TP488-TC

Thermocouple Scanning Monitor

Operation and Instruction Manual

Table of Contents

1   Introduction

This manual contains information for the installation and operation of the TP488-TC eight input scanning monitor. The TP488-TC can accept up to eight thermocouple or 0-75mV inputs. Each input is fully isolated from the other inputs (to prevent ground loop problems). Eight independently programmable relay outputs provide alarm or control for each input.

The TP488 monitors are designed for applications where good visibility is important. Large high intensity 20mm red LEDs provide a wide viewing angle and distance for the display. The display has been designed to be wall mounted and may be panel mounted if required. Each input may be independently calibrated/scaled to display temperature from any combination of eight thermocouple types. An additional digit indicates the currently displayed channel number. Large front panel pushbutton keypads are used to configure the operation of the instrument. Easy to follow "on display" messages assist in setting up of the instrument functions.

The cold junction temperature can be read on the display by changing the channel using the ▲ or ▼ buttons until the channel indicator shows C instead of a channel number, the cold junction reading is only accessible when the TP488 has been powered up in CAL mode, see "Setting up the instrument" chapter.

Standard Features:

1.   4 + 1 Digit 20mm high intensity LED Display.
2.   Pushbutton programming and calibration.
3.   Eight Relay outputs (assignable to one or more channel).
4.   Accepts thermocouple types B, E, J, K, N, R, S and T or 0-75mV
5.   Programmable beeper for each alarm.
6.   Individual calibration for each input.
7.   °C or °F selection.
8.   Programmable decimal point.
9.   Weatherproof IP65 Enclosure.
10. Alarm/relay annunciator LEDs.
11. Programmable Digital Filter.
12. Leading Zero Blanking.
13. Programmable scan rate and may be locked to one input.
14. Alarm annunciator, accepts alarm.
15. On board expansion connections for optional outputs.

Description

The instrument accepts inputs from up to eight thermocouple temperature sensors or direct 0-75mV inputs. Each channel can be allocated different input types if required. The required number of inputs is entered into the set up program - to limit the cycling display range. For example if the instrument is required to measure only 6 inputs the display will cycle from 1 to 6, input 7 and 8 will not be displayed. Note: in applications where some inputs are unused the relays normally applied to the unused inputs are automatically assigned to the last i.e. highest input channel.

Technical Description

The instrument consists of 2 printed circuit boards (PCBs), comprising the main PCB and the display PCB. If options such as retransmission are fitted then there may also be and option board which connects to the main pcb.
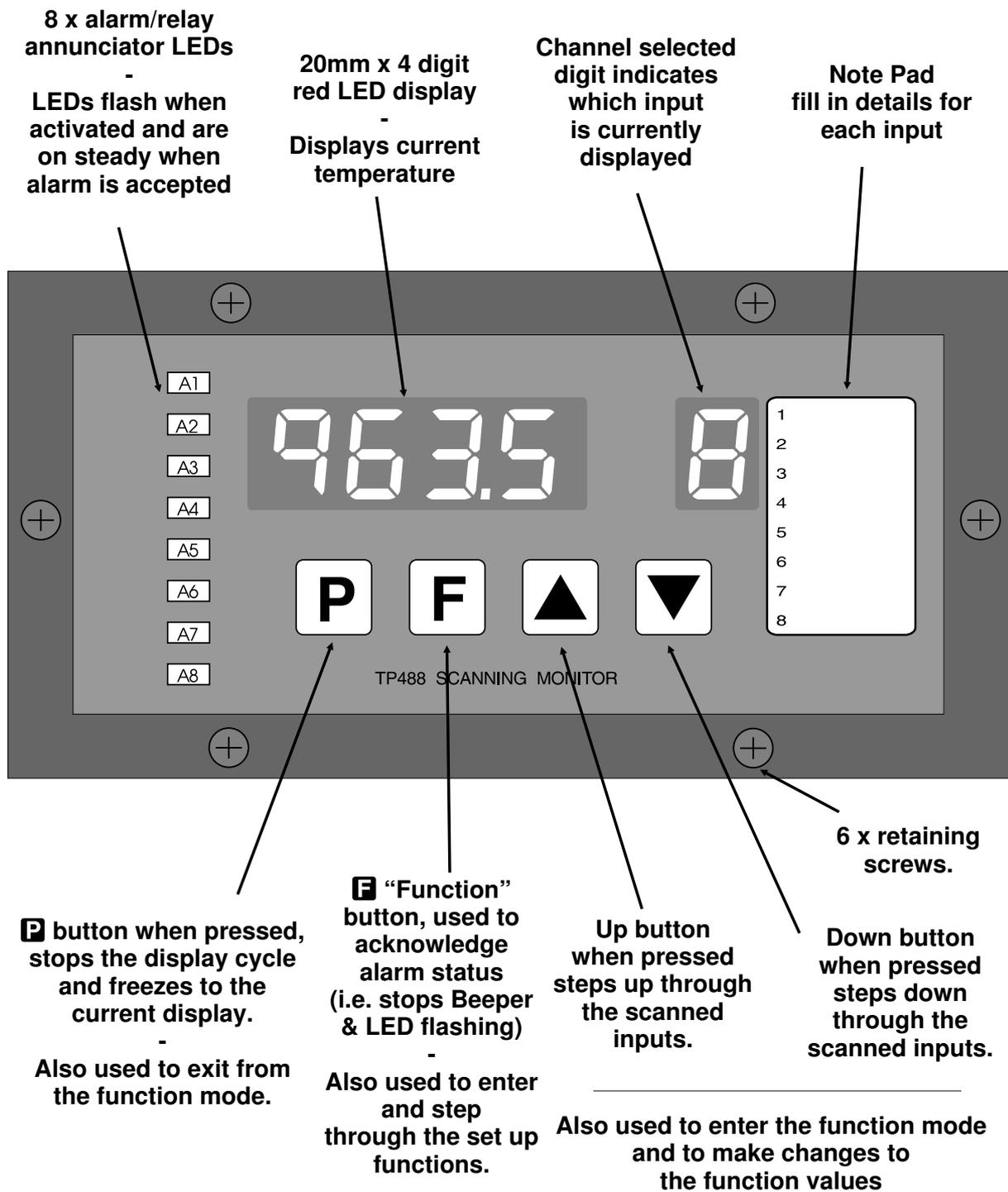
Main PCB

The main PCB contains the terminal connectors, signal conditioning, relay outputs, power supply, a high performance A/D converter and a single chip microprocessor. The full scale display resolution is 9999 to -1999. The main PCB is securely mounted within the enclosure on rigid mounting pillars.

Display Board

The display board contains the pushbutton switches, display driver electronics and the seven segment LED displays. The display board is securely mounted to the rear of the instrument face plate. Unless otherwise specified at the time of your order, your TP488 has been factory set to a standard configuration. The configuration and calibration is easily changed by the user.
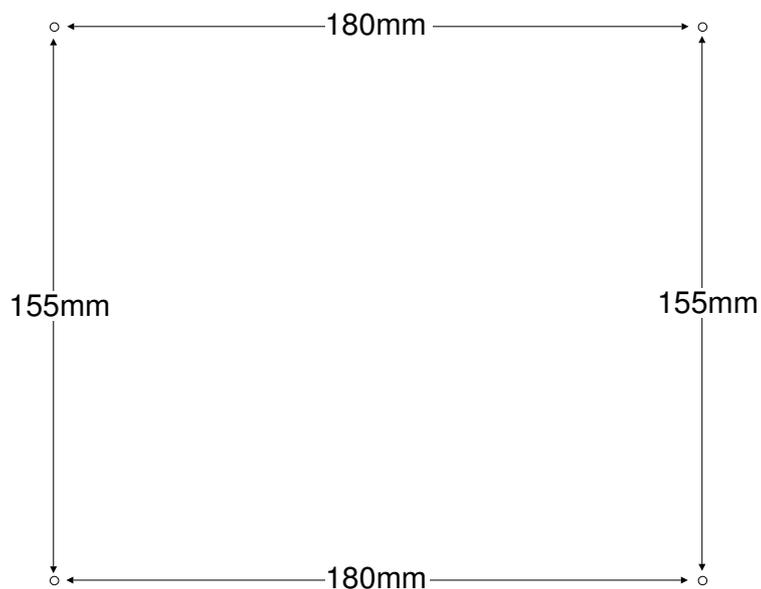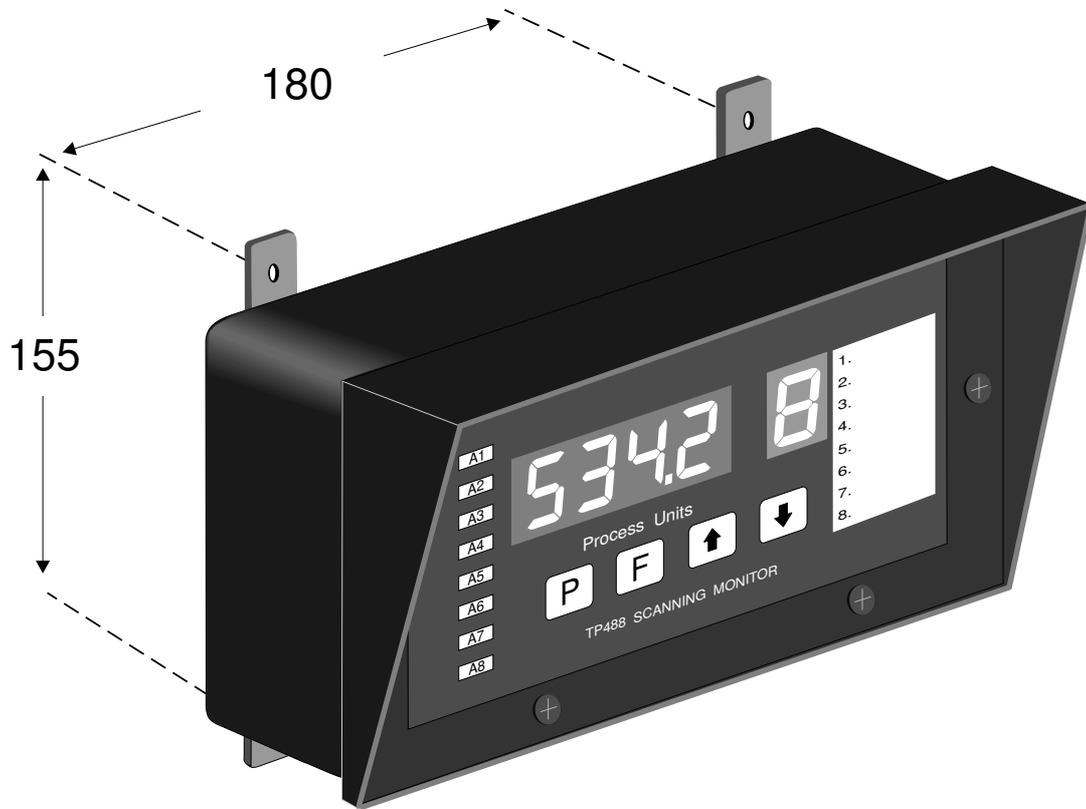
2   Front Panel Description

8 x alarm/relay annunciator LEDs
-
LEDs flash when activated and are on steady when alarm is accepted

20mm x 4 digit red LED display
-
Displays current temperature

Channel selected digit indicates which input is currently displayed

Note Pad fill in details for each input

A1
A2
A3
A4
A5
A6
A7
A8

963.5

8

1
2
3
4
5
6
7
8

P F ▲ ▼

TP488 SCANNING MONITOR

6 x retaining screws.

P button when pressed, stops the display cycle and freezes to the current display.
-
Also used to exit from the function mode.

F "Function" button, used to acknowledge alarm status (i.e. stops Beeper & LED flashing)
-
Also used to enter and step through the set up functions.

Up button when pressed steps up through the scanned inputs.

Down button when pressed steps down through the scanned inputs.

Also used to enter the function mode and to make changes to the function values
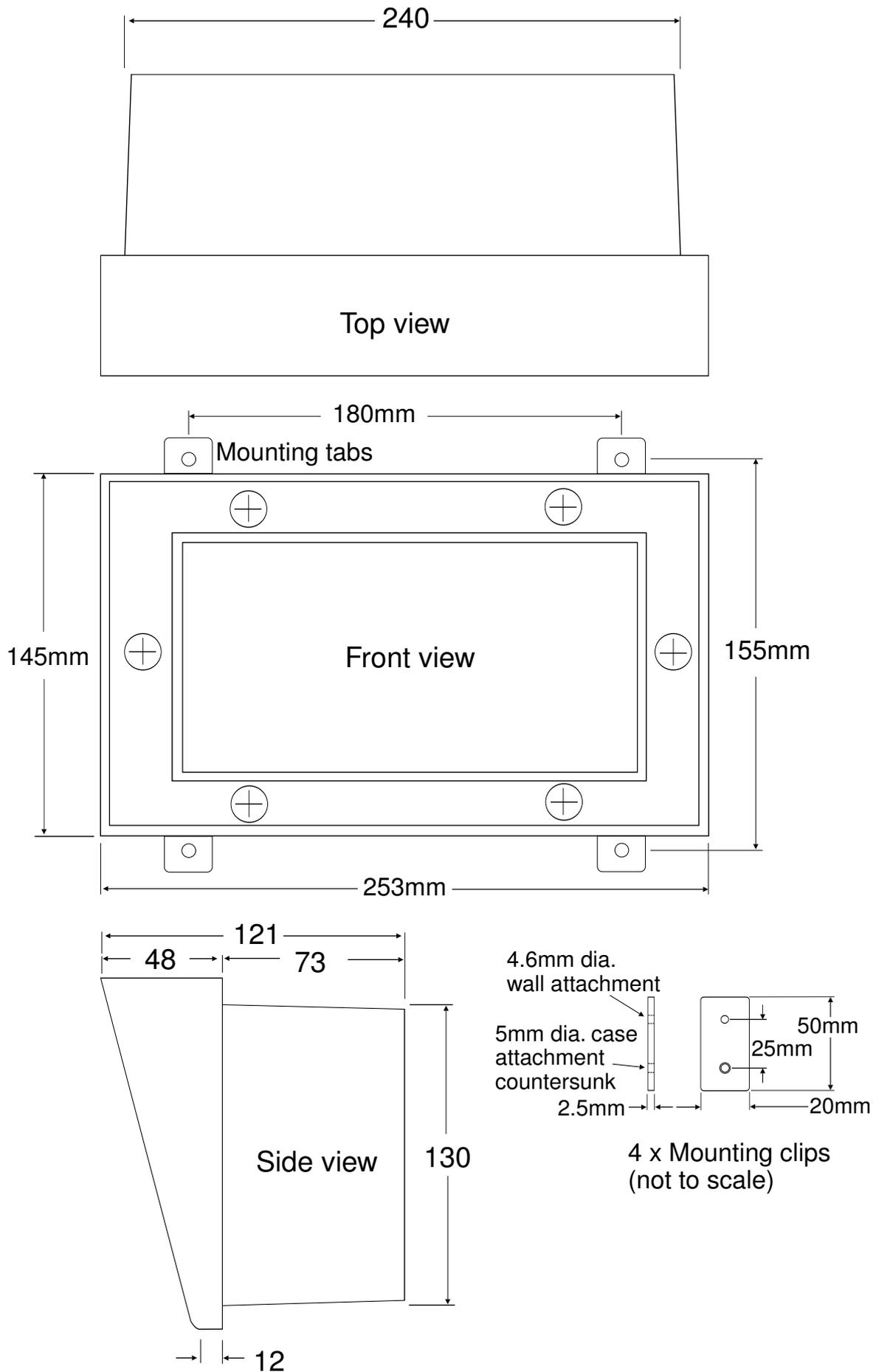
TO ENTER SETUP MODE
First select the input you wish to make changes to (using the up or down button), then press the F button and then (within 2 seconds) press both the up and down buttons simultaneously.
(see also calibration for entering special calibration mode)

3   Mechanical Installation

The instrument is designed to be wall mounted. Carefully measure and drill 4 x mounting holes (max 5mm) as shown below.

4   Mechanical Dimensions

240

Top view

180mm

Mounting tabs

145mm

Front view

155mm

253mm

121

48

73

4.6mm dia.
wall attachment

5mm dia. case
attachment
countersunk

2.5mm

50mm

25mm

20mm

Side view

130

12

4 x Mounting clips
(not to scale)

5   Electrical Installation

The TP488 series displays are designed for continuous operation and therefore no mains/power switch is fitted to the unit. It is recommended that an external switch and fuse be provided to allow the unit to be removed for servicing.

To install cables remove six (6) front panel retaining screws. Remove front panel taking care not to damage the ribbon cable (ribbon cable joins the front display circuit board to the main circuit board). Connect power and input cables to the plug in terminal blocks located within the enclosure. The terminals are clearly labeled and unplug for ease of installation, please take care to connect them correctly. The terminal blocks allow for wires of up to 2.5mm^2 to be fitted.

When power is applied the instrument will cycle through a display sequence, indicating the software version and other status information, this indicates that the instrument is functioning. This manual also contains details for setting up and calibrating the instrument.
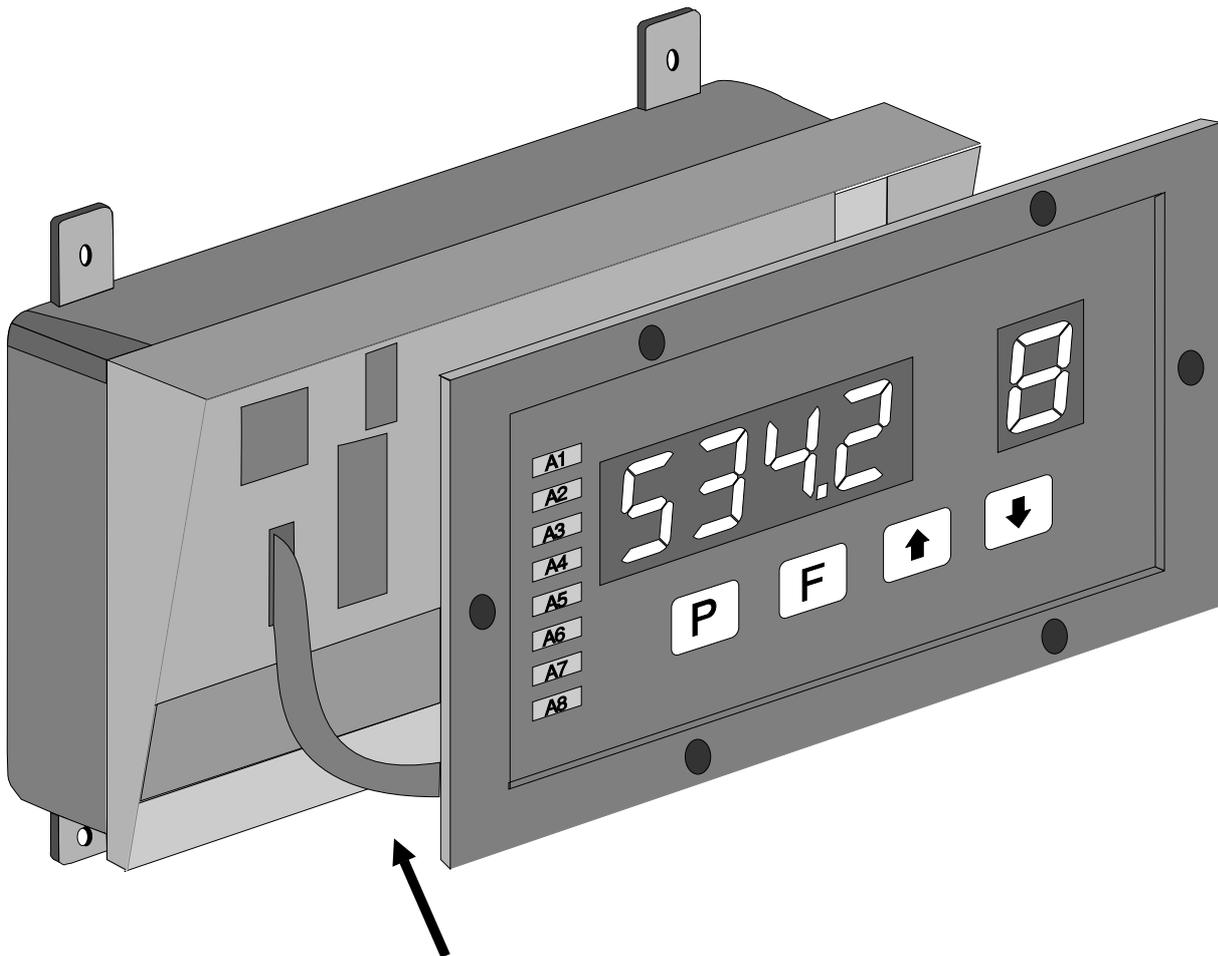
Take care not to damage ribbon cable.
Cable may be unplugged to separate
front panel during installation.

5.1   Printed Circuit Board Layout:

     The circuit board layout shown below shows the location of the plug-in terminal connectors. Relay contacts are voltage free, form A type, i.e. 2 contact normally open. For input configuration and connections see chapter on "Input connections".

   Placing DIP switch 1 the "ON" position will remove access via **FUNC** mode to the set up and calibration functions, thus providing security for the existing settings. To gain access to these functions again place DIP switch 1 in the "OFF" position Irrespective of switch 1 position access to all functions can still be made if the intrument is powered up in **CAL** mode.
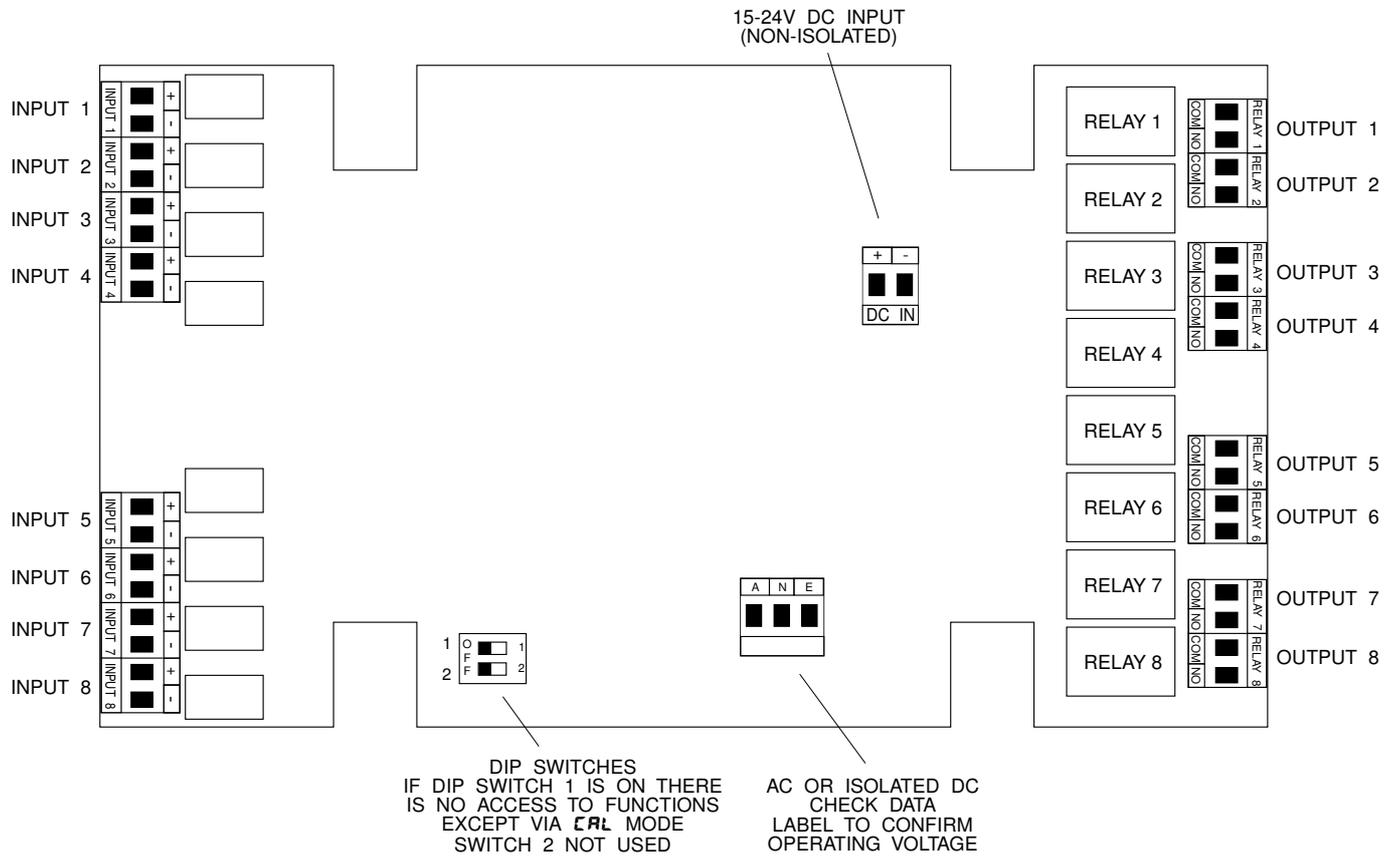
Main Printed Circuit Board

6   Input connections

The TP488-TC is designed to accept combinations of 8 thermocouple types (B, E, J, K, N, R, S & T) or 0-75mV input. The input type is selected at the **ᴸ ⅃Pᴲ** function.
Connect each input as shown below:

Printed circuit board
showing input connections
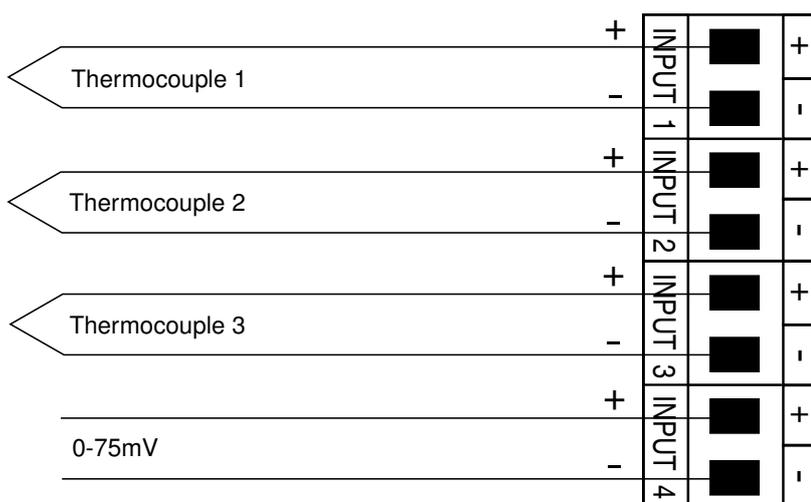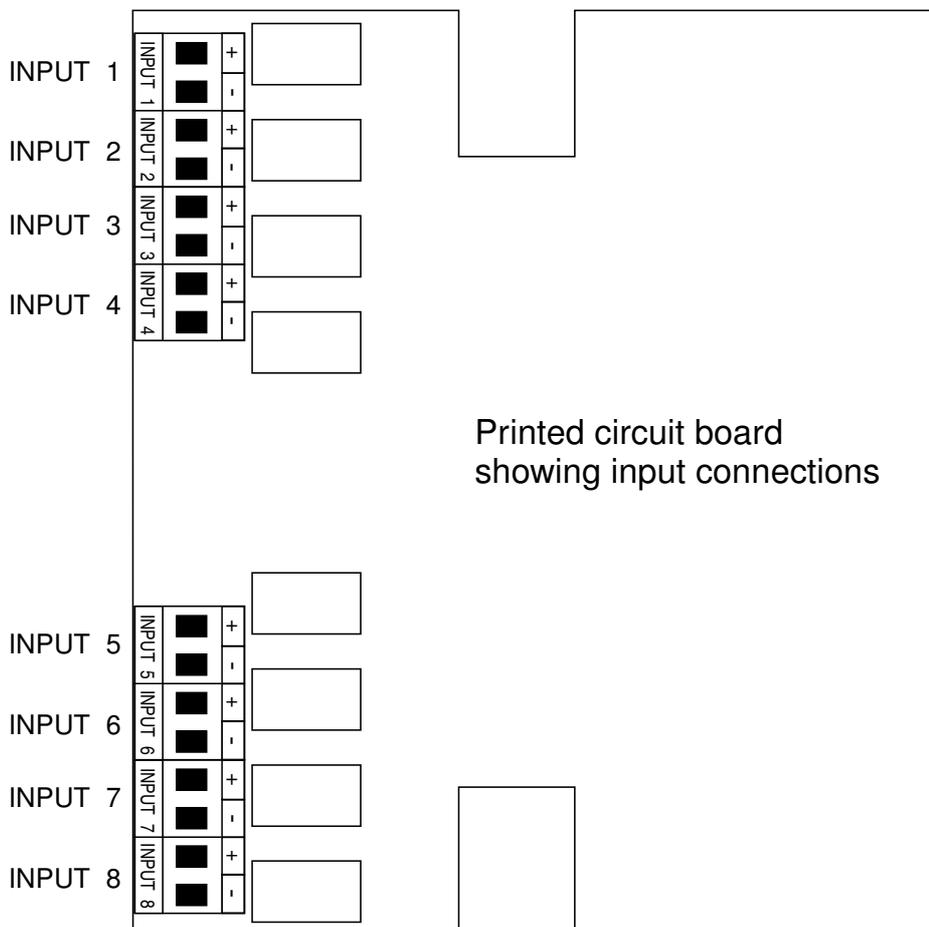
Example: 3 x thermocouples connected to inputs 1, 2, & 3.
0-75mV input on input channel 4.

7   Setting up the Instrument

The TP488 setup and calibration functions are configured through a push button sequence. Two levels of access are provided for setting up and calibrating:-

FUNC (function) mode (simple push button sequence) allows access to commonly set up functions such as alarm setpoints.

CAL mode (power up sequence plus push button sequence) allows access to all functions including calibration parameters.

The **F** , **▲** and **▼** push buttons located on the front panel are used to alter settings. Once you have entered either **CAL** or **FUNC** mode, you step through the functions, by pressing and releasing the **F** push button, until the required function is reached. In most cases the function name e.g. **FLtr** will be followed by the setting for that function e.g. **3**. Changes to function settings are made by pressing the **▲** or **▼** push button when the required function is reached. Changes to a function setting will only be saved if the **F** button is pressed following the change. Some functions require that the **▲** and **▼** buttons are pressed simultaneously before access is given to the settings. See the flow chart on the following page for examples.

The front panel **P** button may be used to exit the function mode at any time and will abort the function currently displayed without accepting any changes to that function. This is useful for quickly exiting the function mode and as a means preventing unwanted changes to the functions.

Entering **CAL** Mode

1. Remove power from the instrument. Hold in the **F** button and reapply power. The display will indicate **CAL** as part of the "wake up messages" when the **CAL** message is seen you can release the **F** button. Now move to step 2 below.

2. When the "wake up" messages have finished and the display has settled down to its normal reading select the channel you want to set up or calibrate then press then release the **F** button. Now move to step 3 below.

3. Within 2 seconds of releasing the **F** button press, then release the **▲** and **▼** buttons together. The display will now indicate show the first function. You are now in the function mode but with access to calibration functions.

Entering **FUNC** Mode

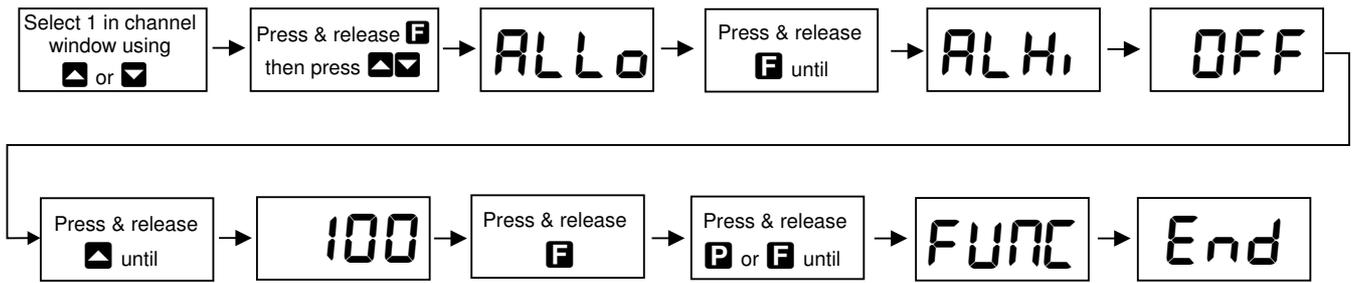No special power up procedure is needed to enter **FUNC** mode.

1. When the "wake up" messages have finished and the display has settled down to its normal reading press, then release the **F** button. Now move to step 2 below.

2. Within 2 seconds of releasing the **F** button press, then release the **▲** and **▼** buttons together. The display will now show the first function.

Example: Entering **FUNC** mode to change relay 1 high function **ALHi** from **OFF** to **100**

Select 1 in channel window using ▲ or ▼ → Press & release **F** then press ▲▼ → | **ALLo** | → Press & release **F** until → | **ALHi** | → | **OFF** |

→ Press & release ▲ until → | **100** | → Press & release **F** → Press & release **P** or **F** until → | **FUNC** | → | **End** |

Example: Entering **CAL** mode to change channel 1 decimal point **dCPt** function from **0** to **0.1**

Switch off instrument → Press & hold **F** → Switch on instrument → Hold **F** until → | **CAL** | → Release **F**

→ Select 1 in channel window using ▲ or ▼ → Press & release **F** then press ▲▼ → | **ALLo** | → Press & release **F** until → | **dCPt** | → | **0** |

→ Press & release ▲ until → | **0.1** | → Press & release **F** → Press & release **P** or **F** until → | **FUNC** | → | **End** |
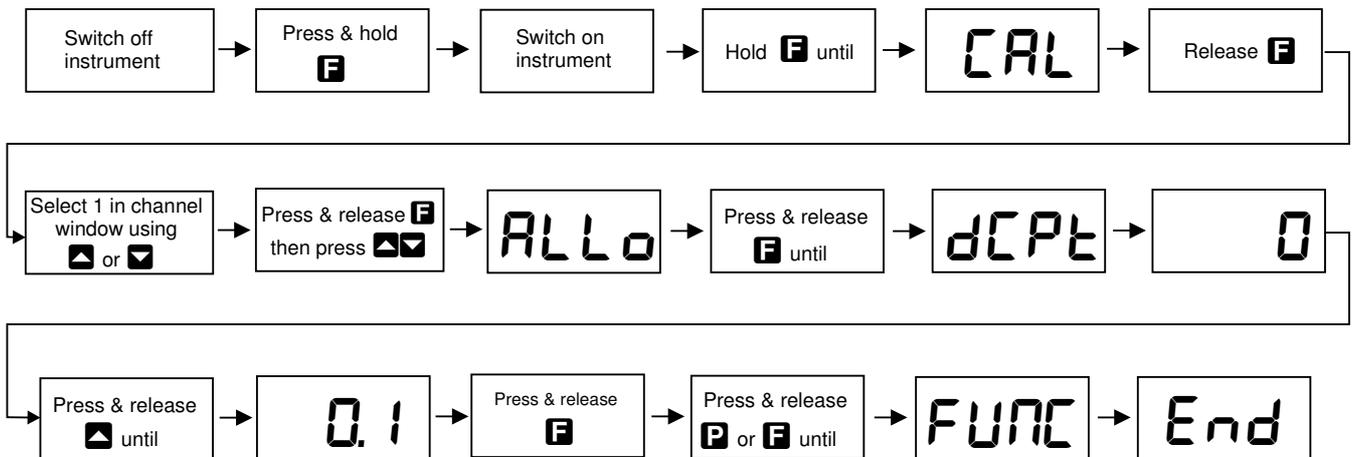
8   Alarm Relays

The TP488 is provided with 8 alarm/setpoint relays, each is rated at 5A, 240VAC into a resistive load. The basic settings for the alarm relays are described below, the three coices of opreating modes (**5n9L**, **5LCE** and **5EL.A**) for these relays are described later in this chapter.

Each relay has the following parameters which may be set by the user:

1.   Low setpoint, adjustable in measurement units.
2.   High setpoint, adjustable in measurement units.
3.   Relay hysteresis, adjustable in measurement units.
4.   Relay trip time, adjustable in seconds.
5.   Relay reset time, adjustable in seconds.
6.   Relay action N/O or N/C.
7.   Setpoint relay mode, auto or latching - with or without beeper.
8.   Allocate alarm to input channel, allows channels in use to be allocated to any alarm relay when in select mode operation.
9.   Alarm mode selection, allows selection of single or select (multi) mode operation.
10. Alarm override via **F.rLY** function.

Notes:

*   The required relay must be selected using the ▲ or ▼ buttons, prior to making changes to the relay functions. In **5n9L** & **5LCE** modes the right hand display digit which normally shows the channel number actually represents the relay number for alarm setup purposes e.g. if **ALLo 2** is seen on the display then the low alarm setpoint for relay 2 is being viewed. In **5EL.A** mode the same display of would mean that the low alarm setpoint for channel 2 is being viewed.

*   In applications where less than eight channels are used, the unused relays are assigned to the highest channel if in **5n9L** mode.

*   The **F** button is used as an alarm reset (see **F.rLY** function) or alarm acknowledge button.

*   When alarm selection is in **5LCE** or **5EL.A** mode the decimal point places must be the same for each channel, the decimal points for each channel will automatically be made the same when "select" alarm mode **5LCE** or **5EL.A** is used.

*   In **5N9L** and **5LCE** alarm modes the alarm annunciator LEDs on the front panel indicate which alarm relay is activated, not which channel caused the activation. In **5EL.A** mode the annunciator indicates which channel has caused the alarm relay operation.

The setpoint relays operate in the following way:

If the measured value is above the high setpoint (**ALHi**) or below the low setpoint (**ALLo**) the alarm trip timer (set via **ALEE**) starts. This timer is reset if the measured value drops below the high setpoint or above the low setpoint. When the duration of the alarm condition exceeds the trip delay time, the alarm is operated. The alarm LED flashes, the setpoint relay is activated, and optionally the beeper sounds.

When the alarm has tripped, the measured value is compared to the high setpoint less the hysteresis value and the low setpoint plus the hysteresis value. If it is less than the high setpoint less the hysteresis value and greater than the low setpoint plus the hysteresis value the setpoint reset relay timer (set via **ALrE**) is started. This timer is reset if the displayed value exceeds the high setpoint less the hysteresis value or drops below the low setpoint plus the hysteresis value. When the time the input has been out of alarm condition exceeds the reset delay time the relay is de-activated. If the setpoint is in automatic mode the LED is extinguished and the relay returns to its position, and the Beeper is silenced. If the setpoint is in latched mode, press the **F** Button to reset the alarm.

By pressing the **F** button the alarm is acknowledged. This silences the beeper, and stops the LED flashing. When the alarm is reset the LED extinguishes and the relay returns to its position.

The **F.rLY** function can be individually set for each relay. This function allows the relay to be reset by pressing the F button even if an alarm condition still exists.

The alarm programmable functions operate as follows:

Alarm Low Setpoint (ALLO)

The low setpoint may be programmed to operate the alarm relay when the measured value falls below the set value. If the low setpoint is not required, it may be set to OFF in the setup mode (press ▲ and ▼ simultaneously to set the alarm to OFF). The instrument is configurable for each relay to have a low and a high setpoint, so the relay may be triggered if the reading deviates outside of the setpoint limits.

Alarm High Setpoint (ALHi)

The high setpoint may be programmed to operate the alarm relay when the measured value exceeds the set value. If the high setpoint is not required, it may be set to OFF in the setup mode (press ▲ and ▼ simultaneously to set the alarm to OFF). Note: an open circuit display (OPEN) on a channel will cause the relay allocated to that channel to activate if a high setpoint has been set for that relay. i.e. an open circuit it treated as a high alarm condition.

Alarm Hysteresis (ALHY)

The hysteresis value is used to prevent too frequent operation of the alarm relay when the measured value stays close to the setpoint. The hysteresis value is common to the high and low relay action for each alarm. Without a hysteresis setting (hysteresis value set to zero) the alarm will activate when the display value goes above the alarm setpoint (for high alarm) and will reset when the display value falls below the setpoint, this can result in repeated on/off switching of the relay at around the setpoint value. The hysteresis setting operates as follows:
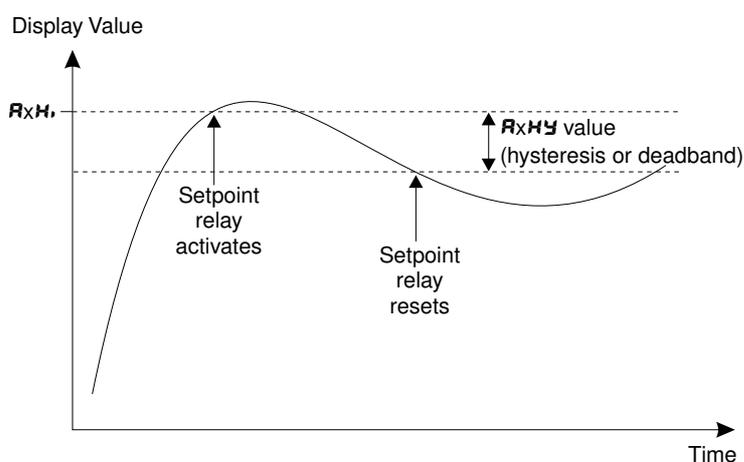
In the high alarm mode, once the alarm is activated the input must fall below the setpoint value minus the hysteresis value to reset the alarm.

e.g. if alarm high value is set to 50.0 and the hysteresis is set to 3.0 then the setpoint output relay will activate once the display value goes above 50.0 and will reset when the display value goes below 47.0 (50.0 minus 3.0).

In the low alarm mode, once the alarm is activated the input must rise above the setpoint value plus the hysteresis value to reset the alarm.
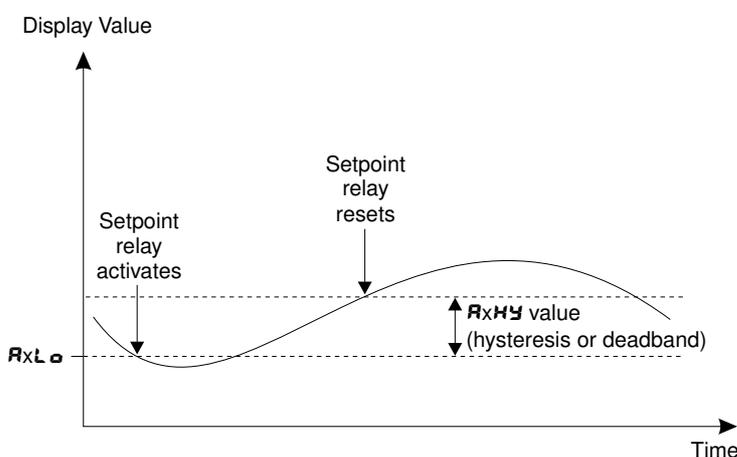
e.g. if alarm low value is set to 20.0 and the hysteresis is set to 10.0 then the alarm output relay will activate when the display value falls below 20.0 and will reset when the display value goes above 30.0 (20.0 plus 10.0).

The hysteresis units are expressed in displayed engineering units.

Alarm Trip Time (ALtt)

The alarm trip time determines how long the measured value has to be above the high trip point or below the low trip point before an alarm is given. This can be used to prevent false alarms on noisy inputs. The value is set in seconds, with a range of 0 - 9999 seconds.

Alarm Reset Time (ALrt)

The alarm reset time determines how long the measured value has to be below the high trip point and above the low trip point before the alarm is reset. This value is set in seconds, with a range of 0 -

9999 seconds. For operation a reset delay of zero is suitable.

Alarm Relay N/O or N/C Operation (ALn.o/n.c)

Each alarm may be programmed to operate as a normally open (N/O) or normally closed (N/C) device. A N/O relay is de-energised when no alarm condition is present and is energised when an alarm condition is present. A N/C relay is normally energised and is de-energised when an alarm condition is present. The N/C mode is useful for power failure detection.

Setpoint Relay Mode

The alarm has four modes of operation:
Anb: Automatic reset, no beeper.
Lnb: Latched alarm, manual reset, no beeper.
AbP: Automatic reset, beeper.
LbP: Latched alarm, manual reset, beeper.

Automatic Reset, with Beeper:

When automatic mode is selected, the relay will automatically reset when the measured input falls within the alarm threshold limits as described above. The beeper is silenced and the LED stops flashing.

If the **F** button is pressed before the measured input falls within the alarm threshold limits, the beeper will be silenced, and the LED will stop flashing, and become constantly illuminated.

Automatic Reset, no Beeper:

This mode is the same as above, except the beeper is not activated. This mode is ideal for control applications.

Latched Alarm, Manual Reset, with beeper:

When latched mode is selected the alarm is latched until the **F** button is pressed.

If the **F** button is pressed before the measured input has returned to non alarm values, the LED stops flashing, staying on steadily, the beeper is silenced. When the measured input has returned to non alarm values the LED is extinguished and the relay reset.

If the measure input has returned to non alarm value levels before the alarm is reset, pressing the alarm reset button immediately extinguished the LED, silences the beeper and resets the relay.

Latched Reset, no Beeper:

This mode is the same as above, except the beeper is not activated.

Relay reset (F.rLY)

When setup to operate in this mode any relay which is activated can be de-activated, i.e. the alarm condition overridden, simply by pressing the **F** button. The front panel annunciator LED will indicate which channel (not necessarily the relay number) which has caused the relay activation. Prior to being reset the annunciator LED for the channel which caused the relay activation will flash, when reset then annunciator LED will extinguish even if this channel is still in an alarm condition.

To allow operation in this mode the F.rLY function must be set to on for the relays required. Any relays with F.rLY set to OFF cannot be reset via the **F** button. If the **F** button is pressed to acknowledge an alarm condition on a relay with F.rLY set to OFF then the annunciator LED for that relay will change from a flashing LED to a solidly lit LED. The LED will remain lit whilst an alarm condition exists for that relay.

Alarm Relay Operating Modes (A.tYP)

The alarms relays operate in two basic modes with three choices, namely "single" (SnGl) mode and "select" (SLCt or SEL.A) modes. In single SnGl mode each relay is assigned to its corresponding channel i.e. relay 1 is assigned to input 1, relay 2 to input 2 etc. In select mode SLCt relays may be assigned to any channel, in SEL.A mode the channel itself is allocated the setpoint and then the relay is allocated to the channel.

Single Mode

In single mode each alarm relay is activated by the input at its corresponding channel, thus alarm relay 1 is assigned to input channel 1 etc. To choose single mode select SnGl at the A.tYP function. The A.tYP function is accessible only when the functions are entered via CAL mode. To set up the

alarm setpoints and other functions simply select the required relay (selected at the channel number display) and step to the required function using the **F** button, then alter the alarm setting required using the **▲** or **▼** button. Press the **F** button to accept the changes.

Input Channel 1	Input Channel 2	Input Channel 3	Input Channel 4	Input Channel 5	Input Channel 6	Input Channel 7	Input Channel 8
Alarm 1	Alarm 2	Alarm 3	Alarm 4	Alarm 5	Alarm 6	Alarm 7	Alarm 8
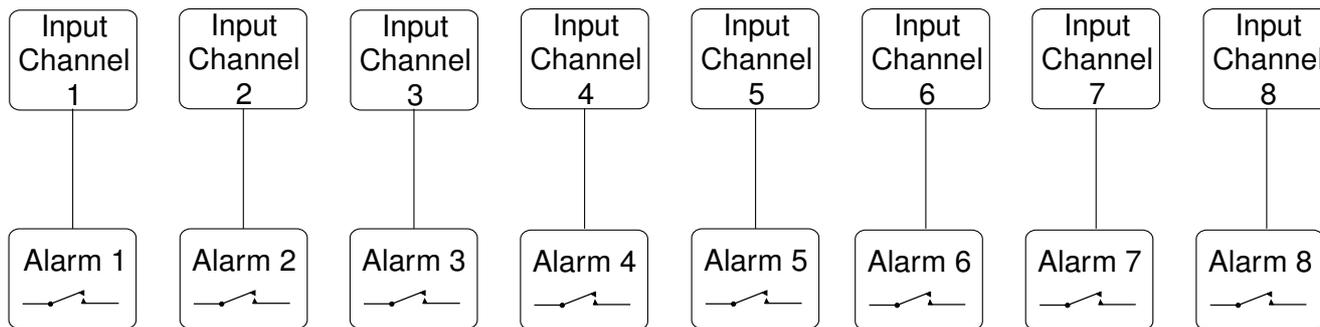
Select Mode

When select mode is used any relay may be allocated to any one or number of input channels. To choose select mode choose **SLCt** or **SEL.A** at the **A.tYP** function. In **SLCt** mode the alarm setpoint is assigned to the **relay** selected, in **SEL.A** mode the alarm setpoint is assigned to the **channel** selected.

For **SLCt** mode set up the alarm functions as you would for single mode but this time when a channel is selected the channel number refers to the alarm number as far as the alarm functions are concerned. For example if channel 3 is selected when function mode is entered and **ALHi** is set to 50 then relay 3 will activate whenever any input channel allocated to relay 3 (via the **AL.CH** function) goes to 100 or above. In **SLCt** mode the alarm annunciators will show which **relays** have been activated.
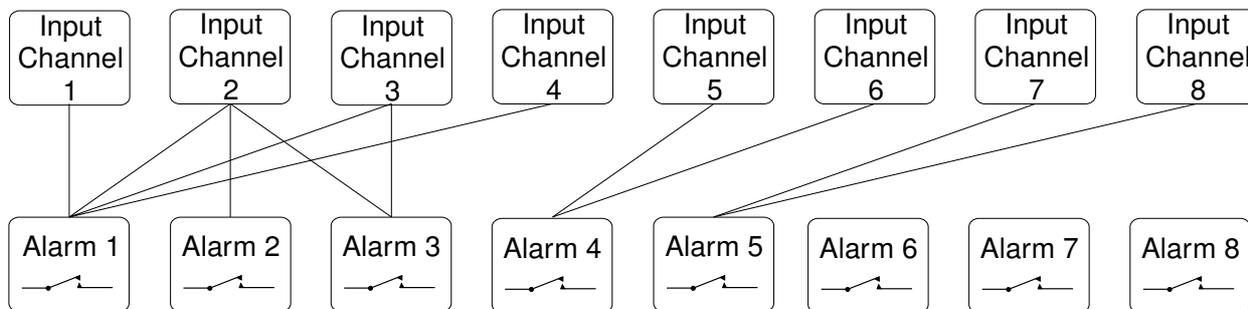
In **SEL.A** mode the user can program setpoint values for **input channels** rather than relays. e.g. if the display is showing channel 2 then any high or low setpoint made whilst channel 2 is displayed will apply to channel 2 rather than relay 2. This mode allows more than one setpoint to operate a single relay. For example if channel 1 is selected and **ALHi** *1* set to 100 then the relays allocated to channel 1 via the **AL.CH** function will all activate when channel 1 has an input which would cause a display of 100 or above. In **SEL.A** mode the alarm annunciator LEDs show which **channel** has caused the alarm condition. Example - if **AL.CH** function for channel 3 is set to **A 1Y** and **A3Y** with all other channels set to **n** then relays 1 and 3 will activate if the input on channel 3 is outside the alarm setting for that channel.

Note: If more than one input channel is assigned to a relay then the decimal point positions must be the same for each of those channels. The TP488 will automatically assign the same decimal point position to each channel. Any further changes to one channel will automatically cause a change to the other channels allocated to the same relay.

When the alarm setpoints etc. for the chosen alarm have been set continue through the functions by pressing and releasing **F** until the **AL.CH** (allocate relay to input channel) function is reached.

The AL.CH function

The **AL.CH** function is only seen when in either **SLCt** or **SEL.A** select mode. This function allows the grouping of inputs to alarm relays. When you reach this function you will already have selected a channel, the LED digit in the right hand window indicates the relay (or channel number in **SEL.A** mode) selected. Each of the channels will flash (use **▲** or **▼** to change channels) with the option to allocate this channel to the relay. For example in **SLCt** mode if the digit in the right hand window indicates **3** then the **AL.CH** function will allow the user to allocate any one or a number of channels to relay 3. The first channel will show up as **C 1Y** or **C 1n** (channel 1 yes or no), use the **P** button to toggle between yes and no. If **C 1Y** is selected then relay 3 will operate from channel 1 input. If **C 1n** is chosen then relay 3 will ignore any inputs on channel 1. Step through each channel and select either yes or no. If a relay is not used it is advisable to select **OFF** for the alarm high and low settings or select "no" for each input channel, this will prevent annoying operation of the relay and its alarm light/buzzer.

Input Channel 1 Input Channel 2 Input Channel 3 Input Channel 4 Input Channel 5 Input Channel 6 Input Channel 7 Input Channel 8

Alarm 1 Alarm 2 Alarm 3 Alarm 4 Alarm 5 Alarm 6 Alarm 7 Alarm 8

To illustrate select mode operation the table below shows the **RL.CH** selection to obtain the connections shown in the diagram above.

	Alarm Relay Number							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Channel 1	C 1Y	C 1n	C 1n	C 1n	C 1n	C 1n	C 1n	C 1n
Channel 2	C2Y	C2Y	C2Y	C2n	C2n	C2n	C2n	C2n
Channel 3	C3Y	C3n	C3Y	C3n	C3n	C3n	C3n	C3n
Channel 4	C4Y	C4n	C4n	C4n	C4n	C4n	C4n	C4n
Channel 5	C5n	C5n	C5n	C5Y	C5n	C5n	C5n	C5n
Channel 6	C6n	C6n	C6n	C6Y	C6n	C6n	C6n	C6n
Channel 7	C7n	C7n	C7n	C7n	C7Y	C7n	C7n	C7n
Channel 8	C8n	C8n	C8n	C8n	C8Y	C8n	C8n	C8n

The **SLCt** mode assigns on setpoint to a relay but then allows more than one channel to activate ther relay. If **SLCt** mode were used then the setpoints are assigned to the relays, not the input channels. e.g. if **RLH,** is set for relays 1, 2, 3, 4 & 5 then for the table above:

Relay 1 will activate if channel 1, 2, 3 or 4 go above the relay 1 setpoint.
Relay 2 will activate if channel 2 goes above the relay 2 setpoint.
Relay 3 will activate if channel 2 or 3 go above the relay 3 setpoint.
Relay 4 will activate if channel 5 or 6 go above the relay 4 setpoint.
Relay 5 will activate if channel 7 or 8 go above the relay 5 setpoint.

The **SEL.R** mode allows individual setpoints to be applied to the input channels with the channels then being assigned to one or more relays. If **SEL.R** mode were used then individual setpoints can be assigned to each input channel e.g. if **RLH,** is set for channels 1 to 8 then for the table above:

Relay 1 will activate if channel 1, 2, 3 or 4 goes above its setpoint.
Relay 2 will activate if channel 2 goes above its setpoint.
Relay 3 will activate if channel 2 or 3 goes above its setpoint.
Relay 4 will activate if channel 5 or 6 goes above its setpoint.
Relay 5 will activate if channel 7 or 8 goes above its setpoint.

e.g. in **SEL.R** mode at the **RL.CH** function for channel 2 the setting to allocate relays 1, 2 & 3 to channel 2 are C 1Y, C2Y, C3Y, C4n, C5n, C6n, C7n, C8n i.e. C 1Y actually means Relay 1 Yes, C2Y actually means Relay 2 Yes etc.

Record your own settings in the table below.

	Alarm Relay Number							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Channel 1								
Channel 2								
Channel 3								
Channel 4								
Channel 5								
Channel 6								
Channel 7								
Channel 8								

9   Explanation of Functions

The LD4 setup and calibration functions are configured through a pushbutton sequence, as explained in "Setting up the instrument" and "Calibration" chapters. Two levels of access are provided for setting up and calibrating - **FUNC** mode (simple pushbutton sequence) allows access to alarm relay setpoint for each channel and **CAL** mode (power up sequence plus pushbutton sequence) allows access to other setup and calibration parameters. Changes to the set points and other functions are made by pressing the ▲ and ▼ pushbuttons. Below is a brief description of each function.

See the chapter titled "Setting up the instrument" for details of how to enter **FUNC** and **CAL** modes.

Function	Range	Description
ALLo	**-1999** to **9999** or **OFF**	Selected channel alarm low setpoint - Displays and sets the alarm low setpoint value. The low alarm setpoint may be disabled by pressing the ▲ and ▼ pushbuttons simultaneously. When the alarm is disabled the display will indicate **OFF**. The alarm will trip when the displayed value is lower than the **ALLO** setpoint value. See "Alarm Relays" chapter for further details of alarm operation.
ALHi	**-1999** to **9999** or **OFF**	Selected channel alarm high setpoint - Displays and sets the alarm high setpoint value. The high alarm setpoint may be disabled by pressing the ▲ and ▼ pushbuttons simultaneously. When the alarm is disabled the display will indicate **OFF**. The alarm will trip when the displayed value is higher than the **ALHi** setpoint value. See "Alarm Relays" chapter for further details of alarm operation. Note: an open circuit display (**OPEN**) on a channel will cause the relay allocated to that channel to activate if a high setpoint has been set for that relay i.e. an open circuit it treated as a high alarm condition.
ALHY	**0** to **9999**	Selected channel alarm hysteresis [deadband] - Displays and sets the alarm hysteresis limit and is common for both high and low setpoint values. The hysteresis units are expressed in displayed engineering units. See "Alarm Relays" chapter for further details of alarm operation.
ALtt	**0** to **9999**	Selected channel alarm trip time in seconds - Displays and sets the alarm trip time and is common for both high and low setpoint values. See "Alarm Relays" chapter for further details of alarm operation.
ALrt	**0** to **9999**	Selected channel alarm reset time in seconds - Displays and sets the alarm reset time and is common for both high and low setpoint values. See "Alarm Relays" chapter for further details of alarm operation.
ALn.o or **ALn.c**	**ALn.o** or **ALn.c**	Selected channel alarm normally open or normally closed - Displays and sets the alarm relay action to normally open (de-energised) or normally closed (energised), when no alarm condition is present. See "Alarm Relays" chapter for further details of alarm operation.
Anb, **Lnb**, **AbP** or **LbP**	**Anb**, **Lnb**, **AbP** or **LbP**	Selected channel alarm mode - Selects the alarm mode for each channel as follows: **Anb** - Auto reset with no beeper **Lnb** - Latching with no beeper **AbP** - Auto reset with beeper **LbP** - Latching with beeper See "Alarm Relays" chapter for further details of alarm operation.
AL.CH	**C 1Y**, **C 1n** etc.	Allocate alarm to input channel - The **AL.CH** function allows each alarm relay to be allocated to one or more input channels. This function will only be seen if the **A.tYP** function is set to **SLCt**. See "Alarm Relays" chapter for further details of alarm operation and for an example of **AL.CH** operation.
F.rLY	**on** or **OFF**	Manual relay reset on or off - This function when set to on allows the front panel **F** button to be used to manually reset an alarm relay. The **F.rLY** must be set to **on** for each channel on which this reset is required i.e. it is possible to allow the relay to be reset on selected channels only. When the relay has been reset the relay itself will become de activated but the front panel alarm LED will remain lit (solid light, not flashing) until the input goes outside the alarm range. Leave the **F.rLY** set to **OFF** for any channels in which manual reset is not required.

Function	Range	Description
d.OFF	**0** to **9999** minutes	Auto display blanking - The function **d.OFF** can be used to select the number of minutes for the automatic display blanking. Settings from 0 to 9999 minutes can be made. If set to 0 the auto display blanking is disabled and the display will remain on. If set to a number other than 0 then the display will switch off in the number of minutes set. When the display blanks the alarm annunciators, the input reading and the channel number will all be blanked. Timing for the auto blanking starts from the last keypad operation i.e. from the last time the **P**, **F**, **▲** or **▼** button was pressed. To turn the display back on or to restart the timing process simply press any of these buttons. The instrument will continue to measure input, operate alarms etc. even if the display is blank.
rEC-	**-1999** to **9999**	Recorder (analog retransmission) low output, only seen if recorder output option is fitted - Displays and selects, for the channel selected, the low output value (4mA or 0V) for retransmission. Select at this function the display value at which the retransmission will start. See also associated functions **ro.CH**, **r.tYP** and **r.Out**. See the "Recorder/Monitor Output" Appendix for hardware details.
rEC⁻	**-1999** to **9999**	Recorder (analog retransmission) high output, only seen if recorder output option is fitted - Displays and selects, for the channel selected, the high output value (20mA, 1V or 10V) for retransmission. i.e. Select at this function the display value at which the retransmission will reach its highest value. See also associated functions **ro.CH**, **r.tYP** and **r.Out**. See the "Recorder/Monitor Output" Appendix for hardware details. The graph below illustrates the recorder output when **r.Out** is set to **4-20**, **rEC-** is set to a display value of 100 and the **rEC⁻** is set to a display value of 500. Recorder Output (mA)
tYPE	**t1b** **t5n** **t2E** **t6r** **t3J** **t75** **t4** **t8t** or **E75**	Select channel input type - Selects and displays the thermocouple or mV type to be used with the selected channel. One of nine input types below are selectable. Type B (display reads **t1b**) Type N (display reads **t5n**) Type E (display reads **t2E**) Type R (display reads **t6r**) Type J (display reads **t3J**) Type S (display reads **t75**) Type K (display reads **t4**) Type T (display reads **t8t**) 0-75mV (display reads **E75**) - allows direct mV input up to 75mV
dCPt	**0** or **0.1**	Selected channel decimal point selection - Displays and sets the decimal point. By pressing the **▲** or **▼** pushbuttons the decimal point position may be set. The display will indicate as follows: **0** (no decimal point), **0.1** (1 decimal place).

Function	Range	Description
FLtr	0 to 8	Digital filter - Displays and sets the digital filter value. Digital filtering is used for reducing susceptibility to short term interference. The digital filter range is selectable from 0 to 8, where 0 = none and 8 = most filtering. A typical value for the digital filter would be 3.
CAL	Live value	Selected channel calibration (seen only with thermocouples input selected i.e. tYPE function set to t1b, t5n, t2E ,t6r ,t3J. t75, t4 or t8t) - see also "Thermocouple and 0-75mV calibration" chapter for a more detailed description. Allows the user to calibrate each channel to suit the individual thermocouple characteristics. To enter this mode press both the ▲ and ▼ pushbuttons simultaneously. The display will read LIVE (displays the current input temperature of the selected channel). When the temperature is stable press F the display will now read SCLE. Enter the correct calibration value by pressing the ▲ or ▼ pushbutton. Then press the F button to enter the corrected value into the memory. The display will read CAL End, indicating that the calibration for the selected channel is complete.
CAL 1	Live value	Selected channel calibration (seen only with 0-75mV input selected i.e. tYPE function set to E 75) - see also "Thermocouple and 0-75mV calibration" chapter for a more detailed description.i.e. tYPE function set to E 75 Allows the user to scale or calibrate each channel for direct mV input. This function is the first calibration point for mV inputs with CAL2 being the second point. For thermocouple inputs CAL (see above) is the only calibration point. To enter this function press both the ▲ and ▼ pushbuttons simultaneously.
CAL 2	Live value	Selected channel calibration (seen only with 0-75mV input selected i.e. tYPE function set to E 75) - see also "Thermocouple and 0-75mV calibration" chapter for a more detailed description. To enter this function press both the ▲ and ▼ pushbuttons simultaneously.
UCAL	n/a	Selected channel uncalibration - Used to set the instrument back to the factory calibration values. This function should only be used when calibration problems exist, and it is necessary to clear the calibration memory. To uncalibrate an input channel first choose the channel you wish to uncalibrate then enter via CAL mode. At the UCAL function press the ▲ and ▼ buttons simultaneosly. The display will show the messgae CAL Clr to show that the calibration memory has been cleared and will then move on to the next function.
Unit	°C or °F	Displayed temperature units °C or °F - common for all channels) Select °C or °F.
SCAN	0 to 60	Scan time per channel - common for all channels. Sets display scanning time from 0 (off) to 60 seconds.
Chnl	1 to 8	Number of active channels - common for all channels. Selects the number of active channels from 1 to 8. This prevents unused channels from being displayed. If less than 8 channels are selected the highest channels are disabled first e.g. if 6 channels are selected channels 7 & 8 will be disabled.
A.tYP	Sn9l , SLCt or SEL.A	Alarm operation mode - common for all channels. Allows selection of normal mode (Sn9l) or multi mode (SLCt or SEL.A) operation. See "Alarm Relays" chapter for further details.
bAud	300, 600, 1200, 2400, 4800, 9600, 19.2 or 38.4	Set baud rate - common for all channels, only seen if serial output option fitted. Displays and sets the baud rate for RS232/RS485 output. Baud rates of 38.4, 19.2, 9600, 4800, 2400, 1200, 600 and 300 are available. See the "RS232/RS485 Output Option" Appendix for more details.
PrtY	NONE, EUEN or Odd	Set parity - common for all channels, only seen if serial output option fitted. Displays and sets the parity bit setting for serial communications. Choose from NONE, EUEN or Odd. See the "RS232/RS485 Output Option" Appendix for more details.

Function	Range	Description
O.Put	di SP, Cont, POLL, A.buS or n.buS	Select serial output mode - <u>common for all channels</u>, only seen if serial output option fitted. Displays and sets the serial output mode. Choose from di SP, Cont, POLL, A.buS or n.buS. See the "RS232/RS485 Output Option" Appendix for further description of di SP, Cont & POLL modes. See "Modbus Communications" Appendix for details of n.buS mode and refer to "Users Guide" supplied with the Windows download software for details of A.buS mode.
Addr	0 to 31	RS485 multidrop address - <u>common for all channels</u>, only seen if serial output option fitted. Displays and sets the multidrop address for RS485 communications using POLL, A.buS or n.buS mode. Addresses available are from 0 to 31 with address 0 being reserved as a paging address. See the "RS232/RS485 Output Option" Appendix for more details.
r.tYP	SLCt, HI, Lo or AUGE	Recorder (analog retransmission) output type - <u>common for all channels</u>, only seen if analog output option is fitted The analog output can be made to operate in one of three ways indicated by SLCt, HI, Lo or AUG. If SLCt is selected within this function then the channel whose input will be output via the recorder output is selected by an external BCD input (SLCT1, SLCT2 and SLCT3 on the circuit board). If HI is selected then the highest input value from any input channel selected in ro.CH will be output. If Lo is selected then the lowest value from any channel selected in ro.CH will be output. If AUG is selected then the average values of all active channels will be output. See the "Recorder/Monitor Output" Appendix for hardware details.
r.Out	4-20, 0-1.0 or 0-10	Recorder (analog retransmission) output mode - <u>common for all channels</u>, only seen if analog output option is fitted. Displays and sets the output mode for the analog output. For 4-20mA output select 4-20. For 0-1V output select 0-1.0. For 0-10V output select 0-10. Note; ensure that correct links are set on the analog output board when selecting output mode. See the "Recorder/Monitor" Output Appendix for hardware details.
ro.CH	HI, Lo or AUG	Recorder (analog retransmission) output channel, only seen if analog output option is fitted. Displays and sets the active channels for the analog output. Use ▲ and ▼ to select required channel. Select Y (yes) or n (no), toggled via the P button e.g. C2 Y means that channel 2 is selected to operate the recorder output (i.e. channel 2 will now affect the recorder output), C2n means that channel 2 will not affect the analog output. Setting all channels to n will make the recorder output inactive regardless of the rEC⁻ and rEC₋ settings. The r.tYP function must be set to either HI, Lo or AUG for the ro.CH function to be seen. See the "Recorder/Monitor Output" Appendix for hardware details.

Important: When the calibration procedure has been completed it is advisable to return the instrument to the normal mode (where calibration functions cannot be tampered with). To return to the normal mode, turn off power to the instrument, wait a few seconds and then restore power.

Note: If you are unable to gain access to any of the instruments functions it is possible that the security lockout DIP switch 1 has been placed in the "ON" position. See the "Electrical Installation" chapter for DIP switch 1 location and description on operation.

Function table page 1

Initial display	Meaning of display	Next display	Record your settings for each input							
			1	2	3	4	5	6	7	8
ALLo X *	Alarm Low Setpoint Value	Setpoint Value or OFF								
AL Hi X	Alarm High Setpoint Value	Setpoint Value or OFF								
ALHY X	Alarm Hysteresis	Hysteresis Value in Measured Units								
ALtt X	Number of seconds before Alarm Trips	0 to 9999 (seconds)								
ALrt X	Number of seconds before Alarm Resets	0 to 9999 (seconds)								
ALn.o X ALn.c X	Alarm normally open or normally closed	ALn.o X or ALn.c X								
Anb X Lnb X AbP X LbP X	Automatic no beeper Latching no beeper Automatic with beeper Latching with beeper	Anb X Lnb X AbP X LbP X								
AL.CH	Allocate relay to input channel	CX Y or CX n								
F.rLY	Relay reset on or off	On or OFF								
d.OFF	Display blanking time (mins.)	0 to 9999								
# rEC_ X	Recorder output low limit	Value in memory								
# rEC¯ X	Recorder output high limit	Value in memory								
tYPE X	Select Thermocouple Type Types B, E, J, K, N, R, S & T or direct 0-75mV	t1b, t2E, t3J, t4, t5n, t6r, t7S, t8t or E 75								
dCPt X	Display Decimal Point	Decimal Pt Position (i.e. 0 or 0. 1)								
FLtr X	Digital Filter Range 0 to 8	0 to 8 (8=most filtering)								

Note: Shaded functions are accessible only when in CAL mode (see "Calibration")
    * Accessible only with serial output option fitted
    # Accessible only when recorder output option fitted

note: X = selected channel number

Function Table page 2

Initial display	Meaning of display	Next display	Record your settings for each input							
			1	2	3	4	5	6	7	8
CAL X	Thermocouple calibration	See calibration section								
CAL1 X	0-75mV Calibration 1st point	See calibration section								
CAL2 X	0-75mV Calibration 2nd point	See calibration section								
UCAL X	Uncalibration	See calibration section								
Unit	Temperature Units °C or °F Selection	°C or °F								
SCAn	Scan Rate Range 0 to 60 seconds	Current Value in Memory								
Chnl	Number of Input Channels	1 to 8								
A.tYP	Alarm operation	Sn9l .SLCt or SEL.A								
* bAud	Baud rate	38.4, 19.2, 9600, 4800, 2400, 1200, 600, 300								
* PrtY	Parity select	nOnE, EUEn or Odd								
* O.Put	Output select	di SP, Cont .POLL .A.buS or n.buS								
* Addr	RS485 multidrop address	1 to 31								
# r.tYP	Recorder output type	SLCt, HI .LO or AU9								
# r.Out	Recorder output type	4-20.0-1.0 or 0-10	Note: Ensure that correct links are set if changing settings. See "Recorder/Monitor Output" Appendix							
# ro.CH	Set active channels for recorder output	CX Y or CX n								
* dLAY	Optional data logger functions - see "Data Logger" chapter									
* Hour										
* dAtE										
* YEAr										
* L.Clr										

Note: Shaded functions are accessible only when in CAL mode (see "Calibration")
    * Accessible only with serial output option fitted
    # Accessible only when recorder output option fitted

11   Thermocouple and 0-75mV calibration

To enter the calibration mode a special `CAL` mode entry procedure must be followed. This procedure prevents accidental alteration of settings and provides a degree of calibration security, see chapter "Setting up the instrument".

Thermocouple calibration - (`TYPE` function set for thermocouple i.e. not set to `E 75`)

Once the `CAL` mode has been entered press and release the 🄵 button until the `CAL` function is reached.

Select the required channel and apply an input to that channel from an accurate millivolt source (see **Note:** below), thermocouple simulator or alternatively place the thermocouple probe into an accurately known temperature environment (this value must be greater than 10% of the input range for the thermocouple selected e.g. the range for type K is 1472°C so a termperature or simulated equivalient of at least 147°C must be input for type K calibration). Now press the 🔼 and 🔽 buttons simultaneously to enter the calibration mode. The display will now indicate `LIUE` (live temperature reading) followed by the current temperature reading.

When the reading has stabilised press the 🄵 button. The display will indicate `SCLE` (scale/calibration) followed by the scale value in memory. Now press the 🔼 or 🔽 pushbutton to obtain the required scale (calibration) value. Press the 🄵 button the display should now show the message `CAL End` indicating that the calibration is complete. The display will return to the normal measure mode (with calibration access). If calibration for another channel is required change the channel number and repeat.

Note: If using a mV source for calibrating as described above then thermocouple tables are required. The the cold junction temperature mV value must be subtracted from the mV figure in the thermocouple table. For example for a type K thermocouple if the cold junction temperature reading is 20°C and you wish to calibrate using a mV input for 1200°C then subtract the type K mV value for 20°C (0.798mV) from the mV value for 1200°C (48.838mV) this gives a value of 48.04mV. Set the mV source to 48.04 and when the `SCLE` value is reached adjust this to read `1200`. The cold junction temperature can be read on the display by changing the channel using the 🔼 or 🔽 buttons until the channel indicator shows `C` instead of a channel number, this is only accessible when the TP488 has been powered up in `CAL` mode.

mV Calibration - for 0-75mV inputs (`TYPE` function set to `E 75`)

1. At the `CAL 1` function press the 🔼 and 🔽 buttons simultaneously to enter the calibration mode. The display will now indicate `LIUE` followed by the "live" reading.

2. Apply a known input to the instrument of nominally 0mV (this value is not critical and may be anywhere within the measuring range of the instrument). Allow at least 5 seconds for the reading to stabilise then press the 🄵 button.

3. The display will indicate `SCL 1` (scale 1) followed by the scale value in memory. Now press the 🔼 or 🔽 button to obtain the required scale (calibration) value. Press the 🄵 button, the display will now indicate `CAL End` (indicating that calibration of the first point is complete).

4. The display will now indicate `CAL2` (2nd calibration point). At this point you have the choice of performing the second calibration point or ignoring the second point. Either step through the functions using the 🄵 button (to bypass the second calibration point) or enter the 2nd calibration mode by pressing the 🔼 and 🔽 buttons simultaneously.

5. Apply an input as close to full input range as possible i.e. 75mV (again this value is not critical, for best accuracy should not be too close to the previous value). Allow at least 5 seconds for the reading to stabilise then press the 🄵 button. The display will now read `SCL2` (scale 2) followed by the second scale value in memory.

6. Press the 🔼 or 🔽 button to obtain the required scale value. Press the 🄵 button the display will now read `CAL End` (indicating that calibration of the second point is complete). The display will return to the measure mode (with calibration access).

Note: When entering the second point independently, the first calibration point may be bypassed, simply by pressing the 🄵 button instead of the 🔼 and 🔽 buttons simultaneously.

Uncalibration

The uncalibration function is accessible following the calibrate function and is displayed as **UCAL**. This function sets the instrument back to the factory calibration value. This function is useful as a temporary measure when the input source/transmitter is replaced and on the spot recalibration is difficult or when a calibrating error exists due to incorrect calibration. The uncalibrate mode follows the calibration mode described above and is initialised by pressing the ▲ and ▼ buttons simultaneously (note: this function will delete the existing calibration and should only be used when necessary). The display will shoe **CAL CLr** indicating that the calibration is cleared. The display will return to the normal measure mode (with calibration access). This function only affects the channel selected.

Returning to the normal measure mode

When the calibration procedure has been completed it is advisable to return the instrument to the normal mode (where calibration functions cannot be tampered with). To return to the normal mode, turn off power to the instrument, wait a few seconds and then restore power.

12 Specifications

Technical Specifications

Input Types:	Thermocouple types B, E, J, K, R, S & T or 0-75mV
Input Isolation:	Full isolation between inputs
Temperature Range:	B 400 to 1866°C, E -100 to 1000°C
	J -100 to 870°C, K -100 to 1372°C
	N -100 to 1300°C, R -35 to 1768°C
	S -35 to 1768°C, T -100 to 400°C
Resolution:	Max display 9999, selectable decimal point
	Temperature display °C or °F, 1 or 0.1°
Accuracy:	Better than 1°C at 25°C (thermocouple)
Sample Rate:	1 second per channel (approx)
Update Rate:	9 seconds (with 8 channels selected)
Display Scan Rate:	Programmable 0 to 60 seconds per channel
A/D Conversion:	Dual Slope ADC
Microprocessor:	MC68HC11 CMOS
Ambient Temperature:	-40 to 60°C
Humidity:	5 to 95% non condensing
Display:	4 digit + 1 digit (channel select) red LED, 20mm digit height
	8 X annunciator LEDs
Power Supply:	AC 240V or 110V 45/65Hz or
	12 to 24VDC isolated or
	15 to 24VDC non isolated
	(supply type is factory configured)
Power Consumption:	AC supply 15VA max,
	DC supply, typical 500mA (2A peak)
Output (standard):	8 x relay, Form A (2 contacts) rated 5A, max. 240 VAC resistive
Relay Action:	Programmable energised or de-energised

Options

Analog Retransmission:	4 to 20mA, 0 to 1V and 0 to 10V link selectable
	Uses binary input to select input channel or will transmit highest or
	lowest or average of selected channels
Serial Communications:	RS232 or RS485 (factory configured)
Internal Data logger:	32k or 128k internal data logger memory (requires serial comms.
	option). Supplied with Windows compatible download software for PC.

Physical Characteristics

Case Size:	255 x 145 x 125mm
Weight:	1.3 kgs

13 Error and Status Messages

Startup Errors

CNFGErr (configuration error)
Micro processor has not been configured at the factory or has been damaged.
Return to the factory for service.

ProG EPrO (program eprom)
New software version installed or eprom error.
Micro processor has reset calibration memory back to factory default values.
All calibration and user settings have been lost and settings returned to default values.

Measurement Errors

- - - - (Overrange error) Input level is too high, check input from sensors.

OPEN : Open circuit thermocouple.

Calibration Errors

GAin Err: (Gain out of range error)
Either the input circuitry is faulty or user has entered a new value which is incorrect.
Gain is limited to ±10%.

SPAN Err: (Calibrating too close to 0°)
User must calibrate instrument at higher temperature. Calibrating close to 0° will cause large errors across the measurement range.

CoLd Err: Cold junction circuitry faulty. Return to the factory for service.

Note: If you are unable to gain access to any of the instruments functions it is possible that the security lockout DIP switch 1 has been placed in the "ON" position. See the "Electrical Installation" chapter for DIP switch 1 location and description on operation.

Appendix -   Recorder/Monitor Output

   This addendum covers TP488 instruments with the analog retansmission board. This board allows retransmission of 4 - 20mA, 0-1V or 0-10V selectable via links and the ⌐.0ᴜᴛ function. See "Configuring the output board" section which follows for link and channel selection details. Refer to the main "Explanation of Functions" chapter for details of functions associated with these outputs and to the Function table for function listing.
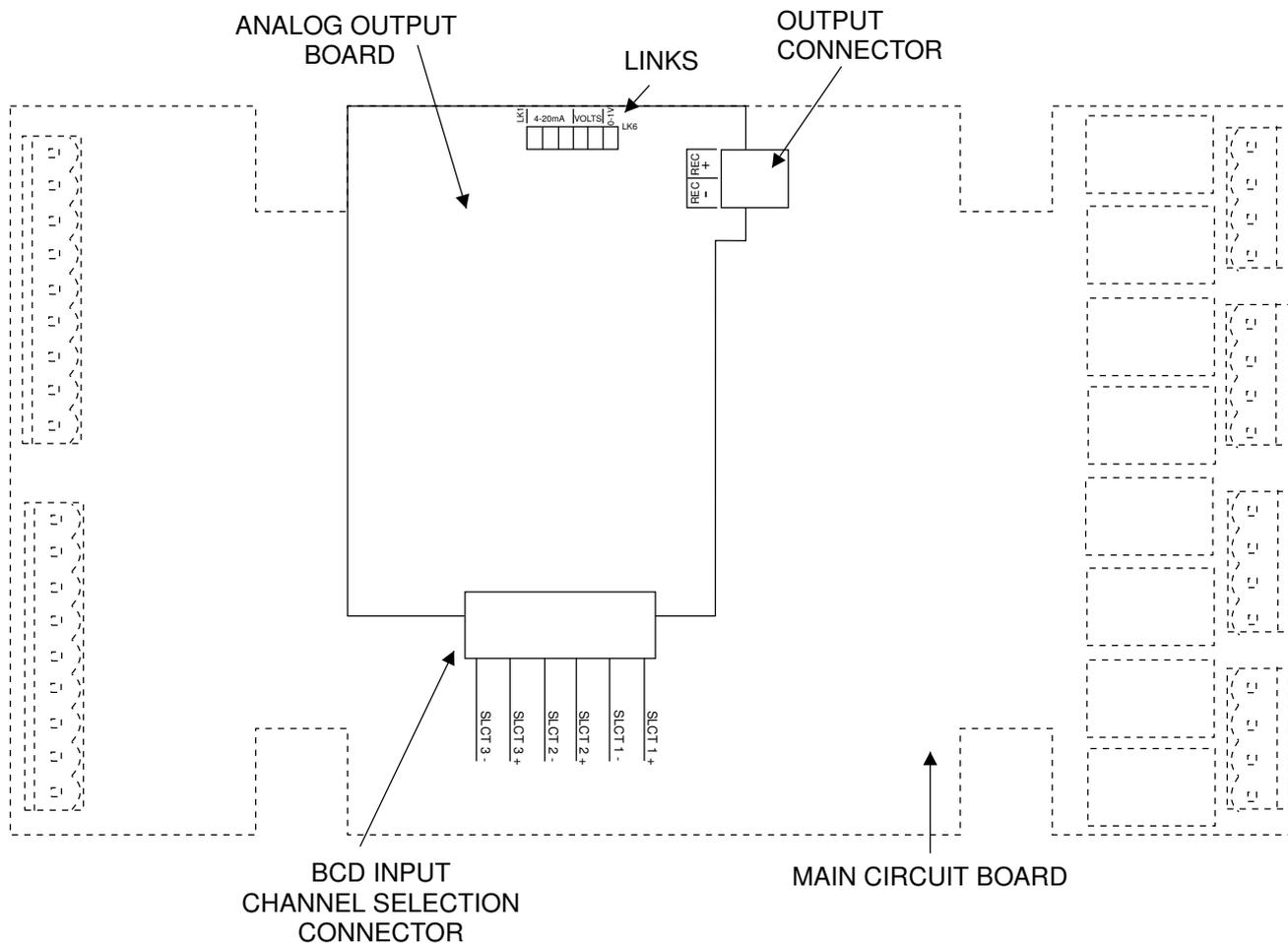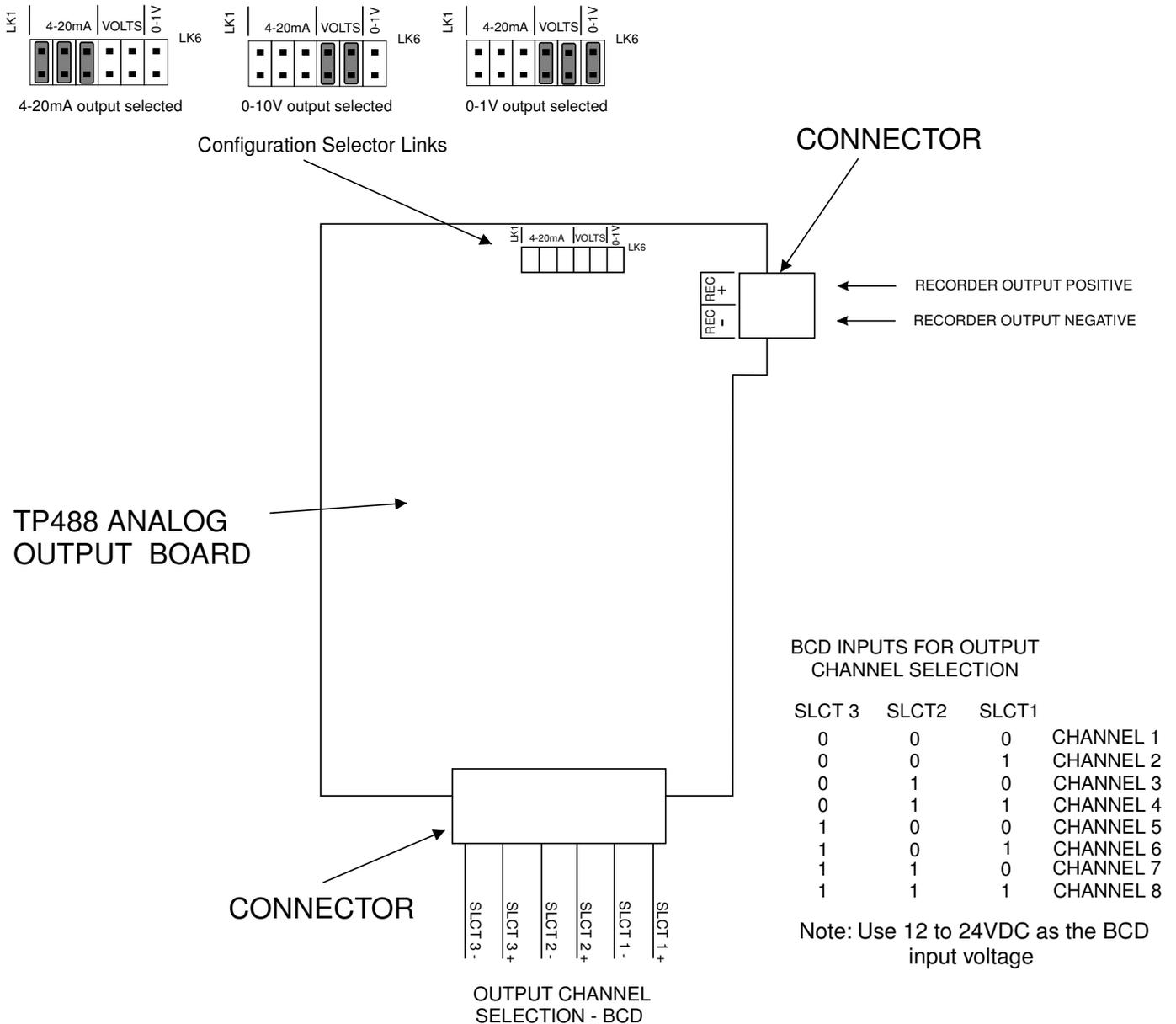
Electrical Connections

See diagram below. Refer to "Electrical Installation" chapter for general information on electrical connections. External connections to the board are via plug in connectors with screw terminals these terminals allow for wires up to 2.5mm^2 to be fitted.

Configuring the output board

The output board has facilities for 4-20mA, 0-1V and 0-10V retransmission and is factory supplied with all the necessary component for the output options required.

PCB links are fitted to the circuit board to connect the electronic components for the correct output types. It may be necessary to alter the PCB links to change the output type (see link settings below).

Two connectors allow for connection of recorder output lines and BCD code channel selection lines.

BCD INPUTS FOR OUTPUT
CHANNEL SELECTION

SLCT 3	SLCT2	SLCT1	
0	0	0	CHANNEL 1
0	0	1	CHANNEL 2
0	1	0	CHANNEL 3
0	1	1	CHANNEL 4
1	0	0	CHANNEL 5
1	0	1	CHANNEL 6
1	1	0	CHANNEL 7
1	1	1	CHANNEL 8

Note: Use 12 to 24VDC as the BCD input voltage

Appendix -   RS232/RS485 Output Option

RS232/RS485 Communications Option

    The information contained in this appendix relates to TP488 scanning monitors with RS232/RS485 output options using the serial output board. The functions associated with this option are **bRud**, **PrtY**, **O.Put** and **Rddr** see the function table for a listing of these functions.

Electrical Installation

    External connections to the serial board are via a plug in connector with screw terminals. These terminals will accept wire up to 2.5mm^2. See diagram below for connector details and wiring diagrams which follow.
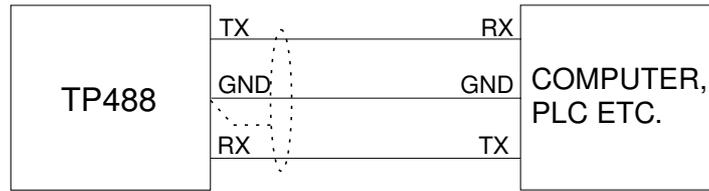
TP488 serial communications connector
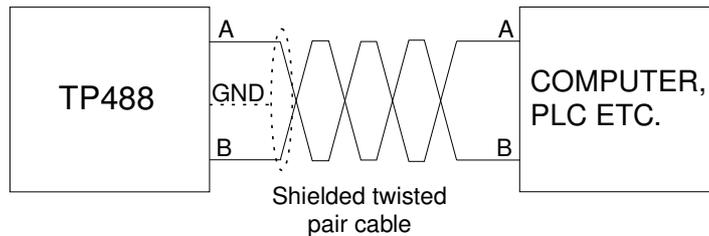
CONNECTIONS TO THE SERIAL OUTPUT BOARD
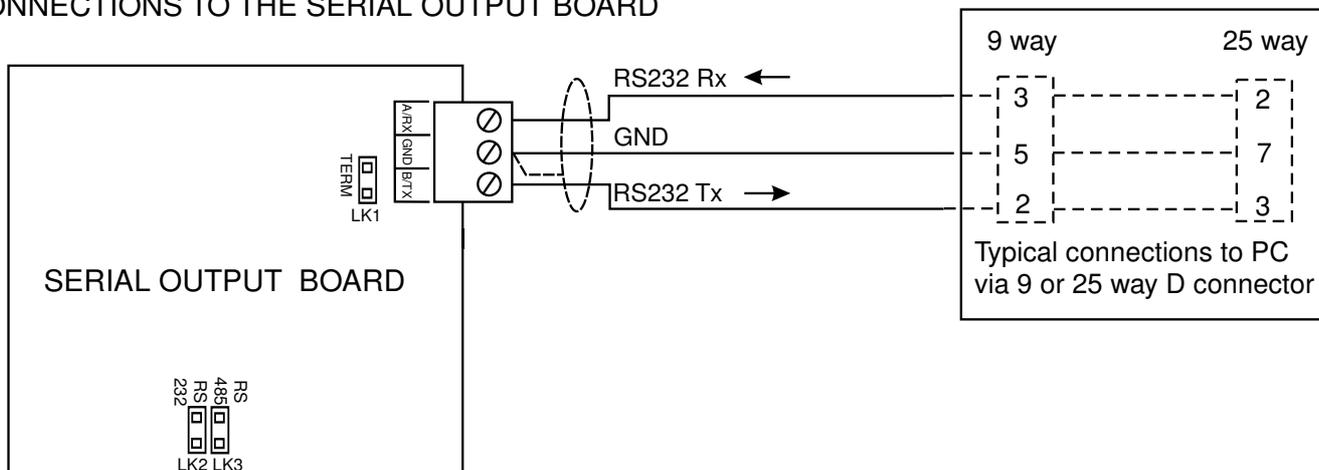
Wiring between TP4 or TP488 and other units

Wiring between units is as shown in the diagrams below.

RS232 CONNECTIONS

RS485 CONNECTIONS

Shielded twisted
pair cable

Use three core screened or twin shielded wire for RS232 connections with the shield being used as the GND connection. RS232 is meant for short distance (up to 50ft, 15m) communication. The maximum transmission distance decreases as the baud rate increases.

In most cases Tx and Rx are crossed i.e. Tx at the TP488 end connects to Rx at teh D connector and Rx at the TP488 end connects to Tx at the D connector.

Use shielded twisted pair shielded wire for RS485 connections with the shield being used as GND connection. RS485 can communicate over much longer distances, approx. 1.2km than RS232, again the maximum transmission distance decreases as the baud rate increases.

RS232/RS485 Functions:

bRud - (set baud rate)

Select the baud rate from **38.4** (38400 baud), **19.2** (19200 baud), **9600**, **4800**, **2400**, **1200**, **600** or **300**

Prty - (set parity)

Select either **NONE**, **EUEN** or **Odd**

O.Put - (select serial output mode)

Select **diSP**, **Cont**, **POLL**, **A.buS** or **m.buS**

> **diSP** - Sends image data from the display without conversion to ASCII
>
> **Cont** - Sends ASCII form of display data every time display is updated
>
> **POLL** - Controlled by computer or PLC as host.
> Host sends command via RS232/RS485 and instrument responds as requested
>
> **A.buS** - is a special binary communications mode used with Windows compatible download software for live data logging or download from the data logger chip. Refer to the user manual supplied with this software for details.
>
> **m.buS** - modbus RTU communications. See "Modbus communications" chapter.

Addr - (set unit address for **POLL**, **A.buS** or **m.buS** mode (0 to 31)

Allows several units to operate on the same RS485 interface reporting on different areas etc. The host computer or PLC may poll each unit in turn by supplying the appropriate address.

The unit address ranges from 0 to 31 (DEC) but is offset by 32 (DEC) to avoid clashing with ASCII special function characters such as <STX> and <CR>. Therefore 32 (DEC) or 20 (HEX) is address 0, 42 (DEC) or 2A (HEX) addresses unit 10. Address 0 should not be used for modbus operation.

Notes: Address 0 is reserved as a paging address i.e. it will address all units present on the

interface. Do not use address 0 as a unit address for normal operation. If the address is omitted from the polling mode command the unit will not echo back an address when replying to the poll.

Multi drop operation is only valid for instruments fitted with the RS485 output option.

RS232/485 Operation and Commands

A choice of one of four serial communication modes can be made in the TP488. The modes of operation available are: **d, SP**, **Cont**, **POLL**, **A.buS** or **m.buS**. **A.buS** is a special binary output for communications with optional download and data logger Windows software for use with a PC (see user manual supplied with the software), **m.buS** is modbus RTU (see "Modbus communications" chapter, the other three modes are described below.

d, SP - Image Display Mode:

In image display mode the display value is sent via RS232/485 as raw data in the following format:

<ESC> IXYYYY   Where:
<ESC> is the ESCAPE character (27 Dec, 1B Hex)
I is the character 'I' (73 Dec, 49 Hex)
X is the number of image bytes in ASCII (49 to 56 Dec, 31 to 38 Hex)
YYYY is the raw, 8 bit display data.

This information is output every display update (approx. once per second - depending upon baud rate). The number of image bytes sent depends on the number of display digits present.

The most common usage would be to provide output for a large digit or remote slave display. The slave displays automatically detects the image mode data and displays the correct value accordingly. The data is in seven segment display image and the slave display would have to be from the same manufacturer as the TP488.

Cont - Continuous Transmit Mode (ASCII):

In this mode the display value is continually sent via the RS232/485 interface every display update (approx. once per second depending on the baud rate). The format for this is as follows:-

<STX> XAAAA, XBBBB, XCCCC,.......XHHHH<CR>

Where:

<STX> is start of text character (2 Dec, 02 Hex)
X SPACE (32 Dec, 20 Hex) for a positive value.
X '-' (45 Dec, 2D Hex) for a negative value.
AAAA is the display value in ASCII for channel 1(length depends on number of display digits)
BBBB is the display value in ASCII for channel 2
CCCC is the display value in ASCII for channel 3
HHHH is the display value in ASCII for channel 8
<CR> is a Carriage Return (13 Dec, 0D Hex)

Note: Display values will only be sent for active channels i.e. the channels selected under the **Chnl** function. The display values will be sent in this manner (one after another) even if the instrument is not in scanning mode.

POLL - Host Controlled Transmit Mode (ASCII):

This mode requires a host computer or PLC to poll the instrument to obtain display or other information or reset various setpoint parameters. The format for the host command is as follows:-

<STX>CA<CR>D<CR> (Standard read etc.)
<STX>CA<CR>D<CR>N<CR>XYYYY (Set Value Command)

Note: if sent without address i.e. <STX>C<CR> etc. the TP488 will act as a stand alone unit and will not return a address when replying to the host.

Where:

<STX> is Start of Text Character (2 Dec, 02 Hex)
C is the command character (see list below)
A is the unit address (Range: 32 to 63 Dec, 20 to 3F Hex - address is offset by 32 Dec, 20 Hex).
Note: address will not be sent if unit address is set to 0.
<CR> is Carriage Return (13 Dec, 0D Hex)

D is the channel number e.g.: 32 Hex would be channel 2
N is the setpoint number in ASCII e.g.: 31 Hex would be alarm 1 etc.
X SPACE for positive and '-' for negative
YYYY is the setpoint value in ASCII

The POLL commands available and instrument responses are as follows:

Transmit Primary Display Value: <STX>PA<CR>D<CR>

Instructs unit to return the primary display value. The primary value is the main reading on an certain instrument such as Thermocouple temperature on a TP488-TC. Format of returned data is:-

 <ACK>PANXYYYY<CR>

Where:

<ACK> is Acknowledge (6 Dec, 06 Hex)
P echo command received 'P' (80 Dec, 50 Hex)
A is the responding unit's address
N is the channel number in ASCII
X SPACE for positive and '-' for negative
YYYY is the display value in ASCII
<CR> is a Carriage Return (13 Dec, 0D Hex)

The number of display characters returned depends on the number of display digits present. If the decimal point is non zero then it will be sent in the appropriate place as '.' (46 Dec, 2E Hex).

Transmit Secondary Display Value: <STX>SA<CR>D<CR>

Instructs unit to return the secondary display value. For example the secondary value would be Cold Junction Temperature on a TP488-TC. Format of returned data is:-

 <ACK>SAXYYYY<CR>

Where:

<ACK> is Acknowledge (6 Dec, 06 Hex)
S echo command received 'S' (83 Dec, 53 Hex)
A is the responding unit's address
X is SPACE for positive and '-' for negative
YYYY is the display value in ASCII
<CR> is a Carriage Return (13 Dec, 0D Hex)

The number of display characters returned depends on the number of display digits present. If the decimal point is non zero then it will be sent in the appropriate place as '.' (46 Dec, 2E Hex).

If the instrument does not have a secondary display then the "invalid" command will be echoed back with no display value (i.e.: <ACK>?A<CR>)

Read Low Alarm Setpoint: <STX>LA<CR>E<CR>

Instructs unit to return value of low alarm setpoint. Format of returned data is:

<ACK>LAEXYYYY<CR>

Where:

<ACK> is Acknowledge (6 Dec, 06 Hex)
L echo command received 'L' (76 Dec, 4C Hex)
A   is the responding unit's address
E   is the setpoint alarm number in ASCII e.g.: 31 Hex would be alarm 1 etc.
X is SPACE for positive and '-' for negative
YYYY is the setpoint value in ASCII (OFF if alarm is set to OFF)
<CR> is a Carriage Return (13 Dec, 0D Hex)

If setpoint number specified is not present the return string will have the setpoint number set to zero (i.e.: <ACK>LA0).

Read High Alarm Setpoint: <STX>HA<CR>N<CR>

Instructs unit to return value of high alarm setpoint. Format of returned data is:

<ACK>HAEXYYYY<CR>

Where:

<ACK> is Acknowledge (6 Dec, 06 Hex)H
H echo command received 'H' (72 Dec, 48 Hex)
A is the responding unit's address
E is the setpoint alarm number in ASCII e.g.: 31 Hex would be alarm 1 etc.
X is SPACE for positive and '-' for negative
YYYY is the setpoint value in ASCII (OFF if alarm is set to OFF)
<CR> is a Carriage Return (13 Dec, 0D Hex)

If setpoint number specified is not present the return string will have the setpoint number set to zero (i.e.: <ACK>HA0).

Set Low Alarm Setpoint: <STX>lA<CR>E<CR>XYYYY<CR>

Instructs unit to change value of low alarm setpoint. Format of returned data is:-

<ACK>lAEXYYYY<CR>

Where:

<ACK> is Acknowledge (6 Dec, 06 Hex)
l echo command received 'l' (108 Dec, 6C Hex)
A is the responding unit's address
E is the setpoint alarm number in ASCII e.g.: 31 Hex would be alarm 1 etc.
X is SPACE for positive and '-' for negative
YYYY is the setpoint value in ASCII
<CR> is a Carriage Return (13 Dec, 0D Hex)

If setpoint number specified is not present the return string will have the setpoint number set to zero i.e.: <ACK>lA0<CR>.

Set High Alarm Setpoint: <STX><CR>E<CR>XYYYY<CR>

Instructs unit to change value of high alarm setpoint. Format of returned data is:-

<ACK>hAEXYYYY<CR>

Where:

<ACK> is Acknowledge (6 Dec, 06 Hex)
h echo command received 'h' (104 Dec, 68 Hex)
A is the responding unit's address
E is the setpoint number in ASCII e.g.: 31 Hex would be alarm 1 etc.
X is SPACE for positive and '-' for negative
YYYY is the setpoint value in ASCII
<CR> is a Carriage Return (13 Dec, 0D Hex)

If setpoint number specified is not present the return string will have the setpoint number set to zero i.e.: <ACK>hA0<CR>.

Transmit Instrument Model and Version: <STX>MA<CR>

Instructs unit to return the model and version number of the instrument. Format of returned data is:-

<ACK>MACCX.X<CR>

Where:

<ACK> is Acknowledge (6 Dec, 06 Hex)
M is echo command received 'M' (77 Dec, 4D Hex)
A is the responding unit's address
CC a 2 character model identifier (e.g.: TC - thermocouple)
X.X is the version number (e.g.: '0.1')
<CR> is a Carriage Return (13 Dec, 0D Hex)

Transmit Number of Active Channels: <STX>CA<CR>

Instructs the unit to return the number of active channels currently selected (ChnI function).

Format of returned data is:-

<ACK>CA N<CR>

Where:

<ACK> is Acknowledge (6 Dec, 06 Hex)
A is the responding unit's address
N is the number of active channels.

Invalid Command

If the command received from the host is not valid then the unit will return the following:-

 <ACK>?A<CR>

Where:

<ACK> is Acknowledge (6 Dec, 06 Hex)
? is the character '?' (63 Dec, 3F Hex)
A is the responding unit's address
<CR> is a Carriage Return (13 Dec, 0D Hex)

If the address received from the host does not match the units address then the unit will not respond at all.

Other commands may be added to suit the particular configuration of each instrument. Value read commands will have the same format as the Transmit Primary Value command. Set Value commands will have the same format as the Set Low Alarm Setpoint command etc.

Host Timing Requirements for RS485 Operation:

RS485 operation requires the host to switch the RS485 transceiver to transmit before a command is sent. The instrument is capable or replying after 1 to 2 milliseconds. Therefore the host should switch the RS485 transceiver back to receive mode within 0.5 milliseconds after the last character of the command has been sent to ensure correct operation.

Note: In some older software version models the instrument will not respond if an invalid setpoint alarm number is given in the alarm setpoint commands e.g. if N is sent as alarm 9 (3A Hex) in the "Read high alarm setpoint" command then the instrument will make no responZse.

Appendix - Data logger

Operation of the Data Logger

See separate booklet "Download Software User Guide" if the datalogger Windows software is being used.

The sample value present at the input to the channel at the time is stored in the datalogger memory.

The data logger automatically logs inputs to all eight TP488 channels. For TP488 channels not selected (see **Chn!** function) the overrange value (**- - - -**) will be logged for each sample. The logging rate is set separately and is independent from the instruments scan rate setting (**SCAN**). If an input is overranged when logged then the overrange value (**- - - -**) will be logged for that channel for as long as the overrange value is present. Readings taken during power failure will also be logged as the overrange value. If in averaging mode, any overranged samples will be discarded. Only the valid samples will be averaged. If no valid samples are taken then the average value will be logged.

The log memory is set up in a circular format. Once the top of memory is reached the log data will overwrite the start of memory (overwriting the oldest record). The recording time available will vary depending on the memory size fitted and the update time selected (**dLAY** function). The table below shows some examples of recording times.

Memory Size	No. of Records	Total Recording Time	
		1.00 min (**dLAY**)	60.00 mins (**dLAY**)
32K	1600	1 day 2 hrs	66 days 16 hrs
128K	6400	4 days 10 hrs	266 days 16 hrs

Data is transmitted in comma separated format making it compatible with many commercially available databases/spreadsheets. Time information is downloaded in Julian time format which is again compatible with many databases/spreadsheets. The internal clock is battery backed. Downloaded log records are in the form of the time followed by the logged record for each channel at that time.

Downloaded information is transmitted via the serial output option board in RS232 or RS485 format, thus a serial output option must be fitted on all instruments with data logging software. Refer to the "RS232/RS485 Output Option" chapter for hardware and software details. Special software details which apply only to data logger option instruments are given at the end of this appendix.

Data Logger Table - Maximum Logging Times

Times are rounded to the nearest minute.

Time between logs	32k Memory	128k Memory
	days : hours : min	days : hours : min
10 Sec	0 : 04 : 26	0 : 17 : 46
20 Sec	0 : 8 : 53	1 : 11 : 33
30 Sec	0 : 13 : 20	2 : 05 : 20
1 Minutes	1 : 02 : 40	4 : 10 : 40
2 Minutes	2 : 05 : 20	8 : 21 : 20
3 Minutes	3 : 08 : 00	13 : 08 : 00
4 Minutes	4 : 10 : 40	17 : 18 : 40
5 Minutes	5 : 13 : 20	22 : 05 : 20
6 Minutes	6 : 16 : 00	26 : 16 : 00
10 Minutes	11 : 02 : 40	44 : 10 : 40
15 Minutes	16 : 16 : 00	66 : 16 : 00
20 Minutes	22 : 05 : 20	88 : 21 : 20
30 Minutes	33 : 08 : 00	133 : 08 : 00
60 Minutes	66 : 16 : 00	266 : 16 : 00

Explanation of Functions

New functions which are used when the data logger option is fitted are accessible only via **CAL** mode. Details of these new functions are given below.

dLAY (select log update time)

Displays and sets the time period between each log sample. Available selections are:

0. 10 (10 seconds), **0.20** (20 seconds), **0.30** (30 seconds), **1.00** (1 minute), **2.00** (2 minutes), **3.00** (3 minutes), **4.00** (4 minutes), **5.00** (5 minutes), **6.00** (6 minutes), **10.00** (10 minutes), **15.00** (15 minutes), **20.00** (20 minutes), **30.00** (30 minutes) and **60.00** (60 minutes).

Note: The data log memory (see **L.Clr** below) must be cleared whenever the log update time is changed or the date and time is changed.

Hour (set time)

Displays and sets the current time in hours and minutes (24 hour format HH.MM) e.g. set as **17.20** for 5:20 pm.

dAtE (set date)

Displays and sets the current date in days and months (DD.MM format). The months will roll over automatically (up at the end of the month, down at the beginning of the month) as the day is scrolled up or down.

YEAr (set year)

Displays and sets the current year (YYYY format). Valid years settings are from 1970 to 2037 (valid Julian time format years).

L.Clr (clear data log memory)

This function clears the data log memory, to clear the memory press then release ▲ and ▼ simultaneously, the display will show **Clr?** asking if you really want to clear the memory. If you wish to clear memory then press then release ▲ and ▼ simultaneously again. The log memory will then be cleared and the log period reset, the display will indicate **ProgLog** to confirm this. Once the memory is cleared all previously logged records will be lost from the instruments memory, if the **Clr?** message is reached and it is not wished to clear the log memory then pressing and releasing either **F** or **P** will abort the function.

Serial Command Format

Instruments using the data logger option are provided with extra software functions to the standard instrument. This section describes these extra functions, refer to "RS232/RS485 Output Option" appendix for standard functions.

Initial Setup

Select the baud rate (**bAud**), parity (**PrtY**) and address (**Addr**) as required. The serial output mode function (**O.Put**) must be set to **POLL** when using the data logger.

Extra Functions

These functions are seen only in data logger software versions of the TP488.

Transmit Record Block:

    <STX>DA<CR>D<CR>TTTTTTTTTT<CR>NNNN<CR>

Where:

TTTTTTTTTT is the start time of the block (in Julian time format).
NNNN is the number of records to be sent.
Instructs the unit to send a block of logged data via the serial interface.

The returned data format is:-

    <ACK>DAD<CR>

Followed by NNNN records in the format:-

TTTTTTTTTT,S1111,S2222,S3333,S4444,S5555,S6666,S7777,S8888<CR>

Where: TTTTTTTTTT is the start time for each record (in Julian time format). If TTTTTTTTTT (time in "Transmit Record Block" request) is sent as 0 then the records will start at the earliest time in log memory.

S is the sign (<SPACE> for positive values and "-" for negative.)

1111, 2222 etc. are the values for each channel.

Values will only be transmitted for active channels. Invalid readings from any channel will be received as the overrange value (——) for that channel.

If the start time requested is not present in the log then <ACK>DA?<CR> will be returned.

Transmit All Logged Data: <STX>DA<CR>A<CR>

Instructs the unit to transmit the entire data log. All log records since the last log memory reset will be sent to the host.

The unit will respond with <ACK>DAA<CR> followed by all log record sent in the same format as above (Transmit Record Block)

Transmit System Time: <STX>DA<CR>T<CR>

Instructs the instrument to transmit the current time in Julian time format as follows:-
<ACK>DAT TTTTTTTTTT<CR>

Transmit the Log Start Time: <STX>DA<CR>S<CR>

Instructs the instrument to transmit the log start time i.e. the time stamp on the first record in the log. Note that if the memory has "wrapped around", i.e. has started to overwrite existing logged records, that the log start time will not be the original time the log started (since this time stamp and associated log record has been overwritten).

The returned data format is:-
<ACK>DAS TTTTTTTTTT<CR>

Transmit the Log Update Time: <STX>DA<CR>U<CR>

Returns the current log update time as set in the log memory. The returned time may be different to the **dLAY** time if there has been no log reset since the **dLAY** function was changed.

The returned data format is:-
<ACK>DAU NNNN<CR>
Where: NNNN is the update time in seconds.

Transmit the Log Memory Size: <STX>DA<CR>M<CR>

Returns the size of the log memory in records.

The returned data format is:-
<ACK>DAM NNNN<CR>
Where: NNNN is the number of records for that memory size e.g. an 8K memory will return 508.

Set the System Time: <STX>DA<CR>t<CR>TTTTTTTTTT<CR>

Set the instrument system clock to Julian time TTTTTTTTTT. If the command is successful then <ACK>DAt<CR> will be returned. If the Julian time is invalid then <ACK>DA?<CR> will be returned.

Set the Log Update Time: <STX>DA<CR>u<CR>NNNN<CR>

Set the log update time to NNNN seconds. Note that the new time will not apply until a log reset is performed. If the command is successful then <ACK>DAu<CR> will be returned. If the update time is invalid then <ACK>DA?<CR> will be returned. Valid times are as shown in the **dLAY** function explanation.

Reset the Log Memory: <STX>DA<CR>R<CR>RESET<CR>

This command will reset the log memory. This will erase all current records and reset the log update time if it has changed. As this will result in a loss of data the command must be sent exactly as it appears or the memory will not be reset.

If the command is successful then <ACK>DAR<CR> will be returned to indicate that the memory has been reset. If the command is invalid then <ACK>DA?<CR> will be returned.
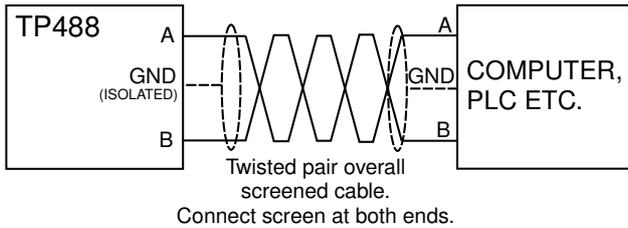
Appendix - Modbus Communications.

This addendum covers the use of Modbus RTU communications when using the TP488 scanning monitor. Refer to the standard TP488 instruction manual for any details of operation not covered in this addendum.
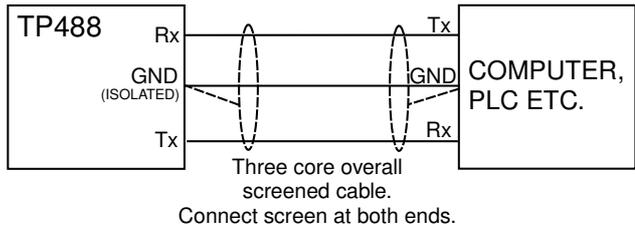
When using modbus communications the instrument must be set up electrically for RS232 or RS485 communications. The serial communications port is situated on a small printed circuit board which plugs into the main printed circuit board. Connections are as shown below.
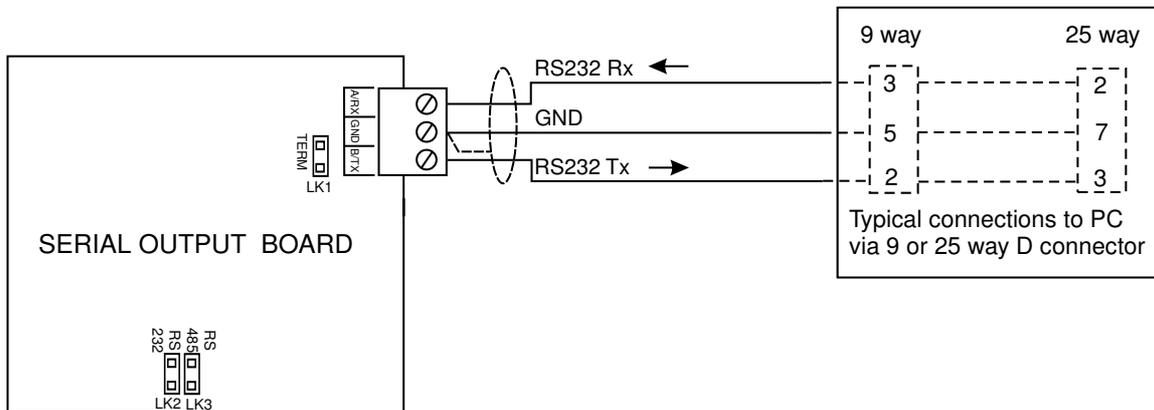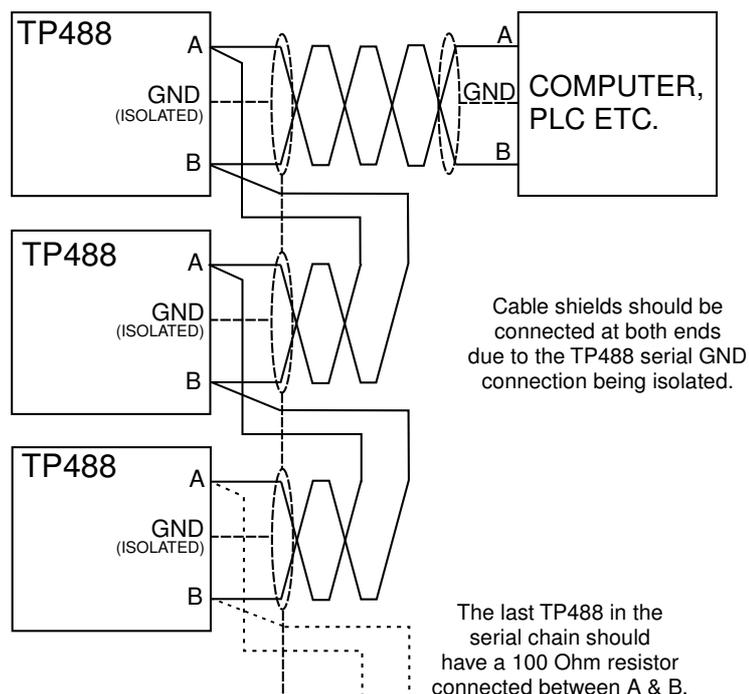
Modbus commands

RS485 CONNECTIONS

Twisted pair overall screened cable. Connect screen at both ends.

RS232 CONNECTIONS

Three core overall screened cable. Connect screen at both ends.

CONNECTIONS TO THE SERIAL OUTPUT BOARD

Typical connections to PC via 9 or 25 way D connector

MILTIPLE CONNECTIONS (RS485 ONLY)

Cable shields should be connected at both ends due to the TP488 serial GND connection being isolated.

The last TP488 in the serial chain should have a 100 Ohm resistor connected between A & B.

Note: the maximum recommended baud rate is 9600.
The following commands are available:

Function 1   Read coil status

Reads the ON/OFF status of the relay coils. Broadcast is not supported. Relays 1 to 8 are addressed as 0 to 7. Logic 1 = ON, Logic 0 = OFF.

To read the coil status a query is sent to the TP488, the TP488 then responds to the query.

An example of a query to read coils 1 to 8 from the TP488 at address 2 is given below.

Field Name	Example (Hex)
Unit address	02
Function	01
Starting address Hi	00
Starting address Lo	00
Number of points Hi	00
Number of points Lo	08
Error check (LRC or CRC)	–

An example of a response is given below:

Field Name	Example (Hex)
Unit address	02
Function	01
Byte count	01
Data (coils 8 to 1)	B6
Error check (LRC or CRC)	–

The status of the relay coils is shown in the Data B6 (hex) or binary 10110110. Relay 1 is indicated by the LSB and relay 8 by the MSB. The status of the relays is therefore:

Relay 1 - OFF, Relay 2 - ON, Relay 3 - ON, Relay 4 - OFF, Relay 5 - ON, Relay 6 - ON, Relay 7 - OFF and Relay 8 - ON.

Function 3 Read holding registers

This function reads the binary contents of the holding registers in the TP488 being addressed. Registers 1 to 8 hold display values for channels 1 to 8. Note a value of 32000 represents a positive overrange and -32000 a negative overrange. Registers 1 to 8 are addressed as 0 to 7.

Registers 9 to 16 hold the alarm high values for relays 1 to 8. Note a value of 0X8000 means that the relay is set to OFF and has no high value. Registers 9 to 16 are addressed as 8 to 15.

Registers 17 to 24 hold the alarm low values for relays 1 to 8. Note a value of 0X8000 means that the relay is set to OFF and has no low value. Registers 17 to 24 are addressed as 16 to 23.

Registers 25 to 32 represent the decimal point settings for channels 1 to 8. Registers 25 to 32 are addressed as 24 to 31.

An example of a query to read holding registers 1 to 3 from the TP488 at address 5 is given below.

Field Name	Example (Hex)
Unit address	05
Function	03
Starting address Hi	00
Starting address Lo	00
Number of points Hi	00
Number of points Lo	03
Error check (LRC or CRC)	–

An example of a response is given below:

Field Name	Example (Hex)
Unit address	05
Function	03
Byte count	06
Data Hi (register 1)	00
Data Lo (register 1)	33
Data Hi (register 2)	00
Data Lo (register 2)	25
Data Hi (register 3)	00
Data Lo (register 3)	17
Error check (LRC or CRC)	–

The contents of register 1 is 33 (hex) or 51 (decimal), register 2 is 25 (hex) or 37 (decimal) and register 3 is 17 (hex) or 23 decimal.

Register table for Function 3

Address	Register	Description
0X00	1	Channel 1 display value
0X01	2	Channel 2 display value
0X02	3	Channel 3 display value
0X03	4	Channel 4 display value
0X04	5	Channel 5 display value
0X05	6	Channel 6 display value
0X06	7	Channel 7 display value
0X07	8	Channel 8 display value
0X08	9	Alarm 1 high setpoint
0X09	10	Alarm 2 high setpoint
0X0A	11	Alarm 3 high setpoint
0X0B	12	Alarm 4 high setpoint
0X0C	13	Alarm 5 high setpoint
0X0D	14	Alarm 6 high setpoint
0X0E	15	Alarm 7 high setpoint
0X0F	16	Alarm 8 high setpoint
0X10	17	Alarm 1 low setpoint
0X11	18	Alarm 2 low setpoint
0X12	19	Alarm 3 low setpoint
0X13	20	Alarm 4 low setpoint
0X14	21	Alarm 5 low setpoint
0X15	22	Alarm 6 low setpoint
0X16	23	Alarm 7 low setpoint
0X17	24	Alarm 8 low setpoint
0X19	26	Channel 1 display decimal point
0X1A	27	Channel 2 display decimal point
0X1B	28	Channel 3 display decimal point
0X1C	29	Channel 4 display decimal point
0X1D	30	Channel 5 display decimal point
0X1E	31	Channel 6 display decimal point
0X1F	32	Channel 7 display decimal point
0X20	33	Channel 8 display decimal point

Guarantee and Service

The product supplied with this manual is guaranteed against faulty workmanship for a period of 2 years from the date of dispatch.

Our obligation assumed under this guarantee is limited to the replacement of parts which, by our examination, are proved to be defective and have not been misused, carelessly handled, defaced or damaged due to incorrect installation. This guarantee is VOID where the unit has been opened, tampered with or if repairs have been made or attempted by anyone except an authorised representative of the manufacturing company.

Products for attention under guarantee (unless otherwise agreed) **must be returned to the manufacturer freight paid** and, if accepted for free repair, will be returned to the customers address in Australia free of charge.

When returning the product for service or repair a full description of the fault and the mode of operation used when the product failed must be given.

In any event the manufacturer has no other obligation or liability beyond replacement or repair of this product.

Modifications may be made to any existing or future models of the unit as it may deem necessary without incurring any obligation to incorporate such modifications in units previously sold or to which this guarantee may relate.