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## Contents T640-FF REFERENCE MANUAL & USER GUIDE

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## INDEX

# Chapter 1 INTRODUCTION

## THE T640

The T640 is the first in the range of T600 Series controllers. It is a multi-purpose 2- or 4-loop controller with a high-speed peer-to-peer communications link and a well-established block-structured database, allowing it to integrate tightly into a Network 6000 distributed control system — where its full versatility and power can be realised. See Figure 1-1. For small yet complex applications, T640's comprehensive front-panel displays and push-buttons mean that it can also work perfectly well on its own as a totally independent controller.

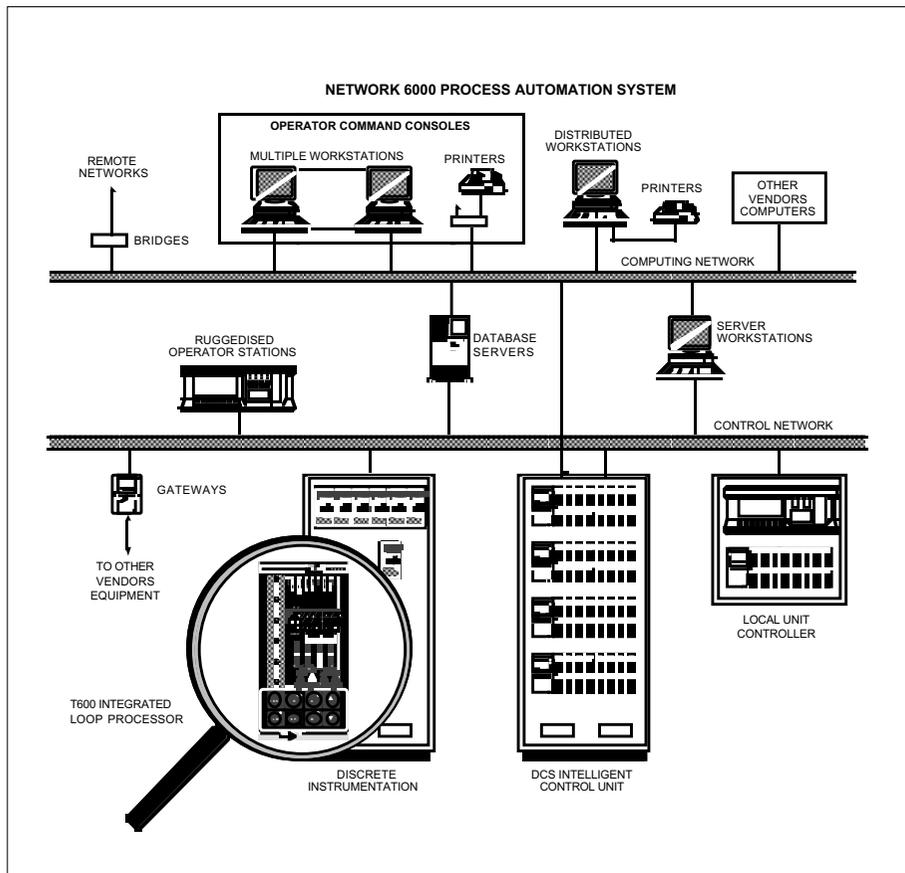


Figure 1-1 Network 6000 distributed control system

## Summary of T640-FF's main features

- Internal switch-selectable pre-configured strategies supplied in the T640's memory
- Easy-to-use 'LINfiler' file-handling package and PC Windows-based parameterisation tool bundled with the instrument
- Clear front-panel text, numeric, and bargraph displays, and controller pushbuttons
- Front-panel overview of all loops, with detail of one selected loop
- Front-panel monitor/edit access to parameter values, protected by IR security key
- High-speed peer-to-peer communications for easy connection to the LIN via bridge
- Serial port option for Bisync slave interface or MODBUS, or for linking internal serial bus to external fascias and remote I/O
- High-level I/O options
- Removable memory module for quick unit replacement and strategy portability
- IP65 front-panel seal, with instrument access entirely from front of panel
- DC or universal AC mains supply options

## What's in this manual

Table 1-1 summarises the contents of the *T640-FF Reference Manual & User Guide* in a concise form. Use the *Table of Contents* at the beginning of the manual for a more detailed breakdown of what's in the individual chapters, and/or the *Index* at the back to locate particular topics.

Chapter	Topics	
1	Introduction	Summary of T640-FF features, packaging, & place in the wider network
2	Installation & startup	Getting T640 going, from unpacking to power-up
3	Hands-on tutorial	Practical experience in using the T640 controls, with a real strategy
4	User interface	Using T640 — front-panel controls & displays explained
5	Fixed-function strategies	Details of the four pre-configured control strategies supplied in ROM
6	Changes logfile	How T640 records every change to a loaded database
7	Inside T640	Internal hardware, pcbs, and communications
8	Error conditions & diagnostics	Error displays & diagnostic messages
9	Specifications	Hardware & software specs. Resources supported. I/O circuits
10	Ordering information	How to order T640 with its various options & accessories

Table 1-1 Topics covered by this manual

## What's not in this manual

### Parameterisation tool

In the fixed-function (FF) version of the T640 you do not have to create your own strategies from scratch — you need only adjust certain parameter values in the databases provided, to adapt them to your particular plant needs. This can be done directly via T640's front panel, and all the information required to do this is given in the present manual. The 'hands-on' tutorial in Chapter 3 also gives you some practice at this.

An alternative way to parameterise fixed-function databases is to use the PC-based *Fixed-Function Parameterisation Tool* (FFPT) supplied in another section of this product manual — section 4. Software and instructions for the FFPT, and also for the file-handling package *LINfiler*, are given there. You will need LINfiler to be able to download/upload databases to/from the T640 via an ALIN link, as well as perform several other useful filing operations.

### Full block-structured strategy configuration using LINTools

If you wish to go on to create and configure your own strategies — or simply adapt existing ones — for running in non fixed-function versions of the T640, you will need to refer to the *LIN Product Manual* (Part No. HA 082 375 U999) for details on all the LIN-based function blocks, their parameters and input/output connections. You will need this data to be able to select, interconnect, and parameterise the blocks in your control strategies.

How to use the PC-based LINTools database configurator to create and download control strategies and sequences is described in the *T500 LINTools Product Manual* (Part No. HA 082 377 U999).

General information on installing, commissioning and using the LIN is given in Section 2 of the product manual you are now reading, in the *LIN/ALIN Installation & User Guide* (Part No. HA 082 429 U005).

## Getting started

The quickest way to get going with the fixed-function version of T640 is to turn directly to Chapter 3 and work through the 'hands-on' tutorial set out there. For this, all you will need is a T640 fitted with an M006 memory module, a power supply, and a piece of wire.

If you are new to the T640, there is no substitute for actual practical experience with the instrument — just reading about it is not the same!

The tutorial will quickly teach you how to navigate around T640's user interface — the front panel — and also introduce you to the simplest of the fixed-function control strategies supplied in the memory module. After that, you will be ready to start customising a selected T640 strategy to suit your plant control needs, based on the detailed information given in Chapter 5, *Fixed function strategies*.

## Chapter 2 INSTALLATION & STARTUP

This chapter presents important safety and EMC information and describes how to install, configure, and power up the loop processor.

The main topics covered are:

- Safety & EMC information
- Unpacking your T640
- Installation
- Connections & wiring
- Hardware configuration
- Binary RS422 configuration
- Modbus RS422/485 configuration
- Software file types
- Control strategies & sequences
- Powerup routine
- Powerup displays.

### SAFETY & EMC INFORMATION

*Please read this section before installing the processor.*

This unit meets the requirements of the European Directives on Safety and EMC. However, it is the responsibility of the installer to ensure the safety and EMC compliance of any particular installation.

### Installation requirements for EMC

This unit conforms with the essential protection requirements of the EMC Directive 89/336/EEC, amended by 93/68/EEC, by the application of a technical construction file.

This unit satisfies the emissions and immunity standards for industrial environments.

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

- **General guidance.** For general guidance refer to the Eurotherm Process Automation *EMC Installation Guide* (Part No. HG 083 635 U001).

- **Relay outputs.** When using relay or triac outputs it may be necessary to fit a filter suitable for suppressing the conducted emissions. The filter requirements will depend on the type of load. For typical applications we recommend Schaffner FN321 or FN612.
- **Use with standard mains socket.** If the unit is plugged into a standard power socket, it is likely that compliance to the commercial and light industrial emissions standard is required. In this case to meet the conducted emissions requirement, a suitable mains filter should be installed. We recommend Schaffner types FN321 and FN612.
- **Routing of wires.** To minimise the pickup of electrical noise, the low voltage DC connections and the sensor input wiring should be routed away from high-current power cables. Where it is impractical to do this, use shielded cables with the shield grounded at both ends.

## Installation safety requirements

This controller complies with the European Low Voltage Directive 73/23/EEC, amended by 93/68/EEC, by the application of the safety standard EN61010-1:1993/A2:1995.

### Personnel

Installation must be carried out only by authorised personnel.

### Protective earth connection



NOTE. A *protective* earth terminal (see symbol inset), in contrast to a *functional* earth terminal, is one that is bonded to conductive parts of an equipment for safety purposes and is intended to be connected to an external protective earthing system.

The following safety measures should be observed:

- Before any other power input connection is made, the protective earth terminal shall be connected to an external protective earthing system.
- Whenever it is likely that protection has been impaired, the unit shall be made inoperative. Seek advice from the nearest manufacturer's service centre.
- The mains supply wiring must be terminated in such a way that, should it slip in the cable clamp, the earth wire is the last wire to become disconnected.

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### WARNING!

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

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## Wiring

It is important to connect the controller in accordance with the wiring data given in this handbook. Wiring installations must comply with all local wiring regulation. Any wiring that is 'Hazardous Live' (as defined in EN61010) must be adequately anchored.

## Disconnecting device

In order to comply with the requirements of safety standard EN61010, the unit shall have one of the following as a disconnecting device, fitted within easy reach of the operator, and labelled as the disconnecting device for the equipment:

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

## Overcurrent protection

To protect the unit against excessive currents, the AC power supply to the unit and power outputs must be wired through independent external fuses or circuit breakers. A minimum of 0.5mm<sup>2</sup> or 16awg wire is recommended. Use independent fuses for the instrument supply and each relay output. Suitable fuses are T type, (IEC 127 time-lag type) as follows;

- Instrument supply: 85 to 264Vac, 2A, (T).
- Relay outputs: 2A (T).

## Installation category voltages

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

Voltage transients across the power supply connections, and between the power supply and ground, must not exceed 2.5kV. Where occasional voltage transients over 2.5kV are expected or measured, the power installation to both the instrument supply and load circuits should include transient limiting devices, e.g. using gas discharge tubes and metal oxide varistors.

## Conductive pollution

Electrically conductive pollution (e.g. carbon dust, water condensation) must be excluded from the cabinet in which the unit is mounted. To ensure the atmosphere is suitable, install an air filter in the air intake of the cabinet. Where condensation is likely, for example at low temperatures, include a thermostatically controlled heater in the cabinet.

## Ventilation

Ensure that the enclosure or cabinet housing the unit provides adequate ventilation/heating to maintain the operating temperature of the unit within the limits indicated in the Specification (see Chapter 9).

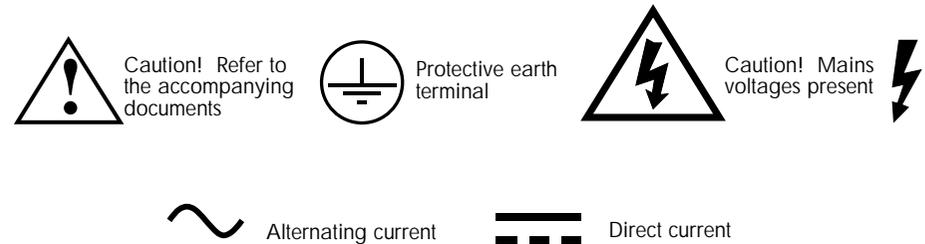
## Electrostatic discharge handling precautions

### Caution

**Electrostatic sensitivity.** Some circuit boards inside the unit contain electrostatically sensitive components. To avoid damage, before you remove or handle any board ensure that you, the working area, and the board are electrostatically grounded. Handle boards only by their edges and do not touch the connectors.

## Safety symbols marked on the unit

Various safety/warning symbols are marked on the unit, which have the following meanings:



## Keeping the product safe

To maintain the unit in a safe condition, observe the following instructions.

### Misuse of equipment

Note that if the equipment is used in a manner not specified in this handbook or by Eurotherm Process Automation, the protection provided by the equipment may be impaired.

### Service and repairs

This unit has no user-serviceable parts. Contact your nearest Eurotherm Process Automation agent for repair.

### Cleaning instructions

Use a suitable antistatic vacuum cleaner to keep the unit and all associated air inlets/outlets clear of dust buildup. Wipe the front panel with a damp cloth to keep it clean and the operator legends and displays clearly visible. Mild detergents may be used to remove grease, but do not use abrasive cleaners or aggressive organic solvents.

### Safe usage of alkaline manganese batteries

The 12V alkaline manganese batteries used in the T950 security key must be stored in a suitable manner, handled and used correctly, and disposed of safely when spent. Read the information given in the following COSHH statement.

**ALKALINE MANGANESE BATTERIES — COSHH STATEMENT**

Product: 12V ALKALINE MANGANESE DIOXIDE CELLS			
Part numbers: Duracell™ MN21, Panasonic™ RV08, or equivalents			
HAZARDOUS INGREDIENTS			
Name	% by weight	OSHA PEL	ACGIH TLV
Potassium hydroxide (KOH)	8	2mg/m <sup>3</sup> (C)	2mg/m <sup>3</sup> (C)
Manganese dioxide (MnO <sub>2</sub> )	37	5mg/m <sup>3</sup> (C)	5mg/m <sup>3</sup> (C)
Zinc (Zn)	15	15mg/m <sup>3</sup> (C)	10mg/m <sup>3</sup> (C)
Carbon (C)	4	3.5mg/m <sup>3</sup> (C)	3.5mg/m <sup>3</sup> (C)
Steel	18	10mg/m <sup>3</sup> (C)	10mg/m <sup>3</sup> (C)
Brass	2	10mg/m <sup>3</sup> (C)	10mg/m <sup>3</sup> (C)
Mercury	none added	0.05mg/m <sup>3</sup> (C)	0.05mg/m <sup>3</sup> (C)
PHYSICAL DATA			
Property	KOH	MNO <sub>2</sub>	Zn
Boiling point (°C)	1320	N/A	907
Vapour pressure (mm Hg)	N/A	N/A	1mm @ 487°C
Vapour density (air=1)	N/A	N/A	N/A
Solubility in water	50%	0%	0%
Specific gravity (water=1)	2.0	5.0	7.14
Melting point (°C)	360	535	420
State & colour	Clear liquid	Black powder	Grey powder
FIRE AND EXPLOSION DATA			
Flash point (method used)	N/A	Extinguishing media	N/A
Flammable limits (LEL & PEL)	N/A		
Special fire-fighting procedures and unusual fire hazards	Fire-fighters should use self-contained breathing apparatus when a large number of cells are involved in a fire. Cells may release toxic zinc fumes when exposed to fire.		
HEALTH HAZARD DATA			
NOTE: These compounds and metals are contained in a sealed can. Potential for exposure should not exist unless the battery leaks, is exposed to high temperature, is swallowed, or is mechanically, physically, or electrically abused.			
Routes of entry	Inhalation: YES. Skin: YES. Ingestion: YES.		
Acute/chronic health hazards	The most likely risk is acute exposure when a cell leaks. Potassium hydroxide (KOH) is caustic and skin contact can cause burns. Eye contact with KOH may cause permanent eye injury. Potential does not exist for chronic exposure.		
Carcinogenity	NTP: NO. IARC Monograph: NO. OSHA Regulated: NO.		
Signs/symptoms of exposure	Skin and eye contact with KOH may cause chemical burns.		
Medical conditions generally aggravated by exposure	An acute exposure will not generally aggravate any medical condition.		

*continued...*

...continued

FIRST AID PROCEDURES	
Skin contact	If leakage from a cell contacts the skin, flush immediately with water and cover with dry gauze.
Eye contact	Flush with copious amounts of water for 15 minutes and seek medical assistance.
Inhalation of vapour	If vapour is inhaled, remove to fresh air.
REACTIVITY DATA	
Stability	Stable.
Conditions to avoid	DO NOT heat, disassemble, or recharge.
Hazardous decomposition or byproducts	When heated, cells may emit caustic vapours of KOH.
PRECAUTIONS FOR SAFE HANDLING, USE, AND DISPOSAL	
Spill or leak procedures	Avoid skin and eye contact. Do not inhale vapours. Neutralise leaked material with weak acidic solution (e.g. vinegar), and/or wash away with copious amounts of water.
Waste disposal method	Dispose of spent batteries in small quantities with normal waste. Do not accumulate, but if unavoidable, quantities of 5 gallons or more should be disposed of in a secure landfill, as should leaking cells, regardless of quantity. Do not incinerate batteries since cells may explode at high temperature. Disposal should be in accordance with all applicable national and local regulations.
Handling and storage	Avoid mechanical or electrical abuse. Use neoprene, rubber, or latex-nitrile gloves when handling leaking cells. Store at room temperature.
Other precautions	Do not attempt to recharge. Install cells in accordance with equipment instructions. Do not dispose of in fire. Replace all batteries in equipment at the same time. Do not mix battery systems such as alkaline and zinc carbon in the same equipment. Do not carry batteries loose in pocket or bag.
SPECIAL PROTECTION INFORMATION	
Respiratory protection	None under normal conditions.
Ventilation	Subsequent to a fire, provide as much ventilation as possible.
Protective gloves	Use neoprene, rubber, or latex-nitrile gloves when handling leaking cells.
Eye protection	Wear safety glasses when handling leaking cells.
Other protective clothing/equipment	None.
ABBREVIATIONS USED IN THIS DOCUMENT	
ACGIH	American Council of Governmental Industrial Hygienists
IARC	International Agency for Research on Cancer
OSHA	Occupational Safety and Health Administration (US)
NTP	National Toxicology Program (US)
PEL	Permissible Exposure Limit
TLV	Threshold Limit Values

## UNPACKING YOUR T640

Unpack the instrument and accessories carefully and inspect the contents for damage. Keep the original packing materials in case re-shipment is required. If there is evidence of shipping damage, please notify Eurotherm Process Automation or the carrier within 72 hours and retain the packaging for inspection by the manufacturer's and/or carrier's representative.

## Handling precautions

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### Caution

**Electrostatic sensitivity.** Some circuit boards inside the T640 contain electrostatically sensitive components. To avoid damage, before you remove or handle any board ensure that you, the working area, and the board are electrostatically grounded. Handle boards only by their edges and do not touch the connectors.

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## Package contents

Check the package contents against your order codes, using the labels on the components to help you. Product labelling includes:

- Outer packaging label. Shows the full instrument order code, instrument serial number, hardware build level, and software issue number.
- Antistatic bag label. Shows the full instrument order code, instrument serial number, and hardware build level.
- Sleeve labels. Two labels, one outside and one inside showing the sleeve order code and sales order number.
- Instrument label. One on the instrument, identical to the antistatic bag label.
- Memory module label. One label showing the software issue number.
- Security key label. Shows access, area, and ID code.

## INSTALLATION

### Dimensions

Figure 2-1 shows the DIN-size aperture needed for panel-mounting the T640. Also shown are the unit's overall dimensions, the mounting clamps, panel section, terminal cover and screw, and the access for cabling.

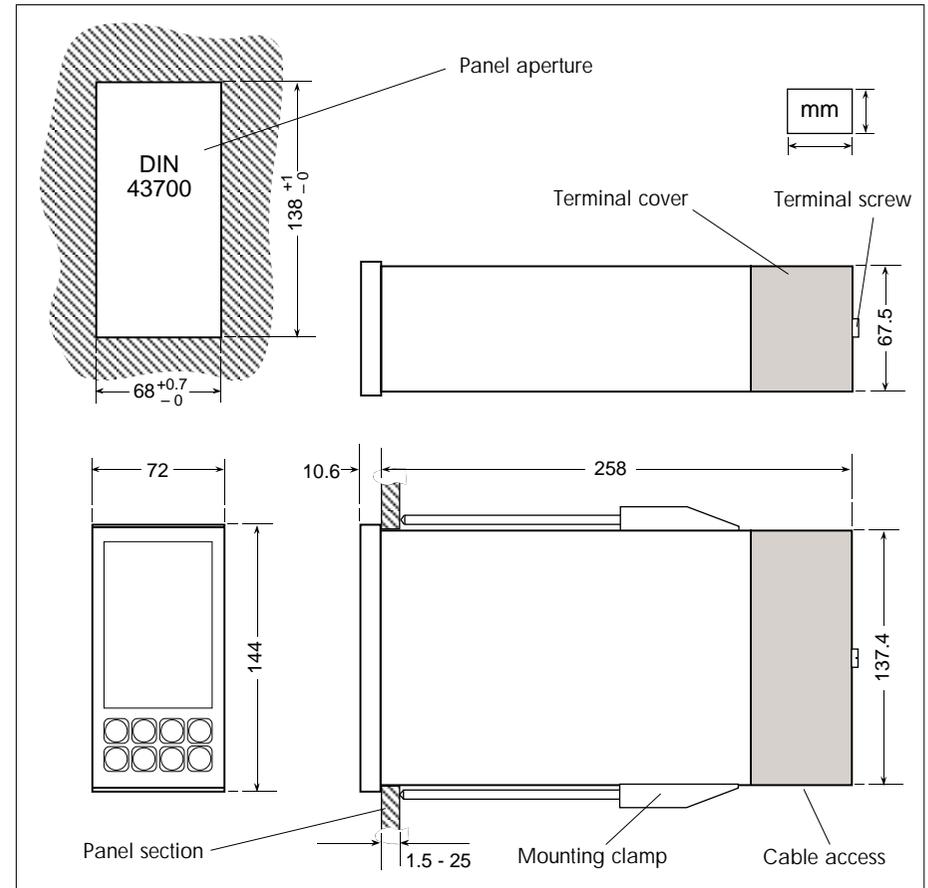


Figure 2-1 T640 principal dimensions

## Panel mounting

Insert the sleeve in the aperture and fit the two clamps as shown in Figure 2-2. To fit a clamp, position it flat on the sleeve, locating the hook in the slot. Slide the clamp away from the panel to engage the hook firmly, and snap the two feet into the two small recesses. Screw the clamp rod in to hold the sleeve lightly in position. Fit the second clamp in the same way. Finally, tighten up both clamps to exert a moderate retaining force. To avoid panel distortion, do not overtighten. The maximum recommended torque is 0.6Nm.

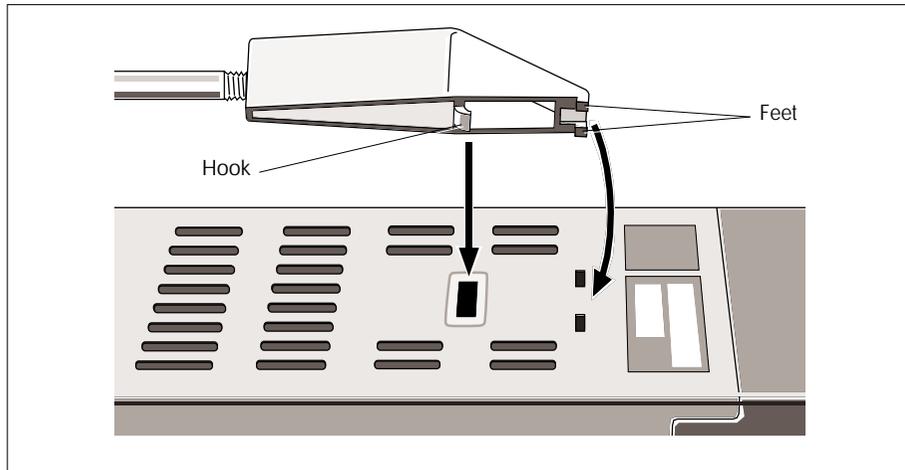


Figure 2-2 Fitting a clamp to the sleeve

## Clamp removal

See Figure 2-3. Slacken off the clamp by at least 2mm and insert a screwdriver blade between the feet at the end of the clamp body. **Lift** the screwdriver handle to lever the clamp towards the panel and disengage it. **Do not press downwards** — this could cause damage!

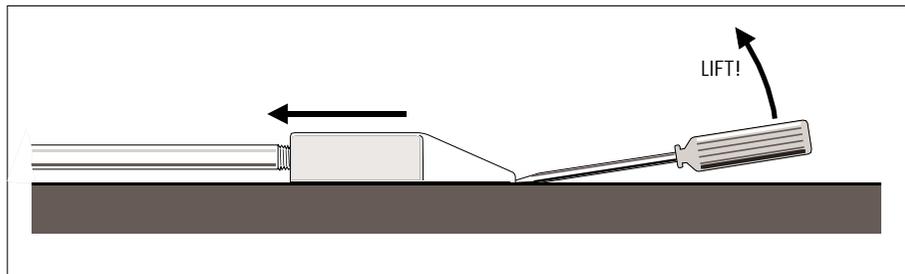


Figure 2-3 Removing a clamp from the sleeve

## Removing T640 from sleeve

Withdrawing the T640 from its sleeve is done entirely from the front of the mounting panel, without disturbing any of the system wiring.

### Caution

Repeated removal/replacement of the T640 under power erodes the connectors. Anti-static precautions must be observed when handling the unit out of its sleeve.

See Figure 2-4. To unlock the T640 insert a small screwdriver blade into the slot in the retaining clip at the bottom of the fascia and slide the clip to the left as far as it will go. Repeat this for the clip at the top of the fascia, but slide it to the right. To withdraw the unit use the extractor tool supplied in the accessory kit (Part No. BD 082253). Hold the tool at an angle of about 45°, insert the hook into the opening under the 'SP-W' pushbutton, then level the tool and pull the unit from the sleeve. Remember to lock both retaining clips after refitting the unit in the sleeve.

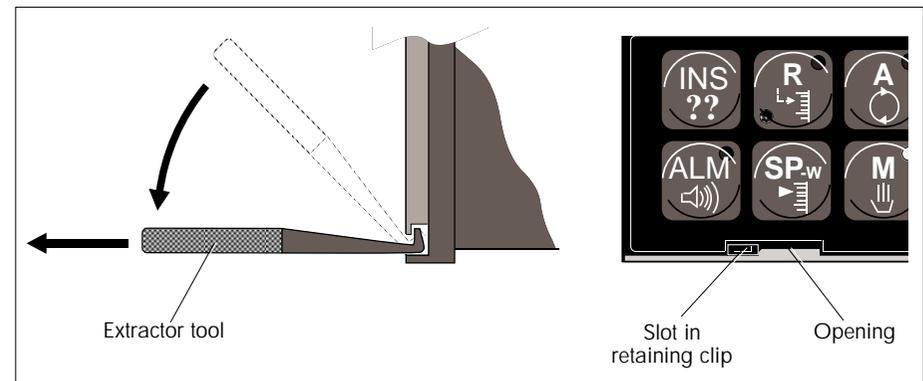


Figure 2-4 Withdrawing T640 from the sleeve

## CONNECTIONS & WIRING

Electrical connections to the T640 are made via three blocks of customer screw terminals at the rear of the sleeve, protected by a terminal cover. Wiring passes through the opening in the base of the terminal cover. All connections are low current and a 16/0.20 cable size is adequate. The maximum cable size for these terminals is 2.5mm<sup>2</sup>. 'Bootlace' type ferrules are strongly recommended.

**Power input.** The instrument supply should be fused externally in accordance with local wiring regulations. The mains option accepts 90 - 265 Vac, 45 - 65 Hz, the DC option 19 - 55 Vdc. Power input depends on the application and configuration, and on the I/O cards fitted, but is a nominal maximum of 25VA per T640. Please refer to Chapter 9, *Specifications*, for further details.

## Terminal cover removal

See Figure 2-5. With the sleeve upright unscrew the retaining screw and pull the cover away from the cover bracket and cable clamp assembly. To remove the bracket, lift it to free the hooks from the tabs, then withdraw it from the sleeve. Refitting the bracket and cover is the reverse procedure.

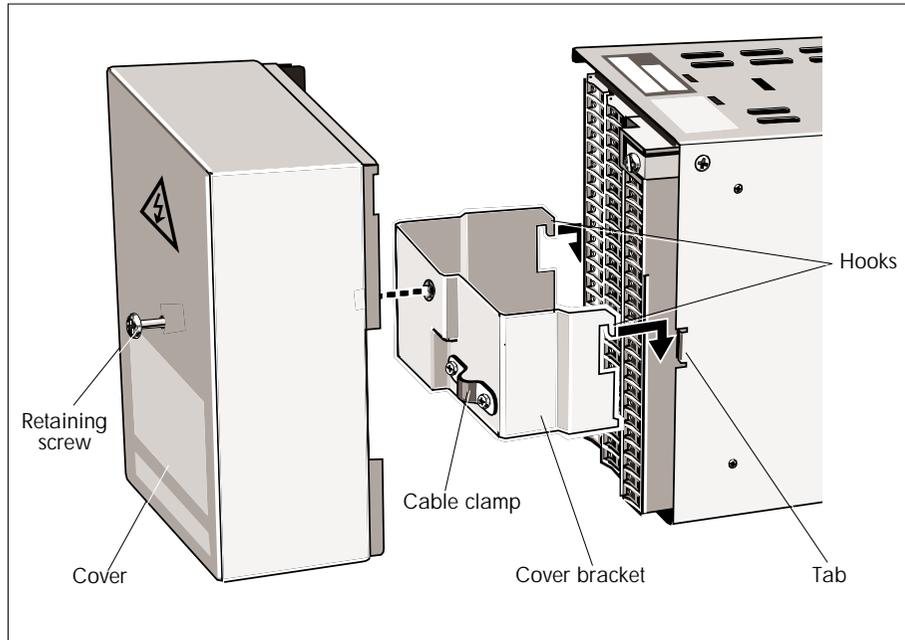


Figure 2-5 Removing the terminal cover

## Customer terminals

Figure 2-6 shows the customer terminals (example). Other configurations are possible depending on the I/O and power supply ordered. The Figure shows the MAINS option motherboard terminal block with safety cover, and Site 1 I/O and Site 2 I/O terminal blocks. Wire connectors, securing screws, and terminal identification labels are also shown. Connect a good local earth to the M4 screw terminal. *Do not* connect an external earth directly to terminals 1 and 2.

### Mains safety cover

This fits over the mains screw terminals to prevent accidental contact with the live screws. To remove the cover loosen the two screws and pull it off. To replace the cover insert its two legs fully into the corresponding terminals and tighten up the screws securely.

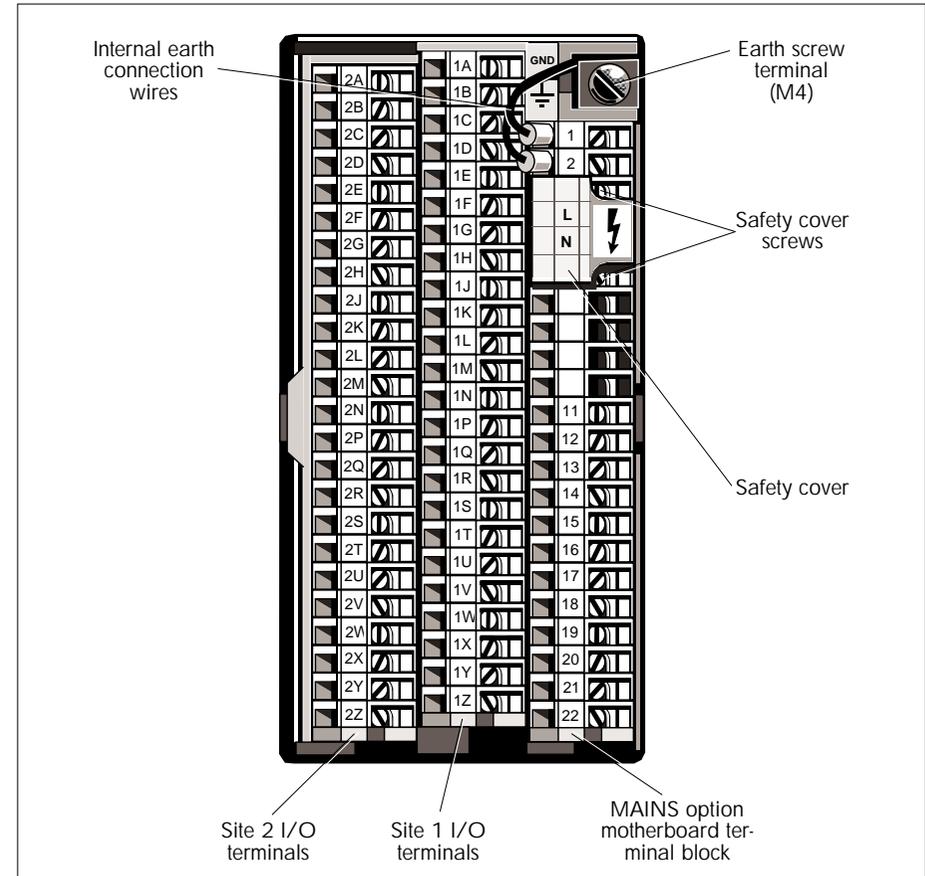


Figure 2-6 Customer terminals (example)

## Terminal designations

### Motherboards

Table 2-1 shows the terminal designations for two motherboard terminal block options, with the ac MAINS option on the left and the DC option on the right of the table.

The uses of these terminals and how they connect to T640's internal circuitry are described in later sections.

 Earth screw terminal (M4)		 Earth screw terminal (M4)	
1		1	Internal earth*
2		2	Internal earth*
L			
N			
		7	DC input 1 +
		8	DC input 1 -
		9	DC input 2 +
		10	DC input 2 -
11		11	RS422 TX+
12		12	RS422 TX-
13		13	RS422 & RS485 Gnd
14		14	RS422 RX+ & RS485 +
15		15	RS422 RX- & RS485 -
16		16	Watchdog/User relay
17		17	OPEN = fail
18		18	Alarm relay
19		19	OPEN = fail
20		20	ALIN Ground
21		21	ALIN phase A
22		22	ALIN phase B

\*Factory-connected externally

Table 2-1 Customer terminals for AC (left) & DC (right) T640 motherboard options

### High-level I/O boards

Table 2-2 shows terminal designations for the high-level I/O board options, fitted in sites 1 (right) and 2 (left). Note that Site 1 terminals are labelled **1A** to **1Z**, and Site 2 terminals are **2A** to **2Z**. Also shown are the software ‘function blocks’ in the control database that link to each terminal or set of terminals, and the required value of their output/input type parameters. (You are introduced to function blocks in the tutorial in Chapter 3.)

Terminal	SiteNo=2)	Linked block	Terminal	SiteNo=1)	Linked block
2/	Current out } Chanr	AN_OUT OutType= mA	1/	Current out } Chanr	AN_OUT OutType= mA
2f			1f		
2(	TX power st		1(	TX power st	
2l	TX power s		1l	TX power s	
2i	Analogue Chanr	AN_IRrType= Vol	1i	Analogue Chanr	AN_IRrType= Vol
2j	Analogue Chanr	AN_IRrType= Vol	1j	Analogue Chanr	AN_IRrType= Vol
2k	Analogue !		1k	Analogue !	
2l	Analogue Chanr	AN_IRrType= Vol	1l	Analogue Chanr	AN_IRrType= Vol
2m	Analogue Chanr	AN_IRrType= Vol	1m	Analogue Chanr	AN_IRrType= Vol
2n	Analogue !		1n	Analogue !	
2o	Analogue ( Chanr	AN_OOTrType= Vol	1o	Analogue ( Chanr	AN_OOTrType= Vol
2p	Analogue ( Chanr	AN_OOTrType= Vol	1p	Analogue ( Chanr	AN_OOTrType= Vol
2q	Analogue !		1q	Analogue !	
2r	Digital i Bi	DG_INrType= Vol	1r	Digital i Bi	DG_INrType= Vol
2s			1s		
2t			1t		
2u			1u		
2v	Digital ou Bi	DG_OU	1v	Digital ou Bi	DG_OUT, DGPU  N.B. In DGPUL! Bit0 - Bit3 corres Chan1Chan4resp
2w			1w		
2x			1x		
2y			1y		
2z	(Not connec		1z	*Pullup: 15V out (	
2'	Digital gr		1'	Digital gr	
2:	Digital gr		1:	Digital gr	

**NB.** SiteNo, Channel, & Bit numbers refer to the associated I/O function block's corresponding parameters  
 \*Pullup connects internally to digital outputs of both sites

Table 2-2 Customer terminals for high-level I/O options — Site 2 (left) & Site 1 (right)

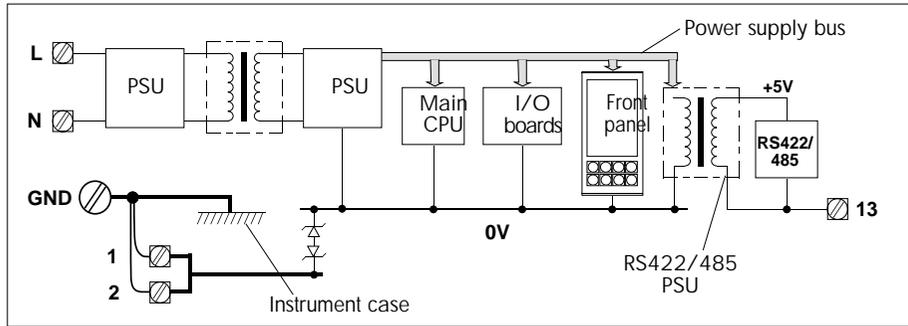


Figure 2-7 T640 internal zero volts & power supplies schematic

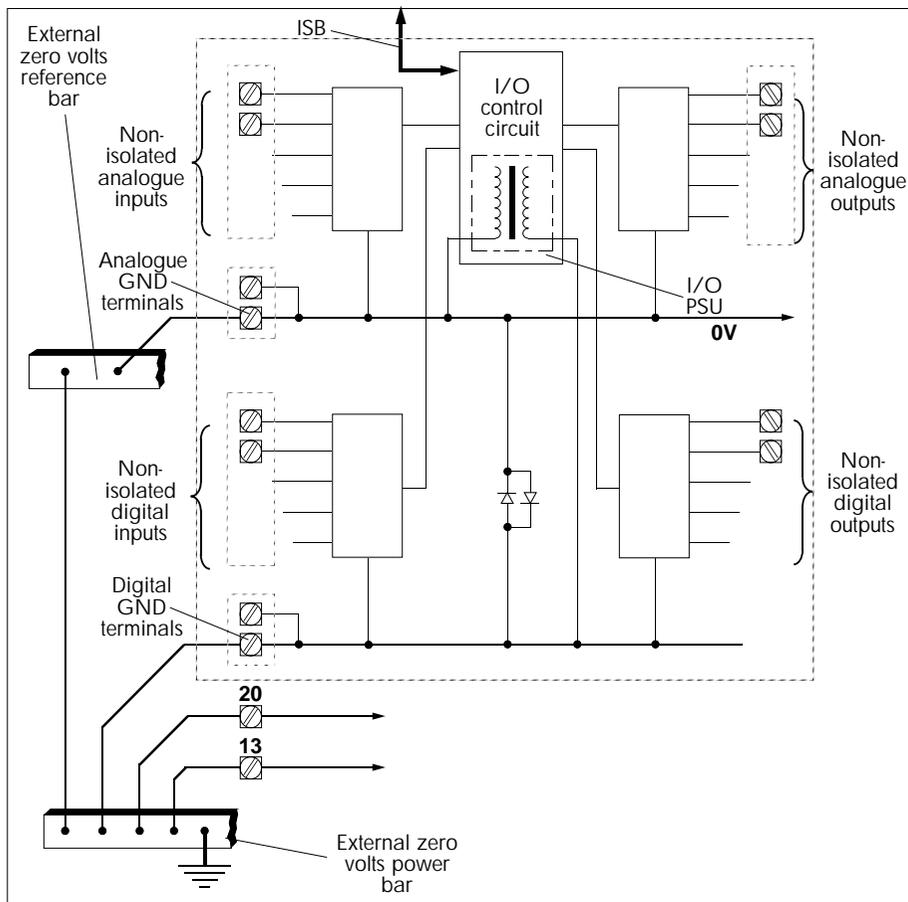


Figure 2-8 T640 I/O zero volts & power supplies schematic

## T640 zero volts schematic

Figure 2-7 shows schematically T640's internal zero volts and power supply arrangements, and associated customer screw terminals. The power supply units feed the main CPU, I/O board(s), front panel, and RS422/485 power supply unit, via a power supply bus. The GND terminal connects directly to the instrument case, and via wires to terminals 1 and 2, which must not be connected to externally.

## I/O zero volts schematic

Figure 2-8 shows the (generalised) I/O zero volts and power supply arrangements, and associated customer screw terminals. The number and designations of terminals associated with the non-isolated analogue inputs and outputs depend on what I/O options are fitted (Table 2-2 shows those currently available). The I/O control circuit communicates via the ISB (Internal Serial Bus). Connect the analogue ground terminal(s) to an external zero volts reference bar as shown.

The number and designations of terminals associated with the non-isolated digital inputs and digital outputs also vary with I/O option. Connect the digital ground(s) to an external zero volts power bar, which should be connected to a clean instrument earth.

## Communications zero volts schematic

Figure 2-9 shows the RS422/485 and ALIN comms connections with associated customer screw terminals. The main CPU is opto-isolated from the RS422/485 transmit/receive terminals. Factory-set jumpers (J4, J5, and others not shown) configure the motherboard for RS422, RS485, or external ISB (Internal Serial Bus) operation. See next section.

**NOTE.** The ALIN cable screen and the RS422/485 cable screen should each be grounded at one point only.

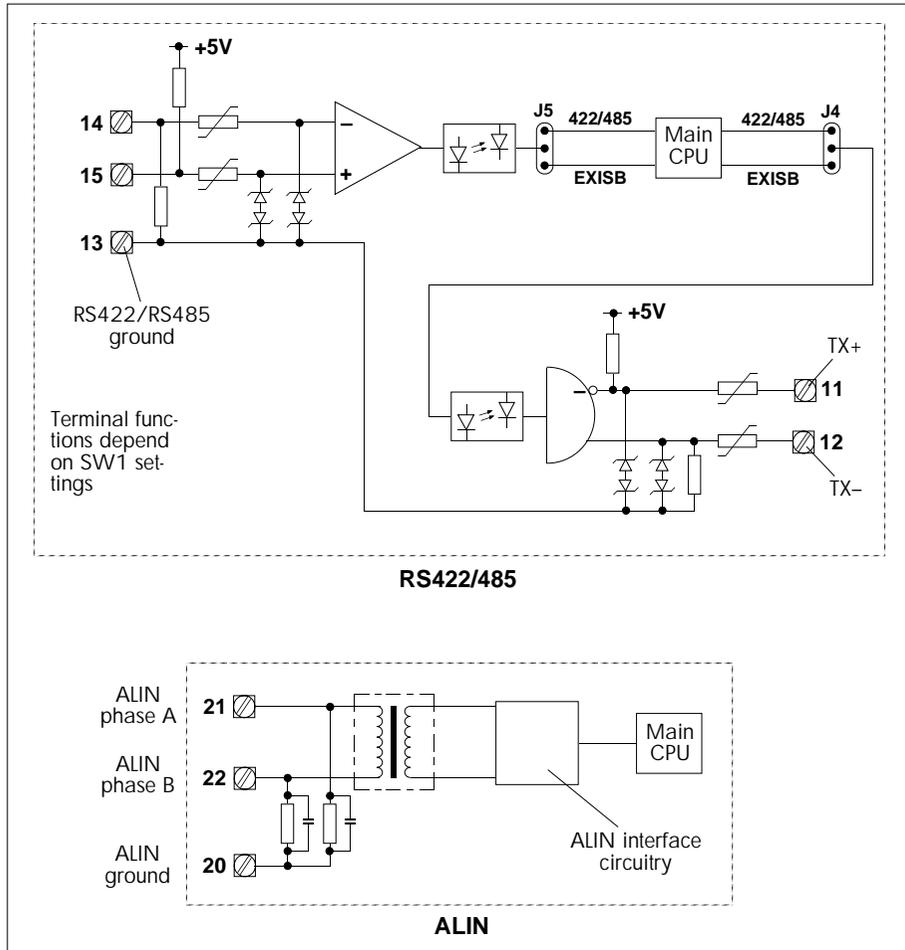


Figure 2-9 T640 communications zero volts schematic

## HARDWARE CONFIGURATION

### Internal layout

Figure 2-10 shows T640's internal layout (example). The motherboard is the main electronics board on which all I/O board options are mounted. It carries two configuration DIL switchbanks 1 and 2, and the memory module in its socket. The figure shows an I/O board in Site 1, and an expansion-type I/O board in Site 2. Other I/O options and arrangements are possible, depending what was ordered.

### Memory module removal

See Figure 2-10. Use a screwdriver blade to slide the retaining clip towards the front panel as far as it will go, then pull the module out of its socket. Replacement is the reverse procedure.

---

#### Caution

The module can be pushed fully home only if it is the right way round. Check this before applying excessive force, which can damage the pins.

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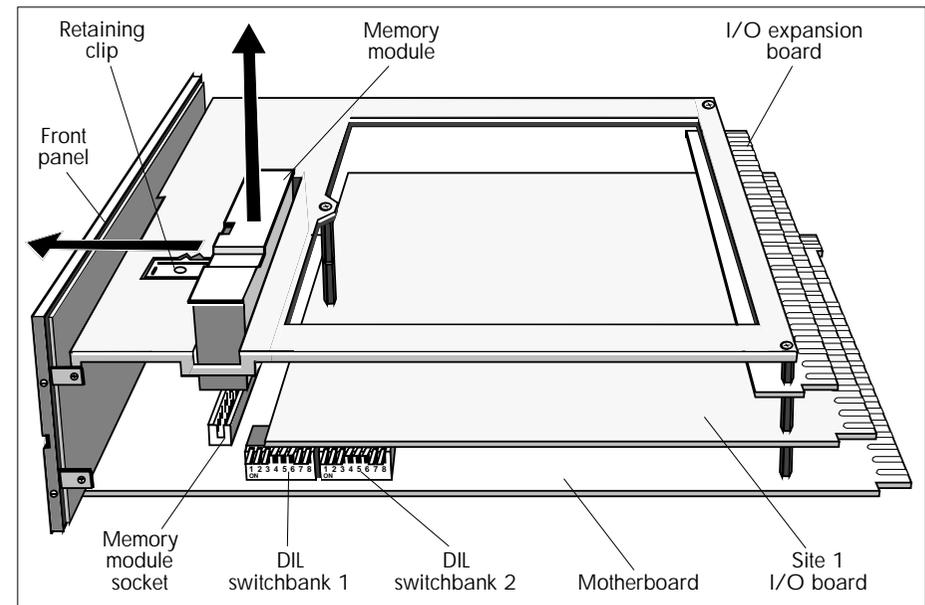


Figure 2-10 T640 internal layout (example)

## Main fuse

See Figure 2-11. The motherboard carries the T640 main fuseholder. The fuse is a  $20 \times 5$  mm 250Vac antisurge cartridge fuse rated at 500mA (AC option), or 2A (DC option). Unscrew the fuse cap anticlockwise to remove.

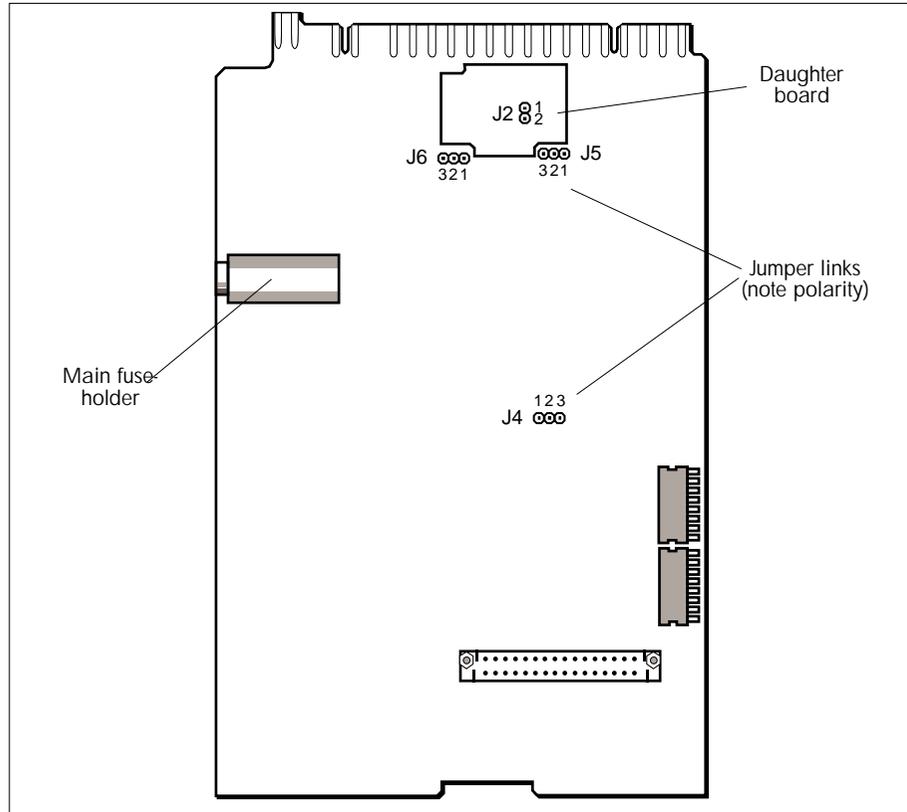


Figure 2-11 T640 motherboard showing fuse & jumper locations



- Switches 3 and 4 configure the way the T640 powers up, and are usually both set to ON for normal operation. T640’s power-up routine is explained in detail later in the section *Power-up routine*.
- Switch 5, when set to ON, causes the watchdog relay contacts — customer terminals 16 & 17 — to open if a loop (user task) stops running or if the database halts. This function is in addition to the relay’s normal actions, i.e. CPU failure watchdog (closed = healthy, open = failure), and user alarm (via the T600 block’s *UsrAlm* field). With switch 5 OFF, the relay does not respond to loop or database halts.
- Switches 6, 7, and 8 select the number of a preconfigured fixed-function strategy to be loaded to RAM and if possible run in the T640. The strategy selected is the sum of the ‘values’ of the three switches (OFF = 0, ON = ‘value’ as shown in Figure 2-12). E.g. strategy #3 has been selected in the figure. Setting these three switches all OFF prevents any standard strategy being loaded. Running standard strategies is explained in Chapter 5, *Fixed function strategies*.

### Switchbank 2

Figure 2-13 shows the ALIN address DIL switchbank 2, and an example setup (7A hex).

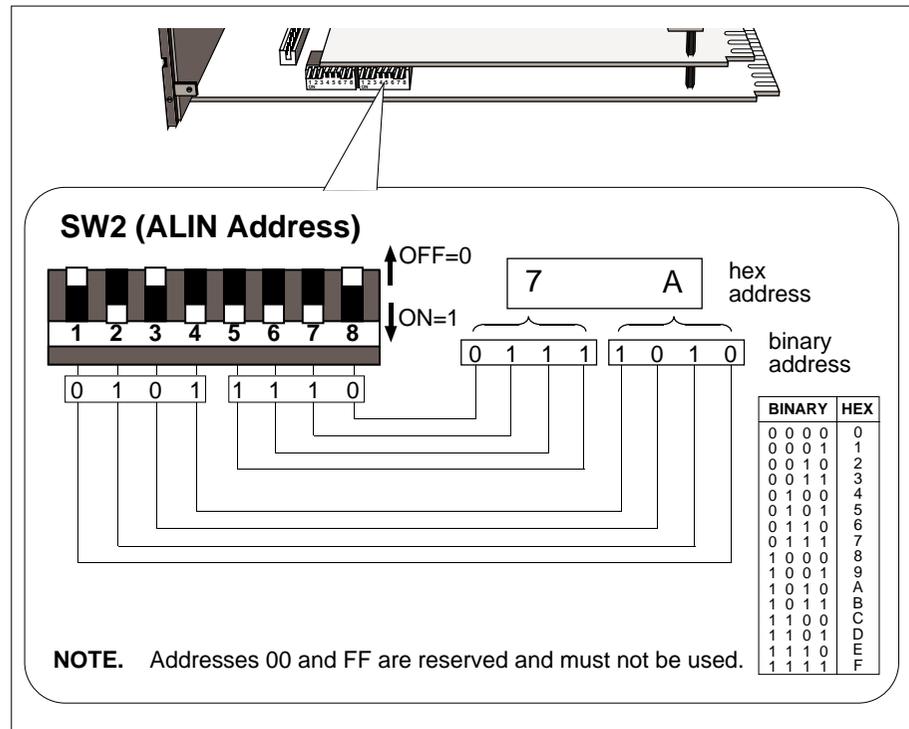


Figure 2-13 SW2 — ALIN address setup (example)

This bank of switches is used to set up the address of the T640 on the ALIN. Figure 2-13 shows how to set them up and read them, using the hexadecimal address **7A** as an example. Note that switch 1 is the least significant bit, and switch 8 the most significant, i.e. they are in ‘reverse order’. **Note also that addresses 00 and FF must not be used.**

## Serial communications jumper links & switches

Four jumper links (J2, J4, J5, and J6), together with switches 1 and 2 of Switchbank 1, are factory-set to configure the motherboard according to what serial comms option was ordered. You can check that these are set as required — the jumpers and switches are located on the motherboard where shown in Figure 2-11. Table 2-3 shows the switch settings and jumper links for the five possible comms options.

Required comms option	D I L s w i t c h		J u m p e r l i n k s			
	SW1/1	SW1/2	J2	J4	J5	J6
Binary RS422	OFF	OFF	Not fitted	2-3	2-3	2-3
Modbus RS422	ON	OFF	Not fitted	2-3	2-3	2-3
Modbus RS485	ON	OFF	1-2	2-3	2-3	2-3
External ISB (RS422)*	Don't care	ON	Not fitted	1-2	1-2	1-2
External ISB (RS485)*	Don't care	ON	1-2	1-2	1-2	1-2

\*Not implemented at current issue

Table 2-3 Comms option switch & jumper link settings

## BINARY RS422 CONFIGURATION

Table 2-3 shows the hardware settings required for communication via an RS422 serial link using binary (BISYNC) protocol.

Each T640 fixed-function strategy database has an S6000 category function block running in it, allowing it to emulate a TCS System 6000 instrument, or to be supervised by a T1000 or other suitable instrument over the serial link. Addresses (instrument numbers, 0-127) are allocated via the S6000 block's *Instr\_No* parameter, and baud rates via the T600 header block's *BinSpd1* and *BinSpd2* parameters.

Chapter 5, *Fixed function strategies*, explains how to set up these parameters.

## MODBUS RS422/485 CONFIGURATION

To configure the hardware for MODBUS comms, set up the motherboard switches and jumper links as shown in Table 2-3. Note that jumper link J2 determines the medium used — RS422 or RS485.

A MODBUS configuration — ‘gateway file’ — must be created and downloaded to the T640 to run alongside the regular LIN control database. This gateway file (.GWF filename extension) defines the communication between the LIN database (.DBF file) and

the MODBUS device(s) connected to the T640 via the serial link. The MODBUS configuration also specifies slave/master status, slave address, comms data rate and parity/stop bits.

Using the LINtools MODBUS configurator is fully described in the *T500 LINtools Product Manual* (Part No. HA 082 377 U999), together with general information on MODBUS.

## SOFTWARE FILE TYPES

Table 2-4 lists the different file types that are found in the T640's EEPROM and EPROM (ROM) memory areas, that you may see via the LINfiler package. Some of these files are supplied already installed — those marked with \* in the table. Others appear automatically when you use the instrument, or may be downloaded from a PC. EEPROM and ROM reside in a removable memory module, which allows a new strategy to be plugged directly into an existing controller, or conversely allows a strategy to remain if the controller must be changed. (Accessing and replacing the memory module was described earlier in this chapter, in the section *Hardware configuration*. T640's internal architecture is described in Chapter 7, *Inside T640*.) Further details on these files are given in the relevant sections of this manual.

Filename	Extension	File type
Control strategy name	.DBF	Control strategy database (parameters, connections, etc.)
Control strategy name	.RUN	T640 coldstart filename (i.e. last database run)
Control strategy name	.GWF	MODBUS configuration file ('GateWay File')
Sequence name	.SDB	Sequence database
System filename	.LIB	*Library of system routines in ROM area
Factory-set filename	.FFn	*Fixed-function strategy in compressed format (n = 1-4)
Control strategy name (current)	.TPD	Tepid data file
Control strategy name	.Lnn	Logfile of database changes via the INS pushbutton (nn = 01 - 99)
Language name	.LNG	Non-English language front-panel messages

Table 2-4 T640 file types

## POWER-UP ROUTINE

This section outlines what happens when a T640 powers up and how its final state is arrived at. You do not generally need to understand the power-up process fully to use a T640, but a general conception of what occurs is useful — especially if something goes wrong.

### I/O cards

I/O cards power up with their outputs ‘killed’ (i.e. tri-stated or low, depending on the particular card). The T640 ISB (internal serial bus) starts before the user tasks start, although initially the I/O card outputs are not written to, and hence remain in their killed state.

### Database acquisition

The database is acquired in a manner depending on the type of startup:

- If a warm start occurs the database is the one in RAM, provided it is uncorrupted. If it is corrupted, the last-loaded database file (.RUN, stored in EEPROM), overlaid with ‘tepid data’, is used. Please refer to the section below for more details on tepid data.
- If a cold start occurs the database is loaded from EEPROM
- Otherwise, the database is loaded from one of the standard pre-configured strategies
- If no valid source is found, a null database is created.

Figure 2-14 charts the events that occur when T640 is powered up. Figure 2-15 shows the warm start routine that may be called during power-up, and should be read in conjunction with Figure 2-14. As there is no hardware realtime clock in the T640, it must derive elapsed time since power-down (needed in the warm start routine) from a clock it maintains over the peer-to-peer communications. If this is not possible, power-up follows the alternative route shown in Figure 2-15. After loading, the entire database is subjected to a sumcheck test.

### User task startup

Before user tasks (‘loops’) start, the output blocks execute their power-up defaults, as defined by their *OPTIONS/PwrFLo* parameters, or in the case of a cold start, as specified by the strategy. This is needed to ensure that the *InitDmnd* value (in the MAN\_STAT block) is itself initialised, and causes the real plant outputs to attain their power up states. Output blocks with sumcheck errors do not execute at all; hence their outputs remain ‘killed’.

The loops now start executing. The MODE block selects manual mode — if *ManPwrUp* is TRUE — and the manual station initialises the *Demand* parameter.

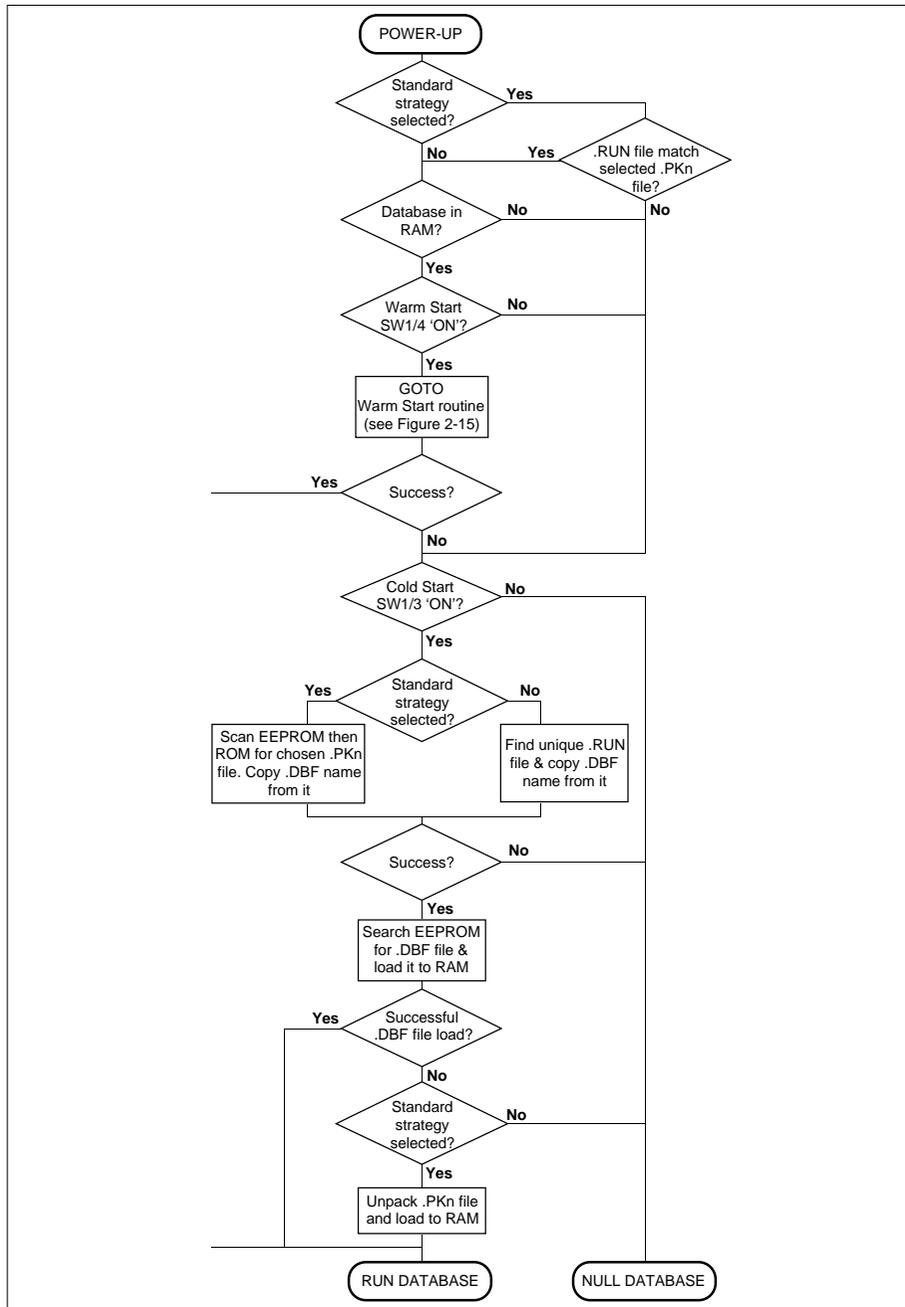


Figure 2-14 T640 power-up routine

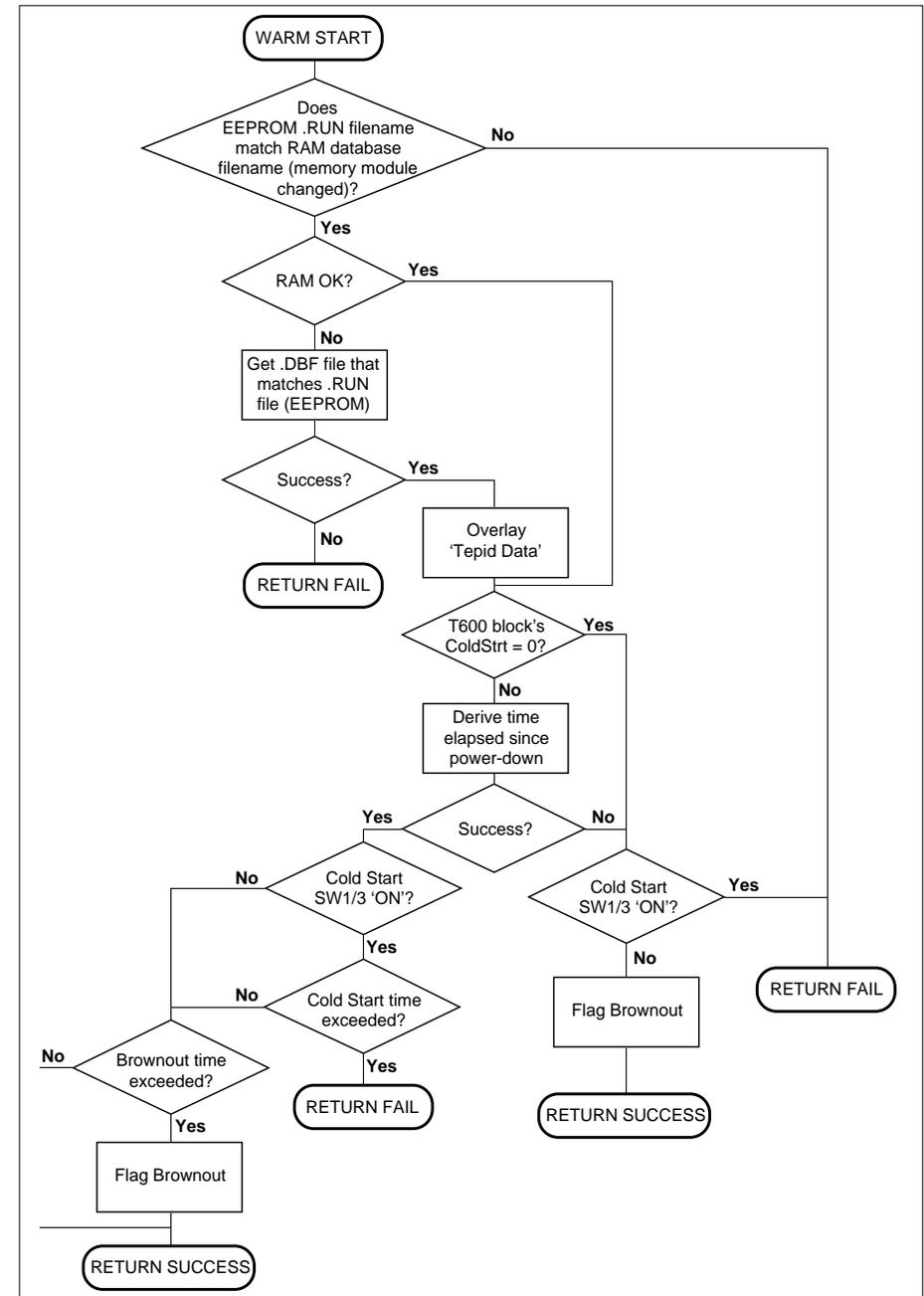


Figure 2-15 T640 warm start routine (& see Figure 2-14)

## Tepid data

At the end of each task iteration a package of data is assembled in a .TPD file in RAM, ready to be written to EEPROM should a power-down occur. This data — ‘tepid data’ — includes each loop’s local setpoint (SL), output (OP), and operating mode (MODE). In the event of a power-down, there is enough time for the tepid data in the .TPD file to be transferred rapidly to EEPROM, ready to be used if required during a subsequent warm start routine (see Figure 2-15).

## Motherboard DIL switchbanks

DIL switchbank SW1, switches 3 and 4, determine how T640 starts up after a power interruption — as charted in Figures 2-14 and 2-15. For normal T640 operation both switches should be ‘ON’ to provide full warm start and cold start capability.

The location of SW1 was shown in Figure 2-12, and the functions of switches 3 and 4 briefly summarised. Table 2-5 below provides more detail on the effect of the four possible switch setting combinations.

Sw 3	Sw 4	T640 power-up routine & final state
OFF	OFF	T640 idle; database not loaded.
OFF	ON	Do warm start, i.e. checksum database in memory. If OK, run database from where it stopped. If corrupted, try tepid start, i.e. get .RUN file if possible, overlay tepid data and run database. If tepid start fails, clear memory and idle without running database.
ON	OFF	Do cold start, i.e.: count xxx.RUN files. If exactly one exists, try to load and run xxx.DBF. If this fails, or unique xxx.RUN file does not exist, idle without running database.
ON	ON	<i>Power interruption &lt; ColdStrt:</i> do warm or tepid start. If this fails, do cold start (as above). <i>Power interruption ≥ ColdStrt:</i> do cold start

Table 2-5 T640 switchbank SW1, switches 3 & 4 functions

## POWER-UP DISPLAYS

This section describes the messages normally displayed on T640’s front panel during power-up. For full details of all the front-panel displays and controls, refer to Chapter 4, *User interface*. The hands-on tutorial presented in Chapter 3 also familiarises you with the front panel power-up messages.

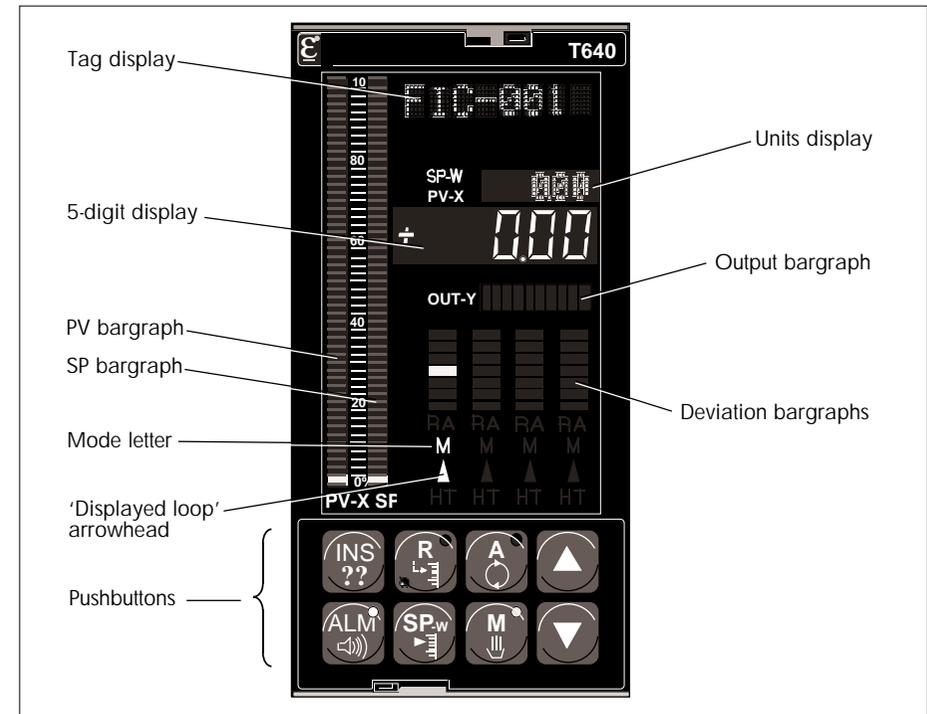


Figure 2-16 T640 front panel — principal features

## Normal power-up

Figure 2-16 shows the principal features of T640's front panel.

A **Power-on Reset** message normally flashes briefly in the red tag display when T640 is powered up, while the front panel awaits communications from the main CPU. Then, **WarmStrt Trying**, **TepidSrt Trying**, or **ColdStrt Trying**, flash to tell you the type of startup procedure T640 is attempting. If a fixed-function strategy is being loaded for the very first time, **Un Pack DataBase** flashes in the tag display as the .FFn file is being decompressed. Finally, the fascia adopts the normal display as described in Chapter 4.

## Error conditions

A number of error conditions can arise during the power-up process, which are reported on the front-panel displays as messages or error codes. These are described in Chapter 8, *Error conditions & diagnostics*. Please refer there for details.

## Chapter 3 HANDS-ON TUTORIAL

### AIMS OF THIS TUTORIAL

This tutorial will give you ‘hands-on’ experience of the T640, and at the same time acquaint you with the simplest of the four in-built ‘fixed-function’ control strategies supplied in ROM. This is #1, a single control loop. The other three fixed-function strategies are all designed around this loop, so what you learn here can be applied to configuring them as well, via T640’s front-panel pushbuttons and displays.

Note that in this tutorial the T640 operates as a stand-alone instrument — no network or communications are involved.

Much of the information given here can also be found in other parts of this manual. Refer there if you need more comprehensive information.

### HARDWARE REQUIRED FOR THE TUTORIAL

- T640 fixed function instrument — fitted with the M006 option memory module.
- Short wire link, terminated (ideally) with bootlace ferrules.
- Terminal screwdriver.
- Digital multimeter (optional).
- An appropriate power supply — DC: 19-55V (25W), MAINS: 90-265Vac, 45-65Hz.

### INSTALLING YOUR T640

If you have not already done so, please refer to Chapter 2, *Installation & startup*, for details on unpacking your T640.

Note that for this tutorial there is no need to panel-mount the instrument — it can simply rest on a bench in its sleeve, with the rear terminal cover removed.

### Connecting the power supply

Remove the terminal cover and cable clamp from the rear of the T640 to access the customer terminals. Figure 3-1 shows the cover and clamp.

First determine which option you have — DC or AC mains. You can see this from Figure 3-2 and also from the order code label on the sleeve (the second field is DC or MAINS, respectively).

With the power switched off, wire the power supply to the terminals shown in the figure, according to your option. Do not power up yet!

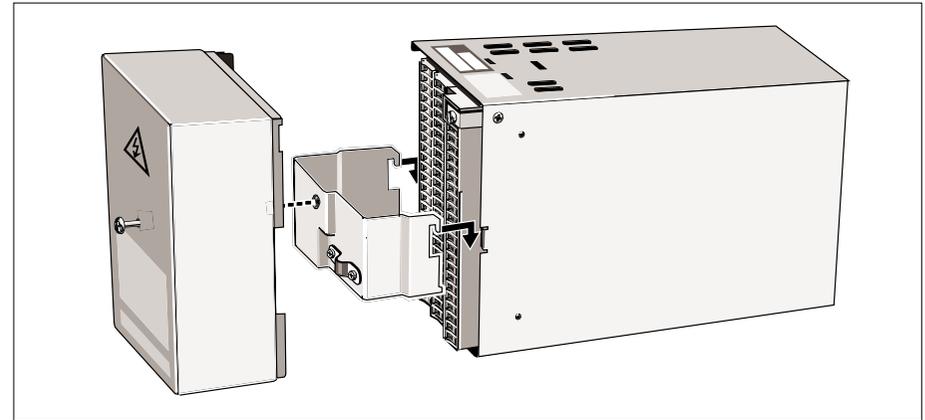


Figure 3-1 Terminal cover removal

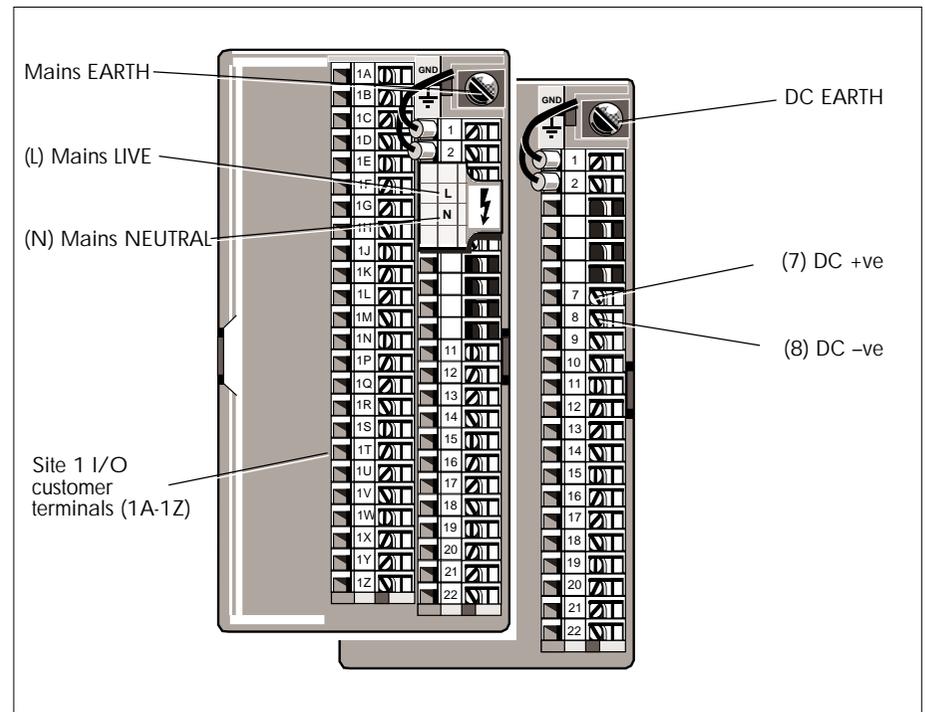


Figure 3-2 Customer terminals — MAINS (left) and DC (right) options

## SWITCH SETTINGS

A bank of eight on-board switches must be configured for this tutorial. To access them you have to remove the T640 from its sleeve.

### Removing the T640 from its sleeve

#### Caution

**Handling precautions.** Some of the circuit boards inside the T640 contain electrostatically sensitive components. To avoid damage, before you remove or handle any board ensure that you, the working area, and the board are electrostatically grounded. Handle boards only by their edges and do not touch the connectors.

See Figure 3-3. To unlock the T640 insert a small screwdriver blade into the slot in the retaining clip at the bottom of the fascia and slide the clip to the left as far as it will go. Repeat this for the clip at the top of the fascia, but slide it to the right. To withdraw the unit use the extractor tool supplied in the accessory kit (Part No. BD 082253). Hold the tool at an angle of about 45°, insert the hook into the opening under the 'SP-W' pushbutton, then level the tool and pull the unit from the sleeve.

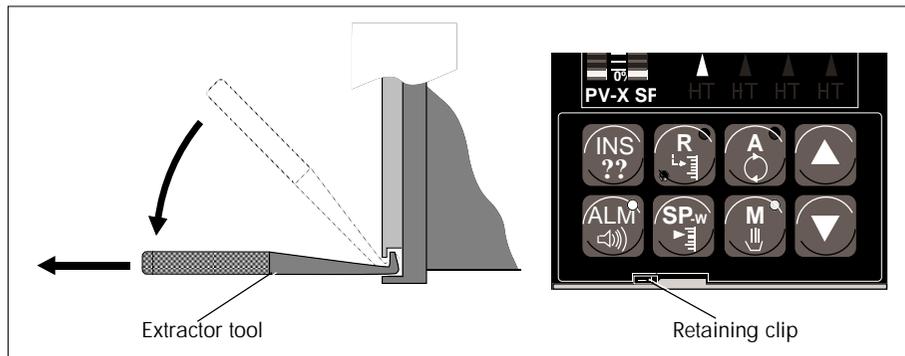


Figure 3-3 Removal of T640 from sleeve

### Setting the switches

Figure 3-4 shows the location of switchbank 1 (SW1) on the T640 motherboard, and also SW1 in detail. Set the switches as shown. Note that for this tutorial the settings of the switchbank SW2 switches are 'don't care'.

Replace the unit in its sleeve. You are now ready to power up the T640, but before doing this you should be introduced to control strategy #1 — a single control loop.

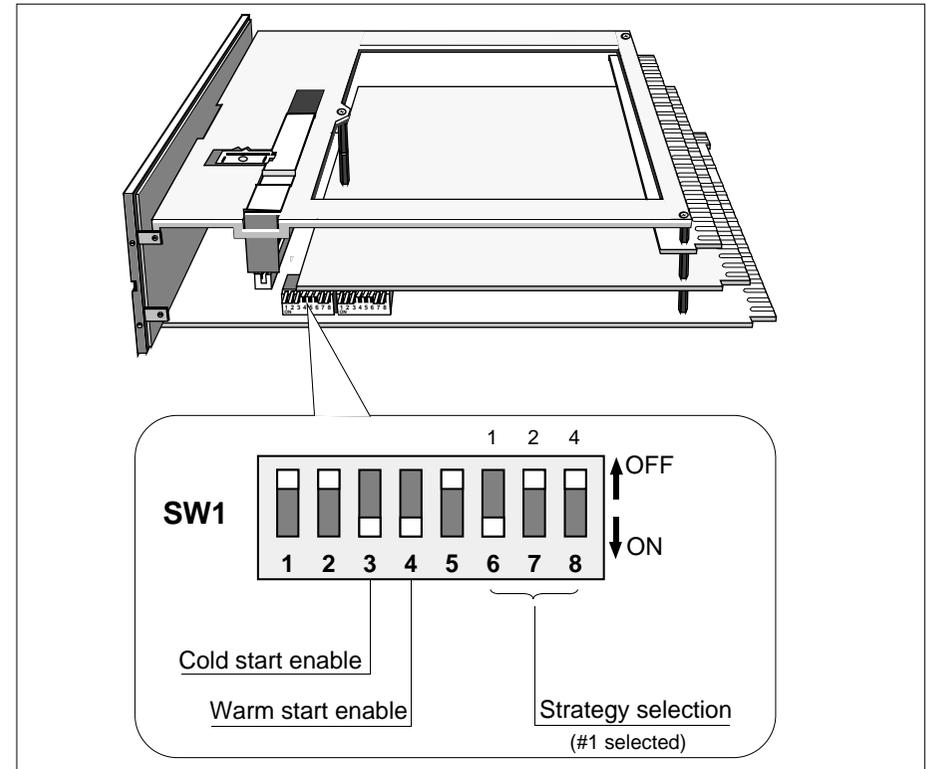


Figure 3-4 SW1 location and settings

## STRATEGY #1 — SINGLE LOOP CONTROLLER

This simple strategy is a single loop controller using one ‘I/O site’, i.e. the column of terminals labelled 1A to 1Z. Figure 3-5 shows an example P & I (piping and instrumentation) diagram for the strategy, with the T640 connected to a flow-control valve and an orifice-plate flow sensor. The measured flow PV is input to the T640, where a PID (proportional-integral-derivative) calculation compares PV with the setpoint to produce a 3-term control output 3T OUT. This is fed to the valve controlling the flow.

Figure 3-6 shows the same control scheme but highlights very schematically the three main areas of software inside the T640 that are responsible for running the strategy. The ‘PV input’ software takes in the measured PV as an analogue voltage and applies ranging, conditioning, limiting, and alarms, before passing the signal to the ‘PID control’ area.

Here, the setpoint and PV are fed into the PID algorithm which calculates a value for the control output needed to be applied to the valve to achieve optimum flow control. Other operations done in the PID control area include ranging, limiting, alarm detection, control mode selection, manual intervention, and application of PID algorithm tuning constants.

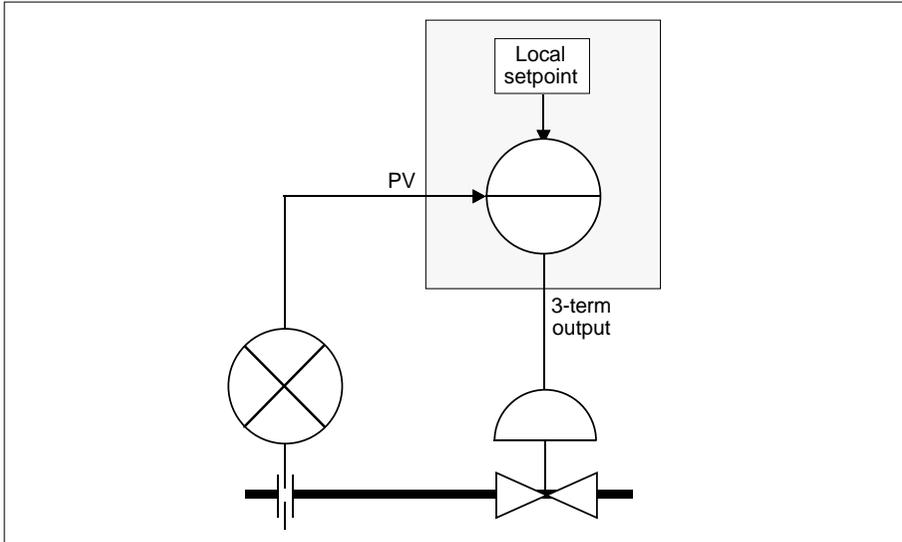


Figure 3-5 Example P & I diagram for strategy #1

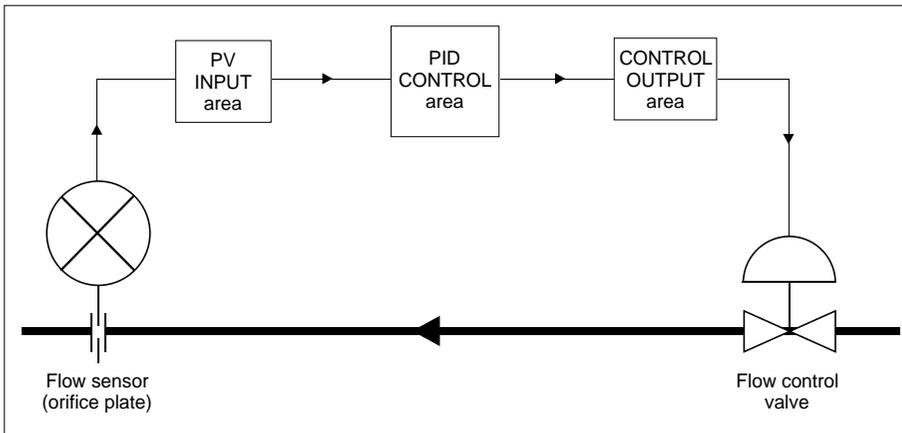


Figure 3-6 Main software areas — strategy #1

The last area — ‘Control output’ — handles output conditioning, ranging, power-up and failure modes.

This tutorial will show you how to access these software areas — via T640’s front-panel buttons and displays — and configure their parameters to suit your particular plant control requirements.

## POWER-UP

### Power-up messages

Switch on the power to the instrument. You may be quick enough to see the message **Power-on** flashing briefly in the red *tag display* at the top of the fascia (see Figure 3-7). Then **ColdStrt Trying** flashes, telling you that T640 is attempting a 'cold startup' of the single loop database (strategy #1). Next, if the strategy is being loaded for the very first time, you will see **Un Pack Database** flashing in the tag display as the strategy #1 file (which you selected via SW1) is being decompressed from storage in ROM. You may also hear the clicking of a relay closing and opening just after these messages.

Finally, the fascia adopts the normal display shown in Figure 3-7.

- NOTES. 1) Slightly different power-up messages may appear if someone else has used the T640 before you — e.g. **TepidSrt Trying** or **WarmStrt Trying**.
- 2) If what has just been described fails to happen and you get an error message (e.g. **Err 6001**), first check that you have set SW1 correctly. If necessary refer to Chapter 8, *Error conditions & diagnostics*, for further information.

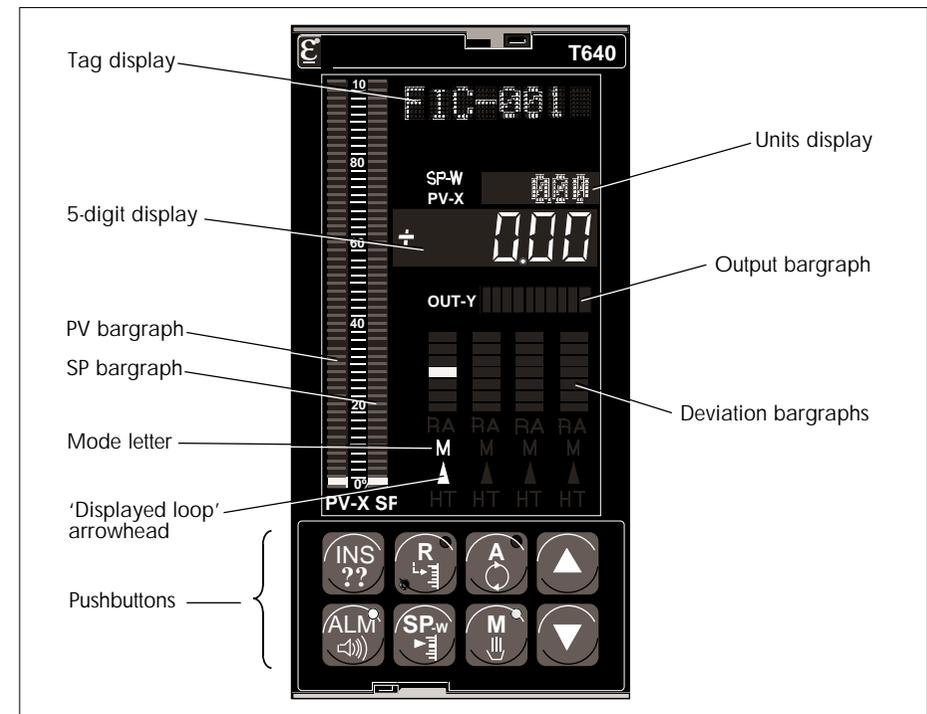


Figure 3-7 T640 front panel — initial power up

## The initial display

Refer to Figure 3-7. **FIC-001** in the red tag display is the loop's 'tagname', appropriate to a flow controller. Note that you can select an alternative tagname if you wish — see Table 5-5 in Chapter 5 — but 'FIC-001' will do for this tutorial. The green **0.00** appearing in the *units display* — accompanied by the glowing green **SP-W** legend — shows the loop's setpoint (SP) value. The red *5-digit display* shows the current PV value (also **0.00**), accompanied by the glowing red **PV-X** legend.

The two *bargraphs* at the left of the fascia, sharing a 0-100% scale, also display PV and SP as red and green vertical bars, respectively. They presently indicate zero — only the bottom LEDs are lit.

Note the brownish-yellow letter **M** flashing above the green arrowhead just above the set of pushbuttons, together with the flashing yellow LED in the **M** (Manual) pushbutton. The brown letter M means that the loop displayed on the fascia is in Manual mode, and its flashing — together with the flashing button yellow LED — means that manual mode selection has been forced by an alarm condition.

Finally, note that the **ALM** (alarm) button shows a steadily-glowing red LED. This draws your attention to the fact that an alarm condition exists somewhere in the instrument.

## INVESTIGATING THE ALARM CONDITION

Whenever the **ALM** button LED is lit you can quickly trace the source of the alarm as follows. (Figure 3-8 shows these how the **ALM** button works.)

- 1 Press **ALM** briefly. The tag display shows **LOOP 1**, and **LOOP** appears in the green units display. This tells you that the alarm is in Loop 1.
- 2 Press **ALM** again. The tag display shows **SETP1**, and **BLOCK** appears in the green units display. This localises the alarm condition to a specific area of the control database called a 'function block', the name of the block in this case being 'SETP1'. (Function blocks are explained in more detail below.)
- 3 To see if there are any other Loop 1 blocks in alarm, press the 'raise' ▲ button. The tag display now shows **PV\_\_1**, indicating that a block called 'PV\_\_1' is also in alarm.
- 4 Investigate the PV\_\_1 block's alarm by pressing **ALM** again. The tag display shows **Hardware**, with **SubFd** showing in the units display. This tells you that the particular type of alarm involves the T640 hardware in some way, 'Hardware' being the name of the Alarm 'subfield' within the affected block. (Subfields are explained in the *Function blocks* section below.)
- 5 To see if there are any other alarms in the PV\_\_1 block, press the 'lower' ▼ button. This changes the tag display to **OCctdel**, which indicates that an open circuit has been detected on the PV input. This is not surprising since you have not connected anything to the input terminals other than the power supply! Note that the hardware alarm you just saw is itself due to the open-circuit condition rather than to any other hardware fault, though this would not always be the case.

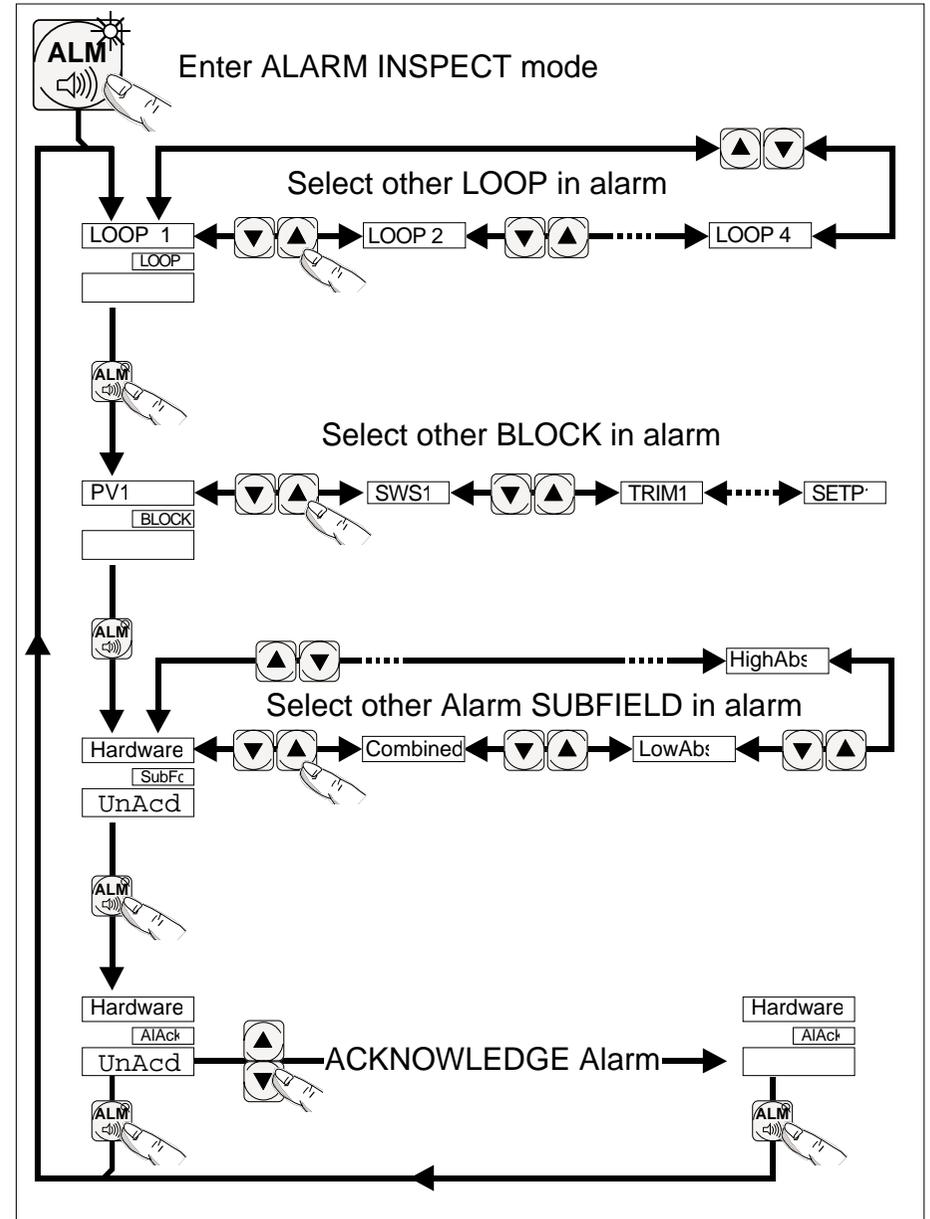


Figure 3-8 Alarm inspect button functions — ALM

- 6 Press ▼ again. **Combined** appears in the display. This is the ‘combined’ or ‘common’ alarm that is always asserted when any other alarm in a block trips.
- 7 Finally, escape from the ‘alarm inspect mode’ by briefly pressing any one of the **R**, **A**, **M**, or **SP-W** buttons. If you do nothing for two minutes a timeout will in any case operate to revert the fascia to its normal display automatically.

## WATCHDOG RELAY

The clicking you may have heard when you powered up the T640 was due (in part) to the closing and opening of the *Watchdog relay*. The contacts of this relay are connected to customer terminals 16 and 17. The watchdog relay is normally closed when the T640 is running and its CPU is healthy. It opens on CPU or power failure, but has also been configured to open if an alarm occurs and remains open until the alarm condition has been cleared.

You can check this by connecting a multimeter set to measure resistance across terminals 16 and 17. These will be open circuit, indicating an alarm condition — the hardware alarm in the PV\_\_1 block.

## FUNCTION BLOCKS

### Blocks

Figure 3-6 (on page 3-5) divided the control database into three broad areas. In fact, each of these areas is further subdivided into pre-defined packages of software, having defined and specialised functions in the running of the control strategy. These are the *function blocks*, or ‘blocks’ for short. Every block has a tagname for reference, and can perform its own specific task in the strategy, e.g. the block called PV\_\_1 is an *analogue input* block type that takes in analogue signals from the plant, processes them, and passes the results on to other blocks in the strategy via ‘wiring’ between the blocks.

Other block types perform such tasks as setpoint generation, PID calculation, digital input, analogue output, mathematical and logical operations, and so on.

### Fields & subfields

Each block includes a collection of database values — *fields* — some of which are subdivided into *subfields*. Note that in the four fixed-function strategies, all the necessary blocks have been installed and wired together for you — all you need do is set some of the block fields to specific values to tailor the strategy to your own plant requirements.

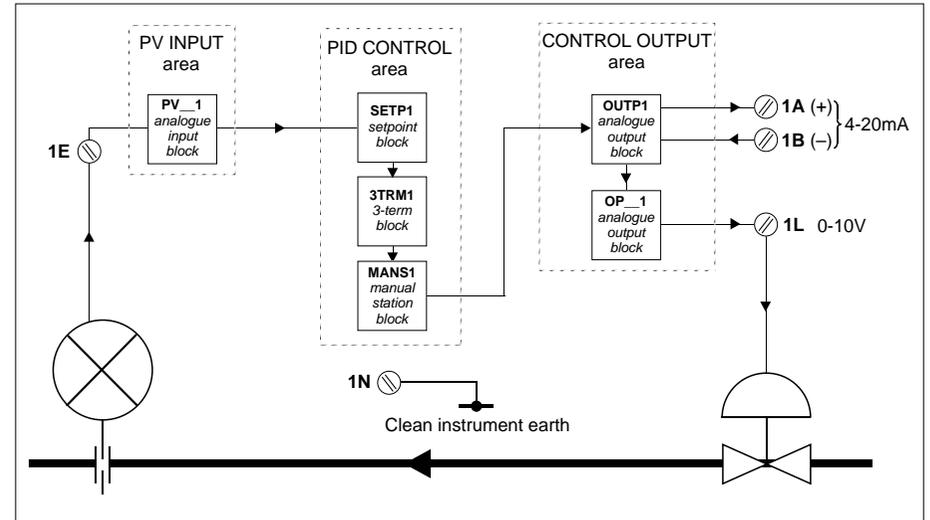


Figure 3-9 Strategy #1 schematic

## Alarm fields

Alarm conditions are represented in each block by an **Alarms** data field. This field is further divided into subfields, which become TRUE when the corresponding alarm condition arises. It was these subfields that you just inspected via the ALM pushbutton.

Figure 3-9 shows strategy #1 in a little more detail, with some of the blocks named and their block types indicated. Also, some of the customer terminals are shown, where plant can be connected. You will need this information to progress with the tutorial.

## Block functions

### PV input area

As already stated, **PV\_1** is an analogue input block that takes in a voltage signal from the plant (the orifice plate in this example) via terminal 1E. **PV\_1** ranges the input signal to engineering units, filters, characterises, and conditions it (e.g. applies square-root for an orifice plate signal). **PV\_1** also checks for alarm conditions including I/O hardware, out-of-range and open-circuit inputs. And as you have just seen, the block detected the fact that its input is in open-circuit.

### PID control area

In the PID control area of the database, the **SETP1** (setpoint) block generates a resultant setpoint from the local setpoint you can enter via the front panel, and subjects it (and PV) to ranging, high/low limits, trim, rate limits, and also provides absolute and deviation alarms. The **3TRM1** (3-term) block generates a 3-term control output from PV and SP, and lets you alter the loop's tuning constants. The **MANS1** (manual station) block applies high and low limits to the control output.

## Control output area

In the control output area, **OUTP1** is an analogue output block configured to provide an isolated 4-20mA control output to the plant, via T640's hardware. This is available on customer terminals 1A and 1B, as shown in the Figure. Also available — via another analogue output block **OP\_\_1** configured to output volts — is a 0-10V control output on terminal 1L. (Any of terminals 1G, 1K, and 1N provide the analogue ground.) The 0-10V output follows the 4-20mA output. Figure 3-2 showed the I/O customer terminals 1A-1Z.

## SIMULATING A FEEDBACK LOOP

Figure 3-9 shows that the 0-10V control output appears on terminal 1L — which could in a real plant be connected to a suitable control valve. The PV input from the orifice plate would be connected to terminal 1E for input to the PV\_\_1 block. You can simulate this control loop by feeding the control output back to the PV input. Do this by simply connecting a wire between terminals 1L and 1E.

Note that within a few moments of connecting the wire the red **ALM** button light goes out (showing the alarm condition has cleared), the **M** button's yellow LED stops flashing (meaning that normal 'un-forced' manual mode now operates), and the watchdog relay closes (which you may see on the multimeter if still connected).

If you now press the **ALM** button, the message **NoAlm** appears in the tag display, meaning no detected alarm condition now exists in the instrument.

With the control loop complete, you can now investigate the strategy further.

## DISPLAYING & ALTERING THE LOCAL SETPOINT

The resultant setpoint is currently 0.00 units, as shown in the green units display (see Figure 3-7). Alter this to about 50 units as follows:

- 1 Press the **SP-w** button to display the local setpoint (0.00) in the red 5-digit display.  
With **SP-w** pressed, **SetLocal** appears in the tag display to remind you what is being displayed. The setpoint's units ('**Eng1**') are shown in the green units display.
- 2 Keeping **SP-w** pressed, hold down the **▲** button and watch the local setpoint value increase — slowly at first, then more and more rapidly. Raise it to about 50 units, then release both buttons. The new resultant setpoint shows in the green units display — it should equal the local setpoint you just configured. Also, the green SP vertical bargraph now displays the resultant setpoint in percentage units. (These happen to equal the engineering units, with the default ranges currently configured.)

Note the negative value now displayed by the Loop 1 deviation bargraph — i.e. the red LEDs are lit below the central green zero LED. Full-scale (all 3 segments lit) represents about 10% deviation (PV-SP).

- 3 Try lowering SP again to zero, by pressing **SP-w** and **▼** together. Note how the green units display shows **Limit** if you try to reduce SP below zero. This tells you that you have hit a configured low limit of 0.00 on the setpoint value. Similarly, you meet another limit if you try to raise SP above 100.00 units.
- 4 Finally, restore SP to about 50 units.  
NOTE. While you have been varying SP, the PV value — as shown by the PV bargraph and the red 5-digit display — has remained at zero. This is because the control loop is still in manual mode and is therefore exerting no control action. Automatic mode will be looked at next.

## SELECTING ANOTHER OPERATING MODE

### Automatic mode

With SP still at about 50 units, press the **A** button to select automatic mode. Its green LED lights — confirming that auto mode has been adopted — and the **M** button's yellow LED goes out. As soon as auto is selected the control output begins to rise due to the action of the PID algorithm in the PID control area of the strategy.

NOTE. While **A** is pressed, **OUTPUT** appears in the tag display and the fascia shows the current control output value and its units (%).

You can see the control output displayed in the horizontal output bargraph, labelled **OUT-Y**. Each of its yellow segments represents about 10% of full range output.

The (simulated) PV value also rises, of course, and shows itself on the red **PV-X** vertical bargraph at the left of the fascia, and also in the 5-digit display. Once the controller has settled down in auto, PV and SP should adopt the same value in this simulation.

The deviation bargraph now shows zero deviation, with just the central green LED lit. The letter **A** glows in green below the deviation bargraph denoting automatic mode for this loop.

### Manual mode

You can press the **M** button at any time to select manual mode. Note that pressing **M** also displays the control output value and units. But in manual mode you can alter the output, not just display it.

Try raising the control output to 100% by pressing **M** and at the same time pressing the **▲** button. You will see the PV and deviation bargraphs rise to their maximum indications. '**Limit**' appears in the green units display, because PV has reached its configured limit.

## Remote mode

Pressing the **R** button cannot select remote mode in this simple loop simulation. Instead, the **A** button's green LED (and the letter **A** below the deviation bargraph) flashes indicating that 'forced automatic' mode has been adopted. This happens if you try to select remote when it has not been enabled, or if the remote setpoint is invalid. Control action is still exerted in this mode. If you don't want remote mode to be selectable you can disable ('mask') the **R** button. This is explained later under *Pushbutton masking* on page 3-23.

Press **A** to restore normal automatic mode.

## POWER INTERRUPTIONS

### Warm start

Remember when you powered up the T640 at the start of the tutorial you saw the message **ColdStrt Trying**, and the instrument performed a cold start. After a cold start the database is initialised and therefore in its default state. Remember also that you set the SW1 switches to enable both cold and warm starts. This enables the T640 to perform a warm start if possible. After a successful warm start the instrument resumes running the control strategy having remembered or regenerated all the database values as they were at the moment of power interruption. Try a warm start now:

- 1 Check that you have automatic mode selected, and a PV value other than the default of 0.00.
- 2 Switch off the power to the T640, either at source or by withdrawing the instrument from its sleeve.
- 3 Restore the power after a few minutes. The message **WarmStrt Trying** flashes in the tag display, and after a few moments the fascia adopts the state it had at power-down, i.e. a warm start has been performed.

### Cold start

Now try interrupting the power with the warm start enable switch OFF:

- 1 Access the interior of the T640 and set SW1 switch 4 to OFF — but leave switch 3 ON.
- 2 Re-insert the T640 in its sleeve to restore power. A cold start is performed, and the strategy starts in its default state, having 'forgotten' your modifications to it.

### Tepid start

A 'tepid' start is a type of warm start, but not quite as good because only some of the database values are restored at power up — including local setpoints, control outputs, and operating modes. Tepid starts occur when the RAM database has been corrupted; it's possible that you may have seen one when you powered up the T640 at the start of this tutorial.

(For more information please refer to Chapter 2, under *Power up routine*.)

## INSPECTING & EDITING THE DATABASE

### Using INS

This section of the tutorial shows you how to inspect and modify parts of the database to tailor the strategy to your particular needs. The first thing you will look at is ranging the setpoint and process variable engineering units. After that you will go on to apply high and low limits to the local setpoint (SL), and then configure absolute and deviation alarms on PV. Finally in this section, you will set up a new decimal point position for the front-panel display.

The function block concerned with this part of the control strategy is the **SETP1** (setpoint) block, which was shown in Figure 3-9 in the 'PID control area' of the database. To carry out modifications you must access the relevant fields inside the SETP1 block. To do this you use the **INS** ('inspect') pushbutton on the front panel.

Table 3-1 lists each of the configurable fields within the SETP1 block, together with its default value, target setting, and a brief description of its function in the strategy. This list will be useful when you are navigating around the fields to configure them. Note that a complete list of blocks and fields for each of the fixed-function strategies is given in the setup sheet included in this manual (at the end of Chapter 5).

Block	Field	Subfield	Default	Setting	Description	
SETP1	HR_SP		100.00	75.00	Engineering unitshigh for SP and PV	
	LR_SP		0.00		Engineering units low for SP and PV	
	HL_SP		100.00		High limit on SP	
	LL_SP		0.00		Low limit on SP	
	HL_SL		100.00	60.00	High limit on SL	
	LL_SL		0.00		Low limit on SL	
	Alarms		HighAbs	2		Alarm priority on HAA
			LowAbs	2		Alarm priority on LAA
			HighDev	2		Alarm priority on HDA
			LowDev	2		Alarm priority on LDA
	HAA		100.00	70.00	High absolute alarm on PV	
	LAA		0.00	30.00	Low absolute alarm on PV	
	HDA		100.00	10.00	High deviation alarm on PV	
	LDA		100.00	10.00	Low deviation alarm on PV	
Dis_DP		2	3	Decimal point position		

Table 3-1 Configurable fields in the SETP1 (setpoint) block

### Configuring ranges and limits

Figure 3-10 shows how the INS button works.

- 1 Press the **INS** button briefly. **LOOP 1** appears in the tag display — this is the loop ready to be inspected, and it is the loop that contains the SETP1 block. The green units display shows **LOOP** (meaning 'loop access mode').

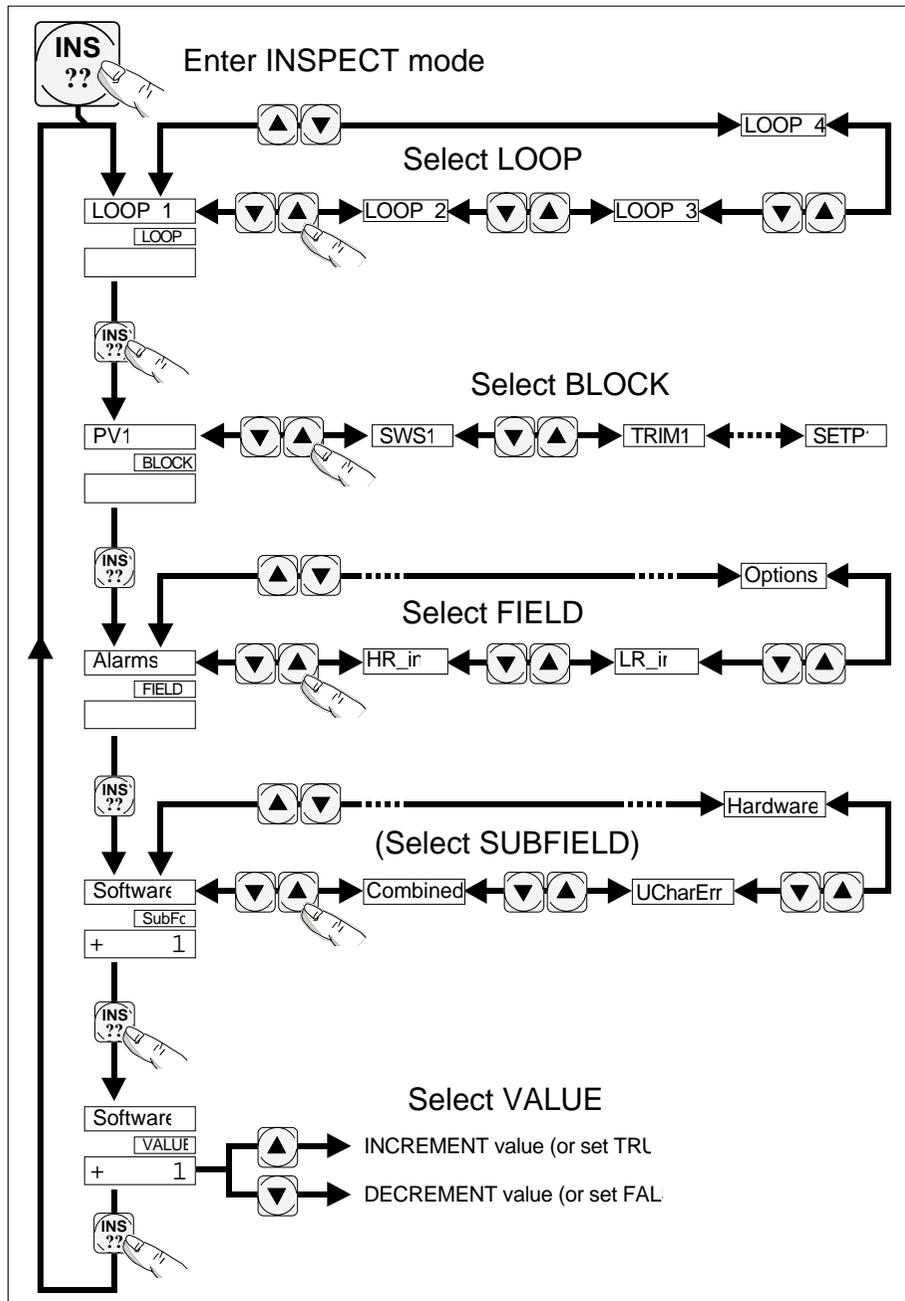


Figure 3-10 Inspect button functions — INS

NOTE. If you now press either ▲ or ▼ you will see another ‘loop’ — **LOOP 4** — in the tag display. Loop 4 is not actually a *control* loop, but is a second independently-running section of the database (‘user task 4’) that you can access via the **INS** button. Loop 4 contains, among other items, configuration data on T640 communications, which do not concern us here.

- 2 With **LOOP 1** in the display, press **INS** again. The units display changes to **BLOCK**, denoting ‘block access mode’, and the tag display now shows the name of the first block in the Loop 1 (i.e. ‘User task 1’) area of the database. This block may or may not be the one you want (**SETP1**) depending on how the T640’s memory module has been programmed at the factory.
- 3 In any case, now press the ▼ button to move down to the next block in Loop 1 and see its name in the tag display.
- 4 Press ▼ again repeatedly to see all the blocks in Loop 1 that you can access for inspection or modification. There are 13 altogether. Use ▲ to move up the list again, if you go past the block you require. Access the **SETP1** block.
- 5 With **SETP1** in the tag display, press **INS** again. This gets you into ‘field access mode’ as shown by **FIELD** in the units display. The tag display now shows the first accessible field in the SETP1 block, which is called **HR\_SP**. This field stores the high range in engineering units for SP and PV. Its current (default) value is shown in the red 5-digit display as **+100.00**. In the next step you will alter this value, but before doing this try accessing the other fields in the SETP1 block using the ▲ and ▼ buttons to move around the list. There are 12 fields in all (see Table 3-1). Get back to **HR\_SP** for the next step.
- 6 With the **HR\_SP** field selected, press **INS** again. **VALUE** appears in the units display, telling you that you can update the field value. Press ▲ to raise the value, or ▼ to lower it, to the one you require (subject to any configured limits). For this tutorial, lower the high range to 75.000 engineering units.
- 7 You now want to move on to the **HL\_SL** field in the block, which specifies a high limit value for the local setpoint SL. Press **INS** three times to return to ‘field access mode’ with **HR\_SP** still accessed (T640 has remembered your selections). Then press ▼ once to access **LR\_SP** (which you will leave at zero) and then three more times to reach **HL\_SL**. Adjust this to 60.000 by pressing **INS** to get into ‘value update mode’ as before, then use ▲ or ▼ as needed. Then return to field access mode by pressing **INS** three times.

### Configuring absolute and deviation alarms

In this stage of the tutorial you set new values for the high and low absolute and deviation alarms.

- 1 Access the **HAA** field in the SETP1 block, as before. (If you've forgotten how to do this, have a look at the previous section again to remind yourself!). **HAA** specifies the high absolute alarm limit on PV, i.e. the PV value which if exceeded trips the high absolute alarm (which you will inspect soon). Its default value is 100.00. Press **INS** to access value update mode and lower the HAA value to 70.000 units. Press **INS** three times to return to field access mode.
- 2 In the same way, set **LAA** (low absolute PV alarm) to 30.000, and set **HDA & LDA** (high and low deviation alarms, respectively) to 10.000 each.

### Configuring the decimal point

- 1 Access the **Dis\_DP** field, which stores the decimal point position used in the 5-digit and the units displays. To do this quickly you can, once into field access mode, just press the **▲** button once to get you directly to the end of the field list, which is cyclic.
- 2 Set **Dis\_DP** to 3 (decimal places), then press **A** to return to the normal display and see the effect of this change.

### Alarm subfields

In this next stage of the tutorial you inspect the subfields of the **Alarms** field in the SETP1 block. To do this:

- 1 Use the **INS** button as before to access the **Alarms** field in the SETP1 block.
- 2 Press **INS** again. This time, instead of entering 'value update mode' you see **SubFd** in the green units display, denoting 'subfield access mode'. This is because the Alarms field consists of a set of *subfields*, unlike the range and limit fields you have met so far. The first subfield accessed is shown in the tag display — **Software** — and its current value appears in the 5-digit display — **1**. This is the *priority* of the Software alarm, which you should not alter at this stage. (You would alter it in the same way as described above, using the **INS** and **▲/▼** buttons.)
- 3 Still in subfield access mode, press **▼** to move to the next subfield in the Alarms field — **HighAbs**. This is the PV high absolute alarm, which trips if PV exceeds the high limit (specified in the **HAA** parameter). Its priority of 2 should be left as is.
- 4 Go on to inspect the rest of the Alarm subfields in the same way. Finally return to the normal fascia display by pressing the **A** button. You may have noticed that if you do nothing for two minutes a timeout operates automatically to escape from 'inspect mode'.

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## EFFECT OF THE ALARM SETTINGS AND LIMITS ON THE FRONT-PANEL DISPLAYS

You can see the effects on the fascia displays of the limits and alarm levels just configured. Start by setting SP to about 50 units with the loop in auto. Let the displays settle.

### Inspecting absolute and deviation alarm settings

- 1 To see these values directly on the PV-X and SP-W bargraphs, press and hold down ▲ and ▼ together. **ALM\_SET** ('alarm settings') appears on the tag display. On the PV bargraph the upper and lower limits (HAA and LAA) appear as a pair of reverse-lit segments superimposed on the bar. This display lets you see immediately where PV is in relation to the limits. At the same time the high and low deviation limits (HDA and LDA) are superimposed on the SP bargraph as reverse-lit segments. These mark the levels above and below the current SP-value, which move up and down with it. If PV goes outside these levels a deviation alarm trips.

### Effect of local setpoint limit

The setpoint limit you set up (in HL\_SL) shows itself when you try to adjust the local setpoint:

- 1 Raise the setpoint as far as possible by pressing **SP-w** together with ▲. When the value reaches 60.000, **Limit** appears in the units display.

### Annunciation of absolute and deviation alarms

Produce alarm conditions and see the effects on the displays:

- 1 Lower the setpoint (from 60) to about 20 engineering units. The green **SP-W** bargraph starts to flash as soon as the setpoint has fallen far enough to trip the high deviation alarm. At the same time the deviation bargraph also flashes, and the **ALM** button light comes on. Shortly after this, when PV has fallen below its low limit (in LAA), the **PV-X** bargraph starts flashing to warn you that the low absolute alarm has tripped. NOTE. You may also have heard the watchdog relay click open, which it is configured to do by any priority 2 alarm.
- 2 After a while, when the fascia has settled and control has been regained (PV = SP), only the low absolute alarm remains. Trace this alarm via the **ALM** button. You should find **LowAbs** (and **Combined**) alarms in the SETP1 block.
- 3 Finally, restore the setpoint to about 50 units to clear all alarms.

## INSPECTING & EDITING THE PV INPUT AREA

This section gives you some more practice at using the **INS** button to access the fields in the **PV\_\_1** (analogue input) block. Remember, **PV\_\_1** takes in and conditions the signal from the orifice plate (in this example). Specifically, you will inspect and edit the input filter time constant, and apply a square root function to the signal from the orifice plate.

Table 3-2 lists the **PV\_\_1** block's configurable fields and target settings.

Block	Field	Subfield	Default	Setting	Description
PV__1	Filter		1.00	2.00	Input filter
	RomChar		None		Input conditioning
	Alarms	Hardware	2		Alarm priority
		OutOfRange	2		Alarm priority
		OCctdel	2		Alarm priority
	HR_in		10.00		Input voltage high
	LR_in		0.00		Input voltage low
	Options	Invert	FALSE		Input conditioning
		Sqrt	FALSE	TRUE	Input conditioning

Table 3-2 Configurable fields in the PV\_\_1 (analogue input) block

Start this section with the T640 set up as at the end of the previous section.

- 1 Press **INS** twice to access block inspect mode, then press **▼** (if needed) to bring up the **PV\_\_1** block.
- 2 Press **INS** again to access the first field in the **PV\_\_1** block — **Filter**.
- 3 Press **INS** again, then increase the value of the filter time to 2.00 (seconds) using the **▲** and **▼** buttons.
- 4 Press **INS** three times to return to field inspect mode.
- 5 Access the **RomChar** field and inspect its contents by pressing **INS** again (to access **VALUE** mode) and using **▲/▼**. As you edit the ROM-based characterisation functions stored in the **RomChar** field you may notice the front-panel displays altering to re-establish control under the new conditions you are creating! Return the **RomChar** value to **None** (the default) before continuing.
- 6 Access the **Options** field in the usual way. This field lets you apply an inversion to the input signal, and/or a square root function.
- 7 Press **INS** to see the **Options** subfields. The first is **Invert** which is **FALSE** by default — i.e. no inversion.
- 8 Press **▼** to move to the second subfield — **Sqrt** (square root).
- 9 Press **INS** again and set the value to **tru** (**TRUE**) using **▲**. (**▼** restores **FALSE**.) You will see the front panel respond as **PV** changes value.
- 10 Finally, press the **A** button to return to the normal display.

## SAVING A DATABASE

Now that you have reconfigured several of the fields in the control strategy you will want to save it to EEPROM, where it will be safe and effectively permanent. At the moment your customised strategy exists only in RAM, which although battery-backed in the T640 is inherently a volatile memory medium.

To save your database currently in RAM you must access a function block called **T60\_00**. (The last two digits are the *node number*, and may differ from **'00'**. Ignore this in the tutorial!) This block contains a field called **Options**. Within Options is a subfield called **FullSave**. You set this TRUE to effect the save to EEPROM.

- 1 Press **INS** to access loop inspect mode.
- 2 Press **▲** or **▼** to move to **LOOP 4**, which is the user task containing the T60\_00 block.
- 3 Press **INS** again to inspect the blocks in Loop 4. The first one is **USR\_ALM**, which stores the alarm priority needed to trip the watchdog alarm relay (currently set at 2).
- 4 Move to the next block — **T60\_00** — and press **INS** to see the **Options** field, which is the only accessible field in this block.
- 5 Press **INS** again to see the Options subfields, and move down the list until you reach **FullSave**.
- 6 Press **INS** and set the value to **tru** by pressing **▲**. The message **SAVING . .** appears in the tag display as the save is executed, and the value of the subfield automatically returns to **FALSE**. After a few moments the tag display reports **Save OK**. Press **A** to return to normal mode.

### Saved databases

Your customised database is now safely stored in EEPROM — under the same filename that the original default database had. But note that the original fixed-function default strategies will always reside in ROM and could be made to overwrite your customised strategy!

To avoid this, if you intend to keep a customised strategy in EEPROM, **do not reset the SW1 strategy-select switches (switches 6, 7, and 8 in Figure 3-4)**. If you do, there is a risk that at power-up a new strategy will replace your customised one in EEPROM.

It is OK to power up with the switches set to the *original* strategy that you subsequently customised (#1 in this case). This is because when the T640 sees that the EEPROM already contains the strategy indicated by the switches, it loads it directly from EEPROM to RAM and runs it *without* 'unpacking' (decompressing) a default database from ROM.

You can test the effect of your save as follows:

- 1 Remove the T640 from its sleeve and set the warm start enable switch to OFF. (Leave the cold start enable switch at ON, and the strategy-select switches at #1.) Figure 3-4 shows the required SW1 switches. This action now ensures that the T640 cannot do a warm start, only a cold start.

- 2 Power up again by replacing the T640 in its sleeve. You will see a cold start performed but all your saved field values are preserved in your customised strategy. Check this using **INS**.
- 3 Finally, return the warm start enable switch to ON.

## INVESTIGATING THE LOOP SETUP 'SWITCHES'

There is a set of 16 'software switches' or bits within a block called **SWS\_1**, in the PID control area of the strategy. You can use them to specify the way the control loop operates. The **SWS\_1** bits select such things as the T640 power-up mode, inversion of control output action, on/off control action, pushbutton disabling ('masking'), and the tagname that appears in the loop's tag display. Table 3-3 lists the **SWS\_1** bitfields.

Try switching some of these bits from their default states (all but one are **FALSE**) to see how they affect the control action.

### Power-up/power-fail mode

- 1 Press **INS** twice to access block inspect mode, then press ▼ as required to bring up the **SWS\_1** block.
- 2 Press **INS** again to see the only accessible field in the **SWS\_1** block — **W Field1**. This consists of 16 subfields called **Bit0** to **BitF** (hexadecimal 'F' is decimal '15').
- 3 Press **INS** again, to access **Bit0**. Table 3-3 tells you that this bit selects the power-up mode. Remember that power-up occurs after unexpected power interruptions — not just when you switch on the T640. **TRUE** causes the loop to adopt manual mode on power-up with zero electrical output for safety — i.e. 0V or 4mA. **FALSE** (the default) causes the loop to maintain its last mode and output value on power-up.

Block	Field	Subfield	Default	Setting	Description
SWS_1	W Field1	Bit0	FALSE	tru	Power up mode
		Bit1	FALSE		PV fail mode
		Bit2	FALSE		tru - inverse output action
		Bit3	FALSE		tru - inverse PID
		Bit4	FALSE	tru	tru - On/Off control
		Bit5	FALSE		tru - setpoint tracks PV if not AUTO
		Bit6	FALSE		tru - PV/SP Out = SP
		Bit7	FALSE		tru - inverse ratio setting
		Bit8	FALSE		tru - Mask R
		Bit9	FALSE		tru - Mask A
		BitA	FALSE		tru - Mask M
		BitB	tru		Tag FIC-001
		BitC	FALSE		Tag LIC-001
		BitD	FALSE		Tag PIC-001
		BitE	FALSE		Tag TIC-001
		BitF	FALSE		Tag AIC-001

} If all bits FALSE, tag is **LOOP 1**

Table 3-3 Configurable fields in the **SWS\_1** (digital connection) block

- 4 Press **INS** and alter Bit0's value to **tru**, then return to the normal display by pressing **A**.
- 5 Now simulate a power interruption by switching the power off then on, and watch the front panel displays. The T640 powers up in manual mode, and the control output falls to zero. Check this by pressing the **M** button and reading the 5-digit display, which should indicate **0.00%** output. Restore control by re-selecting auto mode (press **A**). Restore Bit0 to FALSE.

### PV fail mode

- 1 Use the **INS** button to access **Bit1** of the SWS\_1 block. This bit determines what happens to the control output should the process variable input PV fail. In Bit1's default state (FALSE), the control output holds at its last value on PV failure. With Bit1 TRUE, however, the output falls to electrical zero (i.e. 0V or 4mA) on PV fail.
- 2 Set Bit1 to **tru** and press **A** to return to automatic mode. While **A** is pressed, note the control output value in the 5-digit display.
- 3 Now simulate a PV failure by disconnecting the wire attached to terminal 1E. Notice that the control loop adopts 'forced manual' mode — indicated by the flashing yellow LED in the **M** button, and that the control output drops immediately to zero. (Press **M** to check this.)
- 4 Reconnect terminal 1E and press **A** to restore control.
- 5 Reset Bit1 to **FALSE**, return to auto mode, then repeat the PV fail simulation. This time the control output holds at its current value despite the loss of PV and adoption of forced manual mode.
- 6 Finally, reconnect PV, press **A**, and allow equilibrium to return.

### On/off control

- 1 Use the **INS** button to access **Bit4** of the SWS\_1 block. This bit selects on/off control action (TRUE) or normal continuous control action (FALSE). With on/off action the control output is either at 0% or 100% of range, with nothing in between.
- 2 Set Bit4 to **tru** and watch the chaos on the front panel as the simulated PV oscillates above and below the setpoint trying to attain equilibrium! Restore Bit4 to FALSE. NOTE. With a suitable *Deadband* value selected (via the **3TRM1** block), on/off control can be applied successfully in appropriate plant situations.

### Tracking of PV by the setpoint

- 1 Access **Bit5** of the SWS\_1 block. When TRUE, this bit forces the local setpoint to track (i.e. follow) the process variable PV whenever the controller is not in automatic mode. (It may be safer for SL to keep equal to PV in the event of a loss of control, so that when control is eventually restored and auto mode resumed, there will not be a sudden and possibly damaging change in control output value.)

- 2 Set Bit5 to **tru** and return to the normal display in auto mode (press **A**).
- 3 Now select manual mode by pressing the **M** button, then attempt to change the local setpoint by pressing **SP-w** together with either **▲** or **▼**. You won't be able to!
- 4 Get back to auto mode and try again. Alter the setpoint to be as far as possible from the current PV-value — e.g. to zero — then quickly switch back to manual mode. Note how the setpoint rapidly equalises with PV.
- 5 Now raise the control output, by pressing **M** and **▲** together. Remember that in this simulation the output is being used as a PV input, so you are also raising PV. Notice how the green SP bargraph tracks the rising red PV bargraph, *but not further than the limit you configured earlier*.

## Pushbutton masking

This may be necessary if you want to prevent an operator selecting a particular mode via the front-panel pushbuttons. Note that button-masking does not prevent modes being changed by other means, e.g. automatically during a failure mode, or over the comms network. When TRUE, **Bit8**, **Bit9**, and **BitA** disable the **R**(emote), **A**(uto), and **M**(anual) mode select pushbuttons, respectively.

- 1 Access the **Bit9** subfield of the SWS\_1 block, and alter its value to **tru**. Return to the normal display by pressing **M**.
- 2 Now try to select auto by pressing **A**. You will not succeed, and the message **MASKED** appears in the tag display for about 3 seconds to tell you why.  
NOTE. You may have seen the **MASKED** message at the start of this tutorial if you pressed **R** or **A** before you connected the piece of wire to close the control loop. These buttons are automatically masked in this strategy as a safety precaution in certain alarm conditions.
- 3 Restore Bit9 to FALSE.

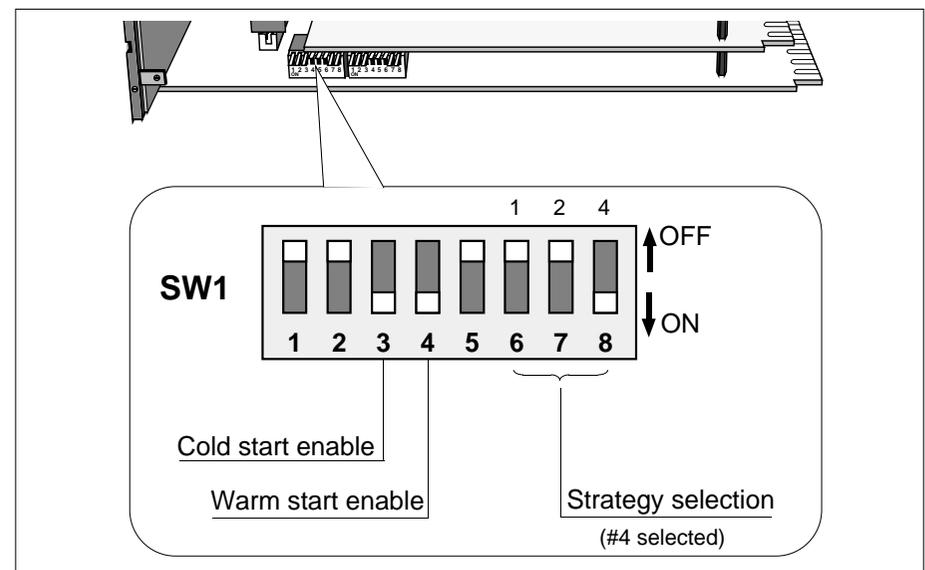


Figure 3-11 SW1 location and settings — strategy #4

## HANDLING MORE THAN ONE CONTROL LOOP

You have nearly completed this tutorial, which has used as its example strategy #1 — a single control loop. When there are two, three, or four control loops in a strategy the front-panel display is able to show you a summary of the status of all the loops at once, together with a more detailed display of one selected loop.

To see how this works in practice, load strategy #4, which has three control loops in it.

- 1 Withdraw the T640 from its sleeve and set the strategy select switches to #4. Figure 3-11 shows the required SW1 switch positions.
- 2 Replace the T640 in its sleeve to power it up. After the initial database unpacking, strategy #4 starts to run, and you now see three deviation bargraph displays illuminated, instead of just one, each applying to one of the control loops. Under one of the deviation bargraphs will be the green arrowhead; this identifies the loop currently selected to occupy the main fascia displays. Its loop tagname is displayed in the tag display at the top of the fascia, and the rest of the displays refer only to this selected loop.
- 3 Select a different loop for main display by holding down ▲ or ▼ to cycle around the available loops. Let go when the required loop is indicated by the green arrowhead. The main display now applies to your selected loop, whose tagname appears in the tag display.
- 4 Try altering a variable of the current loop, e.g. raise its setpoint (by pressing **SP-w** and ▲ together). Note that the front-panel buttons also work only on the currently-selected loop. This applies also to the **ALM** and **INS** pushbuttons.

## Chapter 4 USER INTERFACE

This chapter describes how to use the T640 front-panel pushbuttons and displays to carry out all the basic operations. The front-panel can also indicate failure states; please refer to Chapter 8, *Error conditions & diagnostics*, for details. The present chapter concentrates on the normal running of the T640.

Figure 4-1 shows the front panel, with a typical display.



Figure 4-1 T640 front panel — the operator interface

## OPERATOR DISPLAYS & CONTROLS

### Summary loop displays

Figure 4-1 shows the front panel. Four summary displays show red deviation bargraphs of T640's four loops — Loops 1 to 4 from left to right. *DevnBar*, in the SETPOINT block, specifies the bargraph span as  $\pm 3$ ,  $\pm 10$  (default), or  $\pm 30\%$  deviation. PV can be displayed instead, to 100% of range, if *DevnBar* = *Abs\_PV*. The central green LED glows if the bargraph is showing deviation; the bottom red LED glows if PV is being displayed. A flashing bargraph means the loop is in absolute or deviation alarm.

Operating mode letters glow to show selected modes for each loop: **R** = Remote, **A** = Auto, **M** = Manual, **T** = Track, **H** = Hold). Flashing signifies a 'forced' mode. A totally blank loop summary display and inaccessible main display mean the loop contains no configured blocks, or the related T600 block *FPdiscn* parameter is TRUE.

### Main loop display

This details the status of one of the four loops, indicated by a green arrowhead under the related summary bargraph. To select a loop for main display, hold down a raise **▲** or lower **▼** button. If a loop's MODE block *SelDisp* parameter is TRUE it will always occupy the main display and cannot be deselected. The following features apply only to the loop selected for main display.

### Tag display

This red display normally shows the TAG block's *TAG* field. With no TAG block, the PID/PID\_CONN block name, or SETPOINT block name, or the default **LOOP n** message appears. Special displays can override the normal display, as described in later sections.

### PV-X bargraph display

Red display normally showing the SETPOINT (or PID) block's *PV* value in 2% steps.

### SP-W bargraph display

Green display normally showing the SETPOINT (or PID) block's *SP* value in 2% steps.

### 5-digit display

Red display normally showing the *PV* value of the SETPOINT (or PID) block in engineering units. The **PV-X** legend (see Figure 4-1) glows red only when *PV* is being displayed.

### Units display

Green display normally showing the engineering units associated with the 5-digit display. It can also show the SETPOINT block's *SP* value (*Show\_SP* TRUE). In this case the **SP-W** legend glows green.

NOTE. Pressing **▲** or **▼** displays units in this case.

## Output bargraph

Yellow display normally showing the loop's control output, i.e. the MAN\_STAT block's *MeasPos* value, or its *OP* value if *MPosDisp* is FALSE, or if absent the PID block's *OP* value. All segments lit represents 95% of full range. Note that each bargraph segment can also be driven individually via the MAN\_STAT block's *UserBar* parameter.

## Mode changes

You interact with the main display loop via the eight front-panel pushbuttons. Press **M**(anual), **A**(uto) or **R**(emote) to select the related mode — strategy permitting. The button's top-right LED glows if the mode is adopted; both **R** LEDs glow green in 'computer remote' mode. A flashing LED signifies a 'forced' mode. If a mode button is inhibited (by the MODE block's *PBmasks* parameter, or by a *SelMode* bit), the tag display is overridden by the word **MASKED** for 3 seconds and no mode-change occurs.

## Output display

Holding down a mode button also displays the current value of the control output in the 5-digit display and its units in the units display. The word **OUTPUT** or **MeasPos** appears in the tag display (with **A** or **R** pressed), or **MS\_Dmnd** (with **M** pressed). For the simple PID block only **OUTPUT** appears.

## Changing the output

With **M** pressed and the controller in Manual, press ▲ or ▼ to vary the value of the MAN\_STAT block's *Demand* field (or the PID block's *OP* field). Full-range change takes about 12 seconds.

## Output parameters — quick access

With any of **M**, **A**, or **R** pressed, press **INS** (Inspect) repeatedly to scroll the 5-digit display through the MAN\_STAT block's primary output parameter values.

These are: *OP* (OUTPUT), *Demand* (MS\_Dmnd), *MeasPos* (MeasPos), *PV* (MS\_Input), and *Track* (MS\_Track), identified in the tag display. Only *OP* and *Track* are available from simple PID blocks.

## Setpoint display

Press **SP-W** to display the SETPOINT (or PID) block's *SL* value in the 5-digit display. When in Remote mode the corresponding remote setpoint is seen. With **SP-W** pressed, **SetLocal** or **RemoteSP** appears in the tag display.

## Changing the setpoint

To vary the value of *SL*, press **SP-W** together with ▲ or ▼. Full-range change takes about 30 seconds.

### Setpoint parameters — quick access

With **SP-W** pressed, press **INS** repeatedly to scroll the 5-digit display through the primary setpoint parameter values. These are: *SL* (SetLocal), *SP* (SetPoint), *RemoteSP*, *ComRemSP*, and *TrimSP*, identified in the tag display. *ComRemSP* is not available from simple PID blocks.

### Absolute & deviation alarm settings — viewing

Press **▲** and **▼** together to superimpose the absolute alarm settings on the PV-X bargraph, and the deviation alarm settings on the SP-W bargraph, as pairs of reverse-lit LEDs. The tag display shows **ALM\_SET**.

### Absolute & deviation alarm annunciation

For the main loop on the display, an absolute alarm flashes the red PV-X bargraph and a deviation alarm flashes the green SP-W bargraph. For the four summary loop displays, either alarm flashes the relevant summary deviation bargraph.

## DATABASE ACCESS

The **INS** button lets you inspect and edit database parameters. Two access modes are available — ‘Full’ and ‘Partial’ — requiring a ‘Full’ or ‘Partial’ security key (unless the need for a key is overridden in the T600 block). If necessary, refer to the *Security key* section at the end of this chapter for how to use the key.

Both modes work in the same way, but Partial mode can access only a limited set of blocks and fields. Parameter changes during database access are automatically logged by the T640 in a special EEPROM file — see Chapter 6, *Changes logfile*.

To access the current database, press **INS** repeatedly as required to cycle through the following hierarchy of database access modes; the green units display shows the access level reached.

Figure 4-2 shows how the **INS** button works.

### 1 Loop Access mode

The first **INS** press selects this mode, and **LOOP** appears in the green units display. Unless overridden, a security key must be active for initial entry into this mode.

**NOTE.** If the message ‘**No Key**’ appears in the tag display, you will not be permitted to access inspect mode without a valid security key — see below in the section *Security key* for details.

Press **▲** or **▼** to select a loop for inspection, indicated as **LOOP *n*** (or **Cached**) in the red tag display. The initially selected loop is the same as the main display loop. (Press **ALM** to see the *loop repeat rate*, in seconds, in the 5-digit display.)

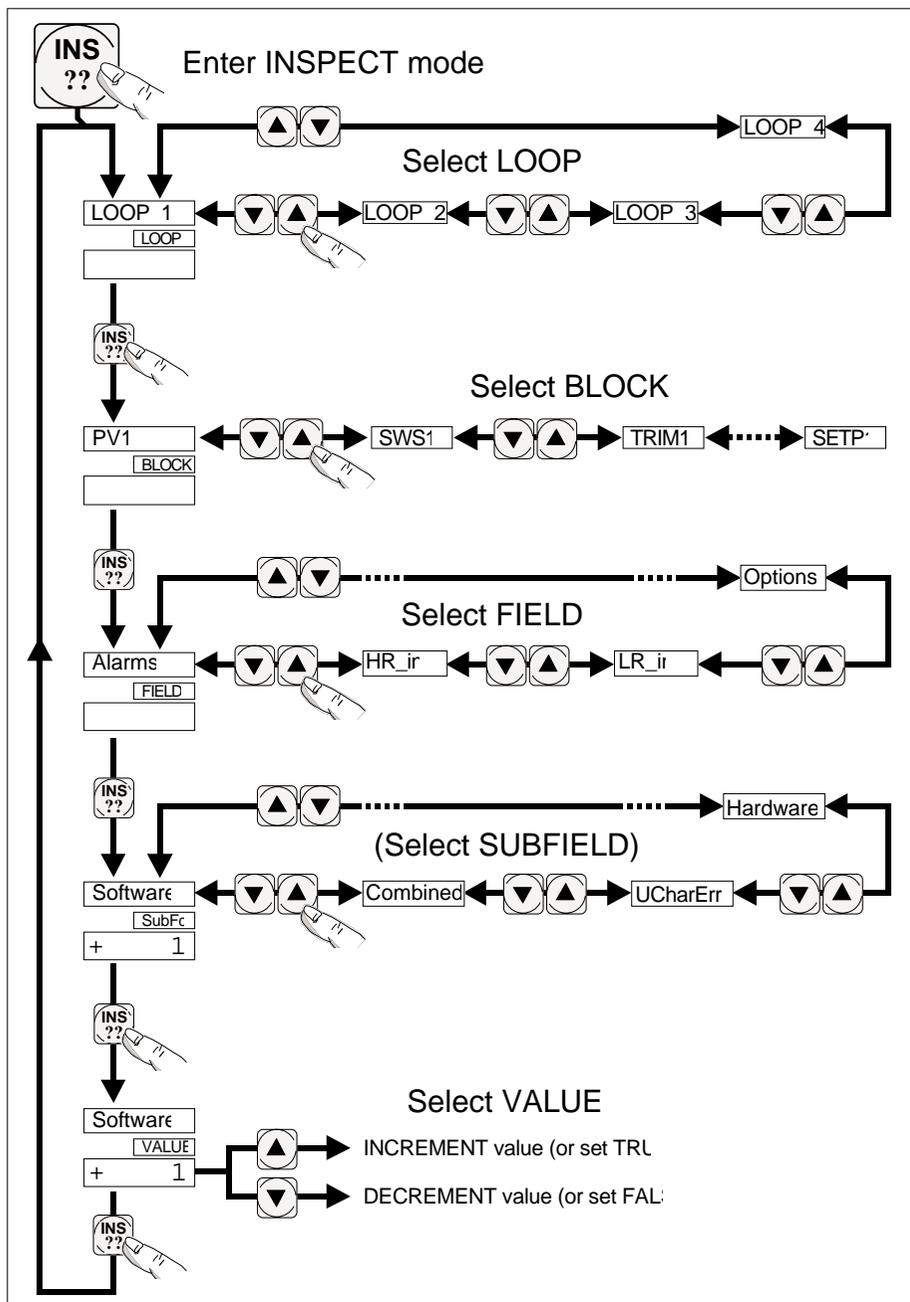


Figure 4-2 Inspect button functions — INS

## 2 Block Access mode

The second **INS** press selects this mode, and **BLOCK** appears in the units display. Press **▲** or **▼** to select a block for inspection. Block tagnames appear in the tag display in execution order. (Press **ALM** to see the block *Type* in the Tag display.)

## 3 Field Access mode

The third **INS** press selects this mode, and **FIELD** appears in the units display. Press **▲** or **▼** to select a field for inspection. The tag display shows the field's name, and the 5-digit display shows its value (format permitting). (Press **ALM** to see the field's *units* in the Tag display.)

## 4 Value Update mode, Connection Enquiry mode, Subfield Access mode

The fourth **INS** press selects one of these three modes, depending on the type of field accessed:

- **Value Update mode.** **VALUE** appears in the units display, or **Ronly** (read-only) if update is not permitted. Press **▲** or **▼** to vary the field value, indicated in the 5-digit display (or in the tag display if text). **Limit** in the units display indicates that a limit has been reached. Pressing **INS** at this point returns you to Loop Access mode. Further **INS** pressing cycles through the access mode hierarchy, retaining your latest selections.
- **Connection Enquiry mode.** If the field has a connection into it, barring manual update, **Conn.** appears in the units display. The tag display shows the first 8 characters defining the source point. Press **▲** or **▼** to see the rest. Press **INS** to return to Loop Access mode.
- **Subfield Access mode.** If this is a subfield, **SubFd** appears in the units display. Press **▲** or **▼** to select a subfield within the current field. The tag display shows the field's name, and the 5-digit display shows its value (format permitting).

## 5 Subfields

If this is a subfield, the fifth **INS** press selects subfield **VALUE** or **Conn.** modes, used as already described.

## Quitting database access modes

Pressing **R**, **A**, **M**, or **SP-W** immediately reverts the T640 to standard operation. A timeout can also be set in the T600 block to revert the display after a defined period of no button activity.

## ALARM DISPLAY & INSPECTION

Whenever any unacknowledged alarms exist in the loop occupying the main display, the highest priority alarm name flashes in alternation with the standard message in the tag display. Unacknowledged alarms elsewhere display **LP n ALM**, where *n* is the relevant loop number.

Any alarm in the instrument — in any of the loops — lights the red LED in the **ALM** button. The LED flashes if any alarm is unacknowledged; otherwise it remains steady.

### Alarm inspection via the ALM button

The **ALM** button lets you quickly locate and acknowledge alarms, wherever they are. Figure 4-3 shows how the **ALM** button works.

- 1 Press **ALM** to enter Loop (Alarm Inspect) mode, indicated by **LOOP** in the green units display. The tag display flashes the highest priority alarm name current in the database, and the corresponding loop is entered for inspection, whether or not it is in the main display. (If no alarm exists anywhere — **ALM** button LED unlit — **NoAlm** is displayed and you cannot enter loop mode.) Once in loop mode, you can press **▲** or **▼** to select another loop for inspection if required; only loops in alarm are accessed.
- 2 Press **ALM** again to display the name of the block with the highest priority alarm in the entered loop. **BLOCK** appears in the units display. (The units display will show **NoAlm** if the loop has since cleared itself of alarms, and you remain in loop mode. In this case you can select another loop in alarm using **▲** or **▼**.)
- 3 Press **ALM** again. The tag display shows the alarm name within the block. The units display shows **SubFd**, and the 5-digit display indicates **UnAcd** if the alarm is unacknowledged, or is blank if acknowledged.
- 4 Press **ALM** again to enter Alarm Acknowledge mode, indicated by **AlAck** in the units display. To acknowledge the alarm, press **▲** or **▼**.
- 5 Press **ALM** again to return to Loop Alarm Inspect mode.

### Quitting alarm inspection modes

Pressing **R**, **A**, **M**, or **SP-W** immediately reverts the T640 to standard operation. A time-out (in the T600 block) can also be set for automatic reversion after a defined period of no button activity.

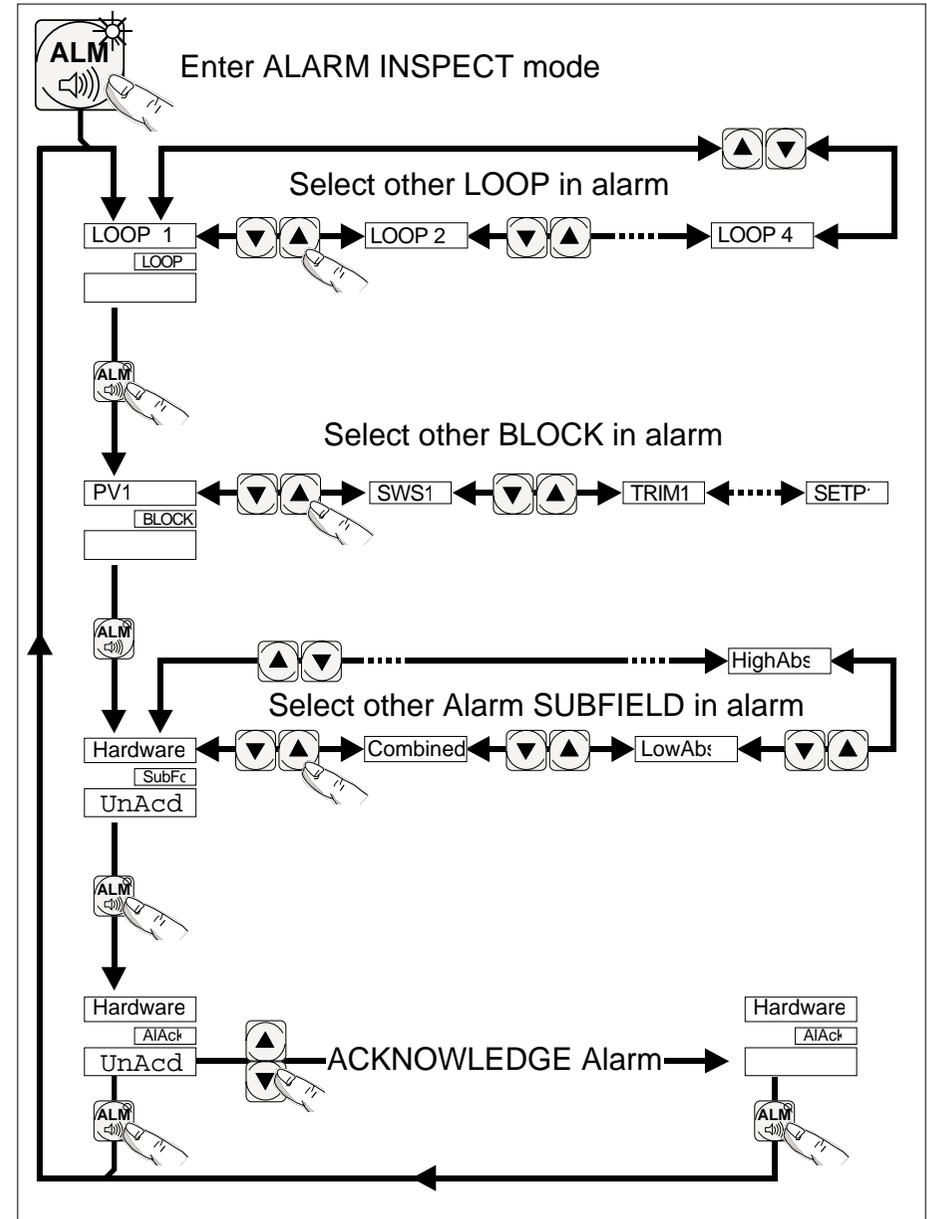


Figure 4-3 Alarm inspect button functions — ALM

## SECURITY KEY

Access to T640's database via the **INS** pushbutton is protected by the T950 infrared-operating security key. (Using **INS** is described in an earlier section: *Database access*.)

### Key parameters

Each key is factory-programmed with three parameters whose values are marked on the key label. There is also a space for entering the keyholder's name. The parameters are:

- **Access.** Specifies how much of the database is accessible to the keyholder. **Full** accesses all parameters; **Partial** accesses the limited default set of parameters specific to each function block (or a set defined during strategy configuration in LINtools). Note that the T600 block's *NoKeyFul* and *NoKeyPrt* parameters if set TRUE allow full or partial access respectively without needing a security key.
- **Area.** Specifies by an area number (1 - 8) what databases are accessible to the keyholder. The area number must match the T600 block's *AreaNo* parameter to gain access (except when *AreaNo* is zero, allowing any key access the database). A key can also have an Area of zero, giving it access only to zero-*AreaNo* databases.
- **ID Code.** Identifies each key with a unique 13-bit number (0 - 8191). Every time the key is used to change a database, a record is logged in a file that includes all the key's parameters. This means that all changes are traceable to a particular keyholder. (See Chapter 6, *Changes logfile*, for details)

### Using the key

Figure 4-4 shows the T950 security key.

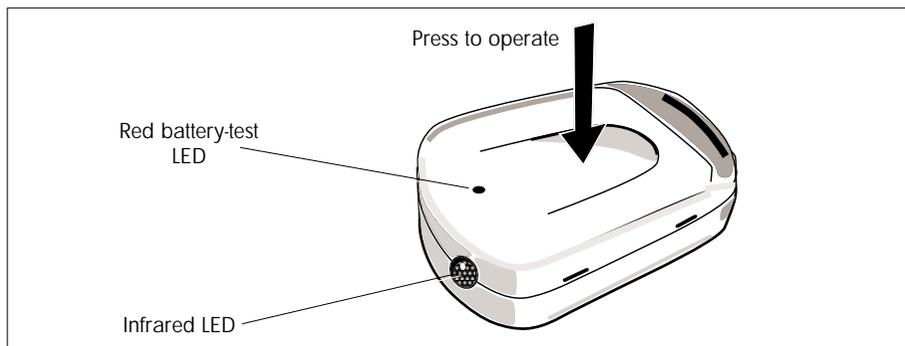


Figure 4-4 Security key — operation

- 1 Press **INS** on the front panel. If no key is needed for access, loop access mode is immediately entered and **LOOP** shows in the units display. Otherwise, **No Key** appears in the tag display and you proceed to step 2.

- 2 Hold the key about 15cm from T640's front-panel, aiming the infrared LED at the **OUT-Y** legend to the left of the output bargraph (see Figure 4-1). The IR sensor is here behind the fascia. Press **INS**, then squeeze the key briefly to click the internal switch. If the security key is valid the tag display replies with **LOOP**, and loop access mode is entered. Invalid keys display **Bad Key**.

NOTE. The battery-test LED on the case should glow when the switch is pressed, indicating a healthy key battery. If not, replace the battery (described below).

While the T640 is in INSpect mode the key is not needed. But if no pushbuttons are pressed for a time specified by the T600 block's *TimeOut* parameter, the fascia reverts to the normal display. Re-entering INSpect mode then needs a security key again.

## Battery replacement

### Caution

Observe anti-static precautions when handling the security key with its lid open.

Replace the battery if the battery-test LED fails to light when the key is operated, and at least every two years. Use a 12V alkaline manganese battery, e.g. Duracell™ MN21, Panasonic™ RV08, or equivalent of overall length 27.5 - 28.5, diameter 9.62 - 10.62 (mm).

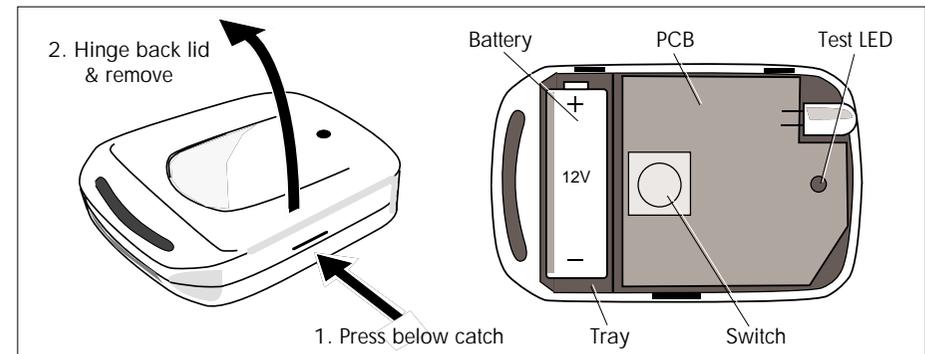


Figure 4-5 Security key — battery replacement

- 1 See Figure 4-5. Press just below the lid catch, hinge back the lid and remove it completely. The interior of the key is shown on the right of the figure.
- 2 Extract the battery and fit a replacement, ensuring correct polarity. This is marked on the tray underneath the battery, and also on the printed circuit board. Test the new battery by pressing the switch. The battery-test LED should light.
- 3 Replace the lid by positioning it over the pair of hinges, then snapping it shut securely over the lid catch.

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## Chapter 5 FIXED-FUNCTION STRATEGIES

This chapter describes the four preconfigured ‘fixed-function’ control strategies supplied with your T640 in its ROM area.

### USING THE STRATEGIES

With the fixed-function T640 you do not have to create your control strategies from scratch. Instead, you just load and run one of the pre-configured fixed-function strategies stored in the instrument’s ROM. Once a fixed-function strategy is loaded you can, directly via the front panel, alter any default parameter values to suit your plant requirements, then save the customised database for future use (via the T600 block’s *FullSave* or *PartSave* parameters). Accessing the database is described in Chapter 4, *User interface*. The tutorial in Chapter 3 also gives you some practice at editing and saving the parameter values of a fixed-function strategy via the front panel.

Instead of customising a fixed-function strategy from the front panel, you can use the PC Windows-based *Fixed-Function Parameterisation Tool* (FFPT) to alter selected parameter values. Software and operating instructions for the FFPT, and also for the file-handling package *LINfiler*, are found in another section of this Product Manual. You use *LINfiler* to download your parameterised databases to the T640, and for several other useful filing operations.

You can also create your own entirely new ‘pre-configured’ strategies, loadable via the motherboard DIL switches in the same way as the regular fixed-function strategies. This is described later in the section, *User-created standard strategies*.

### SUMMARY OF THE STRATEGIES

The fixed-function strategies are supplied in ROM in a compressed — ‘packed’ — format, in files called *name.FFn*, where *name* is the strategy database name and *n* is the number that must be set up on switches 6, 7, and 8 of SW2 to select the strategy ( $n = 1$  to 4). The T640 ‘unpicks’ a .FFn file to create a regular **.DBF** file with the same root filename, ready to be downloaded to RAM and run. Table 5-1 summarises the fixed-function strategies.

n	Name	Summary
1	SINGLE	A single loop controller
2	DUAL	A dual loop controller
3	DUAL_CS	A dual loop controller internally pre-wired in cascade
4	DUAL_RT	A dual loop controller with ratio station

Table 5-1 Summary of the fixed-function strategies supplied in ROM as .FFn files

## CREATING YOUR OWN 'FIXED-FUNCTION' STRATEGIES

To convert any strategy residing in EEPROM — *filename*.DBF — into a switch-selectable 'fixed-function' strategy #*n*, you must create a dummy file called *filename*.FF*n* and store it in EEPROM (via the LINfiler utility) in place of the original strategy compressed file. The dummy .FF*n* file can be empty, as its only function is to link *n* to the chosen root filename.

When you select strategy #*n* via the motherboard DIL switches (Figure 5-1 reminds you how to do this) your custom strategy will load and run. The method works because the T640 does not attempt to unpack (decompress) the dummy .FF*n* file provided the corresponding .DBF file already exists in EEPROM.

## RUNNING A DEFAULT FIXED-FUNCTION STRATEGY

Running a default — as supplied in compressed format — fixed-function strategy from ROM is a particular case of powering up the T640 and running any other strategy. (For a more complete picture of what happens when you power-up the instrument, refer to Chapter 2 in the section *Power-up routine*.)

To run one of the fixed-function strategies:

- 1 Withdraw the T640 from its sleeve (taking the necessary anti-static precautions — see Chapter 2) and set switches 6, 7, and 8 of switchbank 1 to the strategy number required. (Figure 5-1 reminds you of their location and how to set them.)
- 2 Set switch 3 of SW1 ON to enable a cold start. (*Other SW1 switches*: Switch 4 should also be ON if you want warm start capability. Leave other switches as required for your T640 configuration.)
- 3 Power up the T640. Assuming that the selected strategy was not previously being run when power-down occurred, the T640 searches its EEPROM area for a .FF*n* file with the same *n*-value as that specified by switches 6, 7, and 8. If it finds a matching file, it uses this to establish the name of the required strategy. If no match is found in EEPROM, the T640 then searches the ROM area. (If a match still cannot be found — i.e. the .FF*n* file is missing — the T640 adopts an idle state and no database is run.)
- 4 Having determined the required filename, the T640 then checks if the corresponding .DBF file is already in EEPROM. (It won't be if this is the first time the strategy is being used. If it were found, the database would be loaded directly to RAM and run.) If not found, the T640 'unpacks' the compressed .FF*n* file, loads it to RAM and runs it. An 'unpacking database' message appears on the front panel while this happens.

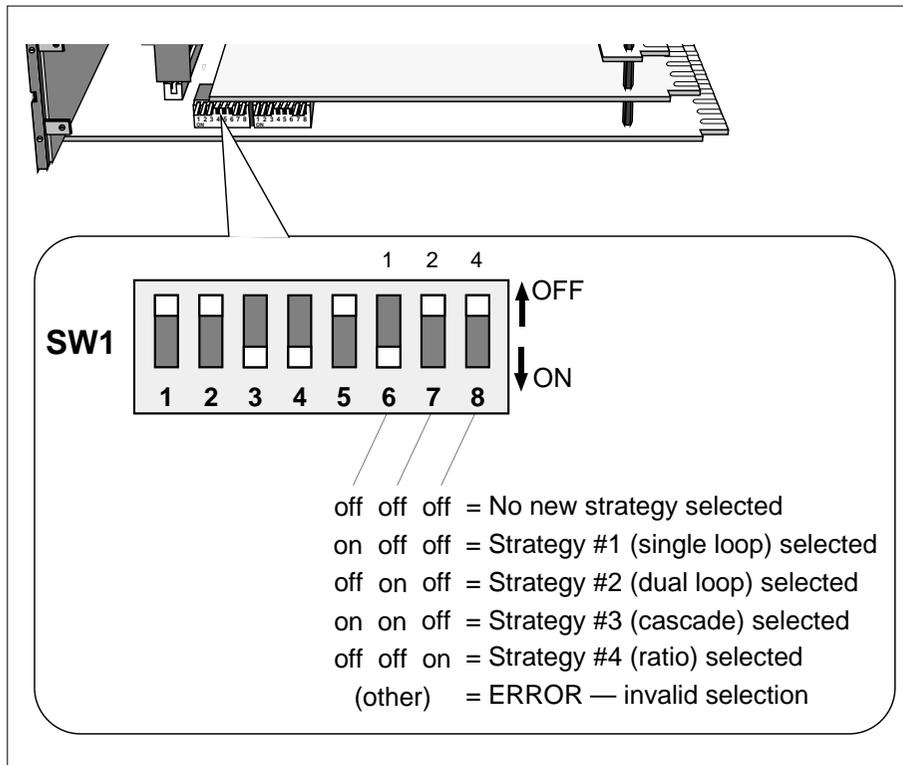


Figure 5-1 SW1 switch settings for strategy selection

## FIXED-FUNCTION STRATEGY DESIGN PRINCIPLES

The four fixed-function strategies have been designed to be as straightforward to configure and use as possible:

- All the control loops follow the same design with the same function blocks and the same I/O allocations on each I/O site (see Table 5-2). The variations are kept to a minimum and are clearly identified.
- The number of parameters that must be set up is minimal.
- All settable parameters have usable default values.
- Partial access is available without a security key by default.
- The only connections required to get something happening are the PV and the 3T OUT terminals.

## FIXED-FUNCTION STRATEGIES — MOTHERBOARD CUSTOMER TERMINALS

Table 5-2 lists the fixed-function strategy motherboard terminal functions, for both the MAINS and the DC options. Where relevant, the table also indicates the names of function blocks having parameters that affect the operation of the corresponding I/O.

Pin	Assignment	Description	Blocks
1	Internal earth	Do not connect these terminals externally!	
2	Internal earth		
L	Mains live	Live & neutral mains input terminals. (MAINS option motherboard only — blank in DC option.)	
N	Mains neutral		
7	DC source 1 +ve	DC option power input terminals. PRIMARY supply. (DC option motherboard only — blank in MAINS option.)	
8	DC source 1 -ve		
9	DC source 2 +ve	DC option power input terminals. BACKUP supply. (DC option motherboard only — blank in MAINS option.)	
10	DC source 2 -ve		
11	RS422 TX+	Serial communication connections. If RS485 is selected pins 11 and 12 are unused, & pins 14 and 15 become RS485+ and RS485- respectively. (See <i>T640 User Guide</i> for details on setting serial comms. switches & jumpers.)	SL661
12	RS422 TX-		
13	RS422 (RS485) Gnd		
14	RS422 RX+ (RS485+)		
15	RS422 RX- (RS485-)		
16	Watchdog 1	Relay output whose contacts are closed in normal operation. They open on power loss or CPU failure. They have been configured to also open on alarm.	USR_ALM
17	Watchdog 2		
18	Alarm 1	Relay output whose contacts are closed in normal operation. They open on power loss or CPU failure. They also open if any alarm of priority 11 to 15 occurs.	
19	Alarm 2		
20	ALIN Gnd	ALIN peer-to-peer communications connections. Connections should be made: Gnd to Gnd, Phase A to Phase A, and Phase B to Phase B.	
21	ALIN Phase A		
22	ALIN Phase B		

Table 5-2 Motherboard terminal assignments (MAINS & DC options)

**STRATEGY #1 — SINGLE CONTROL LOOP**

Strategy #1 is a single-loop controller with a repeat time of about 160ms per scan. Figure 5-2 shows a 'P & I' diagram for the strategy, involving a flow-control valve and an orifice plate flow sensor, by way of example.

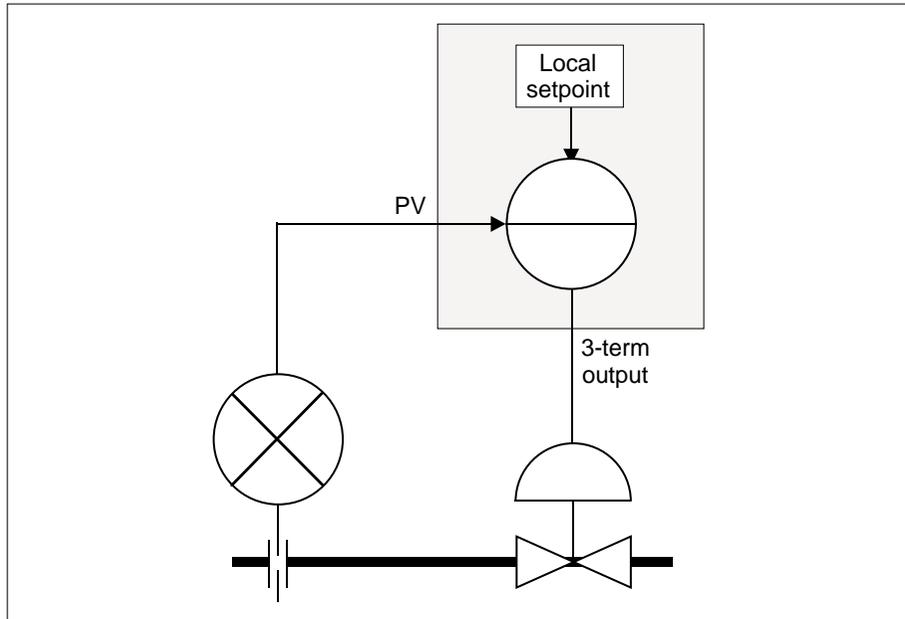


Figure 5-2 Example P & I diagram for strategy #1

### Strategy #1 schematic

Figure 5-3 shows schematically the main function blocks in the strategy, the principal signal flows between them, and their associated customer terminals. Details of each terminal and block are given in the tables that follow.

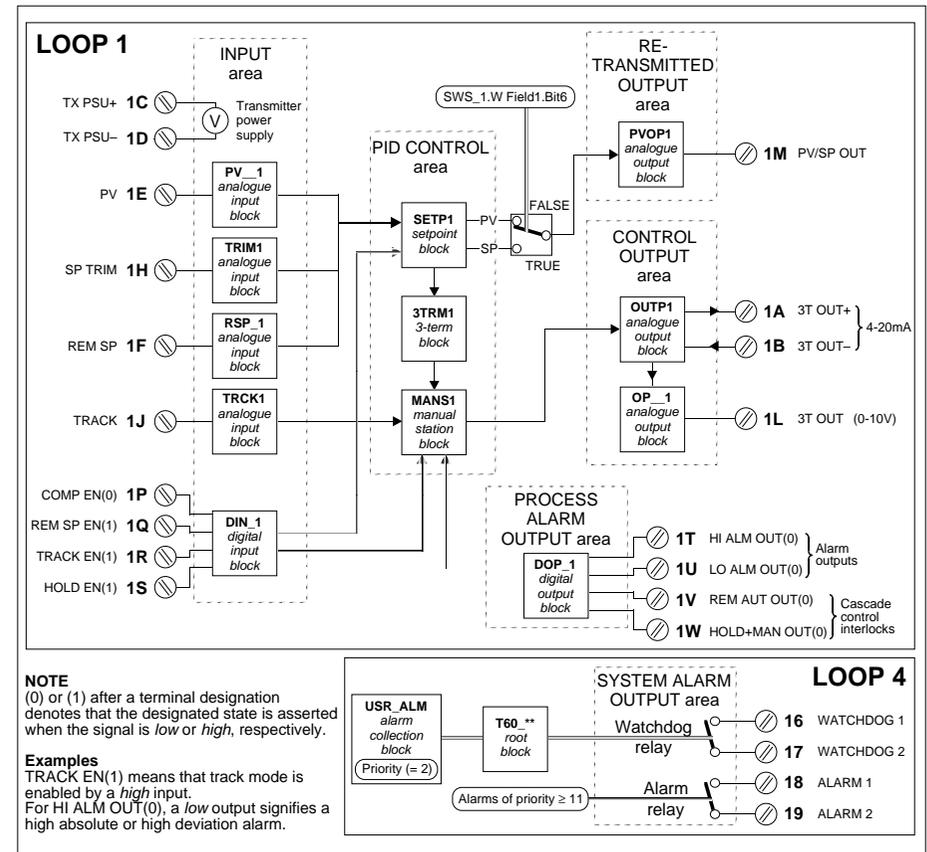


Figure 5-3 Strategy #1 schematic

### Strategy #1 I/O customer terminals

Strategy #1 uses a single I/O board located in site 1 of the T640, accessible via customer terminals 1A to 1Z. Table 5-3 lists these terminations and their functions, and also where relevant the names of function blocks having parameters that affect the operation of the corresponding I/O.

Pin	Assignment	Description	Blocks
1A	3T OUT +VE	Isolated 4-20mA output signal. This is the control output, limited by the manual station block MANS1.	SWS_1
1B	3T OUT -VE		
1C	TX Power Supply+	Isolated 24 volt transmitter power supply.	
1D	TX Power Supply-		
1E	PV	Process variable voltage input.	PV_1
1F	REM SP	Remote Setpoint voltage input. If the remote setpoint input is broken or not connected the loop reverts to its local setpoint. (Not Strategy #4)	RSP_1
	RAT TRIM	Ratio trim input. (Strategy #4 only — see under <i>Strategy #4 — Ratio control</i> for details)	TRIM3
1G	Analogue Gnd	Reference ground for analogue signals	
1H	SP TRIM	Setpoint trim voltage input	TRIM1
	RATIO BIAS	Ratio bias input. (Strategy #4 only — see under <i>Strategy #4 — Ratio control</i> for details)	
1J	TRACK	The control output is forced to this value if the TRACK EN (1) signal is high.	TRCK1
1K	Analogue Gnd	Reference ground for analogue signals	
1L	3T OUT	Control output signal as a voltage	OP_1 SWS_1
1M	PV/SP OUT	Retransmitted process variable or setpoint output as a voltage. Process variable is the default.	PVOP1 SWS_1
1N	Analogue Gnd	Reference ground for analogue signals	
1P	COMP EN(0)*	When high this digital input disables parameter changes via the comms links. It does not prevent parameters being read. This input does not affect MODBUS.	DIN_1
1Q	REM SP EN(1)	When high this digital input allows the remote setpoint to be selected from the front panel provided a signal is connected to REM SP.	DIN_1
1R	TRACK EN(1)	When high this digital input forces the control output to follow the TRACK input	DIN_1
1S	HOLD EN(1)	When high this digital input forces the control output to freeze.	DIN_1
1T	HI ALM OUT(0)	This digital signal goes low if the controller is in high absolute alarm or high deviation alarm	DOP_1
1U	LO ALM OUT(0)	This digital signal goes low if the controller is in low absolute alarm or low deviation alarm	DOP_1
1V	REM AUT OUT(0)	This digital output goes low if the controller is not in Auto with its remote setpoint selected. In cascade this signal should be connected from the slave to the TRACK EN(1) of the master to allow bumpless transfer from local control to cascade. It is also necessary to connect the retransmitted process variable, PV/SP OUT, of the slave to the TRACK input of the master.	DOP_1
1W	HOLD+MAN OUT(0)	This digital output goes low if the controller is in Hold or Manual modes. In cascade this signal should be connected from the master to the REM SP EN(1) of the slave to allow procedureless changes of mode. It also ensures that if the master is removed that the slave goes into local control.	DOP_1
1X	Ext Supply In 24 volts	The digital outputs pull to 15V. If 24V is connected to this pin, the digital outputs pull up to 24V. If not used as an input, this pin may be used as a low-current 15V source to drive inputs via relays or opto-couplers.	
1Y	Digital Gnd	Reference ground for digital signals.	
1Z	Digital Gnd	Reference ground for digital signals.	

\*(0) or (1) denotes bit asserted when low or high, respectively

Table 5-3 Site 1 I/O customer terminal assignments

## Strategy #1 function blocks and parameters

This strategy has two ‘user tasks’ — seen as **LOOP 1** and **LOOP 4** in the tag display — that you can access via the **INS** pushbutton to configure their function blocks. The parameters in Loop 1 deal with configuration of the control loop itself, and those in Loop 4 cover system alarms and general instrument setup.

When you come to configure these parameters you will find the *setup sheets* helpful, because they list the default values of all fields, and include a spare column for you to record your customised values where required. You may want to use photocopies of the printed setup sheets as your working documents. The setup sheets for all strategies are found under *Setup sheets — all strategies* on page 5-32.

### Loop 1

Table 5-4 lists the **Loop 1** parameters for strategy #1, together with explanations of their functions.

**NOTE.** The order of the blocks in the table may not match their order of appearance when you access them via the **INS** button.

Block	Field	Subfield	Description
SL661			This block needs attention only if Bisync communications are to be used.
	Instr_No		Slave address of the control loop's 6366 emulation on the Bisync communications bus.
SWS_1			This is a set of optional switches for setting up the loop
	W Field1		
		Bit0	This defines the power up mode. TRUE: the loop goes into manual on power up with 'zero' output*. FALSE: the loop maintains its last mode and output on power up. 'Zero' means low electrical output irrespective of any ranging or loop inversion.
		Bit1	On PV fail the loop will go from AUTO into FORCED MANUAL. This bit determines the action of the control output. TRUE: 'Zero' output will be forced FALSE: the last output will be maintained. (*Zero' means low electrical output — 0V or 4mA — irrespective of any ranging or loop inversion.)
		Bit2	TRUE inverts the output action, and hence the control action, after the manual station. 100% OP ≡ 4mA; 0% OP ≡ 20mA. This should be set TRUE if the actuator has reverse control action for safety reasons. This bit affects both the 4-20mA and voltage control outputs. It does not affect PV/SP OUT.
		Bit3	This inverts the control action before the manual station. It does not affect the relationship between the output reading and the true electrical output. This may be set true to reverse the action of the loop.
		Bit4	This selects On-Off control. See also 3TRM1.Deadband
		Bit5	FALSE: the local setpoint will remain unchanged. TRUE: the local setpoint will track the process variable if the controller is not in AUTO. Note: the local setpoint will always track the remote setpoint when remote is selected.

\***NB.** If the HOLD EN(1) input is high at power-up, hold mode wins and the last output is maintained, despite Bit0's being TRUE.

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Block	Field	Subfield	Description
		Bit6	FALSE: the second analogue output will be the retransmitted PV TRUE: the second analogue output will be the retransmitted SP
		Bit7	TRUE: Inverse ratio setting is used. Normal: loop1 SP = loop2 PV / ratio setpoint; Inverse: loop1 SP = loop2 PV * ratio setpoint <i>Loop1 only - Ratio controller only</i>
		Bit8	TRUE: Mask R push-button
		Bit9	TRUE: Mask A push-button
		BitA	TRUE: Mask M push-button
		BitB	TRUE: loop tag is FIC-001. Note: BitC has priority over BitB, BitD has priority over BitC and BitB etc. Also loop 2 tags are FIC-002 etc. (If none set, tag defaults to LOOP 1 or LOOP 2.)
		BitC	TRUE: loop tag is LIC-001
		BitD	TRUE: loop tag is PIC-001
		BitE	TRUE: loop tag is TIC-001
		BitF	TRUE: loop tag is AIC-001
RSP_1*			This block processes the remote setpoint input. Status.BrkDtctd is used in conjunction with the input REM SP EN(1) to enable the remote setpoint. If the remote setpoint input is broken the loop reverts to its local setpoint. <i>If no remote setpoint is required all parameters in this block can be left as default.</i>
	Filter		A first order filter with the time constant set will be applied to the input.
	HR_in		The input voltage representing high range
	LR_in		The input voltage representing low range
	Options		Only options believed relevant are described. Some options have defaults relevant to the I/O hardware and should not be changed.
	Invert		TRUE maps HR_in to SETP1.LR_SP and LR_in to SETP1.HR_SP
	Sqrt		TRUE applies a square root function to the input
DIN_1			This block processes the digital inputs
	Invert		This field inverts the sense of the digital inputs on a bit by bit basis. Bit4 to Bit7 are not supported by the hardware. Setting them will have no effect.
		Bit0	TRUE inverts COMP EN(0) If this input is unused do not alter the default. If this input is used it will be normal to invert its action so that a high input is required to enable parameter changes over the communication networks.
		Bit1	FALSE inverts REM SP EN(1) It should not be necessary to alter the default
		Bit2	TRUE inverts TRACK EN (1) It should not be necessary to alter the default
		Bit3	TRUE inverts HOLD EN(1) If this input is unused do not alter the default. If this input is used it will be normal to invert its action.
PV_1			This block processes the process variable input. Alarms.Combined will cause the controller to go into Forced Manual if an alarm with non-zero priority occurs. See SWS_1.W Field1.Bit0.
	Filter		A first order filter with the time constant set will be applied to the input.
	RomChar		This is used to select input linearisation. The common thermocouple and resistance thermometer inputs are available.

\*The RSP\_1 block is absent from Strategy #4 (ratio controllers)  
*continued...*

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Block	Field	Subfield	Description
	Alarms		Although other alarms than those listed below are available, their priority should left at 0. Process alarms may be set in SETP1. The alarms listed below should be left at the priority set unless there is a reason to change them. A reason to change them might be to stop individual alarms affecting the Watchdog relay, or to make alarm acknowledgement necessary (priority ≥6). Note: if a zero priority is set, the alarm condition will no longer select Forced Manual.
	Hardware		(Default = 2)
	OutRange		(Default = 2)
	OCctdel		(Default = 2)
	HR_in		The input voltage representing high range
	LR_in		The input voltage representing low range
	Options		Only options believed relevant are described. Some options have defaults relevant to the I/O hardware and should not be changed.
	Invert		TRUE maps HR_in to SETP1.LR_SP and LR_in to SETP1.HR_SP. TRUE will also have the effect of inverting the control loop.
	Sqrt		TRUE applies a square root function to the input
TRIM1			This input provides a trim to the setpoint. This trim input in engineering units is added to the setpoint whether it is local or remote. <i>If no trim is required all parameters in this block can be left as default.</i>
	MODE		This should be left at MANUAL if a manual trim or no trim are required. Set this input to AUTO if a trim is to be provided as an input signal, SP TRIM
	PV		If MODE is set to MANUAL this input may be used to manually input a setpoint trim.
	HR		This sets the high range in engineering units. HR_in maps to HR. Because trim works in engineering units HR and LR are used to scale the trim input against SETP1 HR_SP and LR_SP.
	LR		This sets the low range in engineering units. LR_in maps to LR. It would not be unusual for LR to be the same value as HR but negative to give a symmetrical trim.
	Filter		A first-order filter with the time constant set applied to the input.
	HR_in		The input voltage representing high range
	LR_in		The input voltage representing low range
	Options		Only options believed relevant are described. Some options have defaults relevant to the I/O hardware and should not be changed.
	Invert		TRUE maps HR_in to LR and LR_in to HR
	Sqrt		TRUE applies a square root function to the input
SETP1			This block provides all the setpoint processing and alarms.
	HR_SP		The high range of the process variable and setpoint in engineering units. The block is internally connected so that the process variable and remote setpoint share the same ranges as HR_SP and LR_SP
	LR_SP		The low range of the process variable and setpoint in engineering units.
	HL_SP		This sets a high limit for the setpoint including any trim whether the setpoint is local or remote.
	LL_SP		This sets a low limit for the setpoint including any trim whether the setpoint is local or remote.
	HL_SL		This sets a high limit for the local setpoint.
	LL_SL		This sets a low limit for the local setpoint.

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Block	Field	Subfield	Description
	Alarms		These are the process alarms of the control loop. Note: Priority 0 disables the alarm completely. An alarm with 0 priority no longer affects the digital output: HI ALM OUT(0) or LO ALM OUT(0) Priority 6-15 need to be acknowledged. Priority 11-15 open the Alarm relay. Alarms with priority set equal to USR_ALM.Priority open the Watchdog relay
	HighAbs		PV exceeds HAA
	LowAbs		PV is less than LAA
	HighDev		PV-SP exceeds HDA
	LowDev		SP-PV exceeds LDA
	HAA		High absolute alarm setting
	LAA		Low absolute alarm setting
	HDA		High deviation alarm setting
	LDA		Low deviation alarm setting
	Dis_DP		Sets the number of digits displayed to the right of the decimal point. This parameter is for display purposes only and has no effect on the ranging.
DOP_1			This block processes the digital outputs. The default values in this block need not normally be altered.
	Invert		This field inverts the sense of the digital outputs on a bit by bit basis. Bit4 to Bit7 are not supported by the hardware. Setting them will have no effect.
	Bit0		FALSE inverts HI ALM OUT(0)
	Bit1		FALSE inverts LO ALM OUT(0)
	Bit2		TRUE inverts REM AUT OUT(0)
	Bit3		TRUE inverts HOLD+MAN OUT(0)
PVOP1			This block processes the retransmitted process variable or setpoint. See SWS_1.W Field1.Bit5
	HR_out		The output voltage representing high range
	LR_out		The output voltage representing low range
3TRM1			This block performs PID ('3-term') control. The default values of XP, TI, and TD allow a measure of control, but should be set to more appropriate values for your application.
	TimeBase		This sets the time units for TI and TD
	XP		This set the proportional band for control
	TI		This sets the integral time constant
	TD		This sets the derivative time constant
	Deadband		This sets the hysteresis band if On/Off control is selected. See SWS_1.W Field1.Bit3. The value set is applied symmetrically above and below the setpoint.
TRCK1			This input processes the TRACK input. <i>If TRACK is not required all parameters in this block can be left as default.</i>
	MODE		If the track input is being provided as an input signal, this should be left AUTO. Selecting MANUAL will cause the control output to adopt the value set in PV if TRACK EN(1) goes high.
	PV		If MODE is set to MANUAL this input may be used to manually input a TRACK value.
	HR_in		The input voltage representing 100% output
	LR_in		The input voltage representing 0% output

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Block	Field	Subfield	Description
MANS1			This block provides output processing from 3TRM1. The output range is fixed at 0-100%.
	HL_OP		High limit for the control output in %
	LL_OP		Low limit for the control output in %
OP_1			This block processes the control voltage output. It follows the 4-20mA output. Output inversion cannot be performed by reversing the values in HR_out and LR_out. SWS_1.W Field1.Bit1 does this.
	HR_out		The output voltage representing 100% (0% if SWS_1.W Field1.Bit2 is TRUE)
	LR_out		The output voltage representing 0% (100% if SWS_1.W Field1.Bit2 is TRUE)

Table 5-4 Loop 1 parameters

**Loop 4**

Table 5-5 lists the **Loop 4** parameters for strategy #1, together with explanations of their functions.

Block	Field	Subfield	Description	
USR_ALM			This block controls watchdog relay output.	
	Priority		(Range: 0-15) The priority of the alarms that are required to open the relay must match this setting.	
T60_**			This block contains the basic options of the controller as an instrument. The ** in the name will be replaced by the node number in hex when the strategy is loaded. E.g. C6	
	Options		Many of the subfields have no relevance to this application. They are included here because they appear during use of the INS button.	
		FPdis1	Leave as default (FALSE)	
		FPdis2	Leave as default: TRUE in the single loop controllers, FALSE in the dual loop controllers	
		FPdis3	Leave as default: TRUE in all but ratio controller, FALSE in ratio controller	
		FPdis4	Leave as default (TRUE)	
		NoKeyPrt	The default (TRUE) allows access to the normally settable parameters without using the security key. This should normally be set to FALSE before the controller is put on to plant.	
		NoKeyFul	This should be left as default (FALSE). Setting this TRUE allows access to all the parameters in the controller without the use of a full access key.	
		LEDtest	If set TRUE all the LEDs on the front panel light. It resets itself to FALSE	
		CommsDis	This is internally wired and may be used only for reading the state of the ALIN and Bisync communications. TRUE: parameter 'writes' inhibited; FALSE: communications fully enabled	
		FullSave	If set TRUE the parameters in the running database are saved to file. These parameters will be used on cold start. This or PartSave should be used after configuration to ensure the set up is not lost. It resets itself to FALSE	
		PartSave	This is the same as FullSave except local setpoints, control outputs and control modes are not saved. This allows tuning parameters to be set up and saved during commissioning without overwriting the start up conditions.	
		BinSpd1 } BinSpd2 }	Bisync baud rate:	BinSpd1    FALSE    FALSE    TRUE    TRUE BinSpd2    FALSE    TRUE    FALSE    TRUE Baud rate =    9600*    4800    1200    300    *default
		Protectd	Leave as default (TRUE)	
	E2Form1		This and E2Form2 when used together in sequence will reformat the EEPROM filing system. The sequence is relatively complex to make it unlikely that the EEPROM is reformatted accidentally.	
	E2Form2		(See previous)	

Table 5-5 Loop 4 parameters

## STRATEGY #2 — DUAL CONTROL LOOP

Strategy #2 is a dual-loop controller. The difference between the single loop (strategy #1) and the dual loop controllers is simply the inclusion of the second loop. This loop is identical to the first, except that its I/O is assigned to site 2 of the T640 (terminals 2A to 2Z).

Note that terminal 2P is unused as COMP EN(0), because 1P is used to disable communications for the whole instrument.

### One loop or two?

If only one loop is needed the single loop controller should be chosen in preference to the dual for the following reasons:

- With only one loop implemented the single loop has a faster update rate — approximately 160ms. The update rate of each loop in the dual loop controller is around 300ms.
- If the second loop in the dual loop strategy is not connected to anything, Loop 2 process variable alarms will appear and remain permanently annunciated.

Figure 5-4 shows a 'P & I' diagram for the strategy, involving flow-control valves and orifice plate flow sensors, by way of example.

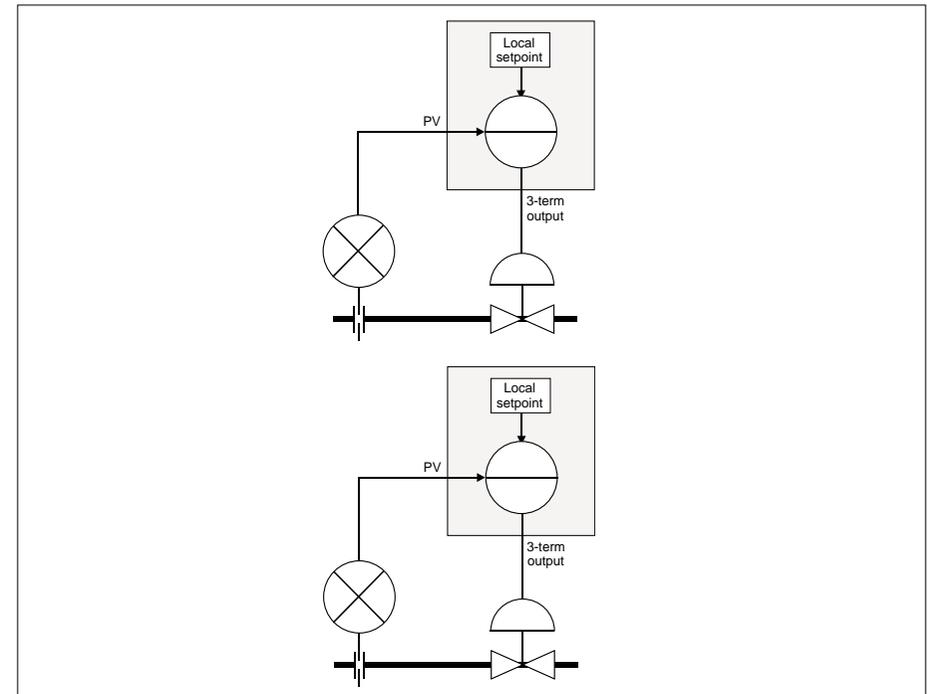


Figure 5-4 Example P & I diagram for strategy #2

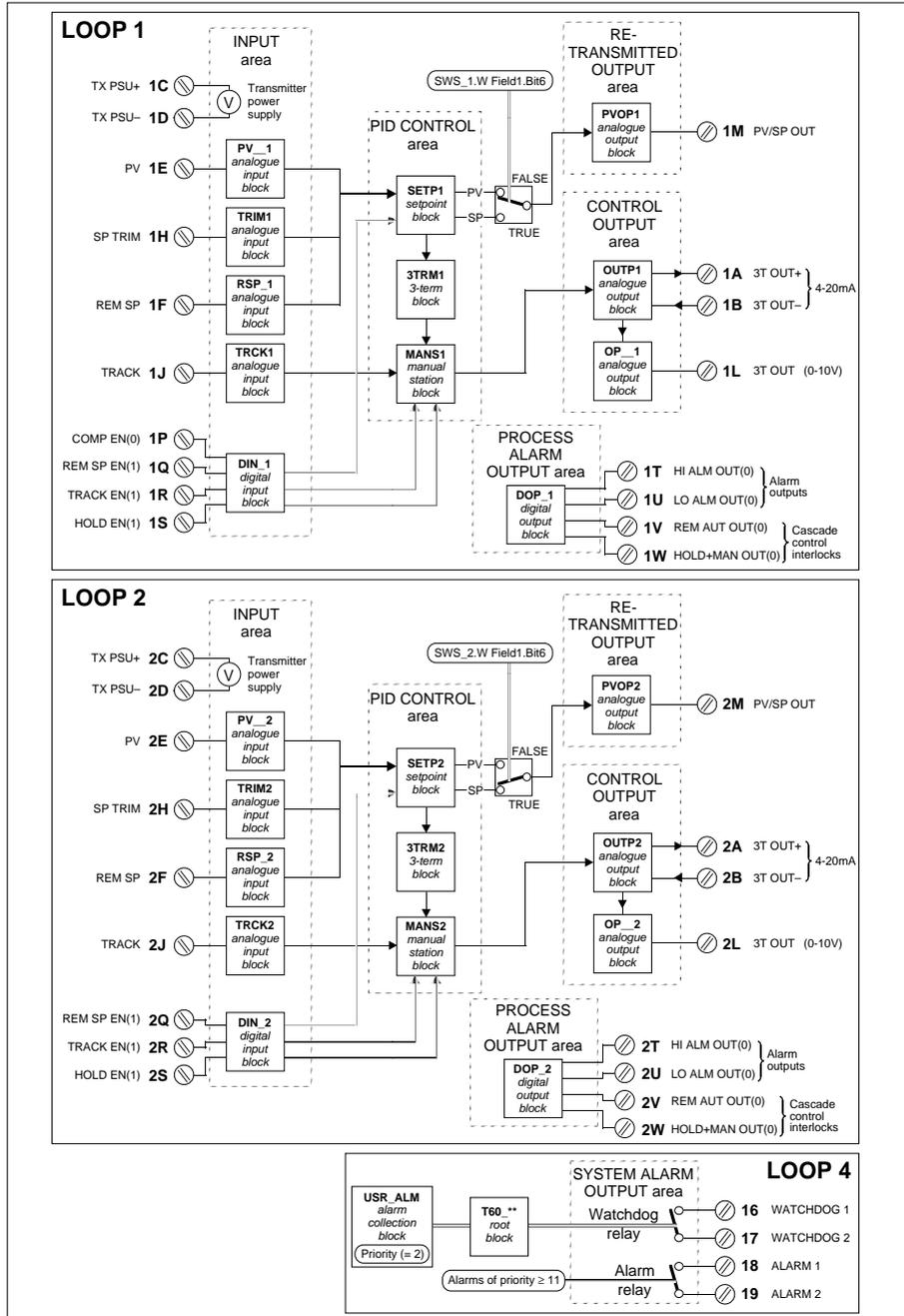


Figure 5-5 Strategy #2 schematic

## Strategy #2 schematic

Figure 5-5 shows schematically the main function blocks in the strategy, the principal signal flows between them, and their associated customer terminals. Details of each terminal and block are given in the tables that follow.

## Strategy #2 I/O customer terminals

Strategy #2 uses a pair of I/O boards located in sites 1 and 2 of the T640, accessible via customer terminals 1A to 1Z (site 1) and 2A to 2Z (site 2). Site 1 terminals are identical to those given for strategy #1 (see Table 5-3 on page 5-7). Table 5-6 lists site 2 terminations and their functions, and also where relevant the names of function blocks having parameters that affect the operation of the corresponding I/O.

Pin	Assignment	Description	Blocks
2A	3T OUT +VE	Isolated 4-20mA output signal. This is the control output.	SWS_2
2B	3T OUT -VE		
2C	TX Power Supply+	Isolated 24 volt transmitter power supply.	
2D	TX Power Supply-		
2E	PV	Process variable voltage input.	PV_2
2F	REM SP	Remote Setpoint voltage input. If the remote setpoint input is broken or not connected the loop reverts to its local setpoint.	RSP_2
	RAT TRIM	Ratio trim input. (See under <i>Strategy #4 — Ratio control</i> for details)	TRIM3
2G	Analogue Gnd	Reference ground for analogue signals	
2H	SP TRIM	Setpoint trim voltage input	TRIM2
2J	TRACK	The control output is forced to this value if the TRACK EN (1) signal is high.	TRCK2
2K	Analogue Gnd	Reference ground for analogue signals	
2L	3T OUT	Control output signal as a voltage	OP_2 SWS_2
2M	PV/SP OUT	Retransmitted process variable or setpoint output as a voltage. Process variable is the default.	PVOP2 SWS_2
2N	Analogue Gnd	Reference ground for analogue signals	
2P	(Unused)		
2Q	REM SP EN(1)	When high this digital input allows the remote setpoint to be selected from the front panel provided a signal is connected to REM SP.	DIN_2
2R	TRACK EN(1)	When high this digital input forces the control output to follow the TRACK input	DIN_2
2S	HOLD EN(1)	When high this digital input forces the control output to freeze.	DIN_2
2T	HI ALM OUT(0)	This digital signal goes low if the controller is in high absolute alarm or high deviation alarm	DOP_2
2U	LO ALM OUT(0)	This digital signal goes low if the controller is in low absolute alarm or low deviation alarm	DOP_2

*continued...*

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Pin	Assignment	Description	Blocks
2V	REM AUT OUT(0)	This digital output goes low if the controller is not in Auto with its remote setpoint selected. In cascade this signal should be connected from the slave to the TRACK EN(1) of the master to allow bumpless transfer from local control to cascade. It is also necessary to connect the retransmitted process variable, PV/SP OUT, of the slave to the TRACK input of the master.	DOP_2
2W	HOLD+MAN OUT(0)	This digital output goes low if the controller is in Hold or Manual modes. In cascade this signal should be connected from the master to the REM SP EN(1) of the slave to allow procedureless changes of mode. It also ensures that if the master is removed that the slave goes into local control.	DOP_2
2X	(Unused)		
2Y	Digital Gnd	Reference ground for digital signals.	
2Z	Digital Gnd	Reference ground for digital signals.	

Table 5-6 Site 2 I/O customer terminal assignments

## Strategy #2 function blocks and parameters

This strategy has three ‘user tasks’ — seen as **LOOP 1**, **LOOP 2**, and **LOOP 4** in the tag display — that you can access via the **INS** pushbutton to configure their function blocks. The parameters in Loops 1 and 2 deal with configuration of the respective control loops themselves, and those in Loop 4 cover system alarms and general instrument setup.

When you come to configure these parameters you will find the *setup sheets* helpful, because they list the default values of all fields, and include a spare column for you to record your customised values where required. You may want to use photocopies of the printed setup sheets as your working documents. The setup sheets for this strategy are found under *Setup sheets — all strategies*, on page 5-32.

### Loop 1

Loop 1 parameters are identical to those given for strategy #1 (see Table 5-4 on page 5-8).

### Loop 2

Table 5-7 lists the **Loop 2** parameters for strategy #2, together with explanations of their functions.

**NOTE.** The order of the blocks in the table may not match their order of appearance when you access them via the **INS** button.

Block	Field	Subfield	Description
SL662			This block needs attention only if Bisync communications are to be used.
	Instr_No		Slave address of the control loop's 6366 emulation on the Bisync communications bus.
SWS_2			This is a set of optional switches for setting up the loop
	W	Field1	
		Bit0	This defines the power up mode. TRUE: the loop goes into manual on power up with 'zero' output*. FALSE: the loop maintains its last mode and output on power up. 'Zero' means low electrical output irrespective of any ranging or loop inversion.
		Bit1	On PV fail the loop will go from AUTO into FORCED MANUAL this bit determines the action of the control output TRUE: 'Zero' output will be forced FALSE: the last output will be maintained. 'Zero' means low electrical output irrespective of any ranging or loop inversion.
		Bit2	TRUE inverts the output action, and hence the control action, after the manual station. 100% OP = 4mA; 0% OP = 20mA. This should be set TRUE if the actuator has reverse control action for safety reasons. This bit affects both the 4-20mA and voltage control outputs. It does not affect PV/SP OUT.
		Bit3	This inverts the control action before the manual station. It does not affect the relationship between the output reading and the true electrical output. This may be set true to reverse the action of the loop.
		Bit4	This selects On-Off control. See also 3TRM2.Deadband
		Bit5	FALSE: the local setpoint will remain unchanged. TRUE: the local setpoint will track the process variable if the controller is not in AUTO. Note: the local setpoint will always track the remote setpoint when remote is selected.
		Bit6	FALSE: the second analogue output will be the retransmitted PV TRUE: the second analogue output will be the retransmitted SP
		Bit7	TRUE: Inverse ratio setting is used. Normal: loop1 SP = loop2 PV / ratio setpoint; Inverse: loop1 SP = loop2 PV * ratio setpoint <i>Loop1 only - Ratio controller only</i>
		Bit8	TRUE: Mask R push-button
		Bit9	TRUE: Mask A push-button
		BitA	TRUE: Mask M push-button
		BitB	TRUE: loop tag is FIC-001. Note: BitC has priority over BitB, BitD has priority over BitC and BitB etc. Also loop 2 tags are FIC-002 etc.
		BitC	TRUE: loop tag is LIC-001
		BitD	TRUE: loop tag is PIC-001
		BitE	TRUE: loop tag is TIC-001
		BitF	TRUE: loop tag is AIC-001

\*NB. If the HOLD EN(1) input is high at power-up, hold mode wins and the last output is maintained, despite Bit0's being TRUE.

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Block	Field	Subfield	Description
RSP_2			This block processes the remote setpoint input. Status.BrkDtctd is used in conjunction with the input REM SP EN(1) to enable the remote setpoint. If the remote setpoint input is broken the loop reverts to its local setpoint. <i>If no remote setpoint is required all parameters in this block can be left as default.</i>
		Filter	A first order filter with the time constant set will be applied to the input.
		HR_in	The input voltage representing high range
		LR_in	The input voltage representing low range
		Options	Only options believed relevant are described. Some options have defaults relevant to the I/O hardware and should not be changed.
		Invert	TRUE maps HR_in to SETP2.LR_SP and LR_in to SETP2.HR_SP
		Sqrt	TRUE applies a square root function to the input
DIN_2			This block processes the digital inputs
		Invert	This field inverts the sense of the digital inputs on a bit by bit basis. Bit4 to Bit7 are not supported by the hardware. Setting them will have no effect.
		Bit0	<i>(Unused)</i>
		Bit1	FALSE inverts REM SP EN(1) It should not be necessary to alter the default
		Bit2	TRUE inverts TRACK EN (1) It should not be necessary to alter the default
PV_2			This block processes the process variable input. Alarms.Combined will cause the controller to go into Forced Manual if an alarm with non-zero priority occurs. See SWS_2.W Field1.Bit0.
		Filter	A first order filter with the time constant set will be applied to the input.
		RomChar	This is used to select input linearisation. The common thermocouple and resistance thermometer inputs are available.
		Alarms	Although other alarms than those listed below are available, their priority should left at 0. Process alarms may be set in SETP2. The alarms listed below should be left at the priority set unless there is a reason to change them. A reason to change them might be to stop individual alarms affecting the Watch Dog relay. Note: if a zero priority is set the alarm condition will no longer select Forced Manual.
		Hardware	<i>(Default = 2)</i>
		OutRange	<i>(Default = 2)</i>
		OCctdel	<i>(Default = 2)</i>
		HR_in	The input voltage representing high range
		LR_in	The input voltage representing low range
		Options	Only options believed relevant are described. Some options have defaults relevant to the I/O hardware and should not be changed.
		Invert	TRUE maps HR_in to SETP2.LR_SP and LR_in to SETP2.HR_SP. TRUE will also have the effect of inverting the control loop.
		Sqrt	TRUE applies a square root function to the input

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Block	Field	Subfield	Description
TRIM2			This input provides a trim to the setpoint. This trim input in engineering units is added to the setpoint whether it is local or remote. If no trim is required all parameters in this block can be left as default.
		MODE	This should be left at MANUAL if a manual trim or no trim are required. Set this input to AUTO if a trim is to be provided as an input signal, SP TRIM
		PV	If MODE is set to MANUAL this input may be used to manually input a setpoint trim.
		HR	This sets the high range in engineering units. HR_in maps to HR. Because trim works in engineering units HR and LR are used to scale the trim input against SETP1 HR_SP and LR_SP.
		LR	This sets the low range in engineering units. LR_in maps to LR. It would not be unusual for LR to be the same value as HR but negative to give a symmetrical trim.
		Filter	A first order filter with the time constant set applied to the input.
		HR_in	The input voltage representing high range
		LR_in	The input voltage representing low range
		Options	Only options believed relevant are described. Some options have defaults relevant to the I/O hardware and should not be changed.
		Invert	TRUE maps HR_in to LR and LR_in to HR
		Sqrt	TRUE applies a square root function to the input
	SETP2		
		HR_SP	The high range of the process variable and setpoint in engineering units. The block is internally connected so that the process variable and remote setpoint share the same ranges as HR_SP and LR_SP
		LR_SP	The low range of the process variable and setpoint in engineering units.
		HL_SP	This sets a high limit for the setpoint including any trim whether the setpoint is local or remote.
		LL_SP	This sets a low limit for the setpoint including any trim whether the setpoint is local or remote.
		HL_SL	This sets a high limit for the local setpoint.
		LL_SL	This sets a low limit for the local setpoint.
		Alarms	These are the process alarms of the control loop. Note: Priority 0 disables the alarm completely. An alarm with 0 priority no longer affects the digital output: HI ALM OUT(0) or LO ALM OUT(0) Priority 6-15 need to be acknowledged. Priority 11-15 open the Alarm relay. Alarms of priority equal to USR_ALM.Priority will open the Watchdog relay.
		HighAbs	PV exceeds HAA
		LowAbs	PV is less than LAA
		HighDev	PV-SP exceeds HDA
		LowDev	SP-PV exceeds LDA
		HAA	High absolute alarm setting
		LAA	Low absolute alarm setting
		HDA	High deviation alarm setting
	LDA	Low deviation alarm setting	
	Dis_DP	Sets the number of digits displayed to the right of the decimal point. This parameter is for display purposes only and has no effect on the ranging.	

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Block	Field	Subfield	Description
DOP_2			This block processes the digital outputs. The default values in this block need not normally be altered.
	Invert		This field inverts the sense of the digital outputs on a bit by bit basis. Bit4 to Bit7 are not supported by the hardware. Setting them will have no effect.
		Bit0	FALSE inverts HI ALM OUT(0)
		Bit1	FALSE inverts LO ALM OUT(0)
		Bit2	TRUE inverts REM AUT OUT(0)
		Bit3	TRUE inverts HOLD+MAN OUT(0)
PVOP2			This block processes the retransmitted process variable or setpoint. See SWS_2.W Field1.Bit5
	HR_out		The output voltage representing high range
	LR_out		The output voltage representing low range
3TRM2			This block performs PID control. The defaults for XP, TI and TD are provided only to allow control to happen. These require setting to appropriate values.
	TimeBase		This sets the time units for TI and TD
	XP		This set the proportional band for control
	TI		This sets the integral time constant
	TD		This sets the derivative time constant
	Deadband		This sets the hysteresis band if On/Off control is selected. See SWS_2.W Field1.Bit3. The value set is applied symmetrically above and below the setpoint.
TRCK2			This input processes the TRACK input. <i>If TRACK is not required all parameters in this block can be left as default.</i>
	MODE		If the track input is being provided as an input signal, this should be left AUTO. Selecting MANUAL will cause the control output to adopt the value set in PV if TRACK EN(1) goes high.
	PV		If MODE is set to MANUAL this input may be used to manually input a TRACK value.
	HR_in		The input voltage representing 100% output
	LR_in		The input voltage representing 0% output
MANS2			This block provides output processing from 3TRM2. The output range is fixed at 0-100%.
	HL_OP		High limit for the control output in %
	LL_OP		Low limit for the control output in %
OP_2			This block processes the control voltage output. It follows the 4-20mA output. Output inversion cannot be performed by reversing the values in HR_out and LR_out. SWS_2.W Field1.Bit1 does this.
	HR_out		The output voltage representing 100% (0% if SWS_2.W Field1.Bit2 is TRUE)
	LR_out		The output voltage representing 0% (100% if SWS_2.W Field1.Bit2 is TRUE)

Table 5-7 Loop 2 parameters

#### Loop 4

Loop 4 parameters are identical to those given for strategy #1 (see Table 5-5 on page 4-10).

### STRATEGY #3 — DUAL CONTROL LOOP (CASCADE)

Strategy #3 is a dual-loop controller. The difference between it and strategy #2 is that the two controllers are internally pre-wired for remote setpoint cascade operation with bumpless transfer.

Figure 5-6 shows a 'P & I' diagram for the strategy in which — by way of example — the outflow from a tank is controlled by the slave loop, according to a remote setpoint output from the master loop. The master loop derives its output from a local setpoint and a measured variable from the tank (e.g. fluid level).

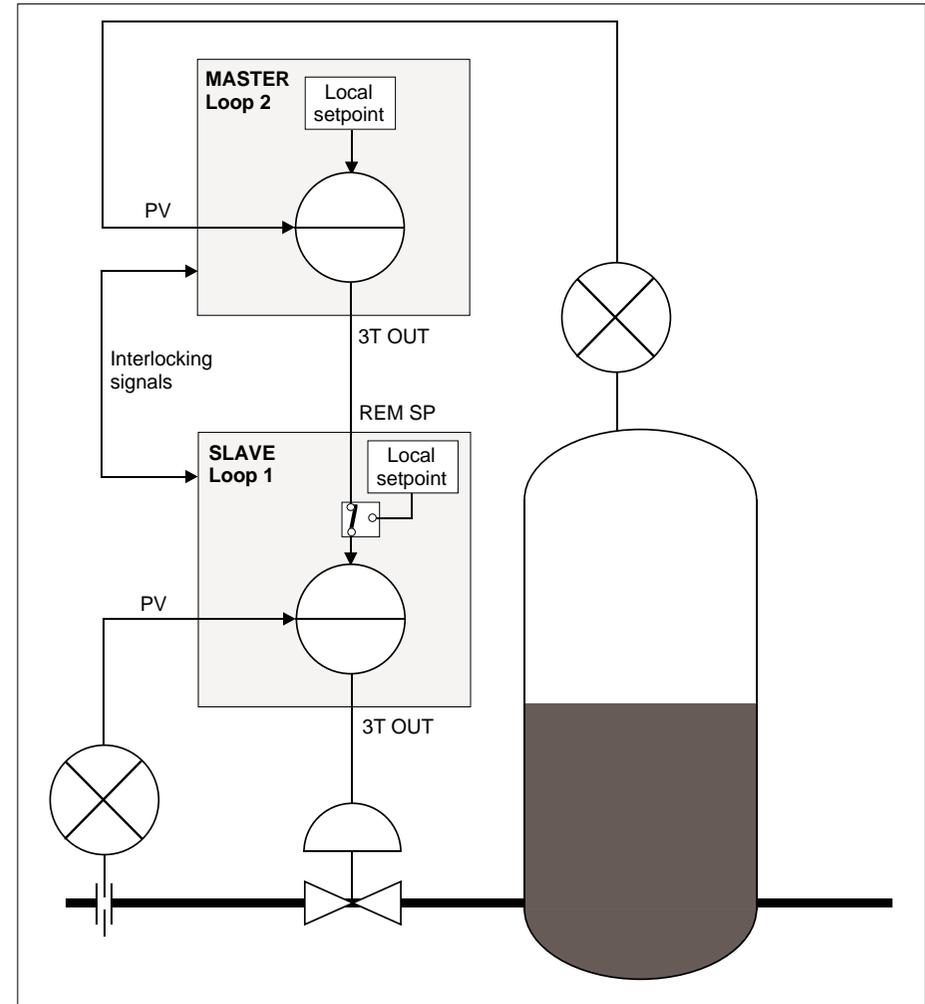


Figure 5-6 Example P & I diagram for strategy #3

The purpose of the interlocking signals indicated in the Figure is to provide bumpless, procedureless transfer between modes of operation. Table 5-8 shows the pin assignments corresponding to these interlocks, with Loop 2 as the master controller and Loop 1 the slave. For completeness the Figure also lists the 3T OUT to REM SP connection — not strictly an ‘interlock signal’.

MASTER			SLAVE	
Pin	Function		Pin	Function
2L	3T OUT	→	1F	REM SP
2J	TRACK	←	1M	PV OUT
2W	HOLD+MAN OUT(0)	→	1Q	REM SP EN(1)
2R	TRACK EN(1)	←	1V	REM AUT OUT(0)

Table 5-8 Cascade interlocking signals — strategy #3

Note that Table 5-8 is given for information only. All the interconnections shown have been made within the strategy in software, so you do not need to wire them externally.

## Cascading a pair of loops

Although you don’t need to physically wire the interlock signals between Loops 1 and 2 if you are using strategy #3 as supplied, you will find Table 5-8 useful if you want to cascade a different pair of loops. As examples, you may want to cascade the disconnected pair of loops supplied in strategy #2 (dual loop), or even two loops running in different instruments.

NOTE. All Eurotherm Process Automation controllers have these interlocks available.

In these cases you decide which loop is to be the master and which the slave, then wire-link the customer terminals associated with each loop — as indicated in Table 5-8. Remember that the number prefix in customer terminal designations must match the I/O site involved — e.g. **2L** is the 3-term output for site **2** I/O, but **1L** is the 3-term output for site **1** I/O, so you will have to interpret the table according to your I/O sites.

## Strategy #3 schematic

Figure 5-7 shows schematically the main function blocks in the strategy, the principal signal flows between them, and their associated customer terminals. Details of each terminal and block are given in the tables that follow.

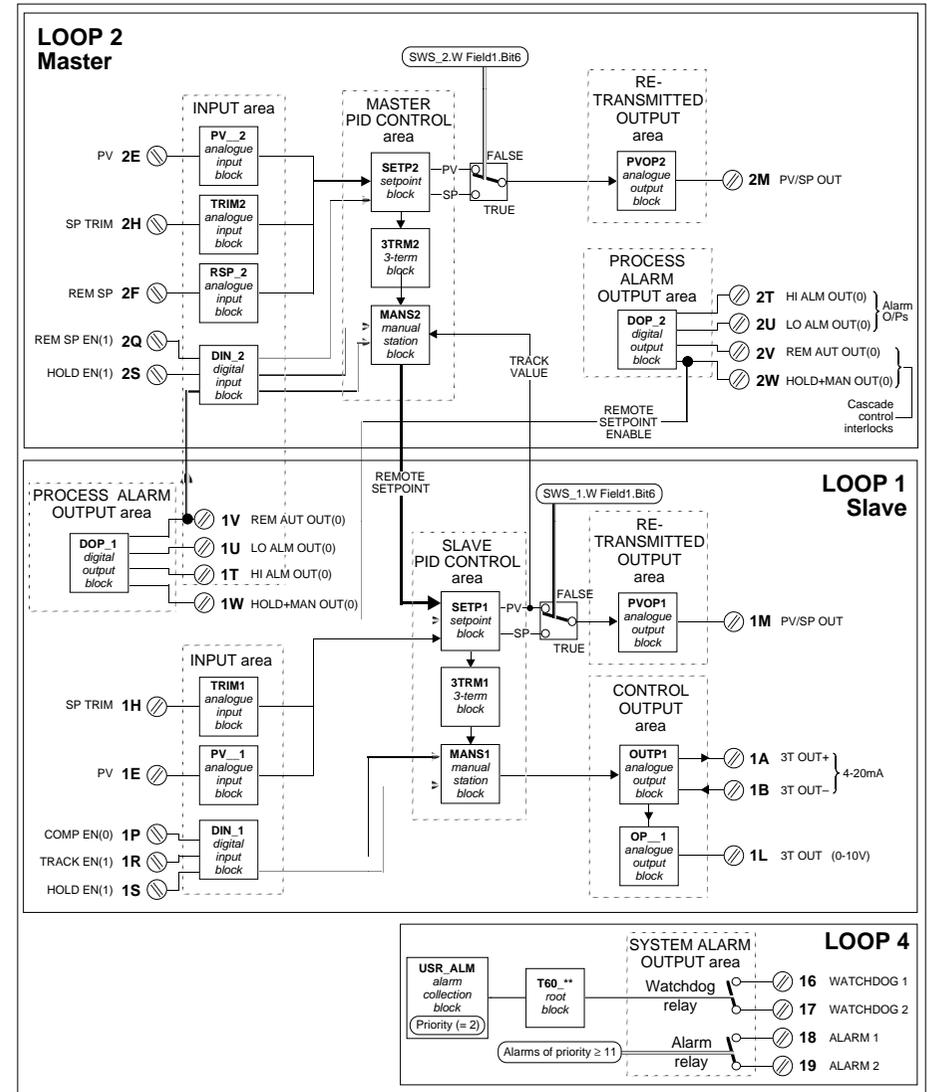


Figure 5-7 Strategy #3 schematic

## Strategy #3 organisation

### Master & slave

The strategy has been internally connected to make Loop 2 the master controller, and Loop 1 the slave controller.

### Blocks & connections

Strategy #3 is similarly-structured to strategy #2, but has the following additions that work behind the scenes:

- Two extra database interconnections are present —

**3TRM1.Status.HiLimFrc** to **3TRM2.Options.FrcHiLim**

**3TRM1.Status.LoLimFrc** to **3TRM2.Options.FrcLoLim**

These cause the master, Loop 2, to behave as if in output limit when the slave, Loop 1, goes into output limit. This has the effect of inhibiting integral term windup in the master controller, and gives faster return to control.

- Range blocks have been added to re-range the ‘analogue’ internal connections between the loops. Loop 2’s output is still ranged 0-100% and loop 1’s PV and SP ranges are chosen to represent engineering units. Note that these range blocks are not accessible via the **INS** button for configuration.

### Loop update rates

The loop update rates have been chosen to let the slave run faster than the master. The update rate of Loop 1 is 220ms, and of Loop 2 is 420mS.

## Strategy #3 — operator interface

Cascade control is selected by putting the slave Loop1 into Remote mode (press the **R** button) and putting the master Loop 2 into Auto mode (press **A**).

NOTE. If these conditions are not true, Loop 1 will be in the mode selected and Loop 2 will be tracking it.

The sequence in which the modes are selected does not matter as the interlocking signals ensure no illegal modes occur:

- If Loop 1’s **R** button is pressed before Loop 2’s **A** button, Loop 1’s **A** indicator will flash indicating the mode ‘Primed’. In operation, Primed is identical to Auto, except that as soon as Loop 2 is put into Auto, Loop 1 goes into Remote.
- If Loop 2’s **A** button is pressed before Loop 1’s **R** button, Loop 2’s **A** indicator will light but the **T** indicator will remain lit indicating that Track is overriding Auto. When Loop 1’s **R** button is pressed, Loop 2 is no longer forced to track and cascade control begins.

### Strategy #3 I/O customer terminals

Strategy #3 uses a pair of I/O boards located in sites 1 and 2 of the T640, accessible via customer terminals 1A to 1Z (site 1) and 2A to 2Z (site 2). These terminations and their functions are almost the same as those for strategy #2, given in Tables 5-3 and 5-6.

The exceptions are that the following terminals have no function in the strategy —

- Pin 1F, **REM SP**
- Pin 1Q, **REM SP EN(1)**
- Pin 2J, **TRACK**
- Pin 2R, **TRACK EN(1)**
- Pin 2P, **COMP EN(0)**

### Strategy #3 function blocks and parameters

This strategy has three ‘user tasks’ — seen as **LOOP 1**, **LOOP 2**, and **LOOP 4** in the tag display — that you can access via the **INS** pushbutton to configure their function blocks. The parameters in Loops 1 and 2 deal with configuration of the respective control loops themselves, and those in Loop 4 cover system alarms and general instrument setup. The three loops are almost the same as those of strategy #2, which were tabulated in Tables 5-4, 5-7, and 5-5.

The exceptions are that —

- The block **RSP\_1** and its input REM SP, pin 1F, are present but have no function
- The block **TRCK2** and its input TRACK, pin 2J, are present but have no function.

When you come to configure these parameters you will find the *setup sheets* for this strategy helpful, because they list the default values of all fields, and include a spare column for you to record your customised values where required. You may want to use photocopies of the printed setup sheets as your working documents. The setup sheets for this strategy are found under *Setup sheets — all strategies* on page 5-32.

## STRATEGY #4 — DUAL CONTROL LOOP (RATIO)

Strategy #4 is a dual-loop controller — Loops 1 and 2 — having in addition a ratio station in Loop 3. All loop interconnections are internally pre-wired in the database.

Figure 5-8 shows a 'P & I' diagram for the strategy in which — by way of example — a pair of flow rates are controlled to maintain a fixed ratio between them.

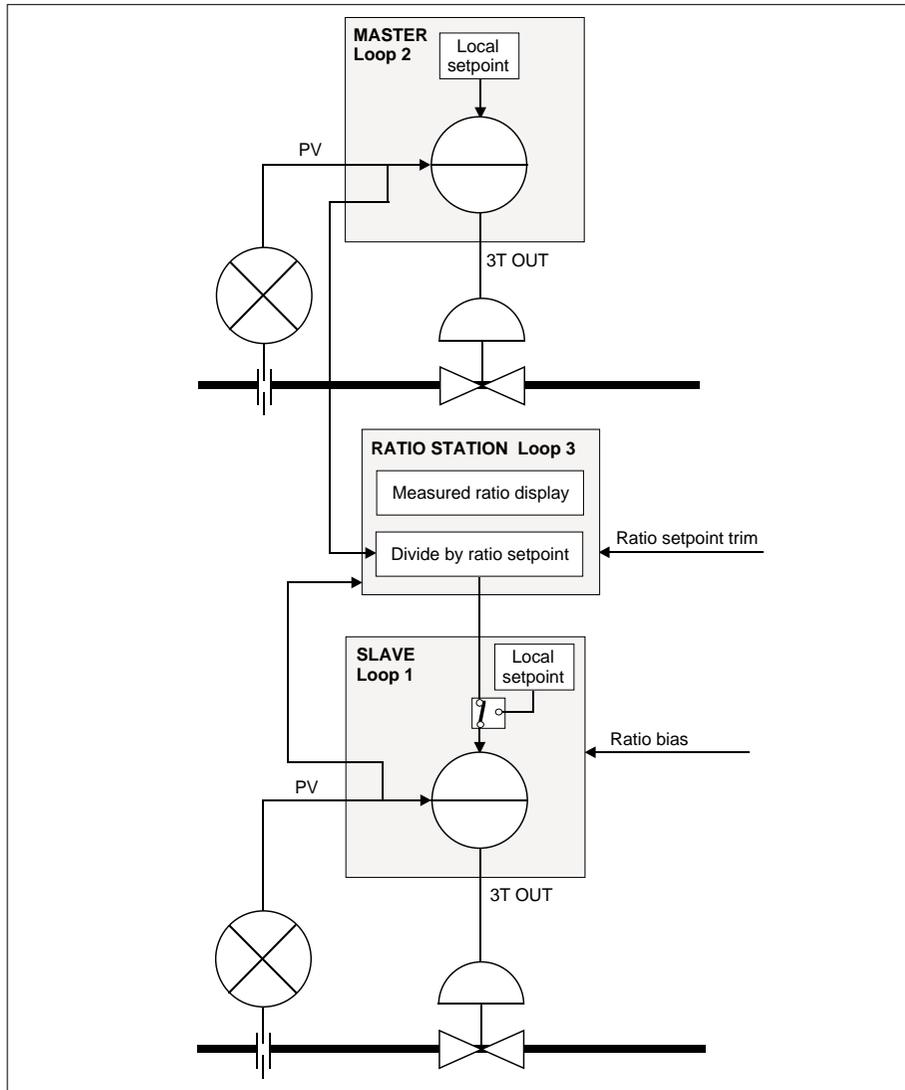


Figure 5-8 Example P & I diagram for strategy #4

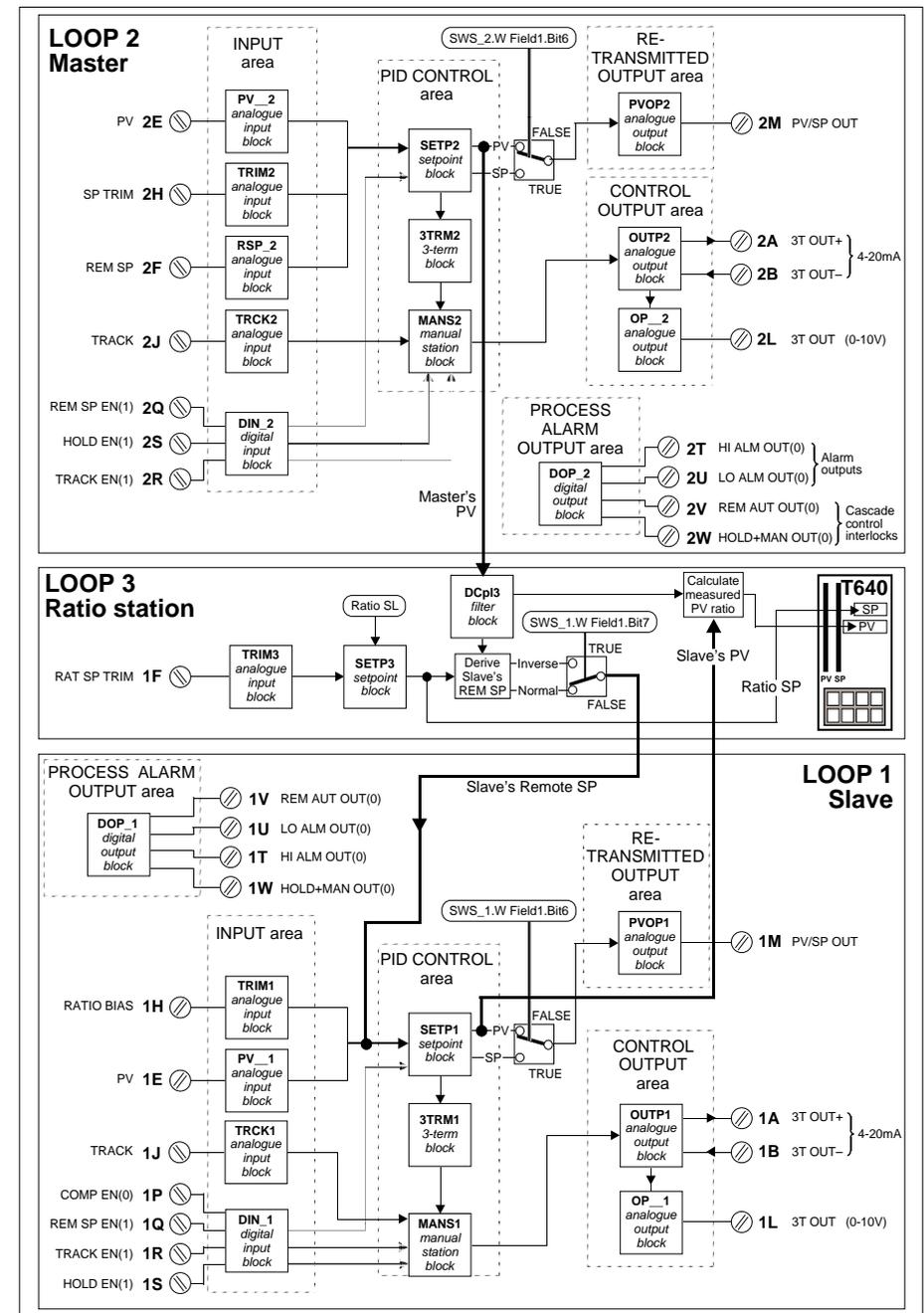


Figure 5-9 Strategy #4 schematic

## Strategy #4 schematic

Figure 5-9 shows schematically the main function blocks in the strategy, the principal signal flows between them, and their associated customer terminals. Details of each terminal and block are given in the tables that follow.

## Strategy #4 organisation

### Master, slave, & ratio station

The strategy has been internally connected to make Loop 2 the master controller, Loop 1 the slave, and Loop 3 the ratio station.

### Normal & inverse ratios

The ratio value may be entered and displayed as the ratio of Loop 1's PV to Loop 2's PV, or the other way round. See **SWS\_1.Bit7** in Table 5-4 on page 5-8.

*Normal* and *inverse* ratio are defined as follows:

- **Normal** — Loop1 SP = Loop2 PV / ratio setpoint
- **Inverse** — Loop1 SP = Loop2 PV \* ratio setpoint

### Modes

Loop 1 can go into ratio mode for all operating modes of Loop2. However if Loop 2's process variable PV becomes invalid, Loop 1 reverts to Auto mode. Ratio control will only resume once Loop 2's PV has re-established and Loop 1's **R** button is re-pressed.

With Loop 2 not used for control, the T640 can be used as a single loop controller with ratio input.

### Ratio setpoint trim

The ratio Setpoint trim input is customer terminal 1F, in place of the unused remote setpoint input for Loop 1. The function block **RSP\_1** does not exist

### Ratio bias

The function of ratio bias is achieved through Loop 1's SP TRIM. This input operates to make the bias function as  $[Ratio + bias]$ , or  $[(1/Ratio) + bias]$ , depending on the ratio setting option.

NOTE. Ratio bias does not perform the function  $[1/(Ratio + bias)]$ .

### Filtering

**SETP2.PV** is filtered before calculating the remote setpoint for **SETP1**. The filter is also applied prior to the measured ratio calculation. The filter prevents open-loop disturbances in Loop 2's PV to affect the closed-loop performance of Loop 1.

### Loop update rates

The update rate of each loop is 320ms.

### Strategy #4 — operator interface

The ratio setpoint is adjusted by selecting Loop 3 and raising or lowering the setpoint.

Ratio control is achieved by pressing the **R** button when Loop 1 is selected. If Loop 1 is not in Remote mode, the two loops will act independently, although the measured ratio is still shown.

### Strategy #4 I/O customer terminals

Strategy #4 uses a pair of I/O boards located in sites 1 and 2 of the T640, accessible via customer terminals 1A to 1Z (site 1) and 2A to 2Z (site 2). These terminals and functions are almost the same as those for strategy #2, given in Tables 5-3 and 5-5. The exception is terminal 1F, which is here the *Ratio Trim* input instead of the *Remote Setpoint* input.

### Strategy #4 function blocks and parameters

This strategy has four ‘user tasks’ — seen as **LOOP 1**, **LOOP 2**, **LOOP 3** and **LOOP 4** in the tag display — that you can access via the **INS** pushbutton to configure their function blocks. The parameters in Loops 1 and 2 deal with configuration of the respective slave and master control loops, those in Loop 3 deal with the ratio station, and those in Loop 4 cover system alarms and general instrument setup. Loops 1, 2, and 4 are the same as those of strategy #2, which were tabulated in Tables 5-4, 5-7, and 5-5.

Loop 3’s configurable blocks and parameters, associated with the ratio station, are listed in Table 5-9 below.

When you come to configure these parameters you will find the *setup sheets* for this strategy helpful, because they list the default values of all fields, and include a spare column for you to record your customised values where required. You may want to use photocopies of the printed setup sheets as your working documents. The setup sheets for this strategy are found under *Setup sheets — all strategies* on page 5-32.

NOTE. The order of the blocks in the table may not match their order of appearance when you access them via the **INS** button.

Block	Field	Subfield	Description
SL663			This block needs attention only if Bisync communications are to be used.
	Instr_No		Slave address of the control loop’s 6366 emulation on the Bisync communications bus.
DCpl3			This block filters SETP2.PV before calculating the remote setpoint for SETP1. The filter is also applied prior to the measured ratio calculation.
	Filter		First-order filter time constant.

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Block	Field	Subfield	Description
TRIM3			This input provides a trim to the ratio setpoint. This trim input is added to the setpoint directly. If no trim is required all parameters in this block can be left as default.
		MODE	This should be left at MANUAL if a manual trim or no trim are required. Set this input to AUTO if a trim is to be provided as an input signal, SP TRIM
		PV	If MODE is set to MANUAL this input may be used to manually input a ratio setpoint trim.
		HR	This sets the high range: HR_in maps to HR. Because trim works by direct addition to the setpoint, HR and LR are used to scale the trim input against SETP1 HR_SP and LR_SP.
		LR	This sets the low range: LR_in maps to LR. It would not be unusual for LR to be the same value as HR but negative to give a symmetrical trim.
		Filter	A first-order filter with the time constant set applied to the input.
		HR_in	The input voltage representing high range
		LR_in	The input voltage representing low range
		Options	Only options believed relevant are described. Some options have defaults relevant to the I/O hardware and should not be changed.
		Invert	TRUE maps HR_in to LR and LR_in to HR. TRUE also inverts the effect of the trim signal.
		Sqrt	TRUE applies a square root function to the input
	SETP3		
		HR_SP	The high range of the ratio setpoint. HR_SP and LR_SP should be chosen to give a clear display on the PV and SP bargraphs of loop 3 which take their ranges from these parameters.
		LR_SP	The low range of the ratio setpoint.
		HL_SP	This sets a high limit for the setpoint including any trim.
		LL_SP	This sets a low limit for the setpoint including any trim.
		HL_SL	This sets a high limit for the local setpoint.
		LL_SL	This sets a low limit for the local setpoint.
		Alarms	These are the process alarms of the control loop. Note: Priority 0 disables the alarm completely. Priority 6-15 need to be acknowledged. Priority 11-15 open the Alarm relay. Alarms of priority equal to USR_ALM.Priority will open the Watchdog relay.
		HighAbs	The measured ratio exceeds HAA
		LowAbs	The measured ratio is less than LAA
		HighDev	The measured ratio exceeds the set ratio by HDA
		LowDev	The measured ratio is less than the set ratio by LDA
		HAA	High absolute alarm setting
		LAA	Low absolute alarm setting
		HDA	High deviation alarm setting
		LDA	Low deviation alarm setting
		Dis_DP	Sets the number of digits displayed to the right of the decimal point. This parameter is for display purposes only and has no effect on the ranging.

Table 5-9 Loop 3 parameters — strategy #4 (ratio station)

## SETUP SHEETS — ALL STRATEGIES

Tables 5-10 to 5-13 list all four strategies' configurable fields and their default values, together with a very brief description of their function. The loops apply to all the strategies, except where indicated. You may want to photocopy these pages and record your customised parameter values on them.

### Loop 1

Block	Field	Subfield	Default	Setting	Description	
SL661	Instr_No		1		BiSynch address	
SWS_1	W Field1	Bit0	FALSE		Power up mode	
		Bit1	FALSE		PV fail mode	
		Bit2	FALSE		tru - inverse output action	
		Bit3	FALSE		tru - inverse PID	
		Bit4	FALSE		tru - On/Off control	
		Bit5	FALSE		tru - setpoint tracks PV if not AUTO	
		Bit6	FALSE		tru - PV/SP Out = SP	
		Bit7	FALSE		tru - inverse ratio setting	
		Bit8	FALSE		tru - Mask R	
		Bit9	FALSE		tru - Mask A	
		BitA	FALSE		tru - Mask M	
		BitB	tru		Tag FIC-001	
		BitC	FALSE		Tag LIC-001	
		BitD	FALSE		Tag PIC-001	
BitE	FALSE		Tag TIC-001			
BitF	FALSE		Tag AIC-001			
RSP_1	Filter		0.00		Input filter	
		HR_in	10.00		Input voltage high	
		LR_in	0.00		Input voltage low	
		Options	Invert	FALSE		Input conditioning
		Options	Sqrt	FALSE		Input conditioning
DIN_1	Invert	Bit0	FALSE		tru inverts COMP EN(0)	
		Bit1	tru		FALSE inverts REM SP EN(1)	
		Bit2	FALSE		tru inverts TRACK EN(1)	
		Bit3	FALSE		tru inverts HOLD EN(1)	
PV__1	Filter		1.00		Input filter	
		RomChar	None		Input conditioning	
		Alarms	Hardware	2		Alarm priority
		OutRange		2		Alarm priority
		OCctdel		2		Alarm priority
		HR_in		10.00		Input voltage high
		LR_in		0.00		Input voltage low
		Options	Invert	FALSE		Input conditioning
		Options	Sqrt	FALSE		Input conditioning

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Block	Field	Subfield	Default	Setting	Description	
TRIM1	MODE		MANUAL		Operating mode (AUTO or MANUAL)	
	PV		0.00		Trim setting if MANUAL	
	HR		100.00		Engineering units high	
	LR		0.00		Engineering units low	
	Filter		0.00		Input filter	
	HR_in		10.00		Input voltage high	
	LR_in		0.00		Input voltage low	
	Options	Invert		FALSE		Input conditioning
		Sqrt		FALSE		Input conditioning
SETP1	HR_SP		100.00		Engineering unitshigh for SP and PV	
	LR_SP		0.00		Engineering units low for SP and PV	
	HL_SP		100.00		High limit on SP	
	LL_SP		0.00		Low limit on SP	
	HL_SL		100.00		High limit on SL	
	LL_SL		0.00		Low limit on SL	
	Alarms	HighAbs		2		Alarm priority on HAA
		LowAbs		2		Alarm priority on LAA
		HighDev		2		Alarm priority on HDA
		LowDev		2		Alarm priority on LDA
	HAA		100.00		High absolute alarm on PV	
	LAA		0.00		Low absolute alarm on PV	
	HDA		100.00		High deviation alarm on PV	
	LDA		100.00		Low deviation alarm on PV	
	Dis_DP		2		Decimal point position	
	DOP_1	Invert	Bit0	tru		FALSE inverts HI ALM OUT(0)
			Bit1	tru		FALSE inverts LO ALM OUT(0)
Bit2		FALSE		tru inverts REM AUT AUT(0)		
Bit3		FALSE		tru inverts HOLD+MAN OUT(0)		
PVOP1	HR_out		10.00		Output voltage high	
	LR_out		0.00		Output voltage low	
3TRM1	TimeBase		Secs		Control settings time base (TI & TD)	
	XP		100.00		Proportional band	
	TI		10.00		Integral time	
	TD		0.00		Derivative time	
	Deadband		0.00		Hysteresis for On/Off control	
TRK1	MODE		AUTO		Operating mode (AUTO or MANUAL)	
	PV		0.00		Track setting if MANUAL	
	HR_in		10.00		Input voltage high	
	LR-in		0.00		Input voltage low	
MANS1	HL_OP		100.00		High limit on control output	
	LL_OP		0.00		Low limit on control output	
OP__1	HR_out		10.00		Output voltage high	
	LR_out		0.00		Output voltage low	

Table 5-10 Setup sheet for Loop 1 — all strategies

**Loop 2**

Block	Field	Subfield	Default	Setting	Description	
SL662	Instr_No		1		BiSynch address	
SWS_2	W Field1	Bit0	FALSE		Power up mode	
		Bit1	FALSE		PV fail mode	
		Bit2	FALSE		tru - inverse output action	
		Bit3	FALSE		tru - inverse PID	
		Bit4	FALSE		tru - On/Off control	
		Bit5	FALSE		tru - setpoint tracks PV if not AUTO	
		Bit6	FALSE		tru - PV/SP Out = SP	
		Bit7	FALSE		tru - inverse ratio setting	
		Bit8	FALSE		tru - Mask R	
		Bit9	FALSE		tru - Mask A	
		BitA	FALSE		tru - Mask M	
		BitB	tru		Tag FIC-001	
		BitC	FALSE		Tag LIC-001	
		BitD	FALSE		Tag PIC-001	
BitE	FALSE		Tag TIC-001			
BitF	FALSE		Tag AIC-001			
RSP_2	Filter		0.00		Input filter	
		HR_in	10.00		Input voltage high	
		LR_in	0.00		Input voltage low	
		Options	Invert	FALSE		Input conditioning
			Sqrt	FALSE		Input conditioning
DIN_2	Invert	Bit0	FALSE		<i>(Unused)</i>	
		Bit1	tru		FALSE inverts REM SP EN(1)	
		Bit2	FALSE		tru inverts TRACK EN(1)	
		Bit3	FALSE		tru inverts HOLD EN(1)	
PV__2	Filter		1.00		Input filter	
		RomChar	None		Input conditioning	
		Alarms	Hardware	2		Alarm priority
			OutRange	2		Alarm priority
			OCctdel	2		Alarm priority
		HR_in		10.00		Input voltage high
		LR_in		0.00		Input voltage low
		Options	Invert	FALSE		Input conditioning
			Sqrt	FALSE		Input conditioning
		TRIM2	MODE		MANUAL	
PV	0.00				Trim setting if MANUAL	
HR	100.00				Engineering units high	
LR	0.00				Engineering units low	
Filter	0.00				Input filter	
HR_in	10.00				Input voltage high	

*continued...*

...continued

Block	Field	Subfield	Default	Setting	Description
	LR_in		0.00		Input voltage low
	Options	Invert	FALSE		Input conditioning
		Sqrt	FALSE		Input conditioning
SETP2	HR_SP		100.00		Engineering unitshigh for SP and PV
	LR_SP		0.00		Engineering units low for SP and PV
	HL_SP		100.00		High limit on SP
	LL_SP		0.00		Low limit on SP
	HL_SL		100.00		High limit on SL
	LL_SL		0.00		Low limit on SL
	Alarms	HighAbs	2		Alarm priority on HAA
		LowAbs	2		Alarm priority on LAA
		HighDev	2		Alarm priority on HDA
		LowDev	2		Alarm priority on LDA
	HAA		100.00		High absolute alarm on PV
	LAA		0.00		Low absolute alarm on PV
	HDA		100.00		High deviation alarm on PV
	LDA		100.00		Low deviation alarm on PV
	Dis_DP		2		Decimal point position
DOP_2	Invert	Bit0	tru		FALSE inverts HI ALM OUT(0)
		Bit1	tru		FALSE inverts LO ALM OUT(0)
		Bit2	FALSE		tru inverts REM AUT AUT(0)
		Bit3	FALSE		tru inverts HOLD+MAN OUT(0)
PVOP2	HR_out		10.00		Output voltage high
	LR_out		0.00		Output voltage low
3TRM2	TimeBase		Secs		Control settings time base (TI & TD)
	XP		100.00		Proportional band
	TI		10.00		Integral time
	TD		0.00		Derivative time
	Deadband		0.00		Hysteresis for On/Off control
TRK2	MODE		AUTO		Operating mode (AUTO or MANUAL)
	PV		0.00		Track setting if MANUAL
	HR_in		10.00		Input voltage high
	LR-in		0.00		Input voltage low
MANS2	HL_OP		100.00		High limit on control output
	LL_OP		0.00		Low limit on control output
OP__2	HR_out		10.00		Output voltage high
	LR_out		0.00		Output voltage low

Table 5-11 Setup sheet for Loop 2

**Loop 3**

Block	Field	Subfield	Default	Setting	Description	
SL663	Instr_No		1		BiSync address	
DCpl3	Filter		0.00		Ratio Decoupling Filter	
TRIM3	MODE		MANUAL		Operating mode (AUTO or MANUAL)	
	PV		0.00		Trim setting if MANUAL	
	HR		100.00		Ratio trim high	
	LR		0.00		Ratio trim low	
	Filter		0.00		Input filter	
	HR_in		10.00		Input voltage high	
	LR_in		0.00		Input voltage low	
	Options	Invert		FALSE		Input conditioning
		Sqrt	FALSE		Input conditioning	
SETP3	HR_SP		100.00		Ratio high range for SP and PV	
	LR_SP		0.00		Ratio low range for SP and PV	
	HL_SP		100.00		High limit on SP	
	LL_SP		0.00		Low limit on SP	
	HL_SL		100.00		High limit on SL	
	LL_SL		0.00		Low limit on SL	
	Alarms	HighAbs		2		Alarm priority on HAA
		LowAbs		2		Alarm priority on LAA
		HighDev		2		Alarm priority on HDA
		LowDev		2		Alarm priority on LDA
HAA		100.00		High absolute alarm on PV (measured ratio)		
LAA		0.00		Low absolute alarm on PV		
HDA		100.00		High deviation alarm on PV		
LDA		100.00		Low deviation alarm on PV		
Dis_DP			3		Decimal point position	

Table 5-12 Setup sheet for Loop 3 — strategy #4 (ratio)

**Loop 4**

Block	Field	Subfield	Default	Setting	Description
USR_ALM	Priority		2		Watch dog relay alarm setting (0-15)
T60_**	Options	NoKeyPrt	tru		FALSE - key required
		NoKeyFul	FALSE		FALSE - key required
		BinSpd1	FALSE		Bisynch baud rate.
		BinSpd2	FALSE		Default gives 9600 baud

Table 5-13 Setup sheet for Loop 4 — all strategies

## COMMUNICATING WITH THE T640

There are three ways in which the T640 may be integrated into a system — via the ALIN, via TCS binary Bisync protocol, and via MODBUS/JBUS. (Please refer to Chapter 2 under *Hardware Configuration* for communications configuration information.)

### Communicating on the ALIN

This is always available and gives tight integration into the Eurotherm Process Automation LIN system. Blocks have been included in the fixed function strategies specifically for caching. The most important of these are PID\_CONN blocks, which allow interaction with the control loops. The names of the PID\_CONN blocks are:

**PIDC1\*\*** for Loop 1, **PIDC2\*\*** for Loop 2, and **PIDC3\*\*** for Loop 3,

where \*\* is the instrument node number. For example, if the ALIN address of the instrument were 88, Loop 1's control block would be named **PIDC188**. T640 automatically substitutes the node number for \*\*.

Furthermore, eleven diagnostic blocks are provided for the instrument as a whole. For details on the operation of these blocks, please refer to the *LIN Blocks Reference Manual* (Part No. HA 082 375 U003). Table 5-14 lists these block types and their names.

Block type	Block name
DB_DIAG	DDIAG_**
EDB_DIAG	EDIAG_**
LIN_DEXT	LDEXT_**
ALINDIAG	ALIND_**
XEC_DIAG	XDIAG_**
T600TUNE	T600T_**
EDB_TBL	ETBL_**
ROUTETBL	ROUTE_**
RTB_DIAG	RDIAG_**
ISB_DIAG	IDIAG_**
ISB_DEXT	IDEXT_**

Table 5-14 Diagnostic blocks in the T640 fixed function strategies

### TCS binary Bisync protocol

As an option, the T640 can be fitted with RS422/RS485 communications. Each loop will emulate a 6366 as far as communications is concerned. This allows the T640 to be integrated into existing 6000 instrument-based systems. Setting up the RS422 node address is done within the SL661, SL662 and SL663 blocks.

### MODBUS/JBUS

This too requires the RS422/RS485 option. To set up and download the MODBUS tables to the T640, you need T500 LINtools. A full explanation of the configuration of the MODBUS interface is given in the *T500 User Guide* (Part No. HA 082 377 U005).

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## Chapter 6 CHANGES LOGFILE

### LOGFILES

The T640 maintains in EEPROM a logfile of every parameter change made via the front panel database access mechanism, i.e. via the **INS** button. (Please refer to Chapter 4, *User interface*, for full details on database access and use of this button.) The logfile contains a complete record of what was changed, when it was changed, and by whom.

### Logfile organisation

The logfile adopts the same root filename as the .DBF file from which the database was loaded, but with extension **.Lnn**, where *nn* is the logfile number, ranging from 01 to 99. When a logfile becomes full (i.e. has reached 1Kbyte) it closes and its number is written to the T600 block's *Log\_File* parameter. The previously held file is deleted. When more logfile data is generated a new file with incremented logfile number is automatically created. Thus the T600 block logfile number defines a file that may be safely uploaded. If *Log\_File* is '0', there is no file to upload. Only the two most recent logfiles are retained in memory: the currently open file and the last closed one.

A logfile can be closed before it is full if another type of file (e.g. a strategy file) is added to EEPROM to make the logfile no longer the latest file. This is because T640's filing system allows data to be appended only to the last file in EEPROM.

### Logfile records

There are two possible records in a log file:

- **Inspect Mode entry.** This record shows the date of entry into Database Inspect mode, and which security key was used to access the mode. One of these records is written to file only if parameter changes were actually made.

Each record is a single text line of the format

**dd/mm/yy T:aa kkkk**

where: dd/mm/yy = the date in day/month/year representation  
T = type of security key (P = partial, F = full, G = global, ignoring area no.)  
aa = area number (0 - 63)  
kkkk = security key number (0 - 4095).

- Parameter Change entry.** This record shows a single instance of parameter updating. In order to control file size when the operator is 'nudging' to the value, there must be a significant time gap between nudges to result in more than one record. Where a change in direction occurs the peaks in each direction are logged (as a minimum). The time logged is the time that the final value was written.

Each record is a single text line of the format

**hh:mm:ss block.field.subfield = value**

or, for a change of mode,

**hh:mm:ss LOOP n = X**

where: hh:mm:ss = the time in hours/minutes/seconds (24hr) representation

block ... = the full path of the point being modified

value = the new value

n = the loop number

X = the new mode, i.e. **M**, **A**, or **R**.

### Example logfile record

```
21/01/93 F: 3:2345
01:12:15 T640C6C3.Options.FPdisl = TRUE
01:12:18 T640C6C3.Options.NoKeyFul = FALSE
01:12:25 LOOP 4 = M
```

## Chapter 7 INSIDE T640

### INTERNAL LAYOUT

Please refer to Chapter 2, *Installation & startup*, for details of T640's dimensions, internal physical and electrical layout, and hardware configuration. The present chapter deals with the software and hardware blocks functioning within the T640.

### FUNCTIONAL BLOCKS

Figure 7-1 shows a functional block schematic of the T640. The main functional blocks are: the motherboard, the front panel, the I/O sub-assemblies (up to two), and the rear-panel customer screw terminals.

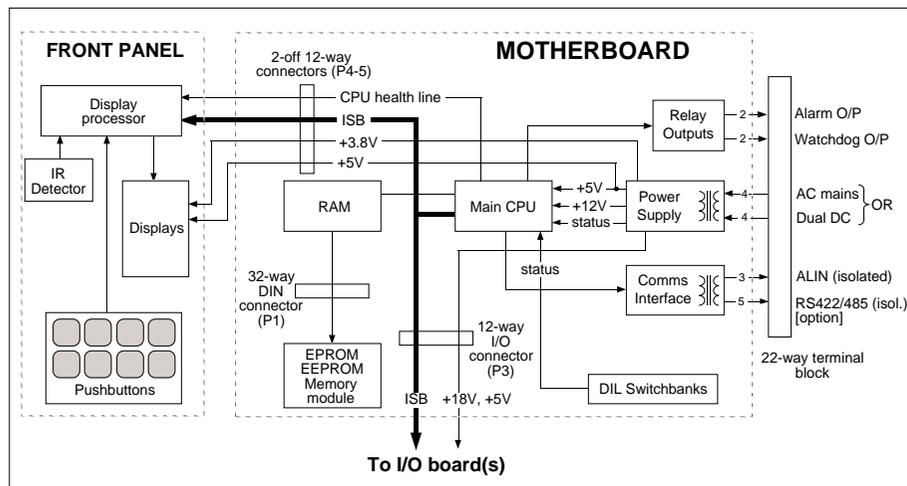


Figure 7-1 T640 Functional block schematic

### Motherboard

The motherboard is the main electronics board in the instrument to which all other sub-assemblies connect. It carries the main CPU, communications electronics, power supply, and the two configuration DIL switchbanks.

### Main CPU

The main CPU has its own limited I/O to read the configuration DIL switches and the power supply status. It also provides a watchdog output to indicate the health of the processor, and a common alarm output. Both these outputs are available at the rear connectors.

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Details on the operation of the watchdog and alarm outputs are given in Chapter 8, *Error conditions & diagnostics*.

## Memory

Memory consists of EPROM for T640 firmware, EEPROM for databases, standard strategies and logfiles, and static RAM for the working memory and operational data (running database with setpoints etc.). The RAM is maintained by a Supercap. This obviates the need for a battery in the instrument, and means that the T640 resumes its exact control conditions in the event of a power failure of up to 24 hours. Key operating parameters, controller modes, setpoints, etc., are passed to EEPROM on power-down to ensure that the controller returns to its correct operating conditions if the power fails for more than 24 hours. (Refer to Chapter 2 for details of T640's power-up routines.)

The EEPROM (and EPROM) memory resides in a removable memory module. This allows a new strategy to be plugged directly into an existing controller, or conversely allows a strategy to remain if the controller must be changed. (Chapter 2 describes memory-module and T640 unit replacement.)

Table 2-4 in Chapter 2 summarised the major T640 file types. Further details on these files are given in the relevant sections of this manual.

## Comms ports

There are three communications ports — two serial, and one peer-to-peer. The two serial ports are the internal serial bus, and the Bisync/MODBUS port, available as options at the rear panel via an isolated RS422/485 driver on the motherboard. Jumpers and motherboard switches select which port is connected via the driver. (Chapter 2 specifies these jumper and switch configurations.) The third port is the peer-to-peer ALIN channel.

**Internal Serial Bus (ISB).** The ISB communicates between the main CPU, the I/O card(s), and the front panel. It also supports remote I/O and external faceplates from the rear connections (*not available at this release*). The external link is half duplex, using a 5-wire RS485-derivative physical and electrical interface to the I/O cards. The front panel and any internally fitted I/O cards are directly coupled to the main processor at logic levels.

The ISB is asynchronous, with 1 start bit, 8 data bits, 1 control bit, and 1 stop bit, operating at 78.125kbits/second. This speed allows messages to be transferred with negligible delay.

The main processor acts as master on this communications bus; no other nodes can transmit without being invited to. Each slave node on the bus is given a node number, in the range 0 - 15. Node number 15 is reserved for the front panel, and node numbers 0 - 7 are allocated to I/O cards. Each I/O card has switches for setting up its ISB node number.

**Bisync/MODBUS Port.** This port provides a Bisync slave interface for connection to existing supervisors or to industry-standard MODBUS units (selectable via SW1/1), via the RS422/485 driver .

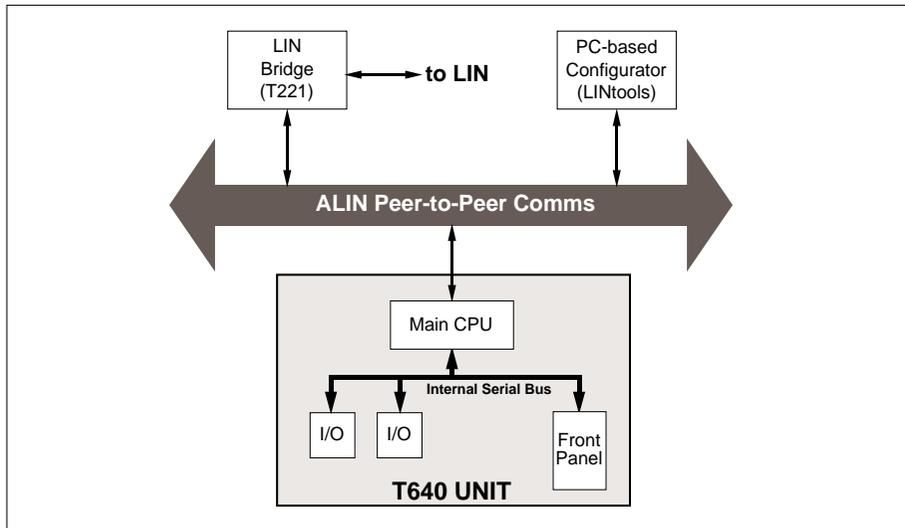


Figure 7-2 ALIN communications schematic

**ALIN peer-to-peer comms.** A high-speed (2.5Mbaud) short-distance form of the LIN, the ALIN is the main communications channel in the instrument, used for configuration, supervision, and inter-instrument communication. See Figure 7-2. It supports all current LIN features — block attachments, field writes, file transfers, etc. — except channel redundancy. ALIN and LIN can be interconnected via a T221 bridge.

ALIN is provided by an ARCNET physical layer and uses the same, though enhanced, application layer as the LIN. The peer-to-peer enhancements — synchronised realtime clock and time-stamped alarms — are provided by the T221 bridge.

### Power supplies

T640 has two power supply options — DC input, and AC input. See Chapter 9, *Specifications*, for details.

### DIL switchbanks

Switchbanks 1 and 2 set T640's comms function and address, startup procedure, standard strategy selection, and also enable/disable a loop failure watchdog alarm. (Refer to Chapter 2 for switchbank functions.) Chapter 5 details the pre-configured fixed-function strategies stored in the T640.

### Front panel

The front panel display sub-assembly is an intelligent unit controlled by its own micro-processor. It communicates with the main CPU on the motherboard via the internal serial bus (see Figure 7-1). The display features are specified in Chapter 9. Using the front panel and the security key are described in Chapter 4, *User interface*.

## **I/O sub-assemblies**

The T640 can be supplied with several I/O options, in the form of I/O boards that mount on the motherboard and communicate with it via the ISB. Note that a T640's I/O is not restricted to its own direct inputs, as it can access data from other instruments across the ALIN. For full descriptions and specifications of the available I/O, see Chapter 9, *Specifications*. Chapter 2 (*Hardware configuration* section) shows an example of how I/O boards fit inside the T640

## **Customer screw terminals**

Full details of the rear-panel screw terminals are given in Chapter 2 in the *Connections & wiring* section.

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## Chapter 8

# ERROR CONDITIONS & DIAGNOSTICS

This chapter deals with T640's error conditions, diagnostic messages, safety features, and alarm strategy. Power-up messages tell you what T640 is doing or attempting to do when power is restored, and subsequently database alarms and hardware/software faults are signalled as special front-panel messages, or 4-digit hex codes which can be looked up in Table 8-1.

The aims of T640's safety features are to report abnormal and fault conditions to the outside world, to prevent — as far as is practicable — unsafe conditions occurring, and if they do occur, to restore the system to a safe state as quickly as possible.

## POWER-UP DISPLAYS

### Normal power-up

**Power-on Reset.** normally flashes briefly in the red tag display when T640 is powered up, while the front panel awaits communications from the main CPU. Then, **WarmStrt Trying**, **TepidStrt Trying**, or **ColdStrt Trying**, flash to tell you the type of startup procedure T640 is attempting. If a standard strategy is being loaded for the very first time, **Un Pack Database** flashes in the tag display as the file is being decompressed. Finally, the fascia adopts the normal display (as described in Chapter 4).

## ERROR CONDITIONS

- **CPU FAIL** flashes in the 5-digit display if the CPU fails to establish comms to the fascia. This message can also mean a watchdog failure (see later under *CPU watchdog*, incorrect motherboard comms option SW1/2 setting (see Table 2-3 in Chapter 2, *Hardware configuration* section), or an absent/faulty memory module.
- **HALTED** in the tag display, with **Error** flashing in the 5-digit display, means the user task in the main display has halted.
- **Err hhhh** flashing brightly in alternation with the normal tag display means a filing system or database system error (e.g. coldstart file access failure) identified by a 4-digit hex code *hhhh*. Filing system alarms override database alarms on the front panel. To clear them, press the ▲ and ▼ keys simultaneously. Table 8-1 lists all the hex code error numbers and their meanings.

- **Database alarms.** Unacknowledged alarms in the loop occupying the main display cause the tag display to bright flash the highest priority alarm name in alternation with the standard message. Unacknowledged alarms elsewhere display **LP *n* ALM**, where *n* is the relevant loop number. Please refer to Chapter 4, *Alarm display & inspection* section, for further details on alarm display, inspection, and acknowledgment.

Error	Meaning
6001	Failure to load MODBUS database
6002	Failure to start MODBUS database
8201	Device not mounted/compatible (not formatted, or corrupt)
8202	Invalid device specified
8203	Error performing I/O to device (write/read protected by wrong switch settings)
8204	Feature not implemented
8205	Formatting error
8206	Physical device not present
8207	Device full
8208	File not found
8209	No handles for file (not enough memory to open file and note its state)
820A	Bad filename
820B	Verify error
820C	File locked, already in use
8301	Bad template
8302	Bad block number
8303	No free blocks
8304	No free database memory
8305	Not allowed by block create
8306	In use
8307	Database already exists
8308	No spare databases
8309	Not enough memory
8320	Bad library file (corrupt ROM file)
8321	Invalid template in library
8322	Bad server (corrupt file when loading)
8323	Cannot create EDB entry
8324	Bad file version
8325	Bad template spec
8326	Unable to make block remote
8327	Invalid parent
8328	Corrupt data in .DBF file
8329	Corrupt block spec
832A	Corrupt block data
832B	Corrupt pool data
832C	No free resources
832D	Template not found
832E	Template resource fault
8330	Cannot start
8331	Cannot stop
8332	Empty database

*continued ...*

... continued

Error	Meaning
8333	Configurator in use
8340	.DBF file write failed
8341	More than one .RUN file found
8342	.RUN file not found
834A	Connection source is not an output
834B	Multiple connection to same input
834C	Connection destination not input
834D	No free connection resources
834E	Bad connection source/destination block/field
834F	Invalid connection destination
8350	Warmstart switch is disabled
8351	No database was running
8352	Real-time clock is not running
8353	Root block clock is not running
8354	Coldstart time was exceeded
8355	Root block is invalid
8356	More than two PID or 3_TERM blocks in a 2-loop controller
8357	Coldstart switch is disabled
8360	Unsynchronised Block Types
8361	DB/Filing system mismatch
8362	Unsynchronised Secondary
8363	Operation forbidden whilst CPUs synchronising
8364	Power-up data inhibits run
8365	POST hardware failure
8366	Not fixed-function strategy
8367	Default strategy missing
FFFF	(Unspecified error)

Table 8-1 T640 Error numbers &amp; their meanings

## ALARM STRATEGY

### Alarm priorities

Alarm priorities in the T640 follow the convention established in all LIN-based instruments. They can be set in individual blocks via their *Alarms* fields and are defined as:

- 0 (lowest priority) = alarm disabled.
- 1 -5 = annunciated with auto acknowledge. These alarms are annunciated only while the alarm condition persists, and clear themselves when the alarm condition clears, without needing manual acknowledgement.
- 6-10 = annunciated with manual acknowledge. These alarms do not automatically clear when the alarm condition disappears, but remain active until manually acknowledged.

- 11-15 (top priority) = annunciated with manual acknowledge and alarm relay. These alarms work in the same way as priority 6-10 alarms but in addition they trip the T640 hardware alarm relay (see below) and set the T600 block's *Status/Alarm* bit.

## Alarm annunciation

Annunciated alarms are indicated on the controller front panel by means of the red LED in the ALM button, and also via the tag display. Please refer to Chapter 4 for further details.

## Alarm events

As an alarm state changes, into or out of alarm, (occurring at block execution time) this event is advised to an alarm event system where it is date/time stamped (*not implemented at Issue 1*). A supervisor may attach to the alarm events of an instrument (*not at Issue 1*). Once so attached, the instrument checks at regular intervals to see if any new alarm events have occurred and transmits them to the supervisor.

To ensure consistent date/time stamping, the date/time is regularly copied across the peer-to-peer communications link, via the T221 bridge (*not implemented at Issue 1*).

## Alarm relay

The alarm relay's contacts are closed when energised and in the no-alarm condition. When a priority 11-15 alarm occurs in the T640, or if the database halts, the contacts open. They also open if the relay is de-energised, i.e. fail safe operation.

## CPU WATCHDOG

### Watchdog output

The instrument is provided with a watchdog output on the main processor unit, which flags an alarm condition if the processor fails. If the watchdog trips, the processor is reset and restarted.

### Watchdog relay

A relay output is provided to indicate that the watchdog has tripped. The contacts are closed when energised and in the healthy condition, but open if the CPU fails. Additionally, the front panel 5-digit display flashes **CPU FAIL** until the processor has been restarted.

## Loop fail

The CPU can also force the watchdog into alarm, to flag if a loop (user task) fails to run, or if the database halts. This facility may be enabled/disabled via the motherboard DIL switchbank SW1, switch 5 (see Figure 2-12 in Chapter 2, *Hardware configuration* section). If a loop fails to run, the outputs assume the state defined in the *OPTIONS/CPUFILo* field of the output block (e.g. 'low').

## User alarm

The watchdog relay can also act as a general-purpose user alarm, via the T600 block's *UsrAlm* field. A TRUE input to *UsrAlm* from the control strategy opens the relay contacts. A FALSE input closes them, but is overridden by a watchdog alarm.

## Main processor (CPU) fail

Both I/O cards and the front panel microprocessor can detect failure of the main CPU, by virtue of there being no activity on the internal serial bus. In this case the front panel replaces the normal 5-digit PV display with a flashing **CPU FAIL** message. The I/O cards can be programmed with action to be performed on main processor fail, e.g. outputs hold or outputs low. If the database stops, either due to a fault, or as a result of a command over the LIN, this will also cause the I/O cards to adopt their CPU-fail state.

## Forced manual mode

In user tasks with MODE blocks, the block adopts forced manual mode under error conditions (i.e. sumcheck, open circuit PV, or other strategy-defined conditions).

## Chapter 9 SPECIFICATIONS

### T640 BASE UNIT

#### Panel cut-out & dimensions

Please refer to Chapter 2, under *Installation*, for details.

#### Mechanical

Fascia dimensions:	height 144mm, width 72mm.
Mounting panel aperture:	height 138 +1 –0 mm, width 68 +0.7 –0 mm.
Behind mounting panel:	depth 258mm (measured from panel front).
Front of mounting panel:	depth 10.6mm.
Weight:	2.15kg.

#### Environmental

Storage temperature:	–10°C to +85°C, at humidity of 5-95% (non-condensing).
Operating temperature:	0°C to +50°C. The enclosure must provide adequate ventilation, and heating if required to avoid condensation at low temperatures.
Atmosphere:	Unsuitable for use above 2000m or in explosive or corrosive atmospheres.
Front panel sealing:	to meet EN60529: IP65.
EMC emissions:	to meet EN50081-2 (Group 1; Class A).
EMC immunity:	to meet EN50082-2.
Electrical safety:	to meet EN61010, Installation category II. Voltage transients on any mains power connected to the unit must not exceed 2.5kV. Electrically conductive pollution must be excluded from the cabinet in which the unit is mounted.
Isolation:	All isolated inputs and outputs are double-insulated as specified in EN61010 to provide protection against electric shock. (Isolation levels for particular I/O types are stated in the relevant section of the specification for the I/O board concerned.)
Vibration:	to meet BS2011 Part 2.1, Test Fc, Table CII, 'Equipment intended for large power plant and general industrial use' (2g, 10-55 Hz).
Shock:	to meet BS2011 Part2.1, Test Ea, Table II, 'General test for robustness, handling and transport' (15g, 11ms).

## Front panel displays

PV bargraph:	red 51-segment vertical % display (flashable via block).
SP bargraph:	green 51-segment vertical % display (flashable via block).
Output bargraph:	yellow 10-segment horizontal display (segments individually addressable).
Numeric display:	5-digit, red 7-segment.
'PV-X' legend:	lit red when PV indicated in Numeric display.
Tag display:	8-character, red dot-matrix (user-configurable).
Units display:	5-character, green dot-matrix (eng. units or SP).
'SP-W' legend:	lit green when SP indicated in Units display.

## Loop status summary

deviation/PV bargraph:	4-off red 7-segment vertical displays, settable via block to 1/2/3%, 1/5/10%, or 10/20/30% deviation; or to 100% PV. Central bicolour LED glows green when deviation shown.
loop mode:	A(uto), R(emote/ratio) green lit single letters M(anual), H(old), T(rack) orange lit single letters.
loop selected:	green lit arrow symbol under deviation/PV bargraph.

## Pushbuttons

loop control: 6-off membrane pushbuttons with symbols—

R (with green LED)	
A (with green LED)	
M (with orange LED)	
SP	
'raise'	
'lower'	
parameter access:	INS pushbutton 
alarm acknowledge:	ALM pushbutton (with red LED) 

(space)	!	"	#	\$	%	&	'	(	)	*	+	,	-	.	/
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Ø	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	↑	_
80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
p	q	r	s	t	u	v	w	x	y	z	{		}	~	Δ
112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
А	Б	В	Г	Д	Е	Ж	З	И	Й	К	Л	М	Н	О	П
128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
Р	С	Т	У	Ф	Х	Ц	Ч	Ш	Щ	Ъ	Ы	Ь	Э	Ю	Я
144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
ι	ζ	α	β	γ	δ	ε	η	θ	λ	μ	ν	π	ρ	σ	τ
160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
φ	χ	ψ	ω	Γ	Δ	Θ	Λ	Ξ	Σ	Φ	Ψ	Ω	£	¥	Å
176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
á	Ä	ä	à	á	â	æ	Æ	ç	É	è	é	ë	ê	ì	í
192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
ï	î	ñ	ñ	Ñ	ñ	ø	ø	Ö	ö	ò	ó	ô	œ	æ	Ü
208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
ü	ù	ú	û	x	y	£	±	≡	≈	≠	∫	√	-1	-2	2
224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
-3	3	°	↑	↑	↓	↓	█	▬	→	←	↓	←	→	°C	°F
240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255

Table 9-1 Dot-matrix display character set (representation)

### Dot-matrix display character set

Table 9-1 shows (in representative typefaces) the complete set of characters displayable by the two dot-matrix front-panel displays — the Tag display and the Units display. The number under each character is its decimal code, used to specify that character for display via the LINtools configuration package. Codes 0 to 31 are reserved and are not user-accessible.

Please refer to the *T500 LINtools User Guide* (Part No. HA 082 377 U005) for further details.

### Relays

Alarm relay:	SPST. 24V ac/dc at 1A. Absolute maximum rating 30Vrms, 60Vdc.
Watchdog relay:	SPST. 24V ac/dc at 1A. Absolute maximum rating 30Vrms, 60Vdc.

### Power supplies

#### Mains version

Input voltage range:	90 - 265 Vac rms.
Input frequency range:	45 - 65 Hz.
Maximum peak input current:	1.1A.
Power rating:	25VA.
Holdup time:	20ms.
Fuse:	T-type (IEC 127 time-lag type) 20 ¥ 5 mm 250Vac antisurge cartridge, 500mA.

#### DC version

Number of inputs:	2 — Channel 1 (main input), channel 2 (backup).
Input voltage range:	19 - 55 V (including rectified 48Vac).
Power rating:	25VA.
Holdup time:	20ms.
Fuse:	T-type (IEC 127 time-lag type) 20 × 5 mm 250Vac antisurge cartridge, 2A.

### T950 Security key

Battery:	12V alkaline manganese dioxide type, of overall length 27.5-28.5 mm, diameter 9.62-10.62 mm. E.g. Duracell™ MN21, Panasonic™ RV08, or equivalent. (Refer to Ch2 for safety precautions.)
----------	--

### ALIN

The ALIN runs on screened twisted pair. Phase A, pin 21, should be bussed to other Phase A signals and likewise Phase B, pin 22. The cable screen should be connected to ALIN Gnd, pin 20. The ALIN connections are galvanically isolated within the T640 to assist with noise rejection and simplify system wiring. The key specifications of the ALIN are summarised as follows:

Cable type:	screened twisted pair.
Line impedance:	82 , nominal.
Network topology:	single non-branching network.
Network terminations:	82 at each end.
Maximum load:	20 nodes.
Maximum length:	100 metres.
Grounding:	single point ground per system.

## RS422 COMMUNICATIONS

Selection:	Via motherboard DIL SW1 & jumper links (see Chapter 2).
Protocols supported:	MODBUS and BISYNC.
Transmission standard:	5-wire RS422 (0-5V).
Line impedance:	120 - 240 twisted pair .
Line length:	1220m (4000ft) maximum at 9600 baud.
Units per line:	16 instruments electrical maximum, expandable to 128 electrical maximum by nesting of 8245 Comms Buffers.

## RS485 COMMUNICATIONS

Selection:	Via motherboard DIL SW1 & jumper links (see Chapter 2).
Protocols supported:	MODBUS.
Transmission standard:	3-wire RS485 (0-5V).
Line impedance:	120 - 240 twisted pair .
Line length:	1220m (4000ft) maximum at 9600 baud.
Units per line:	16 instruments electrical maximum.

## BISYNC PROTOCOL

Selection:	Via motherboard DIL SW1 & jumper links (see Chapter 2).
Conforms to:	ANSI-X3.28 - 2.5 - A4 Revision 1976 — binary version.
Medium:	RS422.
Implementation:	Via appropriate T6000 category function block running in the T640 (see the <i>LIN Blocks Reference Manual</i> ).
Addresses:	128 maximum, software-selectable via the S6000 function block's <i>Instr_No</i> parameter.
Data rate:	Software-selectable, via T600 function block's <i>BinSpd1</i> & <i>BinSpd2</i> parameters, from 300, 1200, 4800, & 9600 baud.
Character length:	11 bits made up of — 1 start + 8 data + 1 parity (even) + 1 stop.

## MODBUS PROTOCOL

Selection:	Via motherboard DIL SW1 & jumper links (see Chapter 2).
Transmission mode:	MODBUS RTU (8-bit) supported.
Medium:	RS422 or RS485.
Implementation:	Via 'gateway' file (.GWF) configured via T500 LINtools MODBUS configurator and stored in the T640 together with the database file (.DBF).
Slave addresses:	254 maximum, software-selectable via T500 LINtools MODBUS configurator.
Data rate:	Software-selectable (via LINtools) from 110, 150, 300, 600, 1200, 2400, 4800, and 9600 baud.
Parity & stop bits:	Software-selectable (via LINtools) from none, odd, and even parity, with 1 or 2 stop bits.

## SOFTWARE

### Maximum resources supported

The table shows the default maximum resources supported by the T640. (This information is also available in the local DB\_DIAG blocks.)

Resource	Default Maximum
Blocks	256
Templates	50
Libraries	32
EDBs	8
Featts	128
Teatts	10
Servers	5
Connections	512

Note that if a database is loaded having more resources than the default maximum, the maximum is set to the new value — which may mean there is not enough memory to load the whole database. In this case it is the connections that disappear first. Featts are an exception. When a database is saved there are generally no Featts present because they are created dynamically at runtime, preventing the default maximum from being overridden.

**Maximum sequencing resources supported**

<b>Resource</b>	<b>Maximum</b>
Simultaneous independent sequences	10
SFC actions	50
Steps	150
Action associations	600
Actions	300
Transitions	225
Servers	5
Sequence execution rate	<i>(determined by repeat rate of User Task 4 loop)</i>

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## HIGH-LEVEL I/O

### Layout

The high-level I/O electronics resides on a main I/O board mounted next to the motherboard, which plugs into the central rear-panel 24-way terminal block (I/O site 1). These terminals can carry only half the available I/O; the second half can be accessed at the left-hand rear-panel 24-way terminal block (I/O site 2) via an expansion I/O board, fitted next to the main board. (Figure 2-10 in the *Hardware configuration* section of Chapter 2 shows this layout.)

### T640 rear-panel customer connections

Please refer to Chapter 2, under *Connections & wiring (Customer terminals)*, for details.

### Input ranges

The appropriate 0-5 V or 0-10 V range is automatically selected by the software when you configure the analogue input or output block in the control database. However, you can override the software and select the 0-1.25 V range specifically by connecting together the two pins of Jumper 1, and those of Jumper 2, on the main high-level I/O board. These are located as shown in Figure 9-1. Both analogue inputs and voltage analogue outputs are forced to the 1.25V range by these jumper links.

**Burden resistors.** If internal burden resistors have been specified (HIB and HGB options), or if external burden resistors are fitted to the customer screw terminals, the analogue input block's range parameters — LR\_in and HR\_in — must be appropriately configured to suit the plant's current input range. Consult Table 9-2.

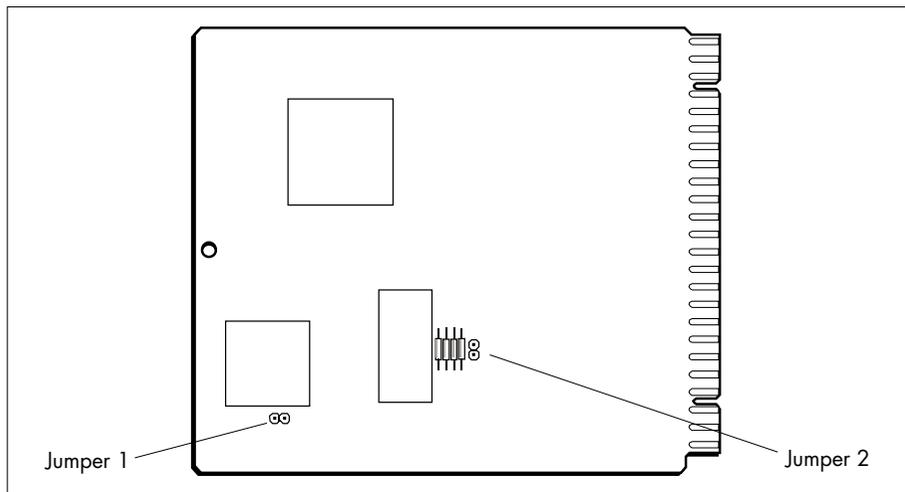


Figure 9-1 High-level I/O board showing 0 - 1.25V range jumpers

Option	Burden resistor	Plant input	AN_IP block setup:	
			LR_in	HR_in
HIB	250	0 - 20 mA	0V	5V
		4 - 20 mA	1V	5V
HGB	62	0 - 20 mA	0V	1.24V
		4 - 20 mA	0.248V	1.24V
External	250	0 - 20 mA	0V	5V
		4 - 20 mA	1V	5V
	50	0 - 20 mA	0V	1V
		4 - 20 mA	0.2V	1V

Table 9-2 Range settings for burden resistors

**Calibration.** The 1.25V range is supplied with a nominal calibration accuracy of better than 5%. If required, the board may be recalibrated to an accuracy of 0.05% — please refer to Eurotherm Process Automation for details.

**NOTE.** In the T640 HI and HIB options the 1.25V range is uncalibrated at the present issue of hardware. This state is not flagged by the STATUS/BadCal bit.

## LIN blocks parameters not supported

The *LIN Blocks Reference Manual* (Part No. HA 082 375 U003) describes in generic terms every block and parameter that can be run in a T640 instrument. However, certain parameters are not supported, or are only partially supported, by the high-level I/O board. Table 9-3 lists these board-specific parameters.

Block type	Parameter	Support
AN_IP	InType	V option only
	CJ_temp	<i>Not supported</i>
	LeadRes	<i>Not supported</i>
	STATUS PSUshort	<i>Not supported</i>
	BrkWarn	<i>Not supported</i>
AN_OUT	BrkDtctd	Not supported when burden resistors in use
	STATUS FaultCct	Voltage outputs: short circuit only Current outputs: not supported
	OverDrv	<i>Not supported</i>
	Killed	<i>Not supported</i>
	ALARMS CctFault	Voltage outputs: short circuit only Current outputs: not supported
	OvrDrive	<i>Not supported</i>
DG_IN	Thresh	<i>Not supported</i>
	InType	Volts option only
DG_OUT	Pullup	<i>Not supported</i>
DGPULS_4 [1]	Pullup	<i>Not supported</i>

[1] With high-level boards in both T640 sites, only site 1 can support a DGPULS\_4 block.

Table 9-3 High-level I/O board LIN blocks parameter support

## Hardware organisation

Figures 9-2 to 9-4 are block schematics outlining the organisation of the high-level I/O board hardware. Figure 9-2 shows the non-isolated analogue I/O, Figure 9-3 shows the digital I/O, and Figure 9-4 shows the current outputs and transmitter power supplies.

### Analogue inputs

Channels:	8.
Input range:	0-5 V and 0-10 V, with software-selectable range. 0-1.25 V range jumper-selectable (see <i>Input ranges</i> above).
Absolute max. input:	15V.
Resolution:	0.025%.
Accuracy:	0.05% of range.

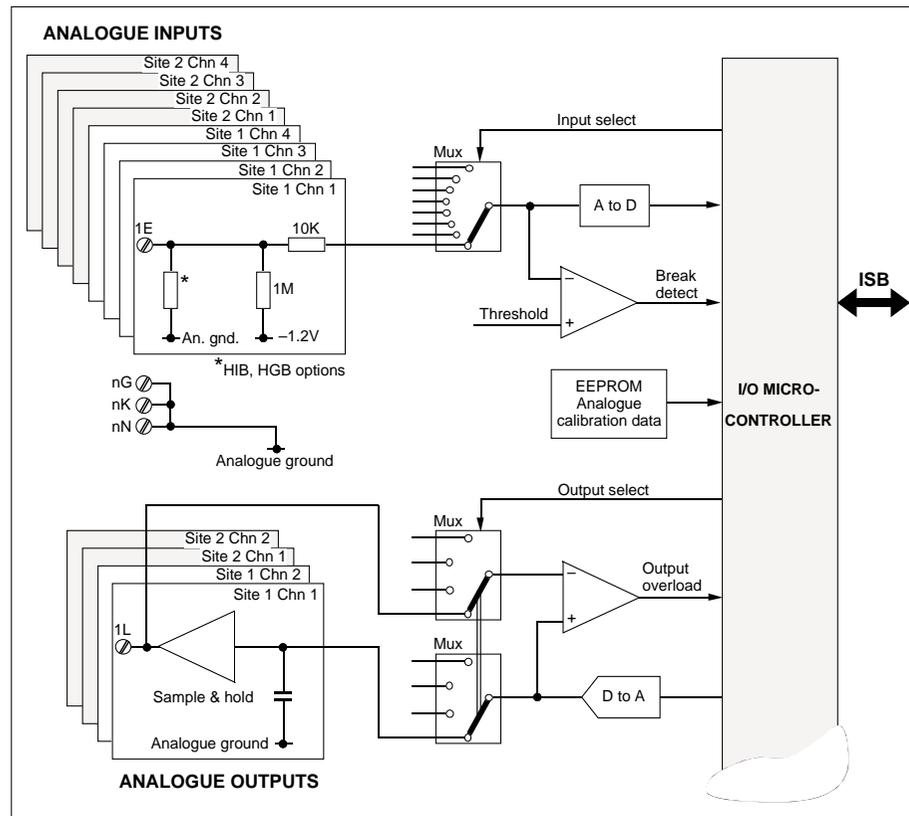


Figure 9-2 Analogue input & output block schematic

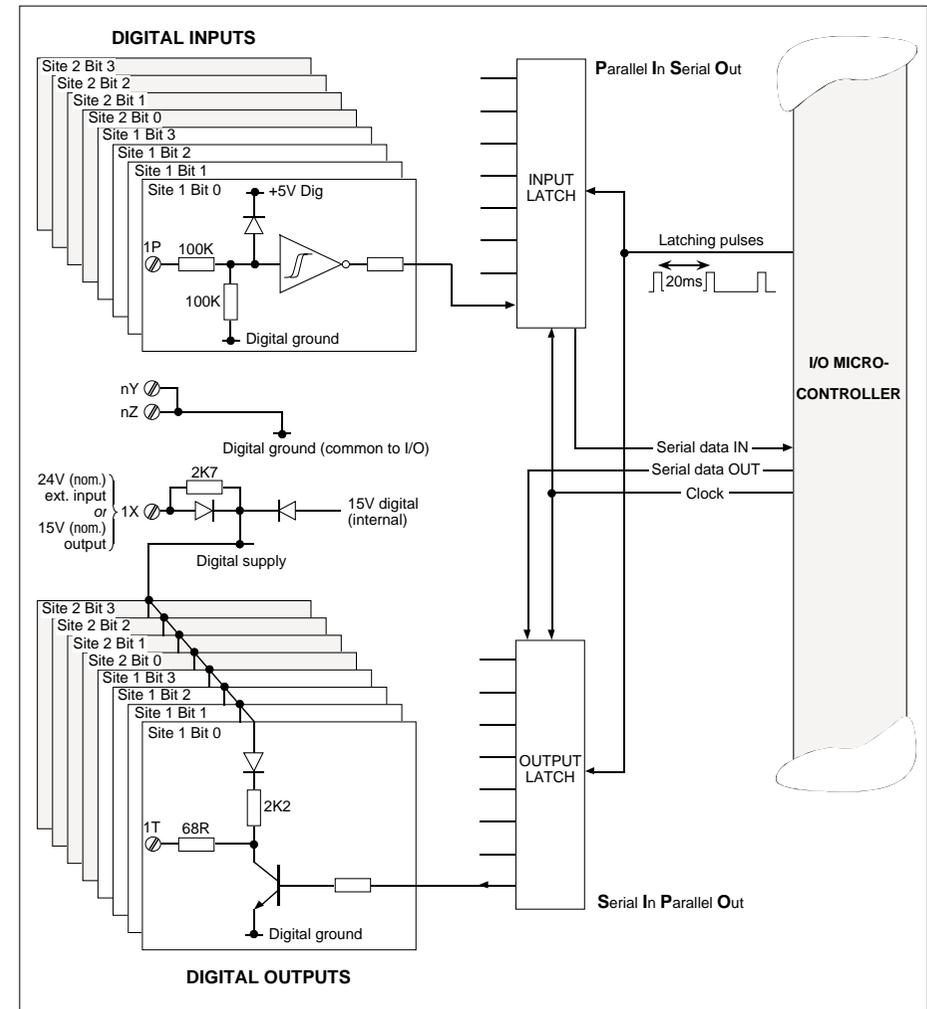


Figure 9-3 Digital input & output block schematic

Gain drift:	30ppm/°C.
Offset drift:	65µV/°C.
Input impedance:	1 M pull-down to -1.2V .
Break detection:	within 1 sample. Protection strategy selected from within the configuration (up-scale, down-scale, etc.).
Isolation:	none.
Sample rate:	9ms per configured input. Only the configured inputs are scanned. The fastest loop update cannot be less than 20ms.

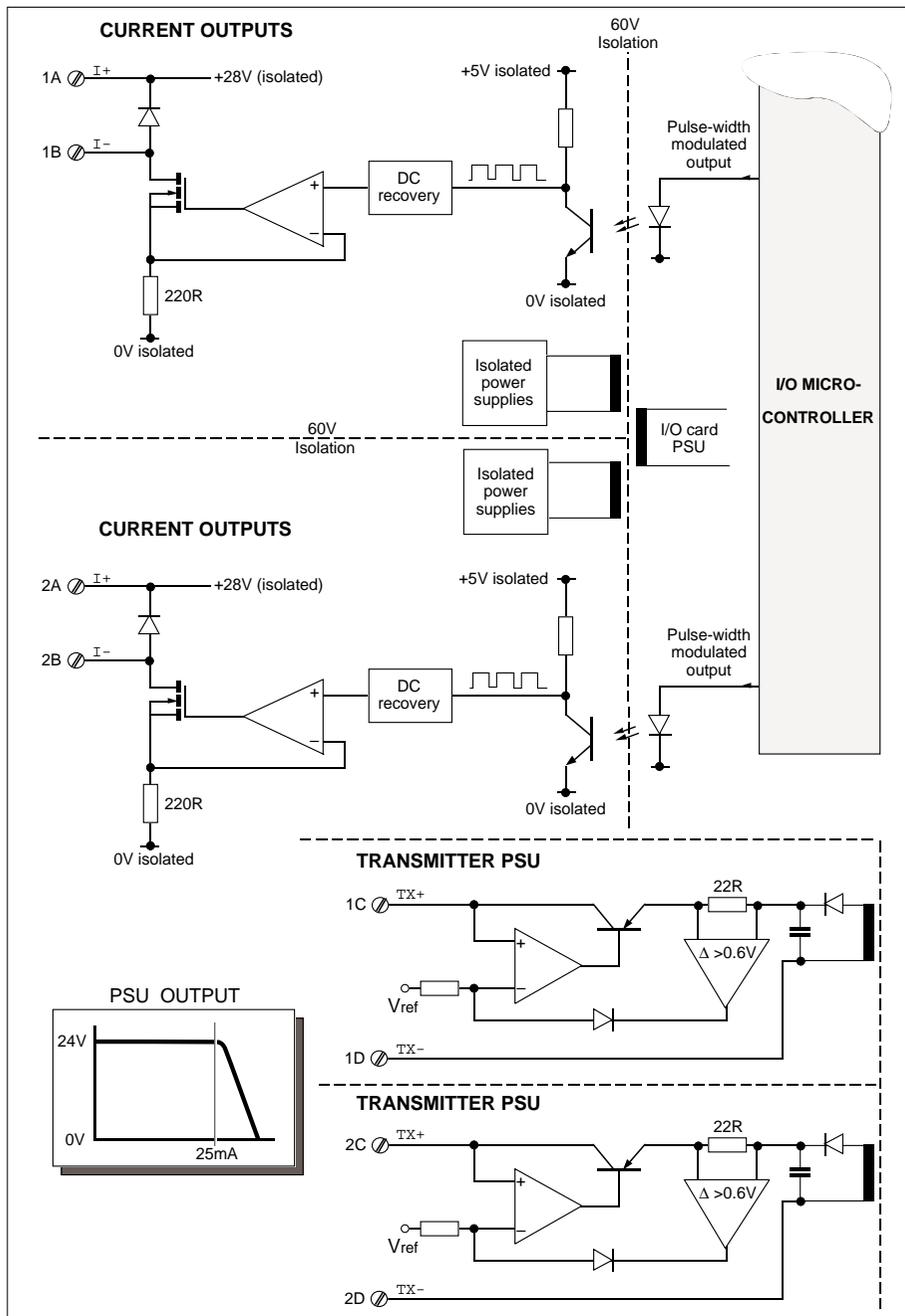


Figure 9-4 Current output & transmitter PSU block schematic

### Internal burden resistors

Values:	HIB option — 250R. HGB option — 62R.
Power:	0.25W.
Tolerance:	0.1%.
Temperature coefficient:	15ppm/°C.

NOTE. Tolerances and temperature coefficients must be added to the specified analogue input tolerances.

### Transmitter power supplies

Channels:	2.
Voltage:	24V $\pm$ 5%.
Current:	0-22 mA.
Current limit:	30mA maximum.
Isolation:	60V ac or dc working.

### Voltage analogue outputs

Channels:	4.
Output range:	0-5 V and 0-10 V, with software-selectable range 0-1.25 V range jumper-selectable (see <i>Input ranges</i> above).
Resolution:	12 bits. (1.25 and 2.5 mV, for the 5 and 10 V ranges resp.)
Accuracy:	0.05% of range.
Gain drift:	30ppm/°C.
Offset drift:	70 $\mu$ V/°C.
Current drive:	$\pm$ 5 mA.
Overload detection:	triggered if the output cannot maintain the desired voltage.
Isolation:	none.

### Current analogue outputs

Channels:	2.
Output range:	0-20 mA. (Rangeable 0-10 mA, 0-20 mA, 4-20 mA etc.)
Over-range:	22mA.
Resolution:	5 $\mu$ A.
Accuracy:	0.1%.
Gain drift:	80ppm/°C.
Offset drift:	0.9 $\mu$ A/°C.
Output drive:	0-1 k .
Isolation:	60V ac or dc working.

## Digital inputs

Channels:	8.
Thresholds:	logic 1: 7.5V minimum logic 0: 2.5V maximum.
Hysteresis:	1.0V minimum, 3.5V maximum.
Input voltage:	28V maximum.
Input impedance:	200k for inputs <10V , 100k for inputs >10V .
Isolation:	none.

## Digital outputs

Channels:	8.
Output levels:	logic 0: 0V logic 1: 15V (14.0V-15.5V internal supply, or external supply).
External supply:	dual function: as input: 15.5V minimum, 28V maximum. as output: 14.0V minimum, 15.5V maximum, ( 7mA) sourced via 2K7 resistor. (Allows hardware pullup of up to 8 digital inputs.)
Drive impedance:	logic 0: 68 , 25mA maximum sink current to maintain logic 0 output level. (37mA absolute maximum sink current.) logic 1: 2.2k .
Isolation:	none.

## General

The environmental, physical, and electrical specifications for this assembly are the same as for the base unit.

## I/O calibration

*Please contact Eurotherm Process Automation if you need to re-calibrate your I/O boards.*

NOTE. In the standard (i.e. non fixed-function) version of the T640 you can re-calibrate I/O boards by installing and running special AI\_CALIB and AO\_CALIB function blocks in the database. Full details are given in the standard T640 Product Manual (Part No. HA 082 468 U999)

### I/O circuits

Figures 9-5 to 9-7 show schematically some ways to use the high-level I/O.

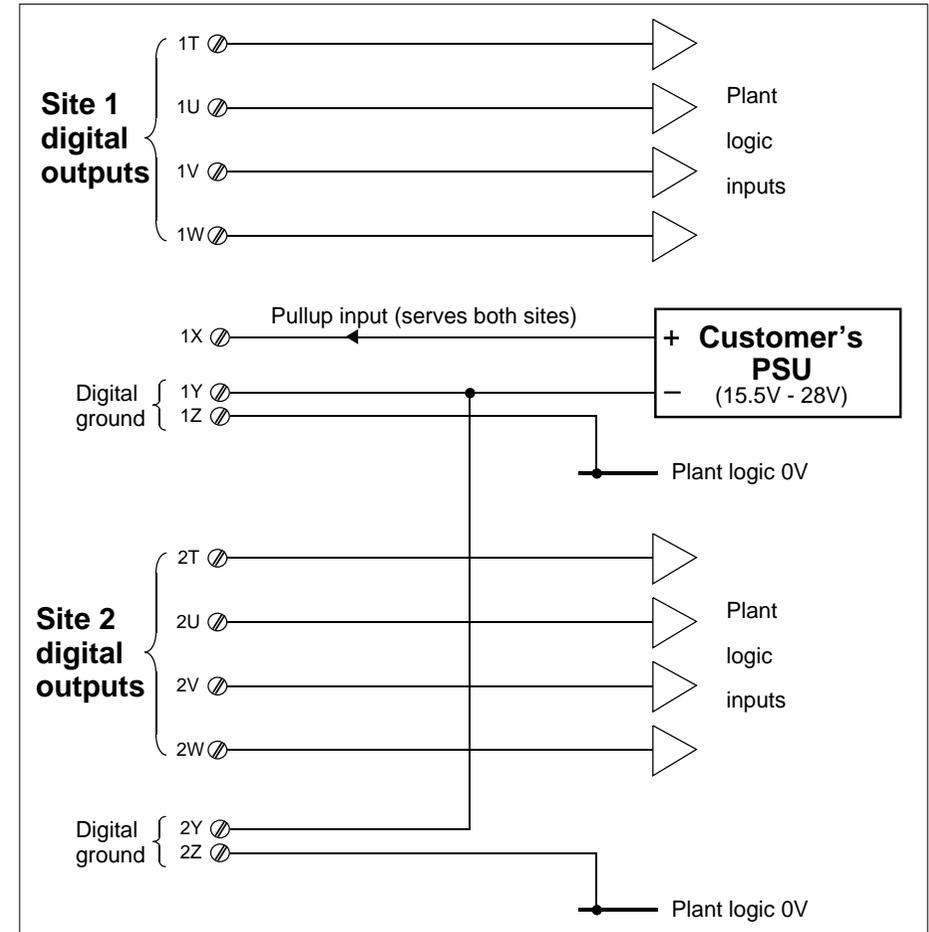


Figure 9-5 Digital outputs driving plant logic using customer's PSU

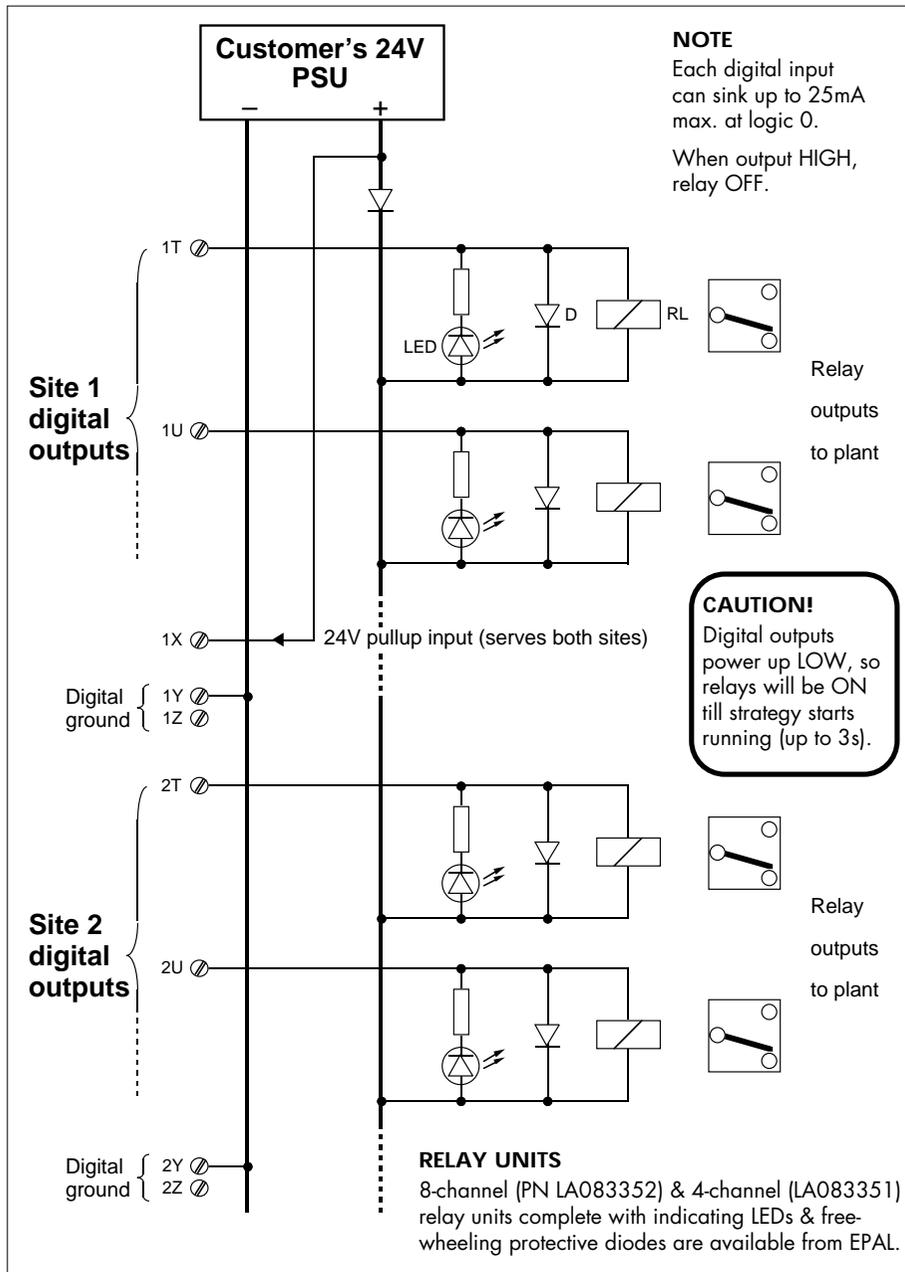


Figure 9-6 Digital outputs operating relays (current sinks) with pullup via customer's PSU

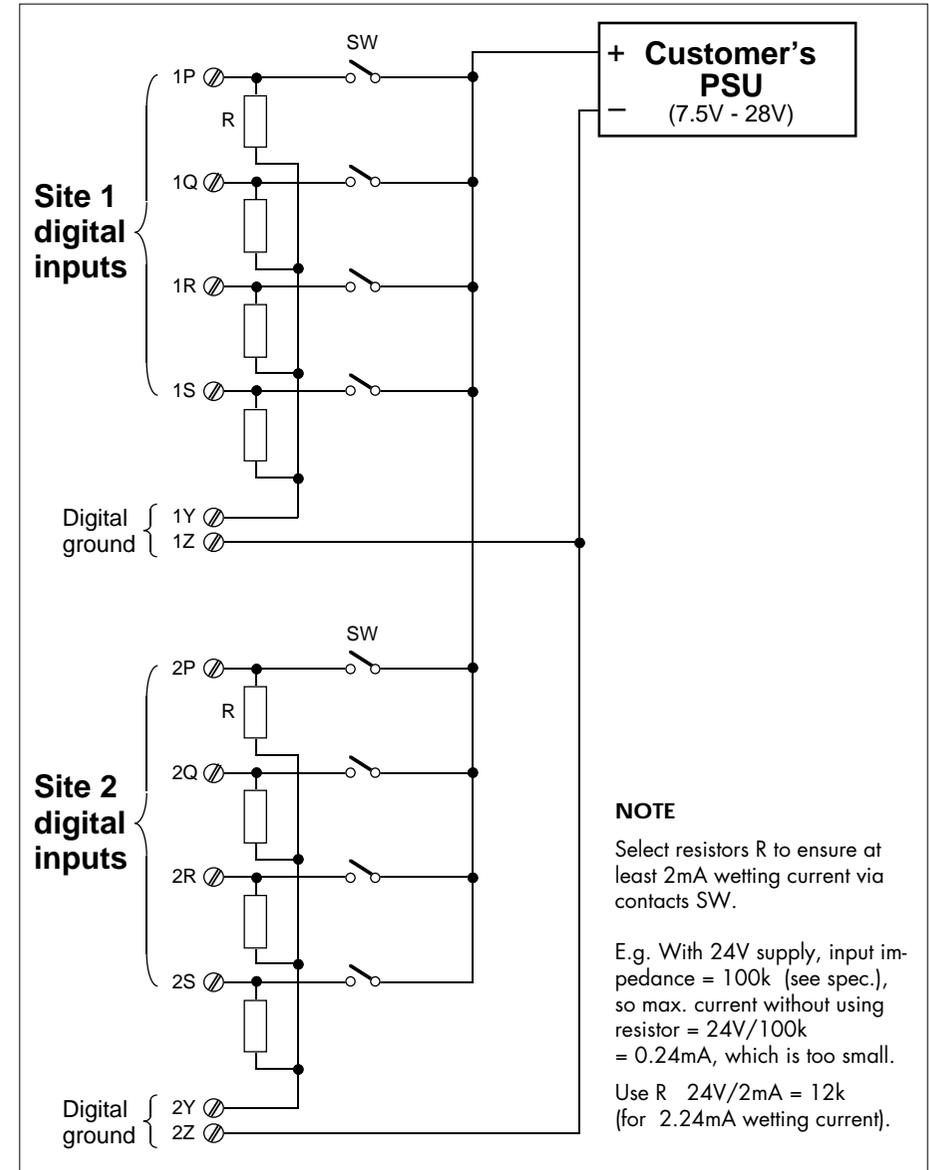


Figure 9-7 Digital input contact-sensing using customer's PSU

## Chapter 10 ORDERING INFORMATION

### ORDERING OPTIONS

The T640 can be ordered as a complete package including sleeve and memory module. The order codes required for this are given in Table 10-1. Sleeves (T710), security keys (T950), memory modules (T901), burden resistor/diode kits, and ALIN terminator kits are separately orderable using the order codes listed in Tables 10-2 to 10-5.

### T640 ORDER CODES

CODE	DESCRIPTION
<b>T640</b>	<b>Base unit</b> Integrated Loop Processor
<b>MAINS DC</b>	<b>Power supply</b> Universal mains 90 to 265 volts ac rms 19 to 55 volts dc power supply
<b>422</b> <b>485</b> <b>ExISB</b> —	<b>Serial communications</b> RS422 Bi-Synch or MODBUS serial communications RS485 MODBUS comms ( <i>Not yet available</i> ) None fitted
<b>HI</b> <b>HG</b> <b>HIB</b> <b>HGB</b>	<b>Site 1 high-level I/O board</b> 0-5V or 0-10V input range automatically selected by database Jumpers set for 0-1.25V fixed input range As HI but with internal burden resistors fitted As HG but with internal burden resistors fitted
<b>HI</b> } <b>HG</b> } <b>HIB</b> } <b>HGB</b> } —	<b>Site 2 high-level I/O expansion board</b> <sup>[1]</sup> Expands board specified in Site 1, but with no burden resistors Expands board specified in Site 1, but with internal burden resistors fitted No board fitted in Site 2
<b>TC</b> <b>RT</b>	<b>Site 1 low-level I/O board</b> <sup>[2]</sup> Thermocouple I/O option ( <i>Not yet available</i> )
<b>TC</b> <b>RT</b>	<b>Site 2 low-level I/O board</b> <sup>[2]</sup> Thermocouple I/O option ( <i>Not yet available</i> )

<sup>[1]</sup>The range specified for Site 2 high-level I/O (**I** or **G** code) must follow that specified for Site 1

<sup>[2]</sup>For standard T640 only; not available for T640-FF version.

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CODE	DESCRIPTION
	<b>Memory module</b>
<b>M001</b>	2-loop Integrated Loop Processor
<b>M002</b>	4-loop Integrated Loop Processor
<b>M003</b>	(Not yet available)
<b>M004</b>	4-loop Integrated Loop Processor with sequencing
<b>M006</b>	Fixed-function Integrated Loop Processor ( <i>High-level I/O only</i> )
—	None fitted
	<b>Sleeve</b>
<b>T710</b>	Supplied in a T710 sleeve
<b>T750</b>	Supplied in a T750 sleeve
—	None supplied
	<b>Calibration certificate</b>
<b>CERT</b>	Calibration certificate supplied
—	None supplied
	<b>Configuration sheet</b>
<b>CONF</b>	Factory-configured to supplied configuration sheet
—	Supplied with I/O settings as specified in the I/O codes
	<b>Labelling language</b>
<b>EN</b>	English
<b>FR</b>	French
<b>GE</b>	German
<b>IT</b>	Italian
<b>SW</b>	Swedish
<b>SP</b>	Spanish
<b>PO</b>	(Not yet available)
<b>CY</b>	(Not yet available)
<b>US</b>	American

Example: T640/MAINS/ — /HI/HI/M001/T710/ — / —/EN

Table 10-1 T640 order codes

**T710 SLEEVE (ORDERED SEPARATELY)**

CODE	DESCRIPTION
	<b>Base unit</b>
<b>T710</b>	DIN sleeve
	<b>Power supply connector assembly</b>
<b>MAINS</b>	Universal mains 90 to 265 volts ac rms
<b>DC</b>	19 to 55 volts dc power supply

continued ...

... continued

CODE	DESCRIPTION
<b>H</b>	<b>Site 1 connector assembly</b> High-level I/O
<b>H</b> —	<b>Site 2 connector assembly</b> High-level I/O [Only if H specified in Site 1] No I/O specified for Site 2
	<b>Labelling language</b>
<b>EN</b>	English
<b>FR</b>	French
<b>GE</b>	German
<b>IT</b>	Italian
<b>SW</b>	Swedish
<b>SP</b>	Spanish
<b>PO</b>	(Not yet available)
<b>CY</b>	(Not yet available)
<b>US</b>	American

Example: T710/DC/H/H/EN

Table 10-2 T710 sleeve order codes

## T950 SECURITY KEY

CODE	DESCRIPTION
<b>T950</b>	<b>Base unit</b> Infrared security key
<b>FULL</b> <b>PARTIAL</b>	<b>Access</b> Full access to all parameters provided Partial access to parameters provided
<b>AREA n</b> —	<b>Area</b> Key operates only instruments with specified area code n, or zero area code. [ <i>n</i> = 1 to 8] Key operates only instruments with zero area code
	<b>Labelling language</b>
<b>EN</b>	English
<b>FR</b>	French
<b>GE</b>	German
<b>IT</b>	Italian
<b>SW</b>	Swedish
<b>SP</b>	Spanish
<b>PO</b>	(Not yet available)
<b>CY</b>	(Not yet available)
<b>US</b>	American

Example: T950/PARTIAL/AREA 3/EN

Table 10-3 T950 security key order codes

**T901 MEMORY MODULE (ORDERED SEPARATELY)**

CODE	DESCRIPTION
<b>T901</b>	<b>Base unit</b> Memory module
<b>M001</b>	<b>Controller function</b> 2-loop control
<b>M002</b>	4-loop control
<b>M003</b>	<i>(Not yet available)</i>
<b>M004</b>	4-loop control with sequencing
<b>M006</b>	Fixed-function Integrated Loop Processor
<b>EN</b>	<b>Labelling language</b> English
<b>FR</b>	French
<b>GE</b>	German
<b>IT</b>	Italian
<b>SW</b>	Swedish
<b>SP</b>	Spanish
<b>PO</b>	<i>(Not yet available)</i>
<b>CY</b>	<i>(Not yet available)</i>
<b>US</b>	American

Example: T901/M001/EN

Table 10-4 T901 memory module order codes

**BURDEN RESISTOR/DIODE & ALIN TERMINATOR KITS**

Encapsulated plug-in modules for insertion in T640's rear-panel customer screw terminals are orderable using the codes listed in Table 10-5. Burden resistors, burden diodes, and ALIN terminating resistors are available.

CODE	DESCRIPTION
<b>LA 082 728</b>	<b>High-level mA kit</b> 4-off double 250R burden resistor plug-in modules 2-off burden diode plug-in modules
<b>LA 082 729</b>	<b>ALIN terminator kit</b> 2-off 82R terminating resistor plug-in modules

Table 10-5 Rear-panel plug-in module kits

**Symbols**

.DBF file ..... 5-1  
.FFn ..... 5-1  
.GWF filename extension ..... 2-22  
.Lnn ..... 6-1  
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Antistatic bag ..... 2-7  
ARCNET ..... 7-3  
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Bargraph span ..... 4-2  
Bargraphs ..... 3-7  
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Battery replacement ..... 4-10  
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