

# TTI 7 TRUE TEMPERATURE INDICATOR



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The company is always willing to give technical advice and assistance where appropriate. Equally, because of the programme of continual development and improvement we reserve the right to amend or alter characteristics and design without prior notice. This publication is for information only.

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**GUARANTEE**

This instrument has been manufactured to exacting standards and is guaranteed for twelve months against electrical breakdown or mechanical failure caused through defective material or workmanship, provided the failure is not the result of misuses.

In the event of failure covered by this guaranteed, the instrument must be returned, carriage paid, to the supplier for examination, and will be replaced or repaired at our option.

FRAGILE CERAMIC AND/OR GLASS PARTS ARE NOT COVERED BY THIS  
GUARANTEE

INTERFERENCE WITH, OR FAILURE TO PROPERLY MAINTAIN THIS INSTRUMENT  
MAY INVALIDATE THIS GUARANTEE

**RECOMMENDATION**

The life of your **ISOTECH** Instrument will be prolonged if regular maintenance and cleaning to remove general dust and debris is carried out.

**We recommend this instrument to be re-calibrated annually.**

Serial No:.....

Date:.....



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**TTI 7  
OPERATING INSTRUCTIONS  
SOFTWARE VERSION 6.1**

**Supplied Accessories**

- 1 Mains Cord
- 1 Operating Instructions (English)

When unpacked, inspect for physical damage and report any defects immediately in writing, retaining packaging materials for inspection.

**Before placing into service, ensure mains voltage is correct.** Other voltages may also be selected according to the chart in the Maintenance section. Be sure to also change the fuse to the correct type and rating.

**SAFETY**

This apparatus is designated Safety class 1 as defined in the IEC publication 1010-1 (Amend 1).

**CE MARKING**

This apparatus complies with the CE marking directive, 93/68/EEC, and is in compliance with the following standards:

Generic Emission Standard	EN5081-1
Conducted Emissions	EN55022 Class B
Radiated Emissions	EN55022 Class B
Generic Immunity Standard	EN5082-1
Conducted Immunity (Power Lines)	prEN60 1000-4-4 1kV
Conducted Immunity (Signal Lines)	prEN60 1000-4-4 500V
Radiated Immunity	prEN60 1000-4-3 3V/m
Electrostatic Discharge Immunity	prEN60 1000-4-2 8kV
Electrical Safety Standard	IEC1010-1 (Amend 1)

## INSTALLATION

The TTI 7 is designed to be either free bench standing, or for rack mounting. The TTI 7 is 19½", 2.5U high.

When connected to a mains supply, the mains cord provided with the equipment should be used, and connected only to a mains supply with a suitable earth connection.

**Before connection to the mains supply, ensure that the correct voltage is set, and the fuse is of the correct rating.**

## MAINTENANCE

Normally no maintenance is required other than cleaning with a moist cloth. Avoid aggressive detergents or solvents.

**CAUTION:** Before any maintenance, repair or exchange of parts or fuses, the instrument must be disconnected from the mains supply and all other power sources. In the event of a fault occurring, the instrument should be returned to our factory or Agent for inspection. A mains fuse is fitted to the mains inlet socket on the rear panel, and should be replaced if necessary. The Instrument should only be serviced/repared by a competent engineer and only design approved replacement parts used.

**CAUTION:** Disconnect the mains lead and all connecting leads, before removing the fuse holder. Replace only with the correct fuse type, i.e. according to the following chart.

LINE VOLTAGE Selection	Range Vac 47-63Hz	Fuse (250V) IEC 127 5 x 20 mm
100V	90-110V}	630mA (T)
120V	108-132V}	
220V	198-244V}	315mA (T)
240V	216-264V}	

Maximum Input Power: 25VA

## BATTERIES

The thermometers may be used either directly connected to the mains supply or for portable applications run from the internal batteries. Approximately 10 hours continuous operation from a full charge is possible. The battery charger is built into the instrument and charging commences immediately the mains supply is connected, illuminating the LINE LED on the front panel. The batteries used are of the sealed lead acid type; continuous trickle charging causes no harm to the batteries and we always recommend running from the mains supply when possible, thus ensuring the batteries are always fully charged and ready for portable applications. The charger will automatically switch to trickle charge or fast charge mode depending upon the battery state.

LOW BATTERY indication is displayed when the batteries have approximately 10% charge left. When this indication appears, the thermometers should be connected to a mains supply as soon as convenient, as approximately 50 minutes operating time remains. To extend the battery life, the backlight can be turned off via the **OPT** menu. Operating time without backlight is approximately 14 hours.

**TECHNICAL SPECIFICATION**

DISPLAY: LCD Graphics Panel, 240 x 64 dot, with LED backlight contrast control via front panel keyboard.

INPUTS: 2 channels for PRTs via 6 pin Lemo sockets. LEMO type number for input plug: FGG1B.306.CLAD52

INPUT IMPEDENCE > 10MΩ  
Max. input Voltage ± 40Vdc, 28Vrms  
Common Mode Rejection 50Vrms

The inputs are linearised and user selectable to the following standards:-

IEC751 R0=100Ohm, Ra=3850  
US/JIS R0=100 Ohm, Ra=3851  
EN-751 R0=100 Ohm, Ra=3850 in accordance with ITS90 standards  
USER Up to 20 probes may be configured to customer entered constant, A B, C, and R0 values.  
A Standby current is always passed through the sensors.

**UNCERTAINTY OF MEASUREMENT:**

INPUT	RANGE °C	RESISTANCE Ohm	CURRENT	RESOLUTION °C °F K	UNCERTAINTY 1 year @ 20 ±5°C
Pt100	-200 to -100	18 to 60	1mA	0.001	0.02°C
	-100 to +500	60 to 280	1mA	0.001	0.01°C
	+500 to +800	280 to 450	1mA	0.001	0.02°C

2 channels for thermocouples via miniature and standard thermocouple connectors.

The Inputs are linearised for the following thermocouple Types B,E,J,K,N,R,S,T and in accordance with the following Standard, NIST 175, ITS 90. Types C & D to ASTM E988

Reference Junction compensation may be selected for the following modes:-

Automatic:- Internal Reference Junction range 0 to +40°C  
External:- Via Pt100 sensor connected to channel A or B range 0 to +100°C  
OFF:- Turns the Reference Junction OFF = 0°C

**UNCERTAINTY OF MEASUREMENT**

TYPE	RANGE °C	RESOLUTION °C °F or K	DISPLAY RESOLUTION µV	UNCERTAINTY @ 20°C ± 5°C 1 YEAR	UNCERTAINTY @ 20% ± 5°C 60 Days	TEMPERATURE COEFFICIENT /°C
B	+250 to +1820	0.01	1.0	± (0.025% Rdg + 0.006%FS) *	± (0.02% Rdg + 0.006% FS) *	7 ppm Rdg + 6 ppm FS
C	0 to +2315	0.01	1.0	± (0.075% Rdg + 0.005%FS)	± (0.05% Rdg + 0.005% FS)	7 ppm Rdg + 6 ppm FS
D	0 to +2315	0.01	1.0	± (0.075% Rdg + 0.005%FS)	± (0.05% Rdg + 0.005% FS)	7 ppm Rdg + 6 ppm FS
E	-200 to +1000	0.01	1.0	± (0.026% Rdg + 0.004%FS)	± (0.01% Rdg + 0.004% FS)	7 ppm Rdg + 6 ppm FS
J	-210 to +1200	0.01	1.0	± (0.03% Rdg + 0.005%FS)	± (0.008% Rdg + 0.005% FS)	7 ppm Rdg + 6 ppm FS
K	-200 to +1372	0.01	1.0	± (0.035% Rdg + 0.006%FS)	± (0.01% Rdg + 0.006% FS)	7 ppm Rdg + 6 ppm FS
N	-200 to +1300	0.01	1.0	± (0.035% Rdg + 0.005%FS)	± (0.01% Rdg + 0.005% FS)	7 ppm Rdg + 6 ppm FS
R	-50 to +1768	0.01	1.0	± (0.02% Rdg + 0.015%FS)	± (0.005% Rdg + 0.015% FS)	7 ppm Rdg + 6 ppm FS
S	-50 to +1768	0.01	1.0	± (0.02% Rdg + 0.015%FS)	± (0.005% Rdg + 0.015% FS)	7 ppm Rdg + 6 ppm FS
T	-200 to +400	0.01	1.0	± (0.025% Rdg + 0.015%FS)	± (0.005% Rdg + 0.015% FS)	7 ppm Rdg + 6 ppm FS

\* Apply to readings above 600°C

The above figures apply to values with Reference Junction switched off.

Reference Junction uncertainty when used in automatic mode (INT) is better than 0.1°C at + 20°C with a deviation of typically 0.01°C/°C over the range 0 to 100°C.

**CALIBRATION:** Digital security code protected. Default number set 9252

**BATTERIES:** 1 x Sealed Lead Acid Battery 6V 2.8AH to power digital circuit and display  
1 x Sealed Lead acid Battery 6V 1.2 AH to power analogue circuit  
1 x Lithium Battery T068AA for data logging memory  
Operating time after full charge 10 hours with backlight, 14 hours without backlight

**WORKING** 0...50°C rel. humidity less than 90% non condensing



TEMPERATURE:

STORAGE TEMPERATURE: -20...+55°C

MAINS SUPPLY: 100/120/220/240 Volts +10% -13%  
47...63Hz. 80VA

DATA LOGGING: Up to 4000 single channel values may be stored with date and time.

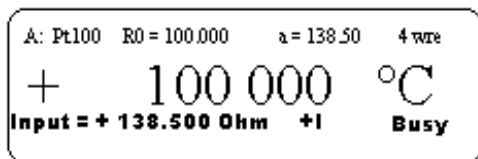
MATHS: Computes Max/Min values, Mean values, peak to Peak values, and standard deviation. Values all computed from values stored in log.

## GENERAL

The TTI 7 comes ready for immediate use, with rechargeable batteries and built-in charger.

The instruments are switched on and off using the left hand buttons marked appropriately. Connecting the mains cord automatically enables the battery charging circuit and charges the batteries at the required rate. The LED marked "LINE" will illuminate to show that mains power has been connected to the thermometer and the LED marked "FAST" will light when the batteries are low and the charger is charging at a high rate. The charger will automatically reduce the charging current to a trickle charge as the batteries reach approximately 80% of full capacity. Continuous trickle charging will not affect the batteries and we recommend that the TTI 7 is used with the mains supply connected whenever possible.

To measure temperature, a suitable probe should be connected to input A or B. The measured temperature will be displayed in large units and the actual resistance or voltage measured will be displayed in smaller units below, together with the measuring current mode selected. In addition the probe configuration and channel details will be displayed along the top of the display.



*fig .1 Typical display*

## FRONT PANEL KEYS



Fig. 2 : Front Panel Keyboard

**DISPLAY CONTRAST:** To change the contrast, press and hold down either the  $\uparrow$  or  $\downarrow$  key the contrast will vary and may be selected for optimum viewing. The contrast and the viewing angle is changed and it may be desirable to alter the contrast from time to time as your reading position alters.

- A** selects channel A to the display
- B** Selects channel B to the display
- A-B** Displays the difference between probe A and probe B.  
In this case the millivolt/resistance reading will not be shown.

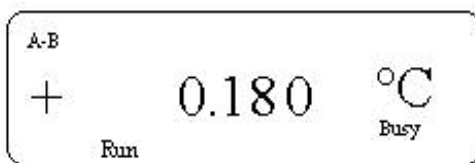


Fig.3: Display in A-B Mode

**SENS** A menu is displayed giving the choice of probe configurations. There are 3 standards to choose from. IEC751, US/JIS, EN-751 in addition there is a fourth option *Usr* which allows the operator to store probe characteristics under a file number, up to 20 different probe characteristics may be stored. **NOTE** The status line at the top of the display will confirm the current sensor configuration. To change sensor configuration press **SENS** key and from the menu displayed select the option required by pressing the button immediately below. If the **Usr** (user) key is pressed a further menu will be displayed, the probe characteristics can then be entered together with a probe number. A maximum of 20 different probes may be stored in this way.

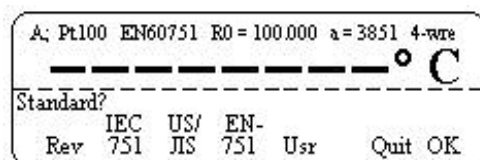


Fig. 4:Probe configuration menu

The menu first offers a choice of Prt's or thermocouples, if Prt's are chosen than the menus are as above. With thermocouples selected a menu will offer a choice of thermocouple types, press the key below your chosen type to select it. The choice of reference junction configuration will then be offered **AUTO** or **EXT**, the most commonly used option is **AUTO** which selects the internal reference. It should be noted that there is a separate reference for each channel and that every effort has been made to ensure that the best possible performance for the reference junction is achieved.

Should an external temperature be used for the reference then the **EXT** option should be selected and a Pt100 probe connected to the RTD input and temperature sensed by this probe will be used as the reference junction temperature. Connect the RTD probe to the same channel to which the thermocouple is connected, eg for a thermocouple on Channel A ensure the RTD is also connected to Channel A. When the OFF option is chosen the Reference Junction is turned OFF and the values are referenced to 0°C.

AN IMPORTANT feature of the thermometer is that each channel may be configured with any sensor type so that RTD's may be compared against thermocouples.

## SENSOR CONFIGURATION

The TTI7 thermometers offer real flexibility, with 3 standard Pt100 linearisations plus a user option. These options may be selected as follows.

Press key **SENS** and menu will display the options:

IEC751: Linearises in accordance with IEC751 tables with  $R_0=100\text{ohm}$  &  $R_a=3850$

US/JIS: Linearises in accordance with US and JIS tables  $R_0=100\text{ohm}$  &  $R_a=3916$

EN-751: Linearises in accordance with ITS90 Standards  $R_0=100\text{ohm}$  &  $R_a=3851$

**Usr** Enables probe specific coefficients to be programmed and stored and recalled with probe identification serial number. The top line of the display shows the configuration of the probe selected, it is permitted to set channels A & B to different configurations. The information is displayed as follows:

Channel identification      Standard selected       $R_0$        $R_a$       3 or 4 wire.  
(If A-B is displayed then this status line blanks)

To change a sensor configuration first select **Usr**, and enter probe number (1 to 20) and confirm with **OK** key. To review/edit the coefficients press the **Rev** button, the upper half of the display will show the probe coefficients  $R_0$ , A, B, & C values. The lower half of the display enables these coefficients to be edited by selecting **Yes**, each value may now be changed individually by pressing the key directly below the option required. (e.g. press **Ro** and you will be asked to enter the  $R_0$  value). Confirm this selection with **OK**, at this point the value is not written to the memory and it is possible to return to the previous setting. Once all the coefficients have been edited press **OK** you will then be asked if these new coefficients should be stored in the memory, press **No** and you will exit the edit menu without storing the new values. Press **Yes** and the new coefficients will be stored. Press **Quit** to return to the measuring screen.

```

A: Pt100 User -1      R0= 100.000 Ohm
                    A= 3.90830 E - 3
                    B= 5.77500 E - 7
                    C= 4.18300 E - 12
Edit Coefficients?
                    Yes No   Quit
  
```

```

A: Pt100 User -1      R0= 100.000 Ohm
                    A= 3.90830 E - 3
                    B= 5.77500 E - 7
                    C= 4.18300 E - 12
Edit Coefficients?
                    RO A   B   C   Quit OK
  
```

Fig.5: Review menu for probe characteristics      Fig.6: Edit menu for probe characteristics

**UNIT** This key changes the units of the temperature display, each key press will change the units to the next available in the order °C °F K

**RESN** When the thermometer first powers up the display defaults to a resolution of 0.01, this resolution can be increased to 0.001 by pressing the **RESN** key, pressing again returns the resolution to 0.01

**MATH** This takes you into the maths function of the thermometer and allows statistical analysis of stored values to be displayed. (use the Log function to store these values) Press **Stats** and the following values will be displayed, **Max** and **Min** values, **Mean** value, **Peak to peak** value, and **Standard deviation**. The number of samples these values are derived from is also displayed.

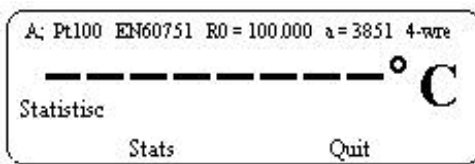


Fig 8. Stats Menu

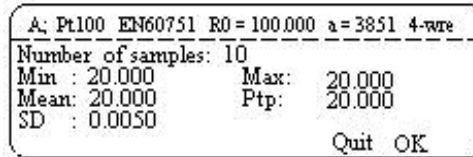


Fig.7 Display of statistics



**WARNING: STATS** will only be calculated and displayed from values held in the log, and will only be displayed when the stored log values are all for the same channel. If different channel readings have been stored the STATS is invalid. It is also important to be aware that changing the probe characteristics settings during logging will invalidate any STATS displayed. A minimum of 2 readings in this log is required to complete the STATS.

**MEM** This key will take you into a menu with the options **Cal** or **Log**. The **Cal** option takes you into the instrument calibration routine and the **Log** into the data logging function.

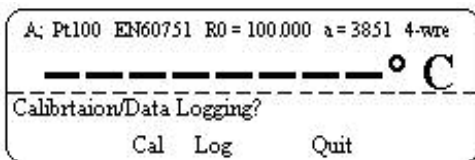
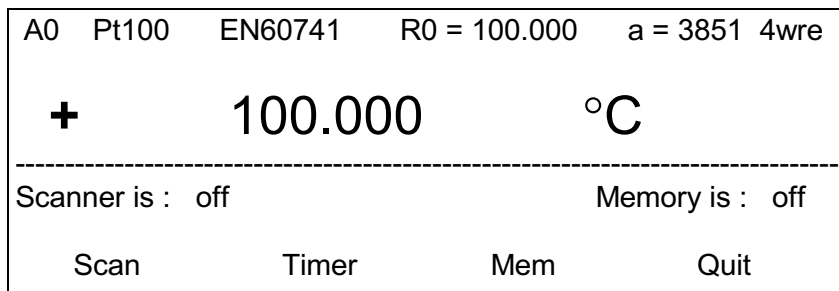


fig.8: Mem menu

## SCAN.DATALOG FUNCTIONS

To set a scan sequence and store values in the datalog enter **SCAN** option the display will read



Select **Scan** from the menu to set up the scan sequence

A0	Pt100	EN60741	R0 = 100.000	a = 3851	4wre
+		100.000		°C	
-----					
Scanning list is : off					
SL1	SL2	SL3	SL4	Edt	Off
Quit	OK				

Four different scanning lists labelled **SL1** to **SL4** may be set up to be stored and recalled for later use, Select the list to be edited using the **Edt** key

A0	Pt100	EN60741	R0 = 100.000	a = 3851	4wre
+		100.000		°C	
-----					
Scanning list edit: SL1					
A0	B0				
<	>	Add	Del	Quit	OK

The channels available to add to the scanning list are designated A0 and B0. The Flashing channel may be added with **Add** key or deleted with the **Del** key moving between the channels with the < > keys. Once a channel is added to the scan list the channel is highlighted, pressing the **OK** key stores that scanning sequence.

A0	Pt100	EN60741	R0 = 100.000	a = 3851	4wre
+		100.000		°C	
-----					
Cyc = Cont		Delay = 00:00:00		Rate =	
00:00:00					
<	>	Clear	Edit	Quit	OK

To set the number of scan cycles and the delay between cycles select the **Timer** and the above menus will be displayed. The changeable parameters will flash. To change the flashing parameter press **Edit** and enter the appropriate number of Cycles 0 to 9999 or continuous. Pressing the **Clear** key returns to the default setting. The following may be set **Cyc** - This is the number of scanning cycles any number between 1 and 9999, continuous can also be set.

**NOTE** if the data logger is turned on then the number scan cycles is limit to 4000 readings.  
**Delay** - This sets the delay before the scanner cycle starts and may be set between



00:00:00 and 59:59:59. **Rate** - This sets the time between each channel selection and may be set between 00:00:00 and 59:59:59.

Example:     Set Cyc to 10  
              Set Delay to 00:10:00  
              Set Rate to 00:00:40

The channels will be scanned 10 times with a start delay of 10 minutes and 40 seconds delay between each channel selection.

A0	Pt100	EN60741	R0 = 100.000	a = 3851	4wre
+		100.000		°C	
Input =138.500 Ohm		+I	Busy		
Hold		SL1	0/10		

The measurement display will start in the measurement **Hold** position Press **TRIG** to start the scan cycle.

A0	Pt100	EN60741	R0 = 100.000	a = 3851	4wre
+		100.000		°C	
Input =138.500 Ohm		+I	Busy		
Run		SL1	0/10		

The display will first show the count down timer once the start time is reach the display will indicate run and the number of scans will be display. Once the set number of scans has completed the display will return to the Hold position until triggered again.

## DATA LOGGING SETUP

To store values enter the **MEM** option and select **Log**, select the **Set Up** option and the number of samples or readings to be stored will be displayed. To accept this number press **Yes**, to change the number press **No**, and then enter the number of samples you wish to store, (this number must be between 1 and 4000.) Press **OK**, you will then be asked to confirm your choice. Press **Yes**, the logging mode can switched on or off and the previous stored values scrolled to the display using the **Rev** option. The values will be displayed with log number, channel measured, the temperature value, date and time.

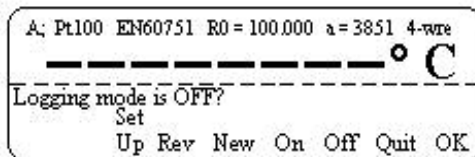


Fig.9 : Data logging Menu

Log#	CH#	Temp(degC)	Date	Time
1	A	20.000	01/05/97	10:00:00
2	A	20.000	01/05/97	10:02:00
3	A	20.000	01/05/97	10:04:00
4	A	20.000	01/05/97	10:06:00
5	A	20.000	01/05/97	10:08:00
6	A	20.000	01/05/97	10:10:00

Fig.10: Screen showing logged values

To scroll the pages use the left hand up/down arrow keys, and to exit the review screen press the **OK/MEM** key.

To clear the current logged values select **New** and the display will ask you to confirm that you wish to clear the current stored values. Press **Yes** or **No**. If **Yes** is pressed you will be requested to confirm your choice, press **Yes** to confirm. The logging mode may then be activated by pressing the **On** key. When the set-up is complete press **Quit** and return to the measurement mode. The bottom line of the display will show the data log status information:-

“Hold Samples = 0/20 ”

To trigger the measurements and store samples press the **TRIG** key. This line will now change to “Run Sample=#/20”, where # = the number of samples stored. When the set number of values are stored, the measurements return to the Hold state. Press the **TRIG** key again and the display will ask if you wish to clear the current log. Press **Yes** and confirm, the **TRIG** key will now start a new measure and store cycle.

The values logged will always relate to the channel on the display. It is possible to stop the logging function, change channels and restart logging using the **TRIG** key (see **TRIG** section below).

**ZERO** This key zeros the displayed value and "Zero" appears in the bottom left hand corner of the display. NOTE: The Zero offset will be cancelled if the measuring channel is changed, if the calibration menu is entered, or if the sensor configuration is changed.

**TRIG** The **TRIG** key operates in two modes. These may be set using the **OPT** menu. The default mode enables the **TRIG** key to be used as a run/hold button and Run appears on the display above the key, pressing **TRIG** holds the display and Hold will appear on the display. It will also be noticed that the

flashing "Busy" blanks in the hold mode. Pressing **TRIG** a second time returns the instrument to the run mode. The second mode of operation may be set using the **OPT** menu. This enables the **TRIG** key to be set in single shot mode, i.e. when pressing the **TRIG** key, one measurement is made and held on the display, and the busy sign flashes once. It should also be noted that even for large changes in temperature readings the new measurement will be valid, the specially designed measurement circuit ensures that the A/D converter is fully zeroed and stabilised before a new measurement is displayed.

When used in conjunction with the data logging function the **TRIG** key is used to start the logging. Pressing the **TRIG** key again puts the instrument into a hold state and the measurement channels may now be changed. Restarting the measurement by pressing the **TRIG** key also resumes the data logging; the newly selected measurement channel now being stored. It is possible to store readings from channels A, B, or A-B. When in single measurement mode the instrument is normally in the hold state. Pressing the **TRIG** key initiates one measurement which will be stored in the log, the instrument then returns to the hold state.

- +I** This selects the measuring current in the positive direction. The measuring time is approx. 1.8 seconds per reading for channels A and B, and 3.6 seconds for A-B.
- I** This selects the measuring current in the negative direction. Measuring time approx. 1.8 seconds per reading for channels A and B and 3.6 seconds for A-B.
- AVE** This automatically switches the measuring current from forward to reverse direction and displays the average of the 2 readings thus eliminating any errors due to thermal emf. Measuring time approximately 3.6 seconds per reading for channels A and B and 7.2 seconds per reading for A-B
- $\sqrt{2}$**  Current is reduced through the measuring probes by  $\sqrt{2}$  (half power) enabling any probe self-heating to be determined. The best method of use for this option is to first allow the sensor to reach a steady temperature and note the value, it will take some time for the sensor to stabilise. Select  $\sqrt{2}$  current and immediately press the ZERO key, the reduced current through the probe will reduce the heating effect on the probe and any value displayed will represent the temperature change due to the reduced current. The advantages of using the ZERO key in this way are twofold, firstly, any errors in the measuring amplifiers due to a change in current are removed, and secondly from a calculation point of view, the change in reading will be displayed without further calibration being required.

## OPT

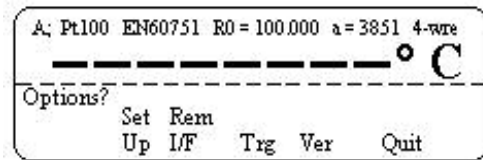


Fig.11: Options menu

Selects the various instrument configurations the following options are offered:

### Set-up:

- BACKLIGHT** may be turned on/off press **OK** to confirm setting.
- BEEPER** may be turned on/off press **OK** to confirm setting.
- TIME** Current set time is displayed, to change press **Chg** and enter the new time. Hours/minutes/seconds format is used. Press **OK** to confirm settings.
- DATE** Current set date is displayed, to change press **Chg** and enter the new date Days/Month/year format is used. Press **OK** to confirm settings.
- REM I/F** Pressing this key will display the various settings available to the interface i.e. Baud rates etc.

**Trg:** The trigger mode can be changed, selecting **Sng** enables the **TRIG** key to be used as a single trigger. Only one measurement will be made and held on the display. Selecting **Run** enables the Run/Hold mode. Pressing the **TRIG** key holds the reading with the current value held on the display. Press **TRIG** again and the measurement is in **Run** mode with continuous measurements being displayed.

## RTD INPUTS

There are 2 LEMO sockets for the Pt100 inputs and the connections are as fig 1. For the best performance we recommend 4 wire sensors, but the TTI7 thermometers are able to measure with 2, 3, and 4 wire sensors. The sensors may be plugged into either channel A or B. The connection plug for the PRT sensors is LEMO type FGG.1B.306.CLAD52

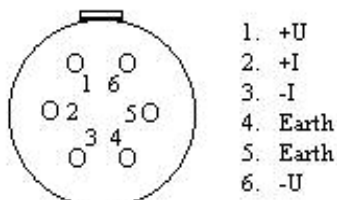
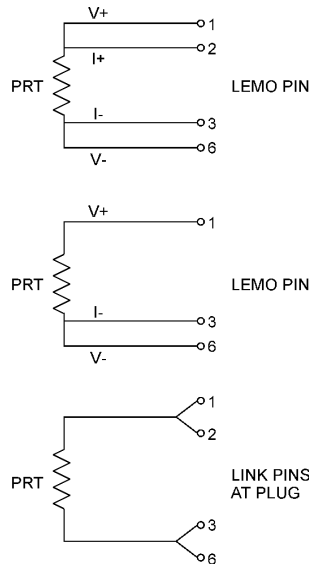


Fig.11: View of input socket

## Probe Connection



## THERMOCOUPLE INPUTS

When measuring thermocouples care should be taken to achieve the best results. The inputs are via 4mm sockets and a range of thermocouple plugs are available for connection. The input sockets are copper and behind the front panel to avoid the external effects of draughts. The reference junction may be set in three different modes, the first is automatic (INT) and Pt100 sensors are attached to the upper input sockets and monitor their temperature automatically applying the corrections. The accuracy of the internal reference is approximately  $\pm 0.1^\circ\text{C}$  to achieve more accurate results, an external reference may be used (Ext), when using an external reference the Pt100 input is used to sense the external reference temperature. The accuracy of this is as for Pt100 measurement  $\pm 0.01^\circ\text{C}$  in addition to this there will be some errors due to the configuration of the external reference, but generally with care, it is possible to achieve better results when using the external reference mode. Finally, the reference junction may be switched off (OFF) and in this mode the thermometer assumes a reference junction temperature of  $0^\circ\text{C}$ . This mode of operation is used when an external automatic reference is used such as our RJ## series. Again using this mode of operation gives slightly better results than will be achieved when using the internal reference.

## **CAUTION**

When measuring thermocouples with the TTI7 thermometer it should be remembered that the temperature may be read to 0.01°C and this is equivalent to approximately 0.4µV per digit with a type K thermocouple. Care must therefore be taken to avoid exposing the instrument inputs to draughts or a heat source such as sun shining on the front panel. To obtain the best results the instrument should be placed in a temperature controlled room and switched on for at least half an hour before measurements are made. Running on battery power without the mains supply connected will also be of benefit.

When connected to the mains the batteries will be charged and additional heat generated inside the instrument. Great care should also be taken to ensure that the correct materials are used when making connections and avoid unnecessary joints of different materials as these again will cause small errors.

We offer a range of thermocouple connectors for use with the TTI7 thermometer as well as a range of automatic reference junctions and an external reference enclosure with integral Pt100 sensor, please ask our sales staff for more information.

## **CALIBRATION**

The TTI 7 has been designed to give long service and permanence of calibration together with a low cost of ownership. Attention to detail in the design stage has produced an instrument that is quick and simple to recalibrate with the minimum of equipment. Prior to calibration the unit should be placed in a temperature controlled environment for a minimum of 4 hours, care could be taken to use good quality test leads, thus avoiding any thermal emf, together with resistance standards of known value. To select the **Cal** option press the **MEM** key and then select the **Cal** option from the menu. The calibration counter number will be displayed, a second menu choice will be given **Cal** or **Prt**. The **Prt** option will print the calibration constants to the screen, this is used as a diagnostic tool to ensure that there is no corruption of these constants. Select the **Cal** option and you now enter the calibration routine. The display will ask for a passcode to be entered, the default passcode number is **9252**, enter this number and press **OK**. Any number between 0 and 9999 is valid. The display will then give you the option of changing the passcode to your own personal number, if you select **Yes** you will then be asked to enter your chosen number via the keypad ending by pressing **OK**. You will then be asked to confirm your number. Once the new number is accepted the calibration counter will increment 1. The display will then give a choice of calibration RTD, T/C, RJA, RJB, it is preferable to calibrate the RTD ranges first.

### RTD CALIBRATION

Select this option by pressing the key below RTD, the display will then prompt you to connect 100 ohm resistance standard to channel A. When connected press **OK** and you will be prompted to enter the exact value of the standard. Once the value is entered and the **OK** pressed you will be asked to confirm the value by pressing **OK** again. The instrument will then calibrate itself against this standard storing the calibration constants in the memory. Next you will be asked to connect a 400 ohm resistance standard and repeat the above. Finally you will be prompted to connect a 250 ohm resistance standard and again repeat the above. Once this calibration is completed the display will return to the main calibration menu. At this point you have the option of calibrating the thermocouple range or pressing **QUIT** key to return to the measuring mode.

## **CAL NOTEPAD**

The models are supplied with Cal NotePad as standard. This easy to use package is compatible with MS Windows 9x. A handbook for Cal NotePad can be found on the first installation disk in Adobe PDF format. If required a free Adobe PDF reader can be downloaded from, [www.adobe.com](http://www.adobe.com).

Cal Notepad can be used to log and display values from Dry Blocks and supported temperature indicators.

## **Minimum System Requirements**

CNP requires Windows 95 / 98, a minimum of 5Mb of free hard drive space and free serial ports for the instruments to be connected.

## **Development**

CNP was developed by Isothermal Technology using LabVIEW from National Instruments.

## **License**

Use of the Cal NotePad software program "CNP" is as granted in this license agreement. In using the CNP

software the user "licensee" is agreeing to the terms of the license. You must read and understand the terms of this license before using CNP.

1, This license permits licensee to use CNP software on a single computer. The user may make copies for back up and archival purposes freely as long as the software is only ever in use on a single computer at any one time. Please enquire about multi-user licenses.

2, CNP is protected by international copyright laws and treaties. CNP must not be distributed to third parties.

3, CNP must not be reversed engineered, disassembled or de-compiled. Licensee may transfer the software to a third party provided that no copies or upgrades of CNP are retained.

4, It is the responsibility of the user to ensure the validity of all stored results and printed certificates. Isothermal Technology Ltd accept no responsibility for any errors caused by inappropriate use, incorrect set up or any other cause; including defects in the software.

5, Limited Warranty. Isothermal Technology warrants that CNP will perform substantially as described in this manual for a period of 90 days from receipt. Any distribution media will under normal used be guaranteed for a period of 90 days.

NO OTHER WARRANTIES, EXCEPT AS STATED ABOVE. The software and documentation is provided "as is" without warranty of any kind and no other warranties (either expressed or implied) are made with regard to CNP. Isothermal Technology does not warrant, guarantee or make any representations regarding the use or results of the use of the software or documentation and does not warrant that the operation of CNP will be error free.

In no event will Isothermal Technology, its employees, agents or other associated people be liable for direct, indirect, incidental or consequential damages, expenses, lost profits, business interruption, lost



business information or other damages arising out the use or inability to use CNP. The license fee reflects this allocation of risk.

CNP is not designed for situations where the results can threaten or cause injury to humans.

### **Installing Cal NotePad**

- I. Insert CNP DISK 1 into the disk drive
- II. Click on the START button on the task bar, select RUN, type A:\SETUP (Where A: is your drive letter) then click OK
- III. Follow the prompts which will install the application and necessary LabVIEW run time support files.
- IV. Should you ever need to uninstall the software then use the Add/Remove Programs option from the Control Panel.

### Starting Cal NotePad

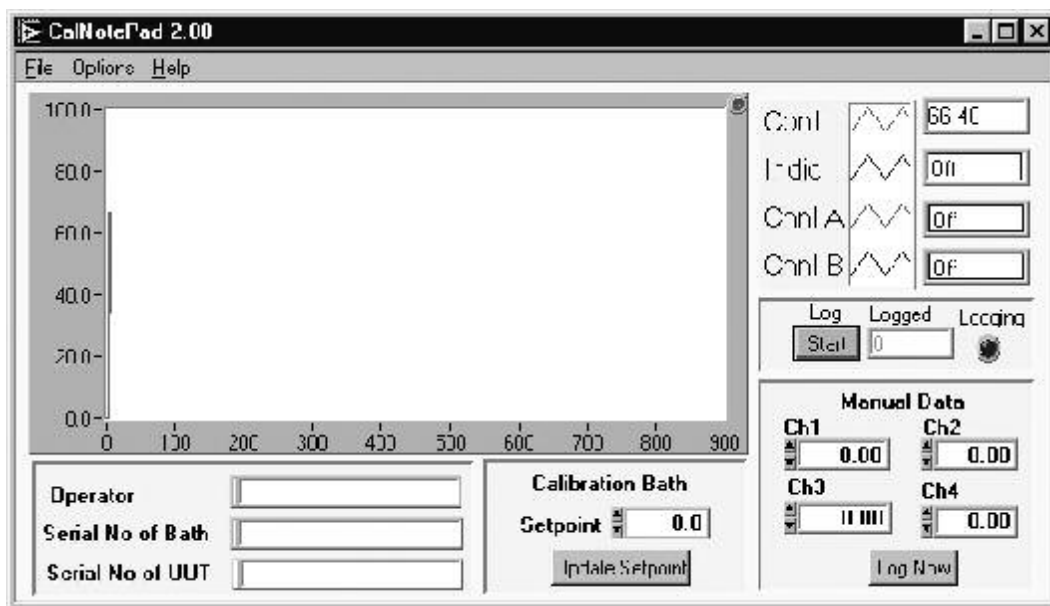
From a Standard Installation:

Click the START button

Highlight PROGRAMS

Select Isotech - Select Calpad

Note: Ensure the TTI 7 is switched on and connected to the PC before starting the software.



### Configuring for the TTI 7

From File – Config select for Instrument and Channels Cropico 3000 ChA for Channel A or to log both channels select Cropico 3000 ChA and B.

Select this option by pressing the T/C key in the calibration menu. Connect a mV source to the thermocouple input of channel A using low thermal copper leads and connectors. The display will prompt you to set the input to 0mVdc and press **OK**. Next +75mVdc should be supplied and **OK** pressed, finally -75mVdc should be supplied and again the **OK** pressed. These three values will calibrate the complete thermocouple range of the instrument. The display will again return to the main calibration screen and the reference junction should now be calibrated.

### **RJ CALIBRATION**

The reference junction of both channel A and channel B should be calibrated. Select RJA, insert a Pt100 standard thermometer in the 4mm negative (lower) input socket of channel A and allow the temperature to stabilise, it is necessary to use a sensor that fits securely into this socket. Once the temperature of the socket has stabilised and a steady temperature reading is obtained, enter the temperature into the instrument, the screen will prompt you to enter the block temperature. Confirm the value and press **OK**. Repeat this procedure for channel B moving the sensor to the negative input socket in channel B.

Once both channels have been calibrated you may exit the calibration menu with the **QUIT** key.

### **EQUIPMENT NEEDED**

1 Resistance Standard Type RS3/100 Value 100 Ohms	1 mV source -75 ... 0 ... +75 mV
1 Resistance Standard Type RS3/250 Value 250 Ohms	1 Pt100 sensor and measuring instrument
1 Resistance Standard Type RS3/400 Value 400 Ohms	
1 Calibration Lead Type TS01	

The Value of the resistance standards should be known with an uncertainty  $\pm 5$ ppm or better Suitable resistance standards are available for calibration together with a calibration connection lead, please consult our sales staff.

### **ENVIRONMENT**

We expect the TTI 7 thermometers to give long and trouble free service but, as with everything, there will come a time when you wish to replace it. Isotech will continue to develop new instruments and to update the design of existing models, and therefore will be able to offer an instrument suitable for your needs.

When disposing of the batteries care should be taken to comply with current legislation concerning their disposal. If in doubt the batteries can be returned to our factory for safe disposal. In addition to the 2 sealed lead acid batteries there is also 1 nickel cadmium battery which supports the logging memory.

**WARNING**



DO NOT DISPOSE OF BATTERIES IN FIRE  
DO NOT SHORT CIRUIT  
DO NOT PUNCTURE, OPEN, DISMANTLE OR  
OTHERWISE  
MECHANICALLY INTERFERE WITH THE  
BATTERIES.  
DO NOT SWALLOW

## APPENDIX A – PC INTERFACE

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## **INTRODUCTION**

The interface card fitted is automatically detected by the instrument software at power-up. Additional features such as Baud Rate and addresses are set from the front panel menu.

## **RS-232 SERIAL INTERFACE - CONNECTION**

This conforms to specification ANSI/EIA/TIA-232-E-1991 "Interface Between Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange." A list of pin assignments is given in Appendix II.

Signal levels: MARK (logical "1"): -3V to -15V  
SPACE (logical "0"): +3V to +15V

Data is transferred using the TXD and RXD lines.

Hardware handshaking for each character transfer uses the RTS and CTS lines.

RTS is an output from the TTI 7 which indicates its receiver status. When asserted (low) it indicates that it is ready to receive another character. When negated (high) the TTI 7 receiver buffer is full and cannot receive another character until the buffer is processed (if the PC sends one it may be lost). As soon as space becomes available in the receiver buffer, RTS is re-asserted to allow the PC to send the next character.

When the TTI 7 detects receipt of a line terminator character, RTS is negated whilst the command line buffer is read and validated. This is to prevent the PC sending further characters whilst a command is being validated. Following validation, RTS is re-asserted to permit the next command to be transmitted by the PC.

CTS is an input to the TTI 7 and controls the transmission of characters. If the PC asserts CTS (low) then the TTI 7 will transmit the next character from the output buffer (if one is waiting). If the PC negates CTS (high) then the TTI 7 will not transmit the character, but will wait until CTS is re-asserted. TXD will remain in the mark (low) condition whilst CTS is negated. Note that changing CTS during transmission of a character will not disrupt the transmission of that character.

If a 3-wire (TXD, RXD, GND) connection is to be used, connect RTS to CTS at the TTI 7 end. But take care; sending characters too quickly to the TTI 7 could cause its receiver buffer (4 characters) to overflow and subsequent characters may be lost. Always use a time delay between transmitted characters, or better still, use the full 5-wire connection for reliable hardware handshaking of each character.

It is recommended that Isotech TTI-7 cable is used for connecting the TTI 7 to a PC. This has the 5-wire connection and will maintain EMC integrity.

For a 9 Pin RS232 Port the cable is wired

PC	TTI-7
2	3
3	2
5	5
7	8
8	7

### **Front Panel Set-up**

Press OPT on the front panel and select Rem I/F. A further menu will now allow the selection of Talk Only Mode and Baud Rate.

#### **Talk Only Mode**

At power-up this is always cleared to the OFF state i.e. the interface is in full talk/listen mode.

Select ON to force the Talk Only Mode. In this mode the interface will ignore all incoming interface commands and the instrument will remain in LOCAL control mode. The result of each temperature measurement is sent to the interface output with the resolution and units as per the main display. See section 5.1 for output data format.

This mode is useful for sending results directly to a printer without the need for a PC.

#### **Baud Rate**

On selecting Baud Rate, the current setting is displayed. This defaults to 9600 following a CAL RESET operation and is the usual setting on shipment. If this is acceptable press "OK".

### **To Use the Isotech Software Leave the Baud Rate set at 9600**

To change the value, press "Chg" and enter the new rate required.

Valid rates are 75, 110, 150, 300, 600, 1200, 2400, 4800, 9600, 19200 Baud. These set the Baud rate for both transmit and receive.

The data word format is fixed at:

Start bit:	1
Data word length:	8 bits
Parity checking:	None
Stop bit:	1

*Software handshaking using XON/XOFF is not implemented.*

### **PROGRAMMING THE INTERFACE - INTRODUCTION**

All interfaces are programmed in a common language which is based on SCPI (Standard Commands for Programmable Instruments). Although similar in style, full conformance to the

SCPI and IEEE488.2 standards is not guaranteed.

The following is a brief guide to the structure and syntax of the programming language.

### Command Tree

Commands are arranged as a hierarchical “tree”, similar to the filing system trees found in personal computers. Commands start at the root level and progress down each level in more detail. The complete path must be specified to access the lower level commands.

*For the TTI 7 series, only one command path per line is accepted.*

### Colon (:)

The colon is used to separate command keywords and automatically move the path down to the next level. All new command lines automatically start at the root-level.

*For the TTI 7 series, a colon must not be sent as the first character. This is treated as a non-recognised character and the “command error” bit (5) of the Standard Event Register is set.*

### Semicolon (;)

The semicolon is also used to separate command keywords, but in this case the path remains at the same level.

*This is not implemented for the TTI 7 series. The semicolon is treated as a non-recognised character and the “command error” bit (5) of the Standard Event Register is set.*

### Whitespace (TAB or SPACE)

A whitespace character must be used to separate the first parameter from a command keyword. If omitted, the “command error” bit (5) of the Standard Event Register is set.

*The TTI 7 series will not accept whitespace characters in subsequent parameter lists. These will set the “command error” bit (5) of the Standard Event Register.*

### Comma (,)

If a command requires multiple parameters, a comma must be used to separate parameters from one another in the parameter list.

### Query (?)

Commands ending in a query (?) indicate that a response is expected from the instrument. This is usually a measured value or status message. Commands sent without a query instruct the instrument to perform a function only without any response. The instrument will not output a response without a query command (except in Talk Only mode).

### Common Commands (\*)



Commands beginning with a “\*” are called common commands and have a precise function as defined by the IEEE-488.2 standard. All instruments behave in an identical way. These commands are primarily concerned with control, reset, self-test and status.

### Command Syntax

Most command keywords have both a long and short form. The bus controller can send commands in either form and also in any combination of upper and lower case characters. Instrument responses, however, are always in the short form, upper case.

### Data Types

The bus controller can also send data in a range of formats, but the instrument always responds in a precise format. There are four principal data types:

**Numeric Parameters** are decimal numbers which include an optional sign, mantissa, decimal point and exponent. Engineering suffix units are not accepted. *Ver 4.0 does not accept numeric parameters.*

**Discrete Parameters** have limited values e.g. SINGLE, INFinite, and like command keywords they can have long and short forms, upper and lower case.

**Boolean Parameters** have a single binary value. The controller can send OFF or 0, ON or 1, but the instrument response is always 0 or 1.

**String Parameters** contain ASCII characters which are placed between a pair of double quotation marks, i.e. “ ”.

### Output Data Format

Non-reading queries <80 ASCII character string

Reading queries	IEEE	SDDDD.DDD <lf>
	RS-232	SDDDD.DDD <cr><lf>

Talk-only format	IEEE	ChA: SDDDD.DDD degC <lf> (or F, K)
	RS-232	ChA: SDDDD.DDD degC <cr><lf> (or F, K)

Where

- S = sign (+/-)
- D = decimal digit (0-9)
- <cr> = carriage return character
- <lf> = linefeed character

The resolution and units will be as set by the last manual or bus commands.

Note: In IEEE mode the EOI line is also asserted with the transmission of the <lf> terminator.

### Input Message Terminators

In RS-232 mode, all messages sent to the instrument must terminate with either a <lf> character or a <cr> character. It is also permitted to send both <cr><lf> to terminate a message; the <lf> is ignored.

For IEEE-488 mode, messages can be terminated in one of two ways:

- by sending a <lf> character at the end of the message
- by asserting the EOI line with the last character sent

It is also permitted to combine these, and assert EOI when sending the <lf> character.

Message termination always forces the command path back to the root-level ready for the next command message.

### Input Buffer

The instrument receives messages into an input buffer and only starts executing commands after receipt of a message terminator. The buffer can store up to 100 characters including separators and terminator.

Sending a new command before the existing command is executed may cause unreliable operation. It is advisable to query the Status Byte (\*STB) to check on the current status of the TTI 7 before sending a new command.

Sending a command whilst the TTI 7 is transmitting (following a ? command) may result in the transmitted response being corrupted. It is advisable to wait for the expected response to be transmitted before sending a new command.

### Measurement Configuration Commands

#### CONFigure Group

These commands allow the measurement configuration of each channel to be set up, but they do not trigger a measurement. If the TTI 7 is in the trigger-run mode it will change to the trigger-hold mode, or if in the trigger-single mode, it will remain in the trigger-single mode.

#### **CONFigure:CHANnel <channel>**

Selects the channel to be measured (use CONF:TEMP to configure the measurement parameters). Only available channels should be selected, else the command will be ignored.

Terminates the current measurement cycle and scanning routine.

Sets the scanner and data logger modes to OFF.

<channel>	A0, A1, A2, A3, A4
	B0, B1, B2, B3, B4
	Ch1-Ch2

**CONFigure:TEMPerature:TC <type>,<rij mode>,<ext rij standard>**

Sets the selected channel for a thermocouple measurement according to the following parameters.

<type>	B,C,D,E,J,K,N,R,S,T	
<rij mode>	Off, Int, Ext	
<ext rij standard>	0	(No standard - off)
	1	(IEC751)
	2	(US/JIS)
	3	(EN60751)
	4-23	(User Probe 1-20)

Terminates the current measurement cycle and scanning routine.  
Sets the scanner and data logger modes to OFF.

Note: When <rij mode> is set to Off or Int, the <ext rij standard> parameter must be set to 0, otherwise the command is not recognised.

**CONFigure:TEMPerature:RTD <type>,<standard>,<con>,<current mode>,<root 2>**

Sets the selected channel for an RTD measurement according to the following parameters.

<type>	Pt100	
<standard>	1	(IEC751)
	2	(US/JIS)
	3	(EN60751)
	4-23	(User Probe 1-20)
<con>	3, 4	(3 or 4 wire connectivity)
<current mode>	+I, -I, AVE	
<root 2>	0, 1, Off, On	

Terminates the current measurement cycle and scanning routine.  
Sets the scanner and data logger modes to OFF.

**CONFigure?**

Used to query the current configuration. The response is an ASCII string of either of the following forms:

“<channel>,TC,<type>,<rij mode>,<ext rij mode>”

“<channel>,RTD,<type>,<standard>,<con>,<current mode>,<root 2>”

Parameter values are as per the tables above. Does not affect the current measurement.

### MEASure Group

These work similarly to the CONFigure commands, except that an immediate measurement is performed with the result being sent to the output buffer. SINGle mode is set, and only one reading is taken. This is the simplest method for taking measurements over the bus, but it does not offer the flexibility of using CONFigure with separate triggering. As with CONFigure, the current measurement cycle will be aborted.

**MEASure:TEMPerature:TC? <type>,<rij mode>,<ext rij standard>**

**MEASure:TEMPerature:RTD? <type>,<standard>,<con>,<current mode>,<root 2>**

**MEASure:CHANnel? <channel>**

Parameters are as for the CONFigure command.

**SENSe:TEMPerature:UNIT <parameter>**

Sets the temperature units to be used in all responses.

<parameter>            C, F, K            (degrees)

**SENSe:TEMPerature:UNIT?**

Queries the temperature unit in force. Responds with "C", "F" or "K".

**SENSe:TEMPerature:RESolution <resolution>**

Sets the temperature resolution to be used in all responses. The default at power-up is 0.01.

<resolution>            1, 0.1, 0.01, 0.001    (degrees)

**SENSe:TEMPerature:RESolution?**

Queries the temperature resolution. Responds with 1, 0.1, 0.01 or 0.001.

**SENSe:ZERO:AUTO <off/on>**

Turns the autozero function off/on. The 'on' mode is automatically reset to 'off' if any of the following commands is sent:

CONFigure:TEMPerature:TC <type>,<rij mode>,<ext rij standard>

CONFigure:TEMPerature:RTD <type>,<standard>,<con>,<current mode>,<root 2>

CONFigure:CHANnel <channel>

MEASure:TEMPerature:TC? <type>,<rij mode>,<ext rij standard>  
MEASure:TEMPerature:RTD? <type>,<standard>,<con>,<current mode>,<root 2>  
MEASure:CHANnel? <channel>

#### **SENSe:ZERO:AUTO?**

Queries the autozero status. Responds with 0 or 1.

### **Mathematical Operation Commands**

#### **CALCulate:AVERage Group**

This group of commands perform statistical calculations on the current contents of the data log. A minimum of 2 readings must be stored, otherwise an “execution error” is generated, i.e. bit (4) of the Standard Event Register is set. This error is also generated if the log contains inconsistent entries, i.e. readings taken on different channels.

#### **CALCulate:AVERage:MINimum?**

Returns the minimum temperature value stored in the data log.

#### **CALCulate:AVERage:MAXimum?**

Returns the maximum temperature value stored in the data log.

#### **CALCulate:AVERage:AVERage?**

Returns the average of all temperature values stored in the data log.

#### **CALCulate:AVERage:COUNT?**

Returns the number of readings stored in the data log.

#### **CALCulate:AVERage:PEAK?**

Returns the peak-to-peak value of the temperature values stored in the data log i.e. max - min.

#### **CALCulate:AVERage:SDEV?**

Returns the standard deviation of the temperature values stored in the data log. This is effectively a measure of rms noise.

### **Route Commands**

#### **ROUTE:SCAN:LSElect <slx>**

This command is used to set the scanner mode, and to select the scan list. The scanner is enabled by selecting a scanning list. An empty scanning list cannot be selected. The ROUTe:SCAN:INTernal command should be used to configure the scanning list.

<slx> SL1, SL2, SL3, SL4  
Off

Terminates the current measurement cycle and scanning routine.  
Sets the Run/Hold trigger mode to HOLD when enabling the scanner.

#### **ROUTe:SCAN:LSElect?**

Queries the state of the scanner, and returns the selected scanning list if enabled, otherwise it returns "OFF".

#### **ROUTe:SCAN:INTernal <slx>, <scanlist>**

This command is used to configure the specified scanning lists for the internal scanner cards.

<slx> SL1, SL2, SL3, SL4

<scanlist> A0, A1, A2, A3, A4,  
B0, B1, B2, B3, B4

To configure a scanning list, specify the scanning list number followed by a list of channels that are required to be active in the list. Only channels that are available should be specified, else the command will be ignored.

Configuring a scanning list that is in use will result in the instrument terminating the current measurement cycle and scanning routine. Also, the Run/Hold trigger mode will be set to HOLD.

#### **ROUTe:SCAN:INTernal? <slx>**

Queries the configuration of a scanning list, and returns a list of active channels, or "NONE" if the specified scanning list is empty.

<slx> SL1, SL2, SL3, SL4

#### **Triggering Commands**

The TRIGer and SAMPlE commands are used to control the instrument's scanner operation, and to configure the scanning lists.

#### **INITiate**

The current measurement cycle and scanning routine is terminated and a new single

measurement is made. The Measurement Available bit (8) of the Operation Condition Register is set on completion. The reading is stored internally and is not sent to the output buffer. Use FETCh? to transfer the value to the output buffer and clear the Measurement Available bit.

Sets the trigger mode to SINGLe.

#### \*TRG

Identical to the INITiate command. Only available with IEEE.

#### FETCh[:<function>]?

Transfers the last reading stored in the instrument's internal memory to the instrument's output buffer. Although normally used with the INITiate command, it can be used following a MEASure? or READ? command.

One of three optional functions can be included with this command:

TEMPerature - Returns the temperature value as displayed on the screen, using the selected unit.

FRESistance - Returns the resistance value, in Ohms, of the Pt100 probe as displayed on the screen.

VOLTage - Returns the voltage produced by the thermocouple probe, as calculated from the voltage measured at the input terminals of the instrument, plus the equivalent voltage represented by the temperature of the reference junction (this can be the internal reference junction, or an external Pt100 probe). The unit is volts, and the format is SDDD.DDE-3, where 'S' is the sign, and 'D' is a decimal digit.

**NB this is different from the voltage displayed on the screen, which is the actual voltage measured at the input terminals.** (If '*rij mode*' is set to OFF, then the voltage returned by the FETCh:VOLTage? command, and the voltage displayed on the screen will be identical.)

If no function is entered, then the default for the first FETCh? is TEMPerature. Subsequently, when used with INITiate, the default is the function used in the previous FETCh?. Using a MEASure? or READ? command resets the default function to TEMPerature.

If an invalid function is included in the FETCh? command (e.g. FETCh:VOLTage? after a Pt100 channel measurement) then it will return the error value, and an "execution error" will be generated. Only TEMPerature can be FETChed when using the Channel1 - Channel2 feature.

If using the RS-232 in INFinite trigger mode, a READ? command followed by a FETCh:<function>? command will continuously send the value of the function to the output buffer as each measurement is completed.

## READ?

A measurement is made and the result is sent directly to the output buffer. The trigger mode is as set using TRIG:MODE command. If in SINGle mode, only one reading is taken. If in INFinite mode, readings continue, with all values sent to the output buffer.

## ABORT

Stops the current measurement and clears the input and output buffers. If the TTI 7 is in the trigger-run mode it will change to the trigger-hold mode or, if in the trigger-single mode, it will remain in the trigger-single mode. It terminates the current measurement cycle and scanning routine. This command is available for RS-232 only.

## TRIGger Group

### TRIGger:MODE <SINGle/INFinite>

Setting the mode to SINGle means that READ? will take one reading and send it to the output buffer.

Setting the mode to INFinite means that READ? will allow the TTI 7 to perform continuous measurements, with all readings being sent to the output buffer. This can be cancelled by sending SINGle, ABORT or CONFigure.  
Terminates the current measurement cycle and scanning routine.

For IEEE, the trigger mode is always forced to single. If the TRIG:MODE INF command is sent it will generate a Command Error and the command is ignored.

### TRIGger:MODE?

Query the current setting. Response is "SING" or "INF".

### TRIGger:COUNT <n> TRIGger:COUNT <slx>, <n>

The TRIGger:COUNT <n> command is used to set the general timer cycle count value.

The TRIGger:COUNT <slx>, <n> command is used to set the individual scanning list timer cycle count values.

<slx>	SL1, SL2, SL3, SL4	Specify scan list
<n>	1 to 9999	Specify cycle count value
	CONTinuous	Cycle count value to continuous
	DEFault	Cycle count value to continuous



Changing a timer cycle count value that is currently in use will result in the instrument terminating the current measurement cycle and scanning routine. Also sets the mode to HOLD.

**TRIGger:COUNT?**

**TRIGger:COUNT? <slx>**

The TRIGger:COUNT? Command queries the general timer cycle count.

The TRIGger:COUNT? <slx> command queries the specified scanning list timer cycle count.

<slx>                    SL1, SL2, SL3, SL4                    Specify scan list

Returns the cycle count value (1 to 9999), or "CONT", if the value is continuous.

**TRIGger:DELAy <hh:mm:ss>**

**TRIGger:DELAy <slx>, <hh:mm:ss>**

The TRIGger:DELAy <hh:mm:ss> command is used to set the general timer cycle delay time.

The TRIGger:DElay <slx>, <hh:mm:ss> command is used to set the individual scanning list timer cycle delay time.

<slx>	SL1, SL2, SL3, SL4	Specify scan list
<hh:mm:ss>	00:00:00 to 99:59:59	Specify timer delay

Terminates the current measurement cycle and scanning routine, and sets the trigger mode to HOLD.

### **TRIGger:DElay?**

#### **TRIGger:DElay? <slx>**

The TRIGger:DElay? Command queries the general timer cycle delay time.

The TRIGger:DElay? <slx> command queries the specified scanning list timer cycle delay time.

<slx>	SL1, SL2, SL3, SL4	Specify scan list
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Returns the delay time (00:00:00 to 99:59:59).

### SAMPlE Group

#### **SAMPlE:COUNT?**

##### **SAMPlE:COUNT? <slx>**

The SAMPlE:COUNT? command queries the general timer sample count. This is the same as the general timer cycle count.

The SAMPlE:COUNT? <slx> command queries the specified scanning list sample count. The sample count is the product of the timer cycle count and the number of active channels in the specified scanning list.

<slx>	SL1, SL2, SL3, SL4	Specify scan list
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Returns the sample count (1 to 9999), or "CONT", if the value is continuous.

#### **SAMPlE:DElay <slx>, <hh:mm:ss>**

This command is used to set the specified scanning list timer sample delay.

<slx>	SL1, SL2, SL3, SL4	Specify scan list
<hh:mm:ss>	00:00:00 to 99:59:59	Specify trigger delay
	DEfault	Trigger delay 00:00:00

Changing a timer sample delay for a scanning list that is currently in use will result in the instrument terminating the current measurement cycle and scanning routine. Also, the Run/Hold trigger mode will be set to HOLD.

**SAMPlE:DELay? <slx>**

Queries the specified scanning list timer sample delay.

<slx>                    SL1, SL2, SL3, SL4                    Specify scan list

Returns the delay time (00:00:00 to 99:59:59).

**System Related Commands**

**DISPlay:BACKlight <off/on>**

Turns the front-panel display backlight off or on. Default is on at power-up.

**DISPlay:BACKlight?**

Query the front-panel display backlight setting. Returns 0 or 1.

**SYSTem:BEEPer**

Issue a single beep immediately.

**SYSTem:BEEPer:STATe <off/on>**

Disable or enable the front-panel beeper. Default is ON at power-up.

**SYSTem:BEEPer:STATe?**

Query the state of the front-panel beeper. Returns "0" (OFF) or "1" (ON).

**SYSTem:VERSion?**

Query the SCPI version to which the instrument conforms. *Ver. 4.0 is not compliant and returns the message "NOT SCPI COMPLIANT".*

**SYSTem:TIME <hh,mm,ss>**

Sets the system calendar/clock time value. Use 24 hour clock format.

**SYSTem:TIME?**

Queries the system calendar/clock time value. Returns "hh,mm,ss" in 24 hour clock format.

**SYSTem:DATE:FORMat <format>**

Sets the system calendar/clock date format for use in date and time stamping of logged data.

<format>        dd:mm:yy  
                  mm:dd:yy

### **SYSTEM:DATE:FORMAt?**

Queries the system calendar/clock date format.  
Returns "DD:MM:YY" or "MM:DD:YY"

### **SYSTEM:DATE <dd,mm,yy> or <mm,dd,yy>**

Sets the system calendar/clock date value, which should be entered in accordance with the selected date format.

### **SYSTEM:DATE?**

Queries the system calendar/clock date value.  
Returns "dd,mm,yy" or "mm,dd,yy"

### DATAlogger Group

This group of commands store and retrieve measurement values using the data logging memory. This memory is non-volatile and can store up to 4000 readings. When the datalog mode is enabled, triggering is controlled by the special DATAlogger commands, i.e. MEASure?, READ?, INITiate and FETCH? are ignored.

### **DATAlogger:MODE <off/on>**

Turn the datalog mode off/on. When turned on, triggering is controlled by START, STOP and STEP, and all readings are sent to the datalog memory. It terminates the current measurement cycle and scanning routine.

### **DATAlogger:MODE?**

Queries the state of the data logger mode setting. Returns "ON" or "OFF".

### **DATAlogger:CLEAR**

Clears the datalog memory. Take care; all the current stored values will be lost!  
Also resets the sample and data logger counter, and resets the scanner routine if the scanner mode is ON.

### **DATAlogger:START**

Forces the trigger-run mode, with all readings being sent to the datalog memory. If the data logger memory is full, any further START commands will generate an "execution error", and the command will be ignored.

Also resets the scanner routine to the beginning and starts the next cycle, if the scanner mode is ON.

This command is only active when DATAlogger:MODE is ON.

### **DATAlogger:STOP**

Forces the trigger-hold mode, and terminates the current measurement cycle. DATAlogger:START or DATAlogger:STEP commands can be used to continue the log from this point.

This command is only active when DATAlogger:MODE is ON.

### **DATAlogger:STEP**

Forces the trigger-single mode and takes a single measurement only, which is stored in the next datalog location.

The command can be used to step through a scanner routine, saving the results in the data logger memory.

On completion of the scanner routine, the next STEP command will reset the scanner routine to the beginning, and start the next cycle. If the data logger memory is full, any further STEP commands will generate an "execution error", and the command will be ignored.

This command is only active when DATAlogger:MODE is ON.

### **DATAlogger:VALue? <value/all>**

Transfers a datalog reading from the memory to the output buffer. A value of between 1 and POINTs will output one reading from that location. If ALL is used, all readings are sent sequentially to the output buffer from location 1 to POINTs. Sending ABORT will cancel the operation. The output format is:

*<record no.>,"<channel>",<temperature>",<unit>",<date>",<time>*

### **DATAlogger:POINTs?**

Queries the number of readings actually stored in the datalog memory. The response will be between 0 and 4000.

### **\*IDN?**

Read the instrument's identification string. This is of the form:

*"<manufacturer>,<model no.>,<serial no.>,<software version>"*

The serial no. field is not used.

e.g. "Isotech,TTI 7,0,Ver6.0"

**\*RST**

For IEEE only, clears all pending operations, and also resets the Operation Complete Command State and Operation Complete Query State.

**\*TST?**

Always returns '0' to indicate self-test OK.

**\*WAI**

This command is accepted, but ignored as all commands are executed sequentially. It is provided only for compatibility with IEEE-488.2.

**Status Reporting Commands**

There are five groups of registers involved.

The Questionable Data and Operation groups each consist of three registers:

- The Condition Register contains the current status of the instrument and is continuously updated. The register value can be read at any time using the appropriate query (?) command.
- The Event Register detects '0' to '1' transitions in the Condition Register and the appropriate bit is set. The register value can be read at any time using the appropriate query (?) command. Reading an Event Register results in all the bits of that register being cleared, and the corresponding bit of the Status Summary Byte is also cleared.
- The Enable Register is a mask which allows any of the bits from the Event Register to set the appropriate bit in the Status Byte. Setting an enable bit to '1' enables the event bit; clearing the enable bit inhibits the corresponding event bit. The register value can be read at any time using the appropriate query (?) command.

The Standard Event group is similar, but consists only of the Event and Enable Registers. There is no Condition Register.

The Output Buffer stores a single line message to be transmitted to the bus. This can be up to 80 characters long. The message is normally the result of a query (?) command.

The Status Byte group are used to read a summary of the other registers.

Note that all Event Registers are cleared after reading, but the Condition Registers, Enable Registers, and Status Byte are left unchanged after reading.