme		3-wire, 2-wire connected to terminals A and B, with link between terminals B and C. 4-wire by leaving one wire disconnected
Number of channels		4
Suitable RTD types		Pt100, Pt1000
Input ranges		0Ω to 500Ω and 0Ω to 5kΩ (including lead resistance)
Calibration accuracy	500Ω range	±0.1% of resistance reading above 10% of range (>50Ω) (full ambient temperature range) ±50mΩ below 10%
	5kΩ range	±0.1% of resistance reading above 10% of range (>500Ω) (full ambient temperature range) ±500mΩ below 10%
Resolution/Noise		>17bit (±8mΩ) with 1.6s filter 16bit (±16mΩ) with no filter
Linearity		20ppm of input range
Temperature coefficient		<±20ppm per °C
Sensor break detection		Within 125ms by high resistance detection

A4.5 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)

A4.6 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)

A4.7 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)

A4.7.1 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

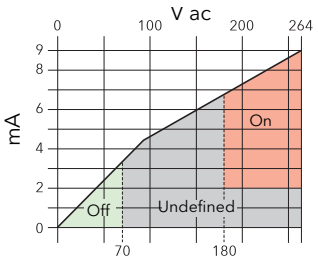
The result of applying RMS voltages between 35V and 95V is not defined.

A4.7.2 230V ac input variant

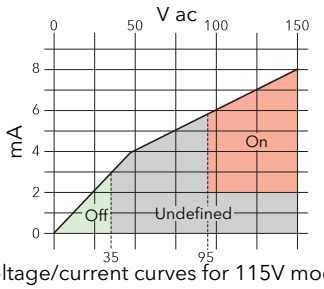
230V inputs

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 180 V is not defined.



Voltage/current curves for 230V module



Voltage/current curves for 115V module

A4.8 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

A4.8.1 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.

A4.8.2 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.

A4.9 DI 16 MODULE

General specification

Power consumption	Logic mode:	0.75 W max.
	Contact mode:	2.0 W max.
Isolation	Channel to channel:	Channels share 'common' ('C') connections.
	to system:	300V RMS or dc (Double insulation).
Minimum pulse width		5ms, 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

Off (logic 0) voltage	-30V to +5V dc
On (logic 1) voltage	10.8V to 30V dc
Input current	3.8mA approx. at 12Vdc; 2.8mA approx. at 24Vdc.

The result of applying voltages between +5V and +10.8V is not defined.

Contact inputs

Off (0) resistance	>7kΩ
On (1) resistance	<1kΩ
Wetting current	4mA min.
Module internal isolated power supply (terminal P voltage)	16 to 18V dc
Wetting voltage (effective)	12V dc min.

The result of applying inputs between 1kΩ and 7kΩ is not defined.

A4.10 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 (V_{CS})	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 (V_{CS})	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)

A4.11 DO8 MODULE

CAUTION

A 4 Amp fuse must be fitted in the voltage supply line in order to ensure against connector overheat

General specification

Power consumption		0.6 W max.
Isolation	Channel to channel:	Channels share 'common' ('C') connections.
	to system:	300V RMS or dc (Double insulation).

Refer to section 2.3.11 for precautions to be taken when fitting DO8 modules

Input specification

Voltage supply (V_{CS})	18 to 30V dc.
Supply protection	Internally limited at 4A (reaction time 4ms max.). Automatically resets 150ms after the cause of the fault has been rectified.
Logic 1 o/p voltage	(Vcs - 3)V for a full load.
Logic 0 o/p voltage	<0.1V
Logic 1 o/p current	0.75A max. per channel; 4A max. per module.

A4.12 DO16 MODULE

General specification

Power consumption (max.)	Module:	0.6W
	Plant side:	850W
Isolation	Channel to channel:	Channels share 'common' ('C') connections.
	to system:	300V RMS or dc (Double insulation).

Refer to section 2.3.12 for precautions to be taken when fitting DO16 modules

Input specification

Voltage supply (V_{CS})	24Vdc ±20%
Logic 1 o/p voltage	(Vcs - 1)V for a full load.
Logic 0 o/p voltage	<1V
Logic 1 o/p current	0.7A max. per channel.
Logic 0 output current	10µA
Short circuit protection	0.7 to 1.7A per channel
Module thermal cut-off (55°C ambient)	90±3°C (restart at 88±3°C).

A4.13 FI2 MODULE

Caution

If more than eight FI2 modules are fitted, and if these have an average output channel load of more than 5mA each, then an external power supply must be used to power the transducer (figure 2.3.13c). Otherwise, if the internal supply is used, damage will be caused to the base unit backplane tracking.

General specification

Power consumption		3.7W max.
Isolation	Channel to channel:	100V RMS or dc (Basic insulation).
	Channel to system:	300V RMS or dc (Double insulation).
Max terminal voltage	'+' to '-'	100V peak-to-peak
	'+' to 'C'	50V dc

'+', '-' and 'C' are terminal identifiers

Channel general specification

Frequency measurement	Ranges:	Logic: 0.01Hz to 40kHz (debounce off) Magnetic: 10Hz to 40kHz.
	Resolution:	<60 ppm of reading for square wave input
	Accuracy:	±100 ppm of reference ± 160ppm overall ± 0.05% drift (five years)
Pulse counting	Ranges:	Logic: DC to 40kHz (debounce off) Magnetic: 10Hz to 40kHz
Resolution		<600 ppm of reading for square wave input.
Max-frequency derating, due to debounce		
	Setting = 5ms:	Max frequency = 100Hz
	Setting = 10ms:	Max frequency = 50Hz
	Setting = 20ms:	Max frequency = 25Hz
	Setting = 50ms:	Max frequency = 10Hz

Magnetic sensor inputs

Input range	10mV to 80V peak-peak
Absolute maximum input	±100V
Input impedance	>30kΩ

Logic inputs

Minimum pulse width (debounce off)		1.2µs
Voltage	Input range:	0 to 20V dc
	Absolute maximum input:	50V dc
	Input impedance:	>30kΩ
	Threshold:	Settable range: 0 to 20V ± 0.2V hysteresis Accuracy ±0.4V or ±7% of range, whichever is the greater
	Sensor break level:	50mV to 310mV ±10%. Active for threshold settings between 200mV and 7.4V.
Current	Input range:	0 to 20mA
	Absolute maximum input:	30mA dc
	Input impedance:	1kΩ
	Threshold:	Settable range: 0 to 20mA ± 0.2mA hysteresis Accuracy: ±0.4mA or ±7% of range, whichever is the greater
	Sensor break level:	0.05mA to 0.31mA ±10%. Active for threshold settings between 0.2mA and 7.4mA.
	Sensor short circuit:	when <100Ω; restored when >350Ω. Active for threshold settings between 0.2mA and 7.4mA
Contact	Input impedance:	5kΩ
	Threshold:	Settable range: 0 to 20V ± 0.2V hysteresis Accuracy ±0.4V or ±7% of range, whichever is the greater

PSU Output specification

Voltage	Selectable as 8, 12 or 24Vdc at 10mA
Maximum current	25mA
Accuracy	±20%
Voltage drop	1V at 25mA
Current limiting	Output short circuit causes temporary failure of pulse input circuit.

A4.14 RLY4 MODULE

Note: Snubber circuits (22nF+100Ω) are fitted internally to this module. They may be removed as described in section 2.3.14. 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

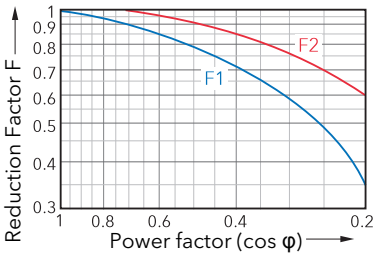
Relay specification

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



F1 = Measured results
F2 = Typical values
Life = Resistive life x reduction factor

A4.15 RLY8 MODULE

Note: Each input is fitted with a 100pF capacitor for EMC purposes. This causes an earth leakage current of approximately 0.02mA at 240Vac 60Hz per relay.

General specification

Power consumption		2.5W 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

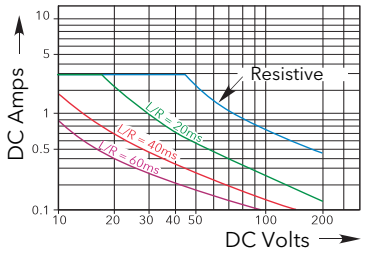
Relay specification

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 8:	Common and normally open contacts. (Open circuit with relay not energised)

DC inductive load breaking capacity derating curves



The above derating curves apply to the relays in both RLY4 and RLY8 modules.

A4.16 ZI MODULE

General specification

Power consumption	1.8W max
Common mode rejection	>80dB (48 to 62 Hz)
Series mode rejection	>60dB (48 to 62Hz)
Isolation ZI Channel to T/C channel:	300V RMS or dc (Basic insulation).
Channel to system:	300V RMS or dc (Double insulation).
Max. voltage across any channel	10V dc

Thermocouple input (channel 1)

Input range	-77mV to +100mV
Input impedance	10MΩ
Calibration accuracy	± 0.1% of reading ±10µV
Noise	<5µV peak - to - peak with 1.6s filter
Resolution	Better than 2µV with 1.6s filter
Linearity	±0.1°C
Temperature coefficient	<±30ppm/° C
Sensor break protection	250nA break high, low or off

Cold Junction

Temperature range:	-10°C to +70°C
CJ Rejection:	>30:1
CJ accuracy:	±0.5°C (typical); ±1.3°C max. (automatic CJC)
Sensor type	Pt100 RTD, located beneath the input connector

Zirconia input (channel 2)

Input range	-10mV to +1800mV
Input impedance	>500MΩ
Calibration accuracy	± 0.2% of input
Noise	<0.1mV peak - to - peak with 1.6s filter
Resolution	<50µV with 1.6s filter
Sensor impedance measurement	0.1kΩ to 100kΩ ±2%
Input leakage current	±1na (typical) ±4nA (max.)

A4.17 netHOST Profibus Master gateway

Electrical specification	
Supply voltage	24V dc ±6V dc (with reverse voltage protection)
Current consumption at 24V (typically)	130 mA
Power consumption	3.2 W
Power connector	Mini-COMBICON, 2-pin
Environmental	
Temperature range	0 to 60° C
Humidity	No condensation permitted
Diagnostic interface	
LED status for	SYS (System), APL (Application), COM (Communication) and Ethernet link and activity
Diagnostic LIN blocks	NETHOST and GWProfM_CON
Physical	
Dimensions (L x W x H)	100 x 52 x 70 mm (without connector)
Weight	150g (approx)
Mounting	on DIN rail EN60715
Protection class	IP 20
Profibus	
Max number of Profibus DP slaves	125
Max number of total cyclic input data	3584 bytes
Max number of total cyclic output data	3584 bytes
Max number of cyclic input data	244 bytes/slave
Max number of cyclic output data	244 bytes/slave
Configuration data	Max 244 bytes per slave
Parameterisation data per slave	7 bytes/slave standard parameters max 237 bytes/slave application specific parameters
Supported baud rates	9.6 kBit/s 19.2 kBit/s 31.25 kBit/s 45.45 kBit/s 93.75 kBit/s 187.5 kBit/s 500 kBit/S 1.5 MBit/s 3 MBit/s 6 MBit/s 12 MBit/s Auto baudrate detection is not supported
Data transport layer	PROFIBUS FDL
Limitations	DP V1 services class 1 and 2 are not supported DP V2 services are not implemented
Interface type	ISO 11898, optically isolated
Connector	Sub D female, 9-pin
Ethernet	
Transmission rate	100 Mbit/s
Half duplex / Full duplex	Supported
Connector	RJ45 x 2

A5 LIN BLOCKS SUPPORTED

A5.1 BATCH BLOCKS

See LIN Blocks reference manual chapter 2 for block details

DISCREP	Discrepancy block
RECORD	Record block
SFC_CON	Sequential function chart control block
SFC_DISP	Sequential function chart display block
SFC_MON	Sequential function chart monitor block

A5.2 COMMUNICATIONS BLOCKS

See LIN Blocks reference manual chapter 3 for block details

GW_CON	Gateway configuration block
GW_TBL	Gateway table block
GW_ProfM_CON	Gateway Profibus Master configuration block
GWProsSCon	Gateway Profibus slave configuration block (not this software release)
RAW_COM	Raw communications block

A5.3 CONDITION

See LIN Blocks reference manual chapter 4 for block details

AGA8DATA	AGA8 Calculation block
AN_ALARM	Analogue alarm block
CHAR	Characterisation block
DIGALARM	Digital alarm block
FILTER	Filter block
FLOW_COMP	Compensated flow block
GASCONC	Natural gas concentration data block
INVERT	Analogue inversion block
LEAD_LAG	Lead/lag filter block (for feed-forward calculations etc.)
LEADLAG	Lead/lag block
RANGE	Range block
TC_LIFE	Thermocouple life-expectancy block
TC_SEL	Thermocouple selector block
UCHAR	Data storage for 'CHAR' block
ZIRCONIA	Zirconia block

A5.4 CONFIGURATION BLOCKS

See LIN Blocks reference manual chapter 5 for block details

PROGRAM	Program configuration (header) block
TACTICIAN	Tactician configuration (header) block

A5.5 CONTROL BLOCKS

See LIN Blocks reference manual chapter 6 for block details

3-TERM	Incremental PID block
AN_CONN	Analogue connections block
AN_DATA	Analogue data block
ANMS	Analogue manual station block
DG_CON	Digital connections block
DGMS	Digital manual station block

LOOP_PID	Loop proportional, integral, derivative block
MAN_STAT	Manual station block
MODE	Mode block
PID	PID Block.
PID_LINK	PID linking block
SETPOINT	Setpoint block
SIM	Simulation block
TUNE_SET	PID tuning set block

A5.6 CONVERT BLOCKS

See LIN Blocks reference manual chapter 7 for block details

REALTIME	Real-time converter block

A5.7 DIAGNOSTIC BLOCKS

See LIN Blocks reference manual chapter 9 for block details

AGA8DIAG	AGA8 diagnostic block
ALH_DIAG	Alarm history diagnostic block
DB_DIAG	Database diagnostic block
EDB_DIAG	External database diagnostic block
EDB_TBL	External database table block
EIO_DIAG	ELIN I/O diagnostic block
ELINDIAG	ELIN MAC and LLC diagnostic block
EMAP_DIAG	Ethernet mapping diagnostic block
ETH_RT_LIM	Ethernet rate limit diagnostic block
FSM_DIAG	File system management diagnostic block
FTQ_DIAG	Processor redundancy management task (PRMT) queues diagnostic block
ICM_DIAG	Inter-processor communications mechanism statistics block
IDENTITY	Instrument identification/status diagnostic block
LIN_DEXT	LIN high level diagnostic extension block
LINMAPD	LIN mapping diagnostic block
LLC_DIAG	Logical link control (LLC) diagnostic block
NETHOST	netHOST diagnostic block
OPT_DIAG	Options diagnostic block
PRP_DIAG	Port resolution protocol diagnostic block
RARCDIAG	Data record archive diagnostic block
RMEMDIAG	Data record memory diagnostic block
ROUTETBL	Routing table block
RSRCDIAG	Resource diagnostic block
RTB_DIAG	Routing table diagnostic block
SFC_DIAG	Sequential function chart diagnostic block
SUM_DIAG	Summary diagnostic block
TACTTUNE	Tactician task summary block
TOD_DIAG	Time-of-day diagnostic block
USERTASK	User task diagnostic block

A5.8 IO BLOCKS

See LIN Blocks reference manual chapter 11 for block details

AI_UIO	Analogue input block
AO_UIO	Analogue output block
CALIB_UIO	Analogue I/O calibration block
DI_UIO	Digital input block
DO_UIO	Digital output block
FI_UIO	frequency input block
MOD_DI_UIO	Multi-channel digital input module block
MOD_DO_UIO	Multi-channel digital output block
MOD_UIO	Module I/O block
TPO_UIO	Time proportioning output block
VP_UIO	Valve positioner block.

A5.9 LOGIC BLOCKS

See LIN Blocks reference manual chapter 12 for block details

AND4	Four-input logical AND block
COMPARE	Compare block
COUNT	Input pulse count block
LATCH	D-Type flip-flop block
NOT	Logical invert block
OR4	Four-input logical OR block
PULSE	Monostable pulse generator block
XOR4	Four-input logical exclusive OR block

A5.10 MATHS BLOCKS

See LIN Blocks reference manual chapter 13 for block details

ACT_2A2W3T	Action block with gated down timers
ACTION	Action block
ADD2	Add block
DIGACT	Digital action block
DIV2	Divide block
EXPR	Expression block
MUL2	Multiply block
SUB2	Subtract block

A5.11 ORGANISE BLOCKS

See LIN Blocks reference manual chapter 15 for block details

AREA	Area block
GROUP	Group block

A5.12 PROGRAMMER BLOCKS

See LIN Blocks reference manual chapter 16 for block details

PROGCHAN	Setpoint programmer channel block
PROGCTRL	Setpoint programmer control block
SEGMENT	Setpoint programmer segment block
SPP_RAMP	Setpoint programmer local ramp block

A5.13 RECORDER BLOCKS

See LIN Blocks reference manual chapter 17 for block details

RGROUP	Data recording group block

A5.14 SELECTOR BLOCKS

See LIN Blocks reference manual chapter 19 for block details

2OF3VOTE	Best average block
ALC	Alarm collection block
SELECT	Selector block
SWITCH	Switch block

A5.15 TIMING BLOCKS

See LIN Blocks reference manual chapter 21 for block details

DELAY	Delay block
DTIME	Dead time block
RATE_ALM	Rate alarm block
RATE_LMT	Rate limit block
SEQ	Sequence block
SEQE	Sequence extension block
TIMEDATE	Time/date event block
TIMER	Timer block
TOT_CON	Totaliser connections block
TOTAL	Totaliser block
TOTAL2	Totaliser block
TPO	Time proportioning output block

Appendix B ERROR MESSAGES

B1 INTRODUCTION

Error messages appear in Event logs and in pop-ups on the pc display. The following subsections list all the error messages that can be generated by the LIN system. The error numbers are in the format: XXYY, where 'XX' is the type of error, related to the software package (listed below) that was running at the time, and YY is the particular error code within that package.

B1.1 Package codes

81	Base error codes (section B2.2.1)
82	File system (section B2.2.2)
83	Database system (section B2.2.3)
85	Objects system (section B2.2.4)
86	Trend system (section B2.2.5)
87	Control config (section B2.2.6)
89	Network error (section B2.2.7)
8B	Sequence database system (section B2.2.8)
8C	Sequence runtime system (section B2.2.9)
8D	Structured text system (section B2.2.10)
8F	PCLIN/PC I/F package (section B2.2.11)
91	Configuration files (section B2.2.12)
92	PRMT error codes (section B2.2.13)
99	External database (section B2.2.14)
9A	MODBUS codes (section B2.2.15)
9B	Xec codes (section B2.2.16)
9C	Kernel items (section B2.2.17)
9D	Objects (section B2.2.18)
9E	Locks (section B2.2.19)
A0	MAL (section B2.2.20)
A1	AMC (section B2.2.21)
A4	Modbus Master Comms (section B2.2.22)
A6	Asynchronous I/O (section B2.2.23)
AD	Profibus (section B2.2.24)
B2	Socket error codes (B2xx) (section B2.2.25)

B2 ERROR CODES

B2.1 Base error codes

8110	Timeout
8111	Received string too long (lost data)
8112	Multiple tasks waiting for CIO
8113	Illegal initialisation parameters
8114	Rx message buffer overrun
8115	Comms hardware break detected
8116	Rx character framing or parity error
8117	Rx character buffer overrun
8118	Tx Buffer full
8120	RTC invalid time.
8130	Licence Key is for different machine type
8131	No Licence Key in file
8132	Wrong size Licence Key
8133	Corrupt Licence Key Header
8134	Invalid character in Licence Key
8135	Error decrypting Licence Key
8136	Checksum error in Licence Key
8137	Licence Key not for this unit

B2.2 File system codes

8201	Not mounted
8202	Invalid device
8203	Physical error
8204	Not implemented
8205	Format error
8206	Not present
8207	Device full
8208	File not found
8209	No handle
820A	Bad filename
820B	Verify error
820C	File locked
820D	File read-only or No key fitted
820E	Unable to perform file check
820F	Unable to defer another file during synchronisation
8210	Illegal combination of open flags
8211	Could not complete file operation as synchronisation is in progress
8212	File cannot be modified
8213	Failed to duplicate file operation
8214	No handle to duplicate queue
8215	File systems no longer synchronised
8216	Synchronisation aborted
8217	Response length error
8218	File system timeout
8219	File synchronisation not requested
821A	Duplicate on secondary rejected
821B	Non specific error
821C	Sync fail due to .DBF check
821D	Sync fail due to .DBF load file name error
821E	Drive letter already assigned
821F	Filing out of memory
8220	Illegal link drive letter
8221	No such link exists
8222	Read/write file transfer to large
8223	Read file error
8224	Write file error

B2.3 Database system error codes

8301 Bad template
8302 Bad block number
8303 No free blocks
8304 No free database memory
8305 Not allowed by block create
8306 In use
8307 Database already exists
8308 No spare databases
8309 Insufficient memory
8320 Bad library file
8321 Bad template in library
8322 Bad server
8323 Cannot create EDB entry
8324 Bad file version
8325 Bad template spec
8326 Unable to make block remote
8327 Bad parent
8328 Corrupt data in .DBF file
8329 Corrupt block spec
832A Corrupt block data
832B Corrupt pool data
832C No free resources
832D Template not found
832E Template resource fault
8330 Cannot start
8331 Cannot stop
8332 Empty database
8333 Configurator in use or device busy
8340 .DBF file write failed
8341 More than one .RUN file found
8342 .RUN file not found
834A Connection Source is not an O/P
834B Multiple connection to same I/P
834C Connection Destination not I/P
834D No free connection resources
834E Bad conn. src/dest block/field
834F Invalid connection destination
8350 Hot/Cold start switch is disabled
8351 No database was running
8352 Real-time clock is not running
8353 Root block clock is not running
8354 Coldstart time was exceeded
8355 Root block is invalid
8356 Too many control loops
8357 Coldstart switch is disabled
8360 Unsynchronised Block Types
8361 DB/Filing system mismatch
8362 Unsynchronised Secondary
8363 Operation forbidden whilst CPUs synchronising/changing over
8364 Pwr-up data inhibits run
8365 POST hardware failure
8366 Not fixed function strategy
8367 Default strategy missing
836A Not duplex instrument
8370 On Line Reconfig in progress
8371 No delta changes to try/discard
8372 No delta changes to untry/apply
8373 On Line Reconfig not supported
8380 Duplicate block name whilst loading database
8390 This is an Invalid Unit (not permitted to run databases)
8391 This unit does not support Licence Control System
8392 Runtime save not supported on this unit.
8393 Reconfig not permitted for this block type.

B2.4 Object system error codes

8501 Out of F RAM - do not save file
8502 Out of N RAM - do not save file

B2.5 Trend system error codes

8602 Bad channel number
8603 Bad type code
8611 Bad handle or not hist
8613 File exists
8614 Exceeded global limit
8615 Unexpected end of file
8616 Read error
8617 Write error
8619 Bad filename
861A Bad timestamp

B2.6 Control configuration error codes

8701	Unnamed blocks
8702	Cannot save compounds
8703	No root block
8704	.GRF file write failed
8705	Compounds too deep
8706	Unused GRF block - deleted
8707	Unused GRF connection - deleted
8708	Missing GRF block - added
8709	Missing GRF connection - added
870A	Unknown DBF/GRF block mismatch
870B	Unknown DBF/GRF connect mismatch
870C	DBF/GRF file mismatch - use FIX

B2.7 Network error codes

8901	Network timeout
8902	Rejected by local node
8903	Rejected by remote node
8904	Not implemented
8905	Not active on local node
8906	Not active on remote node
8907	Transmit failure
8908	Failed to get memory
8909	Decode packet
890A	Remote file system busy
890B	Illegal TEATT
890C	Wrong TEATT
890D	NServer is busy
890E	TEATT not owned
890F	Duplicate block
8910	TEATT rejected
8911	Port disabled
8912	No port configuration
8913	Bad network filename
8999	Network node invalid

B2.8 Sequence database system error codes

8B01	Object Overload
8B02	Text Overload
8B03	No Matching Step Name
8B04	No Matching Action Name
8B05	Step already Exists
8B06	Action already Exists
8B07	Link already Exists
8B08	Leave a Bigger Gap
8B09	Bad Time Format
8B0A	File Read Error
8B0B	File Write Error
8B0C	File doesn't Exist
8B0D	File not Open
8B0E	Create Action ?
8B0F	No Match with string
8B10	No More Matches
8B11	Match found in Transition
8B12	Match found in Action
8B13	Changed - Are you sure ?
8B14	Link Already Exists
8B15	Illegal Chars in Name
8B16	Action Did Not Compile
8B17	Fatal Memory Overflow - Quit Now!
8B18	Out of memory when compiling
8B19	Root action must be SFC
8B1A	Invalid actions found during compilation
8B1B	Invalid DB name
8B1C	No database loaded
8B1D	Map is invalid

B2.9 Sequence runtime error codes

8C01	Database not Running
8C02	No Sequences Loaded
8C03	Sequence is being displayed
8C04	Cannot find an SFC_DISP block
8C05	Cannot find Source File
8C06	Sequence Not Loaded

B2.10 Structured text error codes

8D01 Syntax Error
8D02 Statement expected
8D03 Assignment expected
8D04 THEN expected
8D05 no ELSE or END_IF
8D06 END_IF expected
8D07 ";"expected
8D08 Bad bracket matching
8D09 Identifier too long
8D0A Bad identifier
8D0B Unrecognised symbol
8D0C Code Buffer Full
8D0D Expression expected
8D0E Can't find this name
8D0F "String" > 8 chars
8D10 End quotes expected
8D11 Bad Number
8D20 Can't jump backwards
8D21 Unresolved jump
8D22 Too many jump labels
8D23 Jump target is blank
8D24 "," expected
8D25 Transition must be single rung
8D26 Transition must be Normally Open coil
8D27 Syntax error in literal
8D28 Incomplete Rung
8D29 Bad label

B2.11 PCLIN error codes

8F01 PCLIN Card not responding
8F02 PCLIN Request failed
8F04 EDB not known or not external
8F07 Unknown EDB
8F0A Unable to delete ED
8F14 Bad block number
8F15 Template mismatch
8F16 Block failed to attach
8F17 Block failed to detach

B2.12 Configuration files error codes

9001 Invalid PIN
9002 PINs do not match - unchanged
9003 Invalid PIN - reset to 1234
9004 Access denied
9005 Invalid default security info
9006 Invalid DTU A security info
9007 Invalid DTU B security info

B2.13 PRMT error codes

9201 Unit is not currently synchronised
9202 Unit is currently synchronised
9203 (De)Sync already initiated
9204 Secondary has inferior I/O status
9205 Secondary has inferior LIN status
9206 Primary & Secondary have mismatched LIN protocol versions
9207 Primary & Secondary have mismatched LIN types
9208 Primary & Secondary have mismatched DCM libraries
9209 Primary & Secondary have mismatched ELIN protocol names
920A On-Line Reconfig changes are pending
920B Timeout waiting for status from secondary
920C Timeout waiting for secondary's state machine to terminate
920D Secondary failed to respond to sync start request
920E Secondary failed to achieve file synchronisation
920F Timeout waiting for file synchronisation
9210 Secondary failed to load database
9211 Secondary failed to run database
9212 Database sync cycle failed
9213 Secondary failed to complete synchronsation

B2.14 External database error codes

9901 No EDBs left
9902 EDB already exists
9903 Invalid EDB

B2.15 Modbus error codes

9A01 Invalid Second Register
9A02 Not a 32 bit field type
9A03 Invalid Scan Count
9A04 Incorrect Modbus function types
9A05 Invalid register position
9A06 Second register of 32 bit pair
9A07 Invalid register type

B2.16 Xec error codes

9B01 Illegal unique task id
9B02 Task id already being used
9B03 No more task control blocks
9B04 Out of XEC memory
9B64 Task aborted
9B65 Task timeout

B2.17 Kernel error codes

9C01 Already registered
9C02 Too many kernel users
9C03 Could not allocate the required local storage
9C04 Error changing priority
9C05 Need to supply an instance name
9C06 Failed to get platform info
9C07 Platform not known
9C33 Feature not implemented (QUE)
9C34 Insufficient memory supplied (QUE)
9C35 Size of data for read or write invalid (QUE)
9C36 Unable to write to queue
9C37 Unable to read from queue
9C38 Unable to allocate memory (QUE)
9C65 No Kernel instance to make intra-signal unique
9C66 Signal already exists
9C67 Failed to create signal
9C68 Failed to open signal
9C69 Failed to close signal
9C6A Timeout waiting on signal

B2.18 Objects error codes

9D01 Object already exists
9D02 Out of objects
9D03 Object does not exist
9D04 Bad invocation parameter
9D05 Object handle is now stale
9D06 Object handle is invalid
9D07 Too many users of object

B2.19 Locks error codes

9E01 Lock has entered an inconsistent state and cannot be granted
9E02 Lock was not granted in the required mode
9E03 Timeout attempting to acquire
9E04 Unable to convert mode of lock
9E05 Already hold a read lock
9E06 Already hold a writer lock
9E07 Do not hold a read lock
9E08 Do not hold a writer lock
9E09 Write lock detected during read unlock
9E0A Reader lock detected during write unlock
9E0B Unable to grant read to write conversion as a conversion of this form is already in progress
9E0C Unable to represent user in lock control structures
9E0D lck_Unlock invoked but not enabled
9E0E Nesting requested but lock not a mutex
9E0F Overflow of nested mutex
9E10 Unable to convert a nested mutex

B2.20 MAL error codes

A001 Could not create user's event (MAL)
A002 Could not open user's event (MAL)
A003 Could not set user's event (MAL)
A004 Unable to grant system wide mutex due to it being in an inconsistent state
A005 Unable to grant system wide mutex due to a timeout
A006 Unable to grant system wide mutex reason unknown
A007 Unable to grant system wide mutex as not created
A008 Unable to suspend user (MAL)
A009 Unable to allocate memory (MAL)
A00A Unable to change priority (MAL)
A00B Error waiting on signal (MAL)
A00C Error releasing signal waiters (MAL)

B2.21 AMC error codes

A101 Cyclic comms enabled on node(s)
A102 No memory left
A103 Bad info given
A104 Data is referenced
A105 No data group installed
A106 Pending message
A107 Fault external to AMC
A108 Not supported
A10A Conflict
A10B Task not running
A10C Bug
A10D Manual cyclic only (pmc reject)
A10E Cannot add cyclic request
A10F Slave rejected cyclics
A110 No pmc callback

B2.22 MMC error codes

A401 Out of / Bad resource(s)
A402 Bad info supplied
A403 Pending message
A404 Problem external to MMC
A405 Not supported
A406 Timeout
A407 Frame parity error
A408 Currupt message
A409 Link protocol error
A40A Modbus exception recvd
A40B Tx fail
A40C No Modbus TCP configuration file
A40D Modbus TCP device already configured
A40E Modbus TCP node not configured
A40F No Modbus TCP connection
A410 Asynchronous Modbus TCP buffer appears invalid
A411 Cannot issue an asynchronous Modbus transaction over serial line
A412 Asynchronous Modbus transaction in progress to this node
A413 Modbus TCP device has disconnected
A414 Modbus TCP transaction mismatch
A415 Modbus TCP error reading/writing socket
A416 Asynchronous Modbus TCP not supported
A417 Out of Modbus TCP sessions
A418 TCP connection in progress
A419 No instrument number to Modbus node address
A41A Waiting to form Modbus TCP connection

B2.23 Asynchronous I/O error codes

A601 Asynchronous I/O in progress
A602 No asynchronous I/O in progress
A603 Not yet implemented
A604 Tx operation complete but not all characters transferred
A605 Rx operation complete, but not all characters received
A606 Event not unique
A607 General CIO error
A608 No asynch. operation fetched
A609 Out of serial lines
A60A Unable to allocate the requested line
A60B Failed to submit asynchronous I/O
A60C Input/output timed out
A60D Indeterminate error during fetch
A60E I/O timed out but failed to cancel operation in progress

B2.24 Profibus error codes

AD01 Cyclic data not available
AD02 Cannot make cyclic into acyclic
AD03 Profibus C1 not allowed
AD04 Profibus C2 not allowed
AD05 Acyclic frag. limit exceeded
AD06 Comms line requested is not profibus
AD07 Resource alloc failure
AD08 PMC not initialised
AD09 No more Cyclic data space
AD0A No more cyclic tag space
AD0B Attempt to append while running
AD0C Data attribs. not set
AD0D Data group size / type mismatch
AD0E Data group size / type unknown
AD0F Data group wrong line number
AD10 Data group node addr. wrong
AD11 Data group addresses not contiguous
AD12 Not in assembling mode
AD13 Cyclics not configured
AD14 Cyclics not running
AD15 Attempt to change card state
AD16 Bad data group list
AD17 Changeover not complete
AD18 Acyclics not ready
AD19 Too many diag. clients
AD1A Line already initialised
AD1B Comms attribs ptr failure
AD1C Comms attribs data failure
AD1D Cannot achieve cycle time
AD1E Master baud rate not supported
AD1F Cannot kill cards DB
AD20 Not used
AD21 Unable to set master protocol params.
AD22 Unable to set master comms params.
AD23 Unable to set slave comms params.
AD24 Failed to start profibus line task
AD25 Failed to stop profibus line task
AD26 Bad slave diagnostic
AD27 Acyclics restarted
AD28 Master rejected acyclic req.
AD29 Master acyclic resp. error
AD2A Slave acyclic req. rejected
AD2B Slave acyclic resp error
AD2C Acyclic timeout
AD2D No slave acyclic resp.
AD2E Failed to get diags.
AD2F Failed to get slave diags.
AD30 No slave diags. available
AD31 Bad pointer parameter
AD32 Parameter out of range
AD33 Slave cfg overflow
AD34 Slave prm overflow
AD35 C1 acyclic data too big
AD3C C2 acyclic data too big
AD37 Slave not running
AD38 Pending acyclic
AD39 C2 RW not supported by slave
AD3A C2 unexpected connection close
AD3B Master card startup error
AD3C Not used
AD3D Could not get slave IO data
AD3E Slave not running at changeover

B2.25 Socket error codes

B201 Error doing select
B202 Error accepting connection
B203 Out of connections
B204 Error reading socket
B205 Failed to initialise sockets
B206 Connection has been reset
B207 Unable to listen on socket
B208 Could not allocate socket
B209 Could not get host information
B20A Could not bind socket
B20B Unable to connect socket
B20C Reference is not a valid connection
B20D Failed to send data over connection
B20E Insufficient buffer for connection data
B20F Cannot peek for records
B210 Record does not contain a valid length field
B211 Unable to read record as insufficient buffer was supplied
B212 Incomplete record encountered
B213 Connection closed
B214 Timed out receiving on socket
B215 Error sending over socket
B216 Send would block on socket
B217 Could not establish blocking mode
B218 Sockets out of memory
B219 Peek buffer is full
B21A Global initialisation failed
B21B Connection timed out
B21C Socket session still active
B21D The session name is being used

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Appendix C REFERENCE

C1 FREQUENCY INPUT MODULE DETAILS

This module provides two input channels to be used for data gathering and signal conditioning from a range of common plant sensor types, including magnetic, voltage input, current input and contact closure inputs. The module includes internal power supplies which can provide loop or wetting currents, transducer power as required.

C1.1 TERMINAL CONNECTIONS, LINKS and STATUS LEDS

Section 2.3.13 gives full pinout, link setting and status LED details. For the sake of clarity, figure 2.3.13a shows the links set in the same position for both channels, but as the channel acts independently, the links should be set as appropriate for each channel.

CAUTION

If more than eight FI2 modules are mounted in a base unit, and the channel output at 24V is greater than 5mA per channel, then an external power supply must be used. Using the normal base unit supply in such a situation can cause damage to the backplane.

C1.2 SPECIFICATION

Section A4.12 gives the FI2 module specification

C1.3 APPLICATION DETAILS

C1.3.1 Cable selection

The selection of appropriate cabling to connect the encoder to the FI2 is dependent upon a number of factors. In all cases, it is recommended that sensor cabling does not exceed 30m, otherwise high energy surges (IEC61000-4-5) may be picked-up and applied to the module terminals. The choice of cable depends on how electrically noisy the area is, the length of cabling required, and the frequency being used. Typical cabling choices include:

a) Short cable length in low-noise environments: Basic shielding (a foil jacket and a drain wire) should provide moderate noise protection for cost-sensitive applications.
b) Noisier environments and/or longer (more than 3m) cable runs: In potentially high-noise environments, or for cable runs >3m, it is recommended that each channel is connected to the FI2 using a low-capacitance (<20pF/foot) shielded cable.
c) High-frequency inputs and/or longer cable runs: For high frequency applications (>5kHz), both a foil and braided shielding in a low-capacitance (<20pF/foot) cable is recommended. A foil-wrapped twisted shielded pair in a braided shielded cable can deliver good performance over long distances (depending on the type of output driver used).
d) Best immunity to noise and long cable runs: A multi-conductor cable with 22 and 24 AWG stranded tinned copper conductors, individually foil shielded (100% coverage) and an overall tinned copper braid with a capacitance of 12 pF/foot or less should be considered for longer distances. A cable similar to the Belden 3084A could be used, for example.

C1.3.2 Cable shield connection

Typically, noise immunity can be achieved by connecting the cable shield to the relevant FI2 common connection (C1/C2). However, in some cases connecting the shielding to the common signal return path at the encoder end may achieve better noise immunity. Under no circumstances, connect the shield at both ends.

C1.3.3 Choosing the appropriate output sensor type

The choice of input type is heavily dependent on the distance from the encoder to the FI2 and the noise environment it is operating in.

Open collector/drain

An open collector or open drain output is commonly used in single-ended incremental encoders to provide a simple, economical solution for low-end applications like counters. The FI2 provides a programmable output voltage of 8V, 12V or 24V (maximum 25mA) which can be used as either the encoder power supply (max current output is 25mA) or as the pull-up supply, or both. There is also a dedicated 5kΩ pull-up/pull-down resistor network built into the FI2's terminal unit connected to the programmable power supply. This can be activated by setting the links on the terminal unit to position A.

Refer to "C1.5.4 Contact inputs" on page 171 for a diagram showing the external and effective internal circuit representation for open collector/drain configurations. The figure below shows the connections for this type of configuration on the FI2's terminal unit.

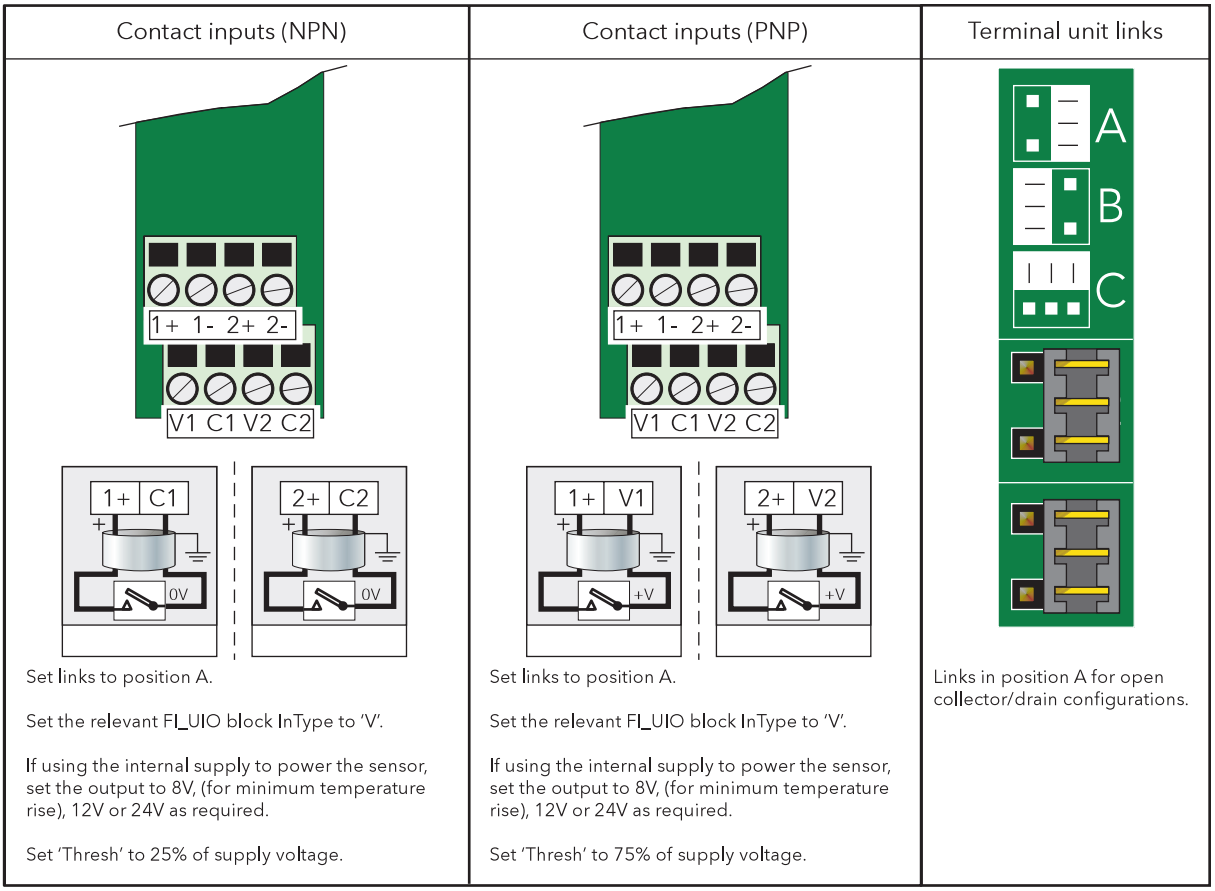


Figure C1.3.3a FI2 terminal unit connectors for open collector/drain configuration

Note that when the links are set to position A on the terminal unit, then half the supply voltage is applied to the 1+ terminal via a voltage divider of 2 x 5KΩ resistors. The input would then have a 5kΩ pull-up to the channel supply and a 5kΩ pull-down to channel 0V. Thus an NPN device (or contacts) would switch between 0V and half the channel supply, and a PNP device (or contacts) would switch between the channel supply and half the channel supply. The threshold will appear in volts and will need to be set according to which connection had been made.

If the FI2 is used in this way, ensure that the *PSU* setting in LinTools is set to the correct voltage (8V, 12V or 24V) for the appropriate FI2 block. The user may enter any voltage in this parameter, but the block will edit the value to 8, 12 or 24, whichever is the nearest to the entered value.

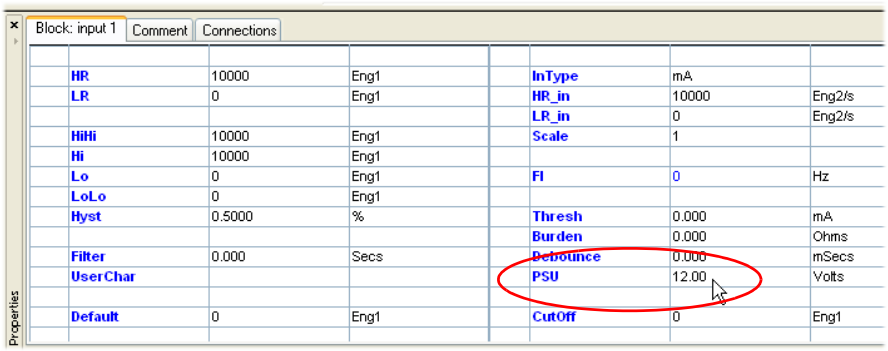


Figure C1.3.3b FI2 block properties page

It should be noted that these types of encoders can be vulnerable to noise and should only be used for cable runs of 3m or less.

Push-pull Totem-Pole output

For higher noise environments, a push-pull or totem-pole output driver provides a far superior solution. Using an encoder with a Push-Pull output will make the design far more noise tolerant and can work well for distances of up to 10m when used in conjunction with a screened cable. Refer to "C1.5.2 Voltage inputs" on page 170 for a diagram showing the external and effective internal circuit representation for Push-pull Totem-Pole configurations. The figure below shows the connections for this type of configuration on the FI2's terminal unit.

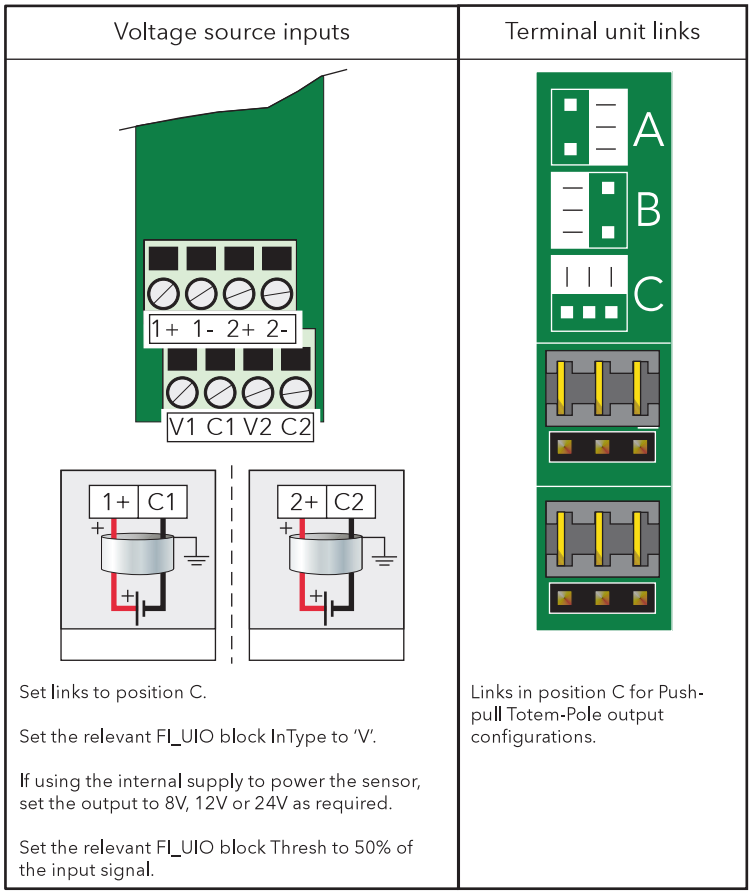


Figure C1.3.3c FI2 terminal unit connectors for Push-pull Totem-Pole input configuration

Ensure the threshold (*Thresh* parameter) in LinTools is initially set to 50% of the input signal. For example, if using the FI2 supply set to 12V as the pull-up supply, set the *Thresh* parameter to 6V.

When the Links are set in the Voltage (position C) or Current (position B), the Threshold must be set, as close to the midpoint between the peak to peak values as is possible, in order to achieve good pulse detection, best repeatability, and to help prevent detection of noise spikes.

If the FI2 power supply output is used as the pull-up supply then note the following:

a) Set the links to position C on the terminal unit. This is clearly marked on the silk screen of the terminal unit.
b) The maximum current that should be drawn from the FI2 supply is 25mA on any selected voltage range.
c) If the FI2 power supply is set to 12V and a 1/4 watt resistor is to be used for the pull-up, the minimum value of resistor that should be used is 1kΩ.
d) If the FI2 power supply is set to 24V and a 1/4 watt resistor is to be used for the pull-up, the minimum value of resistor that should be used is 4.3kΩ.
e) If the FI2 power supply is set to 8V and a 1/4 watt resistor is to be used for the pull-up, the minimum value of resistor that should be used is 470Ω.

C.1.3.4 FI2 General and LinTools configuration

When configuring the FI2 for the first time, it is worth considering the following:

1. Ensure the link positions are set correctly on the terminal unit. See "2.3.13 Two-channel frequency input module (FI2)" on page 33 for details.

2. The settings for the FI2 inputs can be found in the FI_UIO block within LinTools. Ensure that the correct *InType* is selected for the FI2 channel being configured.

3. Consider using the OPC scope which can be found on the LinTools top menu under Tools > OPC Scope, to monitor the output. If noise spikes are still an issue, consider adding a software filter in the *Filter* field of the appropriate FI_UIO block.

   It is possible, if the application permits it to apply a 'debounce' value of 0ms (off), 5ms, 10ms, 20ms, or 50ms, with the algorithm ensuring that pulse edges closer than the set time, are excluded.

   An OverRange warning is not displayed for signals approaching the maximum frequency allowed by the Debounce algorithm. Control loops based on a frequency PV are not recommended, when debounce is applied, without provision for protecting against the consequences should the frequency exceed this upper limit.

It may be necessary to disable the Sensor Break and Sensor Short Circuit detection (via the Options.SBreak and Options.SCct fields in the associated FI_UIO block) to prevent inappropriate alarms. The Sensor Break alarm is set if the Input value falls below 0.05V or 0.05mA. The Sensor Short circuit alarms is set if the Input value rises above 91% of the output supply (Volts or milli-amps).

A NAMUR Input on a module configured in the Current (position B), must be set to 8V output supply, and the threshold must be set to 1.65mA. Sensor Break and Sensor Short circuit detection can be enabled, if required.

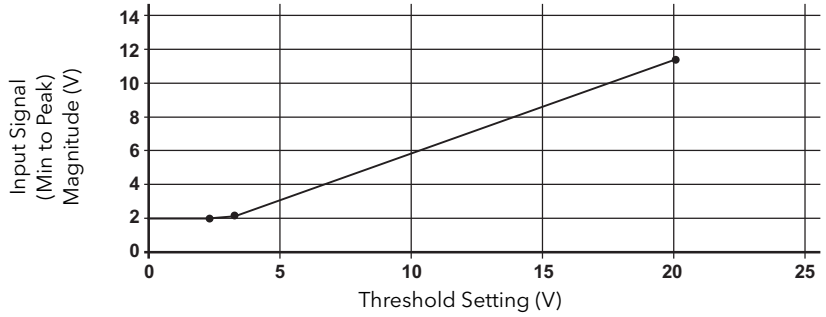


Figure C1.3.4 Input signal versus Threshold

Note: To allow for Hysteresis and Threshold accuracy with temperatures and between modules that have been swapped, the input signal must have sufficient amplitude. The graph in figure C1.3 may be used as a guide to the size of signal for a given Threshold setting.

When the Links are set in the Contact Inputs (position A) position, 5kΩ biasing resistors are connected that provides a wetting current. If more wetting current is required, additional resistors can be fitted to the Terminal Unit, or an external biasing supply can be connected, and the threshold configured accordingly. Sensor Break and Sensor Short circuit detection must be disabled) via the 'Options.SBreak' and 'Options.SCct' fields in the associated FI_UIO block).

C1.4 ISOLATION DIAGRAM

Isolation is implemented in the form of a double insulation (300V) barrier separating all the I/O channels in a module from the rest of the system.

This prevents hazardous voltages on any one I/O channel from introducing hazards to wiring associated with any other I/O module, or from putting the rest of the system at risk.

Modules which provide channel-to-channel isolation further ensure safety and good signal quality on all channels within such modules. Refer to the relevant section of Appendix A for more details.

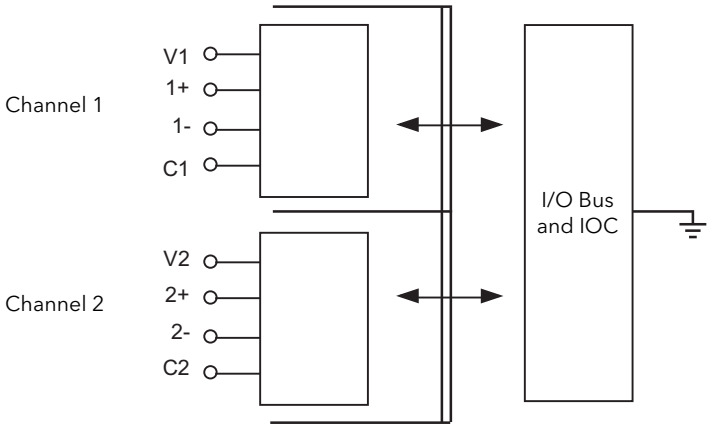


Figure C1.4 Isolation Diagram

C1.5 EQUIVALENT CIRCUITS

C1.5.1 Magnetic inputs

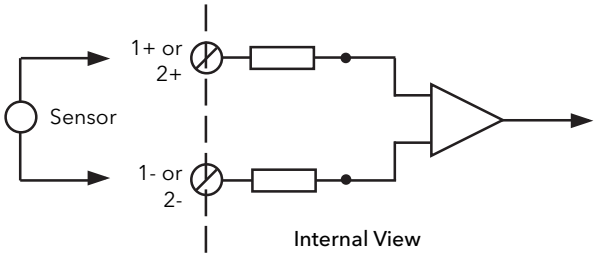


Figure C1.5.1 Magnetic Input

C1.5.2 Voltage inputs

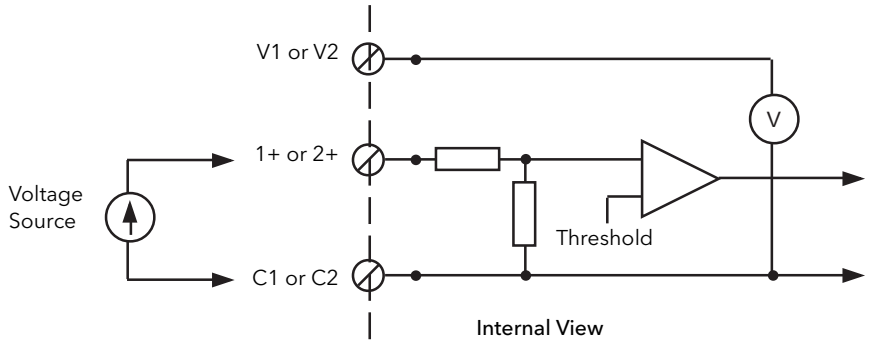


Figure C1.5.2 Voltage Inputs

C1.5.3 Current inputs

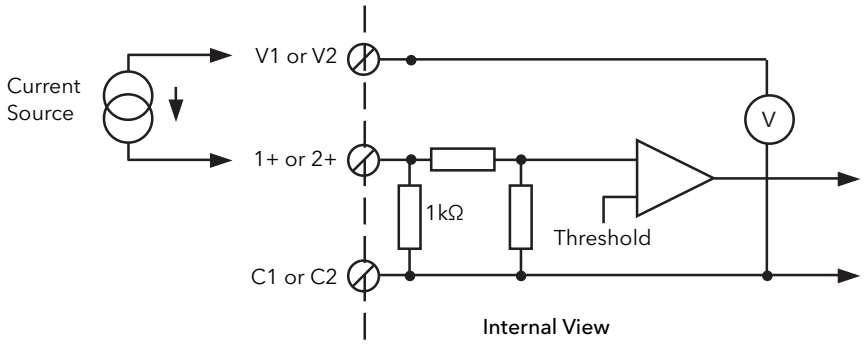


Figure C1.5.3 Current Inputs

C1.5.4 Contact inputs

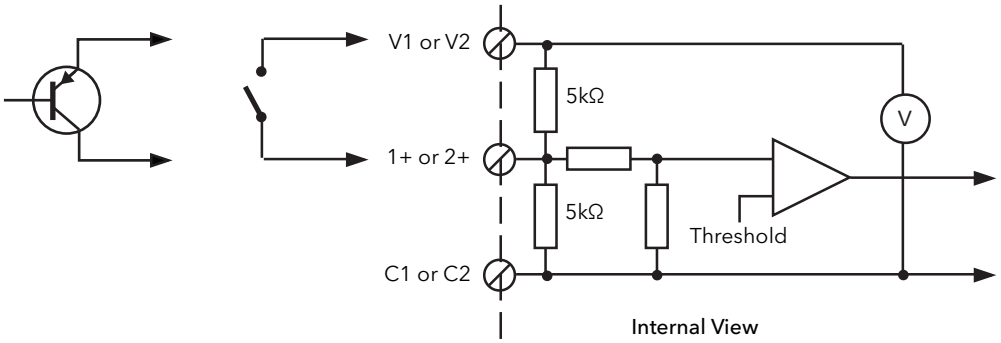


Figure C1.5.4a Contact Inputs (PNP) or Volt-Free

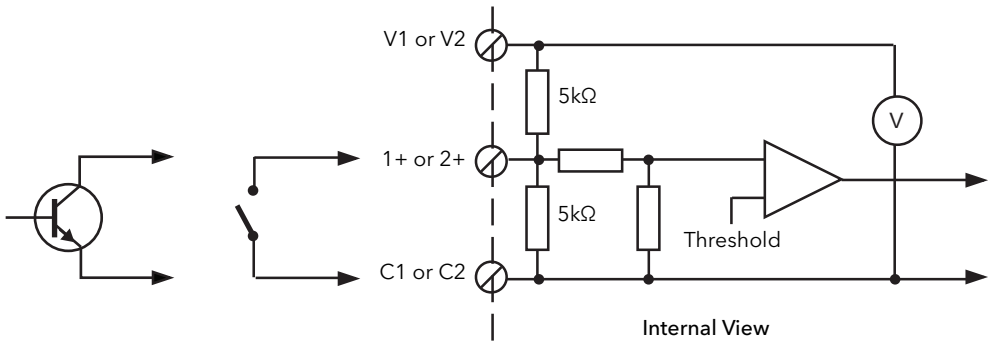


Figure C1.5.4b Contact Inputs (NPN) or Volt-Free

C1.6 FAULT DETECTION

Detected faults can be defined as Field, Setup, or Hardware faults, but any reaction will depend on the Input configuration of the associated FI_UIO block. These faults are indicated via the LEDs on the Module (figure 2.3.13b), and the Status and Alarms bits of the corresponding FI_UIO block.

C1.6.1 Fault Diagnostics

The Status and Alarms bits of the associated FI_UIO block can be inspected in order to locate a fault.

Status	Interpretation
Missing	The associated MOD_UIO block has not been found, caused by an incorrectly configured Strategy, i.e. the MOD_UIO block does not exist in the Strategy. This sets the Alarms.ModBlock field True. To resolve the problem, ensure tat the Strategy contains the required MOD_UIO block.
BadType	The Channel configured in the block, does not correspond to the module. Ensure the block and the module correspond.
Ranging	The Input value is not measurable by the hardware, but a fault is not detected, i.e. the Input is currently being ranged or configured.
BadSetup	An invalid setup is detected, caused by an incorrect 'LR_in' or 'HR_in' field configuration. This sets 'Alarms.OutRange' True. To resolve the problem, ensure 'LR_in' and 'HR_in' fields correspond to the range used by the installed hardware.
HwFlt	A fault in the output supply is detected caused by output supply overload. This sets the Alarms.Hardware field True.
NotAuto	The module is not operating in Automatic mode. This sets the 'Alarms.NotAuto' field True
OverRng	An input value greater than the measurement circuit range is detected, generally caused by an input value greater than 40KHz, but less than 80KHz.
UnderRng	An Input value less than the measurement circuit range is detected. Can be caused by input values less than 10Hz, for a Magnetic Sensor configuration, or less than 0.01Hz for the Voltage, Current, or Contact configuration.
OpenCct	An Open circuit fault in the Logic Sensor is detected., setting the 'Alarms.CctFault' field True.
ShortCct	An Short circuit fault in the Logic Sensor is detected, setting the 'Alarms.CctFault field' True.
BadHwSet	The hardware configuration does not correspond to the Input Type configured in the FI_UIO block. To resolve the problem, ensure the Link configuration (figure 2.3.13a) corresponds with the 'InType' field of the FI_UIO block.
Cutoff	A measured frequency value below the low threshold value (CutOff) is detected, setting 'Alarms.CutOff' True. The measured frequency value adopts the value defined in the 'Default' field.
Badtask	Task Rate configured in the block does not correspond to the Task Rate of the module, this situation setting the Alarms.Hardware field True. To resolve the problem, configure the Task rate of the module and the Task rate in the block to the slow task rate (Task 3: 110ms).

C2 ZIRCONIA INPUT MODULE DETAILS

The Zirconia input module contains two input channels, isolated both from each other and from the system electronics, and intended to be used to measure the temperature at the measuring tip of a zirconia probe (channel 1) and the voltage generated across a zirconia pellet (channel 2).

User Calibration allows the 'permanent' factory calibration to be modified in order to:

1. Calibrate the controller to your reference standards
2. Match the calibration of the controller to that of a particular transducer or sensor
3. Calibrate the controller to suit the characteristics of a particular installation

C2.1 TERMINAL CONNECTIONS and STATUS LEDS

Section 2.3.16 gives full pinout and status LED details.

C2.2 SPECIFICATION

Section A4.15 gives the ZI module specification.

C2.3 APPLICATION DETAILS

This module is used to control the temperature of the process on one channel (loop) and carbon potential on the other. The module, in conjunction with the strategy, generates temperature and carbon potential profiles synchronised to a common timebase.

Channel one is a thermocouple input with automatic Cold Junction Compensation.

Channel two (connected to the Zirconia pellet) offers the high-impedance low leakage 2V range used to output a voltage measurement allowing simple offset and scaling.

To comply with EMC regulations, it is recommended that the Zirconia Probe be connected to Channel 2 of the module using screened cable with a maximum length of 30m

C2.3.1 Temperature Control

The sensor input of the temperature channel (loop) may come from the Zirconia Probe but it is common for a separate thermocouple to be used. The strategy can then control an output which is connected to heating elements (e.g. gas burners or thyristors) to control the temperature. In some applications a cooling output may also be connected to a circulation fan or exhaust damper.

C2.3.2 Carbon Potential Control

The Zirconia probe generates a milli-volt (mV) signal based on the ratio of oxygen concentrations on the reference side of the Probe (outside the furnace) to the amount of oxygen in the furnace. The temperature and carbon potential millivolt values, read into the related block, are used to calculate the percentage of carbon in the furnace.

C2.3.3 Soot Alarm

An alarm can be triggered when the atmospheric conditions within the furnace are such that carbon will be deposited as soot on all surfaces inside the furnace.

C2.3.4 Probe Cleaning

A Probe clean and recovery strategy can be configured either to occur between batches or to be triggered manually. A short blast of compressed air is used to remove any soot and other particles that may have accumulated on the probe. Once cleaning is complete, the time taken for the probe to recover is measured. If the recovery time is too long this indicates that the probe is ageing and replacement or refurbishment is due. During the cleaning and recovery cycle, the %C reading is frozen, ensuring continuous furnace operation.

C2.3.5 Endothermic Gas Correction

A gas analyser may be used to determine the CO or H_2 concentration of the endothermic gas. If a 4 to 20mA output is available from the analyser, it can be connected to the module and used to generate a display of the calculated % carbon reading. Alternatively, this value can be entered manually via the 'GasRef.CO_Local' and 'GasRef.H2_Local' fields.

C2.4 ISOLATION DIAGRAM

In isolation strategy is implemented throughout the base unit, which takes the form of a barrier separating all I/O channels in any I/O module from the rest of the system. This prevents hazardous voltages on any one I/O channel introducing hazards on wiring associated with any other I/O module, or put at risk the rest of the system. Modules providing isolation channel-to-channel ensure safety and good signal quality on all channels

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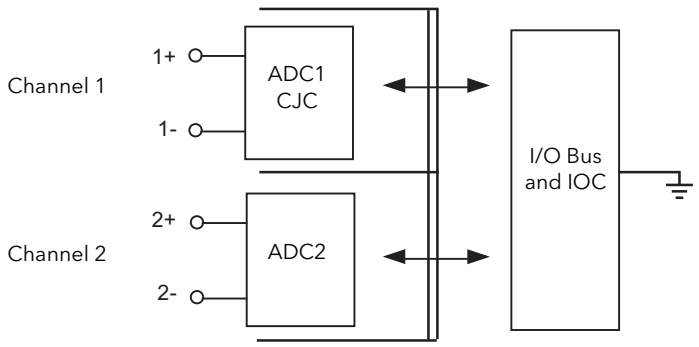


Figure C2.4 Isolation Diagram

C2.5 EQUIVALENT CIRCUITS

C2.5.1 Analogue inputs

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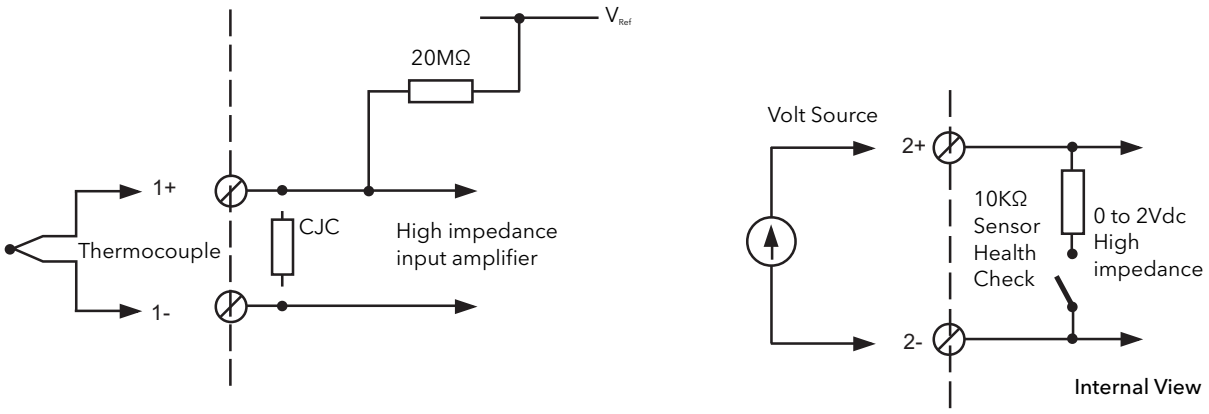


Figure C2.5.1 Equivalent circuit

C3 GLOSSARY (Cont.)

C2.6 FAULT DETECTION

Detected faults can be defined as Field, Setup, or Hardware faults, but any reaction depends on the input configuration of the associated Zirconia block. Faults are indicated via the LEDs on the Module (figure 2.3.13b), and the Status and Alarms bits of the corresponding Zirconia block.

C2.6.1 Fault Diagnostics

The Fields and related Alarms bits of the associated ZI block can be inspected in order to locate a fault.

Status	Interpretation
ProbeSt	The Probe Input value is not measurable by the hardware (possibly caused by a Probe failure). The fault sets the 'Alarms.ProbeSt' field True.
TempSt	The Probe Temperature Input value has failed (possibly due to a Probe failure). This fault sets the 'Alarms.TempS' field True.
CarbPotSt	The Carbon Potential value is not measurable by the hardware. This might be, for example, if the furnace temperature is below the configured minimum calculation temperature value. To resolve the problem, wait until the furnace achieves the configured minimum calculation temperature value, MinCalcT.
DewPntSt	The Dewpoint value is not measurable by the hardware. This might be, for example, if the furnace temperature is below the configured minimum calculation temperature value. To resolve the problem, wait until the furnace to achieve the configured minimum calculation temperature value, MinCalcT.
Oxygen.St	The Oxygen value is not measurable by the hardware. This might be, for example, if the furnace temperature is below the configured minimum calculation temperature value. To resolve the problem, wait until the furnace to achieve the configured minimum calculation temperature value, MinCalcT.
SootWrn	The Probe has detected atmospheric conditions that would cause the deposit of soot on all surfaces inside the furnace. This sets the 'Alarms.SootWrn' field True. To resolve the problem, launch the probe clean sequence and ensure that it completes successfully.
ClnRcvWn	The performance of the probe is degrading, as evidenced by a failure to regain 95% of its original value within the specified time. This sets the 'Alarms.ClnRcvWn' field True. To resolve the problem, launch the probe clean sequence and ensure that it completes successfully. If alarms continue to be generated, replace the probe.
LastClnmV	The probe clean sequence failed, due (for example) to a fault in the probe. This fault sets the 'Alarms.ClnRcvWn' field True.
CO_remSt	The Remote CO Gas value is not measurable by the hardware due (for example) to a Probe failure. This fault sets the 'Alarms.CO_Remte' field True.
H2_RemSt	The Remote H2 Gas value is not measurable by the hardware due (for example) to a Probe failure. This fault sets the 'Alarms.H2_Remte' field True.
MxCnRcvT	The Probe cleaning sequence is not permitted due (for example) by a failure to achieve 95% of the Input value before the defined maximum recovery time after cleaning has expired. This fault sets the 'Alarms.ClnRcvWn' field True. To resolve the problem, launch the cleaning process and ensure that it completes successfully. If alarms continue to be generated, replace the probe.
MxImRcvT	The Probe impedance measurement recovery time has been exceeded, possibly caused by a Probe failure. This fault sets the' Alarms.ImpRcWrn field' True. To resolve the problem, launch the probe clean sequence and ensure it completes successfully. If alarms continue to be generated, replace the probe.
PrbImpHi	The maximum probe impedance threshold value has been exceeded, possibly caused by a Probe failure. This will set the Alarms.PrbImpHi field True. To resolve the problem, ensure the Probe impedance measurement sequence completes successfully or reset the impedance measurement message field ('ImpMsgRt' True).

ImpRcvWn	The Probe impedance measuring sequence could not be performed. This fault sets Alarms.ImpRcvWn field True. To resolve the problem, launch the impedance measuring process and ensure that the Probe impedance measuring completes successfully.

C3 GLOSSARY

This section contains explanations of abbreviations and other terms used within this document.

AMC	Application Master Comms
Duplex	Another term for 'Redundant', meaning that dual systems are in place, such that one system can take over from the other in the event of failure.
ELIN	LIN protocol running over UDP/IP.
ICM	Inter-processor Communications Mechanism. Used to communicate between control modules.
IOC	Input/Output controller. Contains the programs to control the Input/Output modules, and thereby, the process.
IP	Internet Protocol. This is the communications protocol of the public Internet, many wide area networks (WANs) and most local area networks (LANs). The Internet Protocol is part of the TCP/IP protocol suite, and the terms 'IP network' and 'TCP/IP network' are synonymous
LAN	Local area network
LIN	Local instrument network. Generally, LIN refers to real-time software for running control strategies, the communications system (LIN communications) between instruments, and to the suite of tools that configures them (LINtools).
LLC	Logical link control
MAL	Machine Architecture Library
MMC	Master Modbus comms
Mutex	Mutually exclusive
PRMT	Processor redundancy management task
PRP	Port resolution protocol
PSU	Power supply unit
PV	Process variable. This is the displayed value of the variable being measured.
Redundant	This means that two parallel systems are in place, such that if one fails, the other can takeover without interrupting the process being controlled. Also known as 'Duplex'.
Review	A proprietary software option which allows archive data to be stored in a database, this data then being available for display in chart or spreadsheet format. If Store and Forward is enabled, the data in the review database can be used to replace missing data in the EurothermSuite database.
RTC	Real-time clock. A clock used to control sequencing, to provide time and date information etc.
Simplex	Non-redundant working - not applicable to this instrument. See 'Duplex'.
SDHC	High Capacity Secure Digital card used, in this application, to store the user's strategy and license.
SFC	Sequential function chart.
SNTP	Simple Network time Protocol. An SNTP server transmits local time and date. SNTP clients receive this data and use it to control their instrument time and date. A simple way of synchronising multiple instruments.
SP	Setpoint. The target value to be reached.
ST	Structured Text.
Store and Forward	A feature which allows missing data in the EurothermSuite database to be retrieved from the Review database. This makes use of the fact that archive date is stored in the instrument, which can be configured to archive these files on a regular basis. If the

	transmission line fails for any reason, the data continues to be saved until communications are restored, when all the unarchived data is transmitted.
TCP	Transfer control protocol.The reliable transport protocol within the TCP/IP protocol suite. TCP ensures that all data arrive accurately and 100% intact at the other end.
UDP	User Datagram Protocol. A communications protocol providing a direct way to send and receive datagrams over an IP network but with few error recovery resources. Used mainly for broadcasting over a network.
User Screen	This instrument does not have a means of visualising what is happening within the process. It is possible to create user screens (using the User Screen Editor software) to be displayed on a Visual Supervisor, for example. Such screens can display elements of a process, using static and animated graphical symbols, and can contain touch- sensitive push button symbols allowing the user to initiate actions.
USB	Universal Serial Bus. Type of serial bus that allows peripheral devices (disks, modems, printers, digitizers, data gloves, etc.) to be connected to a computer. A "plug-and-play" interface, it allows a device to be added without an adapter card and without rebooting the computer (the latter is known as hot-plugging). The USB standard, developed by several major computer and telecommunications companies, supports data-transfer speeds up to 480 megabits per second.
WAN	Wide area network.

C4 LIN BLOCK LICENCES

This section shows which blocks are included at each licence level.

C4.1 FOUNDATION LEVEL

Input/Output	Communications	Control	Diagnostic
AI_UIO	GW_CON	AN_CONN	All diag blocks
AO_UIO	GW_TBL	DG_CONN	RGROUP
DI_UIO	RAW_COM	Timing	Programmer
DO_UIO	Conditioning	TIMER	PROGCTRL
FI_UIO	CHAR	TIMEDATE	
MOD_UIO	UCHAR	TPO	
MOD_DI_UIO	FILECHAR	RATE_ALM	
MOD_DO_UIO	AN_ALARM	Selector	
TPO_UIO	DIGALARM	ALC	
VP_UIO	ZIRCONIA		
CALIB_UIO			

C4.2 STANDARD LEVEL

Standard level includes all the foundation level blocks, and the following additional blocks:

Conditioning	Control (Cont.)	Selector	Maths	Control modules (Cont.)
INVERT	MAN_STAT	SELECT	ADD2	AN_ALM_2
FILTER	MODE	SWITCH	SUB2	Programmer
LEAD_LAG	PID_LINK	2OF3VOTE	MUL2	PROGCHAN
RANGE	TUNE_SET	Logic	DIV2	SEGMENT
FLOWCOMP	Timing	PULSE	EXPR	Batch
Control	DELAY	AND4	ACT_2A2W3T	RECORD
ANMS	RATE_LMT	OR4	Control modules	DISCREP
DGME	TOTAL	XOR4	VLV1IN	SFC_MON
SIM	TOTAL2	NOT	VLV2IN	SFC_DISP
SETPOINT	TOT_CON	LATCH	VLV3WAY	SFC_CON
TC_SEL	DTIME	COUNT	MTR3IN	
	SEQE	COMPARE	DUTYSTBY	

C4.3 CONTROL LEVEL

Control level includes all the foundation and standard level blocks, together with the following additional blocks:

Control	Maths
TC_LIFE	ACTION
PID	DIGACT
3_TERM	ACT15A3W
LOOP_PID	ACTUI818
Timing	Batch
SEQ	SFC-CON

C4.4 ADVANCED LEVEL

Includes all the above blocks plus Conditioning blocks: GASCONC and AGA8DATA

Appendix D BATTERY REPLACEMENT PROCEDURE (IF FITTED)

Personnel	One engineer, who shall be a suitably qualified person.
Time required to complete	10 minutes.
Parts required	Battery board (contains battery, soldered onto the board) Order Code `T2750A/BAT` For sales contacts see www.eurotherm.com/global
Tools required	Magnetized Pozidrive #1 Screwdriver
When to carry out	If the controller module battery LED (labelled with an ⏚ icon) goes out, or every 12 months, whichever is sooner.

The T2750 has an option to include a 3 V 'coin-cell' style battery, mounted on small board, fitted on the inside of the plastic side panel adjacent to the controller module.

The purpose of the battery is to maintain the contents of the controller module terminal unit's volatile memory when the T2750 is powered off.

Note: The T2750 can be left powered up while the battery is being replaced. This ensures the volatile memory contents will be retained.

The battery is soldered to its board, and the two are replaced as a single unit. Proceed as follows:

1. Open the hinged plastic front cover of the T2750, so that the terminal units can be seen.
2. Locate the back of battery board (Figure D.1): It is on the inside of the plastic side panel to the left of the controller module, and is fixed in place by two screws. A two-wire cable runs from the front of the battery board to the controller module terminal unit; the red wire connects to the **B+** terminal, the black wire connects to the **B-** terminal. It is recommended leaving these wires connected to the terminals whilst replacing the battery.

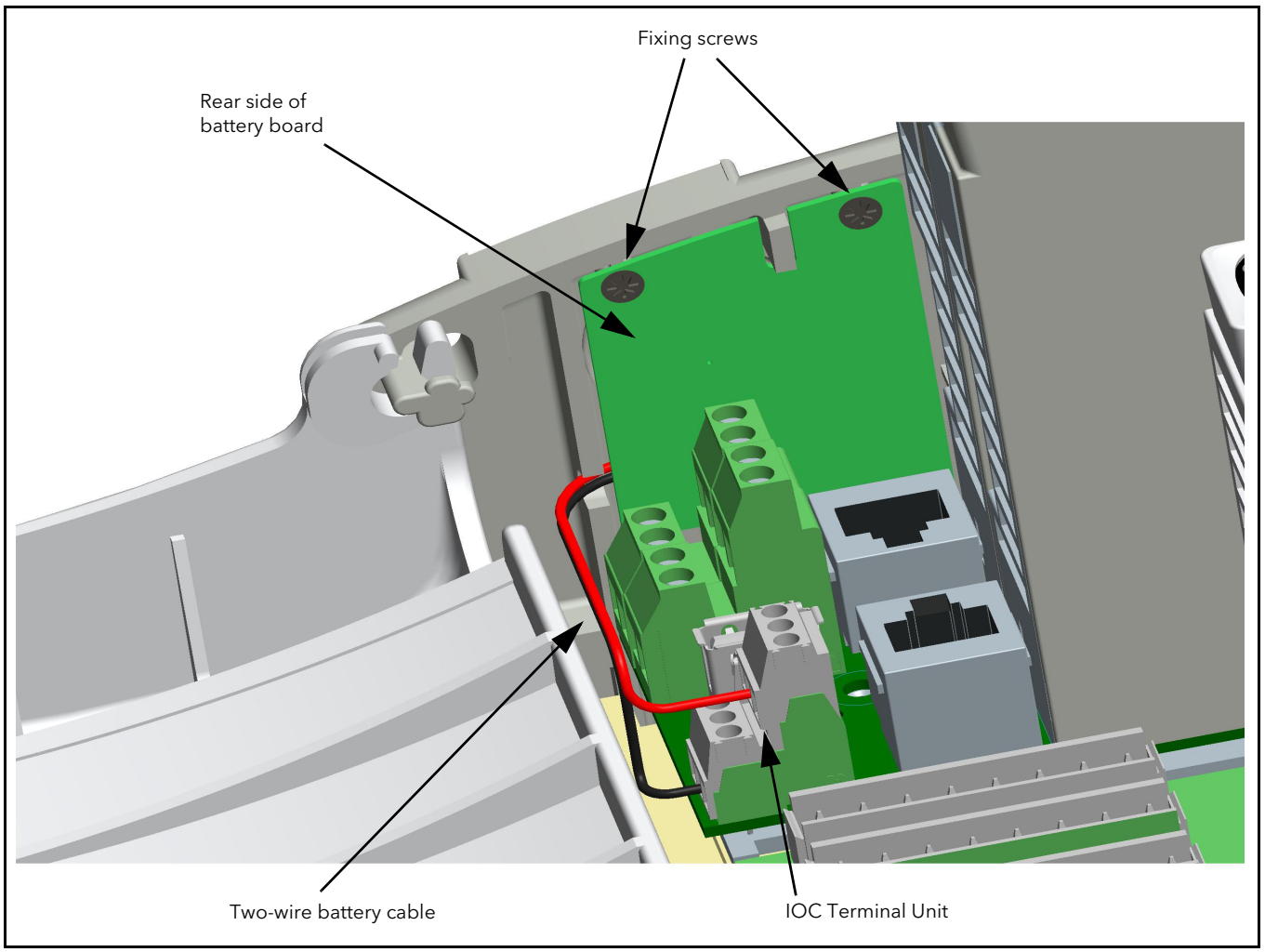


Figure D.1 Battery board in place

3. Using a magnetised Pozidrive #1 screwdriver, unscrew the two fixing screws holding the battery board in place.

4. Carefully manoeuvre the battery board of from the plastic side panel. Unplug the two-wire cable from the board end (Figure D.2).

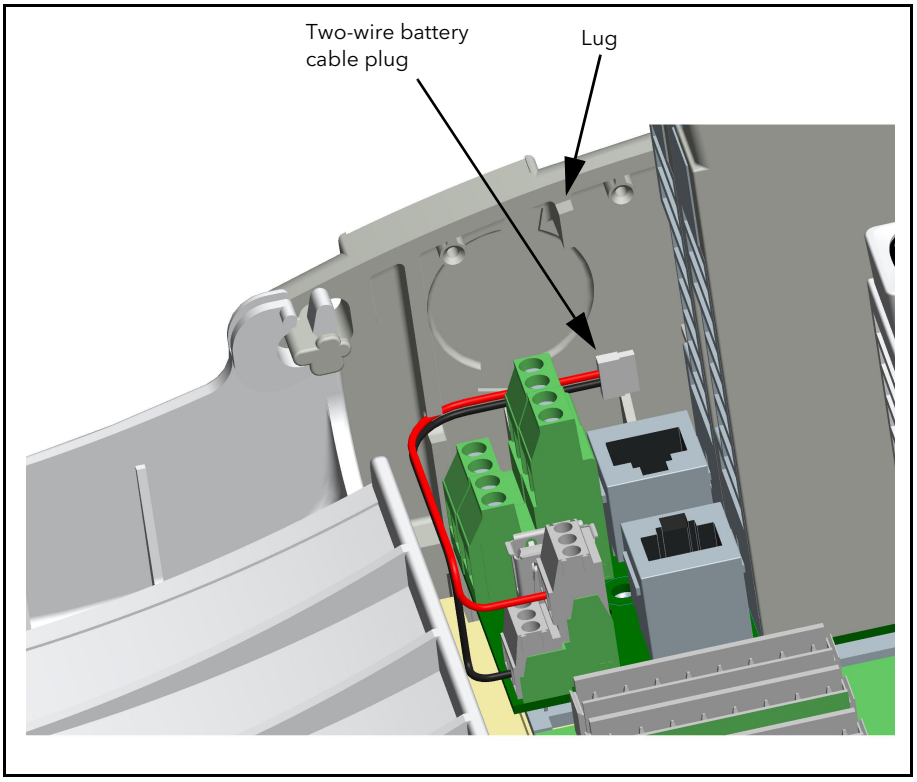


Figure D.2 Battery board removed

WARNING

Do not touch the battery itself using metal pliers or tweezers, as this could cause a short circuit possibly resulting in an explosion of the battery

5. Take the new battery board (Figure D.3), and plug the two-wire battery cable into it.

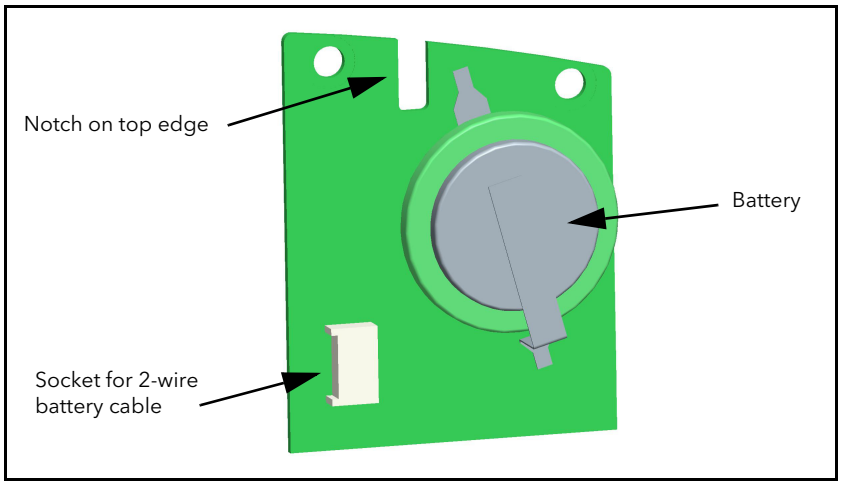


Figure D.3 New battery board

6. Manoeuvre the new battery board into position in the left-hand plastic side panel. Note the lug on the panel which fits into the notch on the top end of the battery board.

7. Using a magnetized Pozidrive #1 screwdriver, screw in the two fixing screws to hold the battery board in place.
8. Close the plastic top cover of the T2750.
9. Ensure the old battery board is disposed of appropriately.

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