

T2750 Eurotherm PAC

User Guide

Firmware V6/0

HA030047 Issue 16

Date: 06/2020



Eurotherm[®]

by **Schneider** Electric

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
HA033151	File Synchronisation User Guide
HA033194	Batch and Recipe on T2750

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 5/0.

Table of Contents

Table of Contents	5
Safety Notes	11
I/O Isolation Strategy.....	12
EMC	12
Symbols Used on the Instrument Labelling.....	13
I/O Isolation Strategy.....	13
Cybersecurity	15
What's in this Chapter	15
Introduction	15
Secure Network Topologies and Good Practices	15
Security Features	15
Instrument Password	15
Whitelisting PCs and File Types	15
Legacy Mode	16
Principle of Secure by Default.....	16
Ethernet Security Features	16
Configuration Backup and Recovery	17
Memory Integrity	17
Firmware	17
Achilles® Communications Certification	17
Decommissioning.....	17
Introduction	19
Physical Structure	19
Modules Available	19
Features.....	20
LIN Communication	20
ELIN Communication	20
Profibus Master Communication	20
Redundant Working	20
Battery Backup.....	21
Configuration.....	21
Data Recording	22
Store and Forward Software	22
Time Localisation Support.....	22
Health Monitoring.....	23
Watchdog	23
IP (Intellectual Property) Protection	23
Front Panel Indicators.....	23
Installation	25
Unpacking the Instrument	25
Mechanical Installation.....	25
Base Unit Mounting.....	27
Terminal Unit Installation.....	28
Module Installation	28
Module Identification	29
Installing the Optional netHOST Gateways	30
Electrical Installation	31
Controller Module (IOC) Terminal Unit.....	31
Two-channel Analogue Input (AI2).....	35
Three-channel Analogue Input (AI3).....	37
Four-channel Analogue Input (AI4).....	39
High Density Analogue Input (AI8).....	40
Two-channel Analogue Output (AO2)	42
Four-channel Digital Input (DI4).....	43

- Six-channel Digital Input Module (DI6) 44
- Eight-channel Digital Input Module (DI8) 45
- 16-Channel Digital Input Module (DI16)..... 46
- Four-channel Digital Output Module (DO4) 47
- Eight-channel Digital Output Module (DO8)..... 48
- 16-channel Digital Output Module (DO16)..... 50
- Two-channel Frequency Input Module (FI2) 51
- Four Output Relay Module (RLY4)..... 53
- Eight Output Relay Module (RLY8)..... 55
- Zirconia Input Module (ZI)..... 56
- netHOST Profibus Master Gateway..... 57
- Hardware Configuration 59
 - LIN Address 59
 - LIN Option Switch 60
 - IP Address Setting 60
 - USB Configuration 70
 - netHOST Profibus Master Configuration 70
- Operator Interface 75**
 - Introduction 75
 - LED Interpretation..... 75
 - Switches..... 76
- Start-up 79**
 - Redundancy Modes 79
 - Start-up Modes..... 79
 - Hot Start..... 79
 - Cold Start..... 79
 - Hot/Cold Start 81
 - Startup Flowchart..... 82
 - Starting the IOC Modules..... 83
 - Start-up Routine..... 83
 - Power-up Decisions 84
 - Autosynchronisation..... 87
 - ELIN Communication Modes 88
- Configuration 89**
 - Automatic I/O Build and Configuration Tools..... 89
 - Automatic I/O Build 89
 - Preparing for the Automatic I/O Build..... 90
 - LINtools 91
 - Starting LINtools 92
 - MODBUS Tools 94
 - Introduction 94
 - Running Modbus Tools 94
 - Configuring Modbus-TCP Slave Communications..... 95
 - Profibus Configuration..... 96
 - Introduction 96
 - Launching the Profibus Master Configurator 96
- Control Loops 101**
 - Introduction 101
 - Temperature Control Loop Example 101
 - Loop PID Function Block 102
 - Main Page..... 102
 - Set Up Tab 105
 - Tuning Tab 108
 - PID Tab 118
 - SP Tab..... 122
 - OP Tab 125
 - Diag Tab..... 131
 - Alarms Tab 132
 - Effect of Control Action, Hysteresis and Deadband 133

Control Action.....	133
Hysteresis	133
Task Organisation	135
Task Scheduling	135
Tasks.....	135
Priorities	135
Functions	135
User Tasks	138
Terminology.....	138
Execution Times.....	138
User Task Block Servers.....	139
User Task Tuning	141
Usertask Block.....	141
Data Coherence	142
Data Flow Between Tasks.....	142
Event and Health Logs	145
Health Log.....	145
Event Log.....	145
Status.....	146
Data Management	147
Data Recording	147
Data Recording (*.uhh) File	147
Data Recording Groups	147
Data Archiving	147
File Transfer Protocol (FTP).....	148
Data Management Configuration	148
Setpoint Programmer	151
Program Template Creation	151
Template Creation.....	151
Program Editor	154
Introduction	154
Editing Procedure	156
Recipe Management	159
Batch Processing	161
Error Conditions and Diagnostics	163
Error Indication Types	163
LED Displays.....	163
Instrument Failure Modes	163
Power Failure.....	164
Watchdog Failure	164
ICM Failure	164
LIN Failure	165
Decoupled Instruments	166
Desynchronisation	166
Power-up Failure.....	167
Start-up Routine.....	167
Power On Self Tests (POSTs).....	167
POST Failure LED Patterns.....	168
SD Card Failure Detection	168
Diagnostics Blocks	169
netHOST PROFIBUS Master Troubleshooting	170
netHOST Fault Scenarios	171
Fault Scenario 1: Ethernet Break between Primary's T2750 and netHOST ..	171
Fault Scenario 2: Total failure of Primary's netHOST.....	172
Fault Scenario 3: Ethernet break between Secondary's T2750 and netHOST	172

Fault Scenario 4: Total failure of Secondary's netHOST.....	173
Fault Scenario 5: Profibus break at Primary's netHOST.....	173
Fault Scenario 6: Profibus Break at Secondary's netHOST	174
Fault Scenario 7: Profibus break in the middle of the Profibus network ..	174
Fault Scenario 8: Profibus Failure of All Slaves	174
Service	177
Preventive Maintenance Schedule.....	177
Replacement Procedures.....	177
Software/Firmware Upgrade	177
Live IOC Module Replacement.....	181
Appendix A Specification	183
A1 Installation Category and Pollution Degree	183
A2 General Specification.....	183
A3 IOC Specification.....	184
A3.1 Terminal Unit.....	184
A3.2 IOC Module	185
A3.2.1 Hardware	185
A3.2.2 Software	185
A4 I/O Module Specifications	187
A4.1 AI2 Module.....	187
A4.1.1 Thermocouple Input Variant	187
A4.1.2 DC Input Variant	187
A4.1.3 mA Input Variant	189
A4.2 AI3 Module.....	189
A4.3 AI4 Module.....	190
A4.3.1 Thermocouple Input Variant	190
A4.3.2 mV Input Variant	190
A4.3.3 mA Input Variant	191
A4.4 AI8 Module.....	191
A4.4.1 mV Input Variant	191
A4.4.2 Thermocouple Input Variant	191
A4.4.3 mA Input Variant	192
A4.4.4 RTD Input Variant	192
A4.5 AO2 Module.....	192
A4.6 DI4 Module	193
A4.7 DI6 Module	193
A4.7.1 115V ac Input Variant	193
A4.7.2 230V ac Input Variant	194
A4.8 DI8 Module	194
A4.8.1 Logic Input Variant.....	194
A4.8.2 Contact Closure Input Variant.....	194
A4.9 DI16 Module	195
A4.10 DO4 Module	195
A4.11 DO8 Module.....	196
A4.12 DO16 Module	196
A4.13 FI2 Module.....	196
A4.14 RLY4 Module	198
A4.15 RLY8 Module	199
A4.16 ZI Module.....	199
A4.17 netHOST Profibus Master Gateway	200
A5 LIN Blocks Supported	201
A5.1 Batch Blocks.....	201
A5.2 Communications Blocks	201
A5.3 Condition	201
A5.4 Configuration Blocks.....	201
A5.5 Control Blocks	201
A5.6 Convert Blocks	202
A5.7 Diagnostics Blocks	202
A5.8 IO Blocks	203
A5.9 Logic Blocks	203
A5.10 Maths Blocks	203

A5.11 Organise Blocks.....	203
A5.12 Programmer Blocks	203
A5.13 Recorder Blocks	204
A5.14 Selector Blocks.....	204
A5.15 Timing Blocks	204
Appendix B Reference	205
B1 Frequency Input Module Details	205
B1.1 Terminal Connections, Links and Status LEDs.....	205
B1.2 Specification	205
B1.3 Application Details	205
B1.3.1 Cable Selection	205
B1.3.2 Cable Shield Connection.....	206
B1.3.3 Choosing the Appropriate Output Sensor Type.....	206
B1.3.4 FI2 General and LinTools Configuration.....	209
B1.4 Isolation Diagram.....	210
B1.5 Equivalent Circuits.....	210
B1.5.1 Magnetic Inputs	210
B1.5.2 Voltage Inputs.....	211
B1.5.3 Current Inputs.....	211
B1.5.4 Contact Inputs	212
B1.6 Fault Detection	212
B1.6.1 Fault Diagnostics	212
B2 Zirconia Input Module Details	213
B2.1 Terminal Connections and Status LEDs.....	213
B2.2 Specification	213
B2.3 Application Details	214
B2.3.1 Temperature Control.....	214
B2.3.2 Carbon Potential Control	214
B2.3.3 Soot Alarm	214
B2.3.4 Probe Cleaning.....	214
B2.3.5 Endothermic Gas Correction	214
B2.4 Isolation Diagram.....	215
B2.5 Equivalent Circuits.....	215
B2.5.1 Analogue Inputs.....	215
B2.6 Fault Detection	215
B2.6.1 Fault Diagnostics	216
B3 Glossary.....	217
B4 LIN Block Licences	218
B4.1 Foundation Level.....	219
B4.2 Standard Level	219
B4.3 Control Level	219
B4.4 Advanced Level	220
Appendix C Battery Replacement Procedure (if Fitted)	221
Appendix D System Variables	225
Appendix E Recover Lost Password	227

Safety Notes

WARNING

Any interruption of the protective conductor inside or outside the apparatus, or disconnection of the protective earth ground 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 ground 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 ground 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 configuration 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 "LIN Option Switch" on page 60 for details on the LIN Options Switch.

10. The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure.
11. Separate or redundant control paths must be provided for critical control functions.
12. System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.
13. Each implementation of this equipment must be individually and thoroughly tested for proper operation before being placed into service.

* 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 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:










1. 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.
2. 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 protective earth ground 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.
3. 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 100MHz. 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 (protective earth ground)
	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
	RCM. Regulatory Compliance Mark for Australia and New Zealand.
	Risk of electric shock

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 for more details.

Cybersecurity

What's in this Chapter

This chapter outlines some good practice approaches to cybersecurity as they relate to use of the T2750 controller, and draws attention to several T2750 features that could assist in implementing robust cybersecurity.

Introduction

When utilising Eurotherm T2750 controllers in an industrial environment, it is important to take cybersecurity into consideration: in other words, the installation's design should aim to prevent unauthorised and malicious access. This includes both physical access (for instance via the T2750 front panel or USB connector), and electronic access (via network connections and digital communications).

Secure Network Topologies and Good Practices

Overall design of a site network is outside the scope of this manual. The Cybersecurity Good Practices Guide, Part Number HA032968 provides an overview of principles to consider. This is available from www.eurotherm.com.

Typically, an industrial controller such as the T2750 together with any associated LIN connected devices and controlled devices should not be placed on a network with direct access to the public Internet. Rather, good practice involves locating the devices on a fire-walled network segment, separated from the public Internet by a so-called 'demilitarized zone' (DMZ).

Security Features

The sections below draw attention to some of the cybersecurity features of T2750 controllers.

Instrument Password

To help prevent unauthorized access to the instrument, every T2750 requires an 'Instrument Password' to be set. This must be set using Network Explorer. Until a valid Instrument Password has been set, the instrument cannot be accessed for configuration nor can it run any application.

Refer to "Setting Procedure (First Use)" on page 62 for details on setting the Instrument Password.

Whitelisting PCs and File Types

It is necessary to 'whitelist' any PC that requires runtime data communications with the instrument. By doing this, the PC will always be authorised for runtime data access to the instrument for which it is whitelisted. Be aware that whitelisting does not provide access to an instrument for configuration. To do this, it will always be necessary to enter the Instrument Password. Whitelisting is carried out using the Instrument Options Editor (part of LINTools).

Note: Runtime communications between controllers does not require whitelisting. Whitelisting is only applicable to unattended PCs that wish to interact with an instrument (for access to cached blocks or to exchange files).

It is also possible to whitelist specific file types for further security.

Refer to "Whitelisting a PC" on page 67 and "Whitelisting file types" on page 68 for details.

Legacy Mode

Legacy Mode enables instrument behaviour that previously existed. It removes the need to whitelist PC in runtime communication and allows configuration of the instrument without entry of the Instrument Password. It can be used for operational cases where the security provided by Instrument Passwords is not appropriate. For example, when using instruments as spares in an existing system, prior to implementing a more secure system solution requiring use of Instrument Passwords.

Notes:

1. To enable Legacy Mode, the Instrument Password must have been set.
2. Putting an instrument into Legacy Mode is NOT recommended unless there are strong operational reasons to do so.

Refer to "Secure Mode" on page 69 for details.

Principle of Secure by Default

Some of the digital communication features on the T2750 can provide greater convenience and ease-of-use (particularly in regards to initial configuration), but also can potentially make the controller more vulnerable. For this reason, it is recommended that features that are not being used are left disabled. This can include the terminal configurator and the serial ports. Also, by default, LIN communication does not allow cross-subnet working. Cross-subnet working should only be enabled when it is really required.

Ethernet Security Features

Ethernet connectivity is always available on T2750 controllers. This connectivity is vulnerable to cyberattacks. One form of cyberattack is to try to make a controller process so much Ethernet traffic that this drains system resources and useful control is compromised. For this reason, the T2750 includes an Ethernet rate protection algorithm, which will detect excessive network activity and help to ensure the controller's resources are prioritized on the control strategy rather than the Ethernet. It is noted in '*.udz' files. This feature will also cause a break of synchronisation (although units will auto re-sync once the rate protection ceases) - this happens because Ethernet rate protection breaks the communications between left & right units.

A 'broadcast storm' is a condition which may be created by cyberattack: spurious network messages are sent to devices which cause them to respond with further network messages, in a chain reaction that escalates until the network is unable to transport normal traffic. The rate protection described in the previous paragraph also provides protection against this type of attack.

Configuration Backup and Recovery

Eurotherm's LINtools software is used to configure a T2750 controller. This configuration is stored locally on the PC running the tool. Thus it is available to be copied onto another controller, or can be used to restore the original controller's settings.

It is important that backups of the configurations are maintained.


Memory Integrity

When a T2750 controller powers up and attempts a 'hot start', it automatically performs an integrity check on the contents of its internal non-volatile memory devices. If this integrity check fails, the hot start fails. Nonvolatile memory is not used.

This is separate from the flash filing system, which is non-volatile storage.

Firmware

From time to time, to provide new functionality or address known issues, Eurotherm may make new versions of the T2750 firmware available. T2750 uses a file 'upgrade.tgz' which includes self-consistency checks as well as the firmware. This file is copied to the instrument which is then power-cycled. The instrument will detect the presence of 'upgrade.tgz' and will verify its contents before attempting the upgrade.

 WARNING
NON-SCHNEIDER ELECTRIC FIRMWARE
There is a potential risk that an attacker could upgrade a T2750 with non-genuine firmware that contains malicious code. Care must be taken to ensure all firmware updates are genuine.
Failure to follow this instruction can result in injury or equipment damage.

Achilles® Communications Certification

The T2750 controller has been certified at Level 1 under the Achilles® Communications Robustness Test Certification scheme. This is an established industry benchmark for the deployment of robust industrial devices recognized by major automation vendors and operators.

Decommissioning

When a T2750 controller is at the end of its life and being decommissioned, Eurotherm advises clearing the contents of the instrument's E: drive. This can help to protect against subsequent data and intellectual property theft if the controller is then acquired by another party.

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.

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.

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

Features

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.

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.

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.

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.

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 \pm 15%, 10 μ A 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.

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.

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 “Error Indication Types” on page 163.).

The LIN Blocks Reference manual contains descriptions of each block.

Blocks are ‘license protected’ into categories that define control levels (section B4 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.

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 data recording files can be interrogated to read any data missing from the database as a result of a break in transmission.

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.

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.

Health Monitoring

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

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 "Controller Module (IOC) Terminal Unit" on page 31.

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.

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.

Front Panel Indicators

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

Installation

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.

Mechanical Installation

Figure 2.1 gives dimensional details; Figure 2.2 gives fixing details.

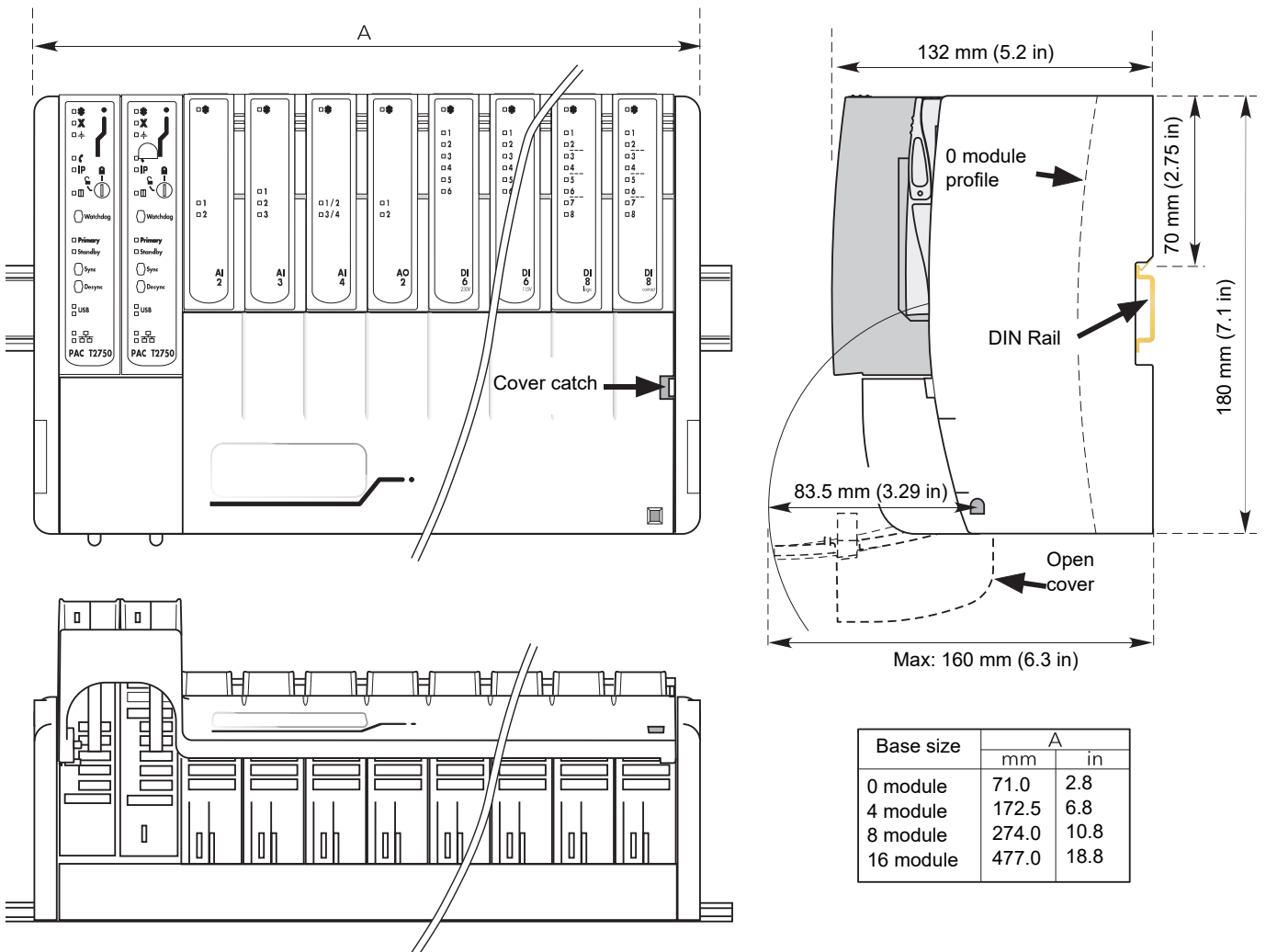


Figure 1 Overall dimensions

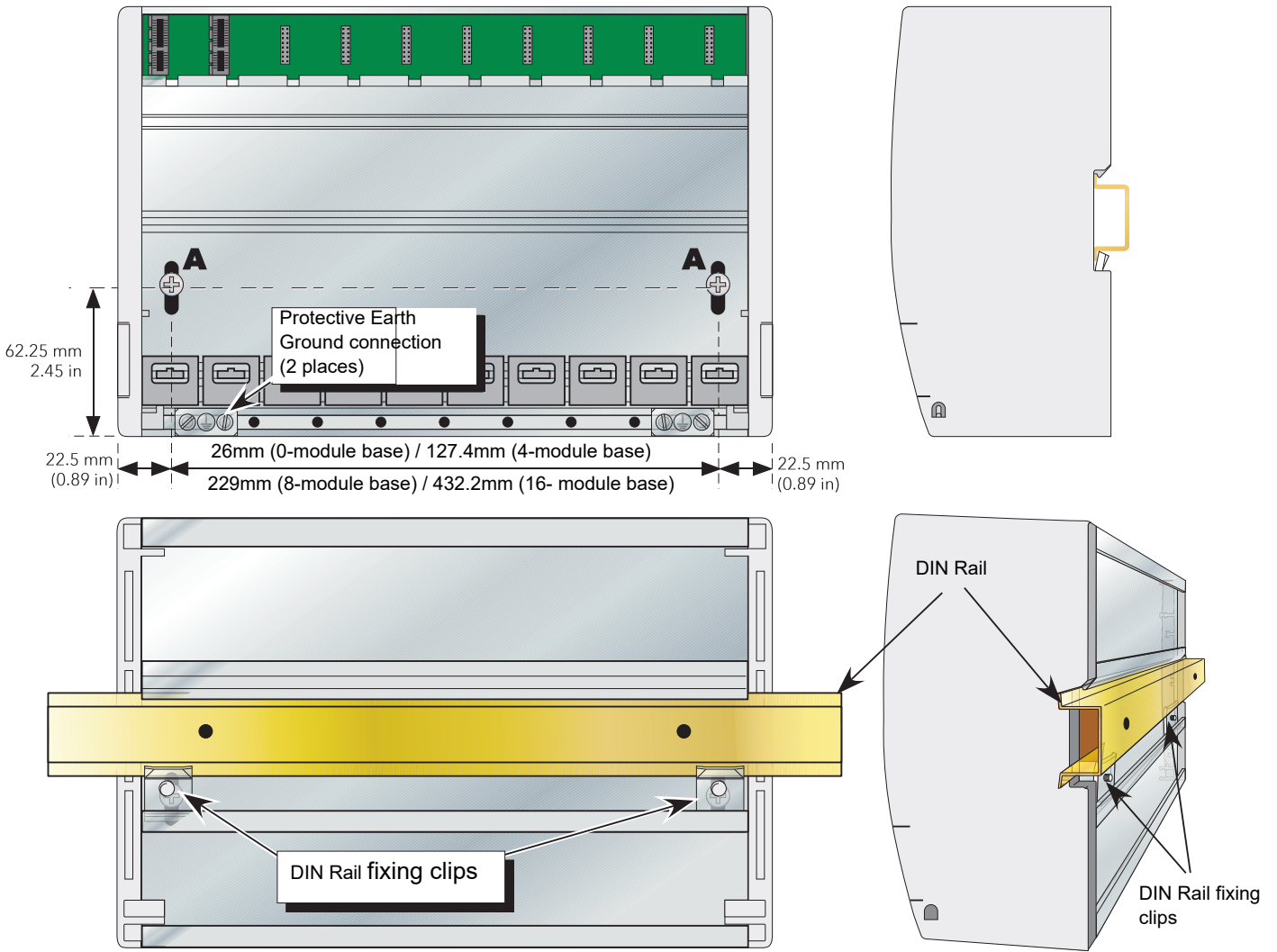


Figure 2 Fixing details

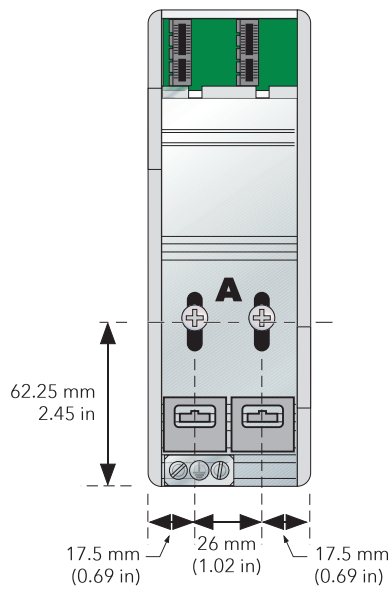


Figure 3 No-module base details

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 ground 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 ground 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 and Figure 3) in the Base Unit, two or three turns, and allow them, and the associated fixing clips to slide to the bottom of the screw slot.
3. Lower the base unit 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 and Figure 3).
4. Slide the screws (A) and associated clips as far as they will go towards the top of the screw slots, ensuring that the top of each fixing clip locates behind the bottom edge of the DIN rail.
5. Tighten the screws, and check that the base unit is fully secure on the rail.

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

Compliance with European EMC Directive

Please refer to the instructions given in the "Safety Notes" on page 11 at the front of this manual which describe precautions which should be taken to conform with the directive.

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 4).
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 ("Module Installation" on page 28, 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').

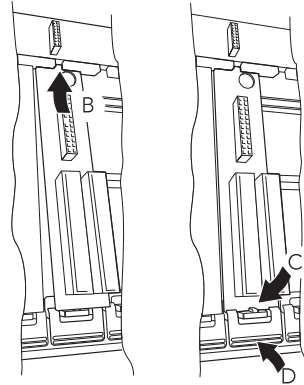


Figure 4 Terminal unit installation/removal

Module Installation

Note:

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 5.
 2. Offer the module up to the terminal unit and the backplane, and push home.
 3. Return the retaining lever to the locked position.

Module Removal

1. Pull the module retaining lever forwards into the unlocked position as shown in Figure 5.
2. Disengage the module from the backplane connector and lift the module out of the base unit.

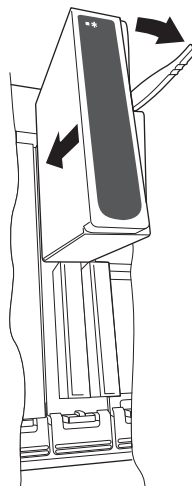


Figure 5 Module installation

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 pre-cut 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.

Label locations (1 per module)

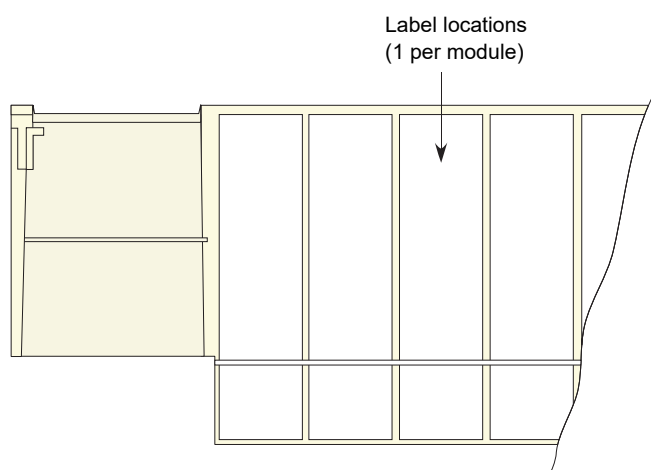


Figure 6 Inside cover

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 7 shows the dimensions of the netHOST.

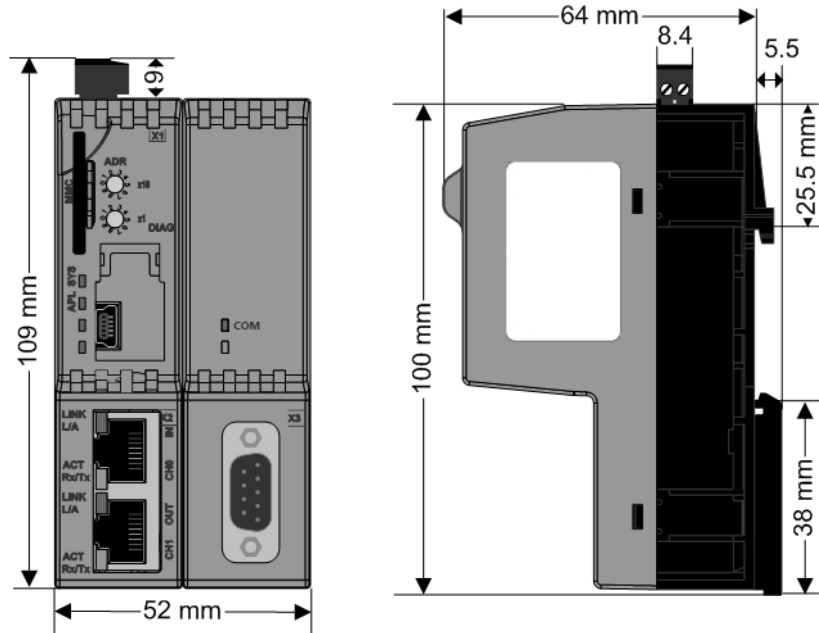


Figure 7 netHOST dimensions

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 8, push the netHOST onto the top hat rail from above (1), and then press against the mounting surface (2).

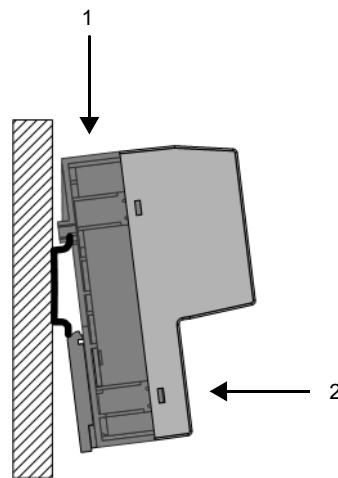


Figure 8 netHOST mounting

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.

Electrical Installation

Controller Module (IOC) Terminal Unit

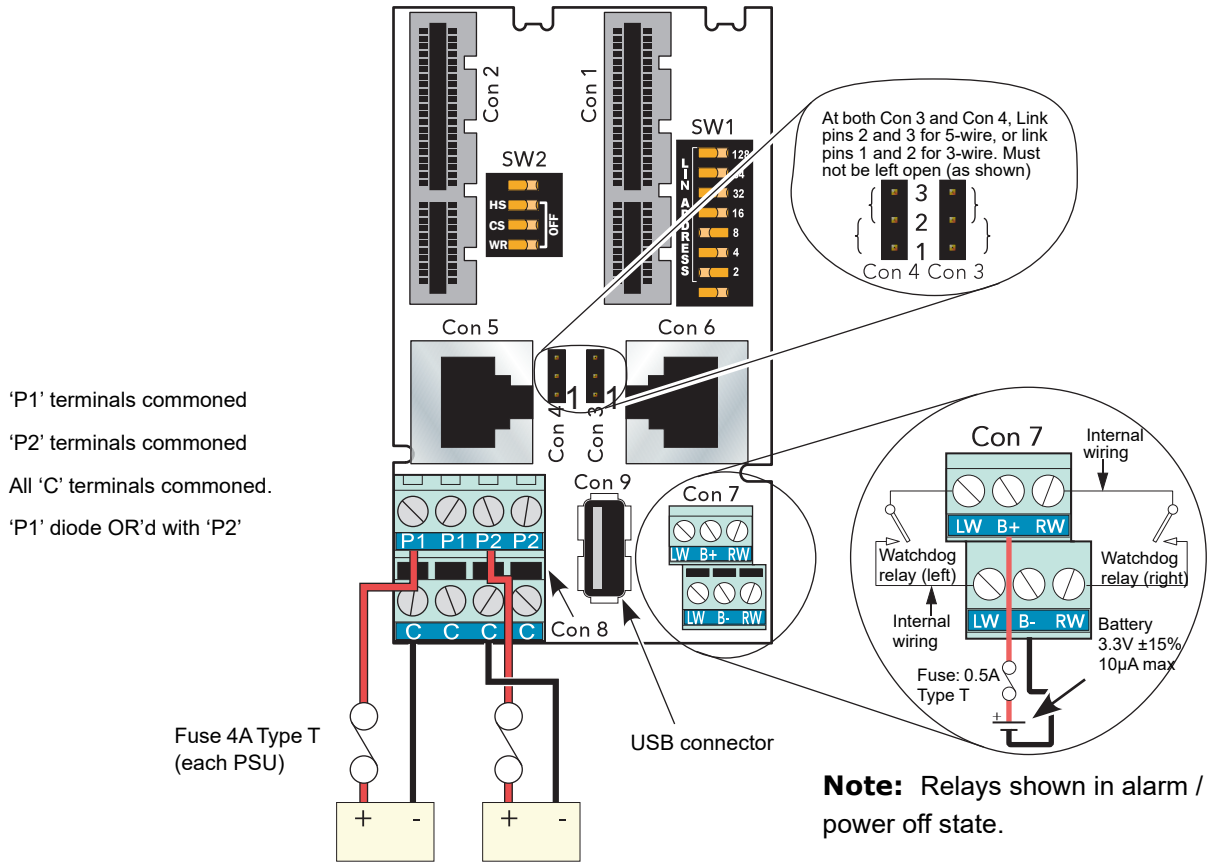


Figure 9 Wiring and hardware configuration details for the IOC terminal unit

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.

Supply Wiring

CAUTION

Neither supply line may be allowed to rise above 30V with respect to protective earth ground.

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 ($3.3 \pm 15\%$) 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 $10\mu\text{A}$ 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 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): 3mm flat blade. Watch dog/battery connector (Con7): 2.5mm 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'.

Protective Earth Ground

Figure 2, above, and associated text gives protective earth ground 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 Tactician header block.

Figure 10, 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 10 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 30Vac/60Vdc at 0.5A.

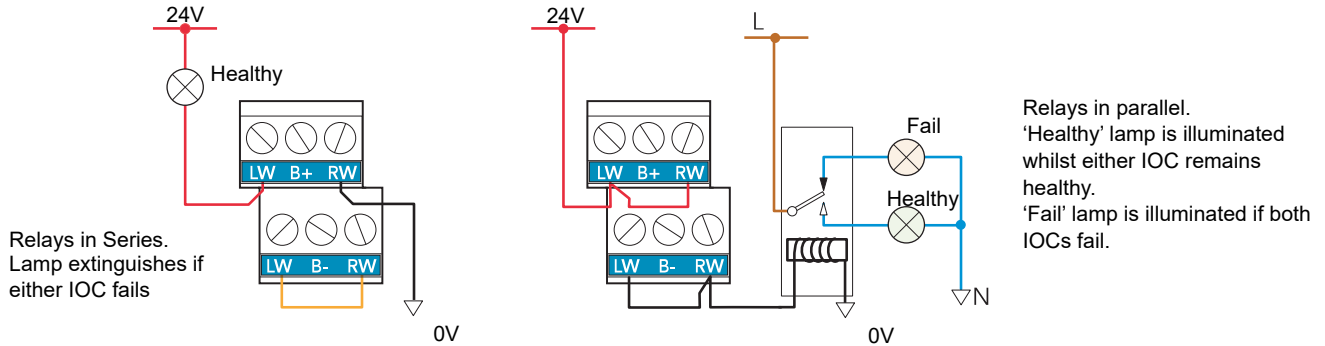


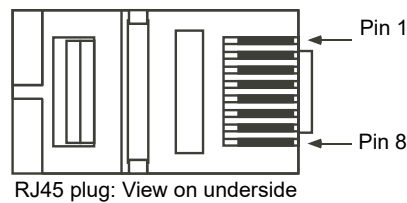
Figure 10 Typical watchdog relay wiring

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 11 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	TxB	NC
8	TxA	TxA	NC

Figure 11 RJ45 pinout (EIA485)

Note: The screen of the cable is connected to earth/ground via the RJ45 connectors. Best RFI performance is achieved if the screen is also earthed/grounded 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 9).

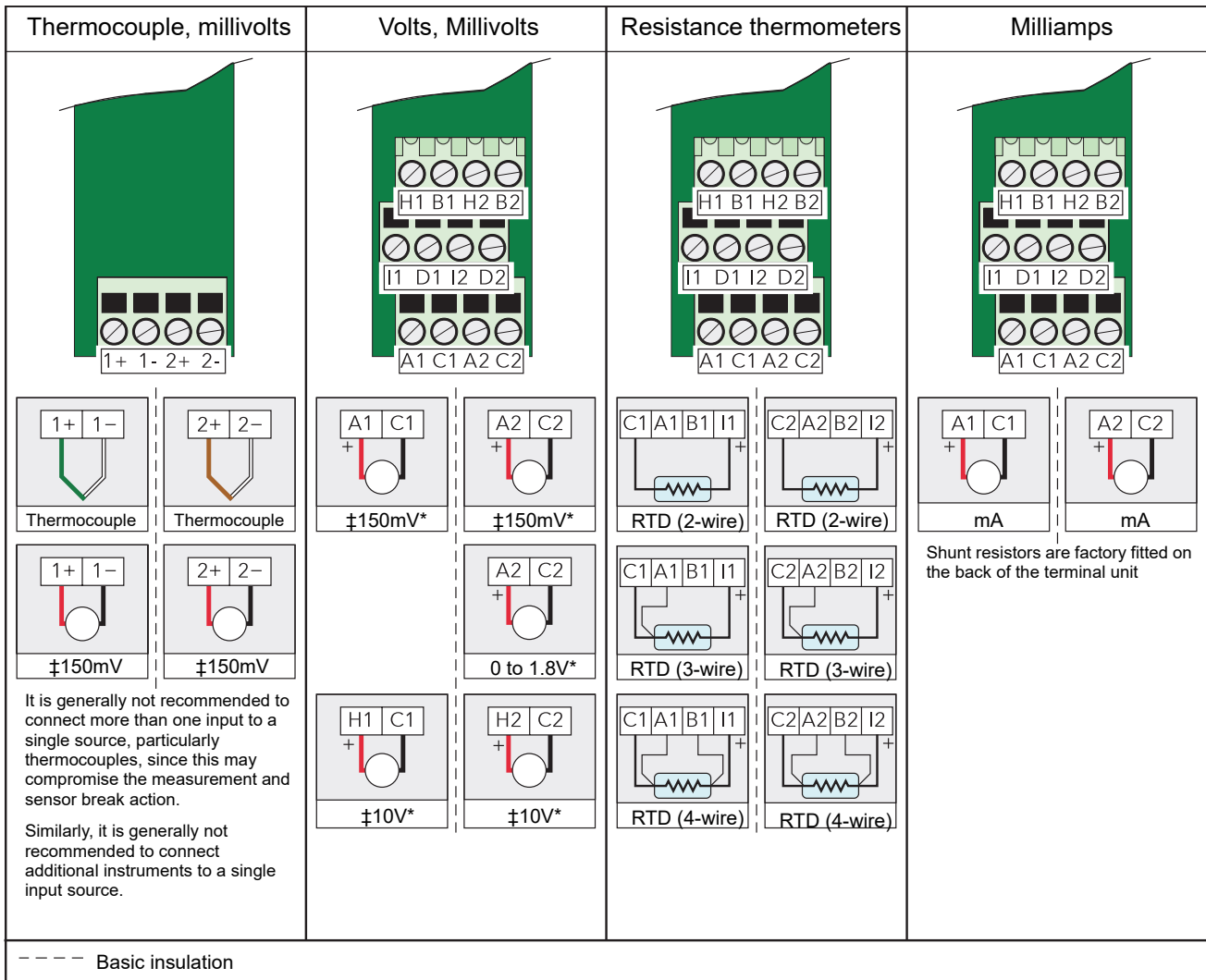
The connector is intended for use with USB memory sticks, and can supply up to 500mA. Attempts to draw more than 500mA causes the current limiting circuitry to shut the USB power down until the fault is removed.

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.

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 12 gives pinout details



Note: 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.

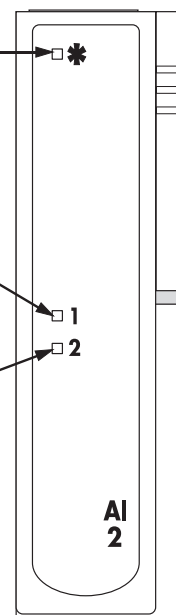
Figure 12 AI2 module pinout

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



Note:

Flashing = 0.5 secs on, 0.5 secs off

Blinking = 0.2 secs on, 1.8 secs off

Figure 13 AI2 Status indicators

Three-channel Analogue Input (AI3)

This module provides three isolated mA input channels. An isolated 24V (nominal) 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 14 shows the pinout.

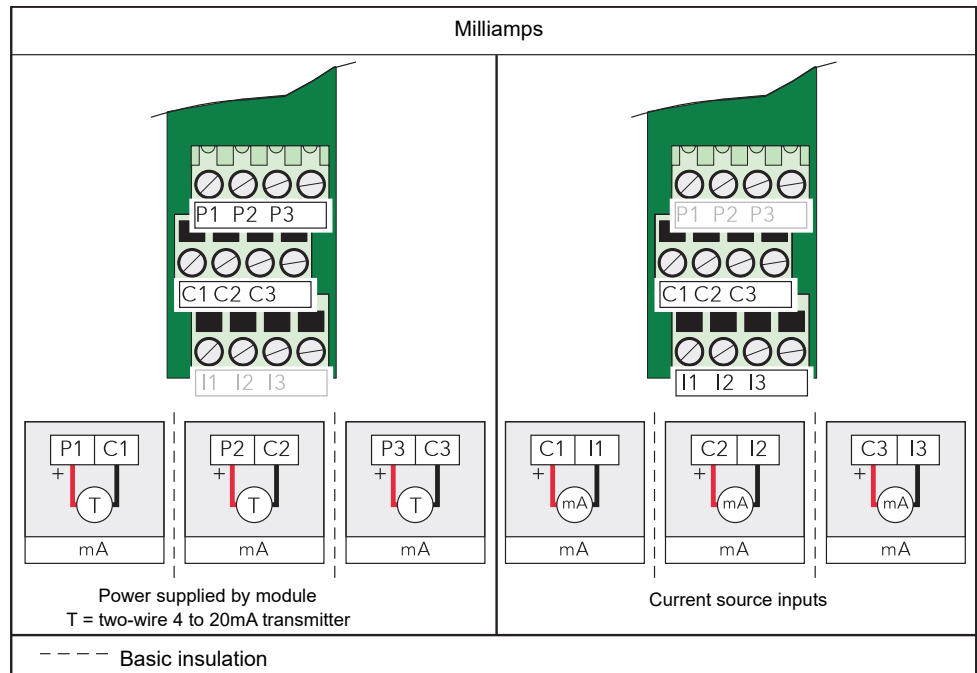
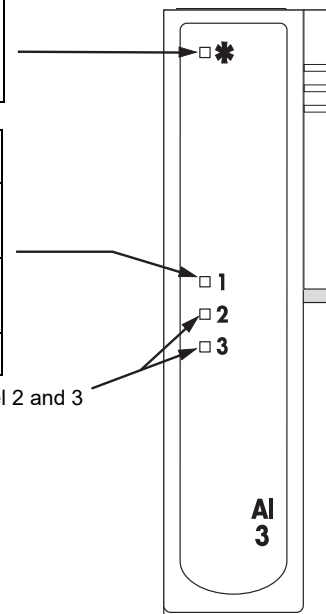


Figure 14 AI3 module pinout

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

As above but for channel 2 and 3



Note:

Flashing = 0.5 secs on, 0.5 secs off

Blinking = 0.2 secs on, 1.8 secs off

Figure 15 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.

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 16 shows the module equivalent circuit, and Figure 17 shows the location of the links on the underside of the terminal unit.

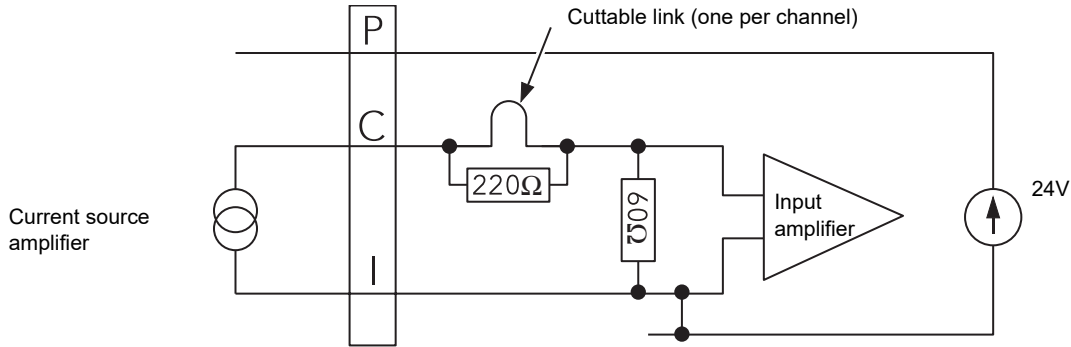


Figure 16 AI3 module equivalent circuit

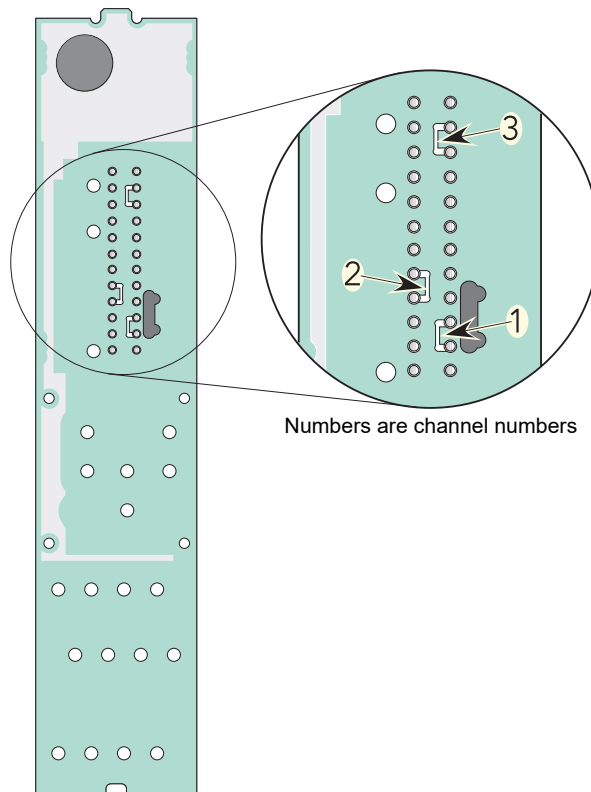


Figure 17 Link locations on underside of terminal unit

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 18 gives pinout details.

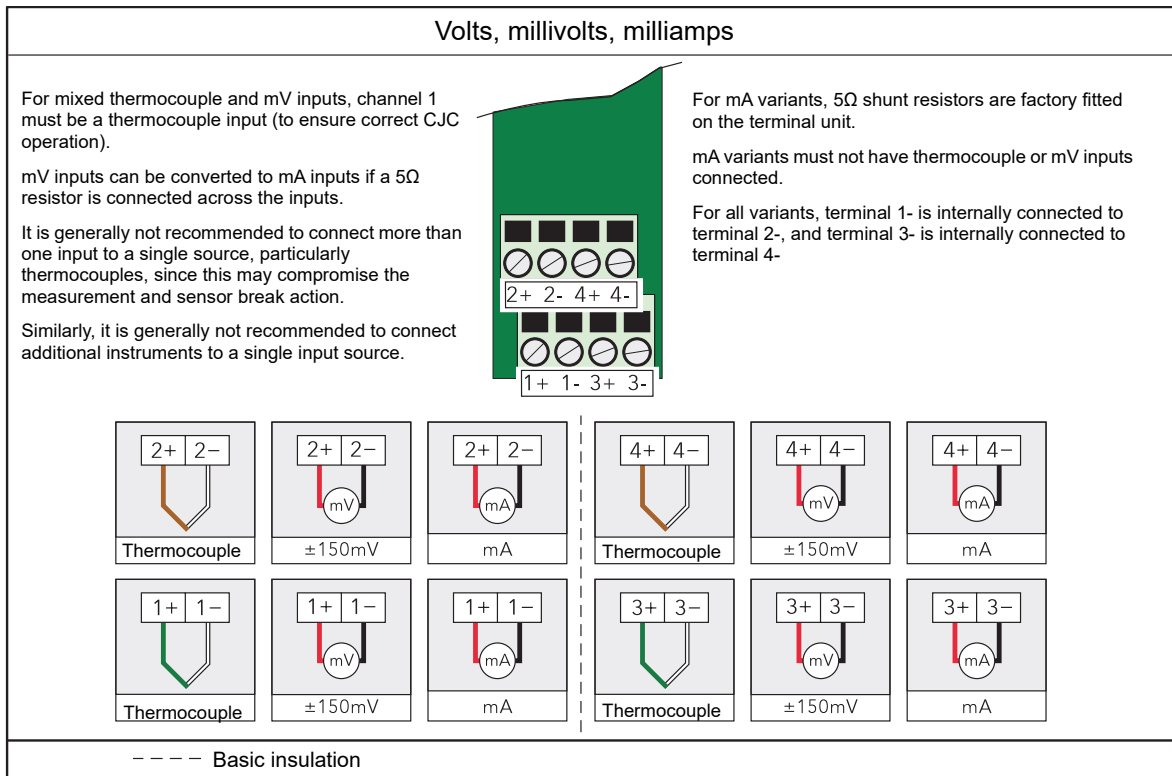


Figure 18 AI4 module pinout

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 channel 3/4

Note:

Flashing = 0.5 secs on, 0.5 secs off

Blinking = 0.2 secs on, 1.8 secs off

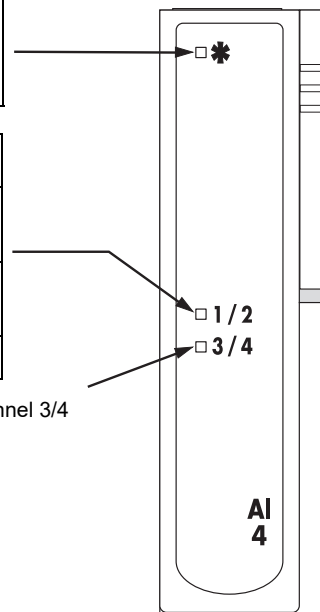


Figure 19 AI4 status indicators

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 20 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 21 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 21 for terminal pin-out details.

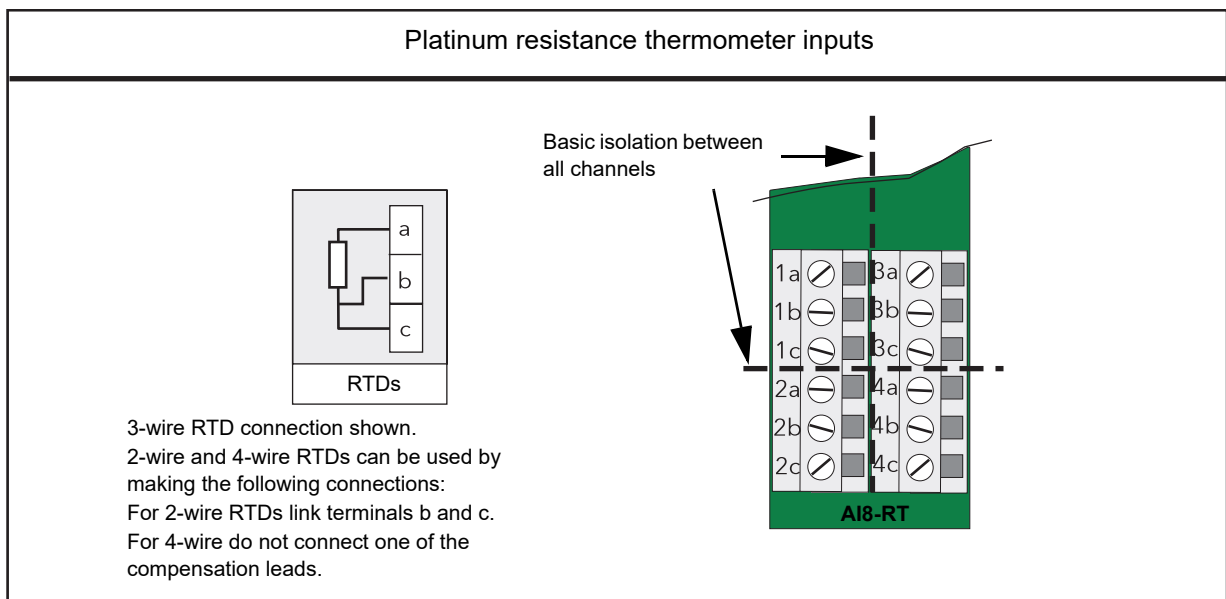


Figure 20 AI8-RT terminal unit

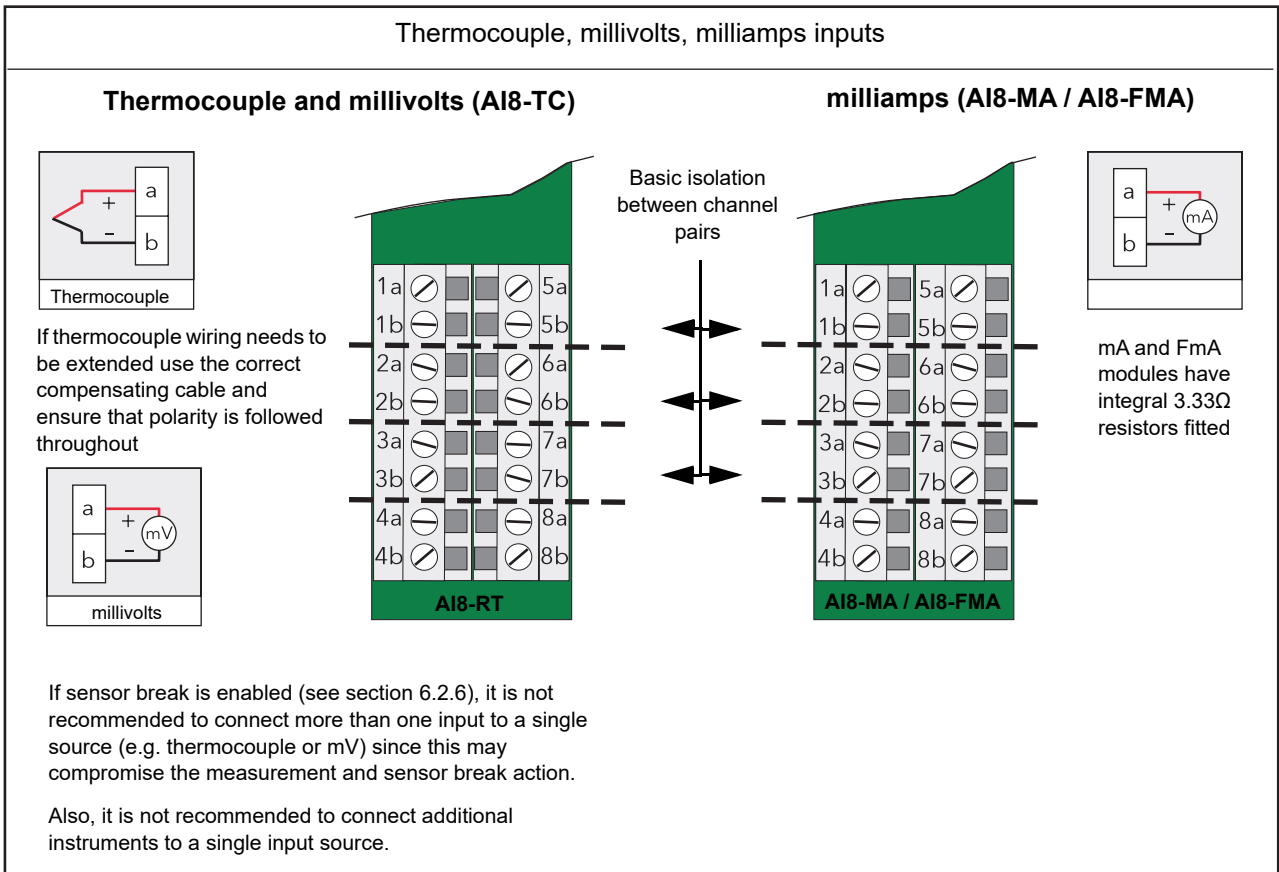


Figure 21 Module pinout for thermocouple, mV and mA inputs

Status Indicators

As shown in Figure 22 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.

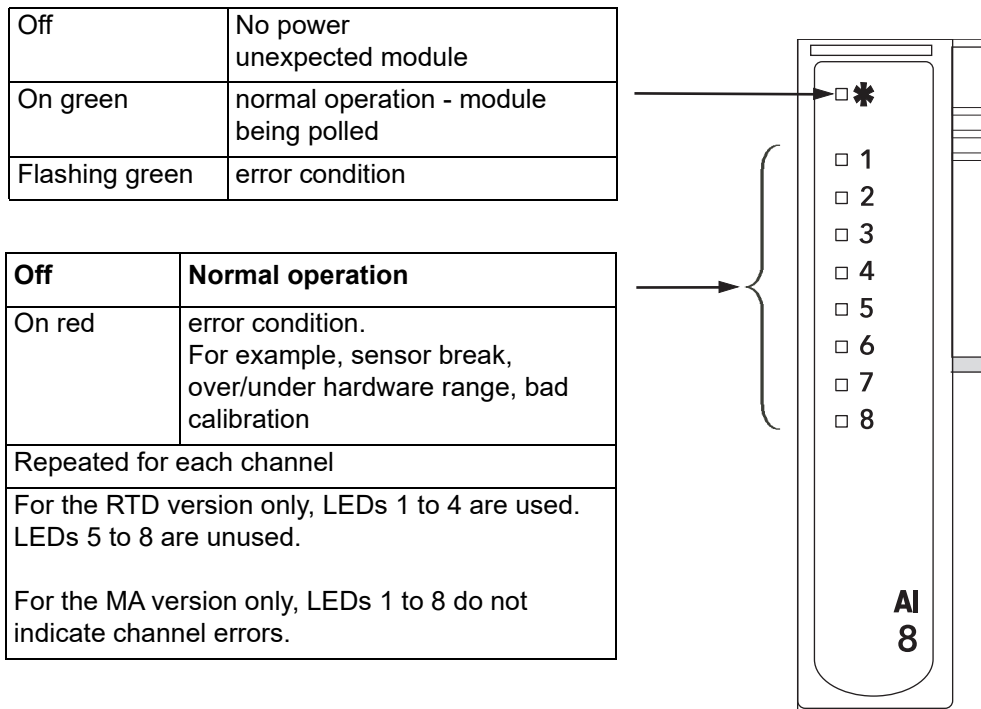


Figure 22 Status indicators

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 1500Ω. Figure 23 gives the module pinout.

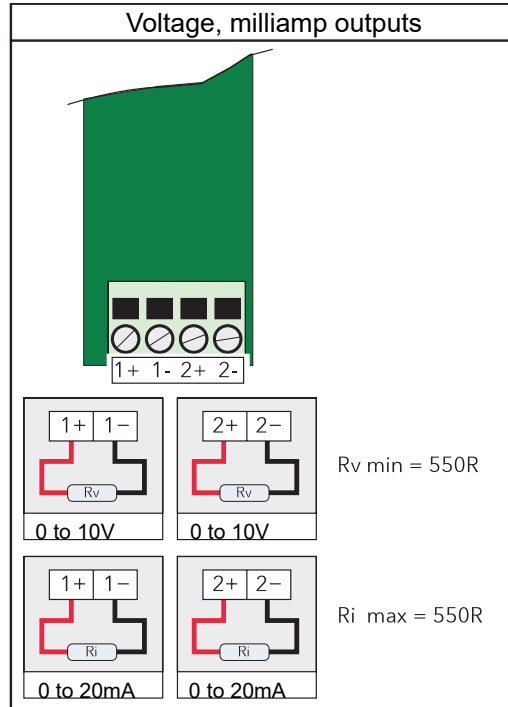


Figure 23 AO2 module pinout

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

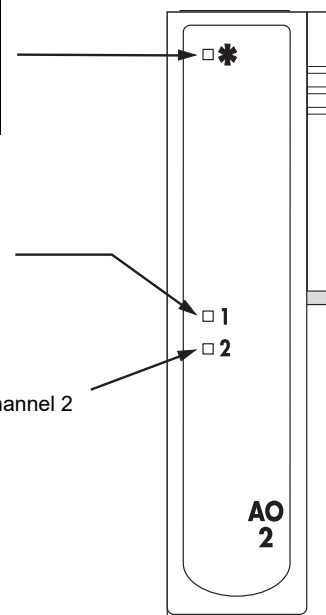


Figure 24 AO2 module status indicators

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.

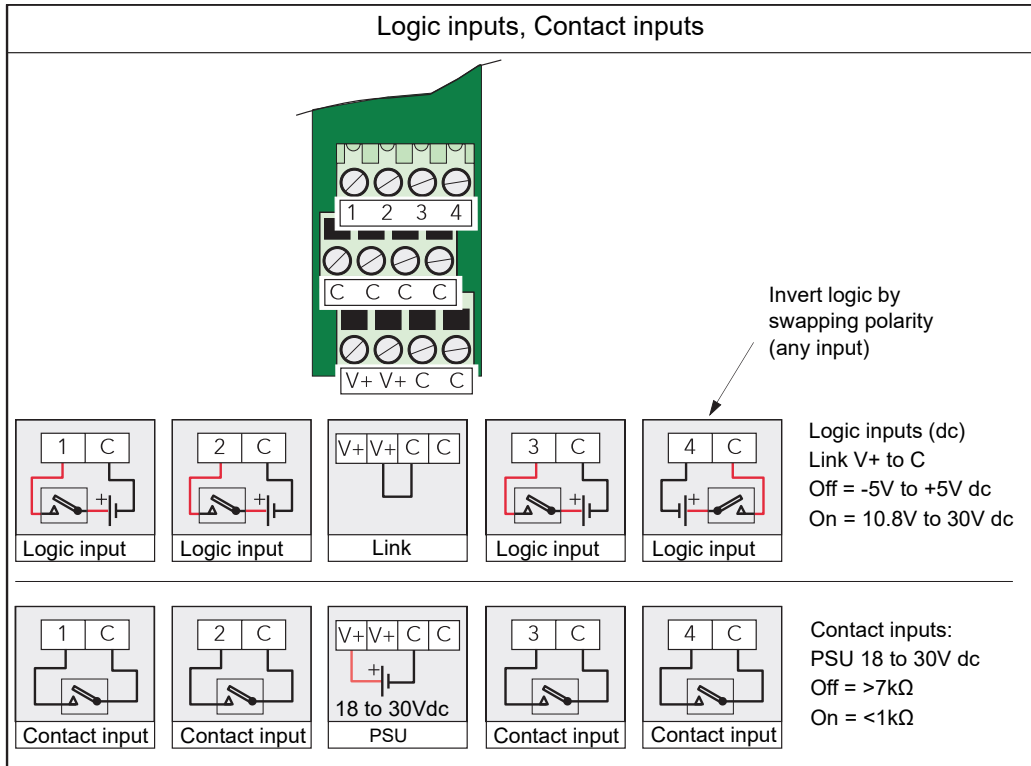


Figure 25 DI4 module pinout

Status Indicators

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

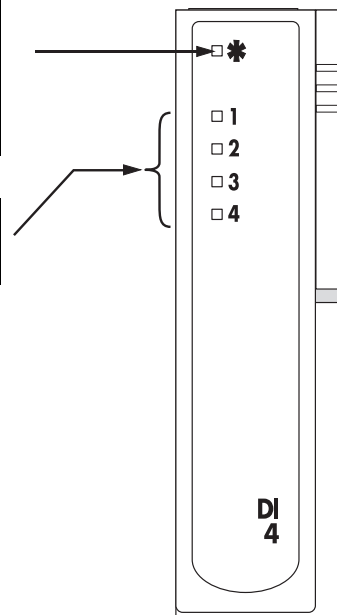


Figure 26 DI4 module status indicators

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.

Status Indicators

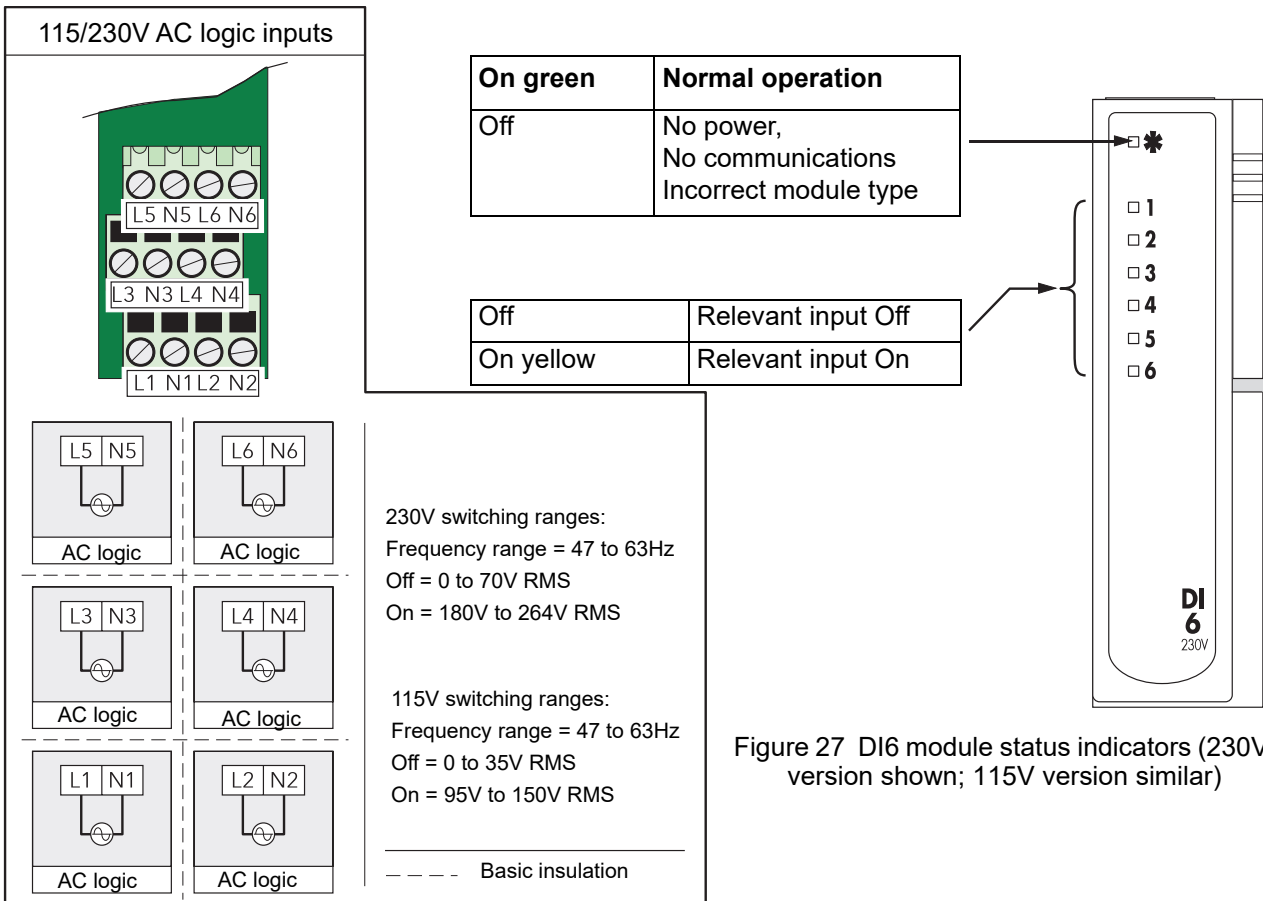


Figure 27 DI6 module status indicators (230V version shown; 115V version similar)

Figure 28 DI6 module pinout

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.

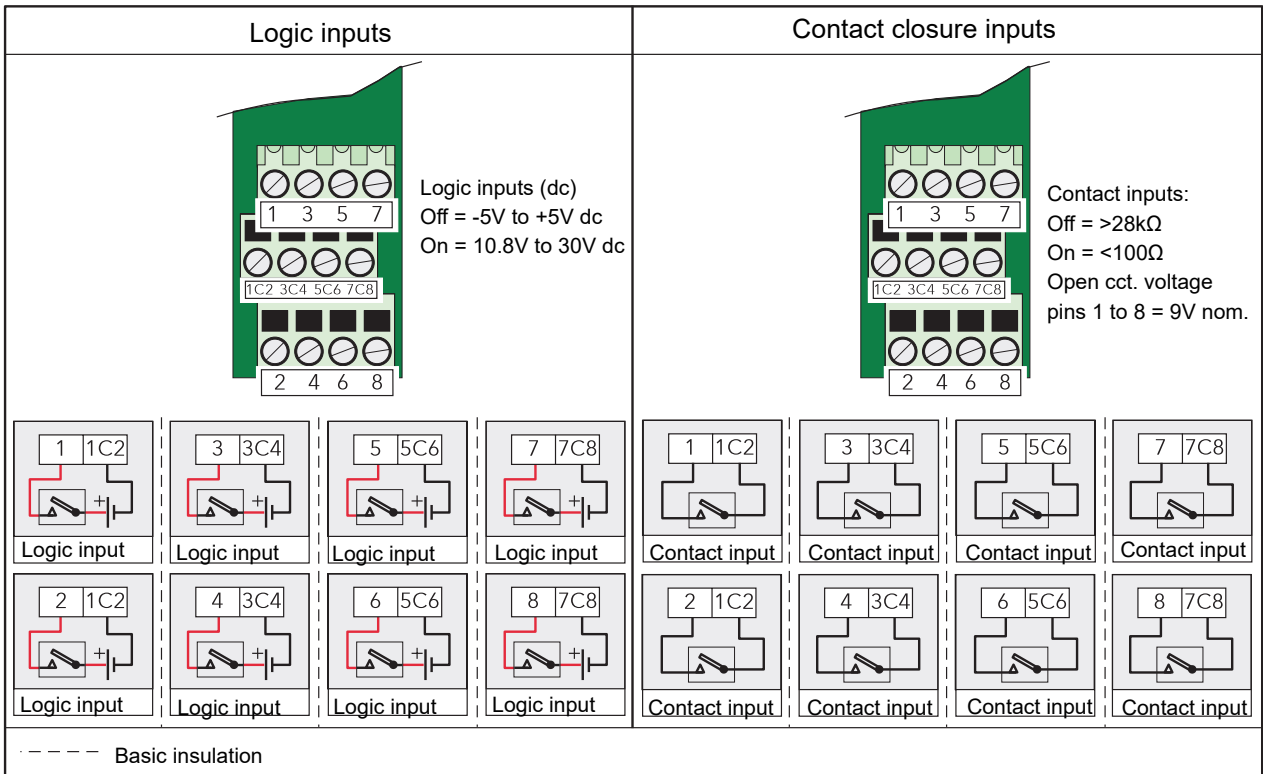


Figure 29 DI8 module pinout

Status Indicators

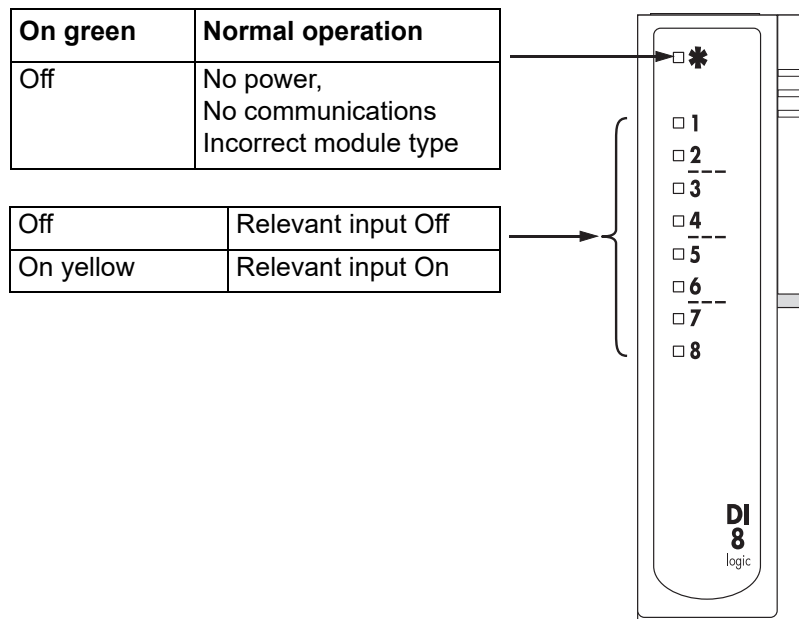


Figure 30 DI8 module status indicators

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.

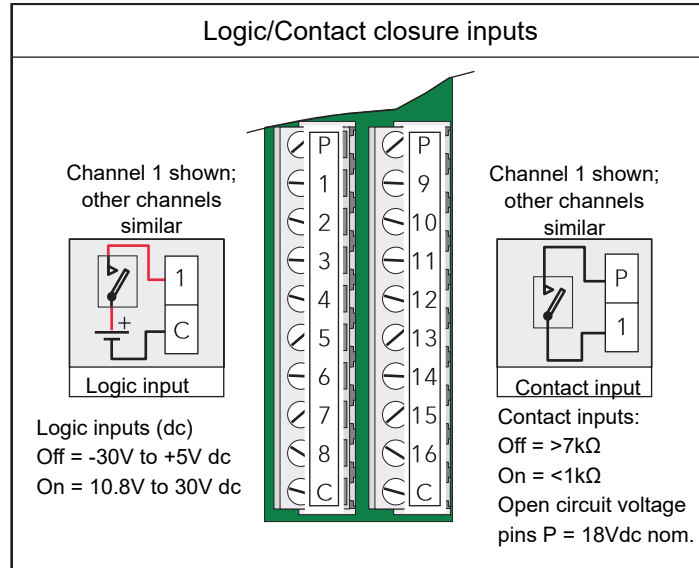


Figure 31 DI16 module pinout

Status Indicators

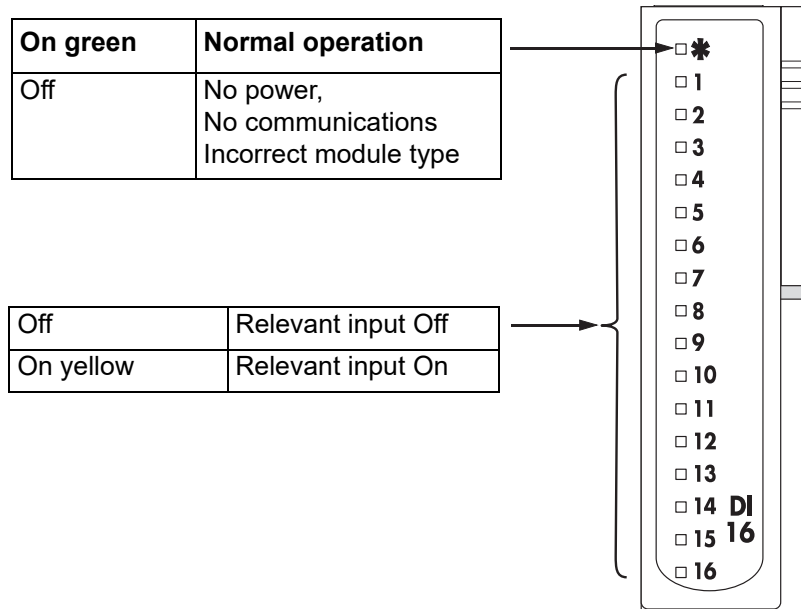


Figure 32 DI16 module status indicators

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 8mA, and DO424 which can supply up to 100mA.

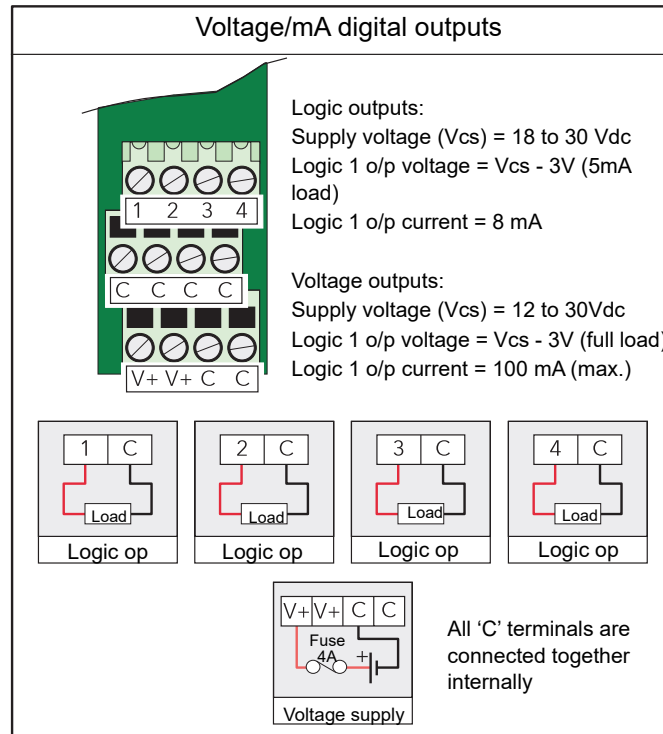


Figure 33 DO4 module pinout

Status Indicators

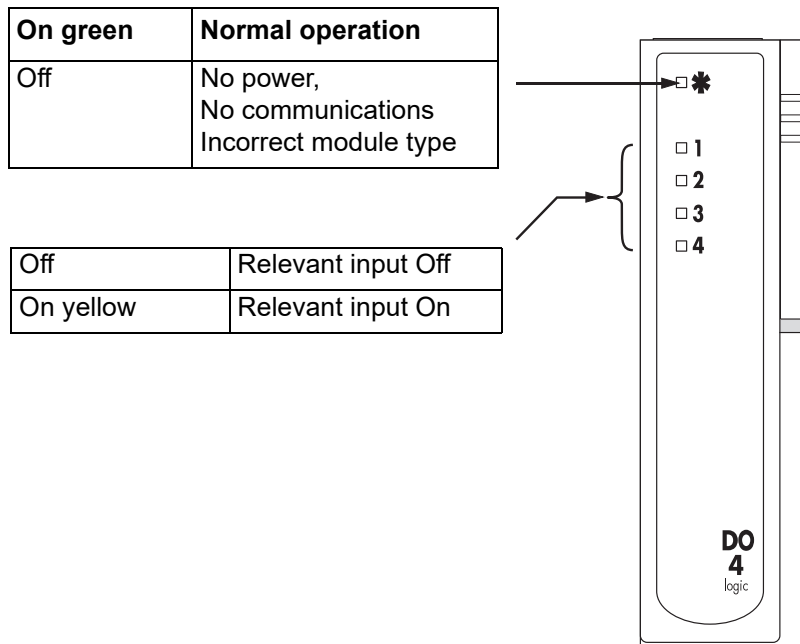


Figure 34 DO4 module status indicators

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.

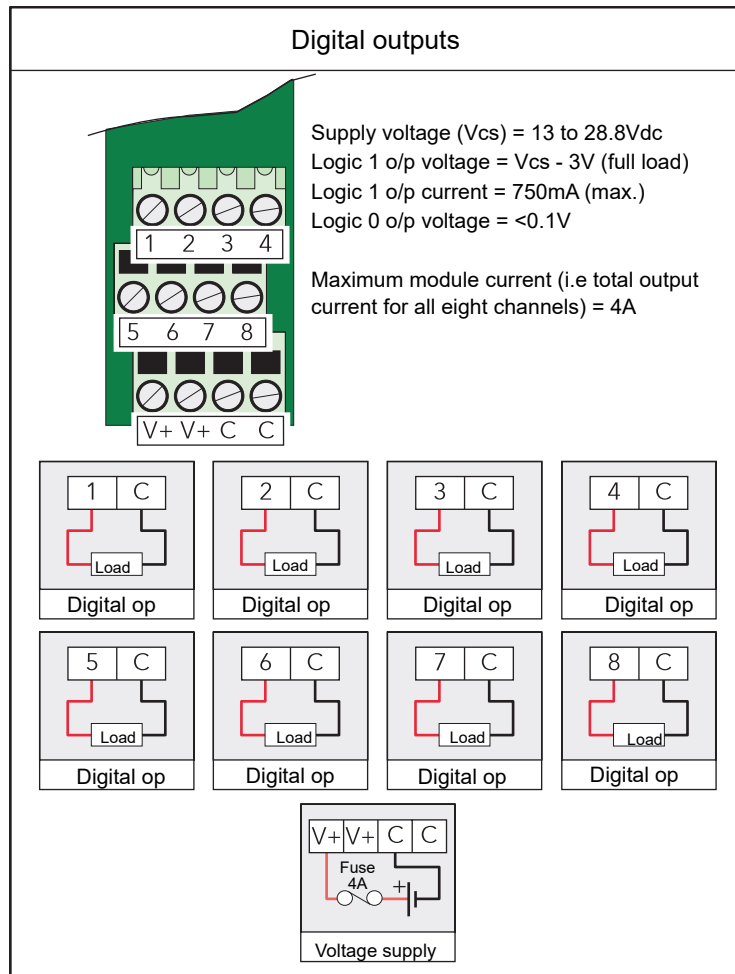


Figure 35 DO8 module pinout

Status Indicators

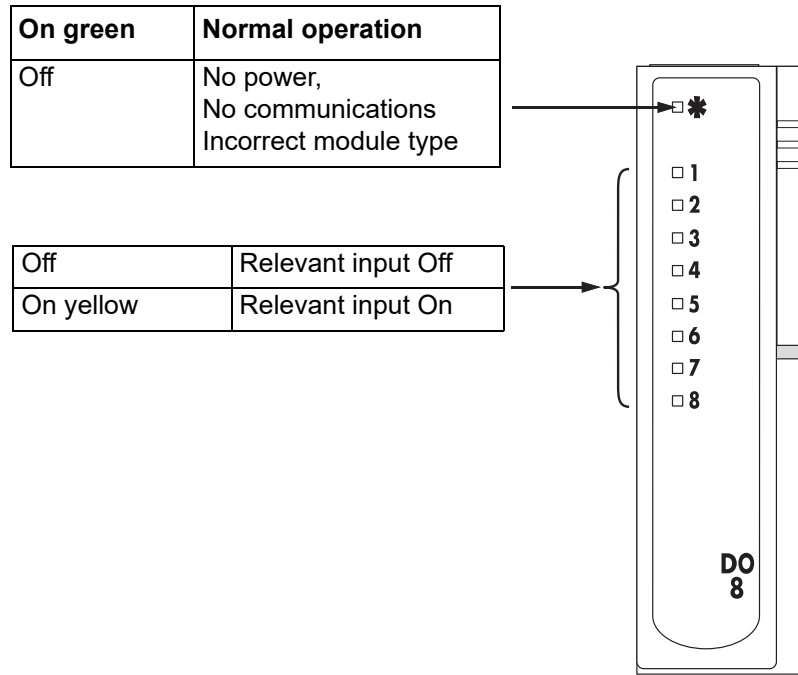


Figure 36 DO8 module status indicators

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.)

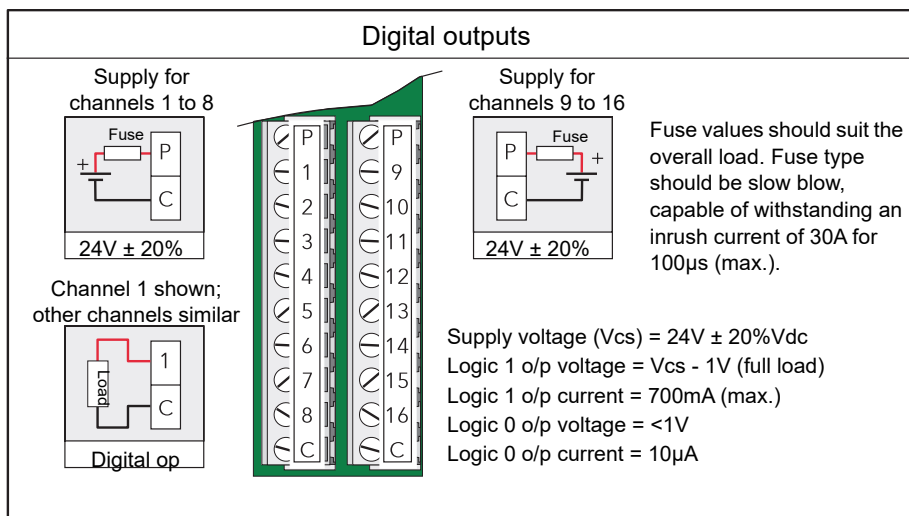


Figure 37 DO16 module pinout

Status Indicators

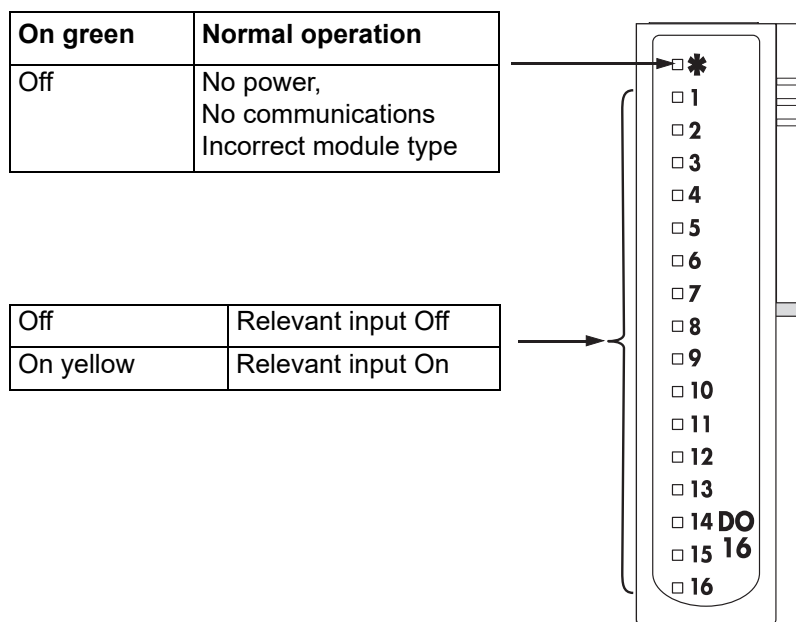


Figure 38 DO16 module status indicators

Two-channel Frequency Input Module (FI2)

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

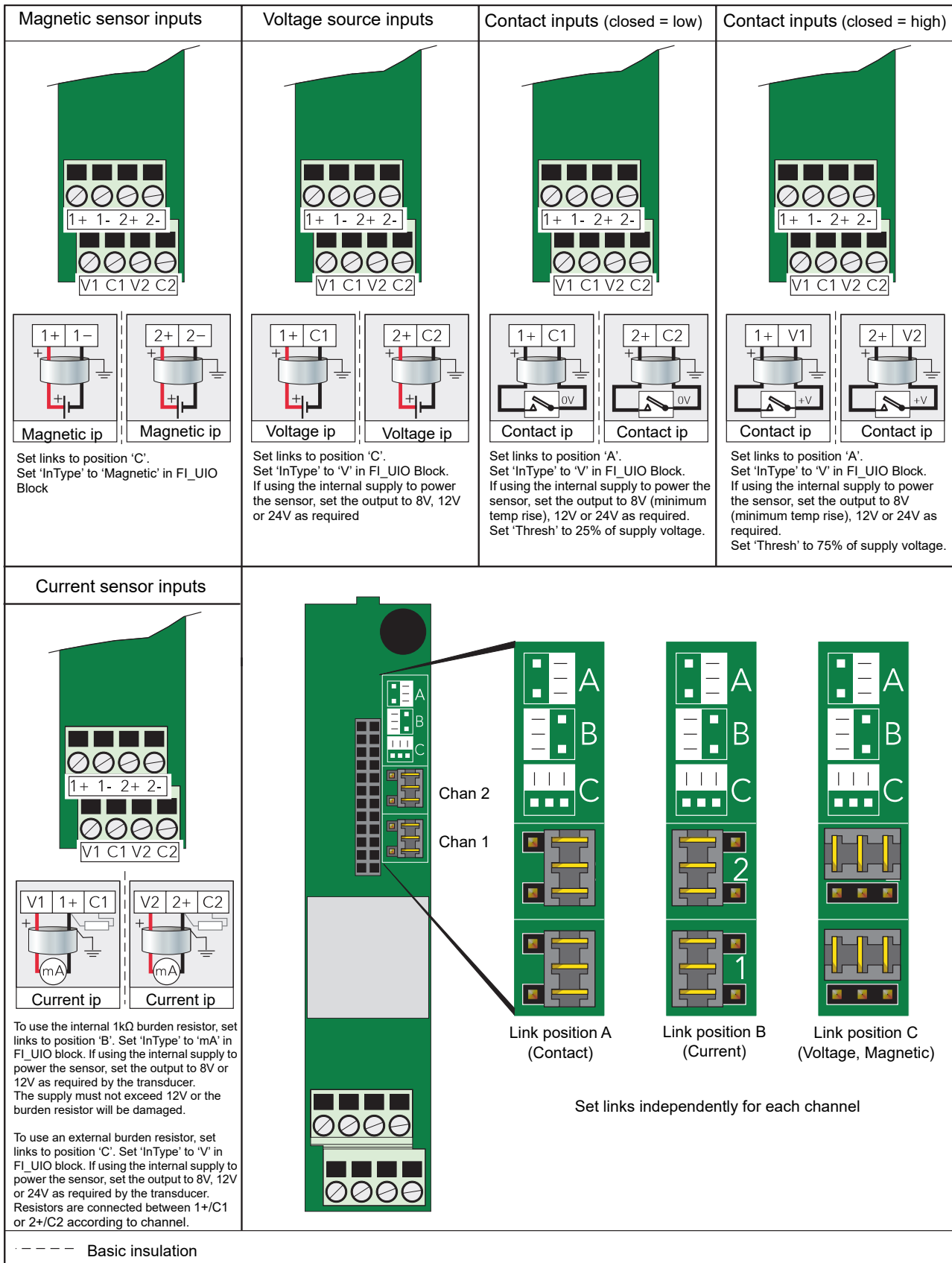


Figure 39 FI2 module pinout (see also Figure 41 and associated cautionary note, below)

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

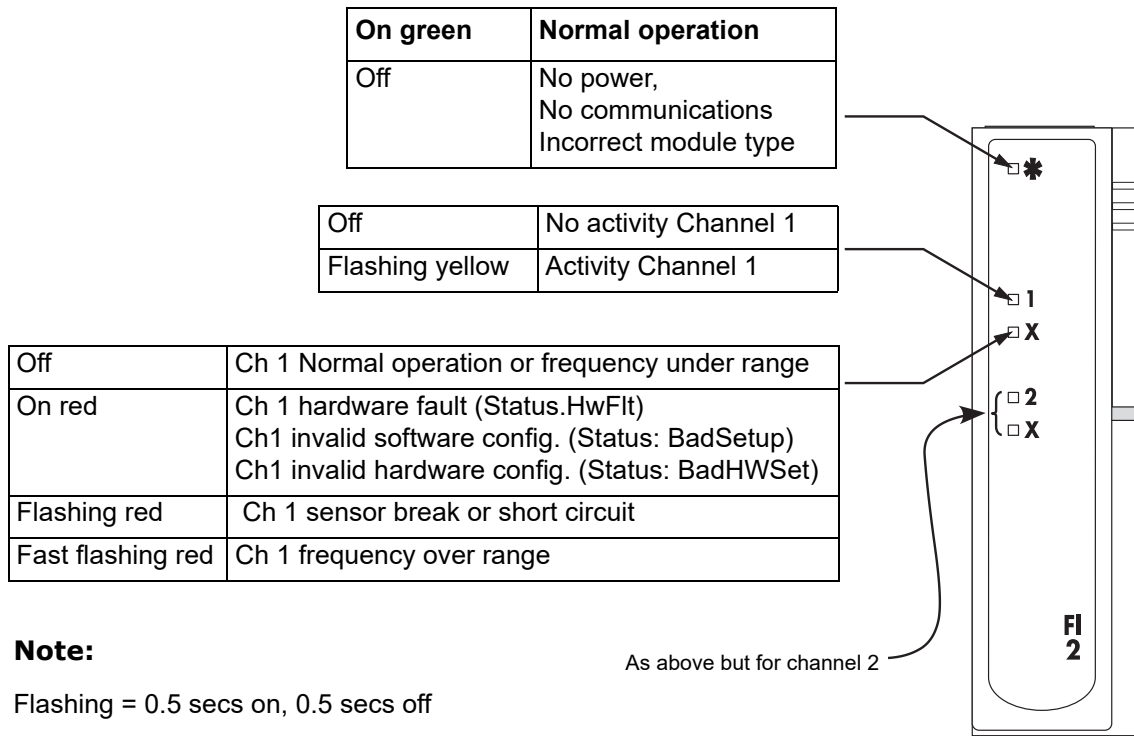


Figure 40 FI2 status indicators

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 (see Figure 41). Otherwise, if the internal supply is used, damage will be caused to the base unit backplane tracking.

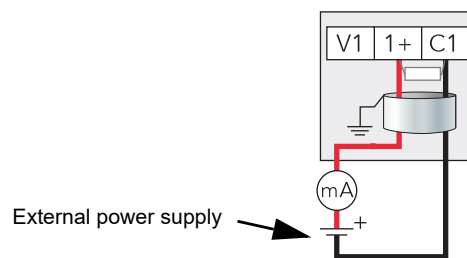


Figure 41 External power supply wiring example

For more details of the Frequency input, see "B1 Frequency Input Module Details" on page 205.

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.

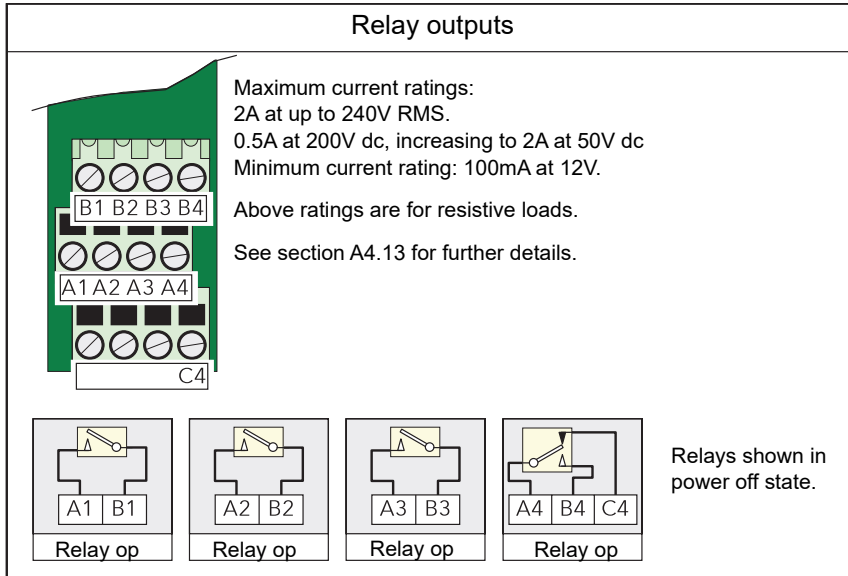


Figure 42 RLY4 module pinout

Status Indicators

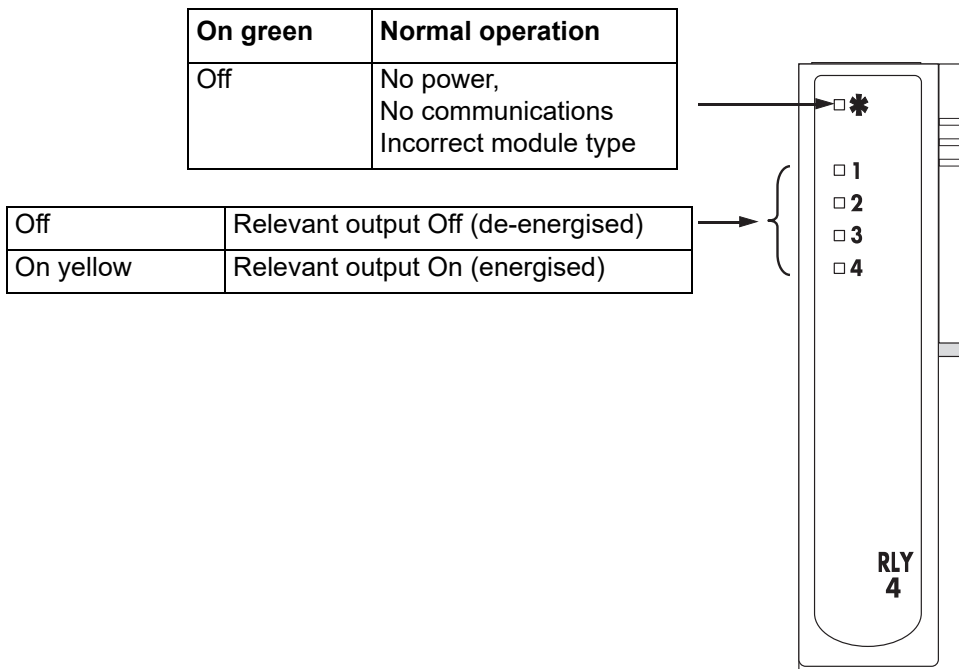
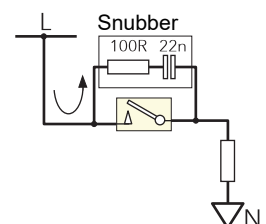


Figure 43 RLY4 status indicators

Snubber Circuits

Each set of relay contacts has an associated snubber circuit (a 22nF capacitor in series with a 100Ω 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 prevent 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 44), 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 gently on the lug 'C' to remove the circuit board from the module moulding.

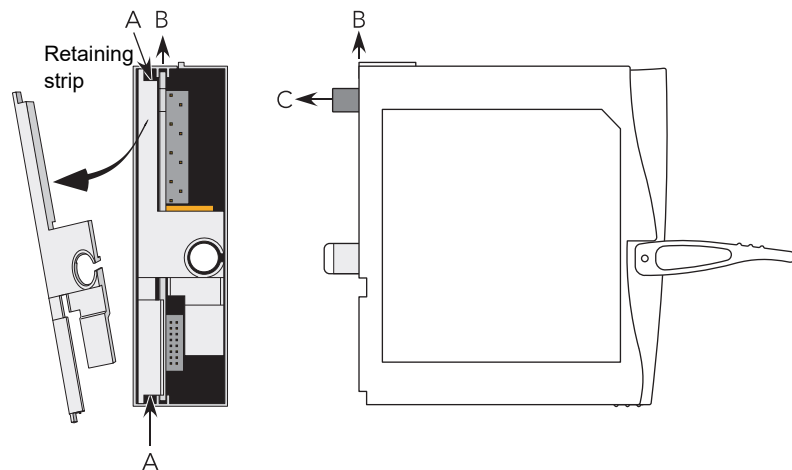


Figure 44 Removal of the relay board from the module

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 45 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.

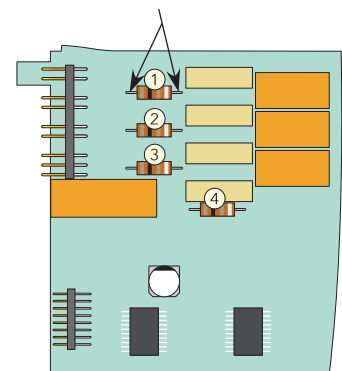


Figure 45 Snubber resistor locations

6. Ensure that the module label is marked appropriately.

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.

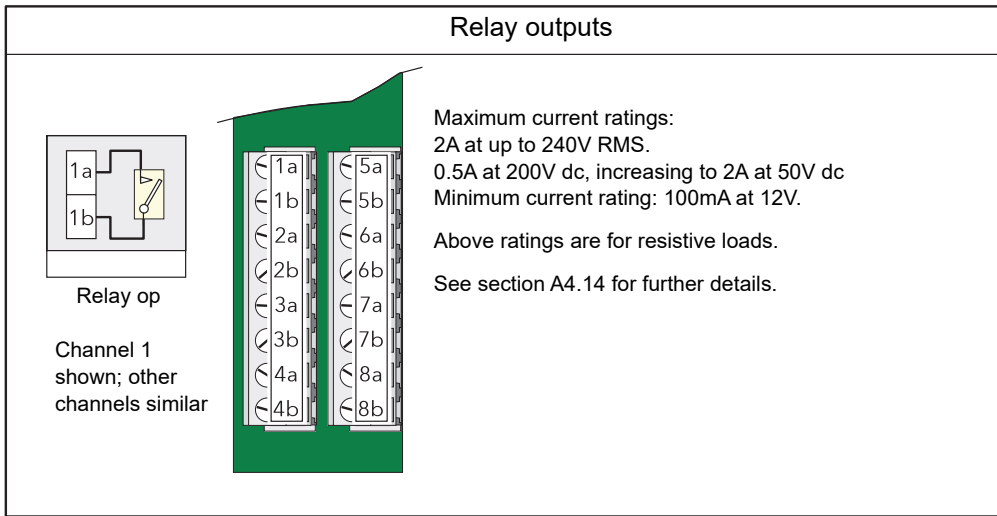


Figure 46 RLY8 module pinout

Status Indicators

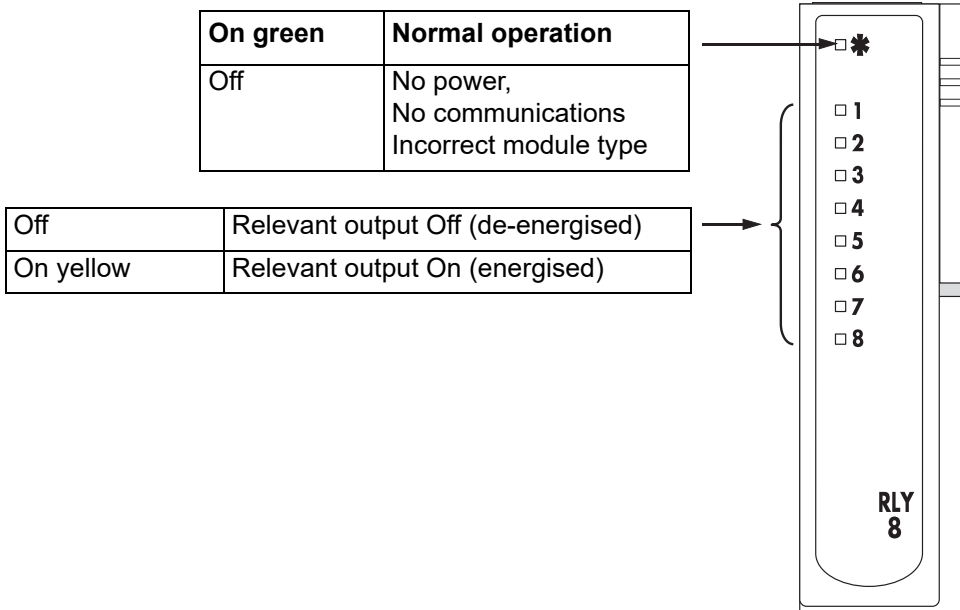


Figure 47 RLY8 status indicators

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.

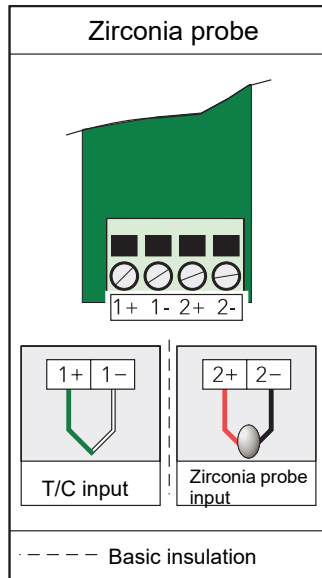
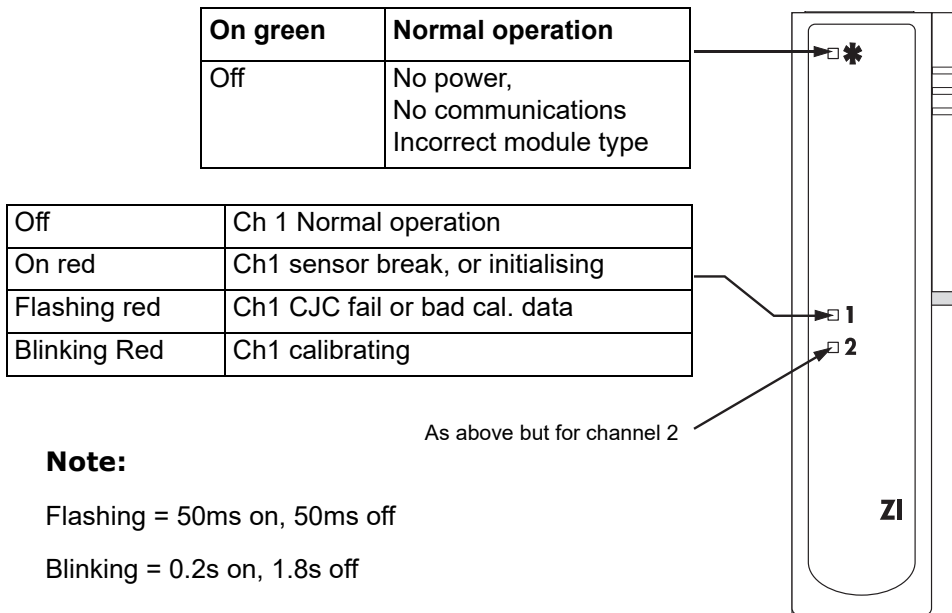


Figure 48 ZI Module pinout

Status Indicators



Note:

Flashing = 50ms on, 50ms off

Blinking = 0.2s on, 1.8s off

Figure 49 ZI module status indicators

For further details of the Zirconia probe and its applications, see "B2 Zirconia Input Module Details" on page 213.

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 50 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.

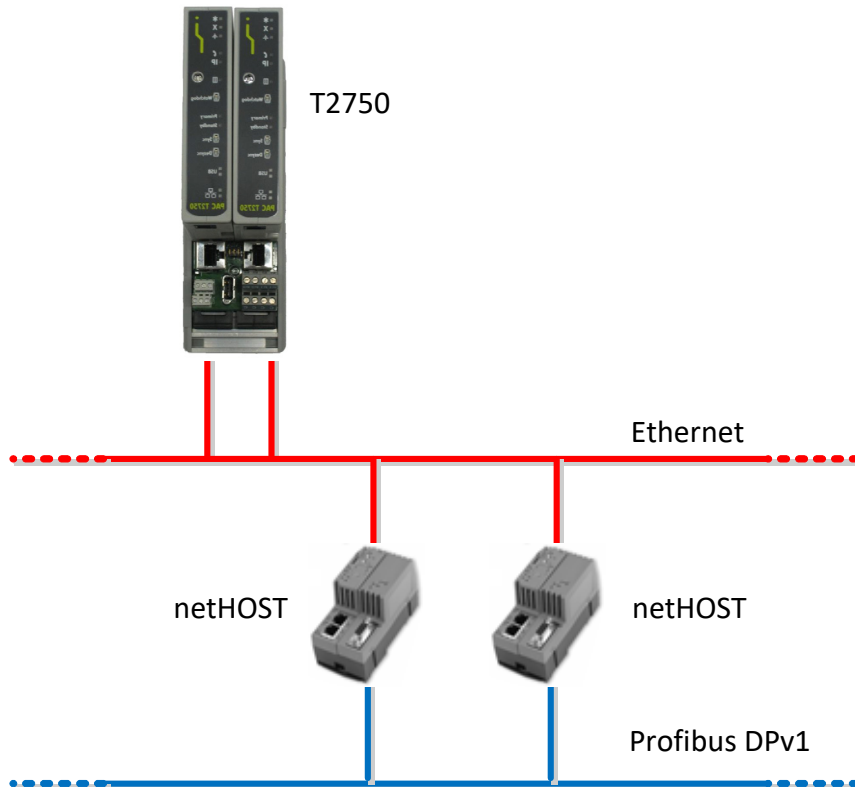


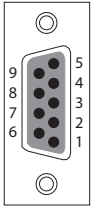
Figure 50 Typical netHOST Ethernet wiring

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.

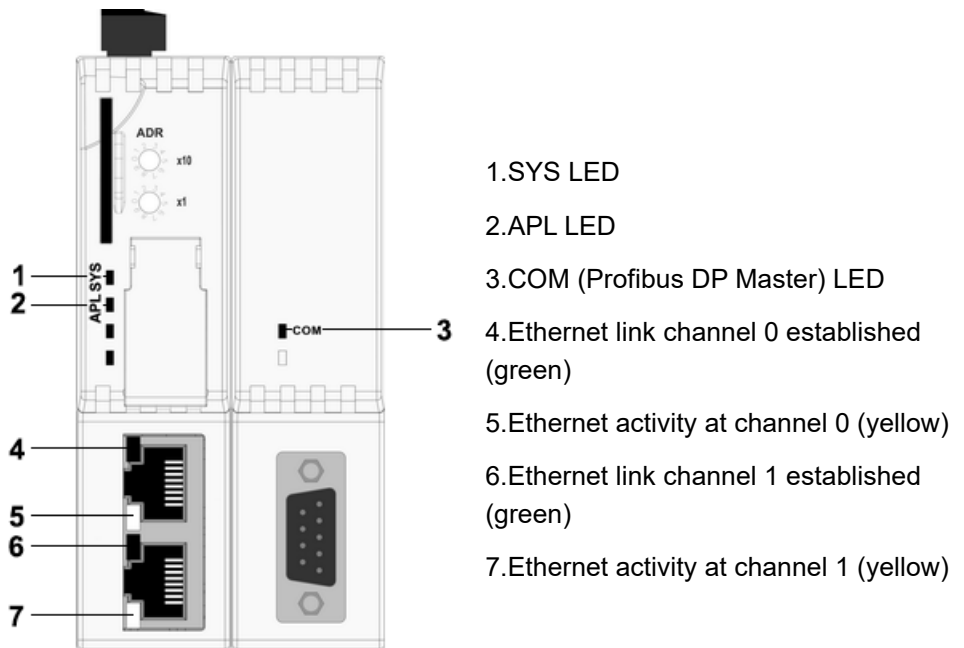


Figure 51 netHOST status LEDs

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.

Hardware Configuration

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 52 shows the detail.

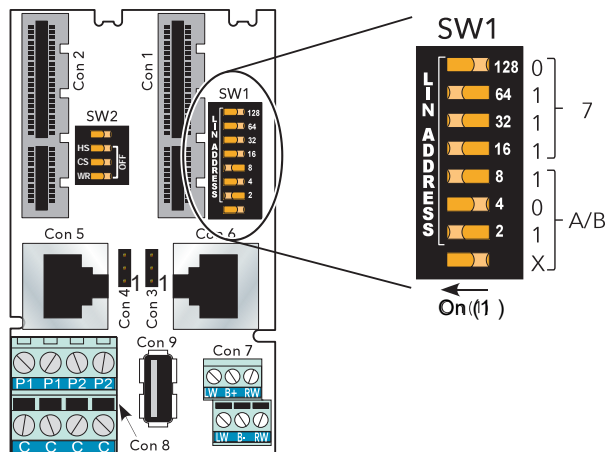


Figure 52 LIN Address setting

LIN Option Switch

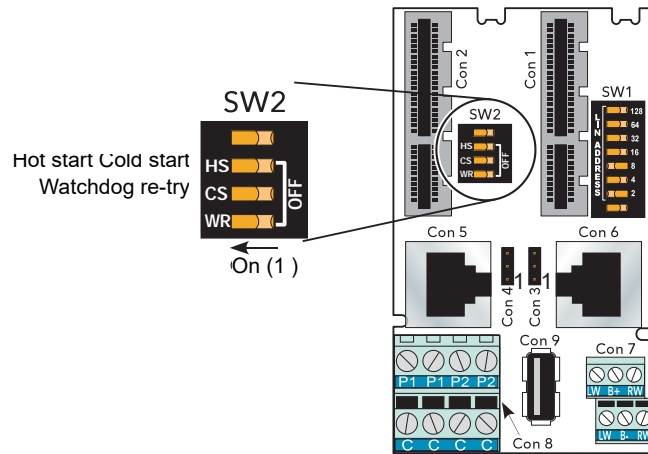


Figure 53 LIN option switch

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 Figure 54, 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.

Figure 54 Start up strategy setting switches

- 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.

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 61 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 startup, 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.

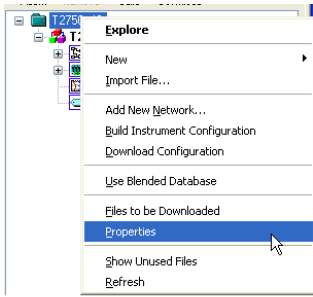
The Link-Local algorithm ensures that an instrument (IP host) on a network chooses a unique IP Address from the Link-Local range.

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.

Setting Procedure

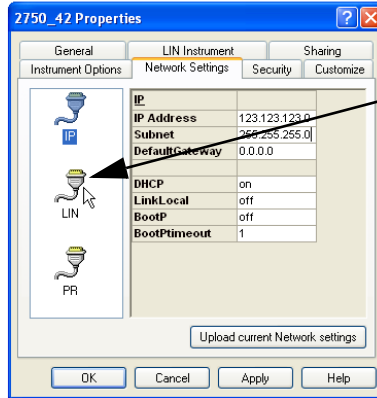
It is assumed that LINtools has been started and a suitable project folder and instrument folder have been created. It is also assumed that communications have been successfully established between the instrument and the host PC. If this is not the case (for example, a brand new instrument with no project or instrument folder defined), refer to the next section, "Setting Procedure (First Use)" on page 62.

1 Right click on the Instrument folder



2 Left click on 'Properties'

3 Left click on 'Network settings' and enter IP address details or select 'DHCP' etc. as required. Use 'Apply' to download the new settings to the instrument. Click on 'Upload current...' to view current settings



4 Left click on 'LIN' if required



Figure 55 Access to IP address setting in LINTools

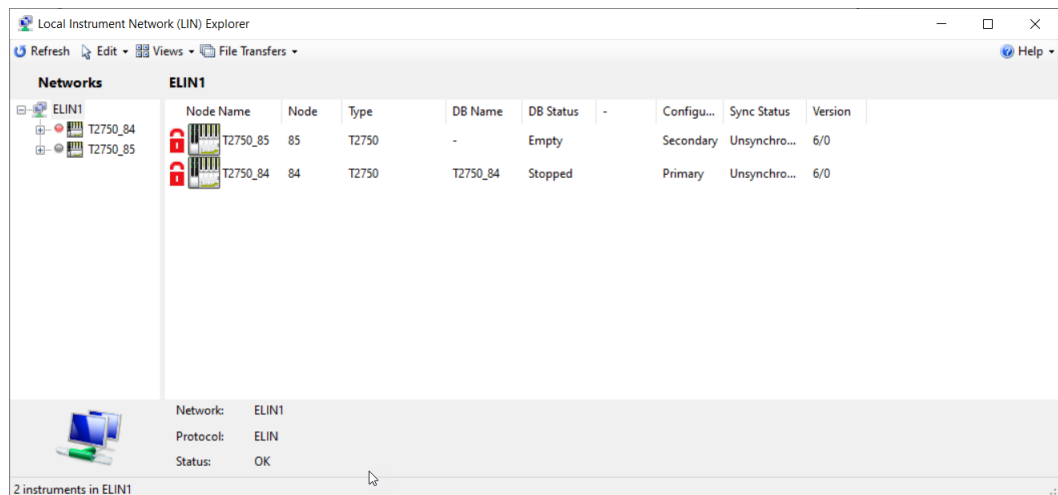
Setting Procedure (First Use)

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.

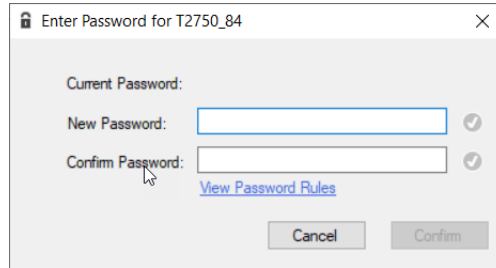
If the T2750 is new, the default network settings (DHCP with Link-Local as a fallback) will be set at the factory. If DHCP is an acceptable method of initially assigning the instrument with an IP address, then a DHCP server will be required to assign an IP address. Ensure the PC is on the same network 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.

Note: The red padlock next to each instrument indicates that the Instrument Password has not yet been set for that instrument. A password **MUST** be set before the instrument can be accessed. A dedicated point-to-point Ethernet link should be used when first setting the instrument password.

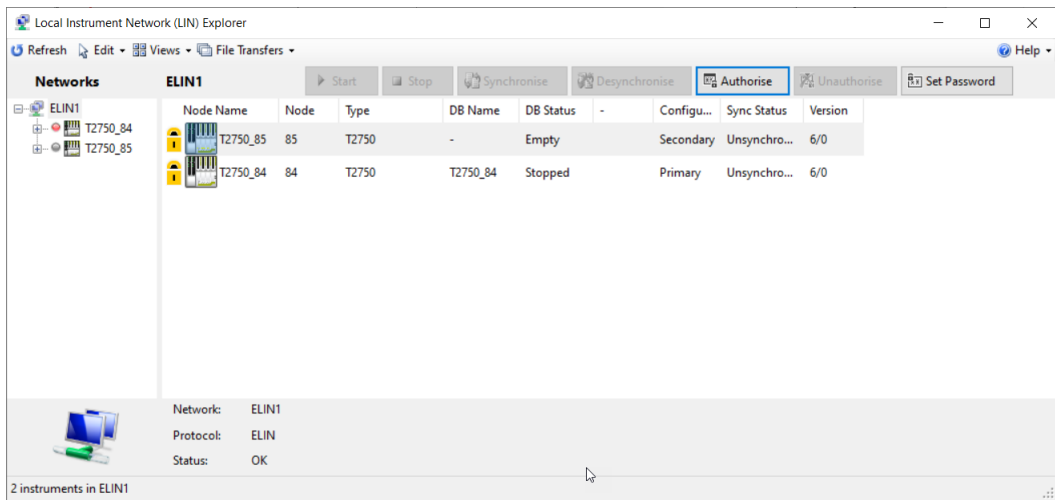


- Click on an instrument to highlight it and click 'Set Password'. The Enter Password dialog is displayed:

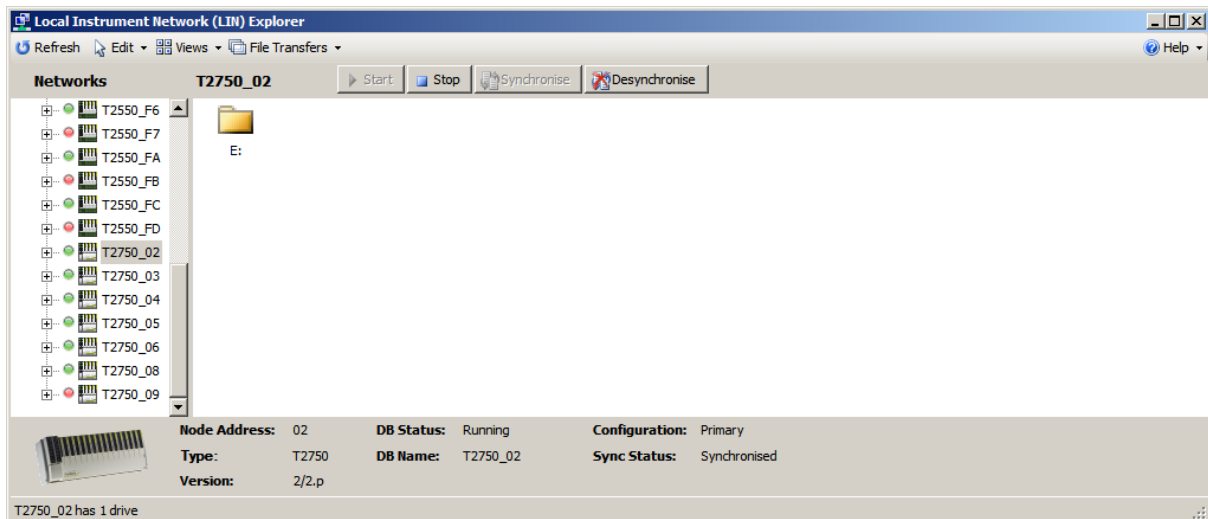


- Enter New and Confirm the Instrument Password, then Click 'Confirm'.
- The padlock changes to Yellow for each instrument with a password.

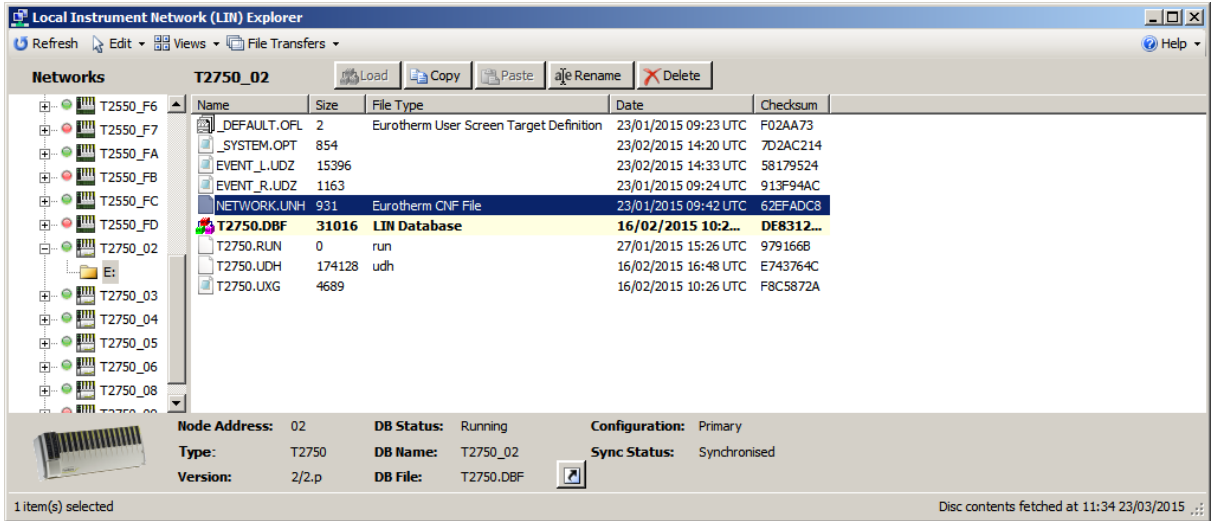
Note: The yellow padlock next to an instrument indicates that the Instrument Password has been set for that instrument.



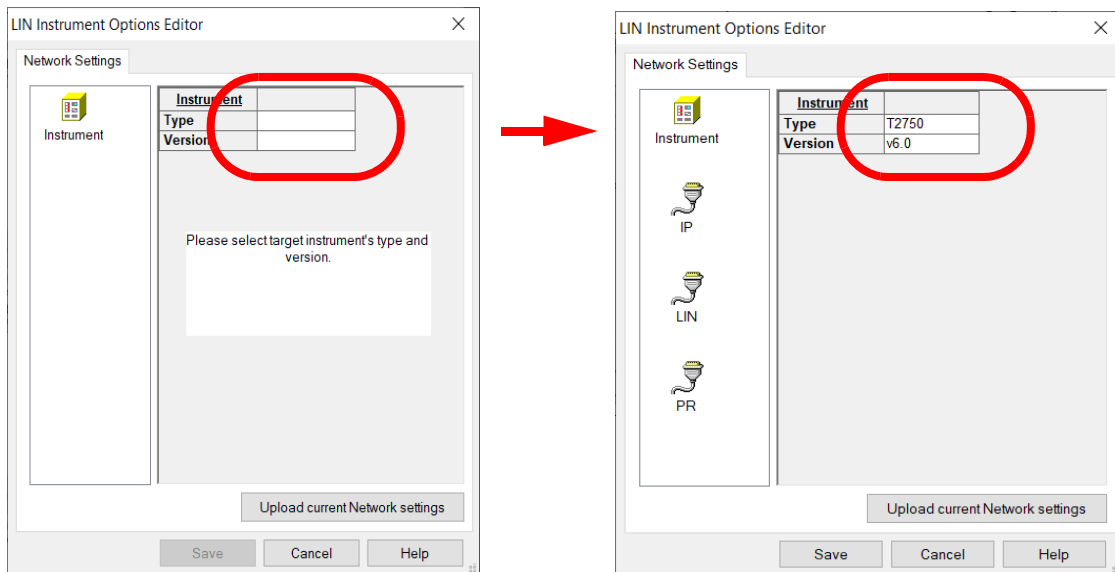
- The next step is to authorise the instrument. Click on the instrument to highlight it and click 'Authorise'.
- In the Authorising dialog, Enter the Instrument Password' and click 'OK'. After a short delay, the padlock changes to green. You can now access the instrument.
- Click on the instrument in the left column to be configured to reveal the instrument's E: drive. An example is shown in the following figure.



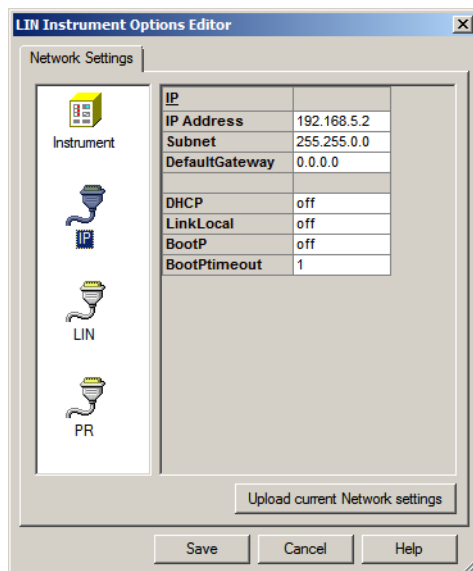
- 8. Double-click on the E drive folder for the instrument to view the contents of the drive.
- 9. Locate the network.unh file and drag the file to the computer desktop (or other memorable location).



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



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



12. Select the LIN tab and edit the LIN Protocol name if required.
13. Click the Save button and select No to the offer to download the new settings to the instrument.
14. Drag the network.unh file from the 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 "LIN address" on page 52 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)

                                     Drag scroll
                                     bar down
>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 to confirm the changes. Press Y to save the changes, or N if not.
7. Once the changes have been confirmed, turn off the T2750. The LIN Node address should then be restored at SW1 on the IOC terminal unit. Finally, re-power the T2750 for the IP address changes to take effect.

Note: If the Instrument Password is not known, or has been forgotten, refer to Appendix E Recover Lost Password for details of resetting it.

Whitelisting a PC

It is necessary to 'whitelist' any PC that requires runtime data communications with the instrument. By doing this, the PC will always be authorised for the instrument for which it is whitelisted. Whitelisting is carried out using the Instrument Options Editor (part of LINtools).

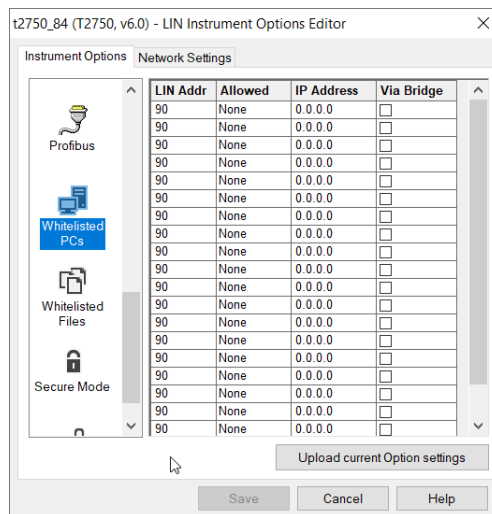
Notes:

1. Runtime communications between controllers does not require whitelisting.

- When a computer has more than one LIN Address then the correct address need to be chosen to be added to the whitelist. Only the address (or addresses) that is being used to communicate with the instrument needs to be added. It is possible that more than one LIN Address from a single computer is being used to communicate with an instrument, e.g. one address might be reserved for tools access and another could be used for runtime access. In that scenario the LIN Address being used for tools access would not be expected to be whitelisted. It is also valid, if required, to add multiple addresses from the same computer (same IP Address but different LIN Address) to the PC whitelist.

To whitelist a PC:

- In LINtools, right-click on the instrument in the left-hand tree view.
- Select Instrument Options from the context menu. The LIN Instrument Options Editor is displayed.
- Scroll down to display 'Whitelisted PCs'.



- Enter the required information. Check 'Bridged' if the PC communicates with the T2750 via a LIN bridge, rather than via a direct connection).

Note: The aspects that can given access to are set in the 'Allowed' column and are:

- None - no access is allowed.
- DB - blocks can be cached and values can be read from and written to blocks. For use with data servers in an HMI system.
- File - some files may be accessed (for example for use with File Synchronisation), see next section: Whitelisting file types.
- DB+File - both blocks and files can be accessed (see previous points).

- Click 'Save'.

Whitelisting file types

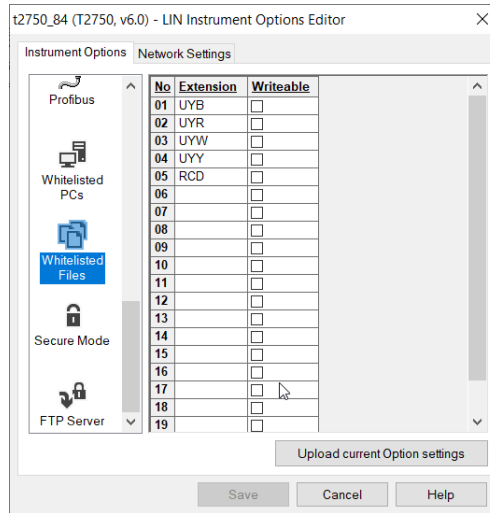
You can additionally specify which file types a whitelisted PC can access. This may be useful for File Synchronisation.

Note: It is only applicable if 'File' (or 'DB+File') is selected in 'Allowed', above.

To whitelist one or more file types:

- Display the LIN Instrument Options Editor as described in the previous section.

2. Scroll down to display the Whitelisted Files.



3. The five file types as displayed above are always whitelisted by default.
4. Enter other file types as required, up to a maximum of 20.
5. If you wish the PC to be able to write to a certain file type, click in the appropriate Writeable checkbox.
6. Click 'Save'.

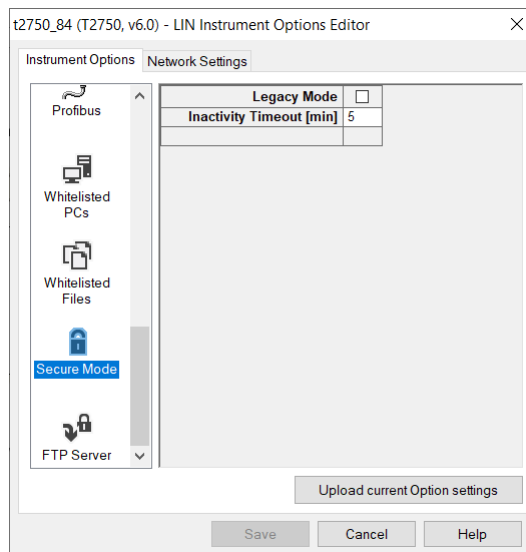
Secure Mode

You can implement Legacy Mode for an instrument which removes the need for authorisation and you no longer need to enter the Instrument Password.

If not in Legacy Mode, you can specify the timeout period (in minutes) of how long the system is left idle before authorisation (by Instrument Password) is removed.

To set these parameters:

1. Display the LIN Instrument Options Editor as described previously.
2. Scroll down to display the Secure Mode.

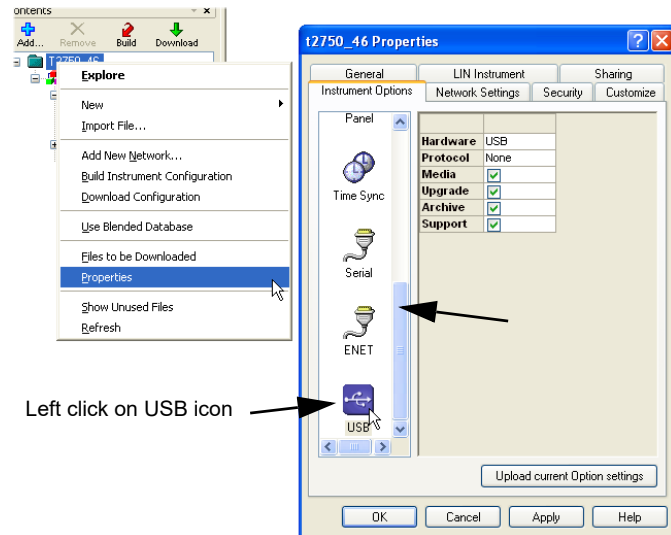


3. To set the instrument into Legacy Mode, click the checkbox.
4. If required, change the timeout period from the default 5 minutes.
5. Click Save.

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. |

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 isolated 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.

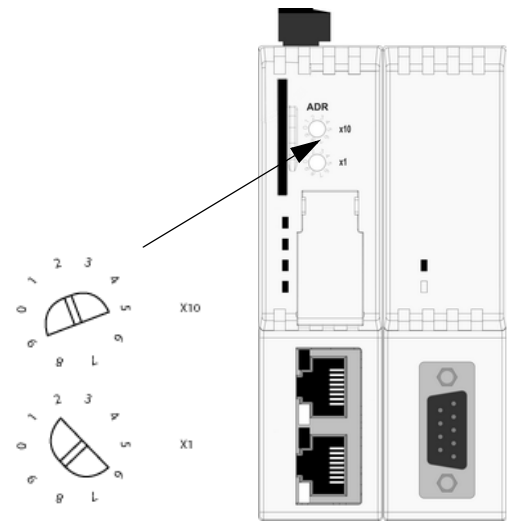
When the T2750 first starts the database file (*.dbf), it scans for all netHOSTs on the local subnet. From the responses, it identifies the netHOST(s) with the correct ADR setting and confirms the IP address is correct. If the IP address is unconfigured, the T2750 will automatically configure the IP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

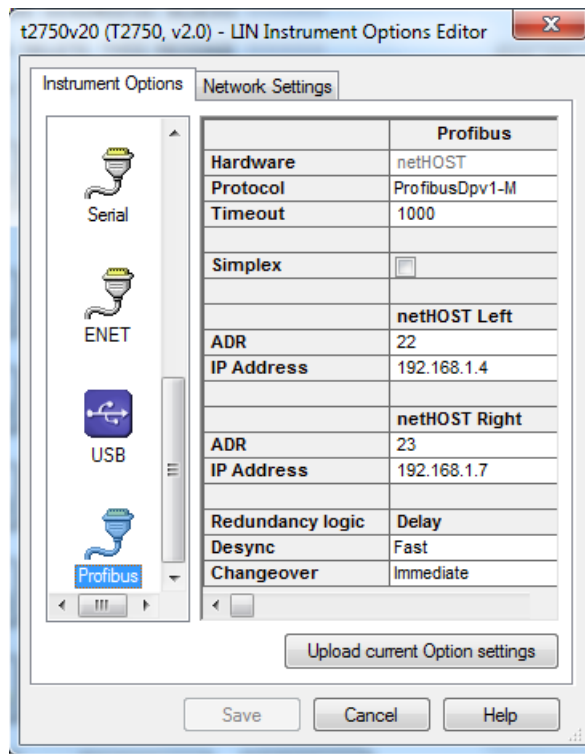


Setting the netHOST's IP Address

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 rightclicking 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 86.

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 functionality below also only applies if the Stay Sync'd option is not selected in the Startup tab of the Instrument Options Editor (if it is enabled, the T2750 will not desynchronise if the secondary IOC has a worse view of the Profibus network than that of the primary. Instead, the SecWorse parameter in the IDENTITY and RED_CTRL function blocks in the strategy - if they exist - will be asserted. The Stay Sync'd option is available in T2750 v4/0 and later). The three options, otherwise, 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 persists 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.

Operator Interface

Introduction

Figure 56 shows the IOC front panel LEDs and switches. Other modules' LEDs are described in "Electrical Installation" on page 31, above.

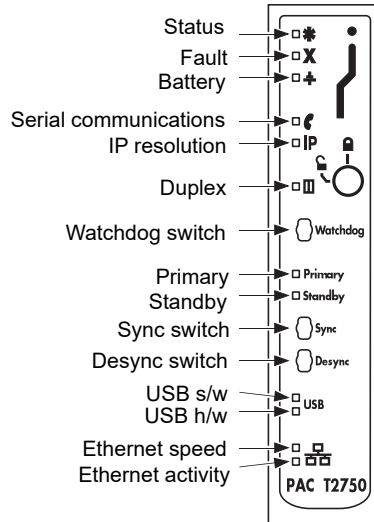


Figure 56 IOC LEDs and switches

LED Interpretation

See also "Power On Self Tests (POSTs)" on page 167 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 isolation (no IOC in other slot).
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.
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 the license level, or contact the supplier to request an additional license. Refer to Appendix B for details of function block licence levels.

Note: If there is a "password error" then the Fault (red) LED will be steady on; and the Battery, Comms & Duplex LEDs will be flashing. This has two possible meanings:

1. The instrument password is not set.
2. This is a duplex pair, and the partner is pre-V6/0 (i.e. does not support Instrument Password). This would normally only occur whilst performing a firmware upgrade of a duplex pair from pre-V6/0. Refer to "Upgrading Duplex Systems" on page 179 for instructions for a hot upgrade of a duplex pair. You will lose the security provided by Instrument Passwords if the partner is not replaced.

Switches

Watchdog	If the unit is in operating normally, or if the watchdog retry switch (LIN Option Switch (page 60)) 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 desynchronise, the Primary module remaining in control.

Operation of the secondary module 'Desync' switch for longer than three seconds causes the secondary module to shut down. When successfully shut down (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, having been synchronised and powered down together beforehand. Should either of these 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 takes a few seconds. If the file system contents are different, synchronisation can take much longer whilst the files are copied. During the synchronisation period, the primary runs the control process as normal.

Start-up

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.

Start-up Modes

Note: The instrument will not load a database if the instrument password is not set; it will enter the idle state.

The required start-up mode is selected using the 'Options' switch (SW2), described in "LIN Option Switch" on page 60, above. This allows 'Hot', 'Hot/Cold', or 'Cold' to be selected, using two elements of the switch. Figure 57 and Figure 58, below, shows a simplified flow diagram for the different modes.

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 "Hot/Cold Start" on page 81 (Hot/cold start).

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

```
(* 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;
```

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

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.

If the ResetOfI 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 three 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.

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.

Startup Flowchart

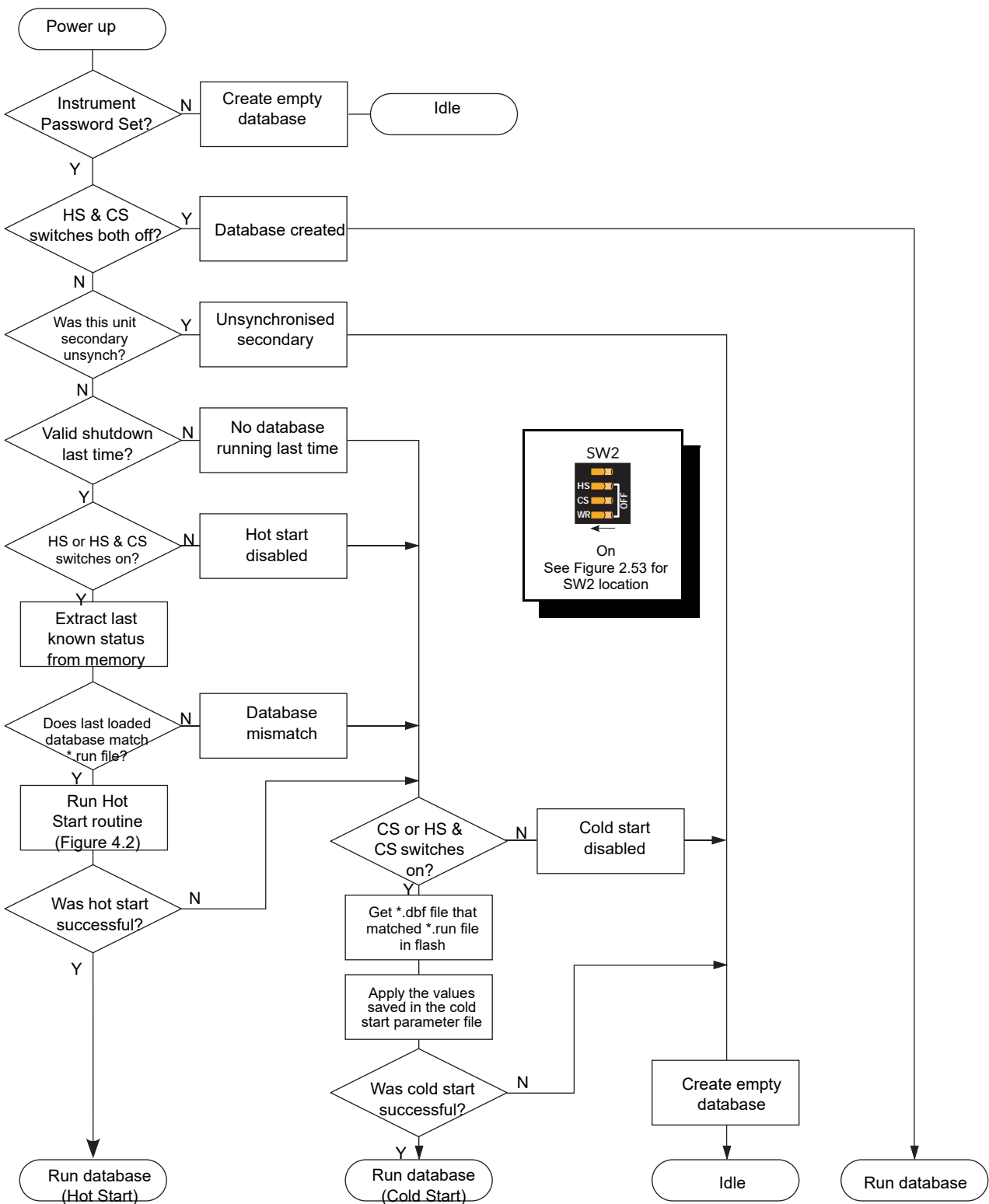


Figure 57 Simplified start-up flow diagram

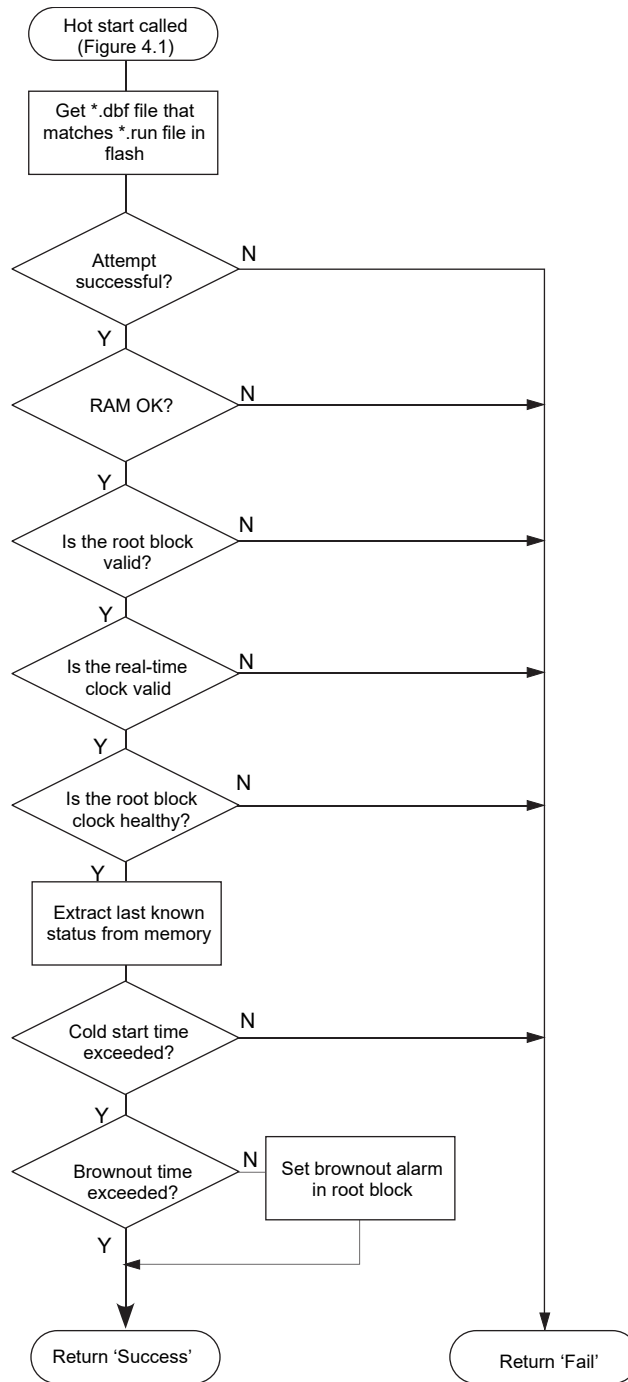


Figure 58 Hot or Hot/Cold start flowchart

Starting the IOC Modules

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

Start-up Routine

The Start-up routine is subject to the successful completion of the Power On Self Tests (POSTs) (see "Power On Self Tests (POSTs)" on page 167 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 "LED Interpretation" on page 75.

Watchdog Relays

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

Power-up Decisions

Figure 59 shows the states possible with a pair of modules in Redundant mode.

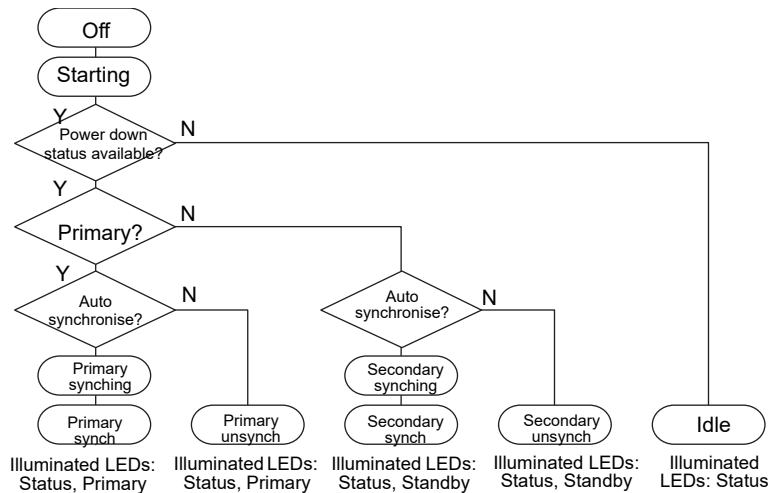


Figure 59 Power-up in redundant mode

CAUTION

If replacing an IOC module on a powered-down system (for example, during an intentional site shutdown), 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 "Redundancy Modes" on page 79 (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 non-volatile 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 or the supercap has insufficient power to retain valid SRAM data, a cold restart will be attempted (if configured). If a cold start is not configured, or fails, 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. The status of the Stay Sync'd option (configured using the Instrument Options Editor, Startup tab) is also taken into consideration. The Stay Sync'd option is available in T2750 v4/0 and above.

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, and the instrument's Stay Sync'd option is not enabled, then the primary and secondary modules desynchronise and a changeover does not occur. If the Stay Sync'd option is enabled, the primary and secondary modules remain synchronised and the SecWorse parameter in the IDENTITY and RED_CTRL blocks in the strategy (if they exist) are asserted to signify that the subsystem health of the secondary IOC is worse.
3. If the primary module believes that the secondary module holds a better outlook of the network, a changeover occurs. In addition, if the Stay Sync'd option is enabled, an automatic resynchronisation occurs and the SecWorse parameter in the IDENTITY and RED_CTRL blocks in the strategy (if they exist) are asserted.

If the communications status is unstable, the decision is debounced to prevent spurious desynchronisations or changeovers occurring whilst faults are introduced to or removed from the network. During this debounce period, there is no desynchronisation or changeover operations.

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 61](#), 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 61 for details on how to change these settings. In addition, the Stay Sync'd option (configured using the Instrument Options Editor, Startup tab) is taken into consideration as to whether a desync will occur if the secondary Profibus health is worse. If this is not enabled, then the functionality below will occur. If Stay Sync'd is enabled, the IOCs will remain synchronised even if the Profibus health in the secondary IOC is worse. If this happens, the SecWorse parameter in the IDENTITY and RED_CTRL blocks are asserted.

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 the 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 still 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). If the Stay Sync'd option is enabled, a Desync will not occur if the subsystem health (Profibus or ELIN, for example) in the secondary IOC is worse. If the subsystem health in the Primary is worse, a changeover occurs but then automatically resynchronises (and asserts the SecWorse parameter).

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. Similar to the 'fast' setting above, if the Stay Sync'd option is enabled, a Desync will not occur if the subsystem health (ELIN or Profibus, for example) in the secondary IOC is worse. If the subsystem health in the Primary is worse, a changeover occurs but then automatically resynchronises (and asserts the SecWorse parameter).

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. With this option selected, no SecWorse enunciation is possible (when the Stay Sync'd option is enabled) because the subsystem health is not monitored and no decision can therefore be made.

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 ("Switches" on page 76). 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. The instrument password is copied from Primary to Secondary.
3. Instructs the secondary module to load the relevant database.
4. 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, and redundant operation starts with the IOC Modules in their synchronised states.

Note: 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 takes just a few seconds. 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.)

ELIN Communication Modes

Note: No configuration or cached block communication is possible until an Instrument Password has been set.

The general principle is that access via any HMI (PC based) must be authenticated but is otherwise unrestricted.

If, however, it is whitelisted, then DB connections are permitted when not authenticated. Additionally some whitelisted PCs will have limited file system access.

Access from remote instruments does not need to be authenticated but is restricted to those operations appropriate to strategy execution.

ELIN Mode is managed individually for each remote LIN node. For example, dual redundant data servers are managed separately so both must be whitelisted. Each computer where configuration tools are used is also managed separately and users must enter the password at each computer as they use the tools

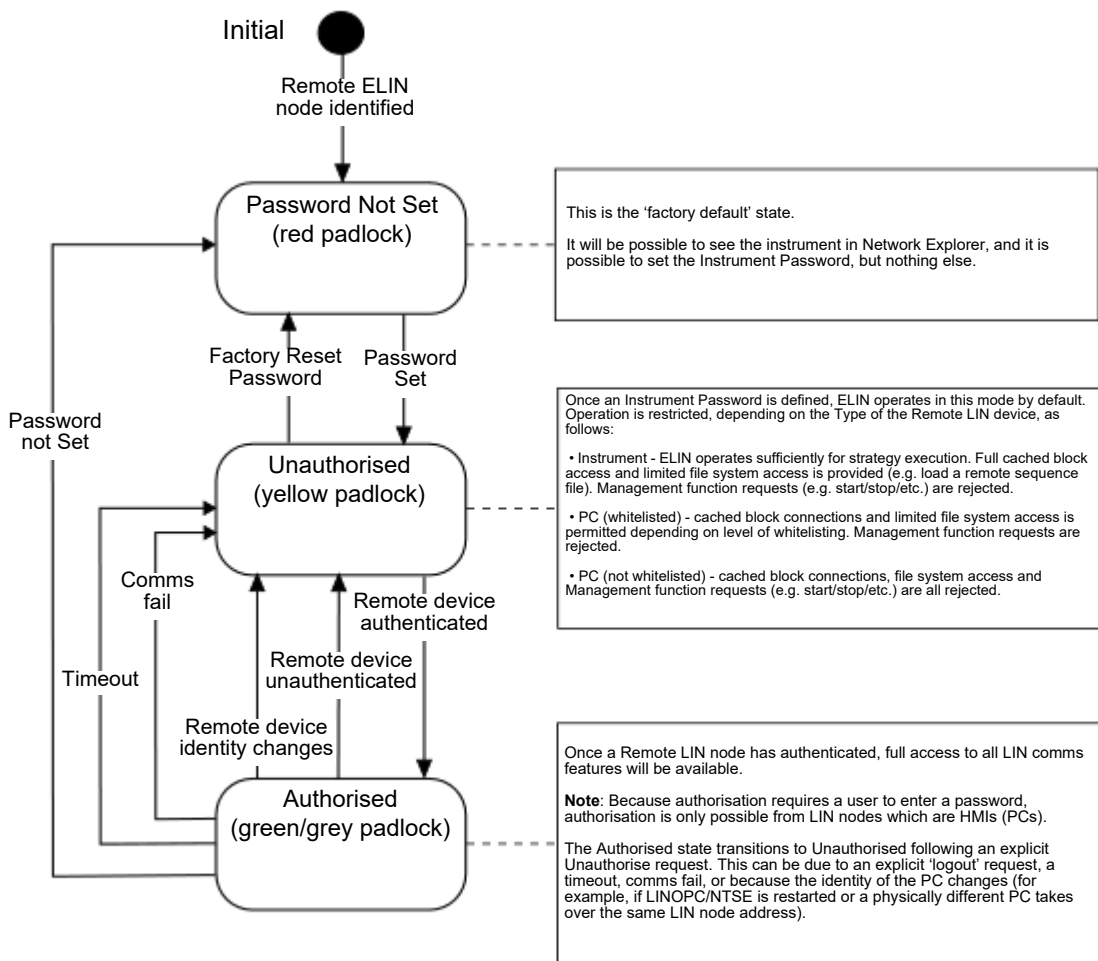


Figure 60 ELIN Mode State Machine

Configuration

Automatic I/O Build and Configuration Tools

Note: This won't work if the instrument password has not yet been set.

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' ("LIN Option Switch" on page 60).

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 or Profibus communications protocols (see Communications Manual). Modbus Tools (part of LINtools) is used to configure the Modbus parameters, and Profibus Master Configurator is used to configure Profibus.

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_OF).
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 Figure 61.
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

Block Type	Naming Convention	Description
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'		

Figure 61 Naming convention used by automatic I/O build

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 "LIN Option Switch" on page 60, 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 ("SD Card Failure Detection" on page 168) function blocks.

The LIN Database runs automatically. The database is unnamed until:

1. it is 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. 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

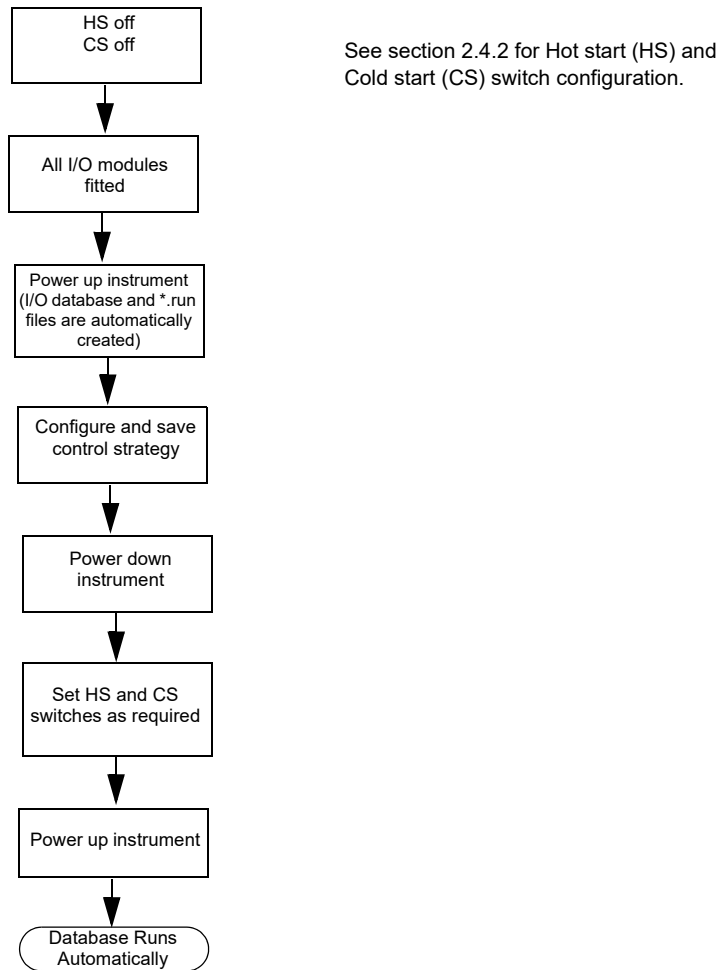


Figure 62 Automatic I/O generation routine

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').

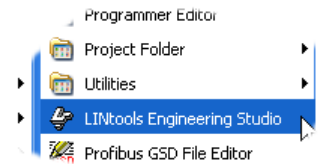
Starting LINtools

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.

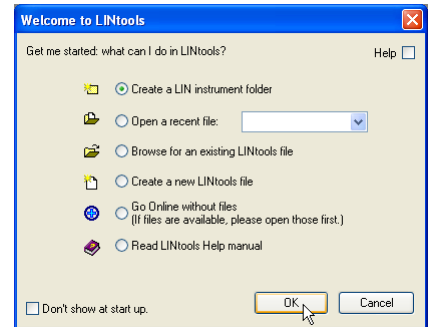
1. Press Start/All Programs/....LINtools Engineering studio....



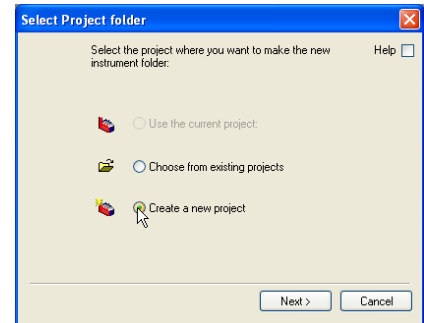
2.or double-click on the desktop short cut.

LINtools starts

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

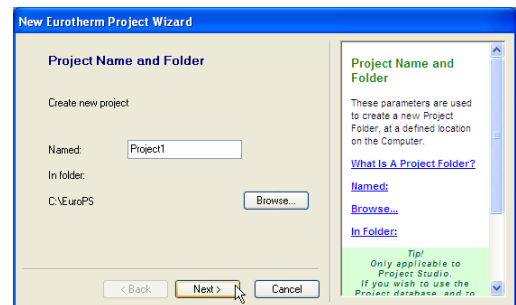


4. Click on 'Create a new Project', then on 'Next'.



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

6. Click on 'Next'.



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

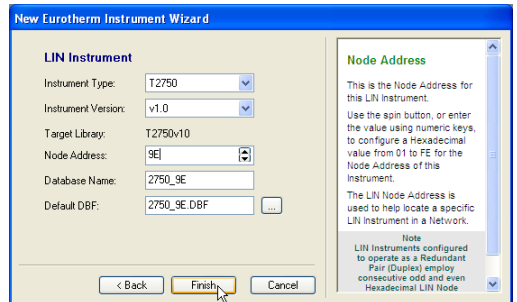
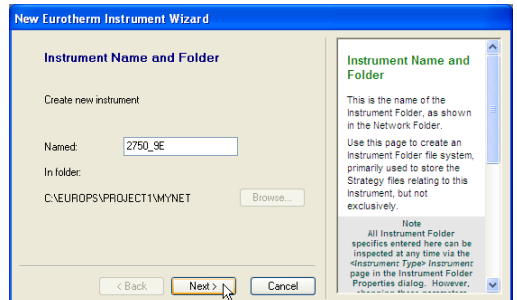
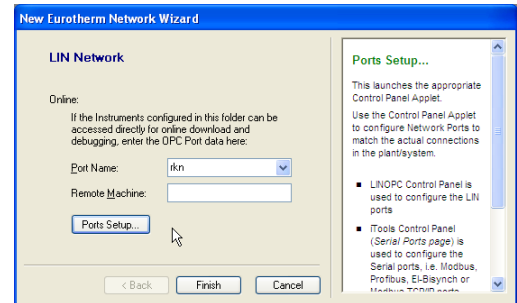
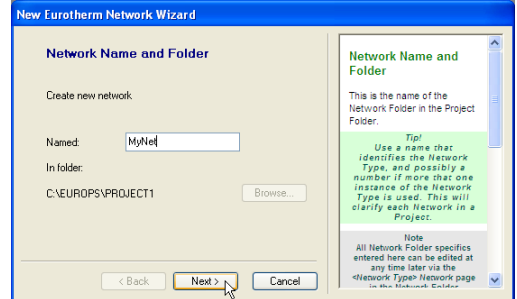
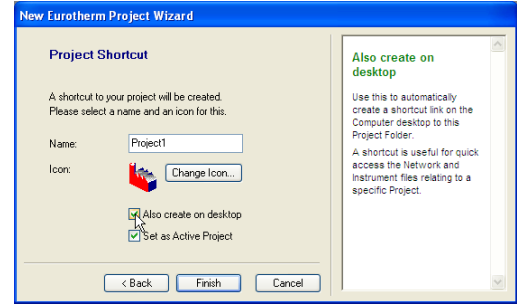
7. Select a different icon from the drop-down menu, if so desired.
8. Click on 'Finish'.
9. Enter the name of the network on which this instrument is to reside.
10. Click on 'Next'.

11. Select the port name for this network. (If it doesn't yet exist, it can be created by clicking on 'Port setup...') and Adding the new port.)
12. Click on 'Finish'.

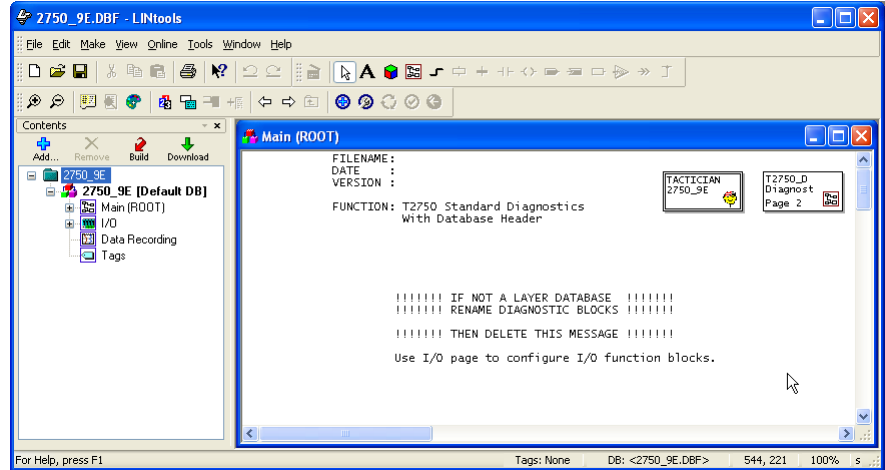
13. Enter an instrument name. Click on 'Next'.

14. 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 dropdown menu.) Fill-in the remaining instrument details.

15. Click on 'Finish'.



- 16. 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 "LIN Address" on page 59.

MODBUS Tools

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.

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.

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.

Figure 63 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).

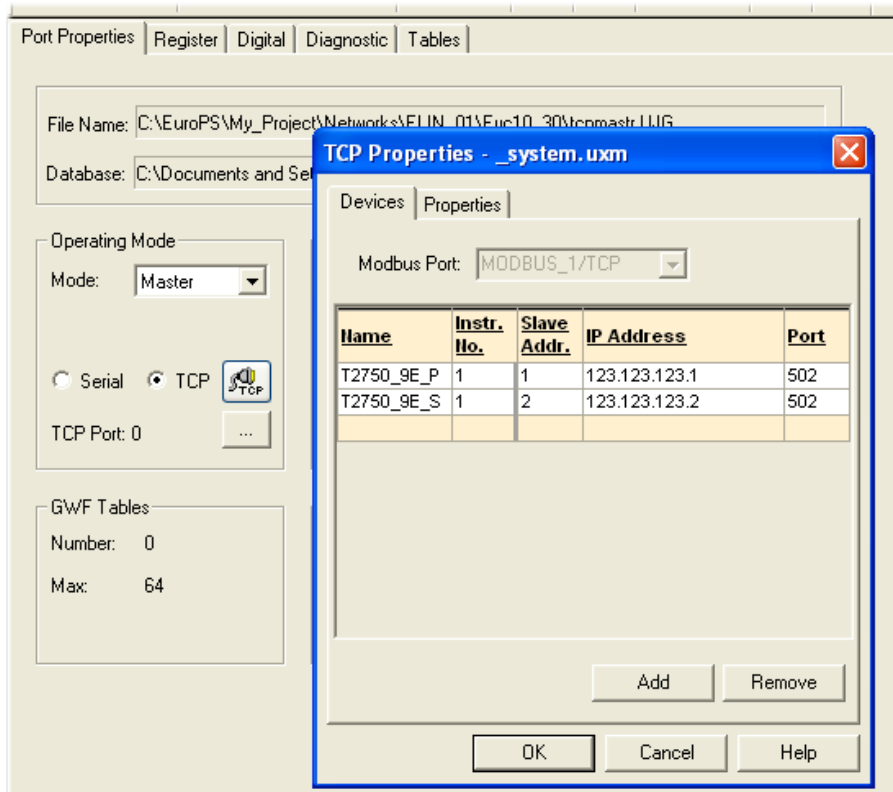


Figure 63 TCP properties

Profibus Configuration

Introduction

This instrument may be configured as a Profibus master when used with the optional external netHOST gateway units. Up to two netHOSTs are required, depending on whether one or two IOC modules are installed.

Interface from the netHOST to the T2750 is via IP over Ethernet. Further information about the netHOST can be found in the following places in this manual:

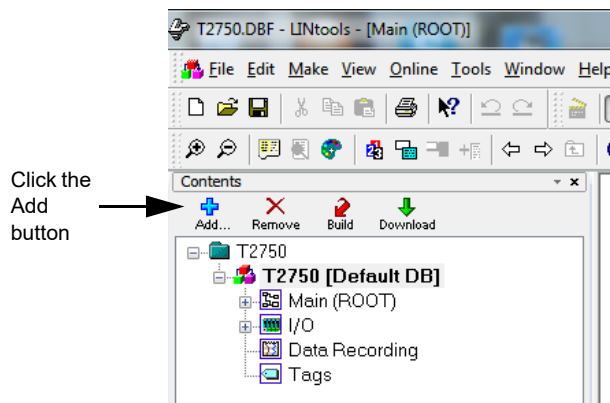
- For information about the physical installation of the netHOST, refer to "Installing the Optional netHOST Gateways" on page 30.
- For information about the wiring of the netHOST, refer to "netHOST Profibus Master Gateway" on page 57.
- For information about configuring the netHOST address, its IP address, and redundancy logic, refer to "netHOST Profibus Master Configuration" on page 70.

The rest of this chapter will introduce how to launch the Profibus Master Configurator from within LINTools.

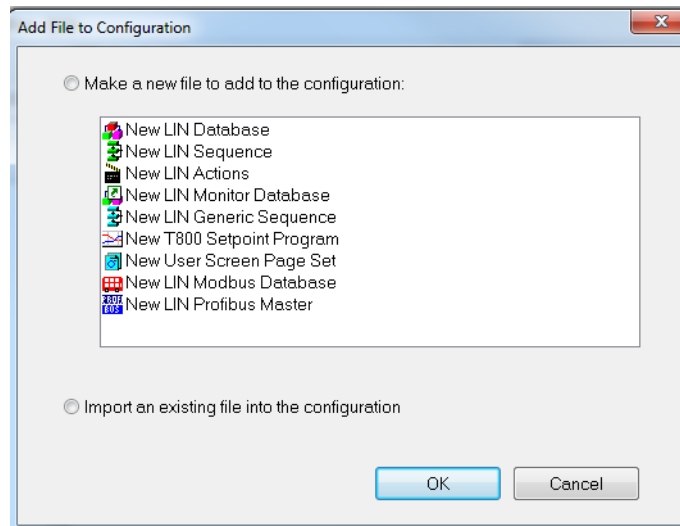
Launching the Profibus Master Configurator

To configure the Profibus Master configuration tool, LINTools must be running with a T2750 strategy loaded (an existing or a new blank one). Then follow the steps outlined below:

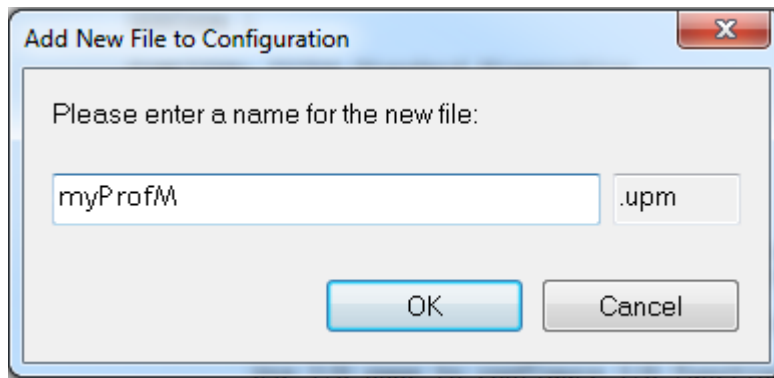
1. Under the Contents pane on the left of the LINTools window, click the blue Add button.



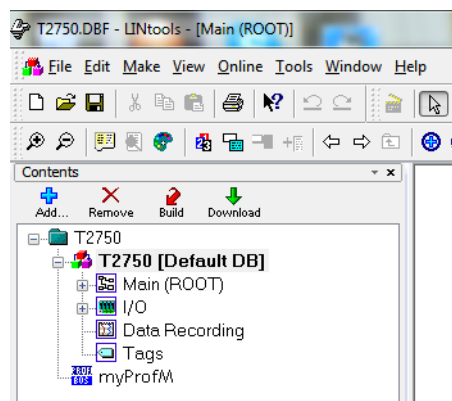
2. The Add File to Configuration dialogue box appears as shown below. Click the New LIN Profibus Master option from the list and click the OK button.



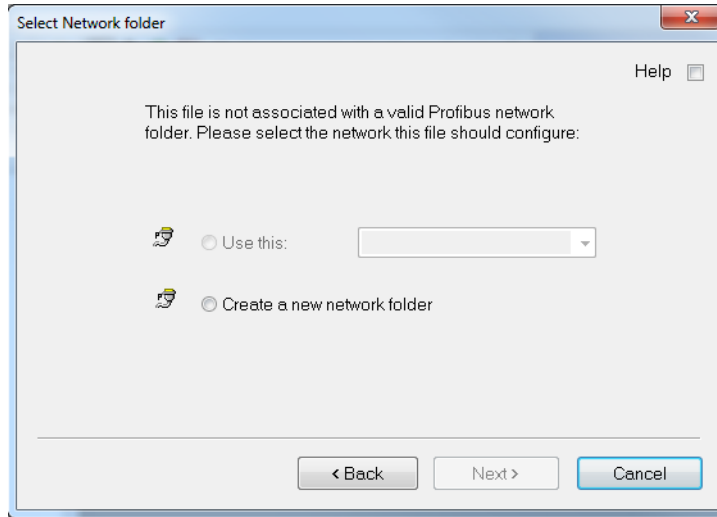
3. A dialogue appears so the new Profibus master configuration file (*.upm file) can be named. Enter an appropriate name and click the OK button.



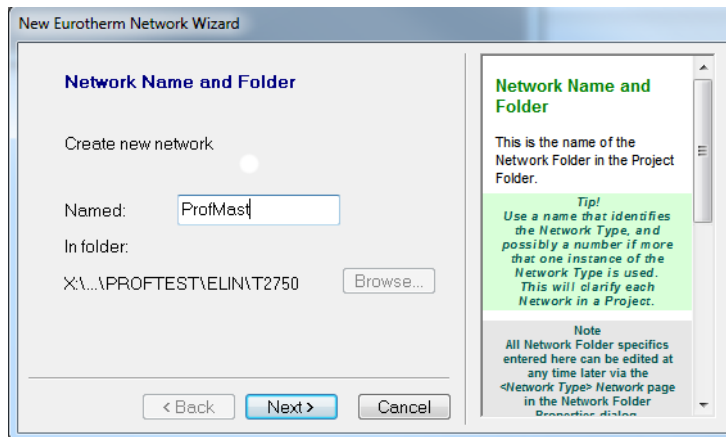
4. The Profibus Master file is added to the strategy as shown in the Contents pane on the left side of LINTools.



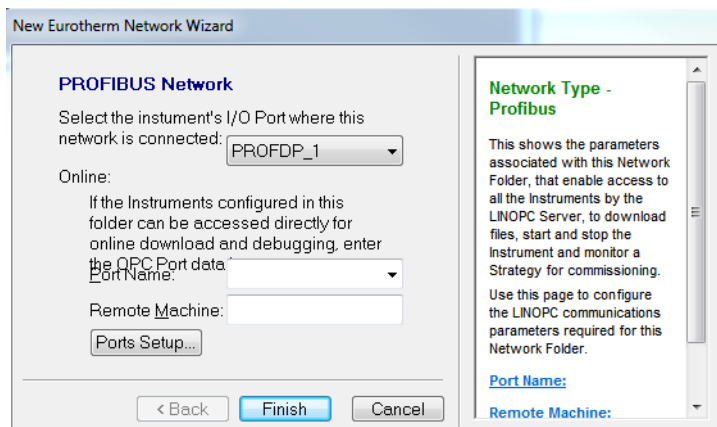
5. Double-click the new Profibus Master file in order to start associating the configuration to a valid Profibus network folder. The Select Network folder dialogue appears.



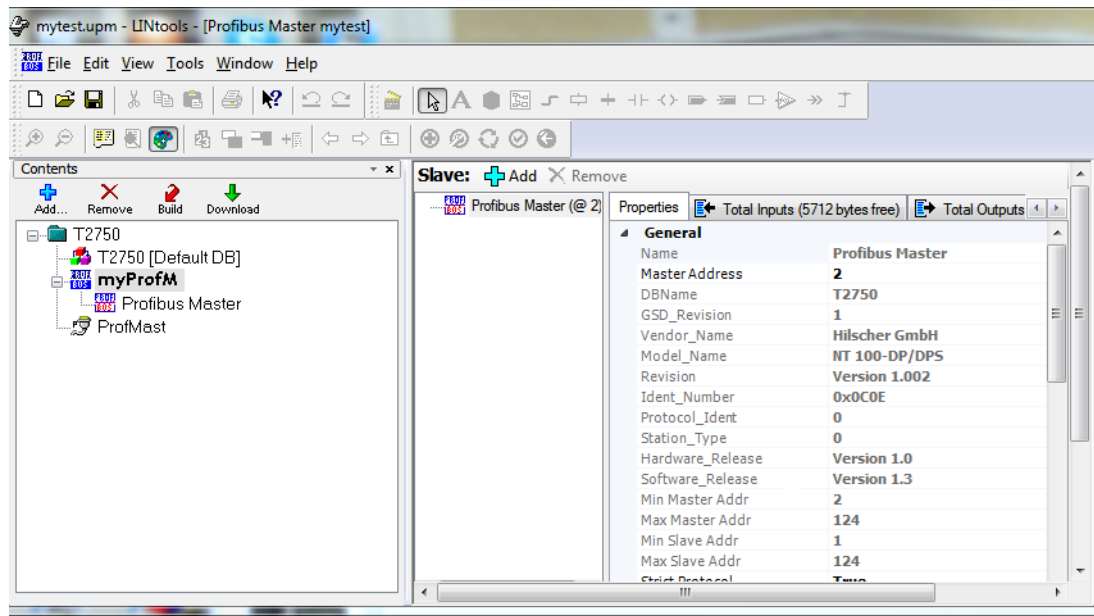
6. Choose the Create a new network folder option and click the Next button to proceed.



7. Enter the name of the network (the example has use ProfMast) and if need be, use the Browse button to determine where the network folder is created. Then click the Next button.



- From this context, the New Eurotherm Network Wizard knows we are creating a Profibus network and has therefore selected the “PROFDP_1” option automatically. Click the Finish button to complete the network setup. The Profibus Master configuration tool appears.



Refer to LINTools help for further information with the configuration of Profibus.

Control Loops

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.

Temperature Control Loop Example

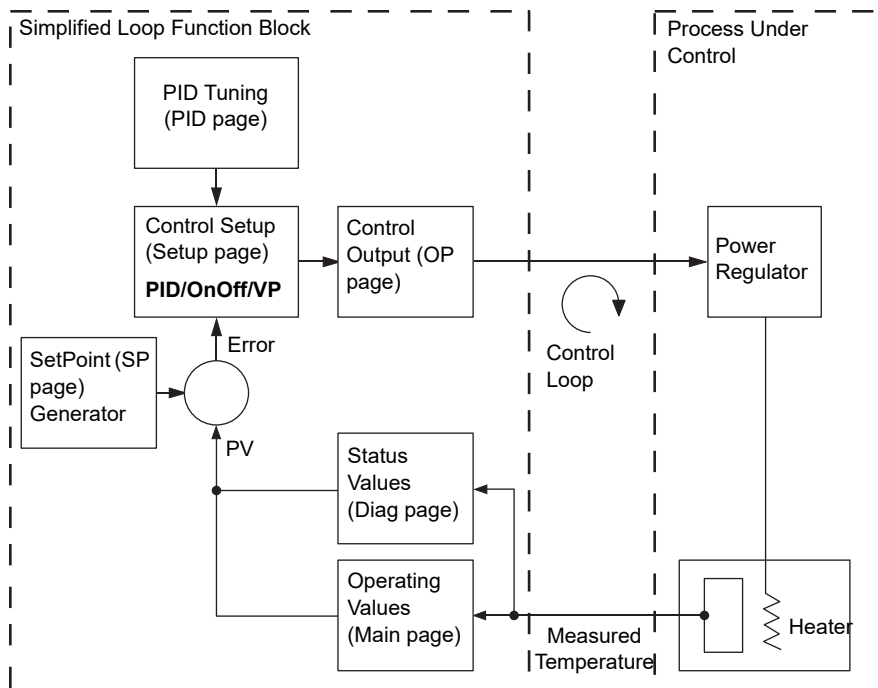


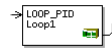
Figure 64 Single Loop, Single Channel Control Loop Block schematic

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.

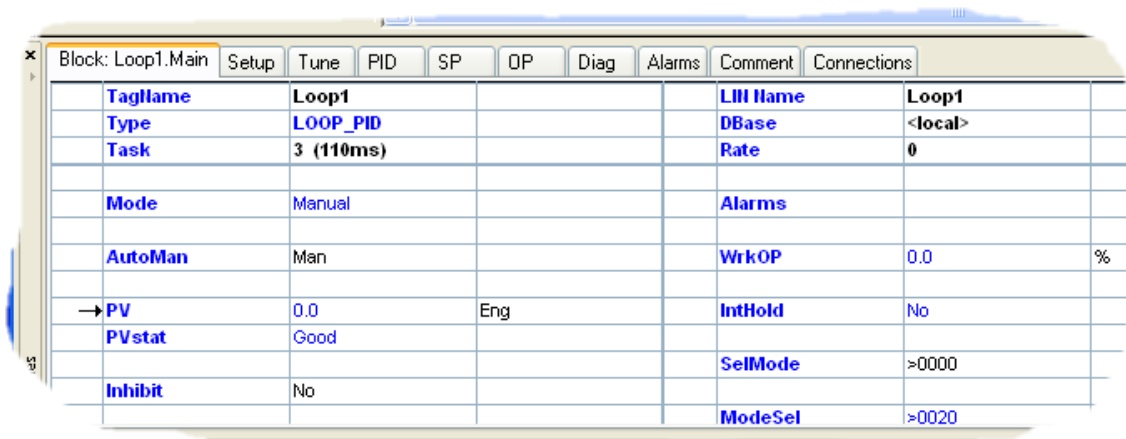
Loop PID Function Block



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 "Main Page" on page 102 for more details.
- Setup** Configures control type for each channel of the selected loop (Main Page (page 102)).
- Tune** Set up and initiate the Auto Tune function (Tuning Tab (page 108)).
- PID** Configures 3-term, Proportional Band, Integral Time, and Derivative Time (PID) control parameters (PID Tab (page 118)).
- SP** Select and adjust setpoint values, limits, and rates of change (SP Tab (page 122)).
- OP** Set up output parameters such as limits, sensor break conditions (OP Tab (page 125)).
- Diag** Control Loop status (Diag Tab (page 131)).
- Alarms** Alarm configuration (Alarms Tab (page 132)).

Parameters are software ‘wired’ using the LINTools Engineering Studio.

See "Control Loops" of the LINBlocks reference manual for full details of this block.

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. To 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
<p>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.</p>

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 ('Mode-Sel.FManSel' is 'True' and 'Mode' is 'F_Man') and the required output can be written to OP.ManOP.

'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 (OP Tab (page 125)). If an output rate limit is set, then the output ramps to the safe level at that rate, otherwise it performs a step change.
IntHold	If setpoint or manual tracking is enabled (in setpoint configuration (SP Tab (page 122)), Inhibit overrides tracking. 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 page 132 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 within 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.

Set Up Tab

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

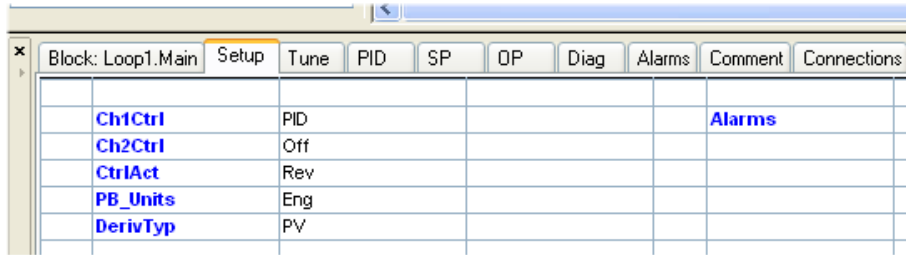


Figure 65 Setup tab

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 67.

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 66 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.

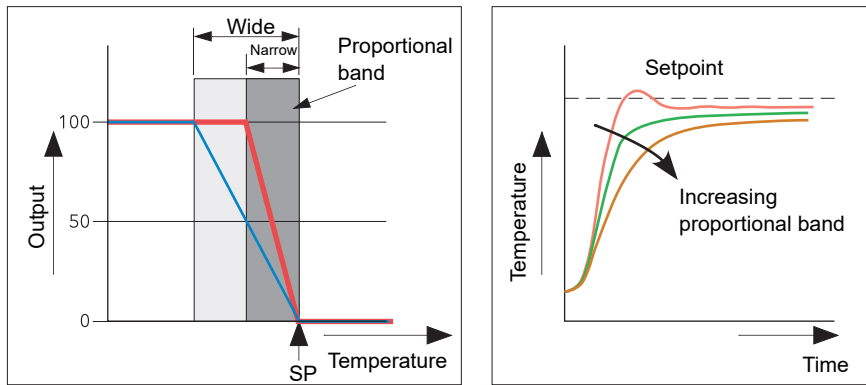


Figure 66 Proportional band action (reverse acting)

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.

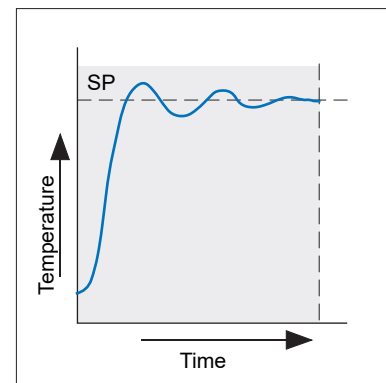


Figure 67 Proportional + Integral Control

Figure 67 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.

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.

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.

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.

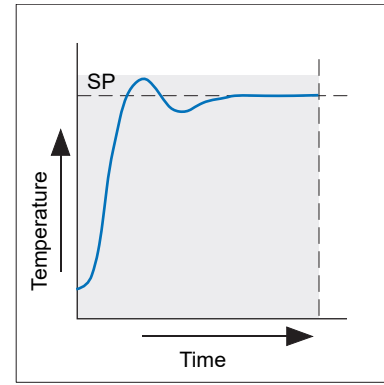


Figure 68 Proportional + Integral + Derivative

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.

Tuning Tab

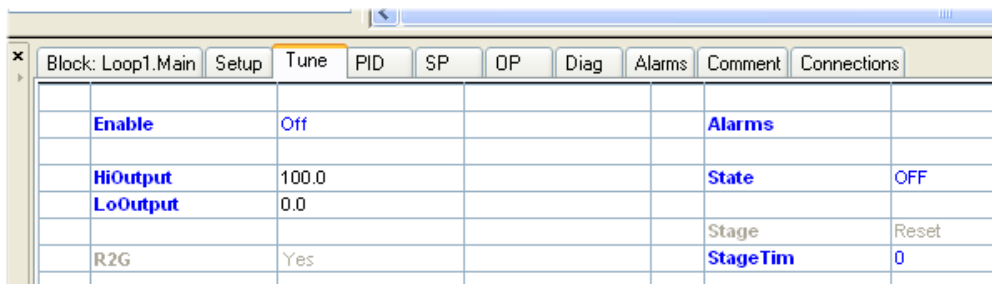


Figure 69 Tuning tab

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 (PID Tab (page 118)):

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 that:

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.

Note: 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.

Loop Response

Ignoring loop oscillation, there are three categories of loop performance: Under damped, Critically damped and Over damped, as described in the following paragraphs:

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 ([SP Tab \(page 122\)](#)).

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 ([PID Tab \(page 118\)](#)):

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 $1.6 \times PB$.
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' (PID Tab (page 118)) for more details. From firmware 4/0, the automatic derivation of R2G can be disabled by setting the R2G parameter on the Tune tab to 'No'.
LBT	Loop break time. Following an autotune, LBT is set to $2 \times Ti$ (if Ti was not previously set 'Off'), or to $12 \times Td$ (if Ti was previously set to 'Off').

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 (OP Tab (page 125)). 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'.

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.

Note: 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.

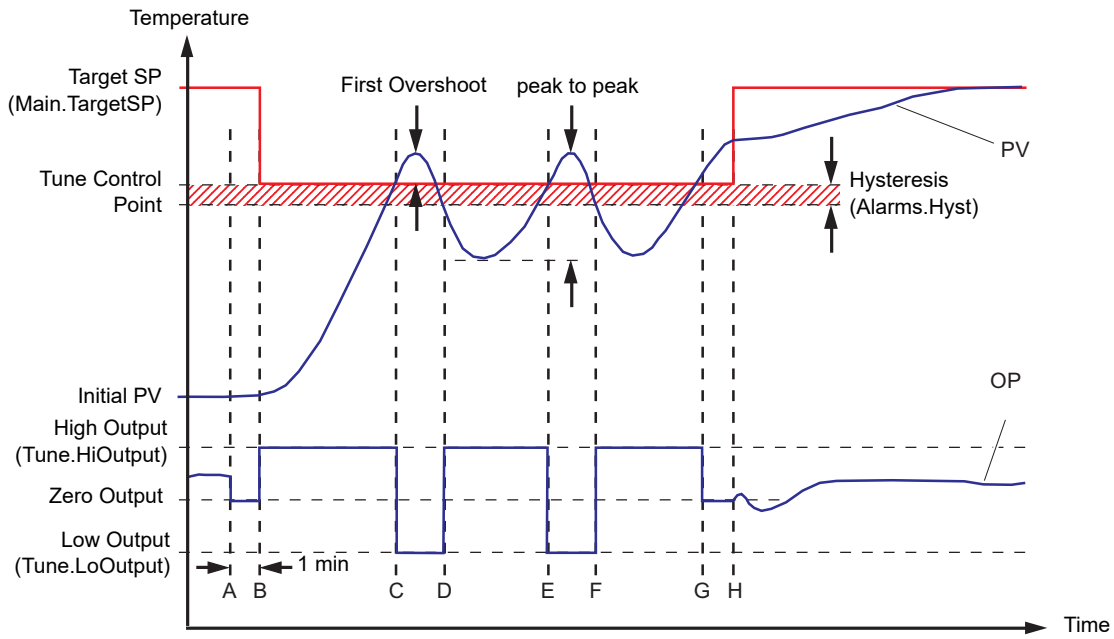


Figure 70 Tuning from below SP - Heat/Cool control loop

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 heatonly 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'.

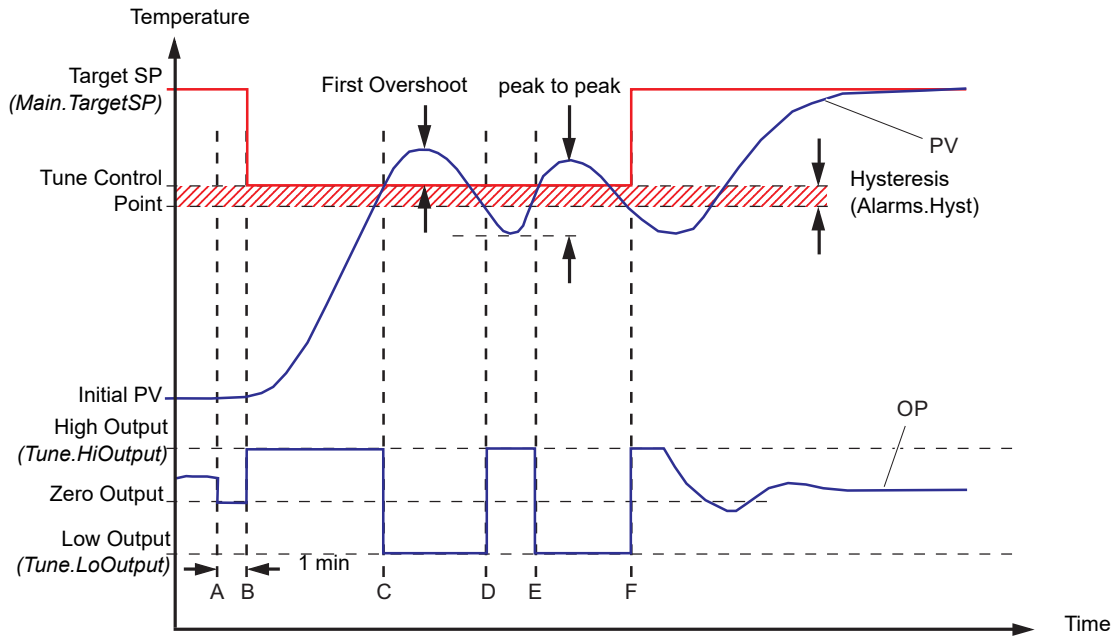


Figure 71 Tuning from below SP - Heat only control loop

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.

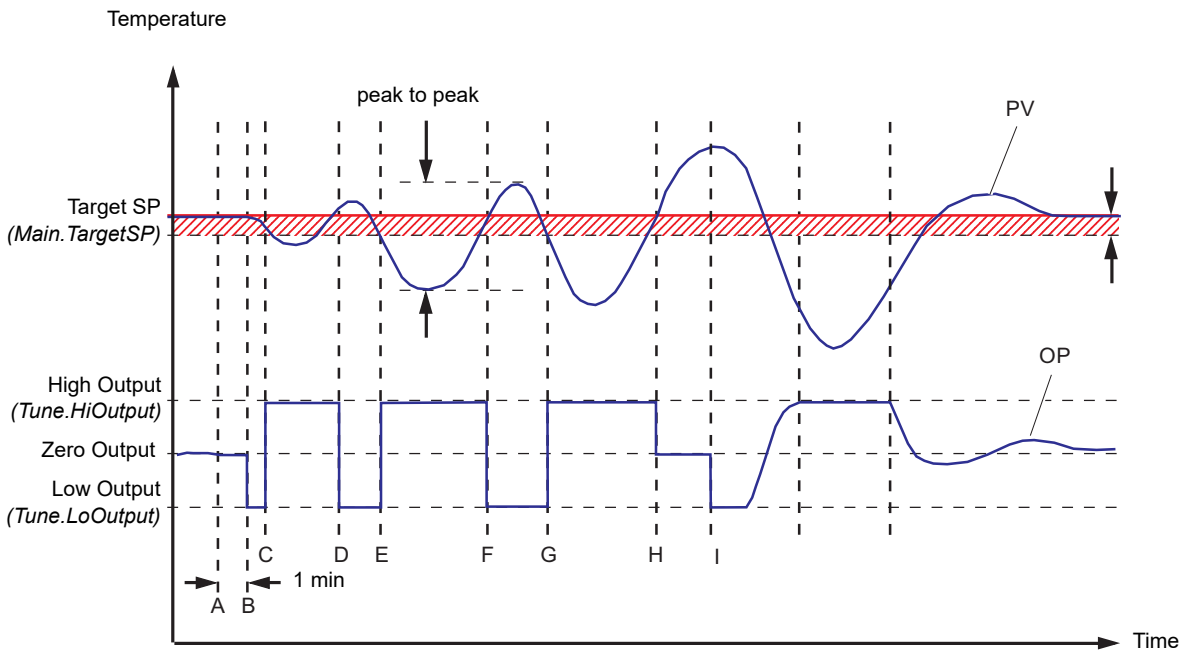


Figure 72 Tuning from below SP - Heat/Cool and Heat only control loop

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 6.11).
7. Set 'PID.PB', 'PID.Ti' and 'PID.Td' according to the table shown in Figure 73.

Control type	PID.PB	PID.Ti	PID.Td
Proportional only	$2 \times PB'$	Off	Off
P + I	$2.2 \times PB'$	$0.8 \times T$	Off
P + I + D	$1.7 \times PB'$	$0.5 \times T$	$0.12 \times T$

Figure 73 Calculate parameter values

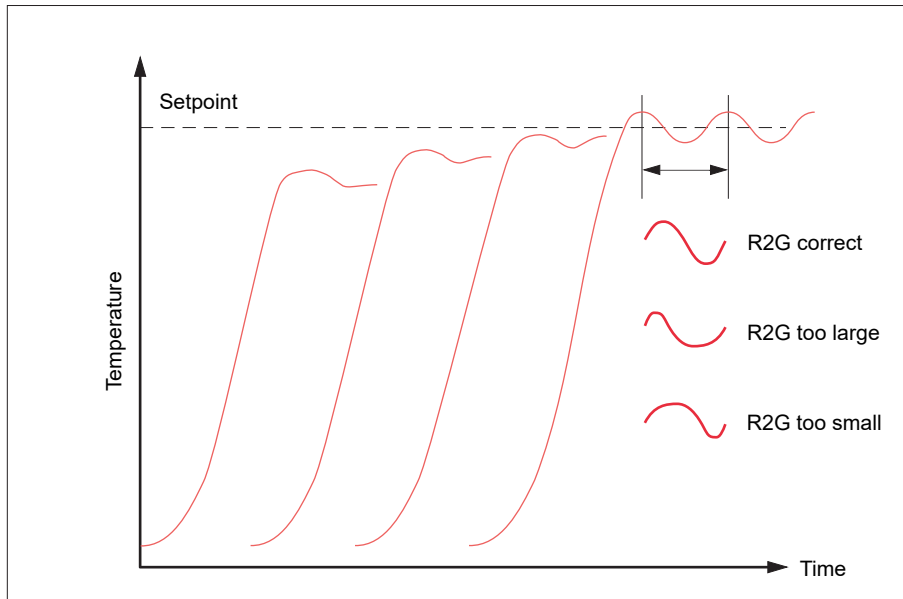


Figure 74 Relative Cool Gain waveform tuning

Cutback Values

The PID terms calculated from the table in Figure 6.10, 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:

$$PB/100 \times \text{Span of controller} = \text{Cutback High and Cutback Low}$$

For example, if PB = 10% and the span of the controller is 0 to 1200°C, then

$$\text{Cutback High} = \text{Cutback Low} = 10/100 \times 1200 = 120$$

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.

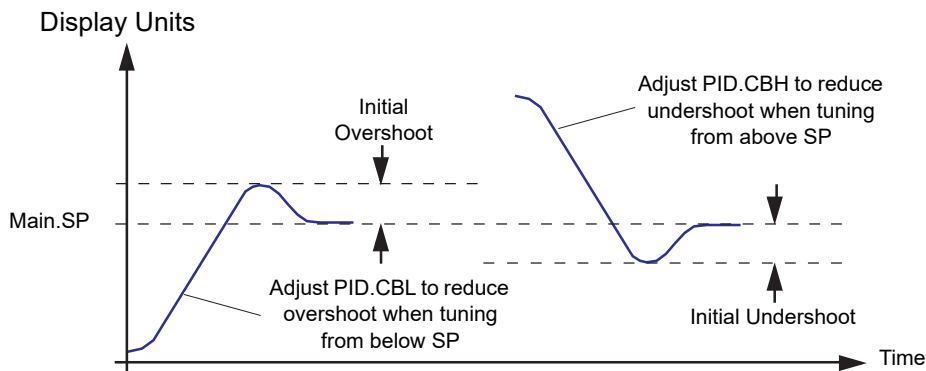


Figure 75 CutBack High (PID.CBH) and CutBack Low (PID.CBL) manual tuning

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 Min.
StageTim	Shows the time since the latest change in 'Stage' occurred.

PID Tab

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

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

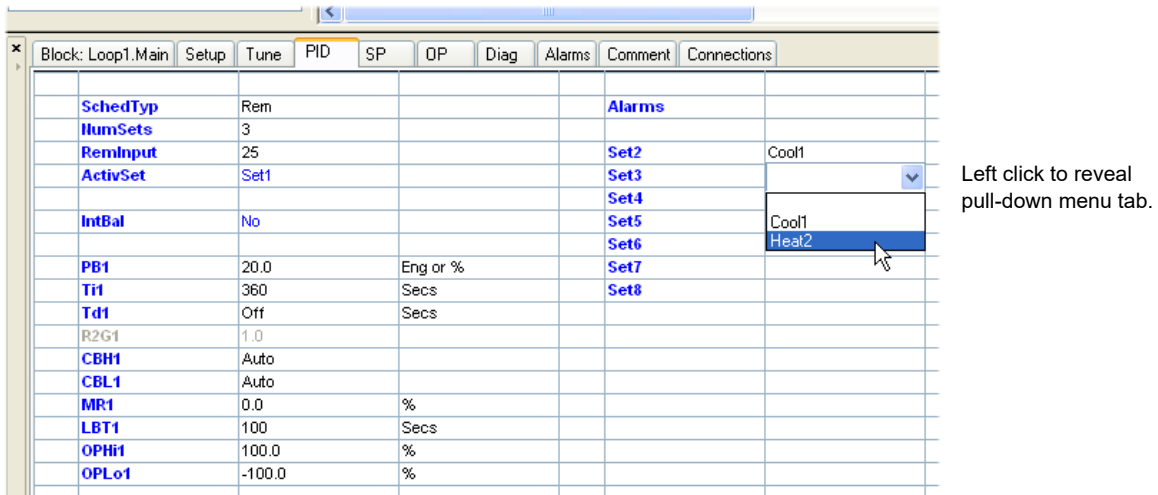


Figure 76 PID tab

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 (Set Up Tab (page 105)) for Set 1.
OPHi1, OPLo1	Maximum and minimum output limits for set 1. NumSets Specifies 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 Figure 76). 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.
SchedTyp	Specifies a method for transferring from one PID set to the next. OffA PID set is not used. ManualThe required PID set is selected by the operator SPSelection 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. PVSelection 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. ErrorSelection 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. OPThe PID set selection is derived from the working output value (Main.WrkOP) and includes an internally defined hysteresis of 0.5% of output span RemPID 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 ("Set Up Tab" on page 105) for Set 1. Off = integrative action disabled
Td1	Derivative time ("Set Up Tab" on page 105) 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.

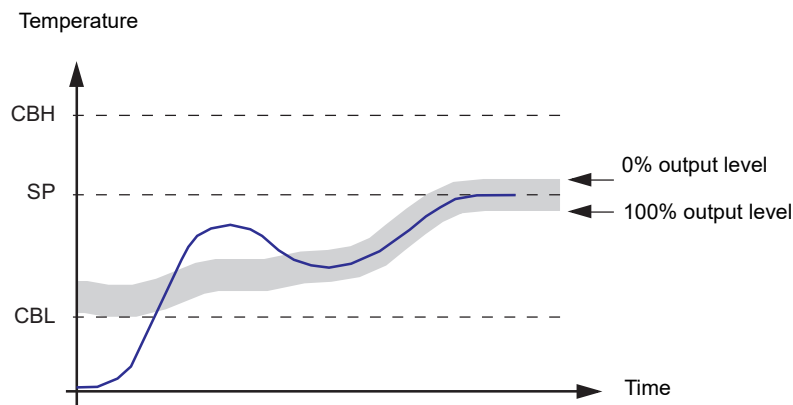


Figure 77 High and Low Cutback (CBH and CBL) configuration

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 "Diag Tab" on page 131) 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 $T_i \times 2$ for a PI or PID loop, or to $12 \times T_d$ for a PD loop. For an On/Off controller loop break detection is based on loop range settings as $0.1 \times \text{Span}$ where $\text{Span} = \text{Range High} - \text{Range Low}$. 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 $>0.5 \times P_b$ 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.

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.

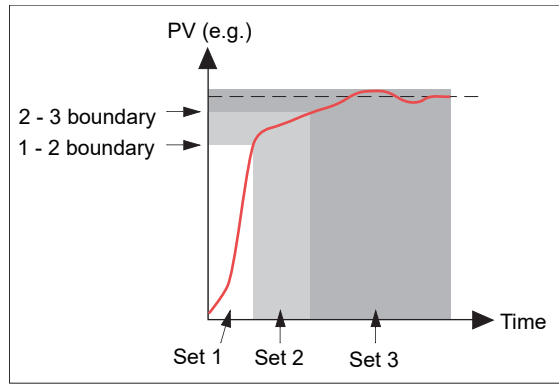


Figure 78 Gain scheduling

SP Tab

Block: Loop1.Main									
	Setup	Tune	PID	SP	OP	Diag	Alarms	Comment	Connections
RangeHi		1372.0		Eng				Alarms	
RangeLo		-200.0		Eng					
SPselect		SP1						SPTrim	0.0 Eng
								SPTrimHi	0.0 Eng
								SPTrimLo	0.0 Eng
SP1		100.0		Eng				ManTrack	Off
SP2		0.0		Eng					
SPHiLim		1372.0		Eng				SPTrack	Off
SPLoLim		-200.0		Eng					
AltSPEn		No						TrackPV	0.0 Eng
AltSP		0.0						TkPVstat	Good
RateSP		20.0		Eng/Min				TrackSP	0.0 Eng
								SPIntBal	Off
RateDone		No							
SPRateDs		Yes							
ServToPV		Yes							

Figure 79 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.

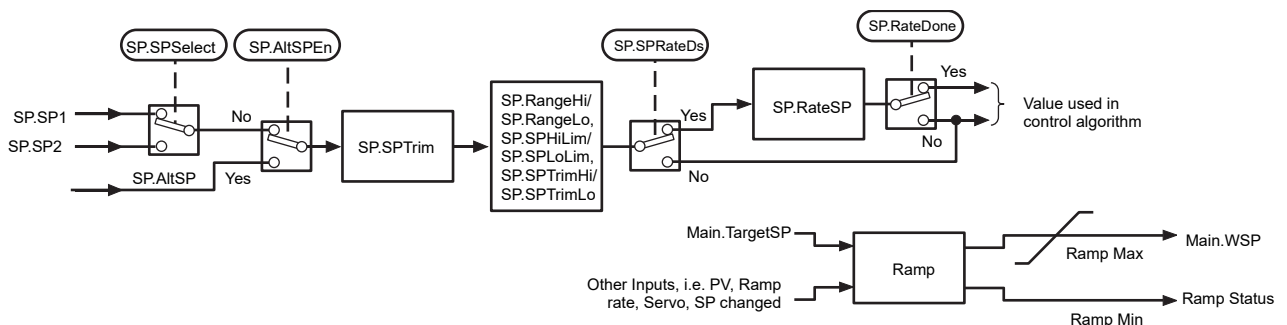


Figure 80 Set Point page block diagram

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.

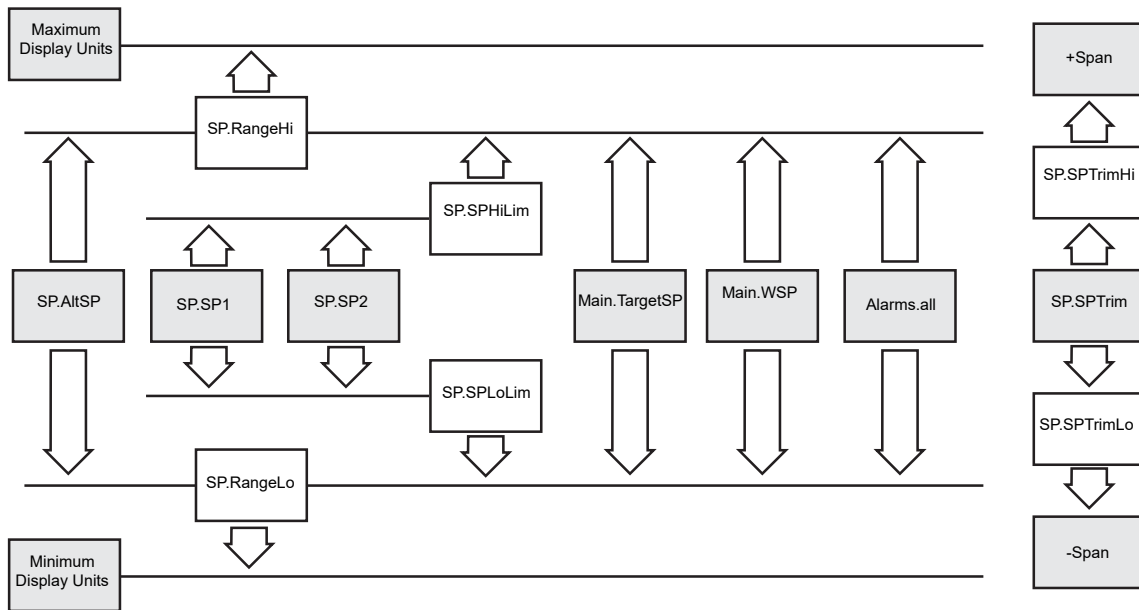


Figure 81 Setpoint Limits

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 ('Alt-SP'), 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'.

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.

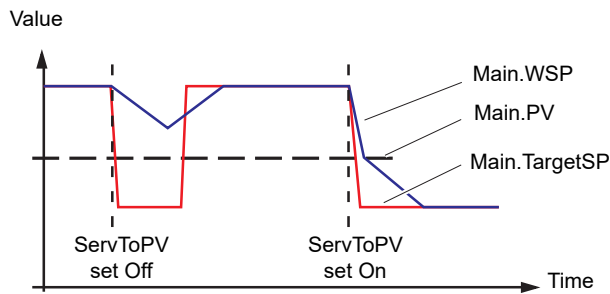


Figure 82 PV starting point

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.
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.

OP Tab

Block: Loop1, Main		Setup	Tune	PID	SP	OP	Diag	Alarms	Comment	Connections
OutputHi	100.0		%					Alarms		
OutputLo	0.0		%							
Ch1Output	0.0		%					SbrkOP	0.0	
Ch2Output	0.0		%					SafeOP	0.0	
Ch2DeadB	Off		%					ManMode	Track	
RateOP	Off		%/Min					ManOP	0.0	%
RateDis	No							ForcedOP	0.0	%
C1OnOffs	10.0		Eng					ManStart	Off	
C2OnOffs	10.0		Eng					PwrffEnb	No	
Ch1TravT	22.0		Secs					Pwrffln	0	Volts
Ch2TravT	22.0		Secs					CoolType	Linear	
PotCal	Off							FFType	None	
fludgeUp	No							FFGain	1.000	
fludgeDn	No							FFOffset	0	%
C1PotPos	0		%					FFTrimLm	100	%
C1PotBrk	Good							FFRem	0	%
C2PotPos	0		%					FFOP	0	%
C2PotBrk	Good							TrackOP	0	
PbrkMode	Raise							TrackEn	Off	
SbrkMode	SbrkOP							RemOPL	0.0	%
								RemOPH	0.0	%

Figure 83 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.Ch1Output' and 'OP.Ch2Output', 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, $\pm 100\%$ 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.

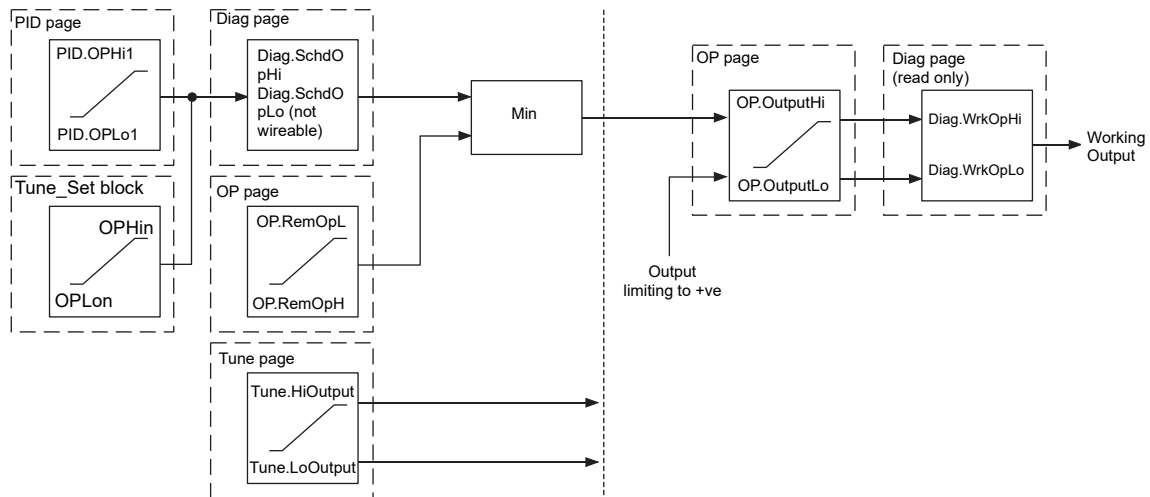


Figure 84 Output Limits

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.RateOP' 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.

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.

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 'OP.FFOffset'. 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.

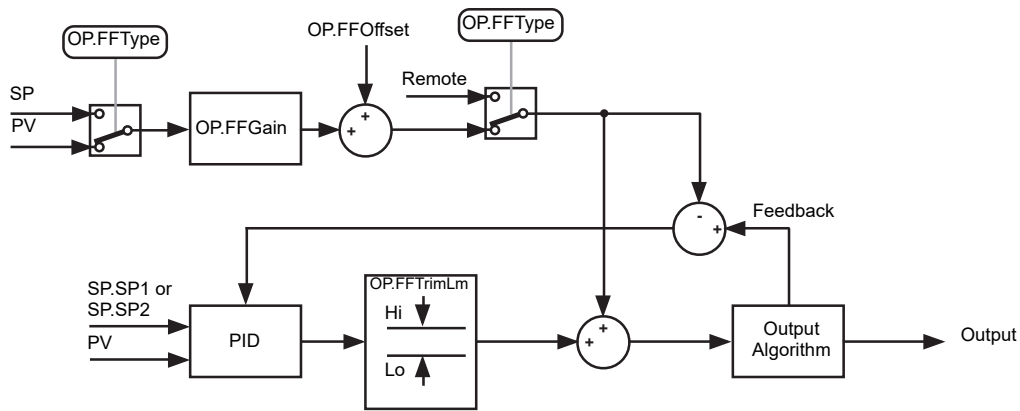


Figure 85 FeedForward block diagram

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%).
Ch1Output	The output value of channel 1
Ch2Output	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 channel 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'
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 feedforward 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 FFGain and FFOffset. PV The feedforward value is derived from the process variable, scaled by FFGain 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 Man-Mode = 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, allowing 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.
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 ("Main Page" on page 102).
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.

Diag Tab

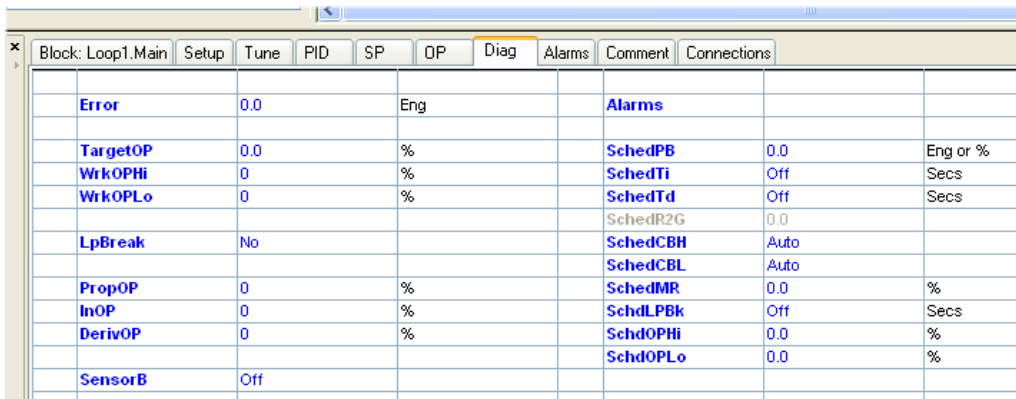


Figure 86 Diag tab

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 within 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.

Alarms Tab

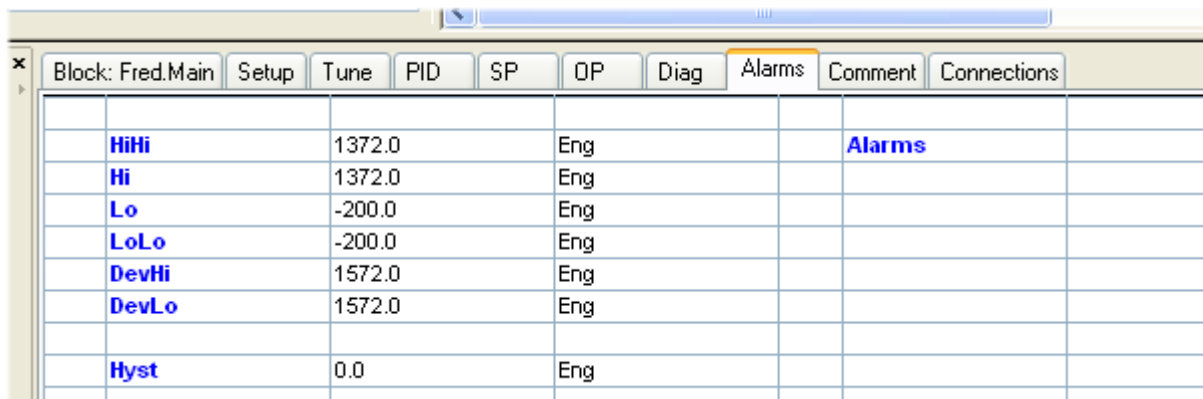


Figure 87 Alarms tab

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). HiHighAI = True when PV>'HiHigh'
2. High Absolute (Alarms.Hi). HighAI = True when PV>'High'
3. Low Absolute (Alarms.Lo). LowAI = True when PV<'Low'
4. Low Low Absolute (Alarms.LoLo). LoLowAI = 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) HighAI = True when PV-Setpoint >'High'
2. Low Deviation (Alarms.DevLo) LowAI = 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.

Effect of Control Action, Hysteresis and Deadband

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.

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.

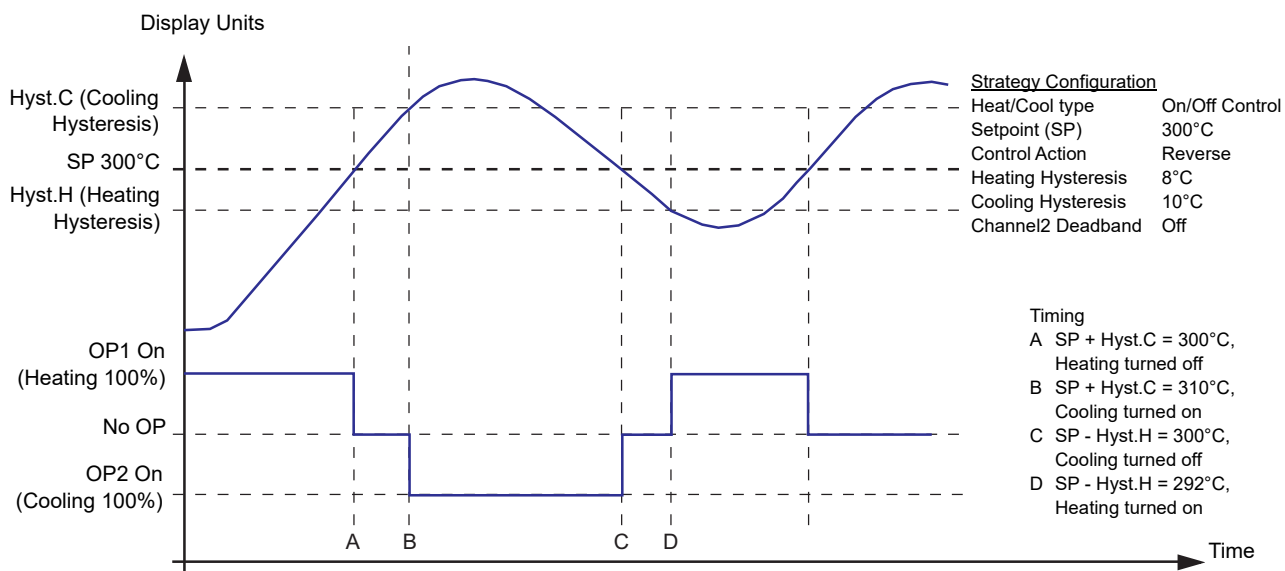


Figure 88 Hysteresis applied, Deadband not applied

Task Organisation

Task Scheduling

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

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 multiple tasks, and some of the more principle ones are discussed here.

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.

Priorities

Each task has a priority based on its importance to efficient and safe operation. 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.

Functions

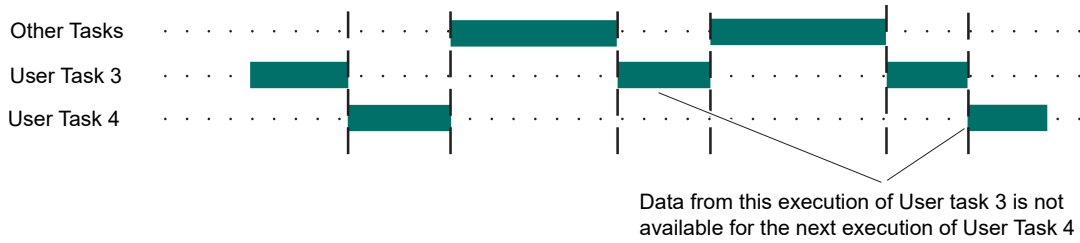
A list of Task functions is given in the table shown in Figure 89, below.

The following six 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 (Figure 90, 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 110ms, 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 110ms, but this may be extended depending on the amount of CPU time remaining after User Tasks have been serviced.

Task	Schedule	Function
Tick	Every 5ms	Provides system check
netHOST (x6)	Event driven	Profibus Master communication is managed via a netHOST gateway device. A total of six tasks are devoted to the management of, and communication to, the netHOST device.
Rx_ICM	Event driven	Processes messages received over the ICM
Rx_LIN	Event driven	Processes messages received over the LIN
ICM_Mgr	Every 50ms	Monitors ICM link low level status. Applies timeouts to transmitted messages. Re-programs ICM hardware if errors detected.
PRMT	Event driven <100ms	Process redundancy management task. Responsible for effecting and maintaining synchronisation between redundant processors.
Pr_Px	Every 100ms (approx.)	Processes messages received using port resolution protocol (PRP) over ELIN
EDBserv (x2)	Every 10ms (approx.)	Manages ELIN communications with external databases via cached blocks.
Network	Event driven	'Housekeeping' for all LIN transactions
File sync	Event driven	Responsible for maintaining synchronisation of filing systems on redundant systems

Task	Schedule	Function
Mod_Rx (x3)	Event driven	Processes messages received via Modbus Gateway. There are three tasks devoted to this.
Profibus Master (x4)	Periodic	Tasks associated with various aspects of managing Profibus data (cyclic, acyclic and diagnostic tables and general communications management). There are four tasks devoted to this.
ModServ (x3)	Periodic	Modbus database management. There are three tasks devoted to this.
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.
Cache Sync Server	Min default 100ms	Maintains synchronisation of cached blocks
Cache Conn Server	Min default 100ms	Responsible for LIN field writes into cached blocks
LLC	Every 110ms (approx.)	Monitors LIN link low-level status. Applies timeouts to transmitted messages. Re-programs LIN hardware if errors are detected.
NFS	Event driven	Network Filing System. Processes LIN filing requests.
TTermcfg	Event driven	Runs the terminal configurator accessed via a Telnet session
Pr_Maint	Every 500ms (approx.)	PRP database management
Load	Event driven	Loads a database as a result of a remote request
Panel	Event driven	Runs the operator interface
Config	Event driven	Runs the terminal configurator via the serial port
BatLoad	Event driven	Responsible for batch load operations (e.g. loading/unloading SFCs)
Bgnd (scan)	Event driven	Collates alarm information. Performs database checksum testing
Idle	Event driven	'Null' task. Provides an environment for CPU execution whilst no other tasks run.

Figure 89 Task scheduling

Module type	Slow task rate (110ms)	Fast task rate 10ms	Module type	Slow task rate (110ms)	Fast task rate 10ms
AI2	yes	no	AI3	yes	no
AI4	yes	no	AI8 (TC)	yes	no
AI8 (MA)	yes	no	AI8 (RT)	yes	no
AI8 (FMA)	yes	yes	AO2	yes	yes
DI4	yes	no	DI6	yes	no
DI8	yes	yes	DI16	yes	yes
DO4	yes	yes	DO8	yes	yes
DO16	yes	yes	RLY4	yes	yes
RLY8	yes	yes	FI2	yes	yes
ZI	yes	no			

Figure 90 Module task rate applicability

User Tasks

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.

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 $N \times 10\text{ms}$, and User Task 3 runs at $M \times 110\text{ms}$, 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 "User Task Block" on page 141, below.

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 Figure 89). The block servers are prioritised, repeat-rate driven, and fully coherent, (see "Data Coherence" on page 142, 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 "Priorities" on page 135, 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 91 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.

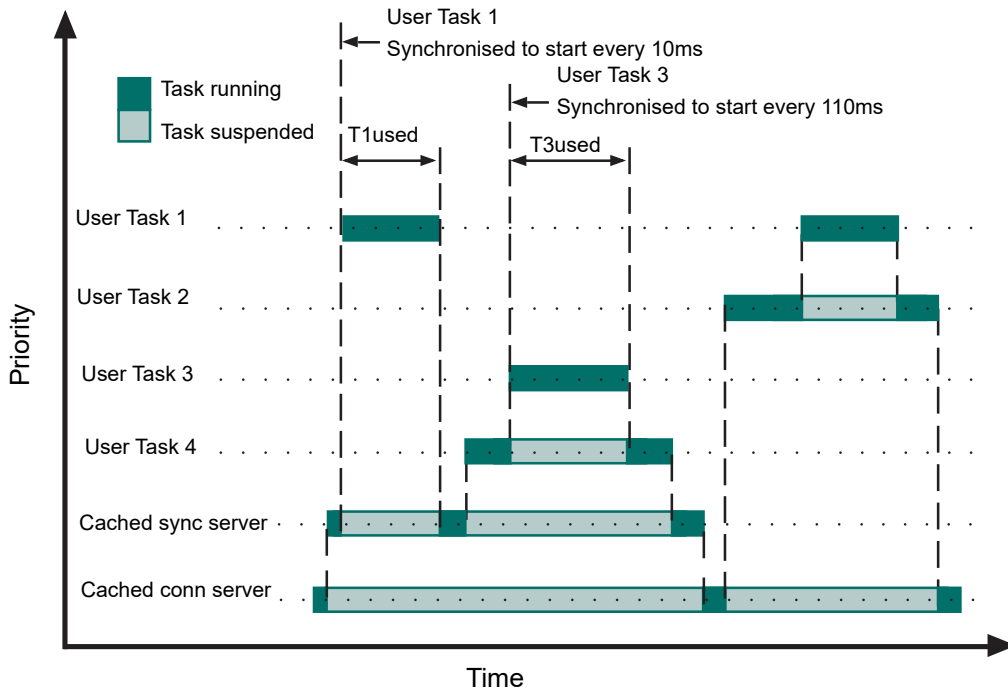


Figure 91 User task block server interactions

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 92 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.

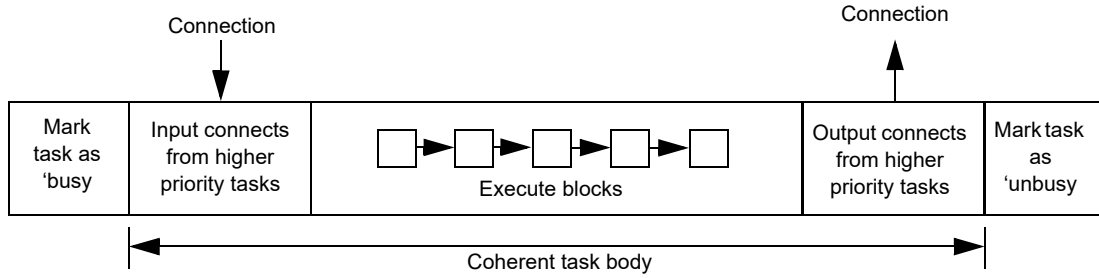


Figure 92 User task block server operation

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).

Usertask Block

Block: UTASK_46					
Comment			Connections		
TagName	UTASK_46			LIN Name	UTASK_46
Type	USERTASK			DBase	<local>
Task	3 (110ms)			Rate	0
T1used	1	ms	Alarms		
T1period	10	ms	Stretch	0.06274	
T2used	0	ms	LastScan	0.02000	secs
T2period	10	ms	ThisScan	0.01500	secs
T3used	4	ms	Suspend1	FALSE	
T3period	110	ms	Suspend2	FALSE	
T4used	0	ms	Suspend3	FALSE	
T4period	110	ms	Suspend4	FALSE	

Figure 93 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 usage 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.

Data Coherence

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 94, 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. The coherent method is preferred as this is more efficient (in terms of communications throughput and impact on local user task execution).

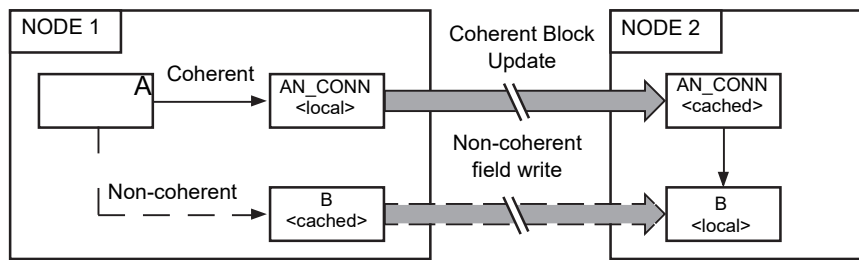


Figure 94 Coherent and non-coherent data flow across network

Event and Health Logs

As of T2750 v4/0, there are two primary event and health logs that are generated in the instrument to aid the diagnosis of problems within the system. The Event Log (EVENT.UDZ) 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. It contains a comprehensive log of events, and as such, may require assistance from Eurotherm to aid analysis. The Health Log (HEALTH.UDZ), however, introduced in T2750 v4/0, provides a user-friendly, plain language log, with messages from both the left and right IOC in a single file.

Health Log

The Health Log is the recommended log to examine in the first instance to aid diagnostics. The file can be retrieved (using LIN Network Explorer or directly from the instrument's SD card if the instrument is powereddown and the SD card is inserted in a separate card reader) from either the left or right IOC (if running in a duplex configuration) as the file includes entries from both processors. The records are stored as an ASCII format using a single line for each event and written in the local language selected via the Instrument Options Editor. The Health Log also includes three header lines at every power-up or reset making the file contents easier to read.

As from T2750 v4/0, the log includes information concerning duplex operation and general status information. A '!' symbol in the first column indicates a condition which needs attention; all other messages are normal operation. "Health Log" on page 145 shows an example Health Log.

```
T2750 4/0 (Revision: 88066) Created: Jun 01 2017, 22:55:40; Bootrom: 3.0 ; Hardware: 1; Serial no:
217439
LIN Node: 0x0004; Protocol Name: "NET"; IP Address: 192.168.1.85; Subnet Mask: 255.255.255.0
Hot Start: enabled; Cold Start: enabled; Time Zone UTC Offset: 0 (Minutes); DST: Inactive

Status,Time (UTC) ,Side ,Role ,Class ,Message
,04/05/17 09:28:50,Left ,Secondary,Status ,Power on / reset
,04/05/17 09:28:50,Right,Secondary,Status ,Power on / reset
,04/05/17 09:28:54,Left ,Primary ,Status ,ELIN health status changed = healthy
,04/05/17 09:28:55,Left ,Primary ,Status ,Power up start result: cold started
,04/05/17 09:28:55,Left ,Primary ,Status ,Started database: FERMENT.DBF
,04/05/17 09:28:55,Left ,Primary ,Redundancy,Start of changeover following: normal Primary database
start
,04/05/17 09:28:55,Left ,Primary ,Redundancy,Changeover completed (units not synchronised): strategy
is running
,04/05/17 09:28:53,Right,Secondary,Status ,ELIN health status changed = healthy
,04/05/17 09:28:54,Right,Secondary,Status ,Power up start result: empty
!,04/05/17 09:30:31,Left ,Primary ,Redundancy,Relative view of ELIN health has changed:Primary is
better
```

Figure 95 Health.udz log example

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. 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.

Because the Event Log can be very detailed, assistance from Eurotherm may be required in order to interpret the output. Figure 96 shows part of a typical event log.

```

T2750 4/0 (Revision: 88066) Created: May 01 2017, 22:55:40; Bootrom: 3.0 ; Hardware: 1; Serial no:
217439
LIN Node: 0x0004; Protocol Name: "NET"; IP Address: 192.168.1.85; Subnet Mask: 255.255.255.0
Hot Start: enabled; Cold Start: enabled; Time Zone UTC Offset: 0 (Minutes); DST: Inactive

Stat Time (UTC)          (XEC time :hires )      Code Message
! 04/01/00 05:52:49      (0x0000007E:1F898272)  81FF Power On / Reset
! 04/01/00 05:52:50      (0x00000107:2135A7AF)  81F1 POST result = SRAM is not initialised
! 04/01/00 05:52:50      (0x00000107:2135ACD8)  815A Last Shutdown Msg 1: Unknown
04/01/00 05:52:50      (0x00000109:213C205A)  92E3 Read Red Power Data = 0
04/01/00 05:52:50      (0x00000127:219B8BC1)  81FC Attempt to check for licence file E:00217439.UTL
04/01/00 05:52:50      (0x0000012F:21B4C7B9)  81F9 Licence file not found
!! 04/01/00 05:52:50     (0x00000130:21B6F71E)  81FA _system.opt: COM3 invalid hardware
!! 04/01/00 05:52:50     (0x00000130:21B706A8)  81FA _system.opt: COM4 invalid hardware
!! 04/01/00 05:52:50     (0x00000130:21B71DB9)  81FA _system.opt: PROFIBUS1 invalid timeout
!! 04/01/00 05:52:50     (0x00000130:21B72BFB)  81FA _system.opt: PROFIBUS2 invalid timeout
04/01/00 05:52:50      (0x00000139:21D3BFAE)  92EE Waiting for other CPU to initialise = 0
04/01/00 05:52:50      (0x00000143:21F2557F)  92E9 Time waited to establish ICM comms = 10
04/01/00 05:52:51      (0x000001D3:23B7F221)  92E5 Successfully coupled
04/01/00 05:52:51      (0x000001D3:23B7F69C)  92EC ICM communications established - so attempt to
resolve mode
04/01/00 05:52:51      (0x000001D3:23B7F978)  92FB Instrument initial mode SECONDARY

```

Figure 96 Event.udz log example

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.

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 ("USB Configuration" on page 70), to a memory stick inserted into the USB connector on the I/O controller module terminal unit (Figure 9).

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 "Data Management" of the LINBlocks reference manual.

Data Recording

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.

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.

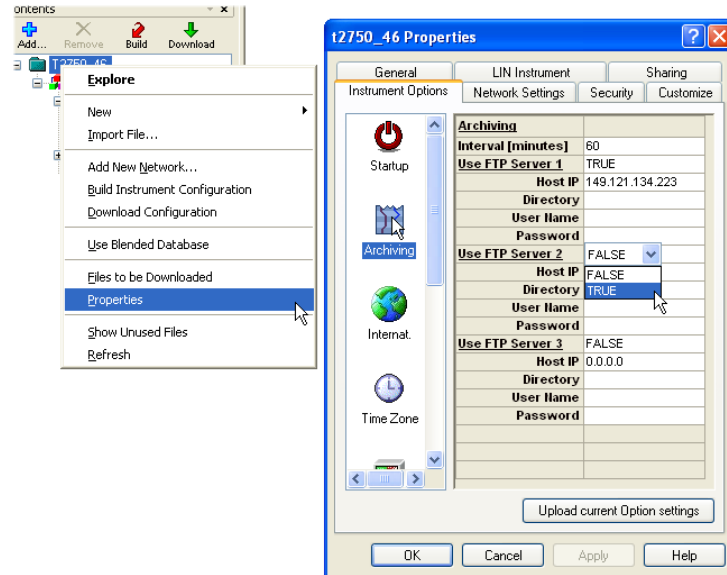
Data Archiving

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 pulldown 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.



File Transfer Protocol (FTP)

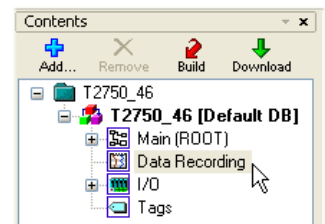
File Transfer Protocol (FTP) is a commonly used Server/Client transfer mechanism. It allows the instrument to act as a FTP client to up to three FTP Servers for the purpose of transferring recorded files from the flash memory to a remote computer. When multiple FTP Servers can be configured to provide 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 ‘firewalls’ or other security systems in place.

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.

LINtools data recording configuration

Data Recording											
Groups Blocks Fields Options											
Field Name	Group	Description	Format	Colour	MinMax	SpanLow	SpanHigh	ZoneLow	ZoneHigh	Active	Inactive
Coolt_Bound	Group1	Coolt_Bound		Red	Off	0.000000	1.000000	0.000000	100.00000		
IDENT_** Duplex.Syncd	Group1	IDENT_** Duplex.Syncd	DIGITAL	Black	Off			0.000000	100.00000	TRUE	FALSE
Loop1_PV	Group1	Loop1_PV		Blue	Off	0.000000	1.000000	0.000000	100.00000		
Loop1_WrkOP	Group1	Loop1_WrkOP		Orange	Off	-100.0000	100.00000	0.000000	100.00000		
Loop1_WSP	Group1	Loop1_WSP		Green	Off	0.000000	1.000000	0.000000	100.00000		
<i>Add Field</i>											

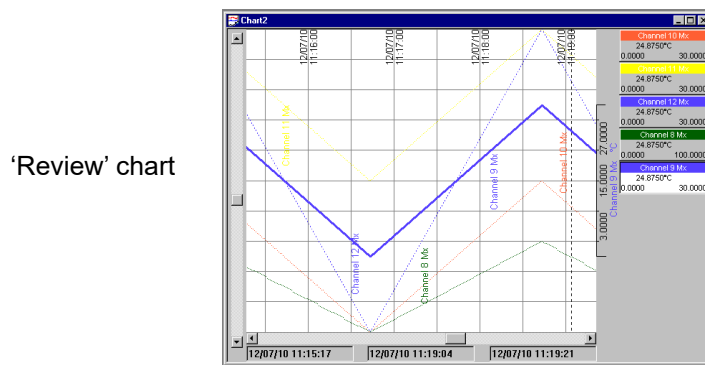
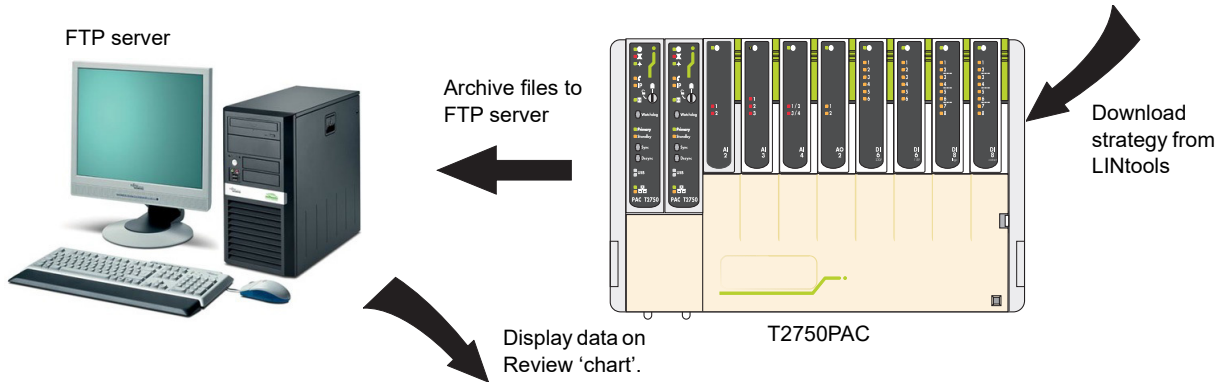


Figure 97 Data management overview

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.

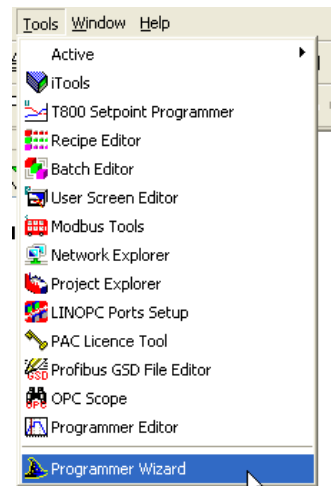


Figure 98 Tools menu

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.

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 four 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.

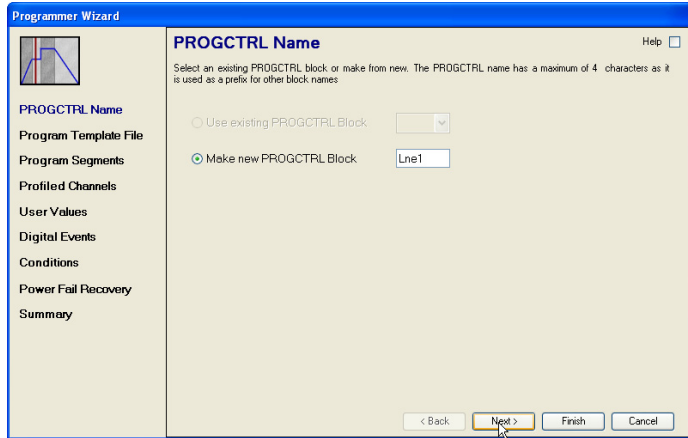
The Program Template file can be referenced by a local instrument or any other instrument on the same network allowing the same file to apply to multiple instruments.

Template Creation

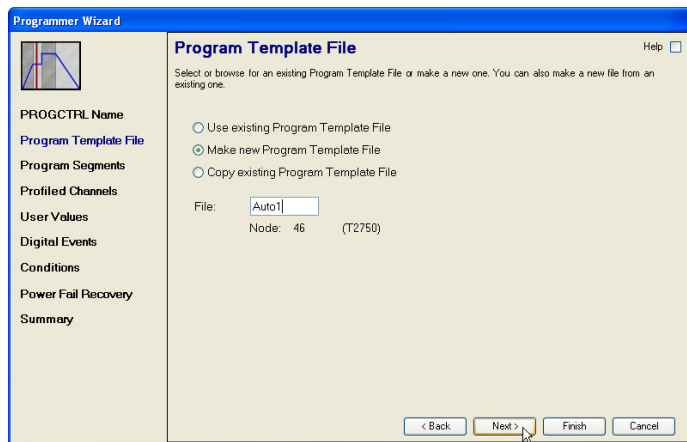
The following sequence illustrates the creation of a simple setpoint program template, with three channels having a maximum of eight segments each. The screen 'Help' has been disabled in order to save space.

1. With LINtools running, click on the Tools menu, then on 'Programmer wizard' (Figure 98, above).

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



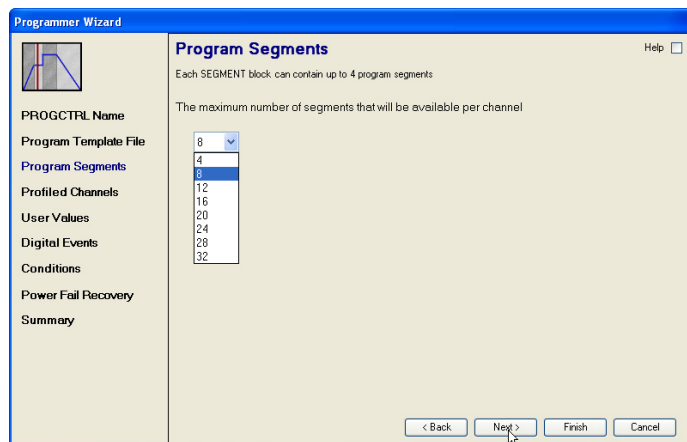
3. The 'Program Template' File page appears. Enter a name for the Program template, and click Next.



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.

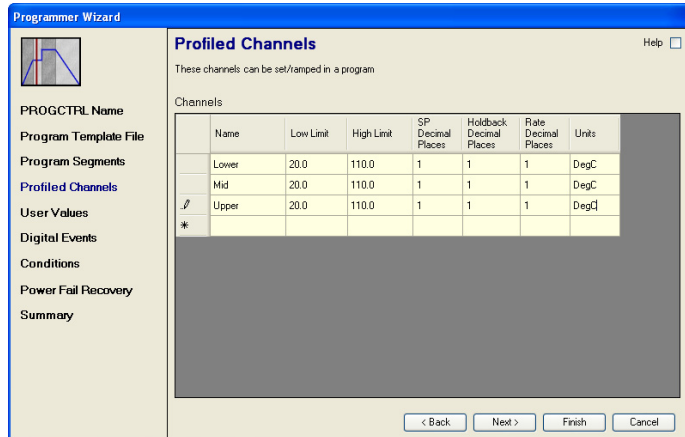
Click on 'Next'.



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'.

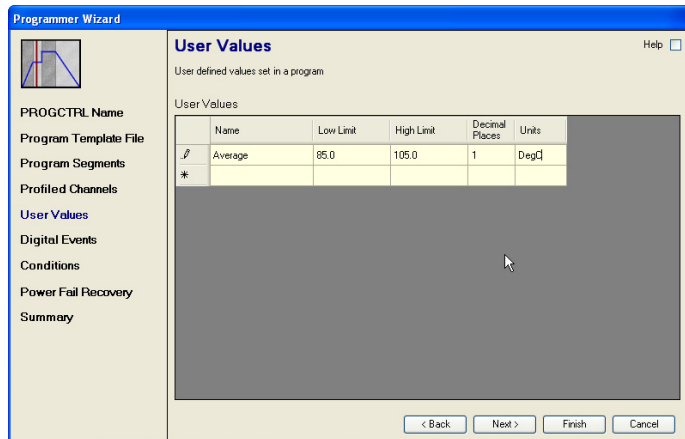
Click on 'Next'.



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.

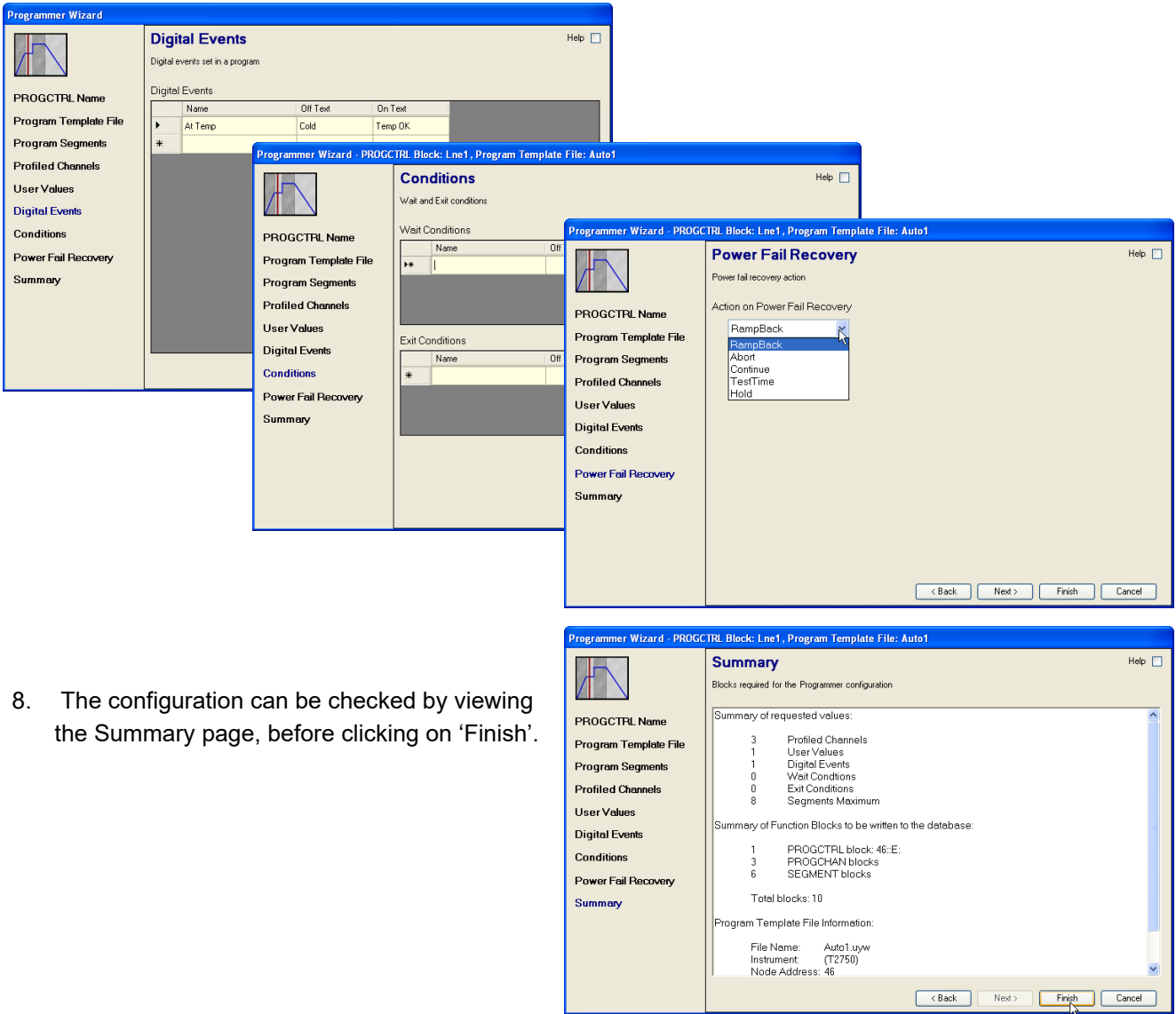
7. In a similar way, enter any Events, Wait Conditions, Exit Conditions and Power Fail recovery action.



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.

Program Editor

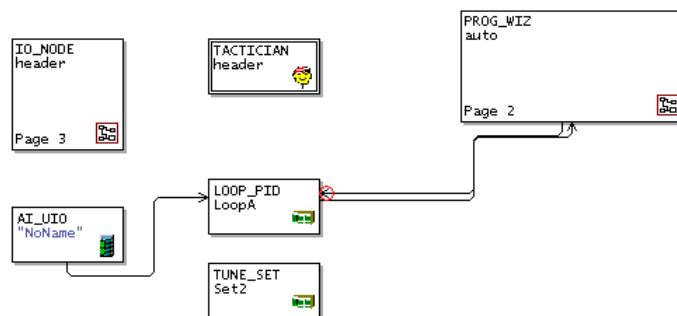
Introduction

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.

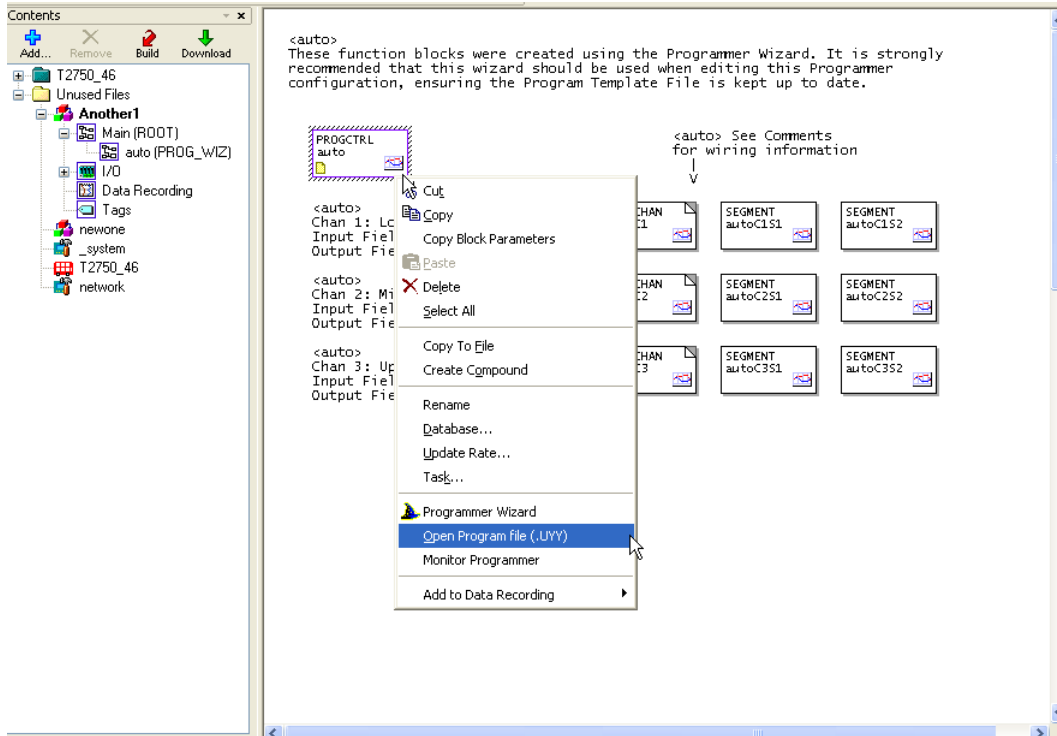
To configure a Setpoint Program:

1. In LINtools, create (edit) the instrument Program Template file using the Programmer Wizard as described in "Template Creation" on page 151, 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.



Editing Procedure

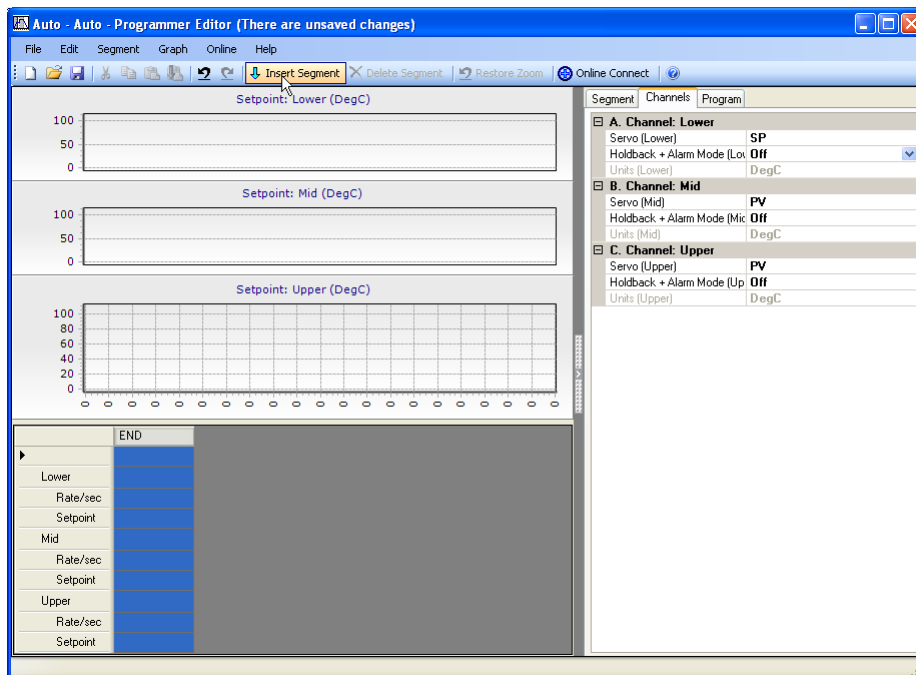
The following sequence shows typical steps in an imaginary segment creation procedure. Refer to "Installation" of the PAC Tutorial user guide for fuller details.



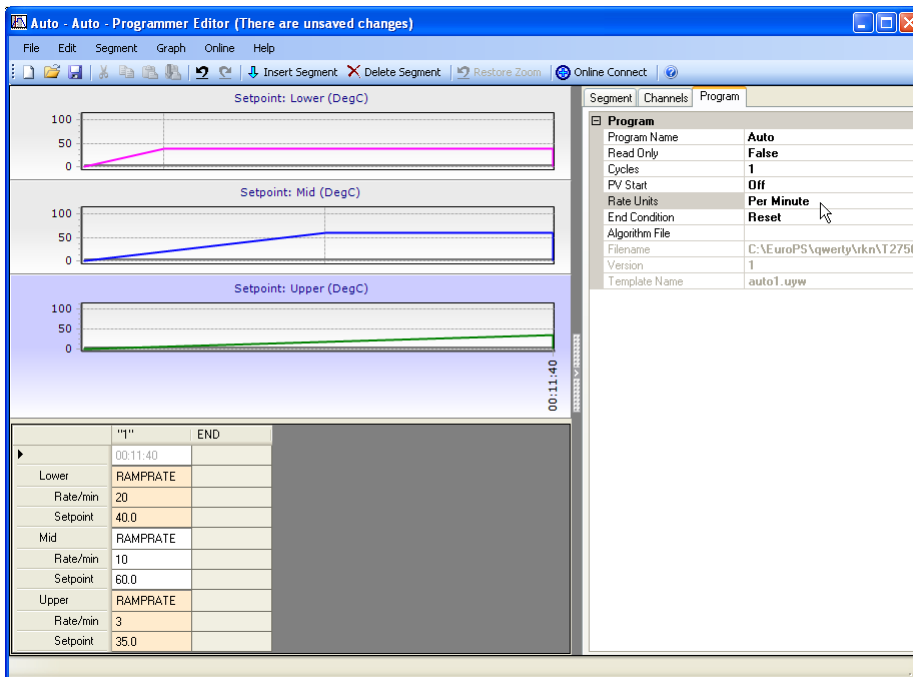
One way of opening the program editor is to right-click on the PROGCTRL block on the LINTools work area, and selecting 'Open program File (UY)' from the pull-down menu. Another way, for existing files, is to select 'Program Editor' from the LINTools 'Tools' menu, and using the browser to search for the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

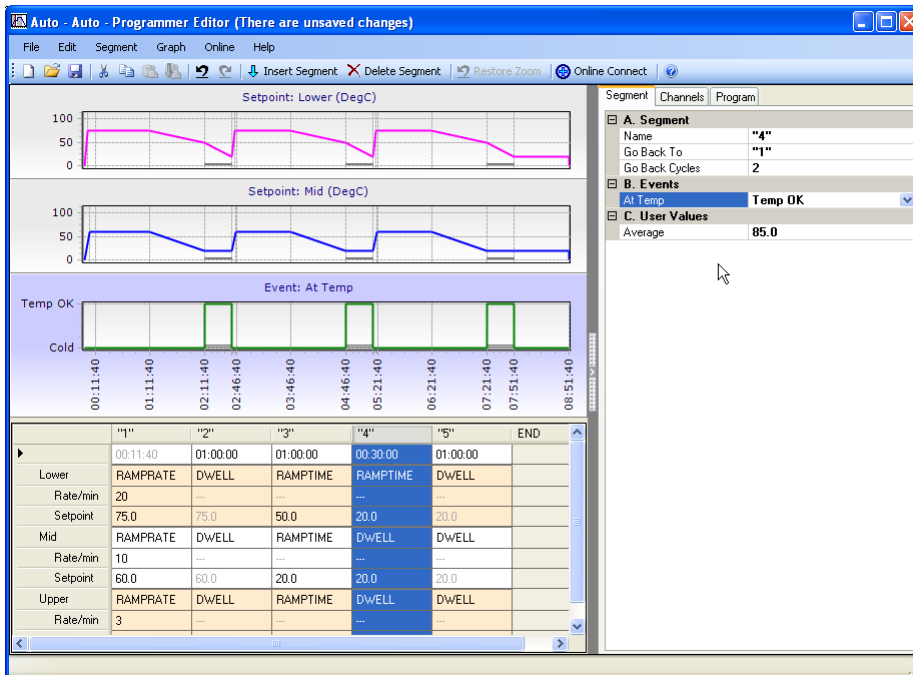
1. Click on the 'End' segment; then on 'Insert segment'.



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.



Recipe Management

The Recipe functionality is used to control the parameters that change based on the product or formula, e.g. reaction time.

Recipes provide a set of LIN function block field names ('variables') with a particular value assigned to each, e.g. if the recipe is for one or more identical cake baking lines, it would include setpoint values representing the amounts of each flavouring in the mixture needed for a particular cake. In use, the recipe is downloaded to the LIN database controlling a particular plant line, i.e. each recipe value is copied to the corresponding LIN block field to achieve the required control.

It will usually be required to run several related recipes on a given plant line at different times, with the same set of variables but with different assigned values, e.g. for different cake types. These recipes constitute a recipe set, that are stored in a single comma-separated text file with extension '.uyr'.

Refer to Batch and Recipe on T2750 (HA033194) for further details.

Batch Processing

Batch Production is a manufacturing method in which the product in question is created stage by stage and small quantities of identical products are made. Each batch having a unique identifier to enable quality control and any potential future investigations. Batch Production is in contrast to Continuous Production which is a flow production method used to manufacture, produce, or process materials without interruption.

Batch production is most common in bakeries and in the manufacture of foodstuffs, pharmaceutical ingredients, inks, paints, and adhesives or for any manufacturing process where a controlled number of products needs to be treated as a distinct manufacturing set.

Within the T2750, Batch Production is controlled and monitored by the Batch Engine. This control is referred to as 'Batch Processing'. The Batch Engine is a State Machine that controls processes which have a defined Start and End. The engine has interfaces to the HMI (Human-Machine Interface) and the Data Recording Engine (for data logging).

Refer to Batch and Recipe on T2750 (HA033194) for further details.

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 ("Error Indication Types" on page 163)
2. LED error displays ("LED Displays" on page 163)
3. Power-up failures ("Power-up Failure" on page 167)
4. Power On Self Tests (POSTs) ("Power On Self Tests (POSTs)" on page 167)
5. SD Card failure detection ("SD Card Failure Detection" on page 168)
6. Diagnostic blocks ("Diagnostics Blocks" on page 169)
7. netHOST Profibus master troubleshooting ("netHOST PROFIBUS Master Troubleshooting" on page 170)
8. netHOST fault scenarios ("netHOST Fault Scenarios" on page 171)

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. Note that if the Watchdog triggers, the LEDs can adopt a different pattern, so it is helpful to record the LED pattern prior to this.
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.

LED Displays

The IOC LEDs are the primary method of displaying error, and an overview description is to be found in "Operator Interface".

Additional information is included in the following subsections.

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
7. Instrument Password issues (either not set, or duplex partner is running pre v6/0 firmware and does not support an Instrument Password). If possible, replace the partner instrument with one that does support Instrument Passwords. You will lose the security provided by Instrument Passwords if the partner is not replaced.

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.

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 'super-capacitor' also maintains this data (for approximately 1 hour) should power fail without a working backup battery being fitted.

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 ("LIN Option Switch" on page 60) is set ON, the IOC module automatically attempts to restart the CPU. If the Watchdog Retry switch is set Off, the CPU will attempt to restart only after an operation of the 'Watchdog' switch (Figure 56 shows the switch location).

Note: It is suggested that the OFF position be used for systems operating in duplex mode, whereas the ON position be used for a single unit operating in isolation.

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

ICM Failure

Note: 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 "Decoupled Instruments" on page 166 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.

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. In redundancy configurations with two IOC modules installed, the status of the Stay Sync'd option (set using the Instrument Options Editor, Startup tab) is also taken in consideration.

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 the Stay Sync'd option is disabled. If the Stay Sync'd option is enabled, then a desync/changeover occurs but then an automatic resynchronisation occurs to make the 'better' unit the primary. The SecWorse parameter in the IDENTITY and RED_CTRL blocks (if in the strategy) are then asserted.

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

If a LIN failure occurs in a synchronised secondary module and the Stay Sync'd option is disabled, the module adopts the Secondary unsynchronised state ('Standby' LED off), and the primary module desynchronises to the Primary unsynchronised state. If the Stay Sync'd option is enabled, and the secondary LIN health is determined to be worse than that of the primary, no desynchronisation occurs. The SecWorse parameter in the IDENTITY and RED_CTRL blocks (if in the strategy) are then asserted. In both cases, if the secondary was unsynchronised at the time of the failure, no change of state occurs.

Effect of LIN Failure on Redundancy Mode Control

LIN failure affects the ability of Primary and Secondary modules to synchronise. For example, if Stay Sync'd is not enabled, a LIN-failed secondary IOC module cannot be synchronised successfully with the primary by pressing the primary's 'Sync' switch (synchronisation will be attempted, but then fail). However, if the Stay Sync'd option is enabled, the secondary IOC module may be able to be synchronised with the primary by pressing the primary's 'Sync' switch. Having synchronised, however, if there is a fault other than worse secondary subsystem health, the two IOCs may immediately desync again (or changeover).

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 decouple - 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 unsynchronised. 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.

Inter-processor Communications Mechanism (ICM) faults will cause a decouple to occur, but a decouple does not necessarily mean an ICM fault has occurred.

Desynchronisation

Desynchronisation occurs when there is a mismatch in health between the Primary and Secondary IOC modules. When this happens, the two IOC modules desynchronise. No changeover occurs and attempts to resynchronise are inhibited by the redundancy control software until the health mismatch is resolved.

Only when the decision to changeover has been accepted, can the secondary IOC module assume control. Changeover occurs when a synchronised pair determines that the secondary's health is better than the primary's health. The changeover occurs to result in the better unit ending up as primary. The process of performing a changeover is shown in Figure 13.1 below. The changeover is complete when the database on the previously primary module is stopped.

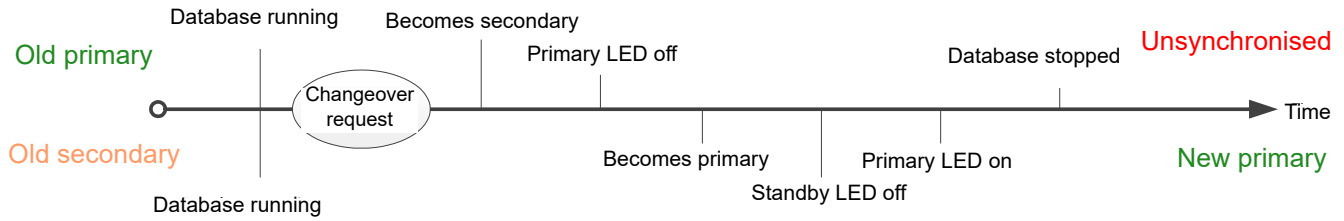


Figure 99 Changeover time line

Power-up Failure

Start-up Routine

A number of error conditions can occur during the power-up phase. This start-up routine is described earlier ("Start-up"), 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.

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 56).

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

Firstly the Boot ROM is checked, running each POST to ensure the SD 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 "Primary/Secondary Criteria" on page 85 using 'signature' data relating to last-time's power down, automatic synchronise states and so on.

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

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.

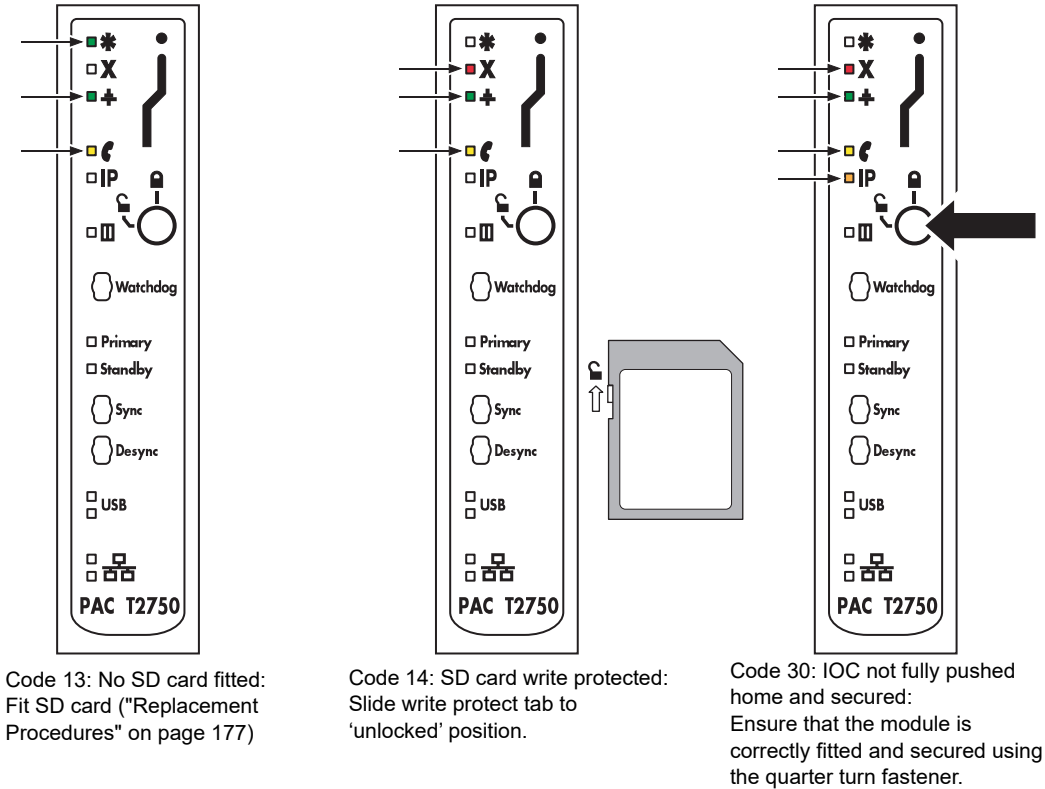


Figure 100 POST failure LED displays

SD Card Failure Detection

The T2750 uses an SD card for its local file storage, which includes the user-defined strategies, SFCs, and configuration data. A defective SD card is therefore potentially highly significant and can manifest itself as a gradual corruption of the file system contents, or stop the T2750 working completely. A corruption of contents could lead to unexpected behaviour or the watchdog triggering.

As of version 3.3 of the T2750 firmware, monitoring of the health of the SD card is performed, and if issues are detected, the card is placed into quarantine mode to help protect against the above possible scenario. Once in quarantine mode, the T2750's local filing system is no longer accessible, though the control strategy continues to function. Any aspects of the control strategy configuration which require access to the filing system (RECORD blocks, load of SFCs, or Modbus or Profibus communications, for example) fail gracefully with the appropriate alarms being raised.

If the file system is quarantined, FilSysEr (bit 8) in the TACTICIAN header block is set to TRUE. For further information, refer to the TACTICIAN block in the LIN Blocks Reference Manual, HA082375U003.

When operating as a duplex pair, if the SD card on one side of the pair enters quarantine mode, the units will change over or desynchronise as necessary so as to ensure the good unit is the Primary. The Udz file of the good unit will log the reason for any change over or desynchronisation.

Diagnostics 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.

Figure 101 shows a list of diagnostic blocks that are generated as part of the automatically created LIN Database, when the Options switches are set correctly ("LIN Option Switch" on page 60).

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	Eurotherm 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.
XEC_DIAG	Task diagnostic block. Displays information on the tasks within the instrument's operation system (XEC).
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 and its status.
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.

Block	Function
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.
SD_DIAG	SD Card Diagnostic Block. Provides basic information about the installed SD card, its performance, and other advanced real-time diagnostic information.
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.

Figure 101 Typical diagnostic blocks

netHOST PROFIBUS Master Troubleshooting

When the T2750 first starts the database file (*.dbf), and if Profibus Master is configured, 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:

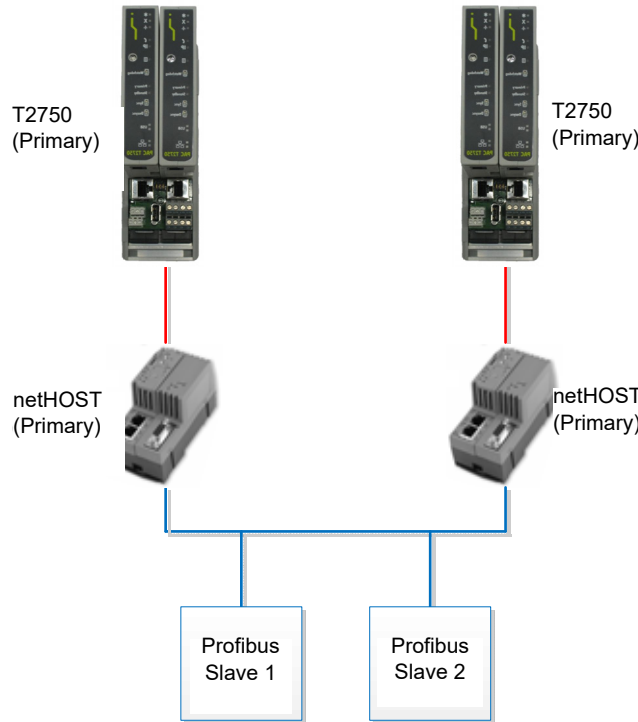
1. No netHOST with the correct ADR found
2. A netHOST with the correct ADR is found, but it is already assigned a different IP address to that expected (implying another T2750 may be using it).
3. A netHOST with the correct ADR is found but no IP address assigned and netIdent fails to correct set the 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 "Status Indicators" on page 58).

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:

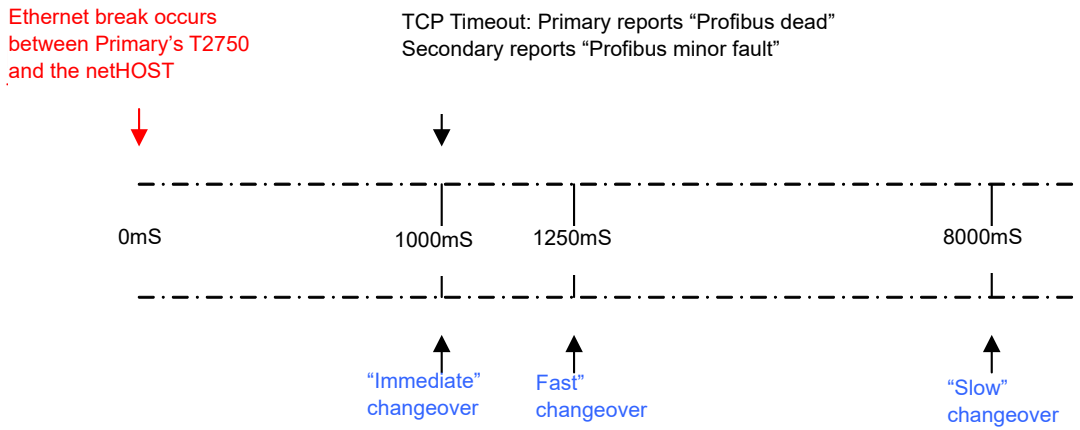


Note: This section does not consider the failure of a T2750, as failures of this nature are detected elsewhere and cause the surviving T2750 to adopt an isolated, unsynchronised primary state virtually immediately, with no impact from the Profibus health monitoring.

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 72 for details.

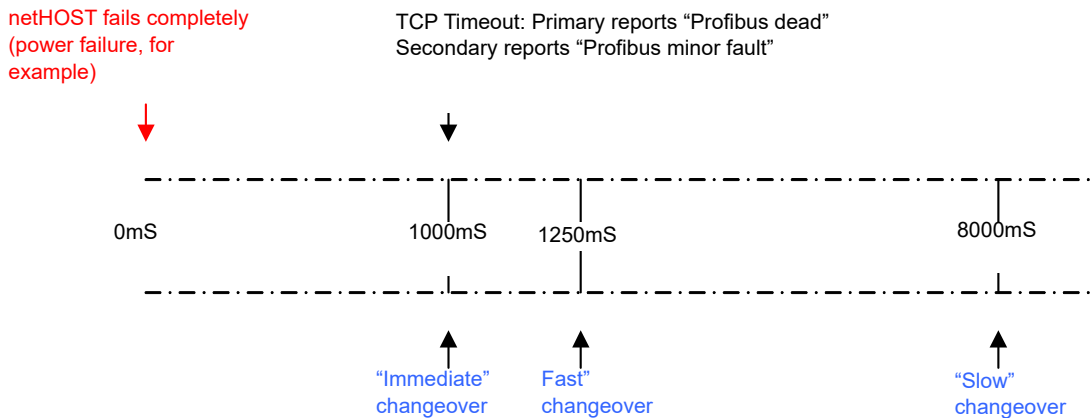
Fault Scenario 1: Ethernet Break between Primary's T2750 and netHOST

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 change over due to Profibus failures.



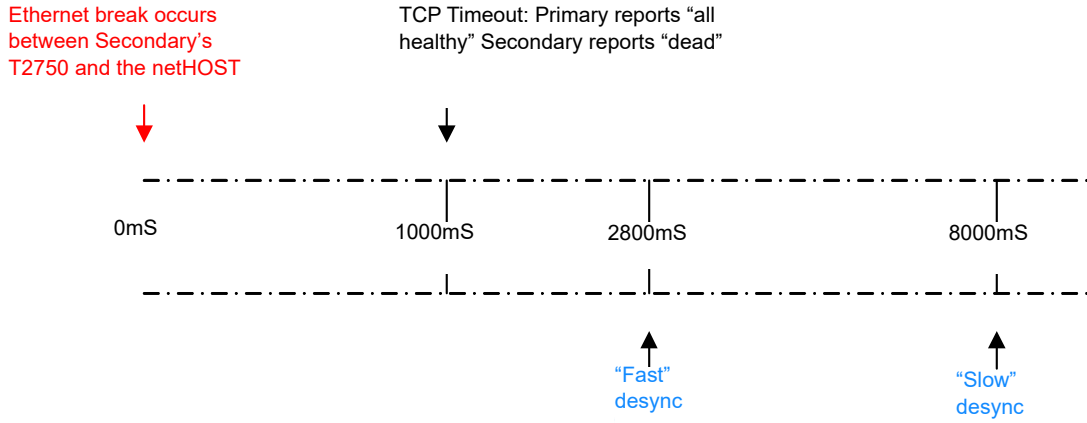
Fault Scenario 2: Total failure of Primary's netHOST

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 change over due to Profibus failures.



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.



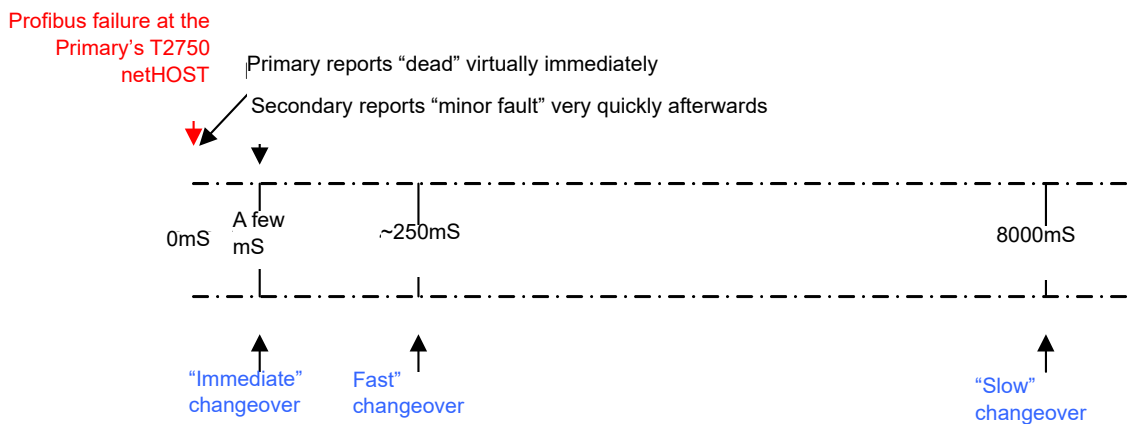
Fault Scenario 4: Total failure of Secondary's netHOST

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 "Fault Scenario 3: Ethernet break between Secondary's T2750 and netHOST" on page 172).

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.

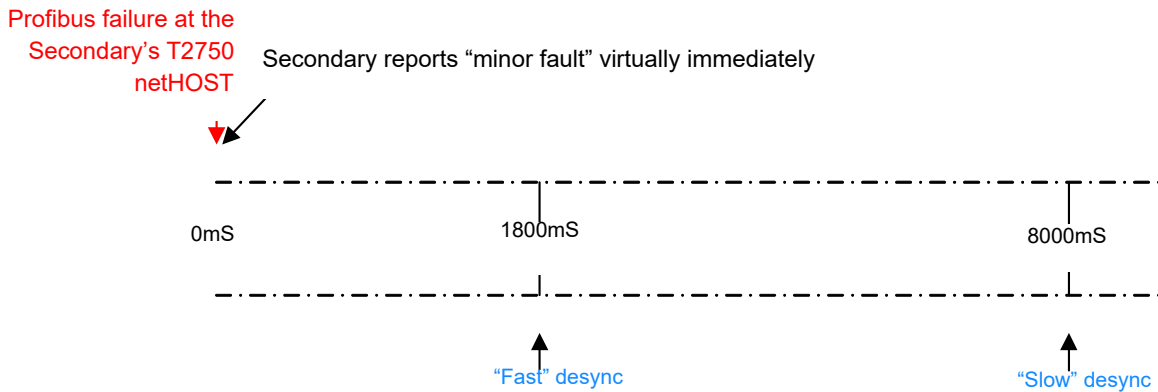
The secondary T2750 will report "minor fault" almost immediately. However, it takes a small, but finite, time for this information to propagate from the secondary to the primary. The figure below shows a timeline of the events which will result in a changeover of the T2750s. If the redundancy logic for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



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 (because the secondary 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.



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 Secondary’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.

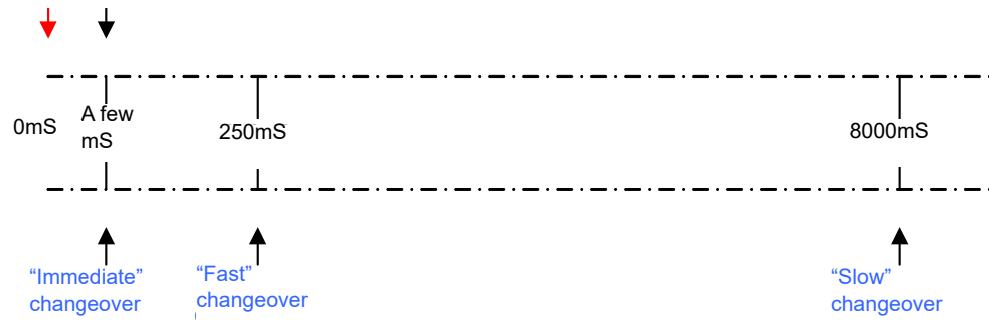
Both the Primary and Secondary T2750 will report “minor fault”, but a desync or changeover will not occur.

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.

All Profibus slaves are missing

Primary reports "minor fault" virtually immediately
Secondary reports "all OK" as it can still see the Primary



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.

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.

Replacement Procedures

Software/Firmware Upgrade

The T2750 software/firmware can be upgraded by putting an upgrade file onto the T2750 and cycling the power. From the T2750 V3/3 onwards, the upgrade file also contains the bootrom image, which will be updated at the same time as the main firmware. Bootrom upgrade is skipped if the bootrom in the instrument is already the latest version.

There are three ways to perform an upgrade, 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 179 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 SD 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 from the T2750 (refer to the "SD CARD REPLACEMENT PROCEDURE" on page 151 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.
7. If upgrading from pre V6/0 to V6/0 (or above), set the Instrument Password if this is a simplex instrument or if this is the first processor of a duplex redundant pair being upgraded.

Option 2 – Upgrading Over a Network

Note: These Notes apply to firmware v6/0 (or above).

Notes:

1. Prior to V6/0 the FTP server supported an account where both the username and password were "DEVT2750".
2. From V6/0, the FTP server password must be configured via the Instrument Options Editor.
3. The file upload.txt contains the password ('DEVT2750') - replace this with the password you have configured.

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.
6. If upgrading from pre V6/0 to V6/0 (or above), set the Instrument Password if this is a simplex instrument or if this is the first processor of a duplex redundant pair being upgraded.

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 "USB Configuration" on page 70 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.
7. If upgrading from pre V6/0 to V6/0 (or above), set the Instrument Password if this is a simplex instrument or if this is the first processor of a duplex redundant pair being upgraded.

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

Note: These Notes apply to firmware v6/0 (or above).

Notes:

1. If both units are V6/0 (or above) there is no need to set the instrument password in the new secondary (it will be copied as part of the synchronisation process).
2. When upgrading from pre-V6/0 to V6/0 (or above) it will be necessary to set the instrument password in the newly upgraded secondary before attempting to run it as a secondary.
3. Whilst the units with pre-V6/0 and V6/0 (or above) are operating as a duplex pair, the unit running V6/0 (or above) will flash its LEDs to indicate "password error" (see "LED Interpretation" on page 75). Once you have changed over so that the new unit is Primary, the units will refuse to resynchronise (i.e. step 8, below, is skipped).
4. It is essential that firmware is updated on both sides of a duplex pair, rather than continuing to run with a pair mixed - one running pre-V6/0 and one running V6/0 (or above).

To upgrade a duplex configured system, upgrade Option 2 – Upgrading Over a Network or Option 3 – Upgrading Using a USB Memory Stick 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 then 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 SD 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.

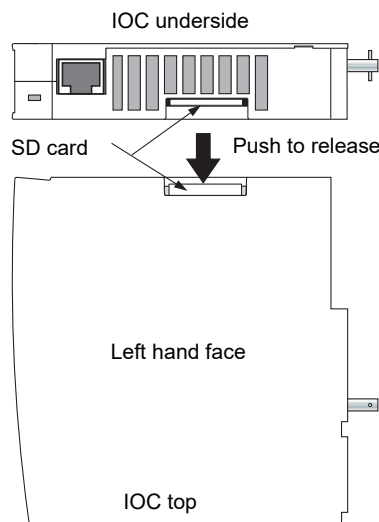


Figure 102 SD card replacement

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 103), then insert 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.

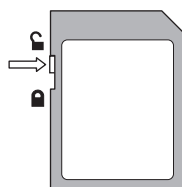


Figure 103 Write protect tab

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.

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. Shut down the secondary module by pressing its 'Desync' switch for longer than three seconds.

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 180mm high x 132mm deep (2.41in x 7.1in x 5.2in) 4 module: 172mm wide x 180mm high x 132mm deep (6.79in x 7.1in x 5.2in) 8 module: 274mm wide x 180mm high x 132mm deep (10.8in x 7.1in x 5.2in) 16 module: 477mm wide x 180mm high x 132mm 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 (9.016in) 16 module: 432.2mm (17.016in)

See Figure 1 and Figure 2 for dimensional details.

Weight

0-way	0.7kg (1.54lb), including controller module.
4-way:	No modules = 0.7kg (1.54lb). Including 2 x IOC and 4 x I/O modules = 1.65kg (3.64lb) max.
8-way:	No modules = 0.98kg (2.16lb). Including 2 x IOC and 8 x I/O modules = 3.1kg (6.83lb) max.
16-way:	No modules = 1.6kg (3.53lb). Including 2 x IOC and 16 x I/O Modules = 5.24kg (11.55lb) max.

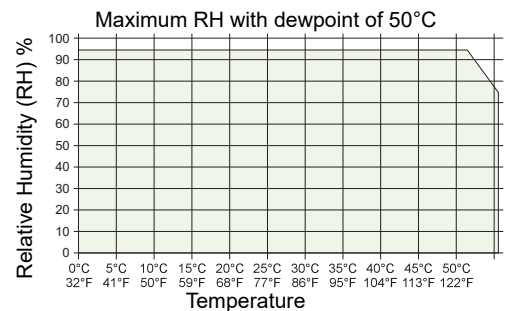
Electrical

Protective earth ground 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 2.9)

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 with-stand	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
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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:	100Mbps
Network Topology:	Star connection to a hub
Line length (max):	100 metres, extendible 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.)	50mm wide x 110mm 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 9)

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 2.9)
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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	25mm wide x 114.3mm high x 110mm deep
Flash memory	32MB
SD card	Factory formatted. Removable from underside of the IOC module
LED Indicators	Status (24V dc nominal - 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)	800kB

Sequence Control Resources

Program data:	400kB
N° of independent sequence tasks:	36 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:	51,672 bytes
Maximum Tables:	250
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 EN-ET3 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

A4.1.1 Thermocouple Input Variant

mV inputs, Thermocouple inputs

Input range	-150mV to +150mV
Input impedance	>100M Ω (sensor break detect circuit 'Off')
Input leakage current	<100nA (sensor break detect circuit 'Off')
Calibration accuracy	$\pm 0.1\%$ of measured value $\pm 10\mu\text{V}$
Noise	<28 μV peak-to-peak with filter off: <4 μV peak-to-peak with 1.6s filter (better with longer time constants)
Resolution	Better than 2 μV with 1.6s filter
Linearity	Better than 5 μV
Temperature coefficient	<40ppm of reading per $^{\circ}\text{C}$
Sensor break protection	Switchable as 'High', 'Low' or 'Off'. Sensor current: 125nA

Cold Junction

Temperature range:	-10 $^{\circ}\text{C}$ to +70 $^{\circ}\text{C}$
CJ Rejection:	>30:1
CJ accuracy:	$\pm 0.5^{\circ}\text{C}$ typical ($\pm 1.0^{\circ}\text{C}$ 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	>100M Ω (sensor break detect circuit 'Off')
Input leakage current	<100nA (sensor break detect circuit 'Off')
Calibration accuracy	$\pm 0.1\%$ of measured value $\pm 20\mu\text{V}$
Noise	<100 μV peak-to-peak with filter off: <15 μV peak-to-peak with 1.6s filter (better with longer time constants)
Resolution	Better than 7 μV with 1.6s filter
Linearity	Better than 50 μV
Temperature coefficient	<40ppm of reading per $^{\circ}\text{C}$

A4.1.2 DC Input Variant

mV inputs

Input range	-150mV to +150mV
Input impedance	>100M Ω (sensor break detect circuit 'Off')
Input leakage current	<100nA (sensor break detect circuit 'Off')
Calibration accuracy	$\pm 0.1\%$ of measured value $\pm 10\mu\text{V}$
Noise	<28 μV peak-to-peak with filter off: <4 μV peak-to-peak with 1.6s filter (better with longer time constants)
Resolution	Better than 2 μV with 1.6s filter
Linearity	Better than 5 μV
Temperature coefficient	<40ppm of reading per $^{\circ}\text{C}$

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	>100M Ω (sensor break detect circuit 'Off')
Input leakage current	<100nA (sensor break detect circuit 'Off')
Calibration accuracy	$\pm 0.1\%$ of measured value $\pm 20\mu\text{V}$
Noise	<100 μV peak-to-peak with filter off: <15 μV peak-to-peak with 1.6s filter (better with longer time constants)
Resolution	Better than 7 μV with 1.6s filter
Linearity	Better than 50 μV
Temperature coefficient	<40ppm of reading per $^{\circ}\text{C}$
Voltage inputs	
Input range	-10.3V to +10.3V
Input impedance	303k Ω
Calibration accuracy	$\pm 0.1\%$ of measured value $\pm 2\text{mV}$
Noise	<2mV peak-to-peak with filter off: <0.4mV peak-to-peak with 1.6s filter (better with longer time constants)
Resolution	Better than 0.2mV with 1.6s filter
Linearity	Better than 0.7mV
Temperature coefficient	<40ppm of reading per $^{\circ}\text{C}$
Resistance inputs	
Input range	0 Ω to 560 Ω (includes support for 2-, 3- or 4-wire RTD connection)
Lead resistance	22 Ω maximum each lead (total resistance to be within range limits)
Sensor current	320 μA maximum
Calibration accuracy	$\pm 0.1\%$ of measured value, $\pm 0.1\Omega$
Noise	<0.08 Ω peak-to-peak with 1.6s filter (better with longer time constants)
Resolution	Better than 0.04 Ω with 1.6s filter
Linearity	Better than 0.05 Ω
Temperature coefficient	<30ppm of reading per $^{\circ}\text{C}$
High Resistance input	
Input range	0 to 6k Ω (includes support for 2-, 3- or 4-wire RTD connection)
Lead resistance	22 Ω maximum each lead (total resistance to be within range limits)
Sensor current	320 μA maximum
Calibration accuracy	$\pm 0.1\%$ of measured value, $\pm 0.6\Omega$
Noise	<0.5 Ω peak-to-peak with 1.6s filter (better with longer time constants)
Resolution	<0.25 Ω with 1.6s filter
Linearity	Better than 0.1 Ω
Temperature coefficient	<30ppm of reading per $^{\circ}\text{C}$
Potentiometer inputs	
Input range	0 to 100% rotation
End-to-end resistance	100 Ω (min.) to 6k Ω (max.)
Drive current	310 μA maximum
Calibration accuracy	$\pm 0.1\%$ of rotation value, $\pm 0.1\%$
Noise	<0.01% peak-to-peak with 1.6s filter (5k Ω pot.); <0.3% peak-to-peak with 1.6s filter (100 Ω pot.)
Resolution	Better than 0.001% with 1.6s filter and 5k Ω pot
Linearity	Better than 0.01%
Temperature coefficient	<20ppm of reading per $^{\circ}\text{C}$

A4.1.3 mA Input Variant

4 to 20mA 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 peak-to-peak with 1.6s filter (better with longer time constants)
Resolution	Better than 0.5μA with 1.6s 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 24W for the eight module base or 48W 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 peak-to-peak with 1.6s filter (better with longer time constants)
Resolution	Better than 0.5μA with 1.6s 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 (nominal) 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 insulation)
Max. voltage across any channel	5V dc

A4.3.1 Thermocouple Input Variant

Thermocouple inputs	
Input range	-150mV to +150mV
Input impedance	>20M Ω (sensor break detect circuit 'Off')
Input leakage current	<125nA (sensor break detect circuit 'Off')
Calibration accuracy	$\pm 0.1\%$ of measured value $\pm 10\mu\text{V}$
Noise	<28 μV peak-to-peak with filter off; <6 μV peak-to-peak with 1.6s filter (better with longer time constants)
Resolution	Better than 2 μV with 1.6s filter
Linearity	Better than 5 μV
Temperature coefficient	<40ppm of reading per $^{\circ}\text{C}$
Sensor break protection	Fixed pull-up. Sensor current: 125nA

Cold Junction

Temperature range:	-10 $^{\circ}\text{C}$ to +70 $^{\circ}\text{C}$
CJ Rejection:	>30:1
CJ accuracy:	$\pm 0.5^{\circ}\text{C}$ typical ($\pm 1^{\circ}\text{C}$ 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	>20M Ω (sensor break detect circuit 'Off')
Input leakage current	<125nA (sensor break detect circuit 'Off')
Calibration accuracy	$\pm 0.1\%$ of measured value $\pm 10\mu\text{V}$
Noise	<28 μV peak-to-peak with filter off; <6 μV peak-to-peak with 1.6s filter (better with longer time constants)
Resolution	Better than 2 μV with 1.6s filter
Linearity	Better than 5 μV
Temperature coefficient	<40ppm of reading per $^{\circ}\text{C}$

A4.3.3 mA Input Variant

Input range	-25mA to +25mA
Calibration accuracy	±0.25% of measured value plus ±2µA max offset
Noise	<1µA peak-to-peak with 1.6s filter (better with longer time constants)
Resolution	Better than 0.5µA with 1.6s 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 AI8-RT)
Module power consumption	<1.8W
Common mode rejection (47 to 63 Hz)	>140dB
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 (at 25°C) ±8µV for values inside -8mV to +8mV
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

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

A4.4.2 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

A4.4.3 mA Input Variant

Suitable transmitter types	4-20mA sensors (floating or grounded)
As mV input, with:	
Input range	± 24 mA with 3.33 Ω burden resistors fitted in the terminal unit
Calibration accuracy	$\pm 0.15\%$ of mA reading for values outside -2.4mA to +2.4mA (at 25°C ambient temperature)
Resolution/Noise	>17bit with 1.6s filter ($\pm 0.5\mu$ A) 16bit of span with no filter ($\pm 1.0\mu$ A)
DC common mode rejection (w.r.t. other channels of the same pair)	>105dB for source impedance mismatch <100 Ω
Linearity	10ppm of span
Temperature coefficient	< ± 40 ppm per °C (using 10ppm burden resistor)
Zero offset	< $\pm 1\mu$ A
Offset drift	< ± 8 pA/°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	0 Ω to 500 Ω and 0 Ω to 5k Ω (including lead resistance)
Calibration accuracy	500 Ω range $\pm 0.1\%$ of resistance reading above 10% of range (>50 Ω) (at 25°C ambient temperature) ± 50 m Ω below 10% 5k Ω range $\pm 0.1\%$ of resistance reading above 10% of range (>500 Ω) (at 25°C ambient temperature) ± 500 m Ω below 10%
Resolution/Noise	>17bit (± 8 m Ω) with 1.6s filter 16bit (± 16 m Ω) with no filter
Linearity	20ppm of input range
Temperature coefficient	< ± 20 ppm 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 500 Ω
Calibration accuracy	Better than $\pm 0.1\%$ of reading
Linearity	0.03% range (0.7 μ A)
Resolution	Better than 1 part in 10000 (1 μ A typical)
Voltage outputs	
Output load limits	-0.1 to 10.1V range: 550 Ω min. -0.3V to +10.3V range: 1500 Ω 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
De-bounce 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 0.04mA at 115Vac 60Hz or 0.08mA 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

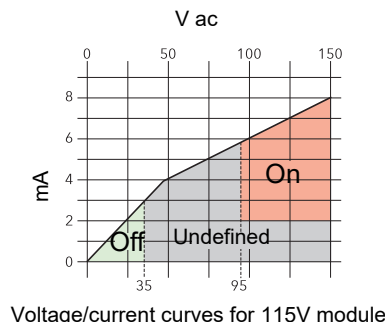
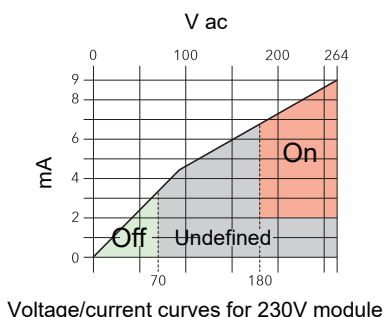
115V inputs	
Off (logic 0) voltage	0 to 35V ac
On (logic 1) voltage	95V to 150V ac
Input current	Maximum: 8mA at 150V RMS
	Minimum: 2mA
Max voltage across any channel	150V RMS

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 180V is not defined.



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
De-bounce 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 DI16 Module

General specification

Power consumption	Logic mode:	0.75W max.
	Contact mode:	2.0W 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
De-bounce 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 12V dc; 2.8mA approx. at 24V dc

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

Contact inputs

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

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

A4.10 DO4 Module

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 \pm 6V dc
Logic 1 o/p voltage	($V_{CS} - 3$)V for a 5mA load
Logic 0 o/p voltage	<1V dc
Logic 1 o/p current	8mA per channel (current limited)
Off state leakage	<0.1mA

Voltage outputs

Voltage supply (V_{CS})	12V to 30V dc
Logic 1 o/p voltage	($V_{CS} - 3$)V for a 5mA load
Logic 0 o/p voltage	<1V dc
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 0.6W max.
 Isolation Channel to channel: Channels share 'common' ('C') connections.
 to system: 300V RMS or dc (Double insulation)

Refer to "Electrical Installation" on page 31 for precautions to be taken when fitting DO8 modules

Input specification

Voltage supply (V_{CS}) 18V 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 ($V_{cs} - 3$)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)

Input specification

Voltage supply (V_{CS}) 24V dc $\pm 20\%$
 Logic 1 o/p voltage ($V_{cs} - 1$)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 10 μ A
 Short circuit protection 0.7A to 1.7A per channel
 Module thermal cut-off (55°C ambient) 90 ± 3 °C (restart at 88 ± 3 °C)

Refer to "Eight-channel Digital Input Module (DI8)" on page 45 for precautions to be taken when fitting DO16 modules

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 41). 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 chan- nel:	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 (de-bounce 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 (de-bounce off)
		Magnetic: 10Hz to 40kHz
Resolution		<600 ppm of reading for square wave input
Max-frequency derating, due to de-bounce		
	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 (de-bounce off)	1.2µs
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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 24V dc 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 "Two-channel Frequency Input Module (FI2)" on page 51. Leakage across the snubber at 240V ac 60Hz = approx. 2mA.

General specification

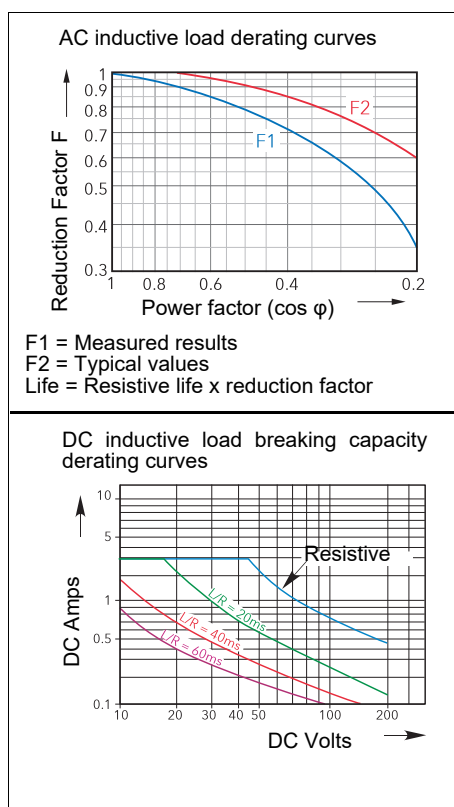
Power consumption	1.1W max.
Isolation	Channel to channel: 300V RMS or dc (Basic insulation)
	Channel to system: 300V RMS or dc (Double insulation)
Contact life (resistive load)	240Vac, 2A: >6x10 ⁵ operations
	240Vac, 1A: >10 ⁷ operations
Contact life (inductive load)	As per derating curves
Mechanical 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



The above derating curves apply to the relays in both RLY4 and RLY8 modules.

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)

A4.16 ZI Module

General specification	
Power consumption	1.8W max
Common mode rejection	>80dB (48 to 62Hz)
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
	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 \pm 6V dc (with reverse voltage protection)
Current consumption at 24V (typically)	130mA
Power consumption	3.2W
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 xH)	100mm x 52mm x 70mm (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
Supported baud rates	max 237 bytes/slave application specific parameters 9.6kbit/s 19.2kbit/s 31.25kbit/s 45.45kbit/s 93.75kbit/s 187.5kbit/s 500kbit/s 1.5Mbit/s 3Mbit/s 6Mbit/s 12Mbit/s Auto baud rate 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	100Mbit/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_DISP_EX	Sequential function chart display extension 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
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_LIFE_EX	Thermocouple life-expectancy extension 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
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A5.7 Diagnostics 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	Eurotherm I/O diagnostic block
ELINDIAG	ELIN MAC and LLC diagnostic block
EMAP_DIAG	ELIN 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
SD_DIAG	SD card 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
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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 Reference

B1 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.

B1.1 Terminal Connections, Links and Status LEDs

"Two-channel Frequency Input Module (FI2)" on page 51 gives full pinout, link setting and status LED details. For the sake of clarity, Figure 39 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.

B1.2 Specification

"A4.13 FI2 Module" on page 196 gives the FI2 module specification

B1.3 Application Details

B1.3.1 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 lowcapacitance (<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 12pF/foot or less should be considered for longer distances. A cable similar to the Belden 3084A could be used, for example.

B1.3.2 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.

B1.3.3 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/pulldown 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 "B1.5.4 Contact Inputs" on page 212 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.

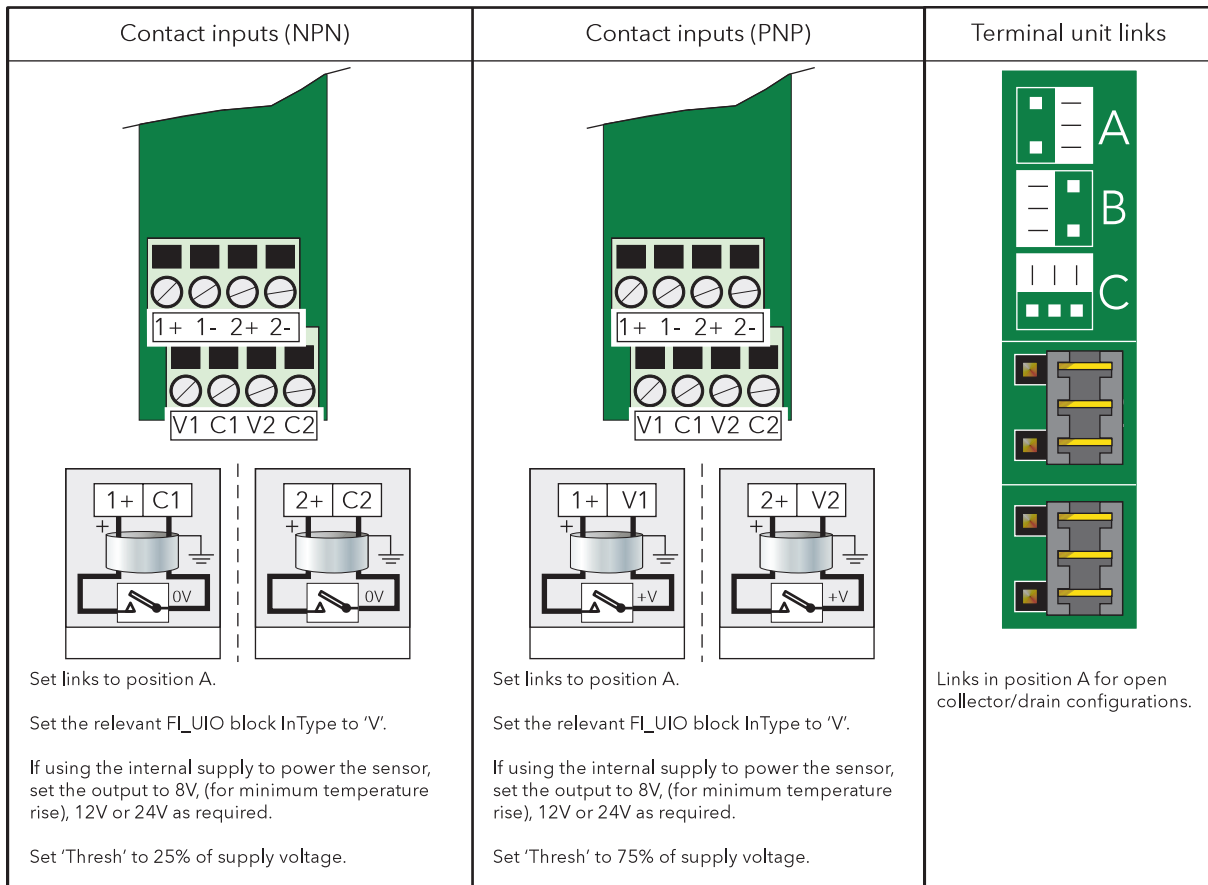


Figure 104 FI2 terminal unit connectors for open collector/drain configuration

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.

Block: input 1		Comment	Connections		
HR	10000	Eng1	InType	mA	
LR	0	Eng1	HR_in	10000	Eng2/s
HiHi	10000	Eng1	LR_in	0	Eng2/s
Hi	10000	Eng1	Scale	1	
Lo	0	Eng1	FI	0	Hz
LoLo	0	Eng1	Thresh	0.000	mA
Hyst	0.5000	%	Burden	0.000	Ohms
Filter	0.000	Secs	Debounce	0.000	mSecs
UserChar			PSU	12.00	Volts
Default	0	Eng1	CutOff	0	Eng1

Figure 105 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 "B1.5.2 Voltage Inputs" on page 211 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.

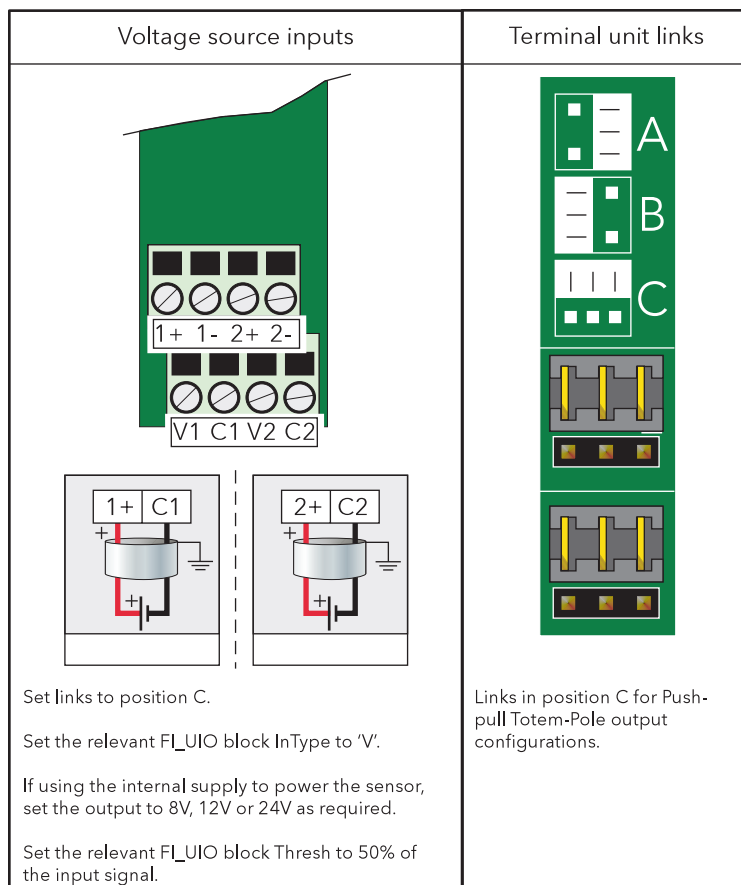


Figure 106 FI2 terminal unit connectors for Push-pull Totem-Pole input configuration

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:

- Set the links to position C on the terminal unit. This is clearly marked on the silk screen of the terminal unit.
- The maximum current that should be drawn from the FI2 supply is 25mA on any selected voltage range.
- 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.

B1.3.4 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 "Two-channel Frequency Input Module (FI2)" on page 51 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 milliamps).

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.

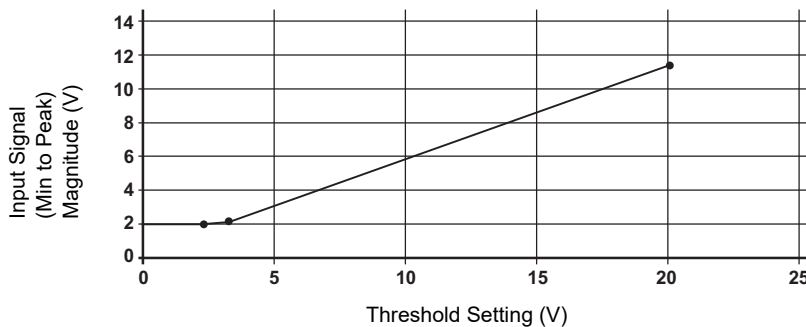


Figure 107 Input signal versus Threshold

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 B.4 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).

B1.4 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.

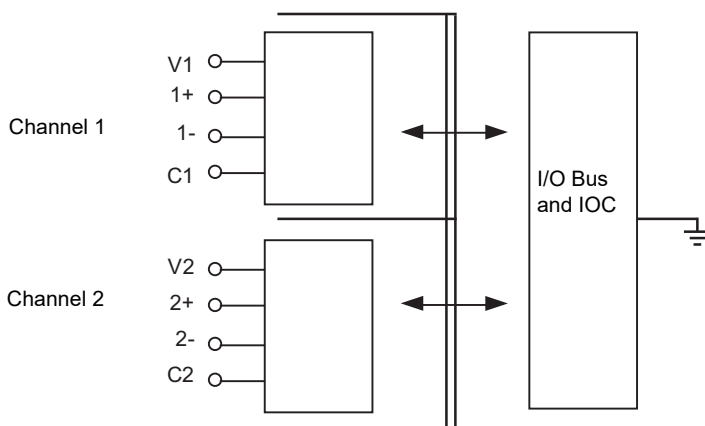


Figure 108 Isolation Diagram

B1.5 Equivalent Circuits

B1.5.1 Magnetic Inputs

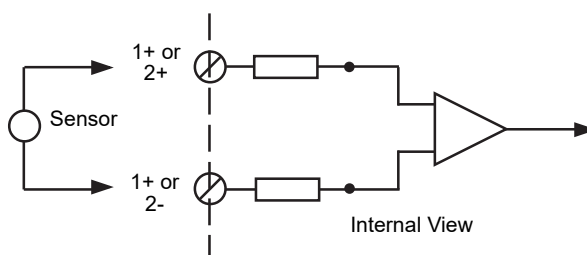


Figure 109 Magnetic Input

B1.5.2 Voltage Inputs

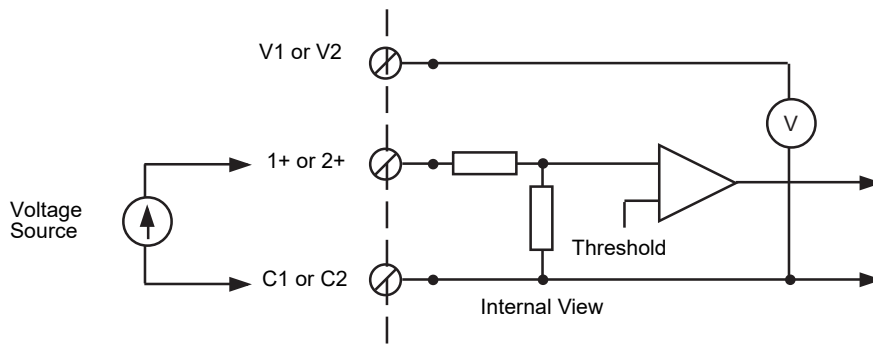


Figure 110 Voltage Inputs

B1.5.3 Current Inputs

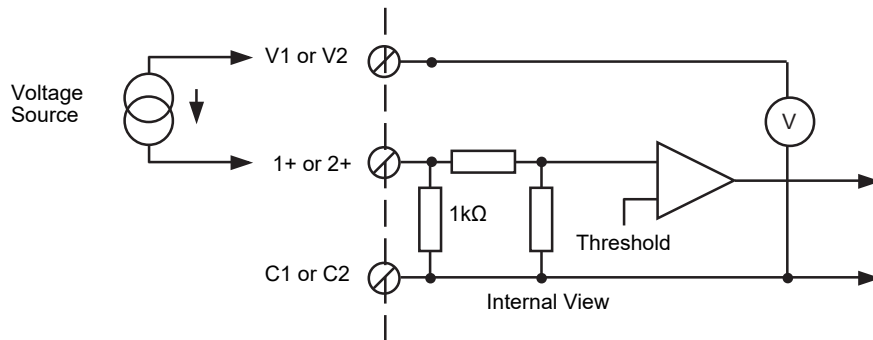


Figure 111 Current Inputs

B1.5.4 Contact Inputs

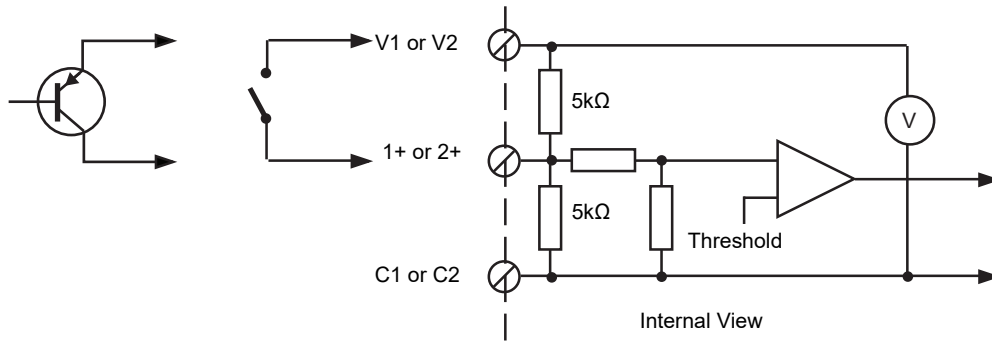


Figure 112 Contact Inputs (PNP) or Volt-Free

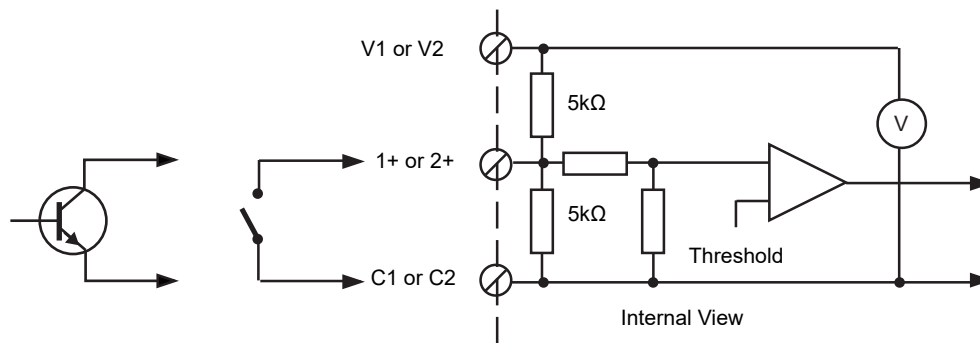


Figure 113 Contact Inputs (NPN) or Volt-Free

B1.6 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 40), and the Status and Alarms bits of the corresponding FI_UIO block.

B1.6.1 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 that 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' to True. To resolve the problem, ensure 'LR_in' and 'HR_in' fields correspond to the range used by the installed hardware.
HwFit	A fault in the output supply is detected caused by output supply overload. This sets the Alarms.Hardware field to True.
NotAuto	The module is not operating in Automatic mode. This sets the 'Alarms.NotAuto' field to 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 to True. ShortCct An Short circuit fault in the Logic Sensor is detected, setting the 'Alarms.CctFault' field to 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 2.39) 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 to 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).

B2 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 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

B2.1 Terminal Connections and Status LEDs

"Zirconia Input Module (ZI)" on page 56 gives full pinout and status LED details.

B2.2 Specification

"A4.16 ZI Module" on page 199 gives the ZI module specification.

B2.3 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.

B2.3.1 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.

B2.3.2 Carbon Potential Control

The Zirconia probe generates a millivolt (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.

B2.3.3 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.

B2.3.4 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.

B2.3.5 Endothermic Gas Correction

A gas analyser may be used to determine the CO or H₂ 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.

B2.4 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.

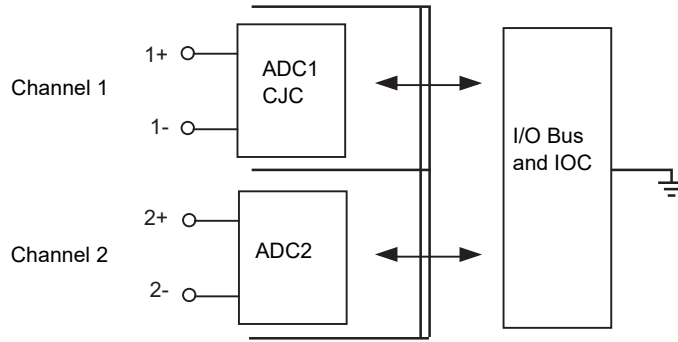


Figure 114 Isolation Diagram

B2.5 Equivalent Circuits

B2.5.1 Analogue Inputs

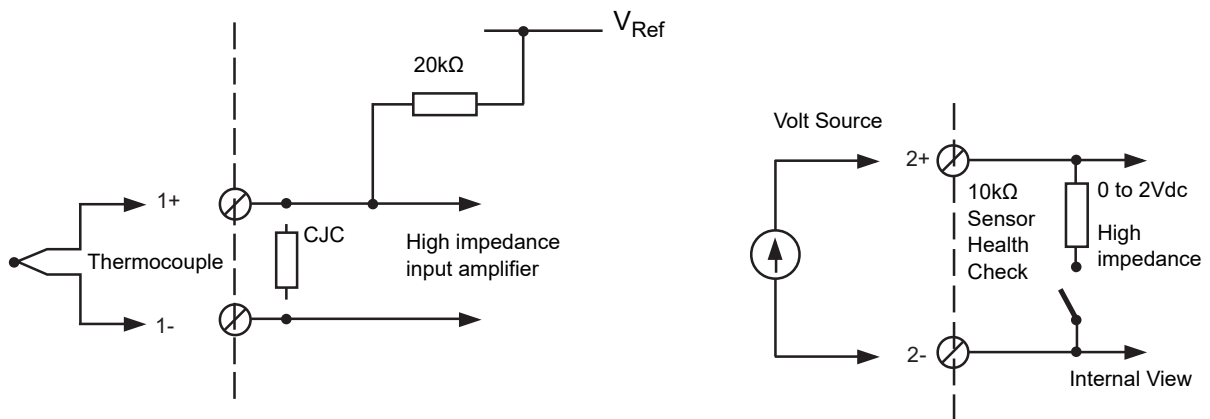


Figure 115 Equivalent circuit

B2.6 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 40), and the Status and Alarms bits of the corresponding Zirconia block.

B2.6.1 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 to True.
TempSt	The Probe Temperature Input value has failed (possibly due to a Probe failure). This fault sets the 'Alarms.TempS' field to 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 to 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 to 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 to 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 to 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 to 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 to True. To resolve the problem, launch the cleaning process and ensure that it completes successfully. If alarms continue to be generated, replace the probe.
MxlmRcvT	The Probe impedance measurement recovery time has been exceeded, possibly caused by a Probe failure. This

	fault sets the ' Alarms.ImpRcWn field' to 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 to True. To resolve the problem, ensure the Probe impedance measurement sequence completes successfully or reset the impedance measurement message field ('ImpMsgRt' to True).
ImpRcvWn	The Probe impedance measuring sequence could not be performed. This fault sets Alarms.ImpRcvWn field to True. To resolve the problem, launch the impedance measuring process and ensure that the Probe impedance measuring completes successfully.

B3 Glossary

This section contains explanations of abbreviations and other terms used within this document.

Abbrev/Term	Meaning/Description
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 often used synonymously despite this being untrue.
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 Communications
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 take over 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.
Reviewer	A proprietary software option, similar to Review, which allows archive data to be stored in a database. Reviewer is available in a number of different variants which range from local installations on a desktop PC (similar to Review) to a cloud-based solution allowing data to be gathered and shared from multiple instruments in multiple sites, and viewed anywhere on any device.
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 data 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 arrives 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.
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

B4 LIN Block Licences

This section shows which blocks are included at each licence level.

B4.1 Foundation Level

Input/Output	Communications	AN_CONN	Diagnostic
AI_UIO	GW_CON	DG_CONN	All diag blocks
AO_UIO	GW_TBL	Timing	RGROUP
DI_UIO	Conditioning	TIMER	Programmer
DO_UIO	CHAR	TIMEDATE	PROGCTRL
FI_UIO	UCHAR	TPO	
MOD_UIO	FILECHAR	RATE_ALM	
MOD_DI_UIO	AN_ALARM	Selector	
MOD_DO_UIO	DIGALARM	ALC	
TPO_UIO	ZIRCONIA		
VP_UIO	Control		
CALIB_UIO			

B4.2 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	
ANMS	RATE_LMT	OR4	Control modules	RECORD
DGME	TOTAL	XOR4	VLV1IN	DISCREP
SIM	TOTAL2	NOT	VLV2IN	SFC_MON
SETPOINT	TOT_CON	LATCH	VLV3WAY	SFC_DISP
TC_SEL	DTIME	COUNT	MTR3IN	SFC_CON
	SEQE	COMPARE	DUTYSTBY	

B4.3 Control Level

Control level includes all the foundation and standard level blocks, together with the following additional blocks:

Control	Maths	Communications
TC_LIFE	ACTION	RAW_COM
PID	DIGACT	
3_TERM	ACT15A3W	
LOOP_PID	ACTUI818	
Timing	Batch	
SEQ	SFC-CON	

B4.4 Advanced Level

Includes all the above blocks plus Conditioning blocks: GASCONC and AGA8DATA

Appendix C 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 116): 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.

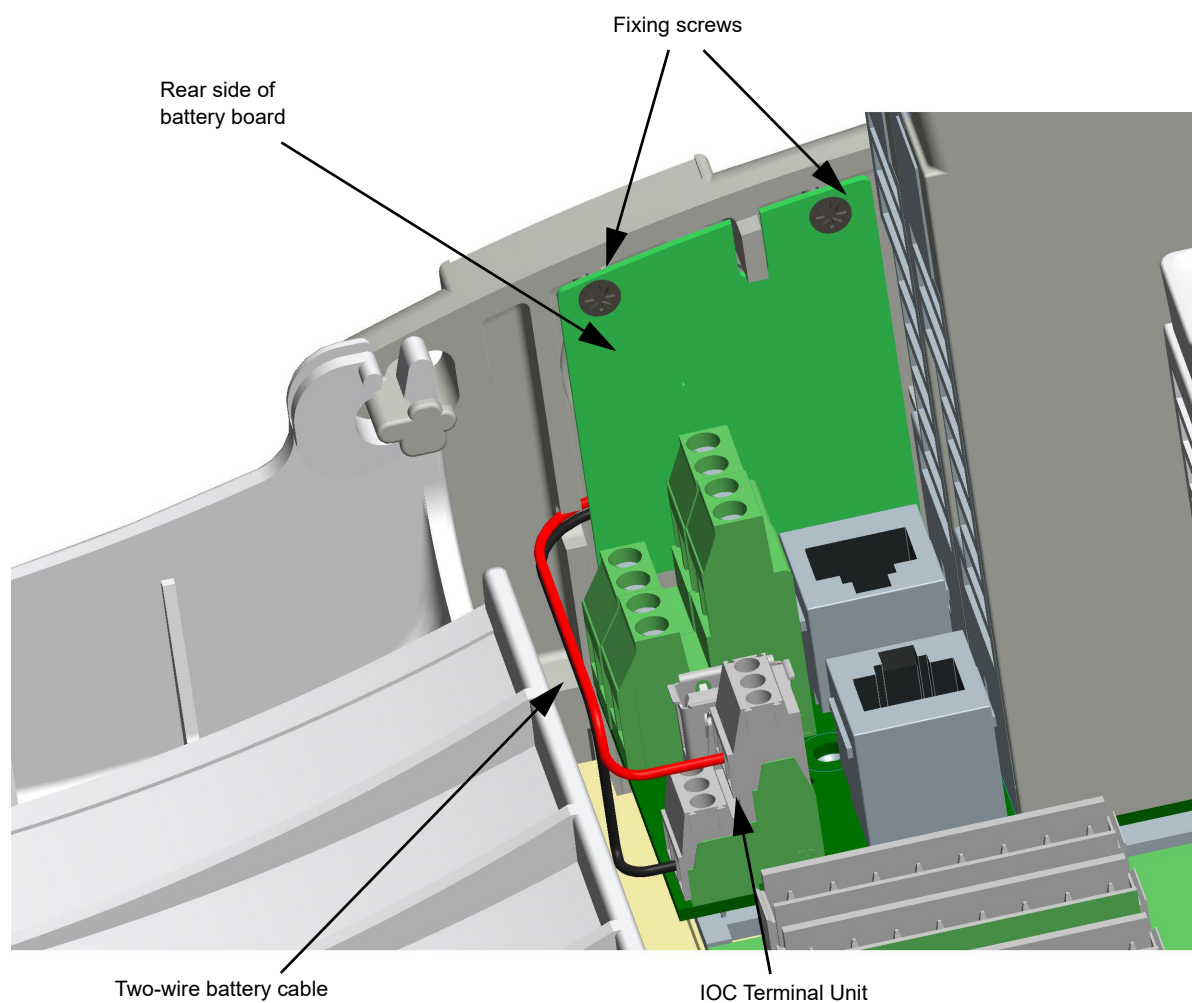


Figure 116 Battery board in place

3. Using a magnetised Pozidrive #1 screwdriver, unscrew the two fixing screws holding the battery board in place.
4. Carefully manoeuvre the battery board off from the plastic side panel. Unplug the two-wire cable from the board end (Figure 117).

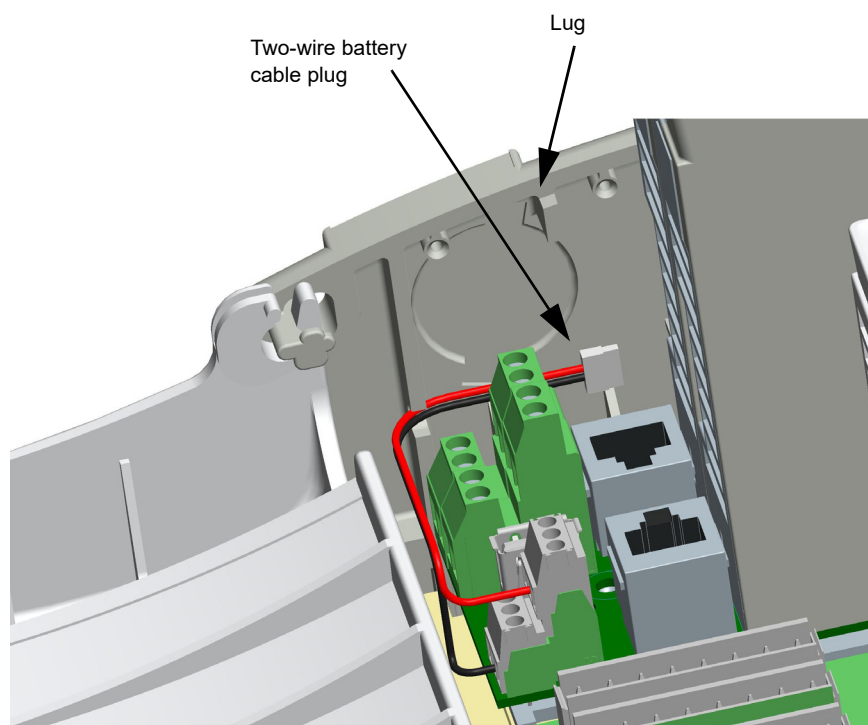


Figure 117 Battery board removed

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 118), and plug the two-wire battery cable into it.

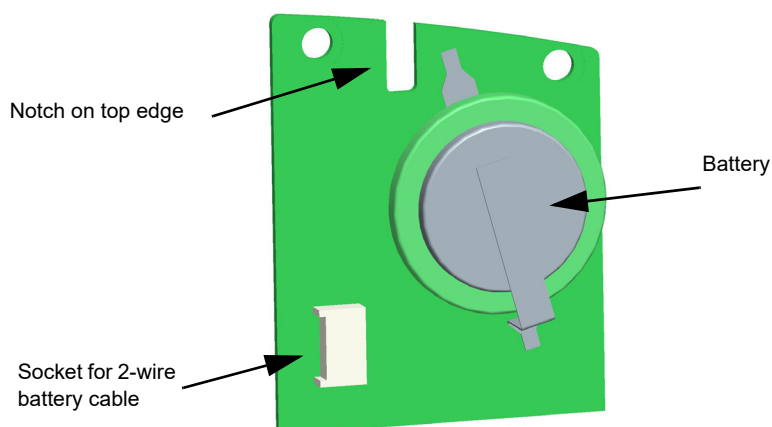


Figure 118 New battery board

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.

Appendix D System Variables

The following tables lists all the system variables used on the T2750 instrument.

Variable Name	Usage	Notes
"DATE"	current date	In the format: dd/mm/yy
"TIME"	current time	In the format: hh/mm/ss
"TZ_DST"	TRUE is DST is active	0 = False 1 = True
"RCP_ID"	ID of currently selected recipe (or 0 if none)	
"BAT_ID"	ID of currently selected batch (or 0 if none)	
"ALM_ACT"	Total number of active alarms	
"ALM_NAK"	Total number of unacknowledged alarms	
"ALM_LVL"	Alarm level	alarm level is bit encoded: 1 = there is at least one active alarm 2 = there is at least one unacked alarm
"ALM_SUP"	Total number of suppressed alarms	
"ALM_STA"	Alarm statistics:	NumActive/NumUnack{/NumSuppressed}
"ALM_URG"	Most urgent alarm	Most urgent entry in alarm history log: Block_Name Alarm_Name
"PROG_ID"	ID (name) of current programmer	
"SYSDATE"	System (UTC) date	In the format: dd/mm/yy
"SYSTIME"	System (UTC) time	In the format: hh/mm/ss
"APP_NAME"	Database name	
"RCP_FILE"	Name of currently loaded recipe file	
"RCP_NAME"	Name of currently loaded recipe	
"RCP_RECEN"	Number of currently loaded recipe	
"BAT_FILE"	Name of currently loaded batch file	
"PROG_END"	Estimated end time or date of program	
"PROG_REM"	Estimated time remaining in program	In the format: hh/mm/ss
"PROG_ERR"		
"PROG_SCH"		
"TZ_SUFFIX"	Time suffix as configured	e.g.'GMT+1'
"RCP_STATE"	State of current recipe	

Variable Name	Usage	Notes
"RCP_STATE"	State of current recipe	
"BAT_STATE"	Batch state	
"BAT_PHASE"	Name of current phase	
PROG_NAME	Program name	
"RCP_LINE_S"	Name of current recipe line	
"RCP_LINE_N"	Index of current recipe line	
"UNRESOLVED"	Count of unresolved references	The function which derives this always returns 0 for the T2750
"PROG_STATE"	Program state	
"PROG_SEG_N"	Current segment number	
"PROG_SEG_S"	Current segment name	
"PROG_HBACK"		
"TZ_SUFFIX1"	Time suffix: name only	e.g. 'Paris'
"TZ_SUFFIX2"	Time suffix: name + 'DST' if active	
"TZ_SUFFIX3"	Time Suffix: GMT offset	
"BAT_PHASE_N"	Phase number of current batch	
"PROG_SEG_ID"	ID of current segment	
"PROG_SEG_REM"	Segment time remaining	
"PROG_CYC_NUM"	Program cycle number	
"PROG_CYC_REM"	Program cycles remaining	
"PROG_CYC_TOT"	Total program cycles	
"PROG_CYC_PCT"	Program cycles executed as a percentage	
"PROG_CYC_FRC"	Program cycles executed as a fraction	

Appendix E Recover Lost Password

Note: A lost password does not affect a running controller even if power fails.

If the instrument password is not known or has been forgotten, then it can be recovered by the following procedure:

1. This procedure requires physical access to the instrument, it must be powered down, the SD Card removed, and inserted to a card reader on a PC.
2. Edit the file IDENTITY.USA (use a simple text editor – e.g. notepad).

Sample IDENTITY.USA contents:

```
SerialNumber=115112  
ResetToFactoryDefault=NO
```

Notes:

- a. DO NOT touch or edit any other file otherwise normal operation may be adversely affected.
 - b. This file is specific to an instrument and must only be edited for that instrument. Do not attempt to copy this file from one instrument to another.
3. Replace the string “ResetToFactoryDefault=NO” with “ResetToFactoryDefault=YES”
 4. Replace the SD Card into the instrument and power it up. The instrument will revert to ‘no instrument password set’. The ‘ResetToFactoryDefault’ line is reset to ‘No’ so does not need to be copied and edited again.
 5. All user configuration files remain intact – a new instrument password must be set before any runtime operation or configuration is possible.
 6. Normal instrument functioning is restored.

Note: For a duplex pair, if the password is forgotten, both will need to be powered off together – this means control will be lost during this process.



Scan for local contents

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HA030047 CN38400