



**TRUE TEMPERATURE
INDICATOR MODEL TTI 7^{PLUS}
User Maintenance Manual/Handbook**

**Isothermal Technology Limited, Pine Grove, Southport, PR9 9AG, England
Tel: +44 (0)1704 543830 Fax: +44 (0)1704 544799 Internet: www.isotech.co.uk E-mail: info@isotech.co.uk**

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.

CONTENTS

GUARANTEE.....	4
EMC INFORMATION	5
ELECTRICAL SAFETY	5
Environmental Ratings	5
OPERATING INSTRUCTIONS: SOFTWARE VERSION 7.1	6
SUPPLIED ACCESSORIES	6
SAFETY	6
CE MARKING	6
INSTALLATION	6
MAINTENANCE	6
Batteries	7
Technical Specification	7
UNCERTAINTY OF MEASUREMENT.....	8
GENERAL	9
FRONT PANEL KEYS.....	9
Data Logging	14
RTD INPUTS	16
PROBE CONNECTION.....	16
THERMOCOUPLE INPUTS.....	16
CALIBRATION	17
RTD Calibration	17
Thermocouple Calibration	17
RJ Calibration.....	18
Equipment Required.....	18
Environment	18
CAL NOTEPAD.....	19
MINIMUM SYSTEM REQUIREMENTS.....	19
Development.....	19
License	19
INSTALLING CAL NOTEPAD	19
STARTING CAL NOTEPAD	20
Configuring for the TTI 7^{PLUS}	20
REMOTE CONTROL INTERFACES	21
INTRODUCTION	21
Version History.....	21
RS-232 SERIAL INTERFACE.....	21
Connection	21
Front Panel Set Up	22
Talk Only Mode.....	22
Baud Rate.....	22
Communicating	22
PROGRAMMING THE INTERFACE	23
Introduction	23
Command Tree	23
Data Types.....	24
Output Data Format	24
Input Message Terminators.....	24
Input Buffer.....	25
Measurement Configuration Commands.....	25
Triggering Commands.....	27
Routing Commands	30
Memory Commands.....	30
Datalogger Commands.....	31
Mathematical Operation Commands	32
Autozero And Rolling Mean & Standard Deviation Commands	33
System Related Commands.....	33
Status Reporting Commands.....	35
Questionable Data Registers	37

Standard Event Registers.....	37
Operation Registers.....	38
Status Byte Registers.....	39
RS-232 Interface Commands.....	40
Front Panel Operations.....	40
APPENDIX I: COMMAND SUMMARY.....	41
Programming Language.....	41
Measurement Configuration Commands.....	41
Triggering Commands.....	41
Routing Commands.....	42
Memory Commands.....	42
Datalogger Commands.....	42
Mathematical Operation Commands.....	42
Autozero andp Rolling Mean & Standard Deviation Commands.....	42
System Related Commands.....	42
Status Reporting Commands.....	43
RS-232 Interface Commands.....	43
APPENDIX II: RS-232 PIN CONNECTIONS.....	44

GUARANTEE

This instrument has been manufactured to exacting standards and is guaranteed for twelve months against electrical break-down or mechanical failure caused through defective material or workmanship, provided the failure is not the result of misuse. In the event of failure covered by this guarantee, 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 that this instrument to be re-calibrated annually.

ISOTECH

ISOTHERMAL TECHNOLOGY LTD.
PINE GROVE, SOUTHPORT
PR9 9AG, ENGLAND

TEL: +44 (0) 1704 543830/544611


FAX: +44 (0) 1704) 544799

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CE EMC INFORMATION

This product meets the requirements of the European Directive on Electromagnetic Compatibility (EMC) 89/336/EEC as amended by EC Directive 92/31/EEC and the European Low Voltage Directive 73/25/EEC, amended by 93/68/EEC. To ensure emission compliance please ensure that any serial communications connecting leads are fully screened.

The product meets the susceptibility requirements of EN 50082-1, criterion B.

Symbol Identification	Publication	Description
	ISO3864	Caution (refer to handbook)
	IEC 417	Caution, Hot Surface

ELECTRICAL SAFETY

This equipment must be correctly earthed.

This equipment is a Class I Appliance. A protective earth is used to ensure the conductive parts can not become live in the event of a failure of the insulation.

The protective conductor of the flexible mains cable which is coloured green/yellow **MUST** be connected to a suitable earth.

The Blue conductor should be connected to Neutral and the Brown conductor to Live (Line).

Warning: Internal mains voltage hazard. Do not remove the panels.

There are no user serviceable parts inside. Contact your nearest Isotech agent for repair.

Voltage transients on the supply must not exceed 2.5kV.

Conductive pollution, e.g. Carbon dust, must be excluded from the apparatus. EN61010 pollution degree 2.

Environmental Ratings

Operating Temperature 0-50°C

Relative Humidity 5-95%, non condensing

OPERATING INSTRUCTIONS: SOFTWARE VERSION 7.1

SUPPLIED ACCESSORIES

- I Mains Cord
- I RS 232 Cable
- I 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. Instruments are normally supplied for 240Volts 50Hz. 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 I as defined in the IEC publication 1010-1 (Amendment 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^{PLUS} is designed to be either free bench-standing, or rack-mounted. The TTI 7^{PLUS} is 1/219", 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 rectification. 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/repaired 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 I27 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 8 hours continuous operation from a full charge is possible. The battery charger is built into the instrument and charging commences immediately when 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:-

EN6071 = 100 Ohm, Ra = 3908

USER: Up to 20 probes may be configured to customer entered constant, A, B, C, and R0 values. For Industrial PRT (CVD) and ITS 90 coefficients for SPRT

A standby current is always passed through the sensors.

UNCERTAINTY OF MEASUREMENT

SENSOR	RANGE °C	RESISTANCE	CURRENT	RESOLUTION °C, °F, K	UNCERTAINTY @ 20°C ±5°C
Pt25	-200 to -100	2.5 to 15	1 mA	0.001	0.02 °C
Pt25	-100 to +500	15 to 75	1 mA	0.001	0.01 °C
Pt25	+500 to +670	75 to 115	1 mA	0.001	0.02 °C
Pt100	-200 to -100	10 to 60	0.5 mA	0.001	0.02 °C
Pt100	-100 to +500	60 to 280	0.5 mA	0.001	0.01 °C
Pt100	+500 to +670	280 to 460	0.5 mA	0.001	0.02 °C

The Inputs are linearised for the following thermocouple Types B,E,J,K,L,N,R,S,T,U,Au/Pt and in accordance with the following Standard, NIST 175, ITS 90. Types C & D to ASTM E988, types L and U to DIN 43710.

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

TYPE	RANGE °C	RESOLUTION °C °F or K	DISPLAY RESOLUTION µV	UNCERTAINTY @ 20°C ± 5°C 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
L	-200 to +500	0.01	1.0	± (0.03% Rdg + 0.005%FS)	± (0.008% Rdg + 0.005% 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
U	-200 to +600	0.01	1.0	± (0.025% Rdg + 0.015%FS)	± (0.005% Rdg + 0.015% FS)	7 ppm Rdg + 6 ppm FS
Au/Pt	0 to +1000	0.01	1.0	± (0.02% 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 8 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^{PLUS} 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^{PLUS} 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.

**FRONT PANEL KEYS**

DISPLAY CONTRAST: To change this display contrast, press and hold down either the ↑ or ↓ key; the contrast will vary and may be selected for optimum viewing. The contrast and the viewing angle are changeable, 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

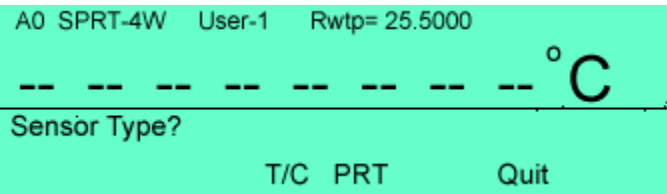
B Selects channel B to the display

A-B Displays the difference between probe A and probe B
in this case the millivolt/resistance reading will not be shown.

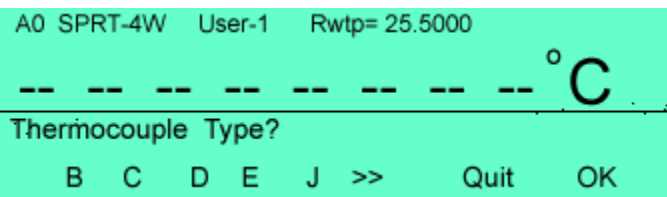


SENS The following sensors may be configured.

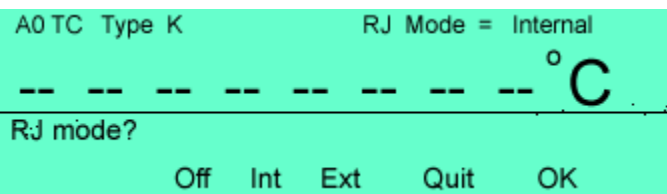
Select **SENS**



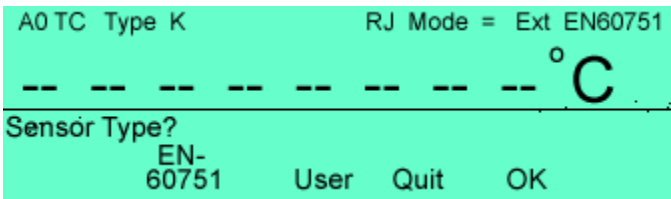
To configure for thermocouples select **T/C** and the following screen will be displayed



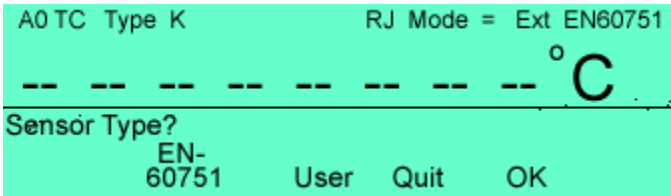
Select from one of the thermocouple options and press **OK** the next screen will help you configure the reference junction



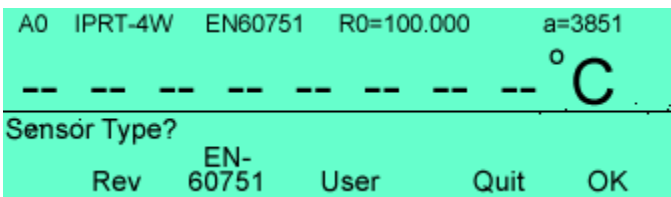
From this screen you can choose from 3 Reference junction modes: **Off** switches the RJ Off. **Int** selects the internal RJ and automatically compensates displaying the true temperature. **Ext** switches to the external RJ mode, and a PRT should be connected to the RTD input of the channel being configured; this PRT can then be used to accurately measure the reference junction temperature. When selecting the Ext option a choice of PRT types is available.



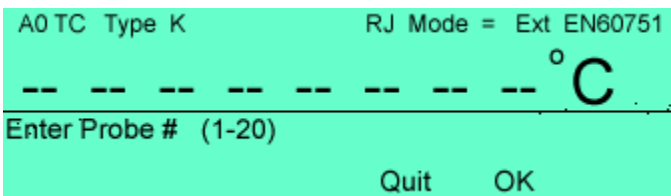
To configure the input for PRT input from the **SENS** screen, select **PRT**.



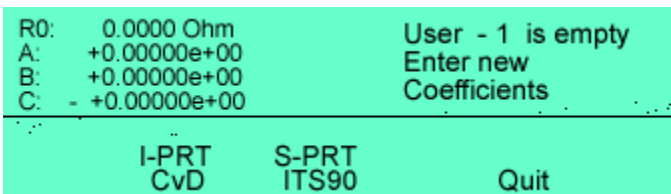
Select EN-60751 to select the Industrial PRT standard linearisation for Pt100, the coefficients may be reviewed by pressing the **Rev** Key but cannot be changed.



To select other coefficients and to configure for Pt25 press the **User** key.

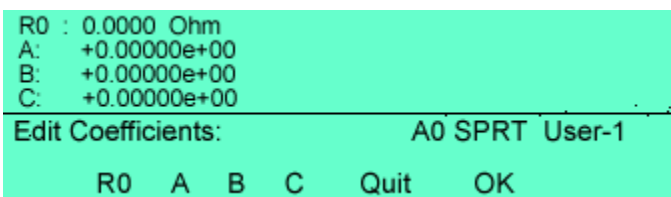


Enter the probe number and press **OK** if the probe number selected has already been configured, then press **Quit** to return to the main measurement menu. If you select a probe number that has no coefficients assigned to it then you will be prompted to enter the probe coefficients.



To enter probe coefficients a choice of either **CvD** (Calendar van Duesen) or **ITS90** coefficients is available.

Select **CvD** and the coefficients should be entered in the following screen



Select **ITS90** and the coefficients should be entered in the following screen

```

Rwtp: 25.50000 Ohm      An: +0.000000e+00
Ap: +3.908300e-03      Bn: +0.000000e+00
Bp: -5.775000e-07
Cp: -4.183000e-12
-----
Edit Coefficients:      A0 SPRT User-1
Rwtp Ap Bp Cp >> Quit OK
    
```

Once a probe has been configured it can be recalled from the **SENS** menu and reconfigured if required using the **Rev** option.

AN IMPORTANT feature of the TTI 7^{PLUS} is that each channel may be configured with any sensor type so that RTD's may be compared against thermocouples. Pt25 against Pt100 etc.

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, this resolution can be increased to 0.01 and 0.001 by pressing the **RESN** key pressing again returns the resolution to 0.

MATH Pressing the MATH key enables you to select and review the statistical values of stored data log values. Press **Log 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.

```

.. Analysis of current log      (A0   Deg C)
-----
Number of samples  5
Min:   841.156      max:   841.210
Mean:  841.179      Ptp:    0.054
SD:    0.0236
-----
                          Quit OK
    
```



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.

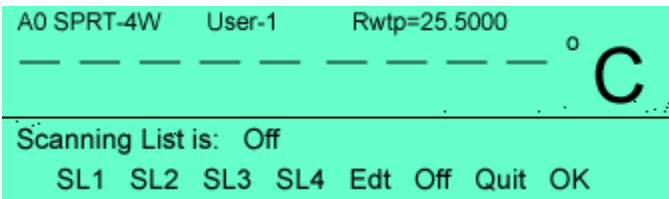
A minimum of 2 readings in this log is required to complete the STATS.

SCAN Selecting this option enables the scanner to be configured and values logged.

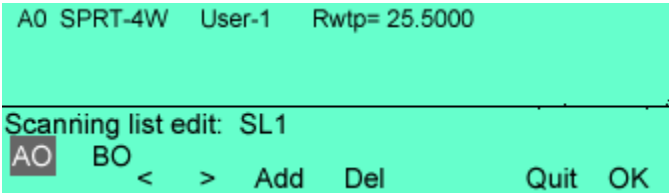
```

A0 SPRT-4W  User-1  Rwtp= 25.5000
+      841.566 °C
-----
Scanner is: Off      Memory is: Off
Scan  Timer  Mem  Quit
    
```

Press **SCAN** this screen enables you to turn the scan sequence ON or OFF and to select one of the 4 available scanning sequences SL1 to SL4; the scanning lists may also be edited.

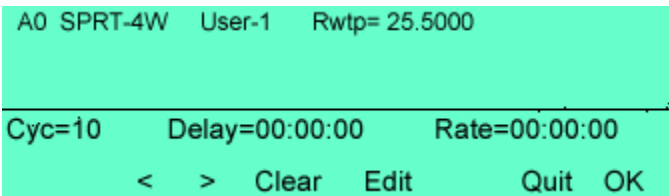


To select a scanning list press SL1 to SL4, to turn off the scanning press Off. With the scanning list selected it is now possible to edit the list press the Edt key



The channels included in the scanning sequence can now be selected by pressing the **Add** key or deleted with the **Del** key; the highlighted channel will be added or deleted. To select a different channel use the **< >** keys NOTE: if scanner cards are fitted then an additional 4 channels will be available per scanner card. Press **OK** to return to previous screen.

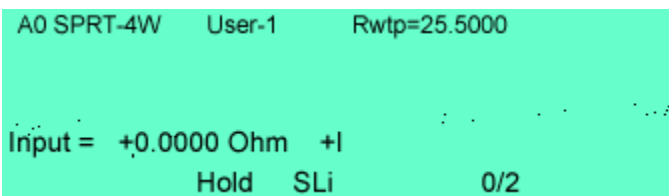
From the **SCAN** main menu select **TIMER** to set the cycle and time intervals.



To select the parameter to change, use the **< >** keys and the selected parameter will flash. Press **Clear** to clear current value set, and **Edit** to change the selected parameter.

To set the number of scan cycles press **Edit** and then key in the number of cycles required, 1 to 9999. To set as continuous scan press **Clear**. Using the **>** key select **Delay** and **Edit** key in the required delay time between scans hh:mm:ss this will also be the delay time before the first scan starts. Press **OK** to confirm set time and **>** to select the reading rate. Press **Edit** and key in the reading rate hh:mm:ss this will be the time between each measurement.

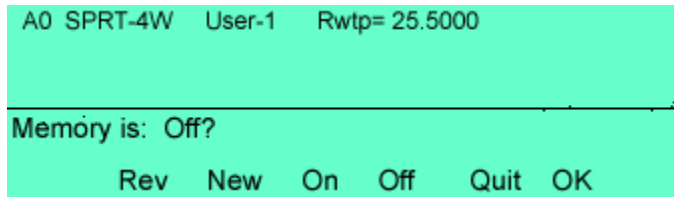
Note: allow sufficient time for temperature to be measured and have regarding for stabilisation time of measured sample. Press **OK** to confirm, and **Quit** to exit to main measurement screen



The thermometer is now set in the Hold mode and the scan sequence is started by pressing the **TRIG** key. A timer will show in place of the Hold and will count down to the measurement scan start.

Data Logging

To configure the data logging from the main measurement screen select **SCAN** and **Mem**



To set up a new log press **New** confirm that you wish to clear the current log and then press **On** to activate the logging function press **OK** to confirm and **Quit** to return to measurement screen. The instrument will be in the measurement hold state and to trigger the measurement start press the **Trig** key. All measured values will now be stored in the Log. The logging function can be used in conjunction with canner sequences.

To review the logged values press **SCAN** and **Rev**

Log#	Ch#	Temp(degC)	Date	Time
1	A0	835.260	19/ 08/05	11:00:00
2	B0	213.023	19/ 08/05	11:01:00
3	A0	835.262	19/ 08/05	11:02:00
4	B0	213.033	19/ 08/05	11:03:00
5	A0	835.254	19/ 08/05	11:04:00
6	B0	213.043	19/ 08/05	11:05:00

The values can be scrolled Up and Down using the Arrow keys

To exit this screen press **OK** (CAL) key

“Hold Samples = 0/20 ”

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" blinks 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 seconds for A-B.

-I This selects the measuring current in the negative direction. Measuring time is approx. 1.8 seconds per reading for channels A and B, and 3 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 5.2 seconds per reading for channels A and B and 10.2 seconds per reading for A-B

√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 Selects the various instrument configurations. The following options are offered:



Sys Conf displays information regarding the instrument configuration

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.

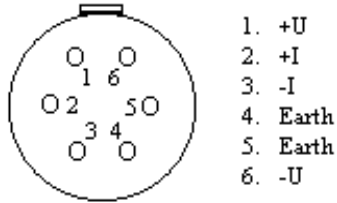
REM I/F If an interface card is fitted, pressing this key will display the various settings available to that interface i.e. Baud rates, address etc. If no interface is fitted then a "No Option Available" message is displayed.

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.

Ver Displays the Model and software versions

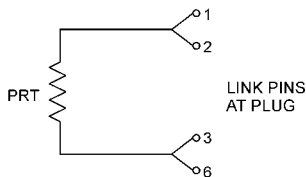
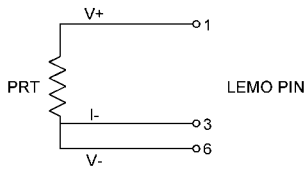
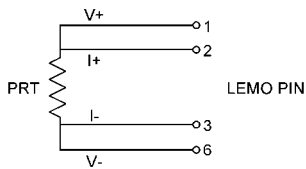
RTD INPUTS

There are 2 LEMO sockets for the Pt100 inputs and the connections are as figure below. For the best performance we recommend 4 wire sensors, but the TTI 7^{PLUS} 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



View of input socket

PROBE CONNECTION



THERMOCOUPLE INPUTS

When measuring thermocouples, care should be taken to achieve the best results. 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 $\pm 0.3^{\circ}\text{C}$; 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°C . This mode of operation is used when an external automatic reference is used such as our Verif 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 TTI 7^{PLUS} 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 TTI 7^{PLUS} 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^{PLUS} 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**. 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**. Any number between 0 and 9999 is valid. 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 RTD. Select Pt100, 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 menu. You now have the option to calibrate the Pt25 range. Follow the display instructions using the 100Ω 25.5 Ω and 62.5 Ω standards.

Thermocouple Calibration

Select this option by pressing the T/C key in the calibration menu. Connect an 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 now 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 Required

- | Resistance Standard Type RS3/100 Value 100 Ohms
- | Resistance Standard Type RS3/250 Value 250 Ohms
- | Resistance Standard Type RS3/400 Value 400 Ohms

- | Resistance Standard Type RS3/25.5 Value 25.5 Ohms
- | Resistance Standard Type RS3/62.5 Value 62.5 Ohms

- | mV source -75 ... 0 ... +75 mV
- | Pt100 sensor and measuring instrument
- | Calibration Lead Type TS01

The Value of the resistance standards should be known with an uncertainty ± 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^{PLUS} 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 SHORTCIRUIT
DO NOT PUNCTURE, OPEN, DISMANTLE OR OTHERWISE MECHANICALLY INTERFERE
WITH THE BATTERIES.
DO NOT SWALLOW

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.

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 I 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

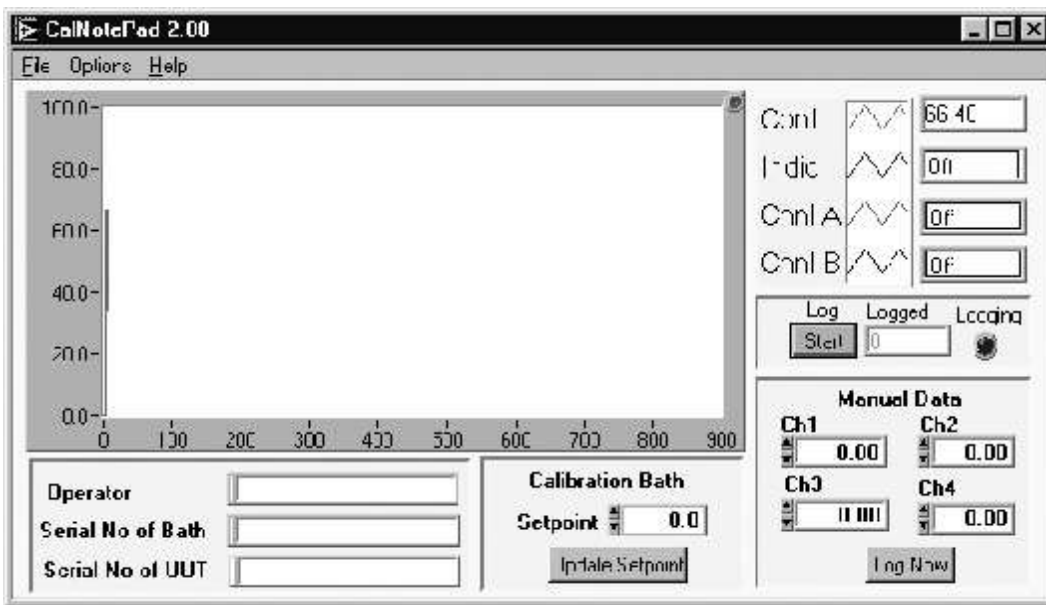
From a Standard Installation:

Click the START button

Highlight PROGRAMS

Select Isotech - Select Calpad

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



Configuring for the TTI 7^{PLUS}

From File – Config select for Instrument and Channels TTI 7 ChA for Channel A or to log both channels select TTI 7 ChA and B.

REMOTE CONTROL INTERFACES

INTRODUCTION

Version History

Ver 7.1 (ECN 253) DATAlogger:CLEAr command corrected to DATAlogger:CLEAr. Both versions will be accepted to maintain backward compatibility.

Ver 7.0 (ECN 239) added Type 'L', 'U' & AuPt thermocouples, SPRT probes and Pt25 probes. The obsolete IEC751 and US/JIS standards for resistance to temperature conversion were deleted.

Commands for the Rolling Mean & Standard Deviation were added, together with the MEMory:COEFFicient? command.

Ver 6.2 (ECN 149) added the facility to send probe voltage and resistance values over the bus, using the FETCh[:<function>]? command.

Ver 6.0 (ECN 112) incorporated the Scanner facility commands.

Ver 5.0 (ECN 76) incorporated automatic detection of model ID links.

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 instrument which indicates its receiver status. When asserted (low) it indicates that it is ready to receive another character. When negated (high) the instrument 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 instrument 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 instrument and controls the transmission of characters. If the PC asserts CTS (low) then the instrument will transmit the next character from the output buffer (if one is waiting). If the PC negates CTS (high) then the instrument 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 instrument end. But take care; sending characters too quickly to the instrument 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 cable be used for connecting the instrument to a PC. This has the 5-wire connection and will maintain EMC integrity.

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

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 3.1 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 an instrument reset, and is the usual setting on shipment. If this is acceptable press "OK".

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.

Communicating

In order to communicate with the instrument using RS-232, the command "SYSTEM:REMOte" must first be sent (see "RS-232 Interface Commands").

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 instrument 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 instrument 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 instrument 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 instrument 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 instrument before sending a new command.

Sending a command whilst the instrument 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 instrument 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,L,N,R,S,T,U,AUPT	
<rij mode>	Off, Int, Ext	
<ext rij standard>	0	(No standard - Off)
	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.

<i><type></i>	Pt25, Pt100	
<i><standard></i>	1	Invalid (Obsolete)
	2	Invalid (Obsolete)
	3	(EN60751)
	4-23	(User Probe 1-20)
<i><con></i>	3, 4	(3 or 4 wire connectivity)
<i><current mode></i>	+I, -I, AVE	
<i><root 2></i>	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. 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 Group

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.

<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.

Triggering Commands

The TRIGger 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 RTD probe as displayed on the screen.

VOLTage Returns the voltage produced by the thermocouple probe, as displayed on the screen. This is 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 RTD probe). The unit is volts, and the format is SDDD.DDE-3, where 'S' is the sign, and 'D' is a decimal digit.

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 an RTD 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.

If the Rolling Mean and Standard Deviation function is on, then the following additional options for <function> are available:

TEMPerature:MEAN**TEMPerature:SDEV**

Returns the Rolling Mean or Standard Deviation of the temperature, using the selected unit.

FRESistance:MEAN**FRESistance:SDEV**

Returns the Rolling Mean or Standard Deviation of the resistance of the RTD probe in Ohms. The resolution of the Mean is normally 0.001, but this is increased to 0.0001 if a Pt25 probe is being used, and the temperature resolution is set to the highest (0.001).

VOLTage:MEAN

VOLTage:SDEV

Returns the Rolling Mean or Standard Deviation of the voltage of the thermocouple probe, calculated as above in "VOLTage".

The resolution of the Standard Deviations are one digit greater than the associated parameter.

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 instrument 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 instrument 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

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

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).

Routing 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.

If the Rolling Mean and Standard Deviation function is on, then this command will be ignored.

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

Memory Commands**MEMory:COEFFicient? <user probe number/all>**

Transfers the user probe coefficients from the memory to the output buffer. A user probe number of between 1 and 20 will output the coefficients for that user probe. If ALL is used, the coefficients for all user probes are sent sequentially to the output buffer. The output format depends on whether the user probe memory is empty, has Industrial PRT (Callendar – van Dusen) coefficients stored, or Standard PRT (ITS90) coefficients stored:

For a user memory with no coefficients stored:

"USER < User no.>:"
 "EMPTY"

For a user memory with IPRT (CvD) coefficients stored:

"USER < User no.>:"
 "TYPE: <PT25 / PT100>"
 "CONV: IPRT"
 "R0: < R0 value>"
 "A: < A coefficient value>"
 "B: < B coefficient value>"
 "C: < C coefficient value>"

For a user memory with SPRT (ITS90) coefficients stored:

"USER < User no.>:"
 "TYPE: <PT25 / PT100>"
 "CONV: SPRT"
 "RWTP: < Rwtp value>"
 "AP: < Ap coefficient value>"
 "BP: < Bp coefficient value>"
 "CP: < Cp coefficient value>"
 "AN: < An coefficient value>"
 "BN: < Bn coefficient value>"

Datalogger Commands

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. (This command also resets the Rolling Mean and Standard Deviation function, if on).

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 currently 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.

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.

Autozero And Rolling Mean & Standard Deviation Commands

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:AVERage:STATe ON
```

If the Rolling Mean and Standard Deviation function is on, then this command will be ignored.

SENSe:ZERO:AUTO?

Queries the autozero status. Responds with 0 or 1.

SENSe:AVERage:STATe <off/on>

Turns the Rolling Mean and Standard Deviation function off/on. This command will be ignored if the scanner mode is on. If the autozero function was on when this command was sent, then the autozero function will be turned off.

Note that the MEASure? commands affect channel, sensor, current mode etc., and will therefore reset the mean and standard deviation. To avoid this, the READ? or INIT/FETCH? commands should be used instead.

SENSe:AVERage:STATe?

Queries the Rolling Mean and Standard Deviation function state. Responds with 0 or 1.

SENSe:AVERage:COUNt <No. of readings>

Sets the maximum number of readings over which the Rolling Mean and Standard Deviation will be calculated.

SENSe:AVERage:COUNt?

Returns the maximum number of readings over which the Rolling Mean and Standard Deviation will be calculated.

SENSe:AVERage:POINTs?

Returns the actual number of readings over which the Rolling Mean and Standard Deviation was calculated.

SENSe:AVERage:CLEar

Resets the Rolling Mean and Standard Deviation.

System Related Commands

DISPlay:BACKlight <off/on>

Turns the front-panel display backlight off or on.

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.

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. The instrument series 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”

***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.

***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.

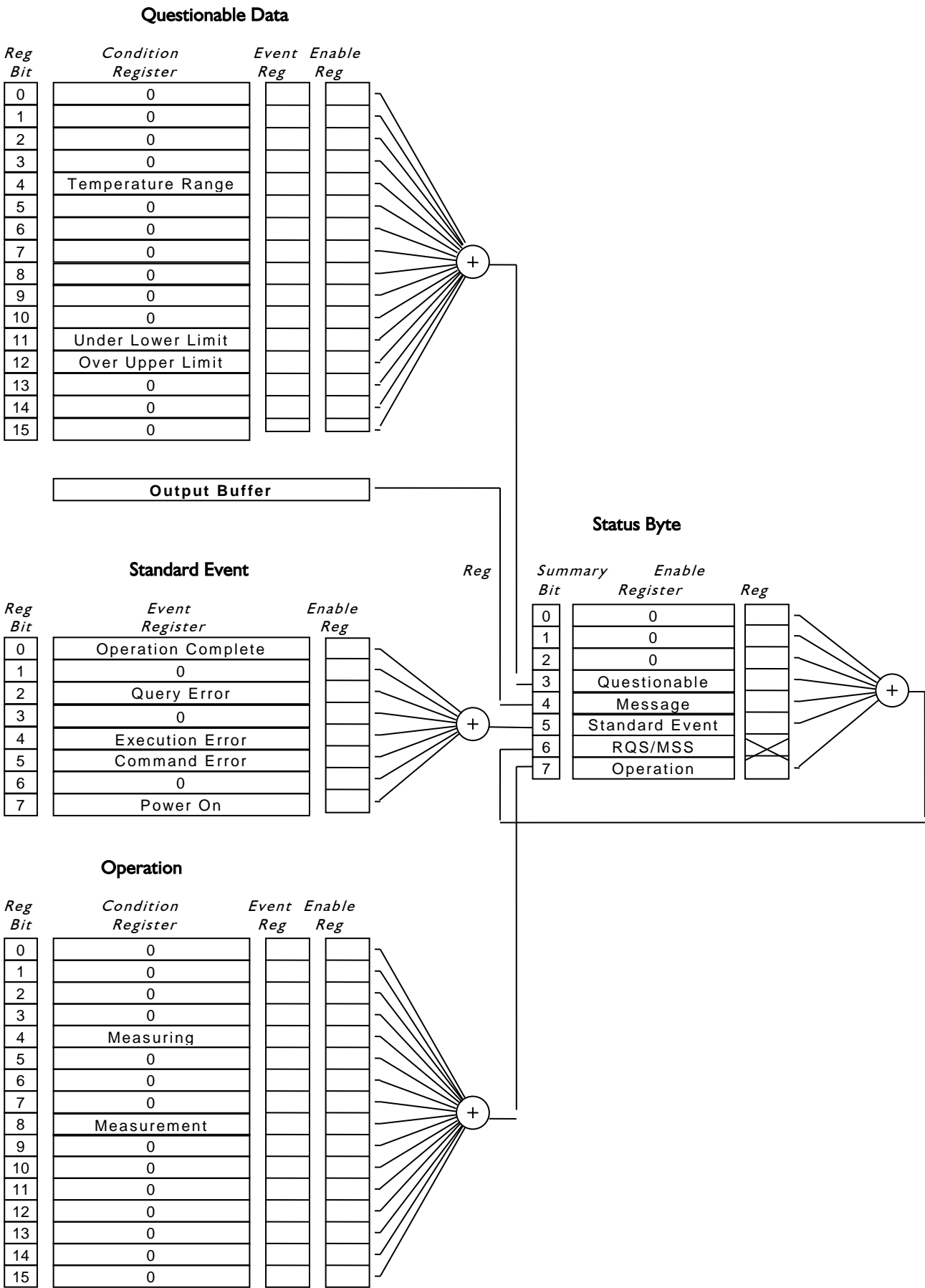
The Standard Event group is similar, but consists only of the Event and Enable Registers. There is no Condition Register.

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.

The Status Reporting System is summarised in the following diagram.



Only a few status bits are used in the instrument, and this reporting system may look a little unwieldy at first. However, it follows the style of SCPI and the unused bits are allocated to other functions which allow for expansion and compatibility with other SCPI compliant devices.

Questionable Data Registers

Temperature Range (bit 4)

This bit is set when the last measurement resulted in a computed temperature that was outside the measuring range of the instrument. It is also set when the “crossed wires” condition is detected.

The following commands are used to access these registers:

STATus:QUEStionable:CONDition?

Queries the Questionable Data Condition Register. The instrument returns a binary-weighted decimal value representing the bits set in the condition register.

STATus:QUEStionable:EVENT?

Queries the Questionable Data Event Register. The instrument returns a binary-weighted decimal value representing the bits set in the event register.

STATus:QUEStionable:ENABLE <enable value>

Enables bits in the Questionable Data Enable Register. The selected bits are then reported to the Status Byte.

STATus:QUEStionable:ENABLE?

Queries the Questionable Data Enable Register. The instrument returns a binary-weighted decimal value representing the bits set in the enable register.

Standard Event Registers

Operation Complete (bit 0)

This bit is set in response to the *OPC command. It indicates that the instrument has completed all pending operations.

Query Error (bit 2)

This bit is set when either an attempt has been made to read data from the output queue when no data is present or pending, or data in the queue has been lost.

Execution Error (bit 4)

This bit is set when a valid command has been received and recognised, but could not be executed at the time. This could be either an out-of-context command or an out of range parameter. The command is ignored.

Command Error (bit 5)

This bit is set when the command line is not recognised by the parser. This could be an invalid command, parameter or syntax. The command is ignored.

Power On (bit 7)

Indicates that an off-on transition has occurred in the instrument’s power supply.

The following commands are used to access these registers:

***ESR?**

Queries the Standard Event Register. The instrument returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

***ESE <enable value>**

Enables bits in the Standard Event Enable Register. The selected bits are then reported to the Status Byte.

***ESE?**

Queries the Standard Event Enable Register. The instrument returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

***OPC**

This command sets the instrument's 'Operation Complete Command State' active. When any 'in-progress' command is completed, the state returns to idle and the Operation Complete bit (0) is set. The command should only be used in conjunction with non-query commands and is only available for IEEE.

Example

Data logging can take an appreciable time to execute, so it is useful to program the instrument to generate a service request on completion of the logging function. The following command sequence can be used:

- *ESE 1 Enables Operation Complete to set the Standard Event bit
- *SRE 32 Enables Standard Event to trigger service request
- *CLS Clears the Operation Complete bit
- DATA:START Initiates data logging
- *OPC Sets RQS on completion of the log

Alternatively, the application programme may continuously poll the Operation Complete bit using *ESR?.

Operation Registers

Measuring (bit 4)

This bit is set when a new measurement starts and is cleared when complete. It corresponds to the BUSY legend on the front panel display.

Measurement Available (bit 8)

This bit is set when a new measurement started by the INITiate command has completed. The bit is cleared when the FETCh? command is used to transfer the value to the output buffer.

The following commands are used to access these registers:

STATus:OPERation:CONDition?

Queries the Operation Condition Register. The instrument returns a binary-weighted decimal value representing the bits set in the condition register.

STATus:OPERation:EVENT?

Queries the Operation Event Register. The instrument returns a binary-weighted decimal value representing the bits set in the event register.

STATus:OPERation:ENABLE <enable value>

Enables bits in the Operation Enable Register. The selected bits are then reported to the Status Byte.

STATus:OPERation:ENABLE?

Queries the Operation Enable Register. The instrument returns a binary-weighted decimal value representing the bits set in the enable register.

Status Byte Registers

The Status Byte Register contains summary bits from the Questionable Data, Standard Event and Operation Registers, and also has a single bit reporting the Service Request function for IEEE.

The Service Request function allows the instrument to request service from the system controller. If the same bit is set simultaneously in both the Status Byte Register and the Service Request Enable Register, the RQS bit is set in the Status Byte Register and the SRQ (service request) bus signal is asserted. In response to the Service Request, the controller will normally be instructed to perform a serial poll sequence on all devices. The instrument returns its Status Byte with SRQ set when it is polled. The action of reading the Status Byte via the serial poll clears RQS and negates SRQ.

The following describes the Status Byte Register Messages.

Questionable Data Summary (bit 3)

This bit is set when an enabled Questionable-Data event has occurred. It is cleared by reading the Questionable Data Event Register or by clearing relevant bits in the Questionable Data Enable Register.

Message Available Summary (bit 4)

This bit indicates that the Output Queue contains response data. It is cleared reading all data from the output queue or, the output queue being flushed by a Query Error or, by the *CLS command.

This bit is particularly useful for synchronising data transfers from the instrument. The application programme can poll the bit to detect when a measurement is complete and data is available. Alternatively, for IEEE, the corresponding enable bit in the Service Request Enable Register can be set so that a Service Request (SRQ) interrupt will occur.

Standard Event Summary (bit 5)

This bit Indicates that an enabled Standard Event has occurred. It is cleared either by reading the Standard Event Status Register, by clearing relevant bits in the Standard Event Enable Register, or by the *CLS common command.

Request for Service/Master Summary Status (bit 6)

The meaning of this bit depends on how the Status Byte Register is read.

RQS

This bit forms part of the IEEE-488.1 Service Request function and is valid only during Serial Poll. It indicates that the instrument is requesting service. It is set when an enabled bit in the Status Byte Register becomes set and cleared by a Serial Poll. Assuming no 'new reason for service' occurs, the bit will be set for one Serial Poll and clear for subsequent Polls. RQS is also cleared if the reason for service disappears, for instance when a status register is read.

MSS

When the Status Byte Register is read with *STB? this bit indicates that an enabled bit in the Status Byte Summary Register is set. The bit is cleared when all summary-messages are clear.

Operation Summary Message (bit 7)

This bit is set when an enabled Operation event has occurred. It is cleared by reading the Operation Event Register or by clearing the relevant bits in the Operation Enable Register.

The following commands are used to access these registers:

*STB?

Queries the Status Byte Summary Register. The instrument returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

***SRE <enable value>**

Enables bits in the Service Request Enable Register. The selected bits are then reported to the Status Byte.

***SRE?**

Queries the Service Request Enable Register. The instrument returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

***CLS**

Clears the Status Byte Summary Register and all event registers, and also resets the Operation Complete Command State and Operation Complete Query State.

***OPC?**

This command sets the instrument's 'Operation Complete Query State' active. When any 'in-progress' command is completed, the state returns to idle, a '1' is placed in the output queue and therefore the Message Available bit (4) is set. The command should only be used in conjunction with non-query commands and is only available for IEEE.

Example

Data logging can take an appreciable time to execute, so it is useful to program the instrument to generate a service request on completion of the logging function. The following command sequence can be used:

*SRE 16	Enables the Message Available bit to trigger a service request
*CLS	Clears the Message Available bit
DATA:START	Initiates data logging
*OPC?	Sets RQS on completion of the log

Alternatively, the application programme can continuously poll the Message Available bit using *STB?.

The Status Byte Register can also be read by an IEEE-488.1 serial poll sequence.

RS-232 Interface Commands**SYSTem:LOCal**

Return the instrument to the local mode from RS-232 operation. All keys on the front panel are fully functional. This is the default at power-up.

SYSTem:REMOte

Place the instrument in the remote mode for RS-232 operation. All keys on the front panel are disabled.

Front Panel Operations

The REMOTE legend indicates that the instrument is under control of the remote interface. The front panel keys will be locked out.

The BUSY legend indicates that a measurement cycle is in progress. This is a particularly useful indication during SINGLE trigger operations.

For the IEEE-488 interface, the ADDRESSED legend ("Adr") indicates that the device has been addressed by the system controller. Operation may be local or remote though.

APPENDIX I: COMMAND SUMMARY

Programming Language

All interfaces use the same commands.

For the RS-232 interface these commands are sent as part of a serial string.

For the IEEE-488 interface these commands are sent as a Multi-wire Interface Message (with ATN=High).

Measurement Configuration Commands

CONFigure

:CHANnel <channel>

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

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

CONFigure?

MEASure

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

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

:CHANnel? <channel>

SENSe

:TEMPerature:UNIT <parameter>

:TEMPerature:UNIT?

:TEMPerature:RESolution <resolution>

:TEMPerature:RESolution?

Triggering Commands

INITiate

*TRG

FETCh[: <function>]?

READ?

ABORT

TRIGger

:MODE <SINGle/INFinite>

:MODE?

:COUNt <n>

:COUNt <slx>, <n>

:COUNt?

:COUNt? <slx>

:DELay <hh:mm:ss>

:DELay <slx>, <hh:mm:ss>

:DELay?

:DELay? <slx>

:SAMPle:COUNt?

:SAMPle:COUNt? <slx>

:SAMPle:DELay <slx>, <hh:mm:ss>

:SAMPle:DELay? <slx>

Routing Commands

ROUTe:

SCAN:LSElect <slx>
SCAN:LSElect?
SCAN:INTernal <slx>, <scanlist>
SCAN:INTernal? <slx>

Memory Commands

MEMory

:COEfficient? <user probe number | ALL>

Datalogger Commands

DATALogger

:MODE <off/on>
:MODE?
:CLEar
:STARt
:STOP
:STEP
:VALue? <value/all>
:POINts?

Mathematical Operation Commands

CALCulate

:AVERage:MINimum?
:AVERage:MAXimum?
:AVERage:AVERage?
:AVERage:COUNT?
:AVERage:PEAK?
:AVERage:SDEV?

Autozero andp Rolling Mean & Standard Deviation Commands

SENSe

:ZERO:AUTO <off/on>
:ZERO:AUTO?
:AVERage:STATe <off/on>
:AVERage:STATe?
:AVERage:COUNT <No. of readings>
:AVERage:COUNT?
:AVERage:POINts?
:AVERage:CLEar

System Related Commands

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

SYSTem

:BEEPer
:BEEPer:STATe <off/on>
:BEEPer:STATe?

SYSTem:VERSion?

SYSTem

:TIME < *hh,mm,ss*>

:TIME?

:DATE:FORMat < *format*>

:DATE:FORMat?

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

:DATE?

*IDN?

*RST

*TST?

*WAI

Status Reporting Commands**STATus**

:QUEStionable:CONDition?

:QUEStionable:EVENT?

:QUEStionable:ENABle < *enable value*>

:QUEStionable:ENABle?

*ESR?

*ESE < *enable value*>

*ESE?

*OPC

STATus

:OPERation:CONDition?

:OPERation:EVENT?

:OPERation:ENABle < *enable value*>

:OPERation:ENABle?

*STB?

*SRE < *enable value*>

*SRE?

*CLS

*OPC?

RS-232 Interface Commands**SYSTem**

:LOCal

:REMote



APPENDIX II: RS-232 PIN CONNECTIONS

1	DCD	Data Carrier Detect	(not connected)
2	RXD	Received Data	(input)
3	TXD	Transmitted Data	(output)
4	DTR	Data Terminal Ready	(not connected)
5	GND	Signal Ground	
6	DSR	Data Set Ready	(not connected)
7	RTS	Request To Send	(output)
8	CTS	Clear To Send	(input)
9	RI	Ring Indicator	(not connected)