

## Manual



## Precision thermometer CTR5000

Accuracy 0.005 K

Version 1.1, 03/14



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## Conventions used in this manual

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### Structure of manual

The manual is divided into sections. Each section deals with a specific topic or related topics. Sections are displayed in a regular, bold typeface, for example - 1.0 Introduction. Sections are sub-divided into sub-headings, for example - 1.1 Features. These may also be subdivided.

### Terminology

The terms CTR5000 Bridge, AC Bridge, CTR5000, bridge and instrument are used interchangeably in this manual.

Menu selection is shown in shorthand form, for example –

Menu → 2 Probe... → ↵

Means Press the Menu soft-key, then move to, and select menu item 2 Probe... and then the enter (↵) soft-key.

### Warnings and Notices

These appear in the body of the text, clearly displayed with a box surrounding the text. The first word within the box displays the type - **Warning** or Note.

A **Warning** (double box) is designed to draw attention to an aspect that may cause danger to the user or damage to the instrument. A Note (single box) is used to bring special attention to something important requiring action or avoidance.

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## Important safety information

---

Read and understand the user instruction manual before attempting to use the instrument.

The CTR5000 is an AC bridge designed for measuring passive resistances. It must not be used for any other purpose.

**Warning**

The protection provided by the instrument may be impaired if the equipment is not used in the manner specified.

Only replace items or components with an approved or equivalent spare part. All spare and consumable parts are available from ASL.

**Warning**

The instrument is NOT designed to be used in a potentially explosive atmosphere or medical environment.

**Warning**

Do NOT open the case. There are no user serviceable parts inside.

**Warning**

Inspect cables and probes regularly, ensuring that their insulation is not damaged.

**Warning**

The instrument and the internal lithium clock battery must be disposed of in accordance with local regulations.

*Warning*

**The instrument is sensitive to radiated noise and care must be taken to ensure a clean mains supply and controlled EM environment..**



General warning symbol. This indicates that a hazardous condition or general danger may exist. You must read the relevant sections in the User Manual before using the instrument.



Refer to manual symbol. When you see this symbol on the instrument it means that there is more information relating to this in the User Manual.

## Important installation information

---

Please ensure that the instrument is installed correctly.

- × Do NOT use the instrument near water or in damp conditions
- × Do NOT locate the instrument near a source of heat
- × Do NOT insert objects into any ventilation openings
- × Do NOT site the instrument in a draught or near an air-conditioning unit
- × Do NOT site the instrument near any strong magnetic fields
- × Do NOT place any weight on top of the instrument
  
- ✓ Locate the instrument on a suitable and secure surface
- ✓ Ensure air can freely circulate around the instrument

The instrument uses a universal input voltage power supply. Use a plug to connect to the mains supply. If in doubt, consult a qualified electrician. The supply connections are shown below (if a UK cord set is fitted).

Brown wire	to Live (Line)	-	L
Blue wire	to Neutral	-	N
Green and Yellow wire	to Earth (Ground)	-	E

**Warning**

**The instrument is designed to be connected to the mains supply via a plug and must be effectively earthed.**

## Important probe safety information

---

Care must be taken with the probes used with the instrument. The following safety information must be observed.

- × Do NOT attempt to lift the CTR5000 by any of the leads
- ✓ Do ensure that long probe-leads and other leads are kept away from areas where people could trip over them or become tangled in them
- ✓ Do ensure the probe-leads and other leads are kept in good condition

### Warning

Because of the nature of the instrument, probes can be excessively HOT or COLD during use. Take suitable precautionary measures when handling probes.

Take care that you (and other people working in the same area) do not come into contact with the metallic probe or the insulating sheath near the probe, which will also be hot/cold.

Precautions apply both during use or when moving the probe from one position to another.

### Warning

Probes may be immersed in various chemicals during use. Some of these chemicals may be dangerous or harmful (even when the probe is cold).

Always assume that the probe has been used this way and DO NOT touch the probe without suitable protective clothing.

### Warning

DO NOT allow the probe to touch any external voltages such as MAINS power.

## Important disposal information

---

If you are responsible for disposal, then please note that this product may contain materials that are regulated in their disposal due to environmental considerations. The presence of these materials is consistent with global regulations applicable at the time this product was placed on the market.



### *European Union*

This symbol means that the product to be disposed of should not be mixed with commercial or general household waste. Used products must be treated separately in accordance with legislation that requires the proper treatment, recovery and recycling of the product.

If you wish to discard the product, then please contact your dealer, supplier or representative who will advise the correct procedure for disposal.

Disposing of the product correctly will help to save valuable resources and prevent environmental damage.

### *Outside the European Union*

The symbol only applies within the European Union. If you need to discard the product, then please contact your dealer, supplier or the local authorities and ask for the correct method of disposal.

### *Batteries*

The CTR5000 contains a replaceable lithium cell held in a holder on the main PCB. This cell must be disposed of in accordance with local regulations

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## 1. Introduction

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### 1.1 Overview

The CTR5000 Precision Thermometer is designed for laboratory, commercial and industrial temperature measurement and calibration applications. The performance and multi-channel capabilities make it ideal for a wide range of applications.

The CTR5000 Bridge is based on AC technology and operates with all 4-wire Platinum Resistance Thermometers (PRTs)<sup>1</sup>. Features include –

- Two, four or six channel operation<sup>2</sup>
- Immunity to most sources of errors present in DC Bridges
- 0.5 second update rate (to full specification)
- 2 m $\Omega$  accuracy, 0.1m $\Omega$  resolution (5mK accuracy and 1mK resolution)
- Internal (25 $\Omega$  and 100  $\Omega$ ) reference resistors
- Wide operational range including all 4-wire thermometers with R<sub>0</sub> values of Pt100 (100  $\Omega$ ), Pt25.5 (25.5  $\Omega$ ) and Pt0.25 (0.25  $\Omega$ )
- Internal and external logging
- Graphical LCD for excellent viewing of results and instrument settings
- Full (expanded) command set for PC control
- Probe coefficient generator from data pair measurements
- Statistical, graphical and large display modes
- User selectable units -- ratio, resistance or temperature display ( $\Omega$ , °C, °F or K)
- Smart probe compatibility
- Expandable multi-channel input multiplexing (up to 64 additional channels)
- Channel scanning on switchboxes

---

<sup>1</sup> Two wire PRTs may be used with reduced accuracy.

<sup>2</sup> Two channels supplied on the CTR5000 as standard, expandable to four or six.

- USB communication interface as standard for automated monitoring and calibration applications
- RS232 or IEEE 488 or LAN interface options
- Automatic calibration against traceable external resistors
- Power-on diagnostic check

The CTR5000 is ASL's second AC bridge<sup>3</sup> with Smart probe capability. It is also the fastest commercially available bridge for its specifications. It has several additional features that are not available on the CTR5000 0.01 K –

- 2 m $\Omega$  accuracy, 0.1m $\Omega$  resolution (5mK accuracy and 1mK resolution)
- Internal (25 $\Omega$  and 100  $\Omega$ ) reference resistors
- Internal and external logging
- Full command set for PC control
- Probe coefficient generator from data pair measurements

Overall system accuracy is better than  $\pm 2\text{m}\Omega$ , (at 20°C  $\pm 5^\circ\text{C}$  - see specification section), equivalent to a temperature measurement accuracy of  $\pm 5\text{mK}$ .

Two measurement channels (A and B) are provided on the front of the instrument. The CTR5000 may be expanded up to six channels with the addition of two more channels (C and D), or four more channels (C, D, E and F) on the rear of the instrument; differential mode operation is provided for these channels. A separate channel connection is supplied for the expansion switchboxes.

Up to 64 channels may be added with the addition of external CTS5000 switchboxes. Two switchbox models are available – the CTS5000–8 and the CTS5000–16 (with 8 or 16 channels respectively). The switchboxes use an expansion connector on the rear of the instrument. Channels A, B (C, D, E and F) operate independently of the switchboxes.

Unlike previous instruments, units may be set on a channel basis, so, for example, channel A may be set to °C and channel B to display ohms.

---

<sup>3</sup> The F252 was the first

## 1.2 Definitions and terminology

See appendix 1

## 1.3 Differences between CTR5000 and F250

The CTR5000 has many more features and options than the F250. The fundamental differences are –

CTR5000 and F250 – fundamental differences	
CTR5000	F250
$\pm 2\text{m}\Omega$ (5mK) accuracy	$\pm 4\text{m}\Omega$ (10mK) accuracy
0.5 s update rate	3 s update rate
2 channels, expandable to 6 channels	2 channels only
Instantaneous temperature conversion	Temperature conversion table takes many seconds
Switchbox uses a separate input	Each switchbox uses one F250 channel
Expandable to 70 channels	32 channels maximum
Units definable per probe	Global units only
Passive and Smart probes	Passive probes only
Full Graphical display	Limited numerical display
Additional $25\Omega$ reference resistor	
Coefficient generation from data pairs	
Internal logging	
External logging	
Full SCPI command set	
Channel scanning	

## 1.4 Differences between CTR5000 0.005 K and CTR5000 0.01 K models

The CTR5000 0.005 K has additional features. The fundamental differences are –

Fundamental differences	
CTR5000 0.005 K	CTR5000 0.01 K
±2mΩ (5mK) accuracy	±4mΩ (10mK) accuracy
Additional 25Ω reference resistor	
Coefficient generation from data pairs	
Internal logging	
External logging	
Full SCPI command set	
Channel scanning	

## 1.5 Principles of measurement

See appendix 6 for a detailed description.

## 1.6 Temperature measurement

When using PRTs, the relationship between resistance and temperature varies slightly from one PRT to another. Therefore, no matter how accurately the CTR5000 measures the PRT resistance, if the relationship between resistance and temperature for a particular PRT is not known, accurate temperature measurement is not possible.

The CTR5000 uses PRT calibration data to overcome this problem and calculates the temperature from conversion functions using calibration data stored in internal non-volatile memory. This method enables the CTR5000 to convert ratio to temperature, uniquely for each sensor used. It is very important, therefore, that a sensor is used with the probe's coefficients correctly entered into the instrument. The CTR5000 uses the standard DIN90 conversion method when specific probe calibration data has not been entered. Temperature conversion occurs in real-time.

**Note**

Always check that the coefficients are correctly set for the probe being used. Failure to do so, will almost certainly lead to incorrect measurements.

System accuracy is a combination of the Bridge's accuracy in measuring the probe's resistance ratio and the calibration uncertainty placed on the reference resistor and PRTs by the calibrating laboratory.

When calibrated PRTs are used with the CTR5000, either with or without switchboxes, the calibration data can be entered via the keypad on the front panel, and is stored in internal memory. Stored PRT calibration data may also be reviewed.

### 1.7 Measurement units

Units can be set on a per probe basis (probes are assigned to channels). When a new channel is selected, the CTR5000 will check to see if a probe is assigned to that channel. If it is, the programmed probe's units will be used (initially) - this does not prevent the units from being changed later. This feature is useful when calibrating probes (if instrument units are selected for the probe, units will remain unchanged when it is used).

### 1.8 Security

Security is important for data integrity and password protection helps to ensure that only authorised personnel can change calibration or system information. Three levels of protection are provided.

**Note**

All examples in the following sections (apart from the section on security) assume that no security mode is selected.

## 2. Setting up the CTR5000

---

### 2.1 Safety information

Please read the safety information section before operating the CTR5000.

### 2.2 Unpacking the instrument

When unpacking the CTR5000 Bridge, check that the following items are present before using the instrument<sup>4</sup> –

- CTR5000 precision thermometry bridge
- Operator's handbook on CD
- Laminated A5 Reference guide
- Test certificate
- Mains lead
- USB lead
- USB memory stick
- Spare fuses

Please contact the ASL Technical Services Group<sup>5</sup> immediately if any of these items are missing or damaged.

Please retain the packaging. In case of return, servicing or calibration, use the original packaging (failure to do so may invalidate the warranty and/or incur additional costs outside the warranty period). Please contact your agent, dealer or supplier when the original packaging is unavailable.

To enable accurate resistance to temperature conversion to be carried out by the instrument, PRT characterisation data may be required.

---

<sup>4</sup> Thermometer probes and other accessories (if ordered) will be supplied separately.

<sup>5</sup> Details are located at the end of the manual (in the Technical support section).

By default, the CTR5000 operates with DIN90 temperature conversion. The instrument may also be set to use DIN68 or CvD or ITS90 conversion methods<sup>6</sup>. Alternatively, the coefficients may be generated automatically from resistance and temperature data-pairs.

The conversion coefficients are fixed for DIN90 (also for CvD and DIN68), so no further data entry is required<sup>7</sup>. However, if ITS90 is used as a conversion method, coefficient data will have to be entered using the simple coefficient editor.

A probe's conversion algorithm and its coefficients are stored in the instrument's internal non-volatile memory. Up to 72 probes may be individually defined<sup>8</sup>.

Set-up details for the probes are covered later in the manual.

## 2.3 Getting started

- Read the manual thoroughly before using the instrument
- Unpack the instrument and allow to thermally stabilise before switching on (particularly if the instrument has been stored in a cold environment)
- Connect a 100 ohm resistor (any type will do) to channel A (as described in section 3.5)<sup>9</sup>
- Connect the mains lead and switch on. After a short diagnostic check sequence, the CTR5000 will start measuring the resistance<sup>10</sup>
- Change one setting at a time to familiarise yourself with each of the options. Start with the Unit key (below the Unit legend) at the bottom right of the LCD, changing to °C, °F, K and back to ohms –



<sup>6</sup> Coefficients are fixed for DIN methods. Default values are used for CvD, but these can be changed. ITS90 coefficient data must be entered.

<sup>7</sup> The  $R_0$  value for these conversion methods will be automatically adjusted when the 25 ohms reference resistor is used.

<sup>8</sup> The probe's information also defines its units, which channel uses the probe and an optional probe identifier string.

<sup>9</sup> If a probe or resistor is not available, use the internal check resistor by selecting channel 99. To do this, press the 9 key on the numerical keypad twice (99) and then press the enter key on the keypad. *IntR* will be displayed at the top left of the LCD. The internal check resistor will be deselected when the channel is changed to any other (or the CTR5000 turned off).

<sup>10</sup> As supplied, the CTR5000 will be set for this measurement.

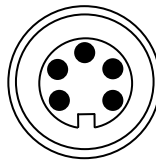
- Press the Chan key under the bottom left of the LCD. The bottom row of the LCD will change to<sup>11</sup> –


Ch A	Ch B	More	Diff
------	------	------	------

- Press the Ch B key and the display will change to show channel B (indicated at the top left of the LCD). The bottom line of the LCD will revert to display –

Chan	Hold	Unit
------	------	------

The open probe symbol will be displayed (no probe on channel B) –



- Press the 1 key on the numeric keypad. The top left of the LCD will display a flashing Cn01, indicating channel 1 (A). Press the ↵ key (bottom right of the keypad). The CTR5000 will return to channel A
- Press the blue display key  (underneath the 7 on the numerical keypad). The bottom line of the LCD will change to show –

Full	Stats	Graph	n.nnn
------	-------	-------	-------

- Press the n.nnn key to change the display resolution between 0 and 3 decimal places (0 and 4 for resistance). Reset to 3 decimal places
- These steps cover most of the F250 functionality (apart from coefficient editing and security modes)
- Press the Stats key to display statistics mode. The bottom line of the LCD will change to –

Chan	Clr	Hold	Unit
------	-----	------	------

(Clr resets the statistics values)

- Press the blue display key again. The LCD will change to display –

Num	Graph	n.nnn
-----	-------	-------

<sup>11</sup> The *More* menu item will only be present if more than 2 channels are fitted.



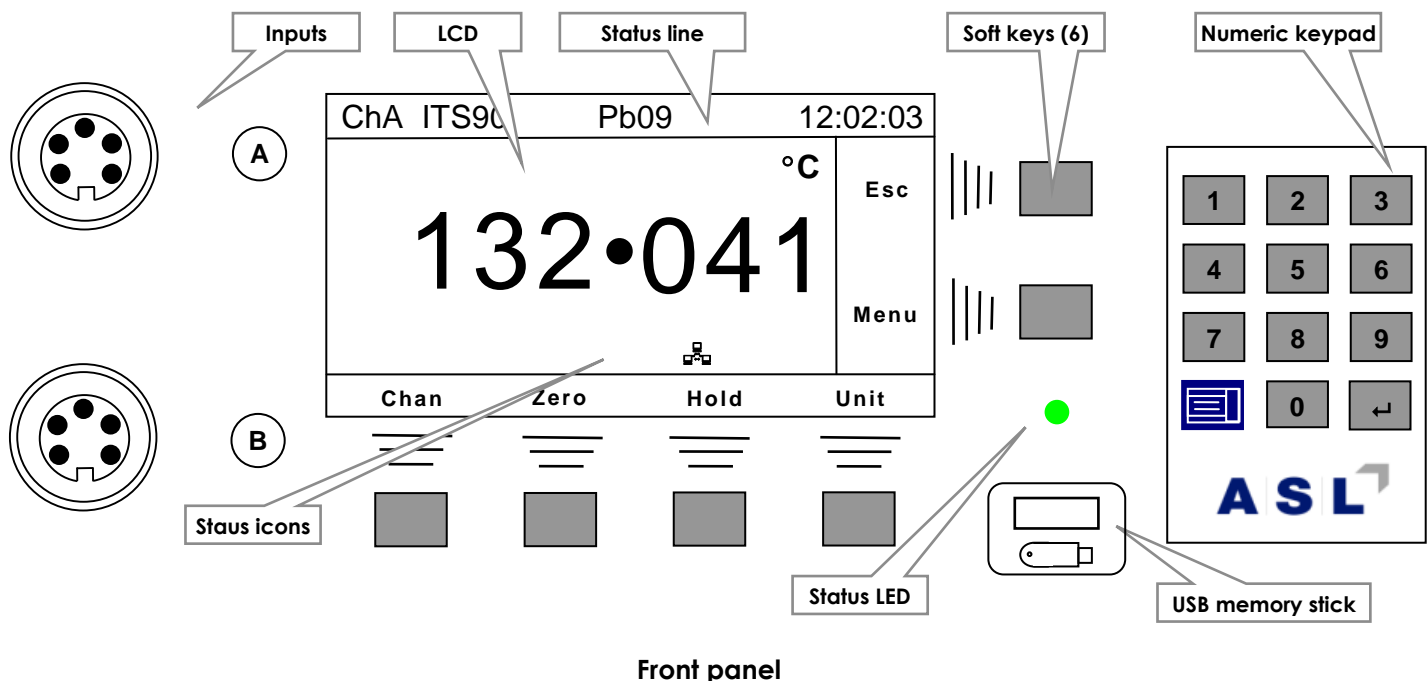
- Press the Graph key to display graphical mode
- Press the blue display key again and then press Num key to return to numerical display mode
- Finally, press the blue display key and then press Full key to display the result in large mode. Press the blue key and Norm to return to normal display mode. All other functions are accessed via the menu system (see section 4)

### 3. About the CTR5000 Precision Bridge

This section introduces the features and functions of the CTR5000 Bridge. Each of the CTR5000 Bridge's features is explained in turn. Once the CTR5000 has been set to your particular requirements, commonly used functions use the minimum number of key-strokes.

#### 3.1 The front panel

The front panel is shown below with the various keys and connectors –



Front panel

The graphical display is positioned approximately in the centre of the instrument with the two input connectors to the left. The LED to the right is used to indicate status (and also that the bridge is in standby mode - when the graphical display is in low power mode). The USB memory-stick connector is positioned below the LED.

The various controls, connectors, displays and keys are described in detail in each of the following sections. The four keys under the display and the two keys to the right are 'soft-keys' - their function varies with the instrument operating mode (whenever these keys can be used, their current function will be displayed next to the key). Channel, probe and conversion information is shown on the top line of the LCD.

The line underneath the result is used to display any relevant icons (LAN icon shown).

### 3.2 About the LCD display screen

The graphic LCD (Liquid Crystal Display) screen presents measurement results, instrument status, the current soft-key legends and menus, to set and control the CTR5000.

The LCD screen is designed for anti-reflective-viewing under normal ambient lighting. The LCD contrast may be set via a menu option (its brightness is fixed).

### 3.3 LED indicator

The LED, to the right of the LCD is used to show normal operation (green) and is lit whenever the bridge is in standby mode. In this mode, the LCD display is turned off, saving power and prolonging the display's life; the remainder of the electronics is still powered normally during standby and the instrument will continue collecting data.

The LED will flash orange when a fault condition is present (overload, , etc). It will flash green when an open-probe is seen.

The LED will turn red if a serious problem is detected.

### 3.4 USB memory stick connector

The USB memory stick connector is positioned below the LED. It is used to connect a memory-stick (to store reports).

USB file conventions are DOS based. File names are automatically allocated in numerical sequence with the correct extension and date and time stamped.

USB operation has been checked with the Kingston range of USB memory sticks. Most other manufacturer's version should also work.

There are several USB related messages that may appear during use. For example, the number of files found in the CTR5000 directory is shown briefly once the memory stick is plugged in.

#### Note

A maximum of 999 files can be stored in the CTR5000 before naming becomes an issue.

It can take several seconds to read the CTR5000 directory. It is recommended that files be transferred to a differently named directory to prevent start-up delays.

It is sensible to transfer important files to an alternative back-up device as soon as practicable.

**Note**

Insert the memory stick before selecting transfer. Allow the directory to be read.

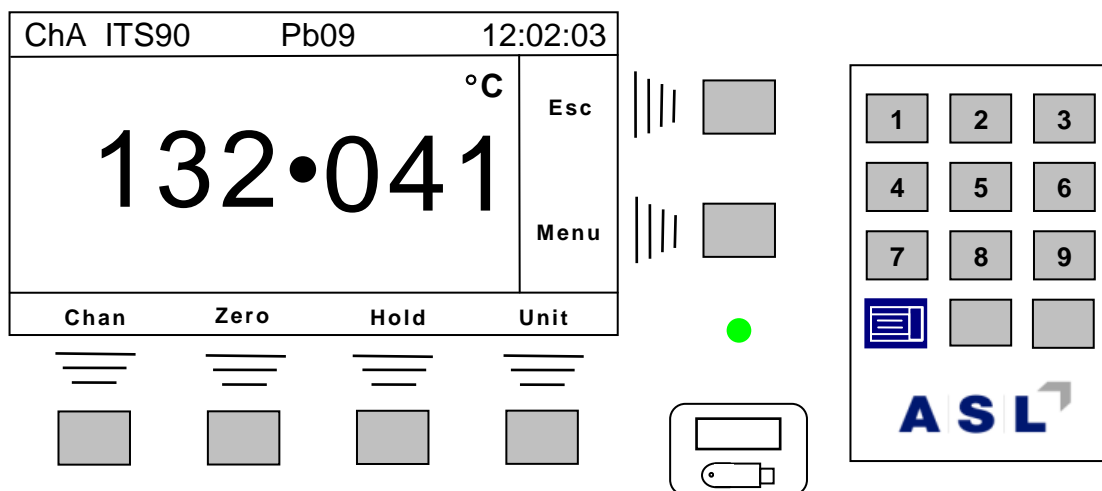
Do not remove the memory stick until any transfer operation is complete.

### 3.5 Keypad

The keys are grouped by type and consist of six soft-keys and a twelve-key numerical keypad. The soft-keys are used to access data and/or functions within the instrument.

The CTR5000 keypad is shown in detail below. The keys are used to select the various functions and menu options and to control the instrument. Generally, all commonly used functions are available at the top level and no more than one or two menu levels are required for other commonly used settings. A few (infrequently used options) require three or four menu levels. Operation is very simple and straightforward, once familiar with the instrument.

It may help to have the instrument to hand when reading through these sections. Refer to section 5 for a detailed description of how to use the keys to operate the instrument.



Front panel detail

The soft-keys are used to select common functions – Chan , Zero, Hold and Unit. The blue display key is used to select other display modes. All other settings and functions are accessed via the menu key. The numeric keypad is used to enter numerical values or to directly select a measurement channel<sup>12</sup> or menu.

<sup>12</sup> By typing a one or two digit channel number followed by the *enter* (+) key on the numeric keypad.

Instrument functions keys		
Key symbol	Description	Function
Chan	Select Input Channel	Displays the channel select options
Zero (see note)	Zero display measurement	Toggles the display zero (null) function
Hold (see note)	Hold display measurement	Toggles the display hold (measurement continues)
Unit	Select display units	Rotates through the display-units ( $\Omega$ , °C, °F or K)
Esc	Escape	Returns without action. The LCD is redrawn
Menu	Display CTR5000 menu	Used to select all other options and functions

**Note**

Zero will not be available in resistance mode.

Zero and Hold will be disabled when the units are changed. Hold takes precedence over Zero.

Numeric keypad		
Key symbol	Description	Function
0 to 9	Numerical data entry	Enters a numerical digit, selects a numeric menu or selects a channel
Enter	Enter data	Used to select a measurement channel or after numerical data entry
Disp	Display mode	Changes the LCD between the 4 display modes – normal, large, statistical and graphical

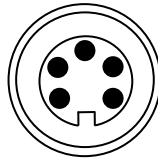
**Summary of front panel key functions**

### 3.6 Input connections

Two 5-pin DIN input sockets (channel A and channel B) are located on the front panel and up to four more sockets may be present on the back of the CTR5000 (channels C, D, E and F).

Up to four expansion switchboxes may be attached to the instrument via the rear expansion port connector. Each switchbox has an additional 8 (model CTS5000-8) or 16 channels (model CTS5000-16), enabling between 2 to 70 channels to be used by the CTR5000.

The selected input channel is interrogated before each measurement cycle, and when enabled, smart probes are identified by 'Smart' appearing at the top of the display. Open circuit thermometer input channels will display the open probe connector symbol shown below –



Open probe symbol

#### 3.6.1 Passive and Smart Probes

All inputs accept Passive probes and/or Smart Probes.

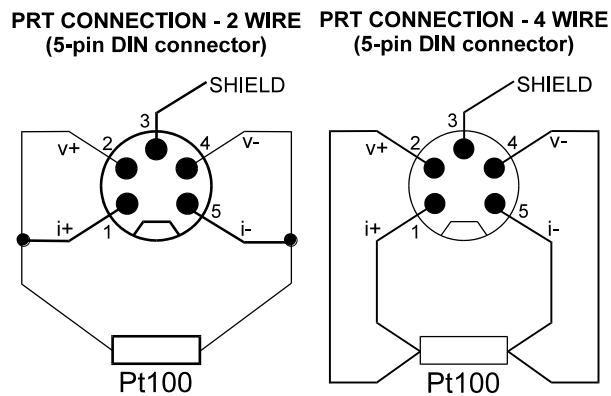
Passive probes do not contain any calibration information and the CTR5000 must be set-up with conversion data for each passive probe used. Up to 72 sets of passive probe information can be stored and retained by the CTR5000. Each available CTR5000 measurement-channel can have one of the stored probes attached to it - the instrument will automatically use the stored conversion data for this channel.

Alternatively, Smart Probes can be used. These probes contain the calibration data within the probe connector and this data will be used to over-ride any internal CTR5000 settings when a smart-probe is seen on an input channel.

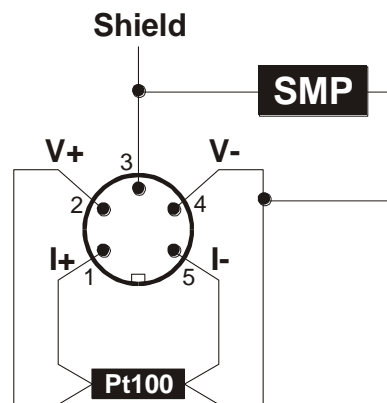
Each input channel can accept either a Smart probe or a Passive probe. Any combination of both types of probe can be use together.

#### 3.6.2 Probe connections

The inputs can be configured for 2-wire or 4-wire probes. Input connections are shown below –



**Passive PRT input (viewed from the front of the instrument)**



**4-Wire SMART probe PRT input connection (viewed from the front of the instrument)**

### 3.6.3 2 Wire PRT

Connect pin 1 to pin 2, pin 4 to pin 5, connect the 2-wire PRT between pin 2 and pin 4.

### 3.6.4 4 Wire PRT

Connect PRT I+ lead to pin 1, V+ lead to pin 2, V- lead to pin 4 and I- lead to pin 5.

### 3.6.5 4 Wire PRT with Smart Probe

Refer to document ASL-SMP-10-101 Smart Probe Conversion Kit.

### 3.6.6 Internal 100Ω check resistor

The CTR5000 contains an internal check resistor. Select channel 99 to use this resistor (IntR will be displayed at the top left of the LCD). It is quite accurate, but not as temperature-stable<sup>13</sup> as the internal reference resistor. The resistor will be deselected when the channel is changed or on power-on. It is not necessary to remove any external resistors when using the internal resistor. The resistor is checked at power-on to ensure the CTR5000 is functioning correctly. Channel 99 only functions with resistance units.

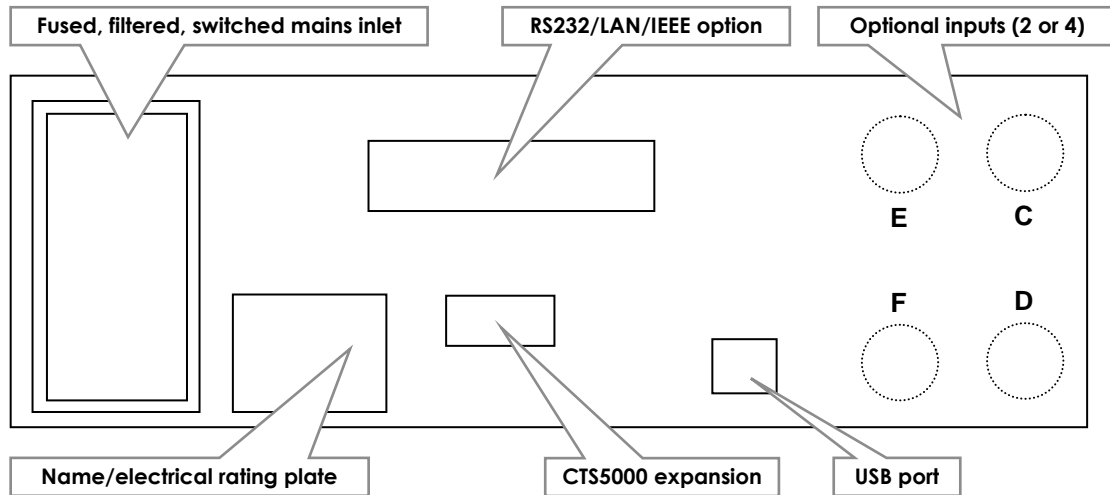
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<sup>13</sup> 10ppm/°C



### 3.7 Rear panel

The rear panel is shown below with the various items and connectors indicated –



Rear panel

#### 3.7.1 Name plate and serial number

The instrument's serial number is shown here.

#### 3.7.2 Electrical rating plate

The instrument rating information on the rear panel shows the instrument's input supply requirements, fuse value and maximum power consumption.

#### 3.7.3 Mains input

The mains input connector is situated on the left of the rear panel. It uses a standard IEC connector and lead (supplied). The input connector has a switch and is fused and filtered. The fuse is located within the body of the connector. Use only the specified fuse value and type.

#### 3.7.4 Expansion port

An expansion port connector is provided on the rear panel. The connector enables up to four CTS5000 switchboxes to be used to expand the number of input connections to provide up to 64 additional channels.

The connector is a (1:1) 15 way socket for signal, power and data connection to the CTS5000-8 or CTS5000-16 switchboxes. It is not compatible with any other connection.

**Note**

The 15 way expansion connector must only be used with CTS5000-8 or CTS5000-16 switchboxes. It is NOT compatible with SB148 & SB158 switchboxes.

A 0.5m lead is supplied as standard. Longer lengths may be used, but system accuracy and the noise specification may be compromised.

### 3.7.5 USB Communication interface connector

The USB connector is fitted as standard. Communication requires the installation of the USB driver on a PC<sup>14</sup>. See the separate information supplied on the CD and at the back of the manual. A standard USB cable is supplied with the instrument.

The instrument can be controlled through simple ASCII commands and can transmit ASCII result-data, which may be recorded using a simple terminal program or using ASL's ULOG program.

The standard F250 command set is supported. See the section on communications for further details.

### 3.7.6 RS232/LAN/IEEE 488 Communication interface connector

The CTR5000 may (optionally) be fitted with one of these interfaces. Operation is similar for all communication interfaces. See the chapter of communications for further details. The optional interface and USB connection may be used simultaneously. However, when sending commands to the CTR5000, operation will depend on timing and may not provide the expected sequence of operation.

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<sup>14</sup> Many PCs now have this driver installed as standard.

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## 4. Operating the CTR5000

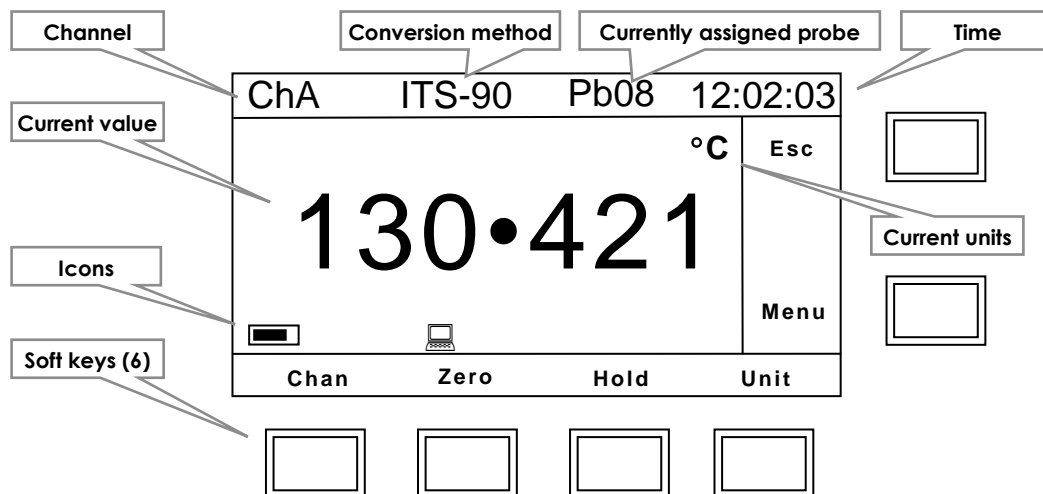
### 4.1 Instrument operating modes

The instrument has two operating modes –

- **Measurement Mode** - displays the reading and instrument status
- **Menu Mode** - allows operating parameters to be viewed and changed

### 4.2 Measurement mode

In Measurement Mode, the screen displays the current reading (its units - resistance or temperature); it also displays the current channel, assigned probe and the time of day. This is the normal operating display mode for the CTR5000. The normal display will look similar to the one shown below –



CTR5000 display screen

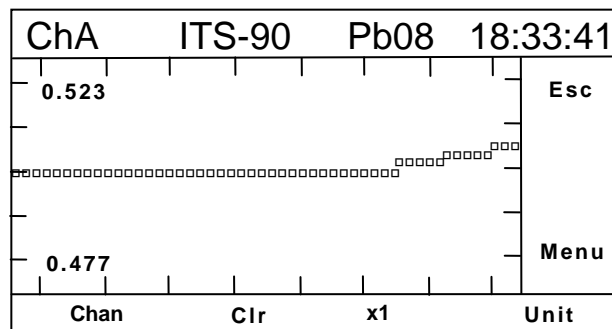
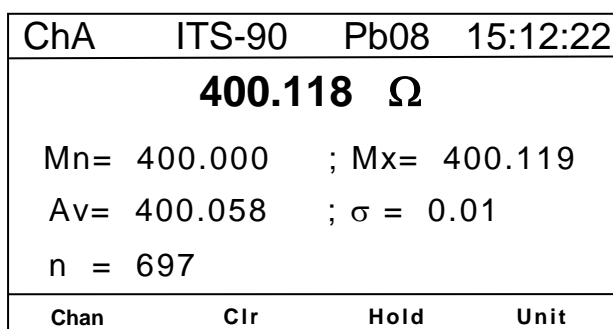
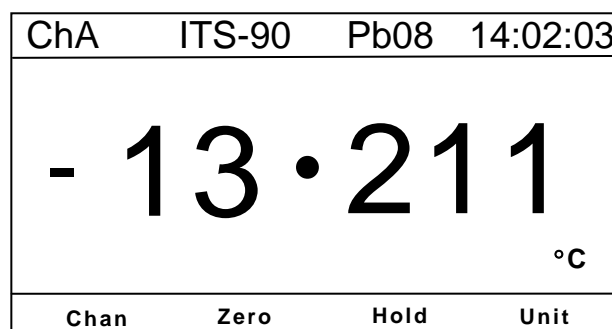
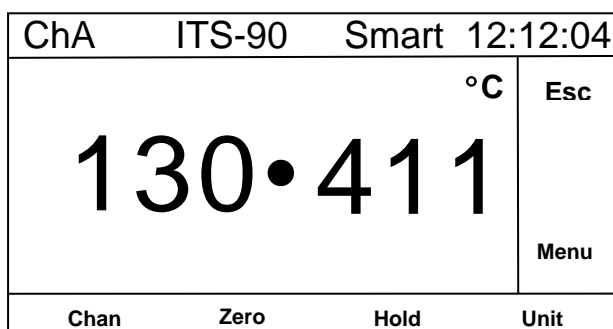
The currently selected channel is always shown at the top left of the display, followed by the temperature conversion method and the number of the probe currently attached to this channel. The unit's symbol alternates (toggles on or off) every time a new reading is displayed.

This display always reflects the operation of the instrument, showing the current reading and settings. There are four soft-keys under the display. Two more soft-keys are positioned to the

right of the display. The action of these keys is context sensitive – i.e. their action depends on the text next to them on the screen. In measurement mode, the display may be set to show –

- the normal numeric display screen
- the larger result screen
- the statistical result screen
- the graphical result screen

Examples of each display are –



### CTR5000 display modes

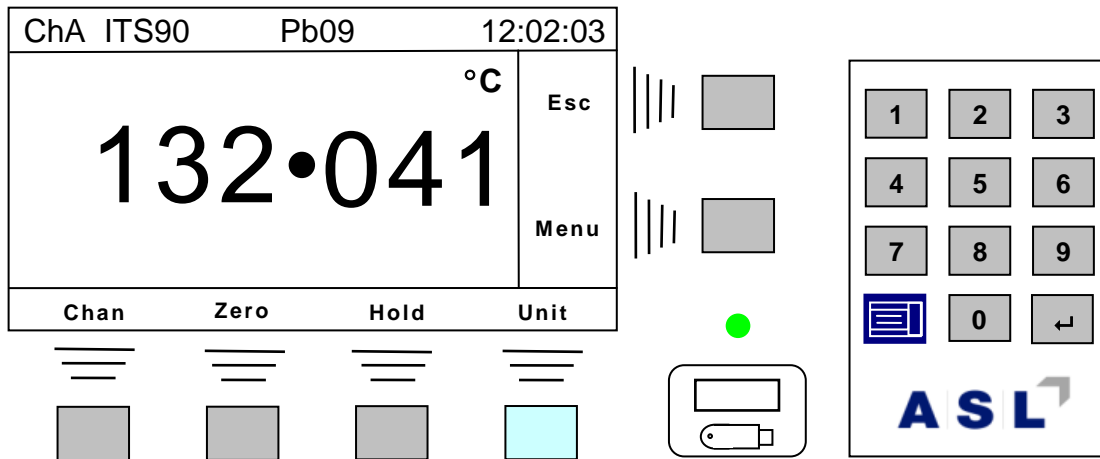
Use the blue key on the numeric key pad to select one of these display modes. The various operating modes are covered in more detail later on in this section.

**Note**

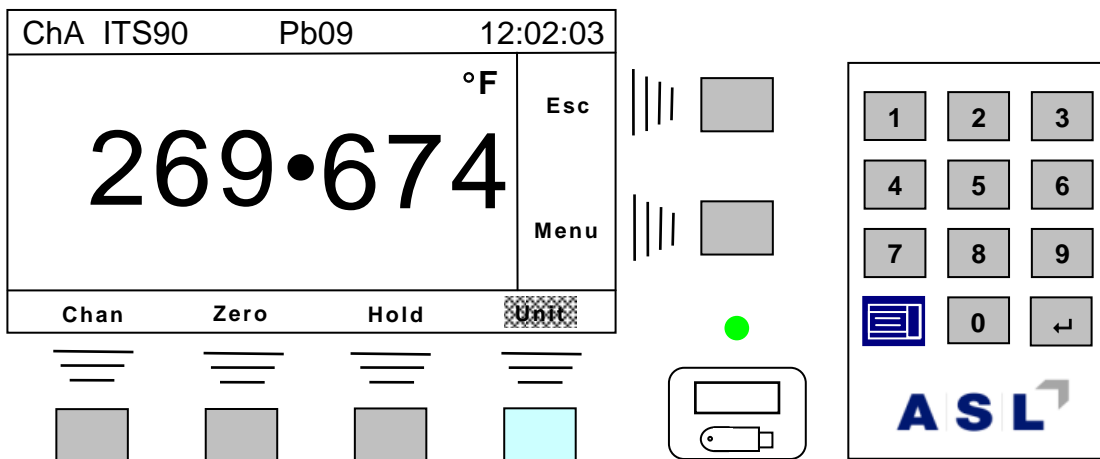
The Menu and Esc keys are still active when the Statistical, Graphical or Large mode screens are selected (the legends are overlaid to allow increased display area).

### 4.3 Setting the instrument's operating conditions

Commonly used function keys are available all the time in measurement mode. These keys are used to select the instrument's operating mode. For example, press the Unit key and the display will change from –



To the following –



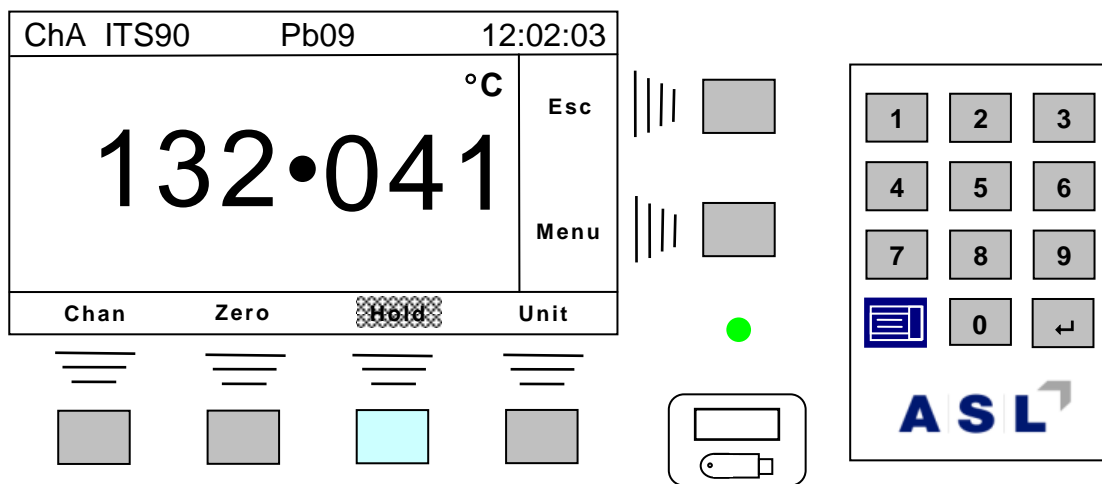
Pressing the key once more will display the result in kelvin; pressing it again will change the display to ohms; one more press will return to the celsius display<sup>15</sup>. The following units are available –

<sup>15</sup> The *Unit* soft-key is shown highlighted in this example. This indicates that the current units are not the same as the pre-programmed units of the attached Passive or Smart probe. This feature is only an indication - it has no other significance.

Unit	Function
Ω	Display ohms
°C	Convert to celsius and display
°F	Convert to fahrenheit and display
K	Convert to kelvin and display

### 4.3.1 Hold key

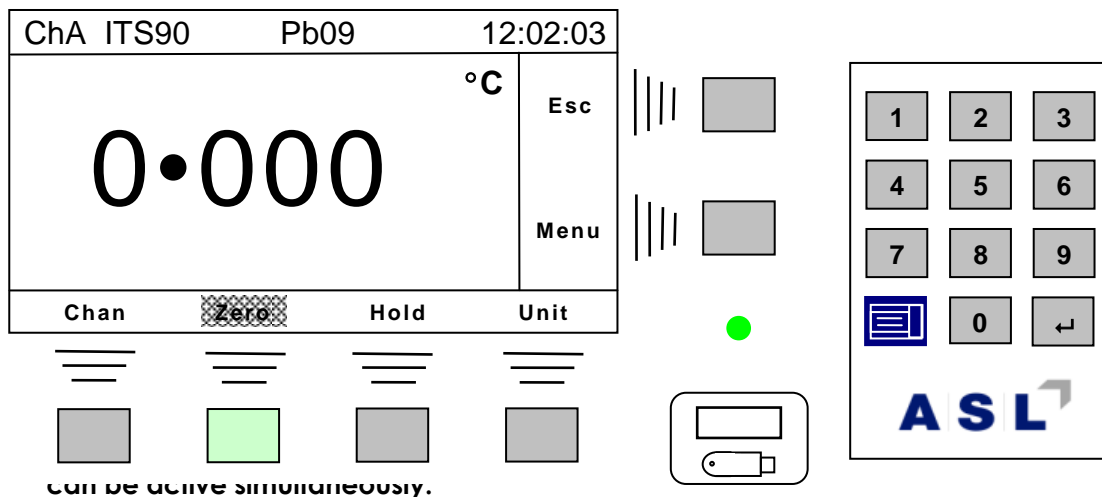
Pressing the Hold key will change the display to –



The reading is frozen (indicated by the highlighted Hold key). Note that Hold and Zero keys can be active simultaneously.

### 4.3.2 Zero key

Pressing the Zero key will change the display to –



Zero and Hold keys can be active simultaneously.

### 4.3.3 Resolution

Press the blue display key. The bottom line of the LCD will change to display –

Full	Stats	Graph	n.nnn
------	-------	-------	-------

Press the n.nnn key to change the display resolution between 0 and 3 decimal places (0 and 4 decimal places for resistance).

The following resolutions are available –

Resolution	Function
n.nnnn	Display four decimal places (resistance only)
n.nnn	Display three decimal places
n.nn	Display two decimal places
n,n	Display one decimal place
n.	Display no decimal places

### 4.3.4 Display key

The display key is used to change display modes (between normal, large, statistical or graphic) and to change instrument resolution.

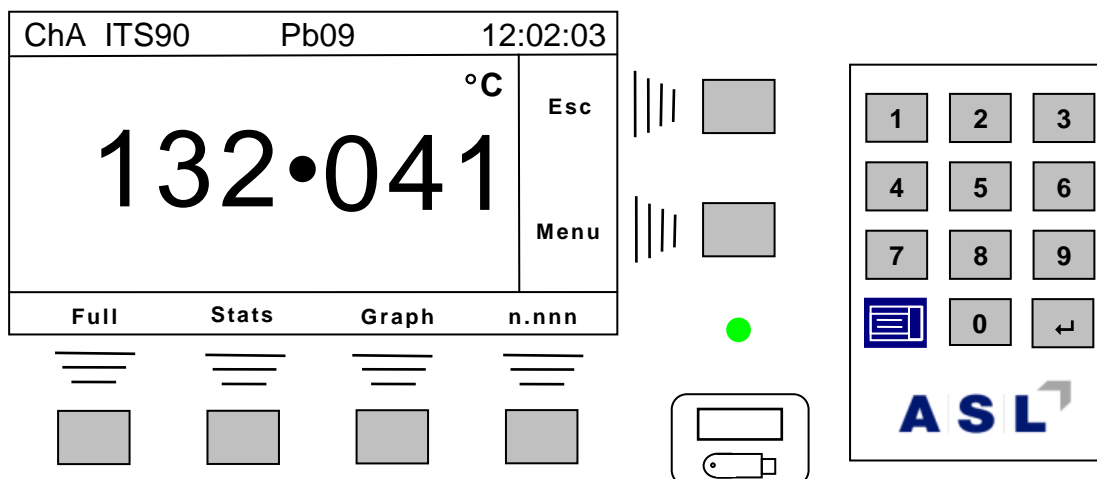
#### 4.3.4.1 Normal display

This is the normal display mode for the instrument. The blue display key is used to change display modes and to allow the result resolution to be set.

#### 4.3.4.2 Full display

Pressing the blue display key will change the display to show –

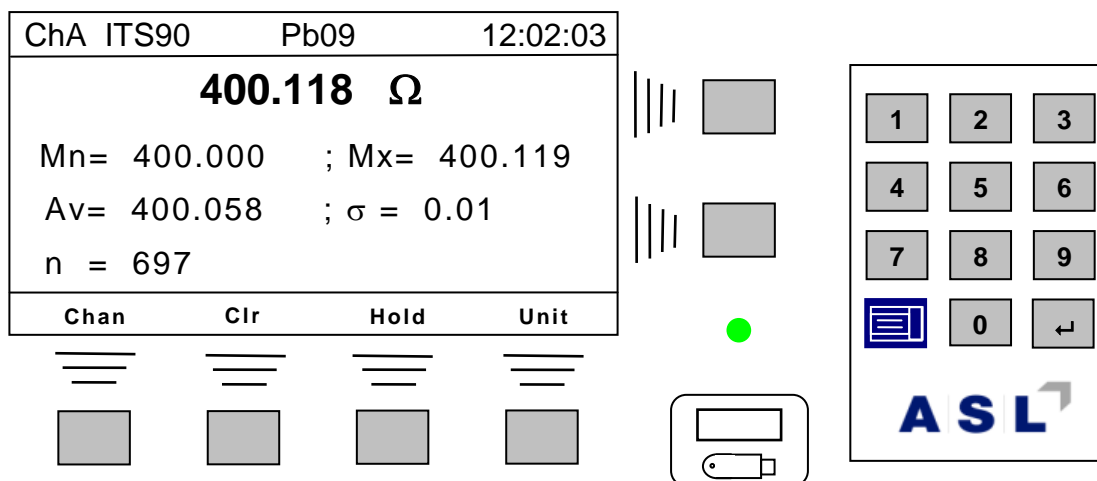




The Full key will select the large display mode (shown in section 4.2), returning to the measurement screen. Press the display key and select Norm to return to the normal display mode.

#### 4.3.4.3 Statistical display

Press the blue display key and then the Stats key and the display will be similar to –



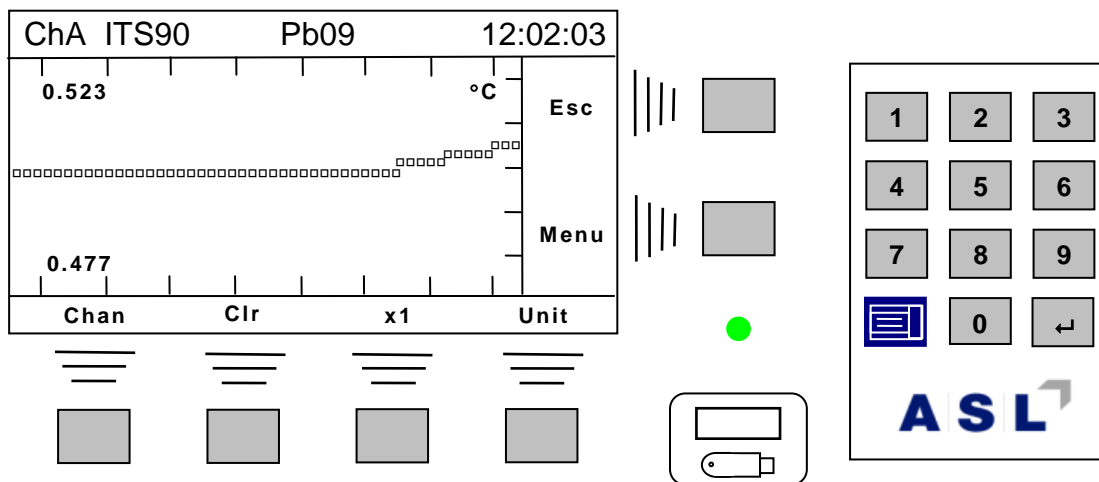
The bottom line of the LCD is similar to the Norm screen, but the zero soft-key has been replaced by Clr. Pressing the Clr soft-key will ask for confirmation that you want to clear (reset) the statistics.

Note that the Esc and Menu soft-keys are still active.

Press the blue display key to select an alternative display mode.

4.3.4.4 Graphical display

Press the blue display key and then the Graph key and the display will be similar to –



The bottom line of the LCD is similar to the Norm screen, but the zero soft-key has been replaced by Clr and the hold soft-key by the scale factor x1.

Pressing the Clr soft-key will clear (reset) the graph.

Pressing the x1 key will change scale, circulating through x1, x10, x100, and x0.1.

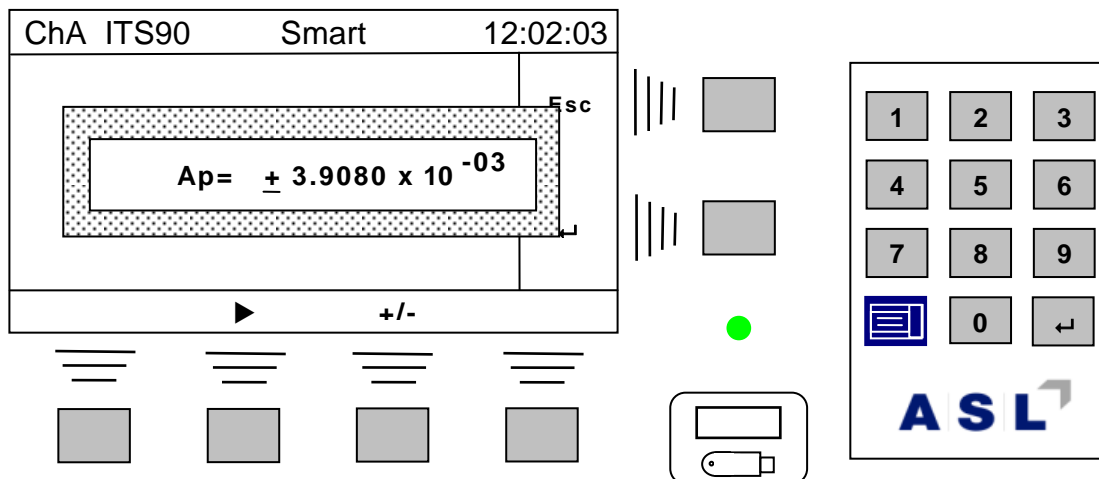
Press the blue display key to select an alternative display mode.

4.3.5 Channel soft-key

This is described in full detail in section 4.5.

### 4.3.6 Editor

Several soft-keys are used during editing and data entry. An example of using the editor to change a coefficient is shown below –



A flashing cursor is positioned below the + sign when the screen first appears. The flashing cursor indicates the current edit position.

The +/- soft-key is used to toggle (alternate) the sign. The +/- soft-key will only appear when the cursor is under a sign character. If pressed<sup>16</sup>, the cursor will automatically advance to the next position (or the ► soft-key can be used to move the cursor position one place to the right). Once moved the bottom line of the display will change to –



The cursor position can also be moved to the left now. The +/- sign is no longer active. The editor deals with fixed length coefficients. The decimal place and x10 positions will be automatically skipped. When the cursor is at the end of the number (last exponent digit), the bottom line of the LCD will show –



Once the coefficient has been correctly entered, press the enter key (↵) to selected the edited number or press the Esc key to return without changing the value.

Strings (e.g. the Probe id field) are edited in a similar way.

<sup>16</sup> Keys auto-repeat.

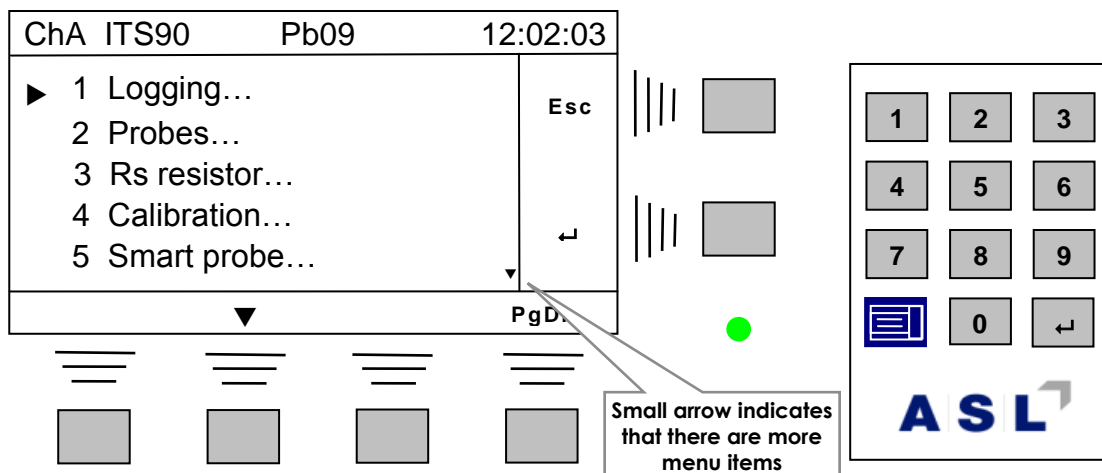
## 4.4 Menu mode

The exact appearances of the menus depend on the options fitted to the CTR5000. For example, if a RS232 interface is fitted, the communication and other relevant menus will change to reflect this; similarly, channel menu options reflect the number of additional channels fitted. All options are automatically detected, and so the menus will always reflect the exact configuration for your instrument.

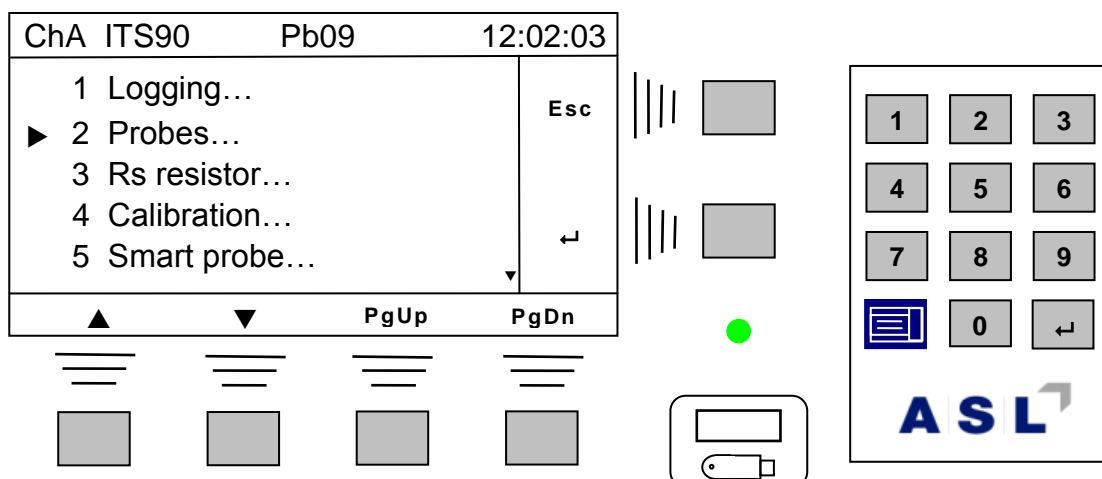
### 4.4.1 Menu soft-key

All other instrument parameters and options are accessed through the Menu soft-key. These menus may display additional sub-menus.

Pressing the Menu soft-key will change the display to menu mode –



Pressing the down arrow (▼) will show the following –



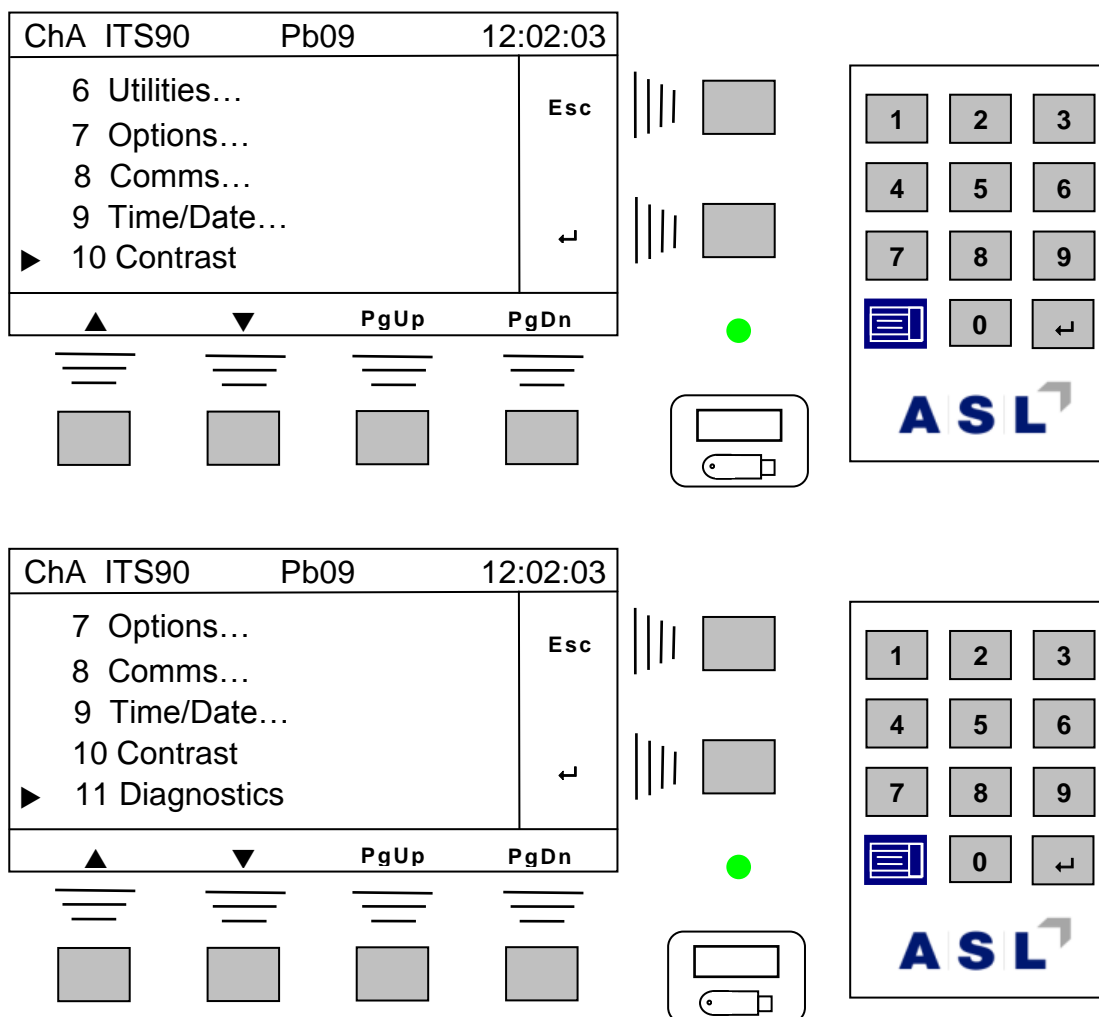
The line selection arrow has moved down one line and the ▲ arrow, and PgUp legends have appeared.

Use the up and down arrows (▲ and ▼) to scroll through the display. The PgUp and PgDn keys will move the menu select indicator by 5 lines (or as many as possible).

Scroll the display to select the required menu (or alternatively, use the numeric keypad to directly select the menu by number).

Press the enter key (↵) to selected the highlighted line or press the Esc key to return without changing the current selection.

There are more menu items than can be shown on the screen at one time. The display will scroll up and down through the list allow the required menu to be selected<sup>17</sup>. For example pressing the PgDn soft-key will lead to the display –

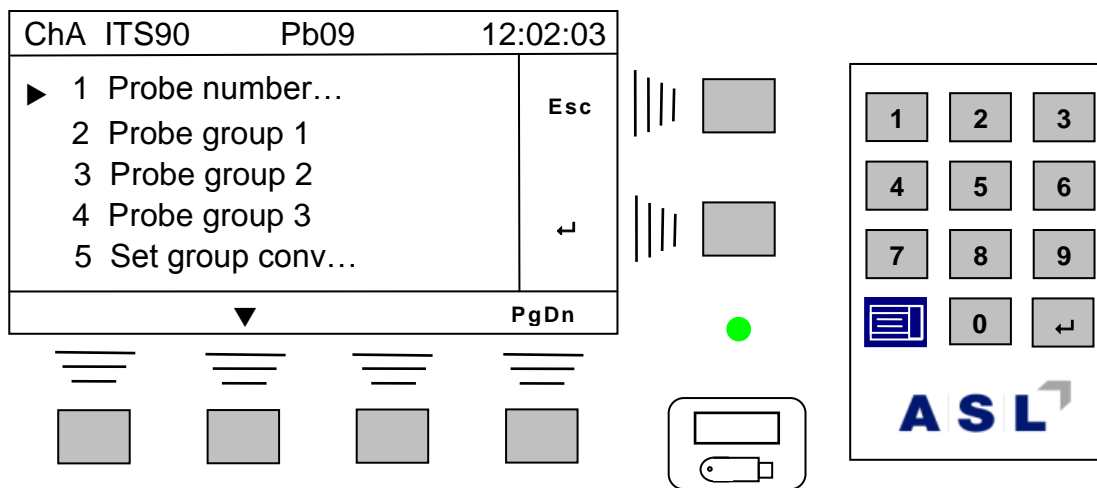


<sup>17</sup> A small down arrow will be shown at the bottom right of the menu screen when additional menu options are available.

The menu options are shown below<sup>18</sup> –

Menu item	Function
Logging...	Logging menu and options
Probes.....	Enter probe information and coefficients
Rs resistor.....	Set R <sub>s</sub> resistor value
Calibration.....	Reference resistor and instrument calibration
Smart probes.....	View and edit smart probe parameters
Utilities.....	Utility menus
Options.....	Instrument options menu
Comms.....	Set and/or review communication options
Time/Date.....	Set time and/or date
Contrast...	Set LCD contrast
Diagnostics.....	Instrument diagnostics menu (password protected)

For example, selecting Probes... will show –



**Note**

The instrument continues to measure normally during all menu displays and selection options. The graph is frozen.

<sup>18</sup> The three dots (...) after the legend indicate that there are more menu available for this item

## Selecting channels

The following sections cover channel selection with the basic instrument and also when one or more switchboxes are attached. The top left of the screen will always show the currently selected channel. There are two ways to select a new channel.

### 4.4.2 Channel selection – method 1

With the screen in measurement mode, use the numeric keypad to enter a one or two digit channel number and press the numeric keypad enter (↵) key. Channel A is selected by entering 1 (or 01), Channel B by entering 2 (or 02) and so on<sup>19</sup> –

Channel	Channel number
A	1
B	2
C (if fitted)	3
D (if fitted)	4
E (if fitted)	5
F (if fitted)	6
A minus B	8
B minus A	9
A alternating with B	10
A divided by B	11
A minus X	12
B minus Y	13

where X = B, C, D, E, F or any switchbox channel

where Y = A, C, D, E, F or any switchbox channel

Switchbox channels are selected by entering their channel numbers<sup>20</sup> –

Switchbox	CTS5000-16 channel number	CTS5000-8 channel number
1	16 – 31	16 - 23
2	32 – 47	32 - 39
3	48 – 63	48 - 55
4	64 – 79	62 - 71

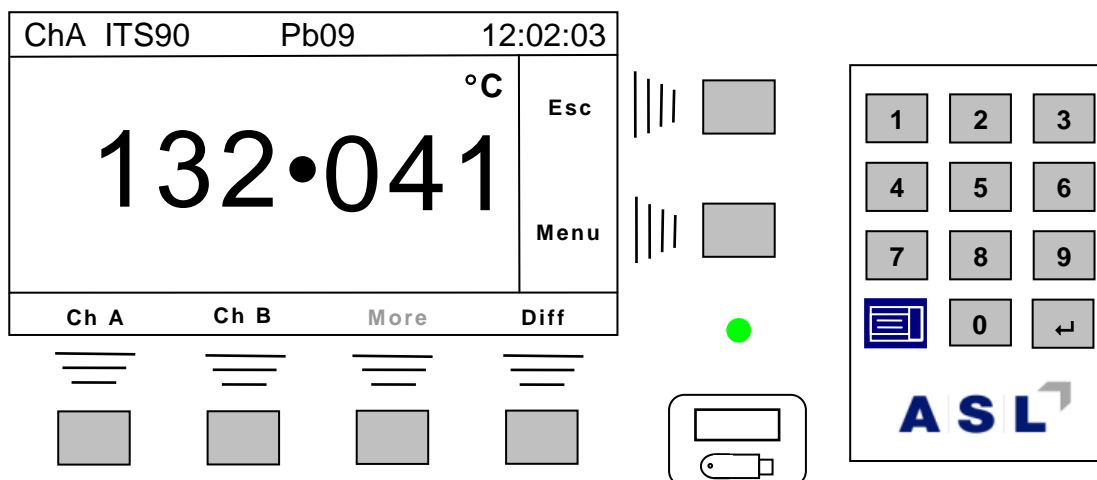
See the section on switchboxes for further details.

<sup>19</sup> A flashing *Cnxx* will be shown at the top left of the screen when channel data is entered this way.

<sup>20</sup> CTS5000-16's and CTS5000-8's may be mixed in any order. However, for ease of use, it is advisable to provide consecutive addresses.

## 4.4.3 Channel selection – method 2

Use the Chan soft-key. Press the Chan key. The display will change to –



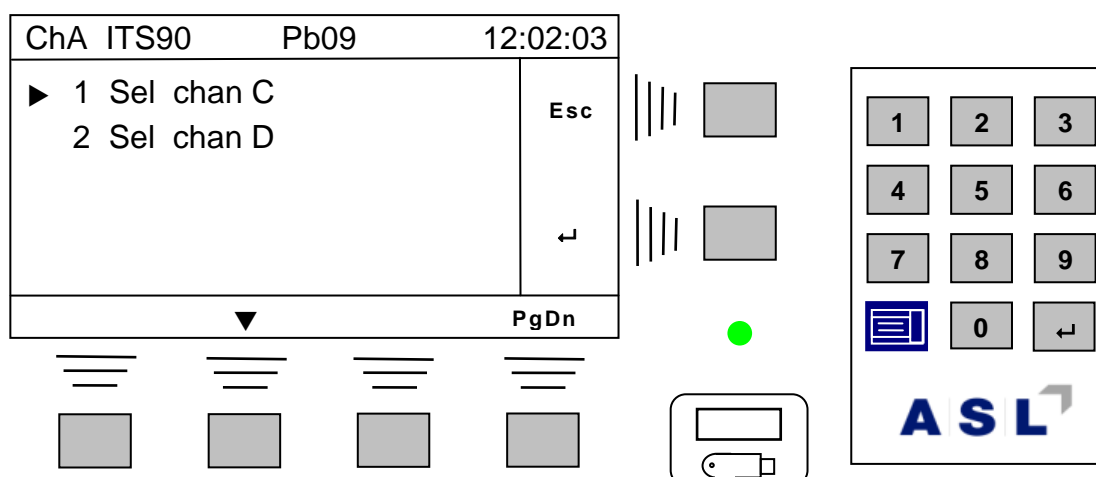
Channel A is currently selected (see top left of LCD). Press the Ch B soft-key to change to channel B; the display will change back to the previous screen.

**Note**

The More soft-key will only be displayed if more than two channels are fitted. Its use will be covered below.

The More menu allows an alternative means of switchbox channel selection (see the switchbox section).

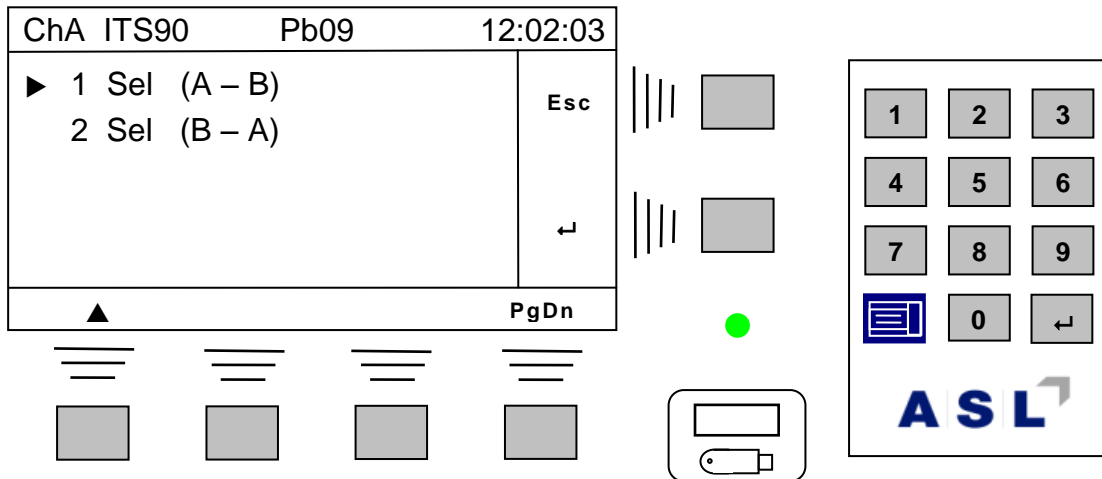
When more than two channels are fitted, the exact appearance of the More display depends on the number of channels fitted. For example, if channels C and D are fitted, pressing the More soft-key will show –



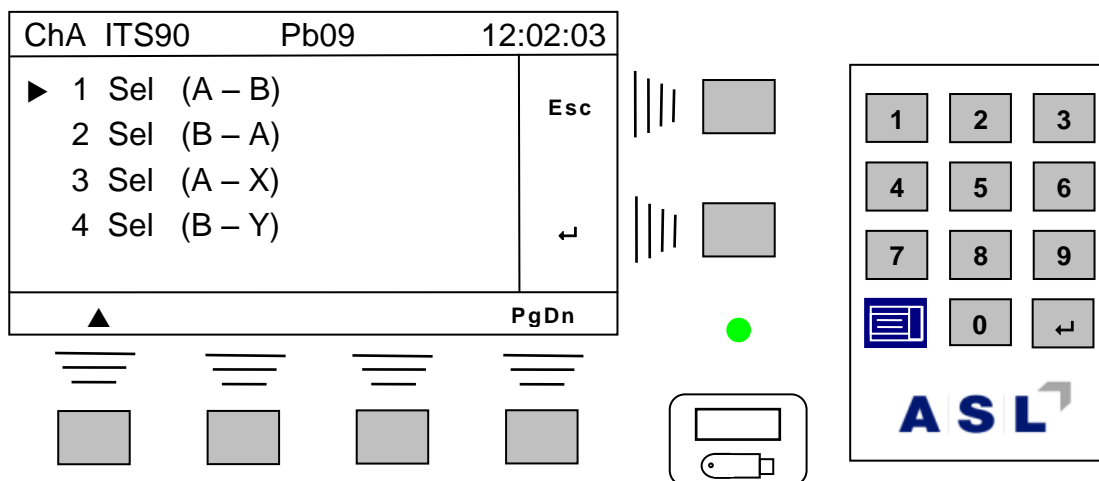


#### 4.4.4 Difference channel selection

The Diff key is used to select the differential operating modes. Again, its exact appearance depends on the number of channels present –

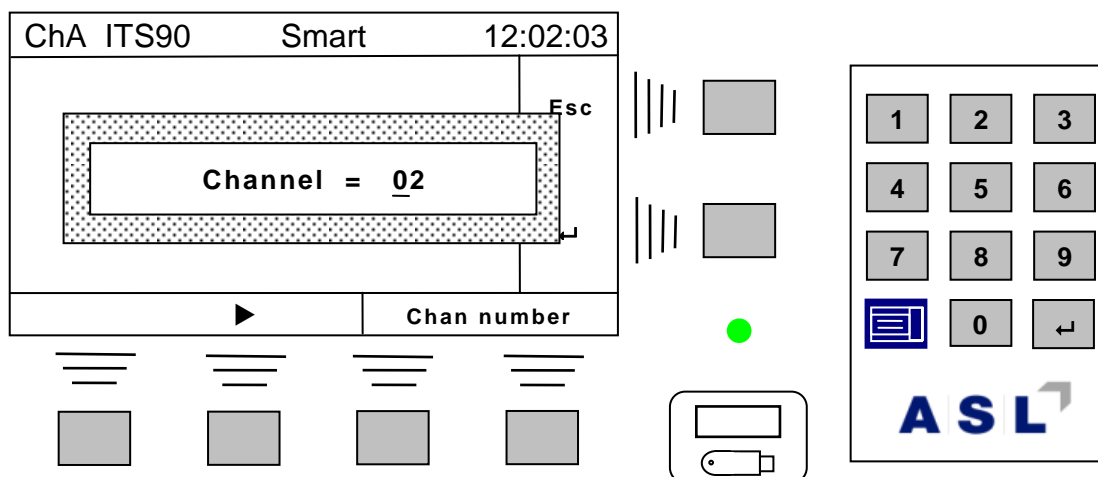


When more than 2 channels are fitted, the difference menu will look similar to –



Menu item 3 Sel (A - X) selects a difference reading between channel A and another CTR5000 channel<sup>21</sup>. Similarly, menu item 4 Sel (B - Y) selects a difference reading between channel B and another CTR5000 channel. For example selecting menu 3 Sel (A - X) will display the following –

<sup>21</sup> Difference modes are also supported for switchbox channels.



The screen allows entry of the X channel for the difference mode (the channels are referenced by their channel numbers). Use the numeric keypad and cursor keys to enter a two digit channel number for the difference calculation (see the section on editing numbers for more details on this).

#### Note

The difference can be calculated between any two valid CTR5000 channels.  
An error message will be displayed if the channel is not available.

#### Note

Smart probes take time to read their stored information. The Smart probe 'read on channel change' is disabled once a difference mode is selected. To change probes, select a single channel before reselecting a difference mode with Smart probes.

#### 4.4.5 Channel selection with CTS5000-8 and CTS5000-16 switchboxes

This section applies to instruments with one or more switchboxes.

Switchboxes are detected at power-on and are daisy-chained<sup>22</sup>. Addresses are assigned in order, so the first switchbox connected to the CTR5000 will start with the lowest address.

The LED next to the connector will be illuminated when a switchbox channel is selected.

Switchboxes need not be adjacent to the CTR5000, connections of several meters are possible. Also, switchboxes may have several metres of cable interconnecting them. However, signal noise may increase when long cables are used.

There are three ways of changing the current switchbox channel –

- Method A – by using numerical keypad, as described previously
- Method B – by using the Chan soft-key
- Method C – by using the Enter key on the numeric keypad

##### 4.4.5.1 Method A

The first channel on the first switchbox starts at address 16; the first channel on the second switchbox starts at address 32 (and so on). Switchbox addresses are assigned in the order switchboxes are connected to the CTR5000. Unused addresses will be ignored on 8 channel switchboxes. Addresses are –

First switchbox –

Channel	Numerical address
1	16
2	17
-	-
-	-
16	31

Second switchbox –

Channel	Numerical address
1	32
2	33
-	--
-	-
16	47

<sup>22</sup> The first switchbox connects to the CTR5000, a second to the first switchbox and so on.

Third switchbox –

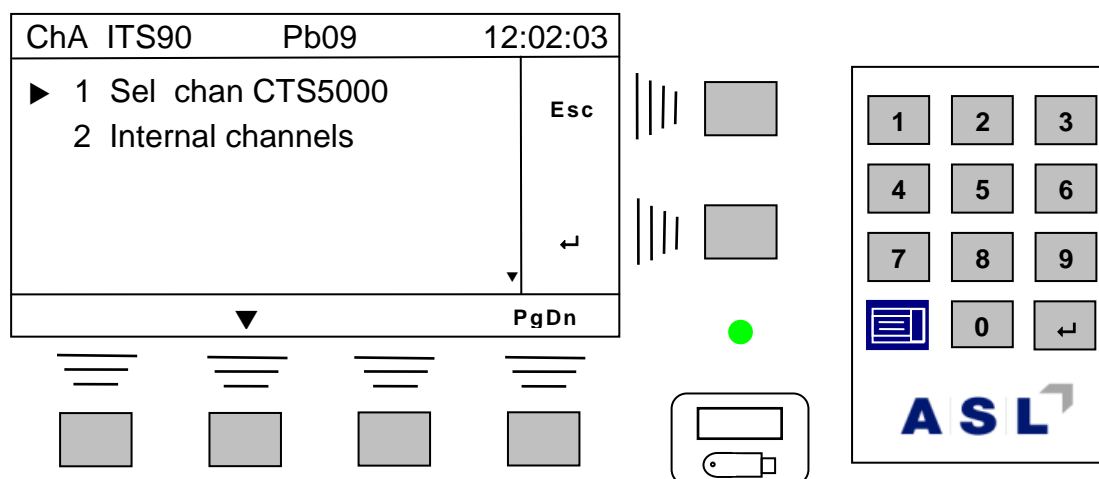
Channel	Numerical address
1	48
2	49
-	-
-	-
16	63

Fourth switchbox –

Channel	Numerical address
1	64
2	65
-	-
-	-
16	71

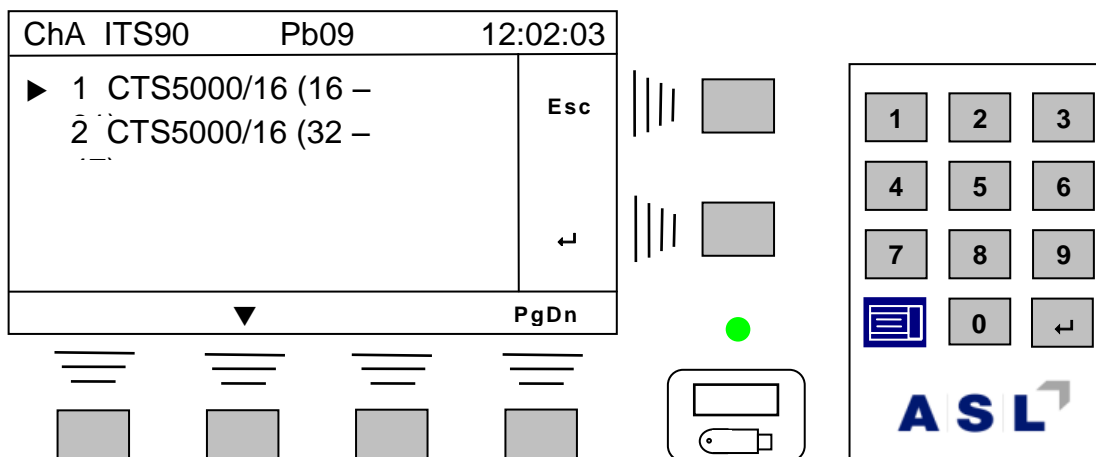
#### 4.4.5.2 Method B

Press the Chan soft-key and then the More soft-key. The display will change to<sup>23</sup> –

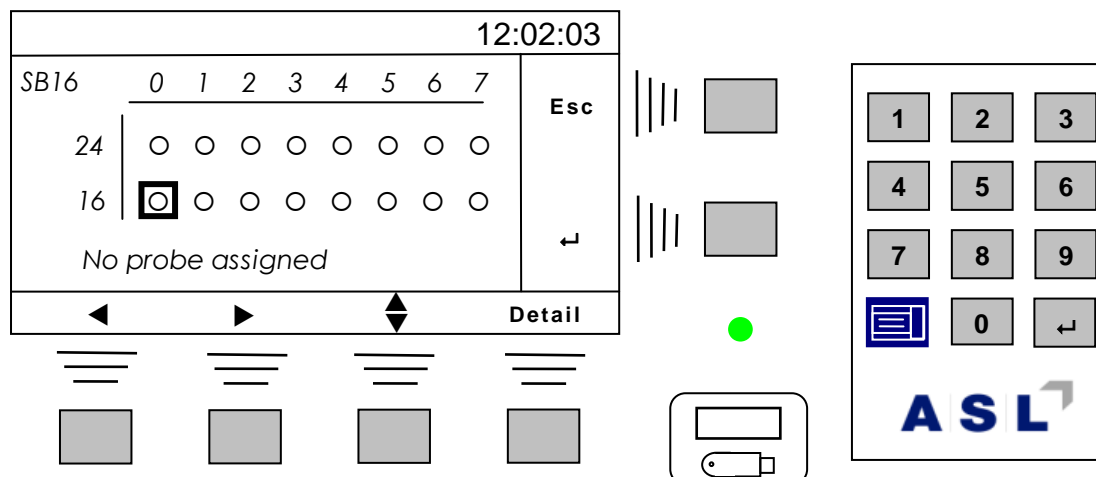


Select the Sel chan CTS5000 menu option and press one of the  $\leftarrow$  enter keys. The display will change (depending on the number of switchboxes fitted) to –

<sup>23</sup> The exact appearance of the display will depend on which additional channels are fitted to the instrument



Select the first menu 1 CTS5000/16 (16 – 31) with one of the enter keys, and the display will change to show the message Surveying. The CTR5000 will take a few seconds to check the switchbox(es) for Smart probes. The screen will then show the layout of the switchbox –

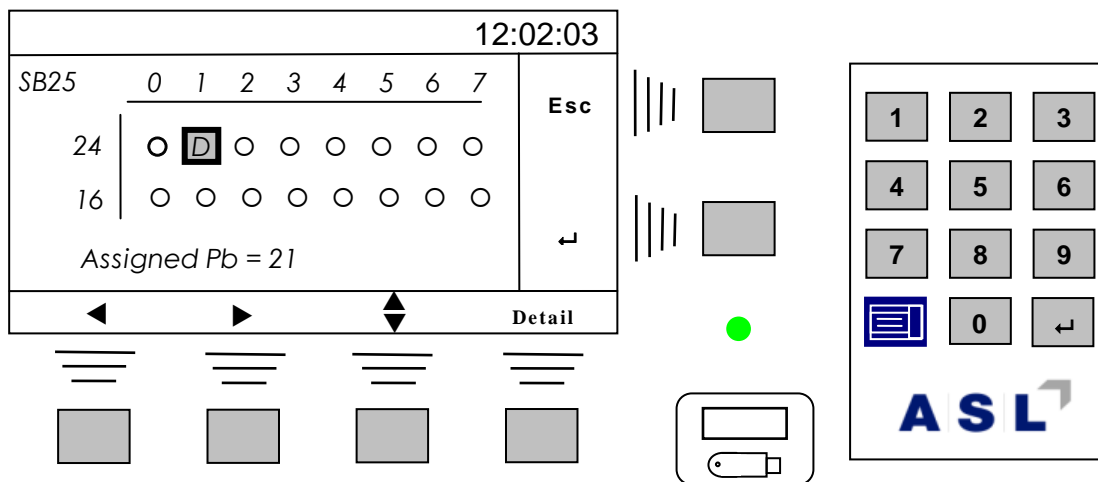


In this example, the display has changed to show a graphical representation of the first 16 channel switchbox, arranged in the same physical layout as the switchbox itself. The square  covering channel 16 is the currently addressed channel (shown at the top left of the display). Use the ◀, ▶ and ▲(up/down) soft-keys to move to the required switchbox channel and press the enter key (↵) to select it. Alternatively, press the Detail soft-key to view details for the current cursor channel (type of probe and coefficients).

**Note**

The circle (○) will be replaced by a highlighted S, D, d, C or I (assigned probe type) if the channel has a probe assigned to it. The bottom line will show the attached probe number.

For example –

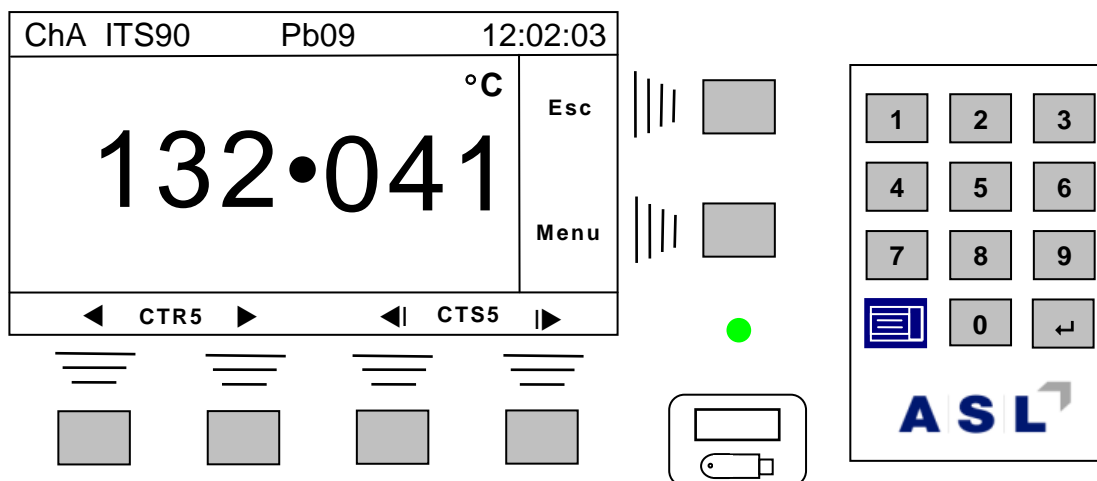


The probe possible symbols are listed in the table below –

Symbol	Conversion method
S	Smart probe
D	DIN90
d	DIN68
C	CvD
I	ITS90

#### 4.4.5.3 Method C

Press the Chan soft-key and then the More soft-key. The display will change to<sup>24</sup> –



<sup>24</sup> The exact appearance of the display will depend on which additional channels are fitted to the instrument

The arrow soft-keys will move through sequential channels. The keys auto-repeat. Press the Esc key to exit.

**Note**

Switchbox connections are determined dynamically by the instrument at power-on. The CTR5000 menus will always change automatically to show the current connection configuration.

**Warning**

**Do NOT plug or unplug switchboxes when the CTR5000 is powered**

## 4.5 Logging menu

The CTR5000 can log (record) data points. Two logging methods are possible –

- Internal – up to 8000 data points held in internal non-volatile memory
- External – up to 65000 data points

Once the internal log has stored data, it may be viewed on the LCD or sent to external communications interfaces. The memory is non-volatile so that, once recorded, the log is available until it is overwritten<sup>25</sup>.

The options for external logging depend on the interfaces fitted to the CTR5000. As a minimum, this includes the USB data link.

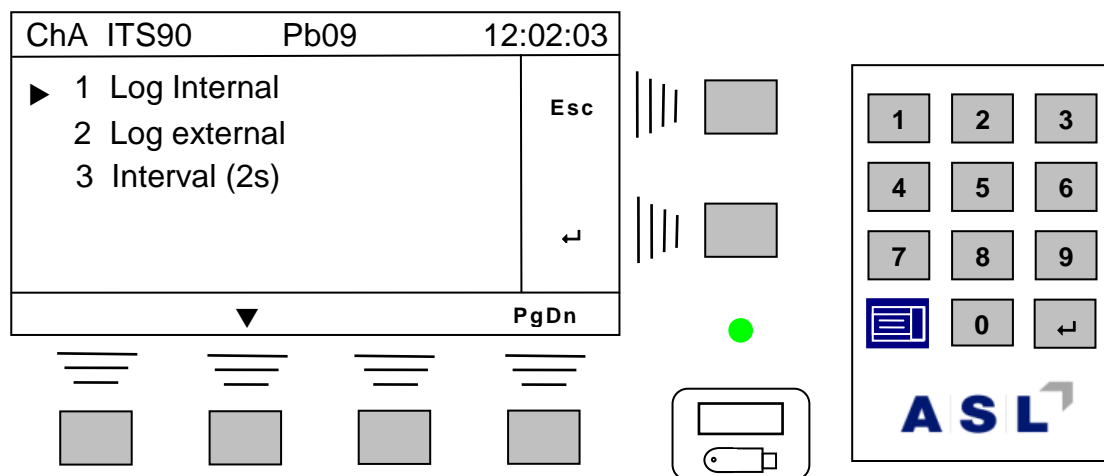
The CTR5000 can also scan a preset sequence of channels when one or more CTS5000 switch-boxes are fitted. Scanning is covered at the end of the logging section.

### Note

The CTR5000 logs the currently selected channel

### 4.5.1 Internal logging menu

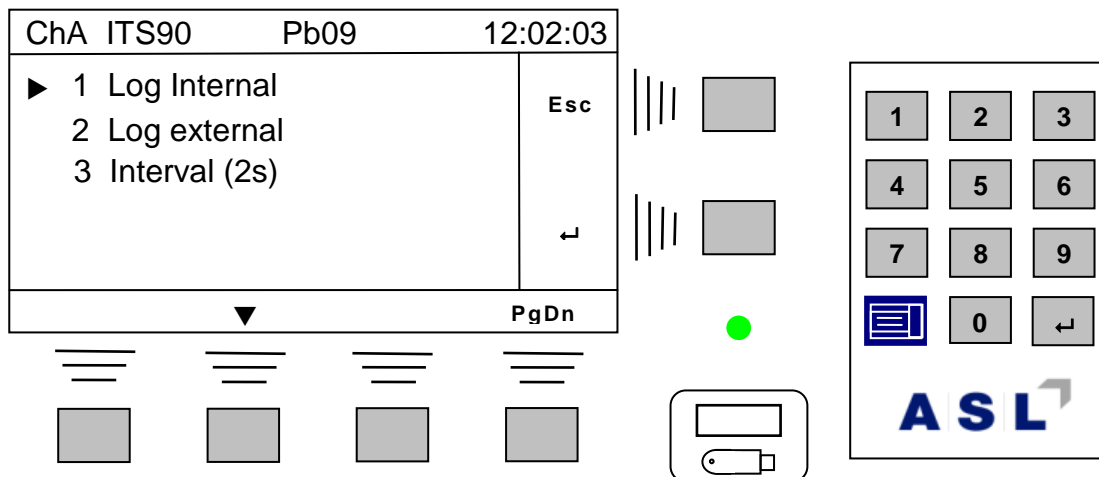
Select the Logging menu Menu → 1 Logging... → ↵ (i.e. the Menu key, then Logging... (default), then the enter key (↵) ) and the screen will look like –



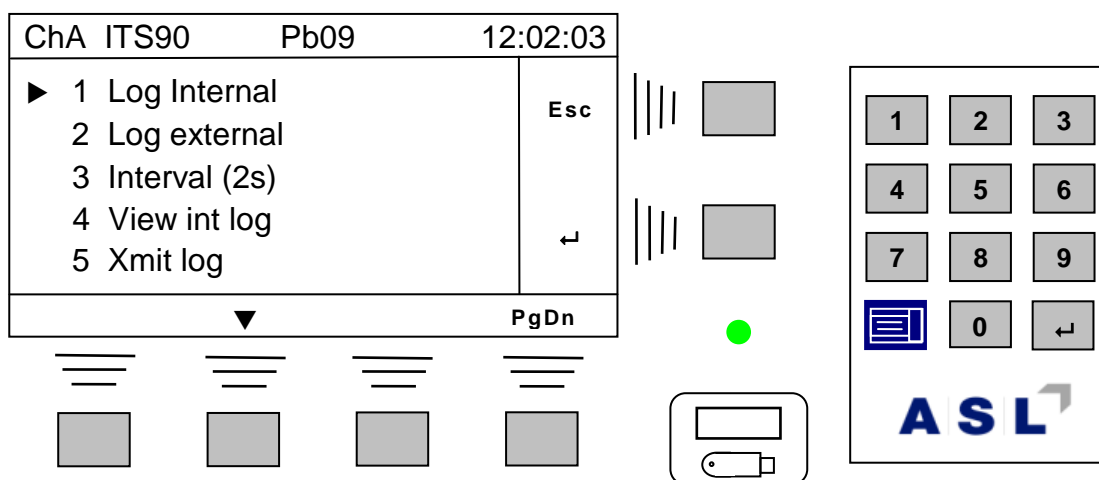
<sup>25</sup> There is no clear log option available. Data remains in the log until the next logging session.



Selecting Logging... will show –



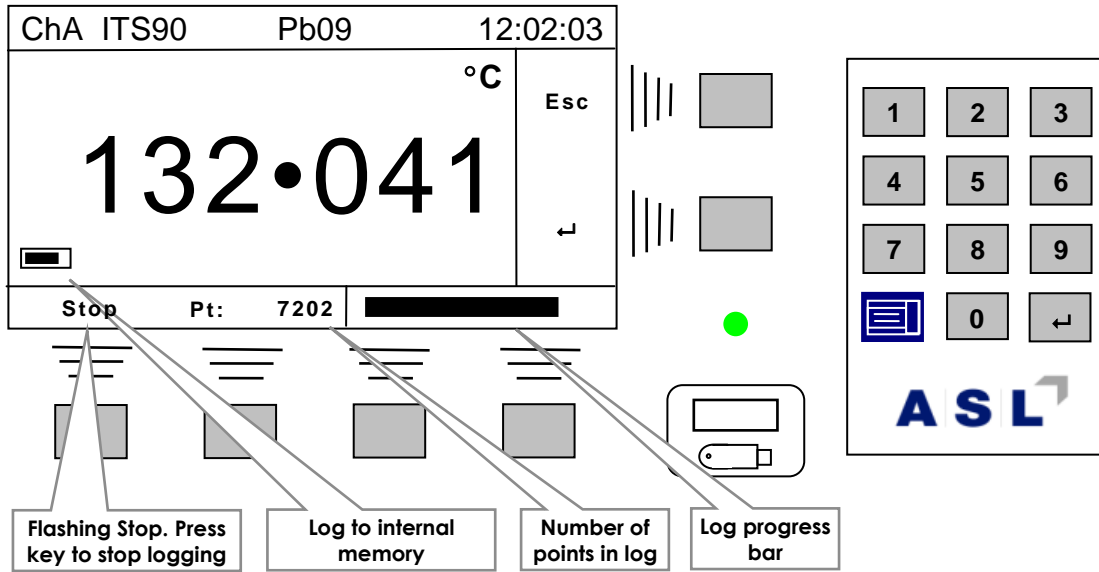
Once some data points have been logged, this menu screen will change to –



Two more menu items appear, allowing the internal log to be viewed on the LCD or sent to an external interface device. The measurement screen will show the internal log icon (see section 4.2).

#### 4.5.2 Internal logging screen

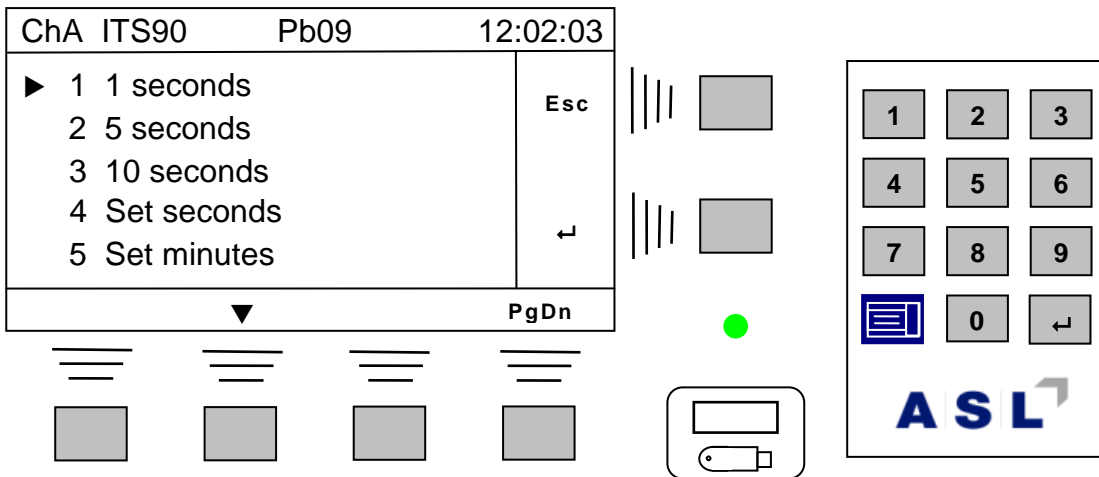
The screen below shows the display when internal logging is taking place –



4.5.2.1 Logging interval

The default logging interval is 2 seconds; the current interval is shown after the menu item. The log interval may be set between 1 and 99 seconds or between 1 minute and 99 minutes.

Select 3 Interval to set the logging interval –

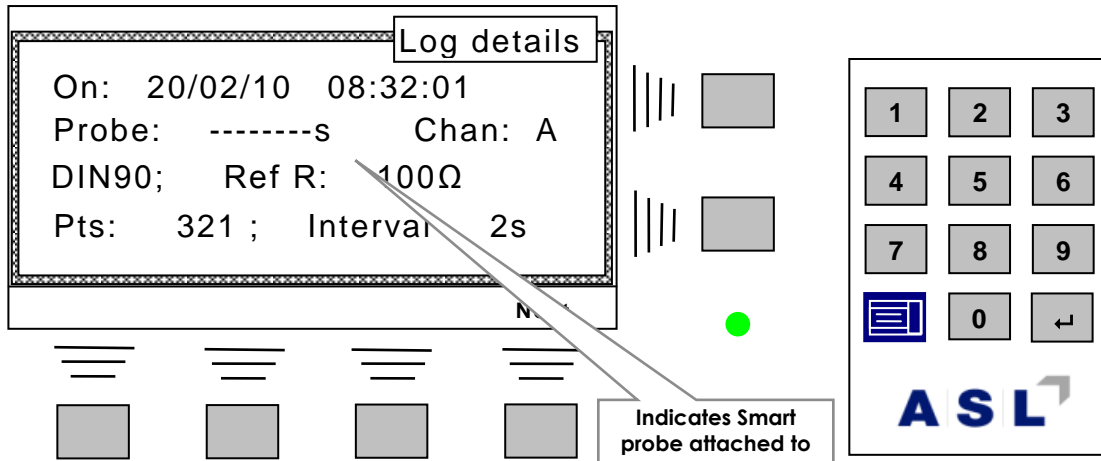


Select the required interval from one of the preset times or enter other intervals using the Set seconds or Set minutes menu options.

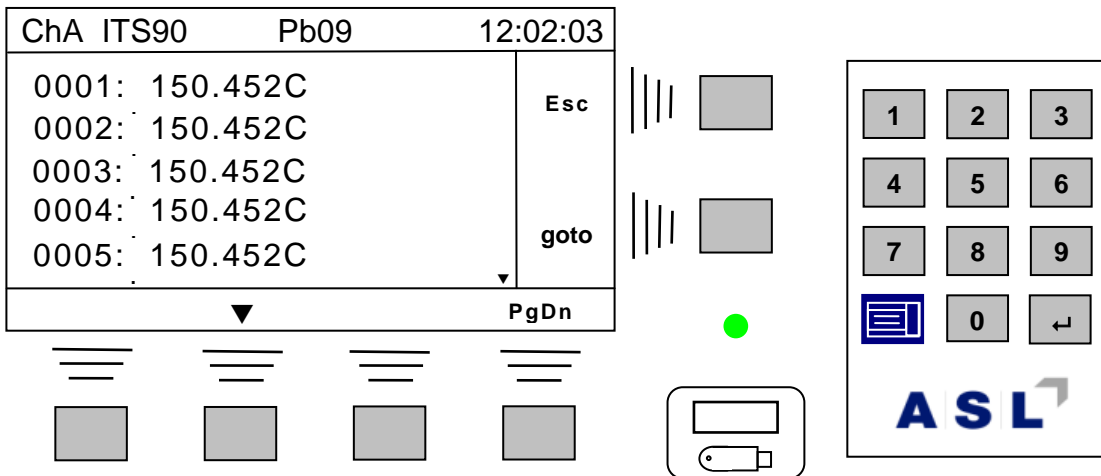
**Note**  
The logging interval is also used when scanning

4.5.2.2 View int log

The internal log may be viewed on the CTR5000 LCD. Select Menu → 1 Logging... → View int log ← to see the log. The initial screen will show details of the log – time, interval etc –



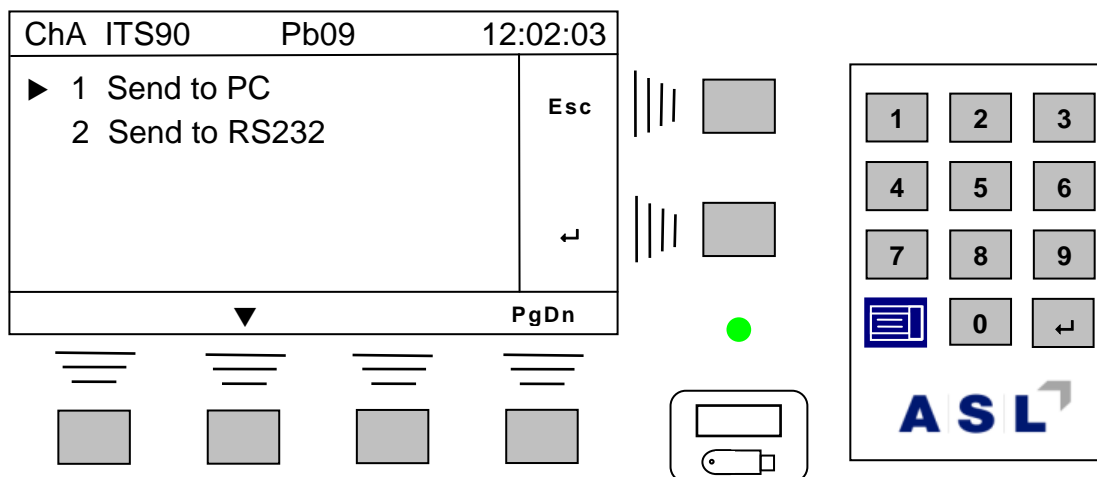
Press Next to view the log –



The log is displayed. The soft keys on the bottom line are used to scroll through the log. These keys will accelerate the log display if they are held down, enabling the whole log to be navigated in a relatively short time. Alternatively, the goto soft-key will allow a log entry number to be entered and jumped to.

## 4.5.2.3 Xmit Int log

The internal log may be transmitted to a variety of interfaces (the exact appearance of the screen will depend on the attached interfaces). Select the sequence **Menu → 1 Logging... → 1 Xmit log... → ↵**. The Xmit log... screen will look like –



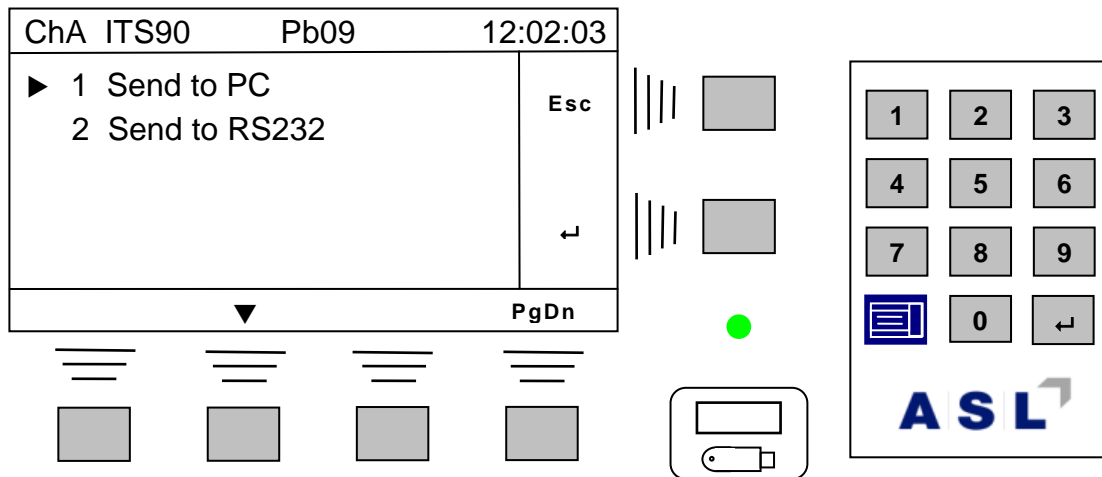
Select the required destination for the log and press Enter to transmit it. The log may be re-transmitted any number of times (until it is overwritten).

**Note**

Transmission times may be quite long, depending on the number of points logged. For example, a 1000 point log will transmit approximately 20 000 characters taking about 50 seconds.

## 4.5.3 External logging

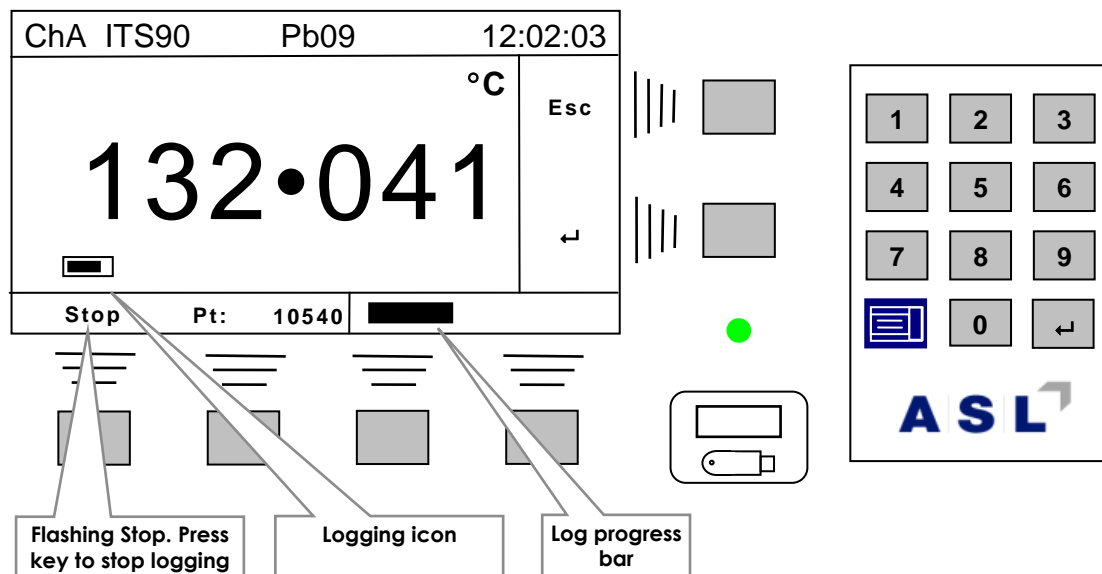
Select **Menu → 1 Logging... → 1 Log external... → ↵** to log to an external device. This will show a menu similar to the one below. The exact appearance will depend on which interfaces are fitted –



Select the required destination for the log and press Enter.

#### 4.5.4 External logging screen

The display below shows the CTR5000 logging to external USB –



The display will be similar for other external logging options.

#### 4.5.5 Logging limitations

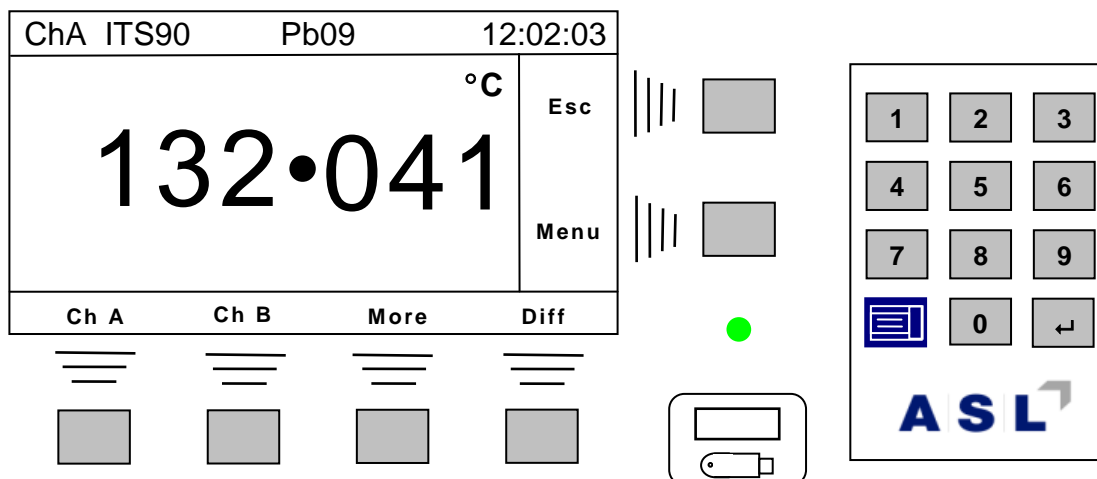
There are some common limitations that apply whilst logging –

- All front panel keys (except for Stop soft-key) are inactive
- No external PC communications allowed (an error message will be generated on the communicating )

- The Smart and probe status for the channel and probe information will be frozen – i.e. any change of probe coefficients or settings will not register during logging. Only probes with identical settings will work correctly if changed during logging

#### 4.5.6 Scanning

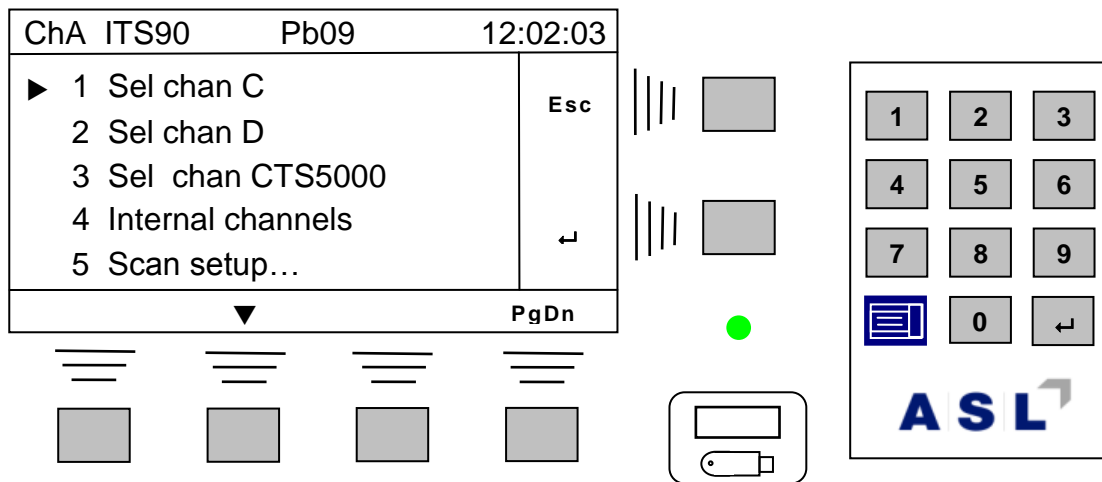
The CTR5000 is capable of automatically scanning through switch box channels. Channels are selected automatically and logged. In all other respects, scanning is similar to logging. Scanning enable, and start and end scan channels are set up from the More menu on the channels selection soft-key –



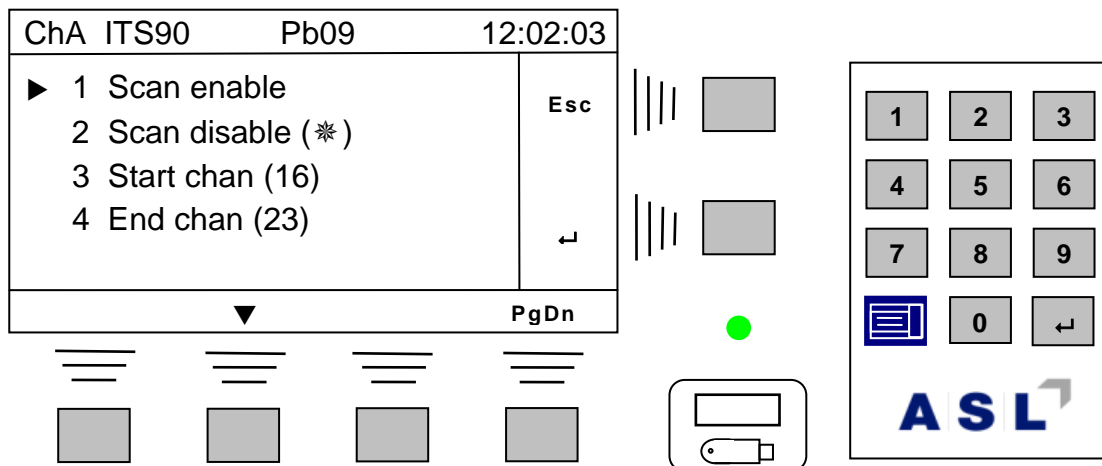
#### Note

The More soft-key will only be displayed if more than two channels are fitted.

When more than two channels are fitted, the exact appearance of the More display depends on the number of channels fitted. For example, if channels C and D are fitted, pressing the More soft-key will show –



Select the Scan setup... menu to show the following screen –



The first two menus enable and disable scanning during logging (disabled by default),  
 Selecting the third menu item allows the start channel to be set and selecting the last menu  
 sets the end channel. The CTR5000 will not allow the start and end channels to overlap.

Scanning (if enabled) will take place when logging is started.

**Note**

As with single channel logging, probe settings are frozen when logging starts

#### 4.5.7 Channel and probes

The CTR5000 needs to know what temperature conversion method (and coefficients) to use as different channels are selected.

**Note**

There is a fundamental difference between the F250 and CTR5000. The F250 allowed coefficient data to be entered for a channel. The CTR5000 is NOT the same. See below.

The CTR5000 allows the coefficient data (and units, etc) to be entered for one of 72 probes. The probe is then assigned to a particular channel. Once assigned to the channel, the data for that probe is used. This is a far more flexible system; probes may assigned or unassigned at will without other entered data being lost.

When the channel is changed, the instrument will check to see if a probe number has been assigned to the new channel. If it has, it will use the conversion method set-up for the assigned probe. If no probe has been assigned, then the CTR5000 will only display the probes resistance or use the default DIN90 conversion method to display temperature<sup>26</sup>.

**Note**

The instrument will always use valid smart-probe parameters to over-ride the assigned probe when a smart probe is detected on a channel.

Any combination of Passive and Smart probes may be mixed on the CTR5000 and switchboxes.

**Note**

When first supplied, for convenience only, Probe1 is attached to channel 1(A) and so on for all the internal channels fitted. Similarly, Probes 16 to 31 are attached to the first switchbox channels. Default DIN settings are used.

---

<sup>26</sup> There is no need to enter the maximum/minimum temperatures for the CTR5000. These are defined by the conversion method. The screen will display a warning if the temperatures are outside the valid conversion range –e.g.  $t > t_{max}$



#### 4.5.8 Probe review and edit

Up to 72 probes may be defined and stored by the CTR5000. Each probe number (1 to 72) can be entered or edited to define its conversion method, coefficients used, resistance and probe id string. Once defined, a probe may be assigned to a channel so that when this channel is selected, the probe's data will be used. The probes are defined and reviewed using the menu system.

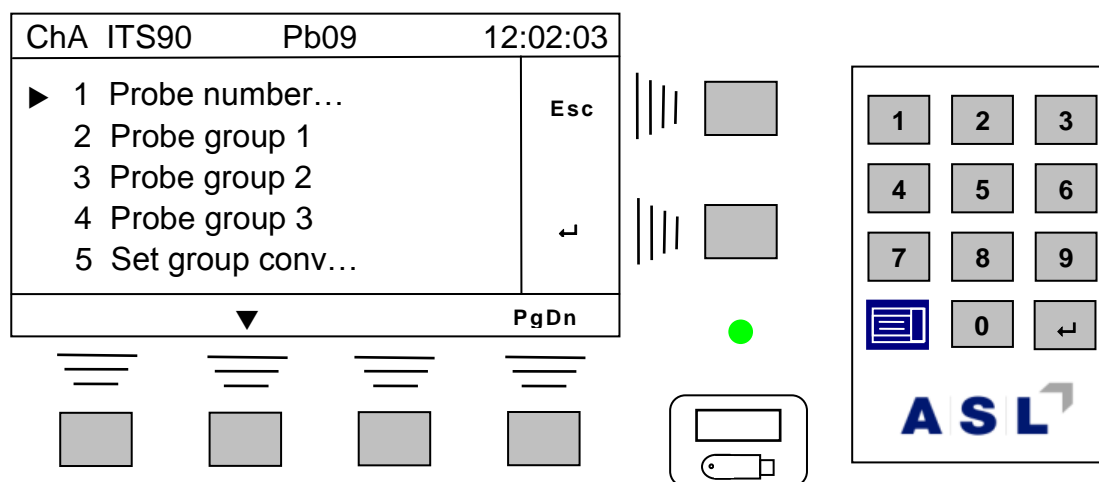
For convenience, probes are divided into three groups. Each group has 24 probes - the grouping has no other significance.

A probe id string (up to 10 characters long) may be given to each probe. Characters must be numeric when entered from the CTR5000 editor. However, alpha-numeric data can be entered through a data link (e.g. USB) using the N command (see the communications section). The id string can be reviewed or edited (numerical characters only) on the CTR5000. The string will be reproduced on a probe report.

##### 4.5.8.1 Probe menu

This menu is used to select and edit probes.

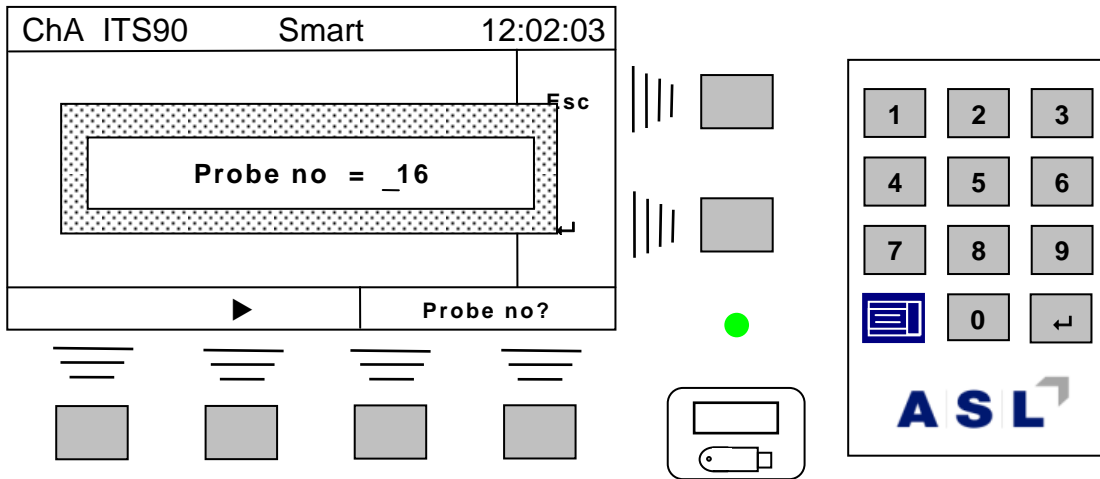
Select the Probe menu Menu → 2 Probes... → ↵ (i.e. the Menu key, then Probes, then the enter key (↵) ) and the screen will look like –



The first menu option allows a probe to be selected by number via the numeric keypad. The remainder of the menu options allow probes to be selected from a group. Three groups of 24 probes are selectable to make it easier to remember where any particular probe is. Finally, for convenience, all probes in a group may be set to have the same temperature conversion method (Set group conv... menu)

4.5.8.2 Probe selection (individual)

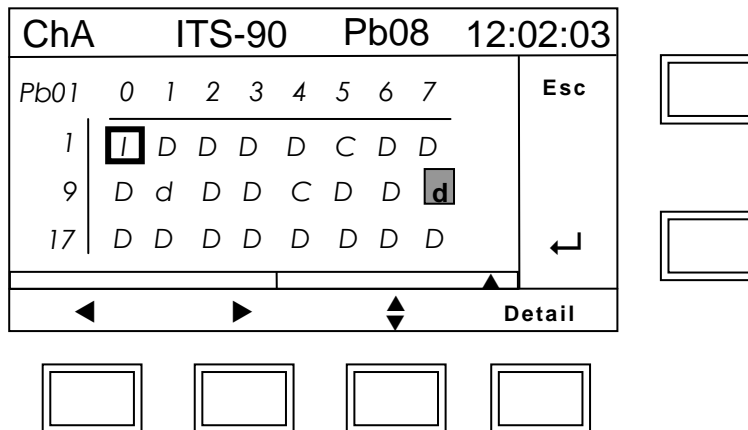
Use the first menu (Probe number...) to select an individual probe for review/editing. The screen will be similar to –



The last selected probe (16 in the example) will be shown. Press the enter key (↵) to select this probe, or change the number to the required probe and then press enter. This probe will be selected for review or editing.

4.5.8.3 Probe groups menu (from group)

Select one of the probe groups and the next screen will show (second group selected in this example) –

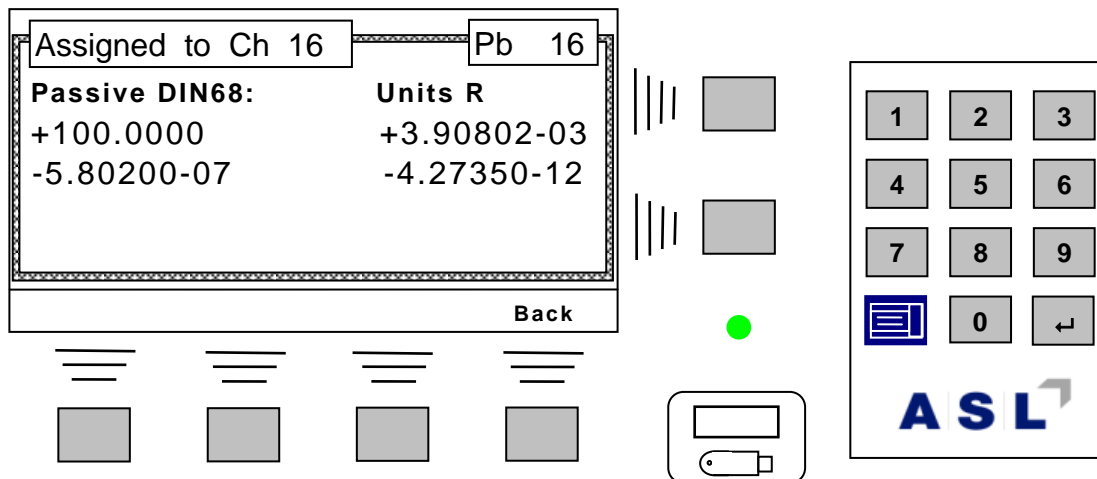


The top left of the probe screen shows the cursor over probe 1 (Pb01). The editing (arrow) soft-keys are used to move the cursor to the desired probe number (current probe selection is indicated at the top left of the screen). The majority of the probes have not been defined and are currently set to the default of DIN90 (D).

The I character under the cursor indicates that this probe has been defined to use ITS90 as its conversion method (but not assigned to any particular channel). The reverse video background d (probe 16) indicates that this probe is in use – i.e. attached to a channel. Other letters indicate probe conversion methods (for example probe 10 is defined as a DIN68 probe). The codes are –

Symbol	Code
■	Probe attached when reverse video
D	Probe defined as DIN90
d	Probe defined as DIN68
C	Probe defined as CvD
I	Probe defined as ITS90

Information for any particular probe (once the cursor is over it) can be viewed using the Detail soft-key. For example, assuming the cursor has been moved to Pb16, pressing the Detail soft-key will show a screen similar to –

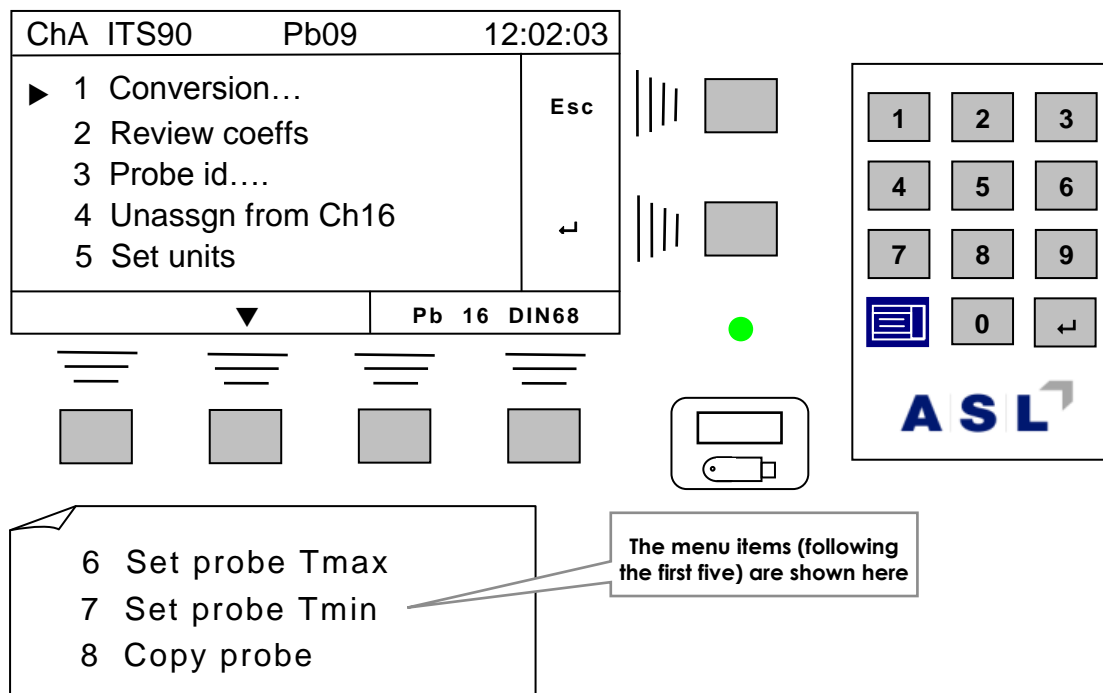


Press the Back soft-key to return to the previous screen.

Once the cursor is over the required probe, press the enter key (↵) to select this probe number for review or editing.

#### 4.5.9 Probe review and editing

The probe menu screen is shown below. Each of the menu items on this screen will be covered in more detail. The currently selected probe number and conversion type is shown on the bottom right of the LCD. The exact appearance of this menu will depend on the conversion method. The coefficients cannot be changed for the DIN68 method, so the Edit coeffs menu is not available (normally follows View coeffs).



A summary is shown in the tables below for fixed and editable coefficients–

#### Probe menu example with fixed coefficients – DIN, CvD and DIN68

Menu item	Description	Notes
1 Conversion...	Select conversion method	DIN90, CvD, ITS90 or DIN68
2 Review coeffs	View the coefficients	For currently selected method
3 Probe id...	View and/or edit the Probe id string	Up to 10 characters
4 Unasgn from Ch16	Unassign from channel 16	DIN defaults restored
5 Set units...	Set the initial units	Used on channel (probe) select
6 Set probe Tmax	Set the probe upper temperature limit	Default set to DIN limits
7 Set probe Tmin	Set the probe lower temperature limit	Default set to DIN limits
8 Copy probe	Copy current probe settings to another	Channel assignment unchanged

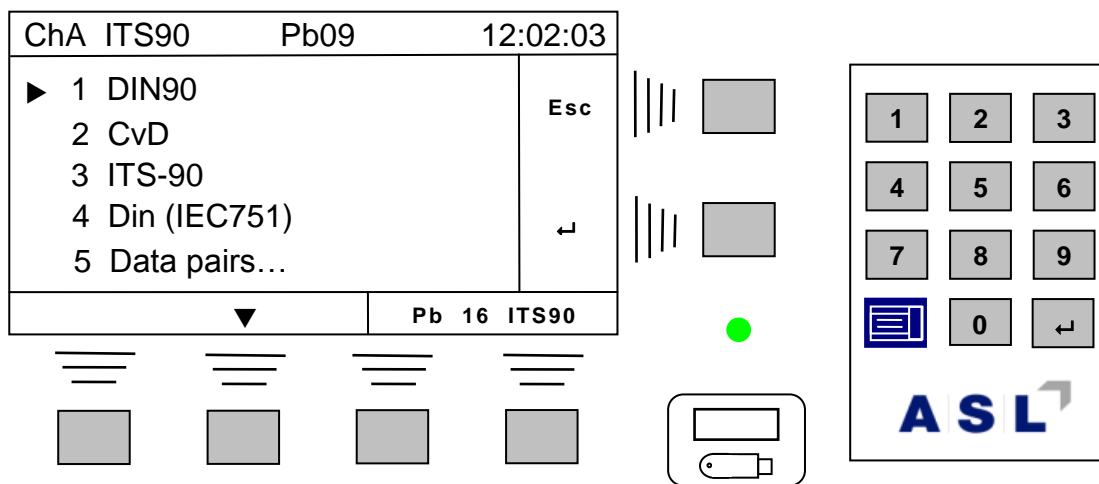
Probe menu example with variable coefficients – ITS90

Menu item	Description	Notes
1 Conversion...	Select conversion method	DIN90, CvD, ITS90 or DIN68
2 Review coeffs	View the coefficients	For currently selected method
3 Edit coeffs...	Edit the methods coefficients	ITS90 only
4 Probe id...	View and/or edit the Probe id string	Up to 10 characters
5 Assign to chan	Currently unassigned	
6 Set units...	Set the initial units	Used on channel (probe) select
8 Set probe Tmax	Set the probe upper temperature limit	Default set to DIN limits
9 Set probe Tmin	Set the probe lower temperature limit	Default set to DIN limits
10 Copy probe	Copy current probe settings to another	Channel assignment unchanged

Each menu options is described below –

4.5.9.1 Conversion

The following screen will be displayed once the Conversion menu is selected –



Use the editing arrows, or enter the menu number, to select the required conversion method. The exact appearance of the previous screen will depend on whether the coefficients can be changed.

The last menu item allows data-pair entry. This menu and its sub-menus provide coefficient calculation after entering the required number of data-pairs. Use of this menu item will be covered in a subsequent section.

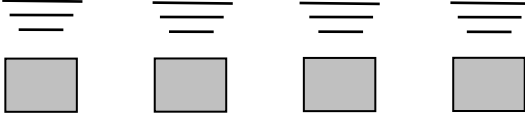
**Note**


Selecting (or reselecting) a conversion method will reset the coefficients to their default values.

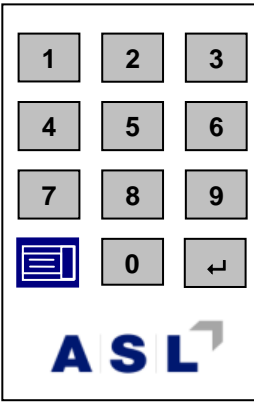
4.5.9.2 Review coeffs

Shown below for the DIN90 method –

ChA	ITS90	Pb09	12:02:03
▶ 1	R0	==+100.0000	Esc  ↵
2	A90	==+3.90830-3	
3	B90	== -5.77500-7	
4	C90	== -4.18300-12	
▼		Pb 16 DIN90	









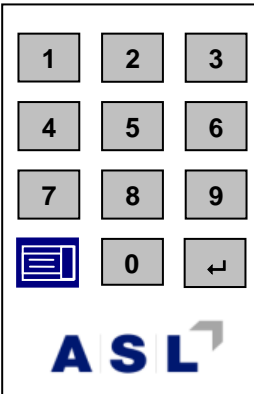
4.5.9.3 Edit coeffs

Shown below for the ITS-90 method –

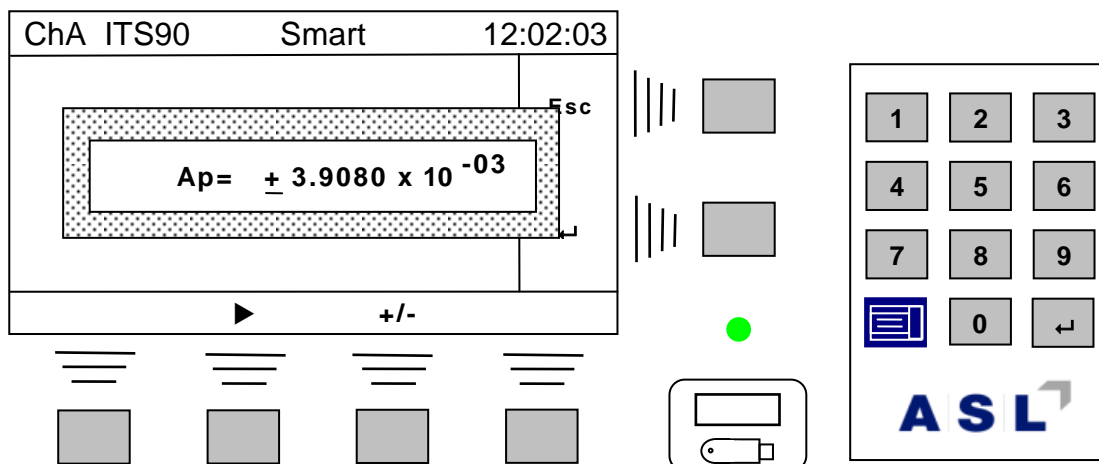
ChA	ITS90	Pb09	12:02:03
▶ 1	R0.01	==+100.0000	Esc  ↵  ▼
2	Ap	==+3.90830-3	
3	Bp	== -5.77500-7	
4	Cp	== -4.18300-12	
5	Dp	== -4.18300-12	
▼		Pb 16 ITS90	







Note that there are more than five coefficients in this example. Select one of the coefficients (e.g. Ap) –

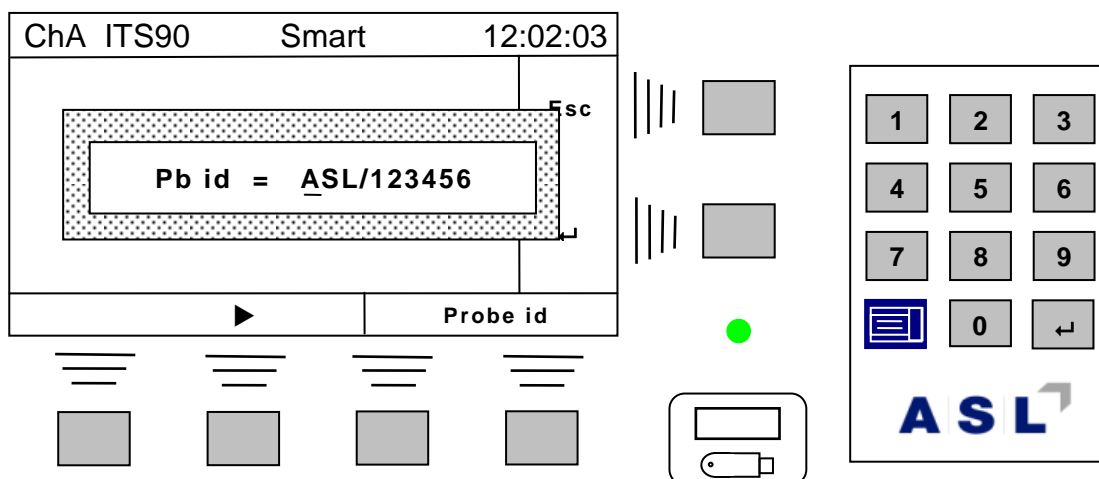


Use the editor to change the value. The decimal place and x10 characters cannot be changed, See the section on editing for more detail. Use the enter key (↵) to accept the new coefficient or Esc key to leave it unchanged. Both keys return to the previous menu, allowing other coefficients to be edited.

**Note**

There is no range checking on coefficients – they may be changed to any value.

4.5.9.4 Probe id





Use the editor to change the id (identifier) string. Up to 10 characters are available to use as a probe id. Strings are empty to start with. Use the enter key (↵) to accept the change or Esc key to leave it unchanged.

#### Note

The CTR5000 editor can only use numerical characters to overwrite existing characters. However, other characters can be entered using a data interface and the N command.

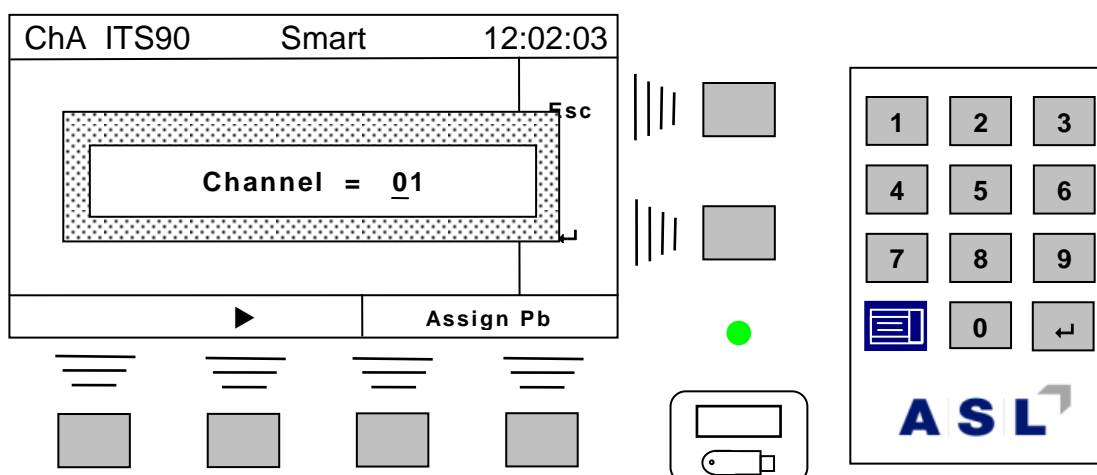
#### 4.5.9.5 Assign to chan (Unasgn from)

Probes may be edited or set-up in any order.

A probe's set of values will not be used until it is assigned to a channel. Once assigned, the channel will use the programmed values every time that channel is selected.

Note that if a probe is already assigned, then this menu will instead read Unasgn from Chxx - where the currently assigned channel xx is indicated.

Selecting the Assign to chan menu will show a screen similar to the following one -



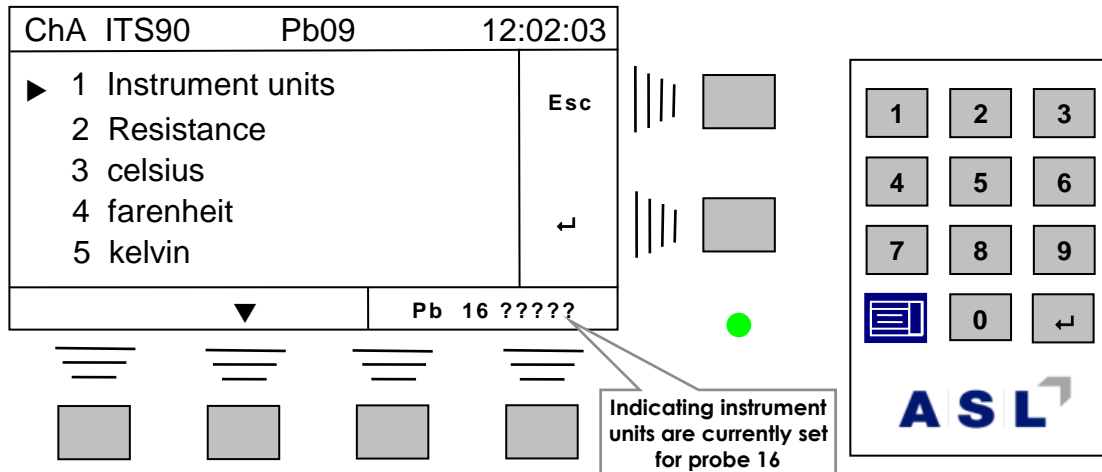
Use the editor to set the required channel and then use the enter key (↵) to accept the value or the Esc key to leave it unchanged.

Once a probe has been assigned to a channel, the menu will change to, for example, Unasgn from Ch01. Selecting this menu will unassign the probe. No warning message is given since probes are simple to assign. DIN defaults will be restored.

## 4.5.9.6 Set units

Probes may have their units set. When the probe is assigned to a channel, these pre-programmed units are selected every time the channel is changed to the one with the assigned probe.

Selecting this menu will display –




Instrument units are the default - when selected, the CTR5000 will use the current units rather than changing to another on channel selection. The units can still be changed from the initial units using the Unit menu – there is no other significance to the setting.

Select the required unit and then use the enter key (↵) to accept this or the Esc key to leave the current state unchanged.

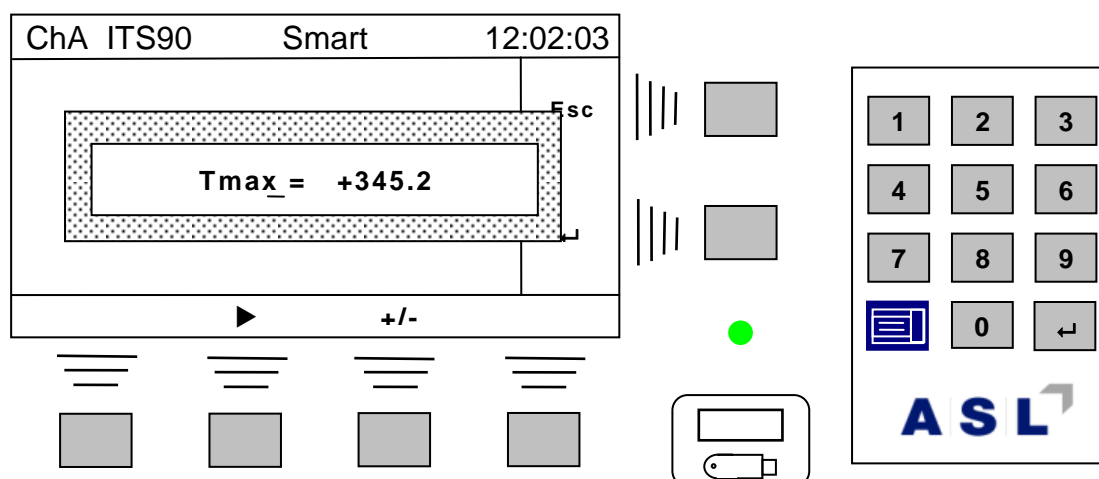
Finally, use the Esc soft-key to return to Measurement mode.

## 4.5.9.7 Set Probe Tmax

Probes may have a maximum temperature set for them (positive or negative). When the probe is assigned to a channel, the probe's temperature is checked against the set maximum and a range error issued if the maximum temperature is exceeded.

The temperature will still be displayed (it does not matter what the units are), but, if the buzzer is enabled, a short, repetitive beep will be heard and the over-range icon  will flash on the line below the result and the panel LED will flash red.

Selecting this menu will show a display similar to –




The default conversion limit will be set the first time this display is shown (range checking is not active when Tmax is set to (or above) the limit).

Set the required limit and then use the enter key (↵) to accept this or the Esc key to leave the current value unchanged.

#### 4.5.9.8 Set Probe Tmin

Probes may have a minimum temperature set for them (positive or negative). When the probe is assigned to a channel, the probe's temperature is checked against the set minimum and a range error issued if the minimum temperature is exceeded.

The temperature will still be displayed (it does not matter what the units are), but, if the buzzer is enabled, a short, repetitive beep will be heard and the under-range icon  will flash on the line below the result<sup>27</sup> and the panel LED will flash red.

See the Set Probe Tmax menu since data entry is very similar.

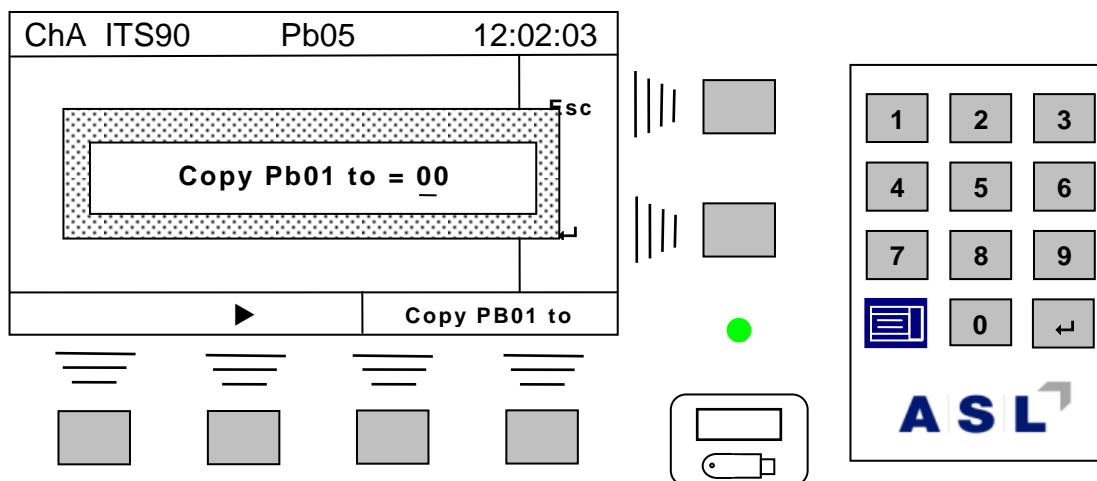
#### Note

The Tmax and Tmin limits can be set with a small 'window' if a particular temperature needs to be monitored.

<sup>27</sup> Note that the icons will only be displayed on the numerical display screen

## 4.5.9.9 Copy probe

The details of one probe may be copied to another using this menu. Once selected, the screen will be similar to –



Enter the number of the probe you want to copy the current probe to and then use the enter key (↵) to copy the probe details or use the Esc key to exit without any changes.

**Note**

All details, except the channel assignment, are copied to the probe number selected.

## 4.5.10 Set group conversion

For convenience, all probes in a group may be set to the same conversion method. This menu will prompt for the group number, then the conversion method (and then ask for confirmation). All probes in the group will be set to use the default conversion coefficients for the method. The channel assignments, and probe id string are NOT changed. All other parameters (e.g. units) are copied from the first probe of the group.

## 4.6 Reference resistors

The CTR5000 allows the choice between two internal reference resistors (25Ω and 100Ω). The 25 ohm resistor should only be used when a 25 ohm PRT (or lower) is used.

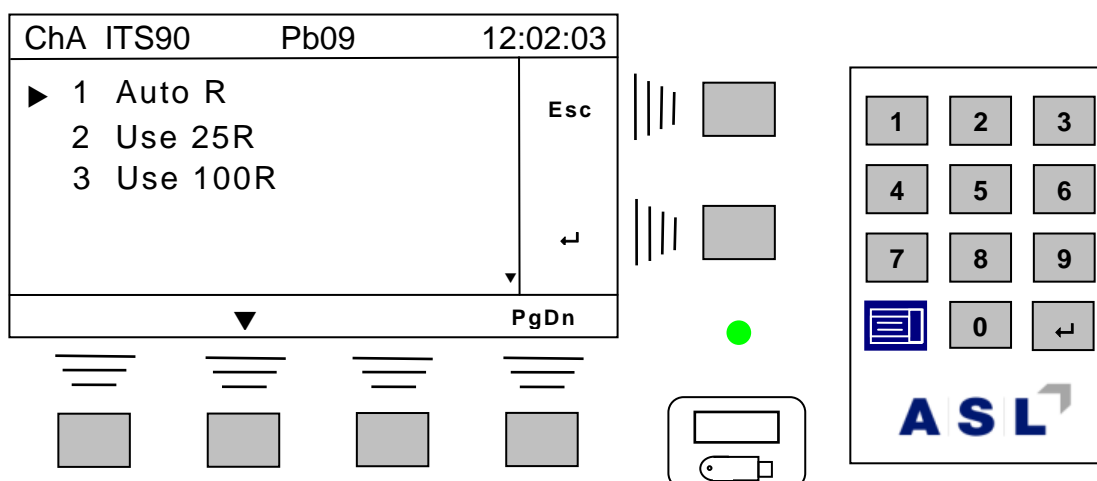
**Note**

Use the 100Ω reference resistor for all probes with  $R_0$  values above 25 Ω

The CTR5000 automatically adjusts the PRT current (from 1 mA for the 100 ohm reference) to 2 mA for the 25 ohm reference.

### 4.6.1 Reference resistor menu

From the measurement screen, select Menu → 3 Rs Resistor... → ←



Select the required reference resistor<sup>28</sup>.

#### 4.6.1.1 Auto reference resistor

The menu allows the use of Auto R selection. The auto R selection looks at the  $R_0$  value of the probe. If  $R_0$  is below 50 ohms, the 25 ohm reference is selected; any  $R_0$  value equal to or above 50 ohms will use the 100 ohm reference. See the 7 Options... menu to allow the reference value to be displayed (replaces the time display on the top right of LCD).

<sup>28</sup> Note that the reference settings is ignored for Smart Probes - the reference resistor used is set as one of the parameters.

## 4.7 Calibration

It is vital to ensure the CTR5000 is correctly calibrated to obtain the most accurate results. Good laboratory practice dictates that any instrument should be checked before and after a day's measurements.

**Note**

Regularly check calibration.

The CTR5000 contains very accurate and stable 25  $\Omega$  and 100 $\Omega$  reference resistors. The exact values of these resistors are found by comparing their ratio against traceable, external 25 $\Omega$  and 100 $\Omega$  resistors. The results of the comparison are used to calculate the value of the internal resistors – i.e. they are calibrated<sup>29</sup>. The CTR5000 needs other points to ensure that its linearity specification is met across its full range<sup>30</sup>. The user calibration values are –

- 0  $\Omega$
- 25  $\Omega$
- 100  $\Omega$

A four terminal zero-ohm resistor is required together with traceable, calibrated resistors for the 25 and 100 ohm points<sup>31</sup>.

The calibration procedure is simple and is partially automated. The procedure is described in the following sections.

### 4.7.1 Calibration menu

From the measurement screen, select Menu → 4 Calibration... → ↵

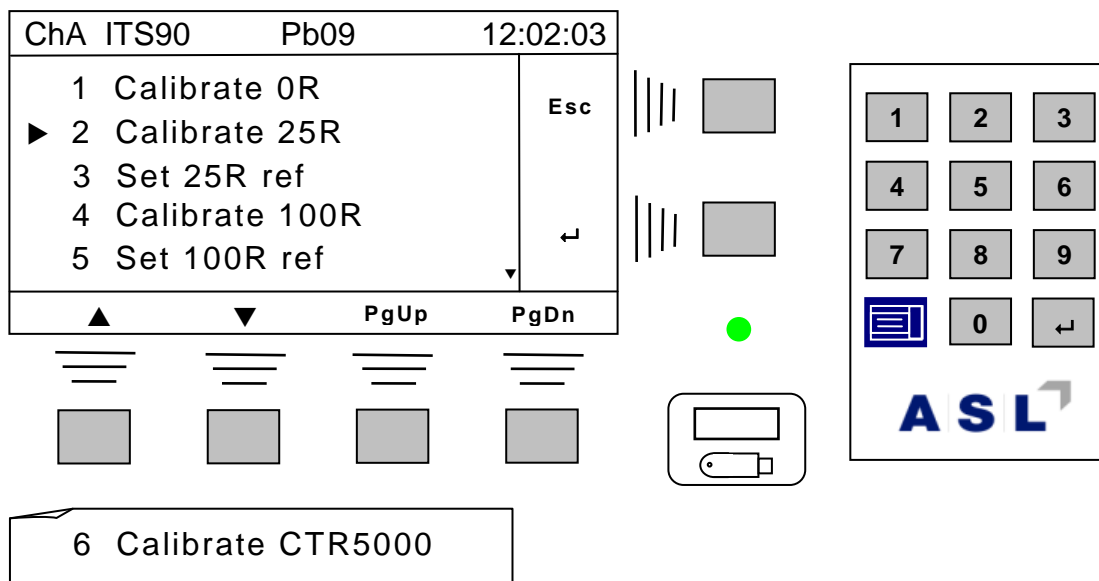
The calibration menu is shown below –

---

<sup>29</sup> It also contains another accurate 100 $\Omega$  resistor for diagnostic purposes. The value of this resistor is stored when the instrument is built and used at start-up to check performance at a ratio of 1:1.

<sup>30</sup> Yearly recalibration by the agent or supplier is recommended

<sup>31</sup> Both available from ASL



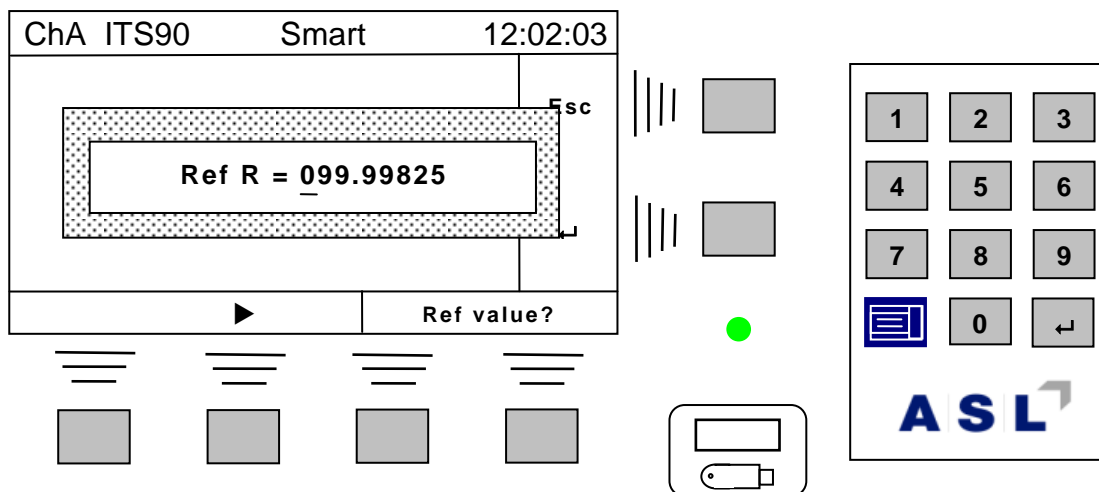
The procedure is the same for both calibration points. To illustrate calibration, only one value will be covered.

It is only necessary to enter the true, calibrated value of the resistor used for the 25 ohm and 100 ohm calibration points. The 0 Ω resistor is assumed to be 0 ohms.

4.7.1.1 Calibration reference resistor

First, enter the calibration values for the 100 Ω resistor from its calibration certificate<sup>32</sup>.

Menu item 5 has been selected (100 Ω reference resistor) to show the reference value setting -



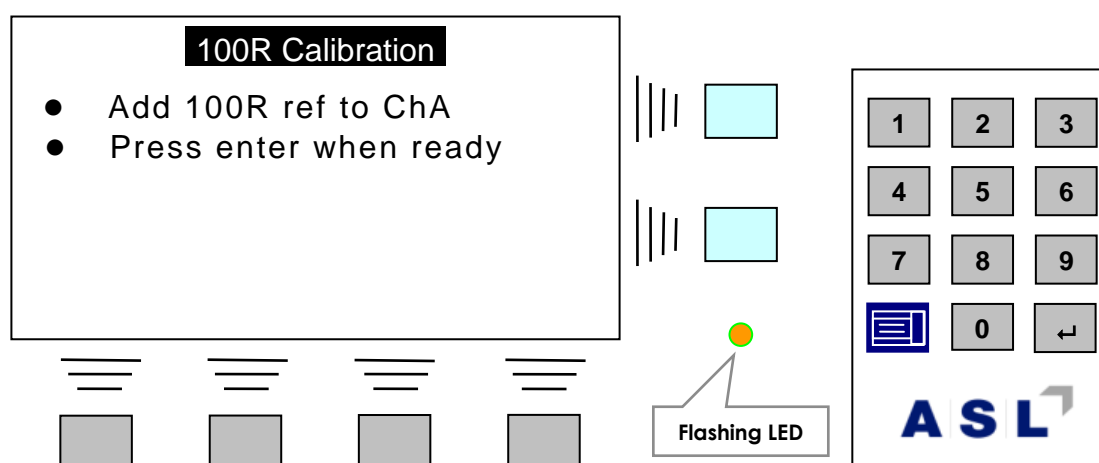
<sup>32</sup> The values of the external, calibrated reference resistors must be accurate to at least 4 decimal places to ensure the CTR5000 is calibrated correctly. Less accurate resistors may be used, but the instrument accuracy will suffer accordingly.

A spread of up to  $\pm 1 \Omega$  is allowed for the resistors. Use the editor to set the calibrated value and then use the enter key ( $\rightarrow$ ) to accept this value or the Esc key to leave the current value unchanged.

#### 4.7.1.2 Calibration method

First, enter the calibration value for the 100  $\Omega$  resistor from its calibration certificate (see previous section).

Menu item 4 has been selected (100  $\Omega$  calibration) to illustrate the procedure –



#### Note

Allow at least 40 minutes with power applied before recalibration.

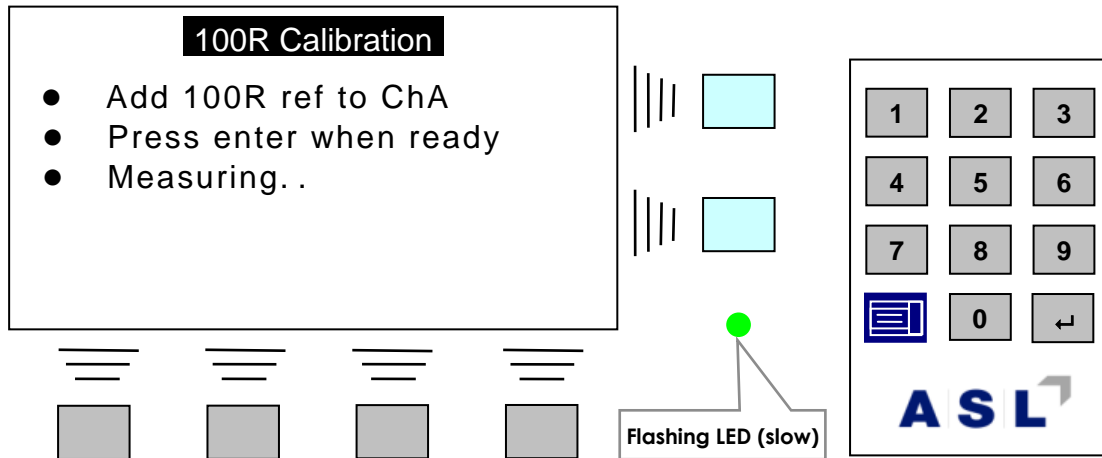
#### Note

For best accuracy calibrate the 100 ohm resistor before the 25 ohm resistor.

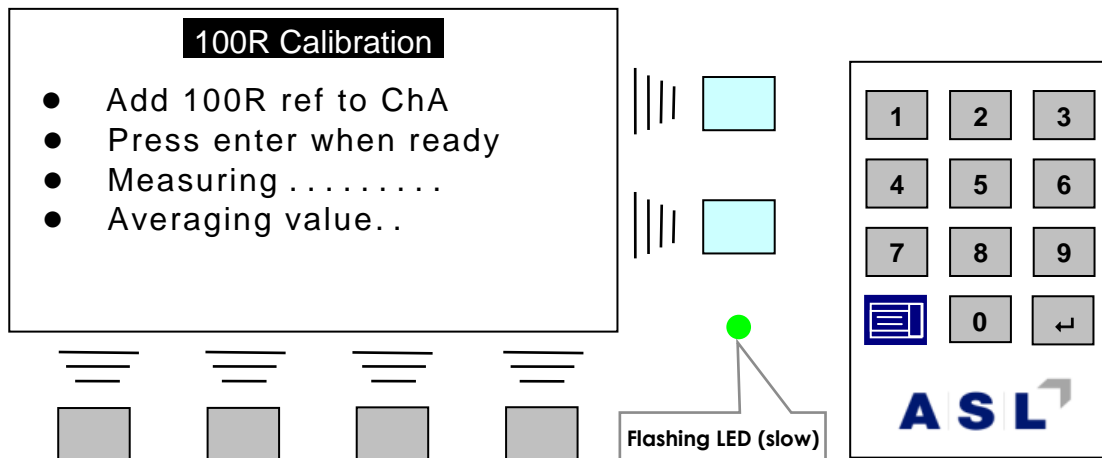
Follow the on-screen instructions, noting that the relevant external resistor must be connected to channel A.



Use the enter key (↵) to accept this step and move on, or press the Esc key twice to abort

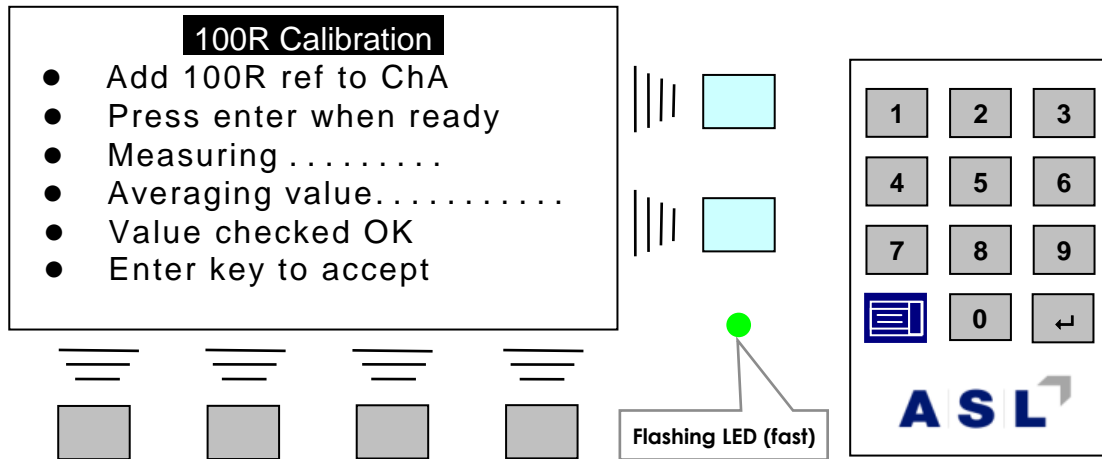


This will change to the following screen once the measurement check is complete –



Once the external reference resistor value has been checked, its value will be averaged (note that the average measurement is performed twice). On completion, the screen will show –

<sup>33</sup> Use the Esc soft-key to abort the procedure at any time.



Use the enter key (↵) to accept this value, or press the Esc key ignore the calibration measurement. The last line of the display will briefly show “Ref calibrated OK”.

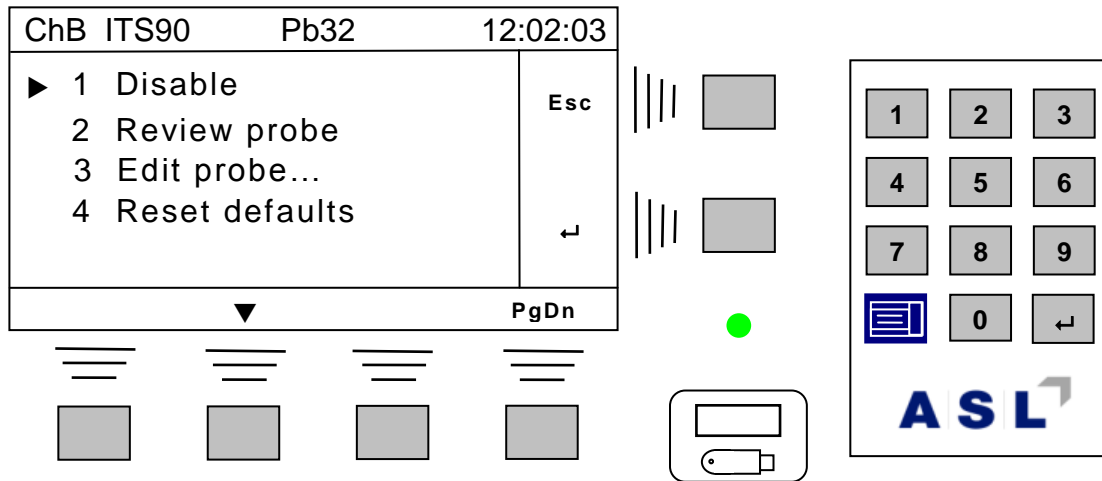
Complete all calibration values.

#### 4.7.1.3 Automatic instrument calibration

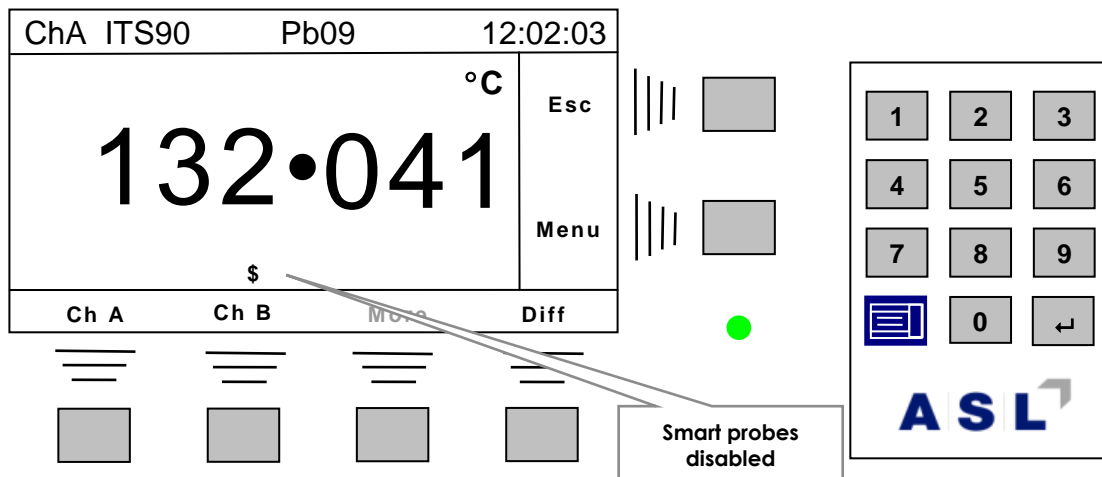
A CTS5000 switchbox is required with a set of calibrated resistors. Once started, the calibration sequence is fully automated. Instrument calibration should be carried out yearly by the supplier or agent. This menu item is password protected.

### 4.7.2 Smart probe menu

From the measurement screen, select Menu → 5 Smart probe... → ↵



There are four menu items available. The first menu (1 Disable) disables all Smart probes. This is indicated on the main screen by a crossed-out s –



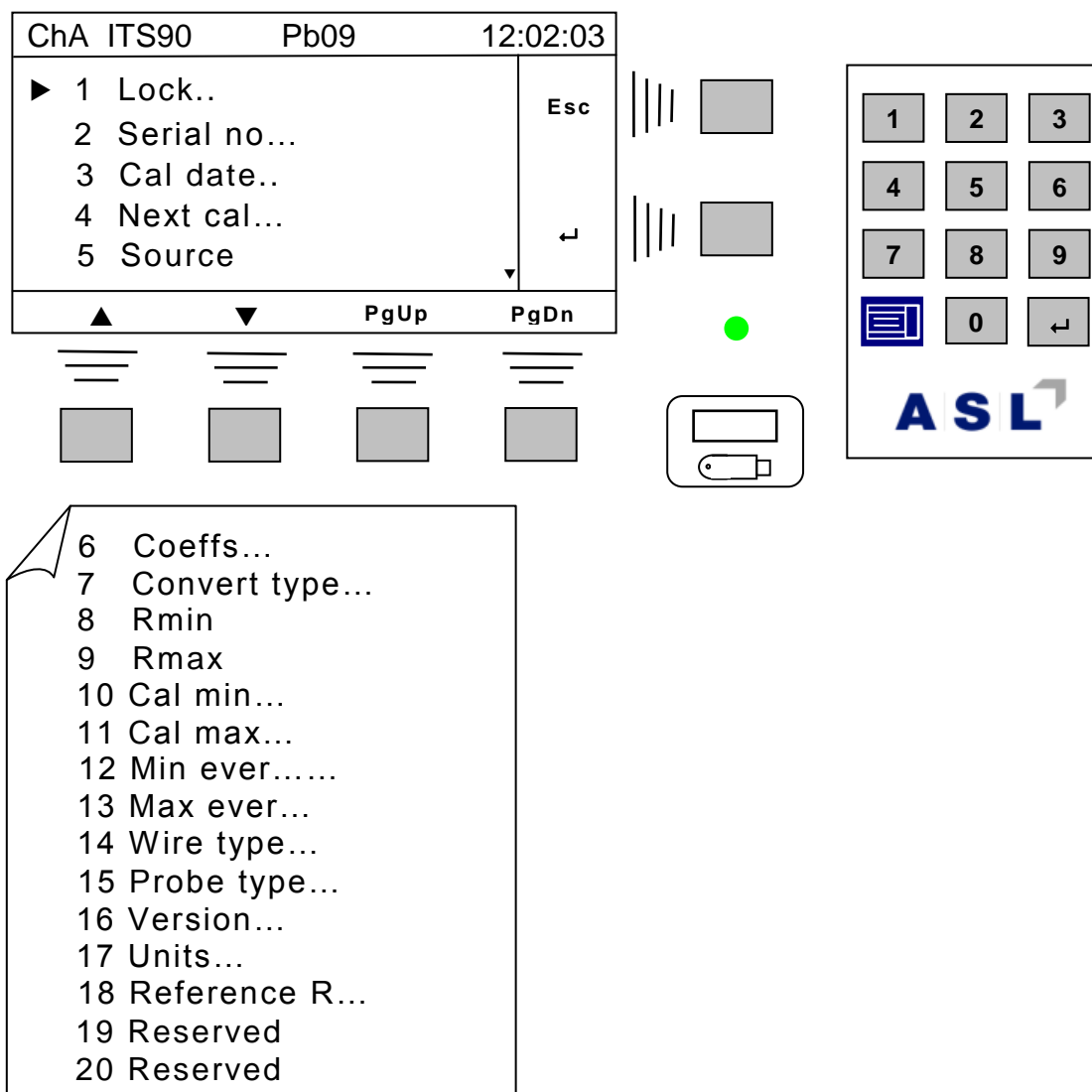
Once disabled, the Smart probe menu will change to show just –



Select this to re-enable Smart probes (once disabled, Smart probes must be re-enabled to use them again).

The 2 Review probe and 3 Edit probe... menus are very similar - the only difference is that the Smart probe values cannot be changed during 2 Review probe; for this reason, only edit menu will be covered.

Enter Menu → 3 Edit probe → ↵ to see the following menu for the Smart probe connected to the current channel<sup>34</sup> –



A detailed description for the Smart probe in the F200 User's manual (on the CD provided).

Editing is similar to other menus.

<sup>34</sup> A message showing *No Smart probe Chnn* will be briefly displayed if the current channel does not have a Smart probe.

There are two fields that need more explanation –

### 1 Serial no...

The Smart probe serial number is normally 19 characters long. However, due to space limitation on the LCD, the CTR5000 can only display 10 characters. Although only numerical values can be entered from the editor, alpha-numeric characters can be displayed and overwritten. The data comms N command can be used to enter any arbitrary string.

### 2 Source...

The Smart probe serial number is normally 17 characters long. However, due to space limitation on the LCD, the CTR5000 can only display 10 characters. Although only numerical values can be entered from the editor, alpha-numeric characters can be displayed and overwritten. The data comms N command can be used to enter any arbitrary string.

#### 4.7.2.1 Reset defaults menu

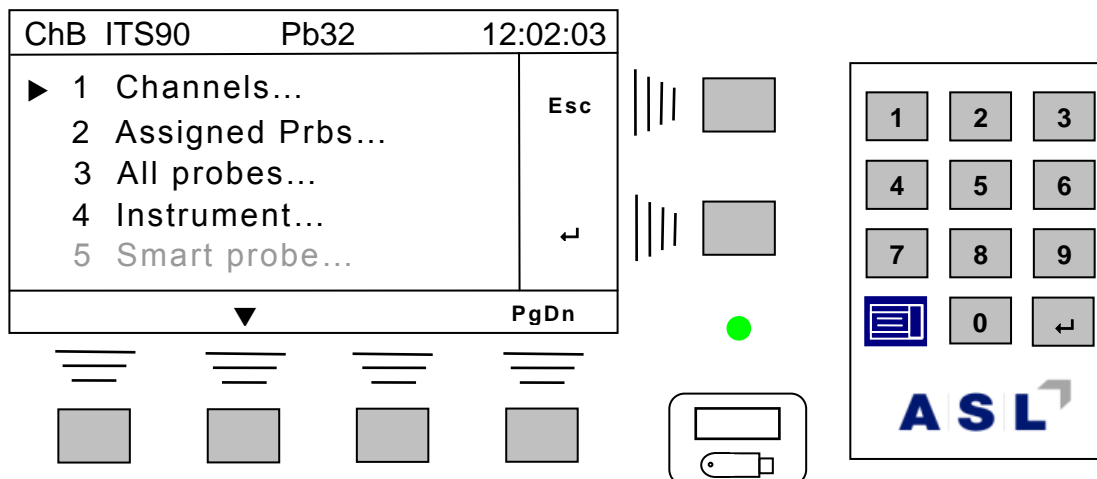
Use this menu to reset all the Smart probe data fields to their default values for the CTR5000. Select the menu and respond to the Reset defaults? message.

**Note**

All data will be lost when the defaults are set - take care when using this menu option.

#### 4.7.3 Utilities menu

From the measurement screen, select Menu → 6 Utilities... → ↵

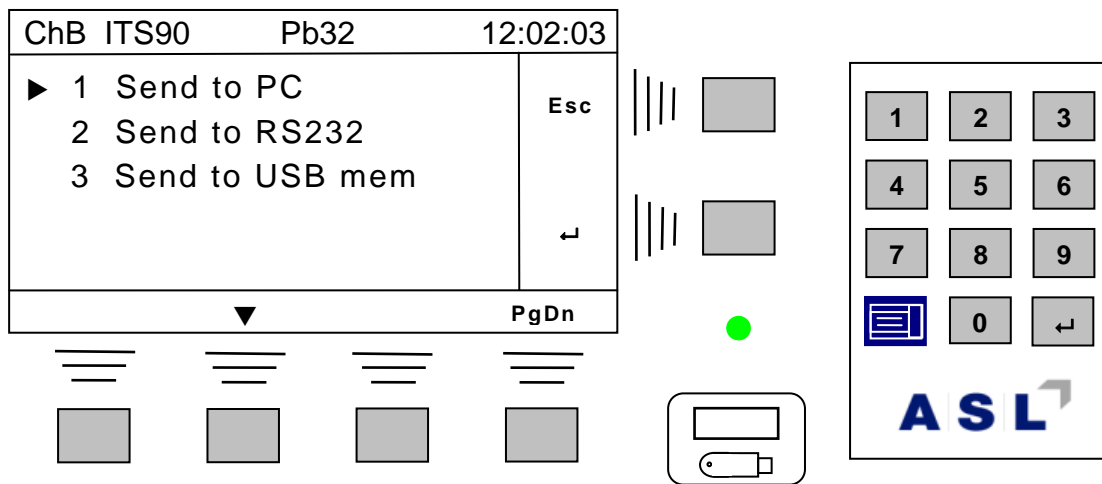


The last menu item 5 Smart probe... will only be present if a Smart probe is connected to the currently selected channel.

The Utilities menu is used to view information or send reports to a data port. The options are described below.

Utilities item	Description	Notes
1 Channels...	Send a channel report to a data port	Report available channels
2 Assigned Prbs...	Send a probe report to a data port	Report assigned probes only
3 All probes...	Send a probe report to a data port	Report all 72 probes
4 Instrument...	View or send instrument details to a data port	
5 Smart probe...	Send Smart probe report to a data port	Only available when Smart probe connected

Once one of these menus is selected, various options for the report destinations are displayed (the Instrument... menu is slightly different since the report can be viewed on the LCD). An example for the Channels... menu (with the RS232 option is fitted) is shown below –



The report can be sent to the PC (standard USB port), the RS232 port the USB memory stick (or any other attached interface). Select one of these destinations to send the report to.

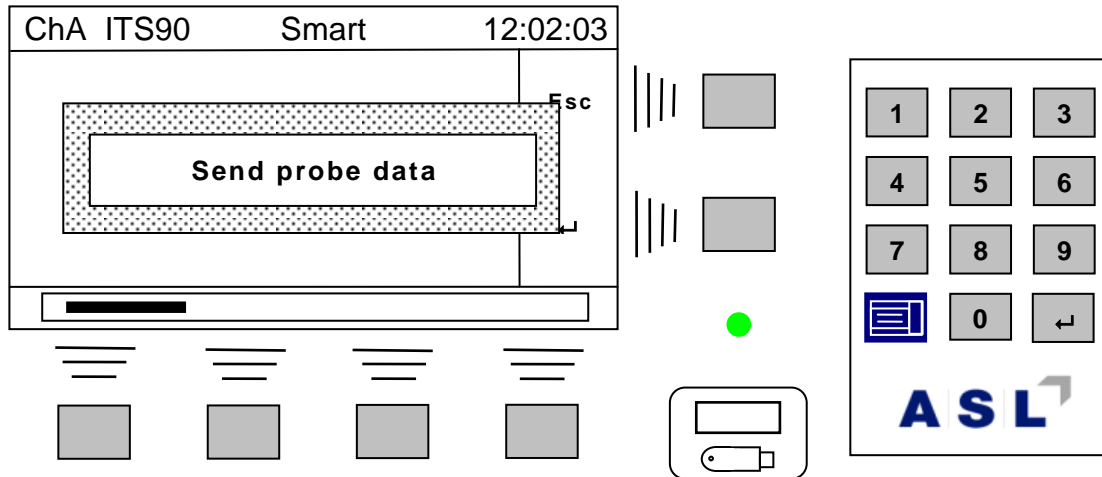
Typical examples of all reports are shown in appendix 7.

The Channel... report has to gather information about any Smart probes plugged in and takes a few seconds to this<sup>35</sup>. A Channel survey message is displayed whilst it collects information.

The data are sent to the specified data port. This can take several seconds for a full Probe report.

A progress bar is shown on the bottom line of the LCD while all the data are transmitted, for example

-

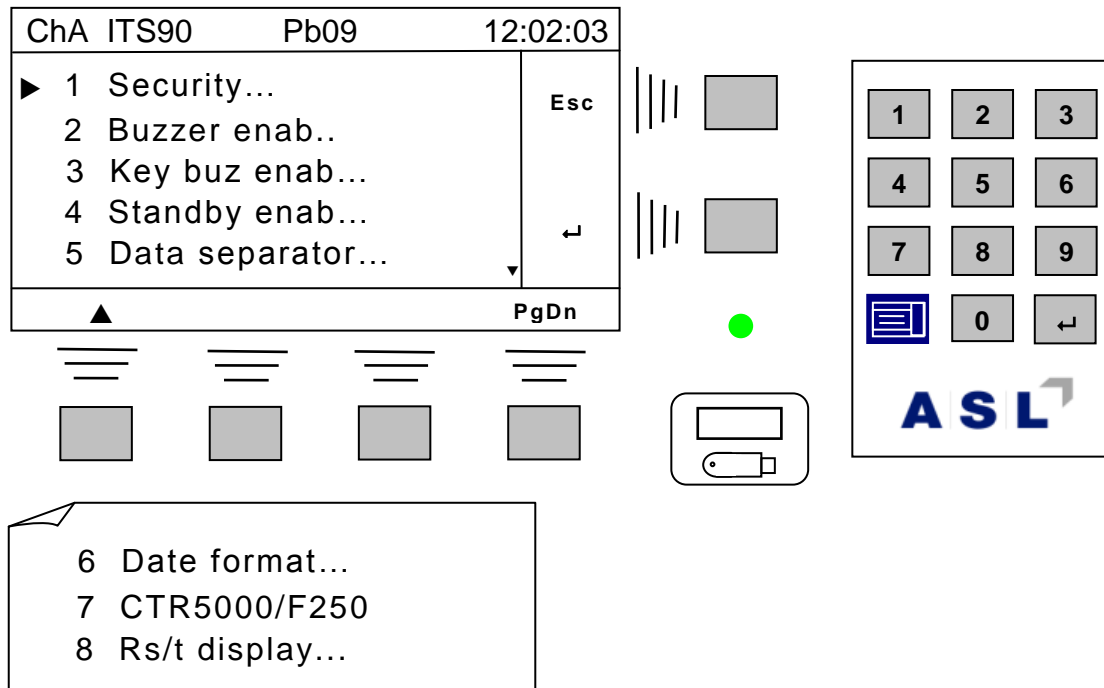


<sup>35</sup> The exact time depends on the number of channels the CTR5000 has.

#### 4.7.4 Options menu

From the measurement screen, select Menu → 7 Options... → ↵

The Options menu is shown below –



The Options menu is used to set various instrumental options. Once set, the menu will rarely be referred to. The options are described below –

Utilities item	Description	Notes
1 Security...	Selects security mode menu	Report available channels
2 Buzzer enab...	Buzzer on or off menu	Default on
3 Key buz enab...	Key buzzer on or off menu	Default on
4 Standby enab...	LCD backlight standby menu	Default on
5 Data separator...	Data separator menu	Data separator (comma default)
6 Date format...	Date format menu dd/mm/yy or mm/dd/yy	Date format (default dd/mm/yy)
7 CTR5000/F250 mode...	Data collection interval	0.5 s (default) or 3.0 s
8 Rs/t display...	Display the reference resistor or the current time	Default is time (top right of LCD)

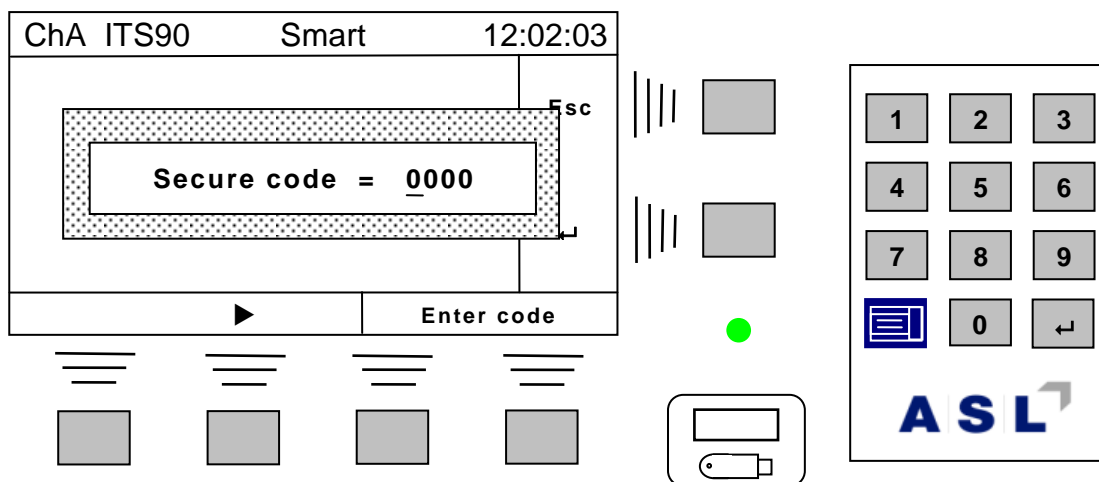
The Options menus are described in more detail in the following sections.



4.7.4.1 Security

The menus and operation of the instrument may be limited by setting security modes. For example any security mode (apart from Security Off) will not allow CTR5000 re-calibration). Higher security modes can be used to restrict access to various menus.

Select Security... and the display will show –



Enter the required security code –

Security mode	Security code
Off	4300
Low	4301
Medium	4302
High	4303

The three security modes are<sup>36</sup> –

<sup>36</sup> A Secured menu message may be displayed if an attempt is made to use a secured menu.

- Off** All menus and options are available
- Low** All menus and options are available, except for the Calibration menu. Smart probes may be disabled or data may be viewed (but not changed).

**Medium** As Low security; only the following menus are available –

- 1 Logging
- 2 Utilities
- 3 Options (security menu only)
- 4 Contrast

The channel menus, Zero, Hold and Units options are not available. The bottom line of the LCD will display –

Menus secured (Med)

**High** As Medium security; only the following menus are available –

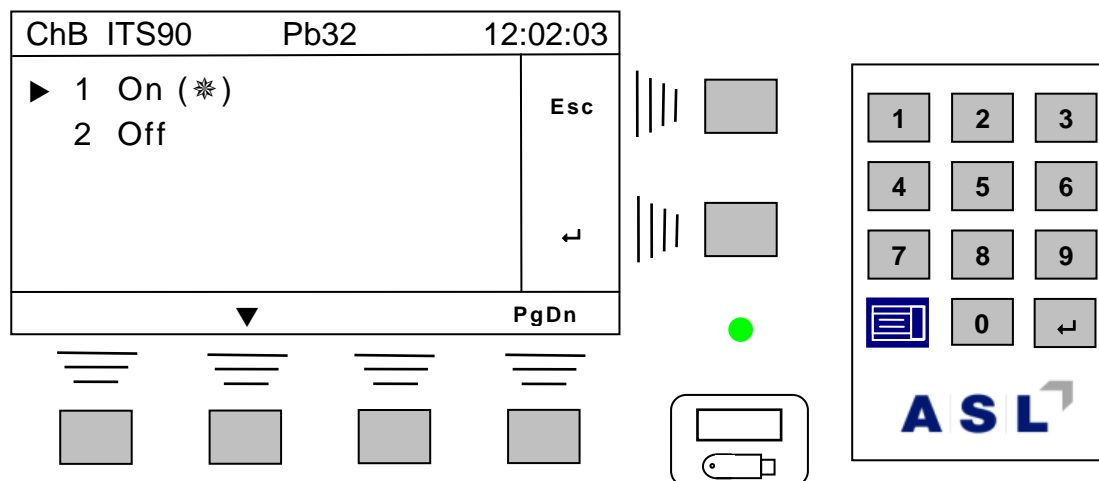
- 1 Utilities
- 2 Options (security menu only)
- 3 Contrast

The channel menus, Zero, Hold and Units options are not available. The bottom line of the LCD will display –

Menus secured (High)

## 4.7.4.2 Buzzer enab...

The buzzer can be turned on or off. Selecting this will show the select menu –



The (\*) marker indicates that this is the current state of the buzzer option.

Select the required state then use the enter key (↵) to accept this or the Esc key to leave the current state unchanged.

## 4.7.4.3 Key buz enab...

The key buzzer (buzz on key press) can be turned on or off. This menu is very similar to the Buzzer enab... (see above).

## 4.7.4.4 Standby enab...

The CTR5000 can be enabled to enter standby mode as a power-saving feature. When enabled, the instrument will turn the LCD backlight off after 30 minutes after the last key press<sup>37</sup> (the LED will still be active). The instrument will still measure (and transmit) data, but the LCD backlight intensity is turned off to save power. Once the CTR5000 is in standby mode, any key-press will turn on the LCB backlight back on<sup>38</sup>.

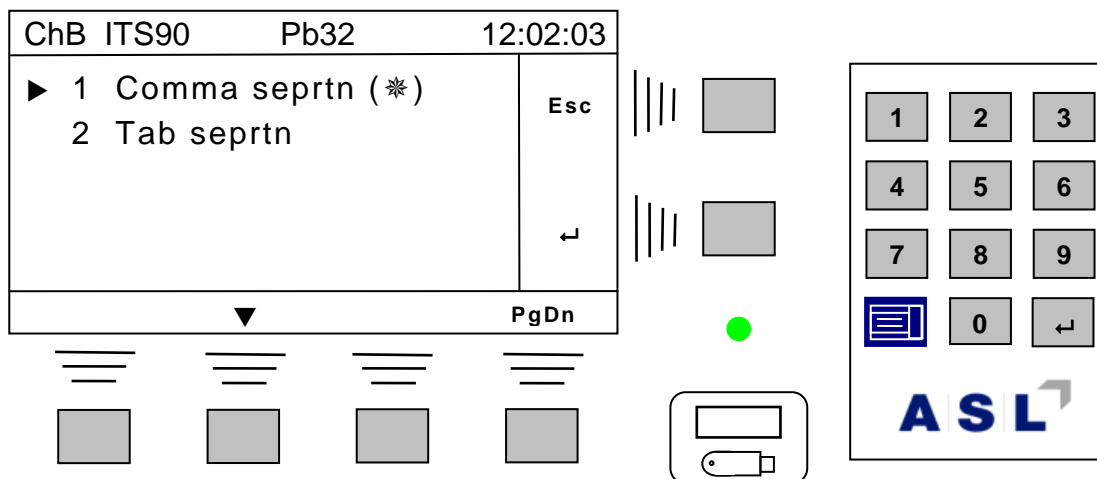
This menu is very similar to the Buzzer enab... (see above).

<sup>37</sup> Or when receiving data from a comms link.

<sup>38</sup> Data communications will not be affected by standby mode.

## 4.7.4.5 Data separator

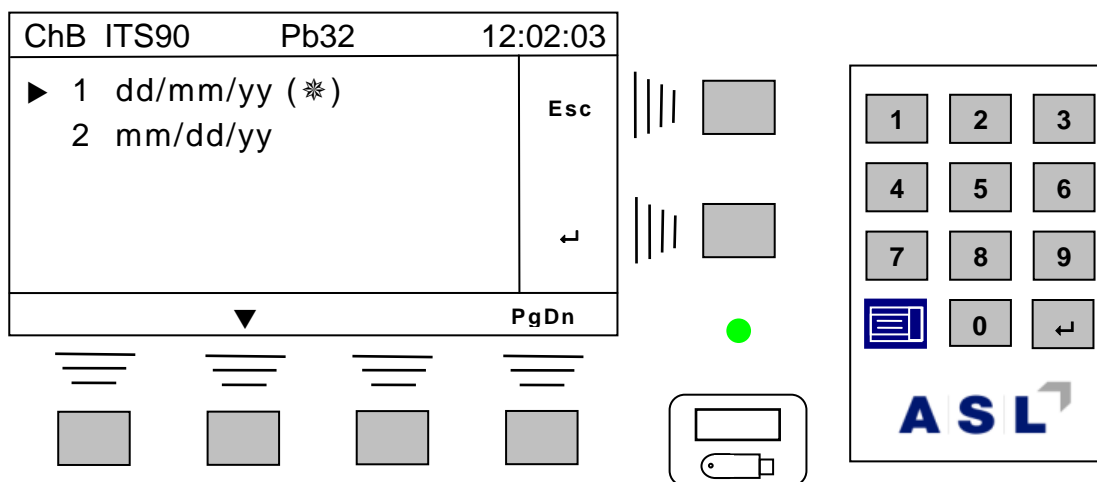
This menu selects the separator to be used between data elements when data are sent to a comms port. –



Select the separator then use the enter key (↵) to accept this or the Esc key to leave the current separator unchanged.

## 4.7.4.6 Date format

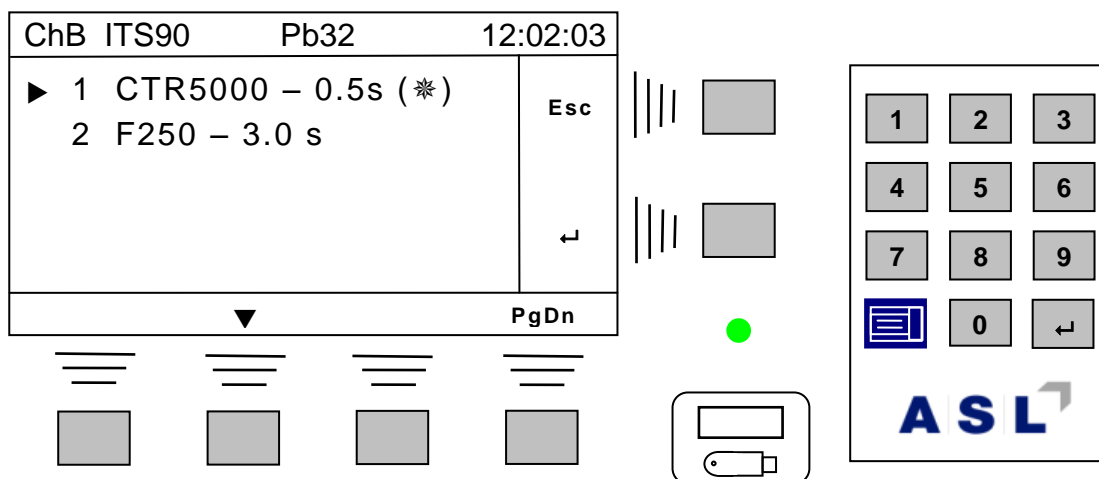
The CTR5000 can display dates in the default format dd/mm/yy, or the alternative format mm/dd/yy. Selecting this menu will display –



Select the date format and then use the enter key (↵) to accept this or the Esc key to leave the current format unchanged.

4.7.4.7 CTR5000/F250 mode...

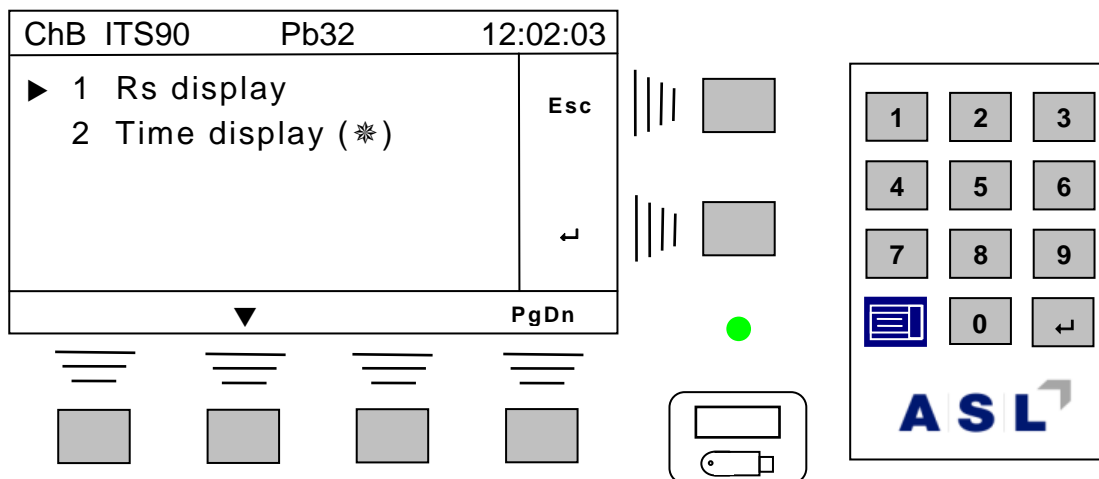
By default, the instrument is set to collect data every 0.5 s; this may be changed to an interval of every 3 s (F250 default mode)<sup>39</sup> using this menu –



Select the required mode then use the enter key (↵) to accept this or the Esc key to leave the current mode unchanged.

4.7.4.8 Rs/t display...

This menu selects the information displayed on the top of the display –



Select the required option and then use the enter key (↵) to accept this or the Esc key to leave the current display unchanged.

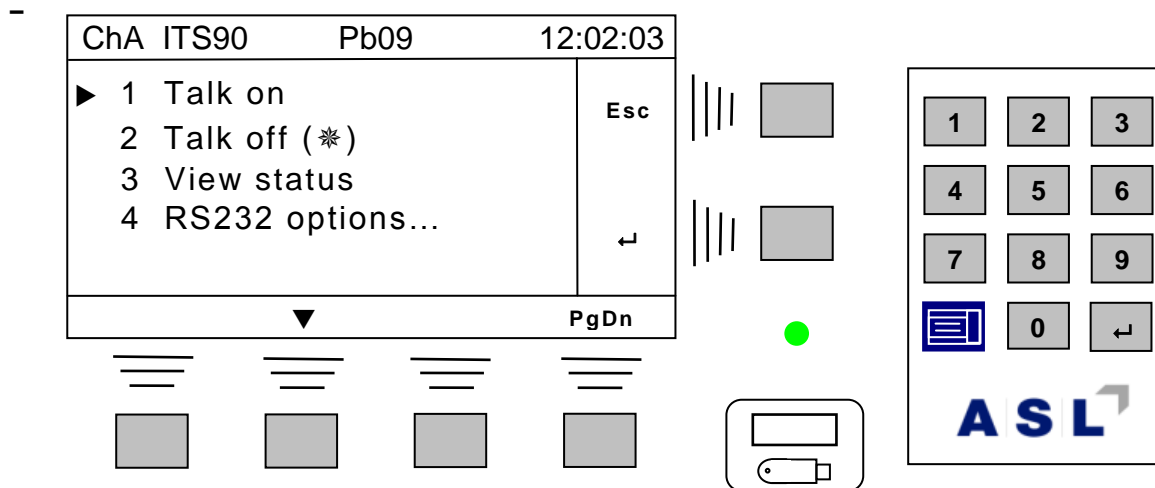
<sup>39</sup> The six data points are averaged. Because of the superior noise performance of the CTR5000, this is unlikely to give any real advantage, but might be useful in a noisy environment or when long cables are used.

#### 4.7.5 Comms menu

From the measurement screen, select Menu → 8 Comms... → ↵

Th

»W



The exact appearance of this menu will depend on which comms options are fitted.

##### 4.7.5.1 Talk on and Talk off

The CTR5000 can be set to transmit the result every time a new one is available (Talk on). Set the talk status as required.

#### Note

Talk on will be changed to Talk off if the data comms interface detects any activity.

##### 4.7.5.2 View status

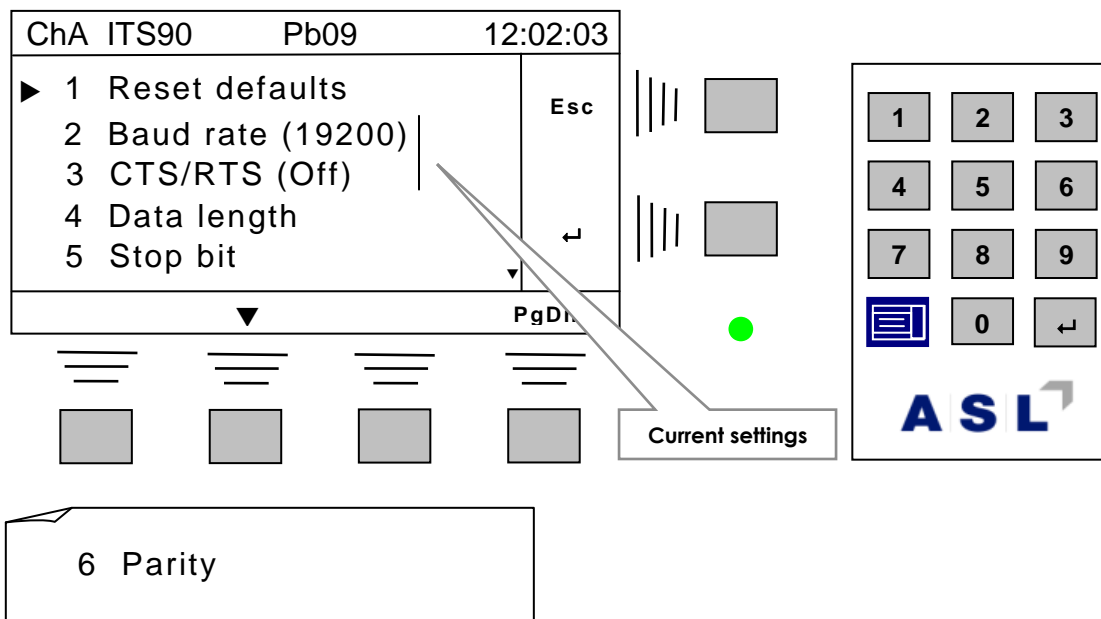
The comms status will be displayed on the screen when this menu item is selected.

4.7.5.3 RS232 and IEEE options

This menu may or may not be present. The exact wording will depend on which (if any) comms options are fitted. There are no USB or LAN options.

1 RS232 options...

The CTR5000 default settings are the same as the F250's –



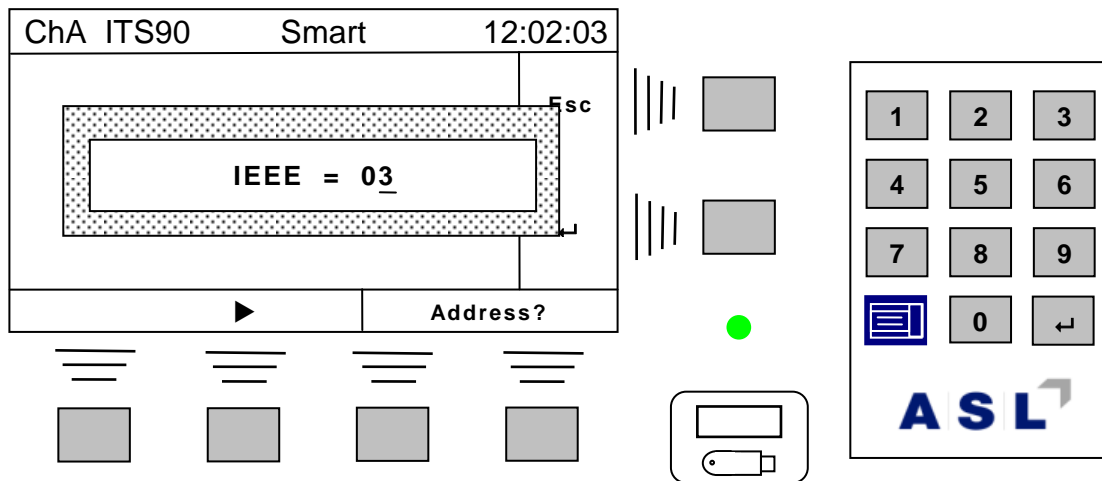
The RS232 options... menu is used to set various RS232 parameters. Once set, the menu will rarely be referred to. The options are described below –

RS232 options	Description	Notes
1 Reset defaults	Resets CTR5000 defaults	Immediately resets to F250 defaults
2 Baud rate (19200)	Select baud rate	1200, 2400, 4800, 9600 or 19200 (default)
3 CTS/RTS (On)	Handshaking on or off	Toggles On (default) or Off
4 Data length	Data length	7 bits or 8 bits (default)
5 Stop bit	Number of stop bits	1 bit or 2 bits (default)
6 Parity	Parity	None (default), Odd or Even

Each RS232 option has its own menu.

## 2 IEEE options...

The default IEEE address (IEEE = 3) may be changed by selecting this menu -



Use the editor to set the address and then the enter key (↵) to accept the value (or the Esc key to leave the address unchanged).

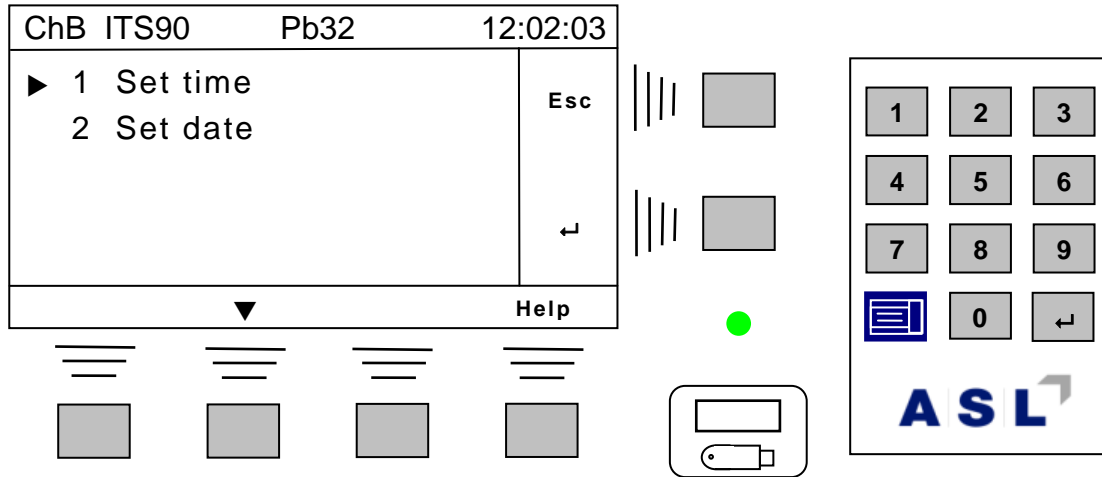
The default setting is 3. Any address in the range 0 to 31 may be used.



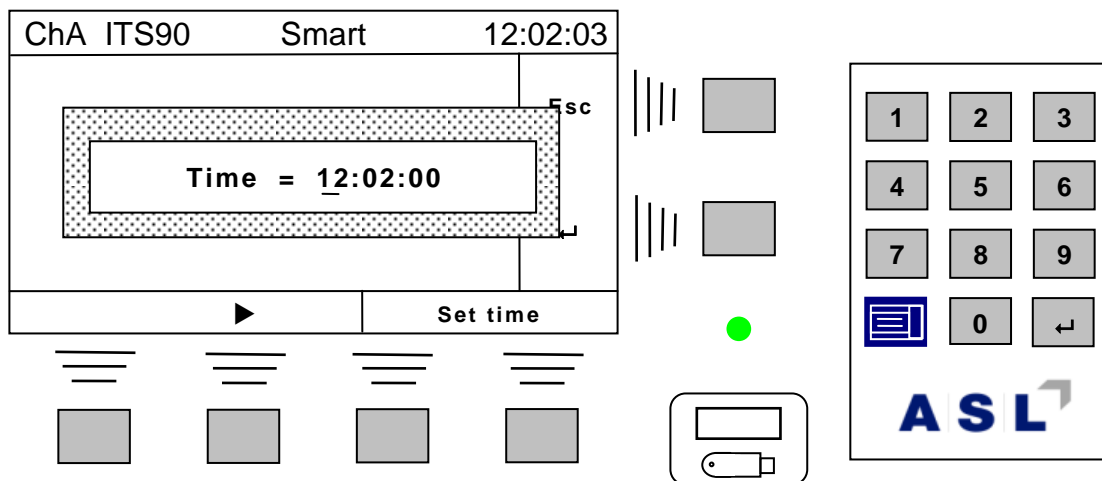
4.7.5.4 Time and date

From the measurement screen, select Menu → 9 Time/Date... → ↵

This menu sets the current time or date for the real-time clock<sup>40</sup>. The screen will show –



Select the required menu format and use the enter key (↵) to select this or the Esc key to return. Selecting 1 Set time will show –



Use the editor to set the time (the colon symbols will be skipped) and then use the enter key (↵) to accept the value (or the Esc key to leave the time unchanged).

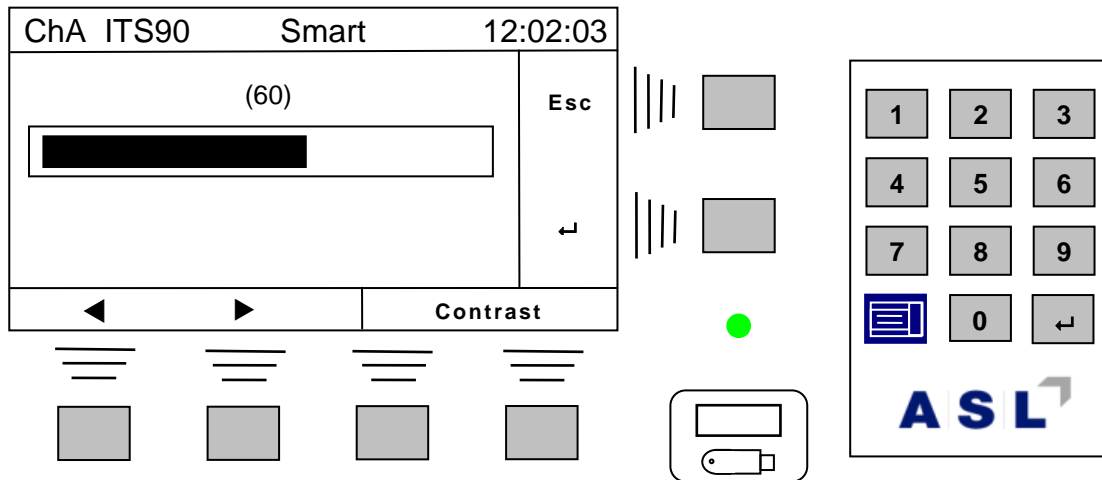
Date entry is similar.

<sup>40</sup> The real-time clock uses a small, replaceable, internal lithium battery that will last for many years.

## 4.7.5.5 Contrast

From the measurement screen, select Menu → 10 Contrast → ↵

The screen will change to show the LCD contrast adjustment screen –



Use the two ◀ and ▶ soft-keys to adjust the LCD contrast to the desired level before returning to measurement mode by pressing the enter key (or ↵), or press the Esc key to exit without changing the current setting. Alternatively, type the required value on the numeric keypad.

**Note**

The screen will automatically revert to Measurement mode if no changes are made within 60 seconds.

#### 4.7.5.6 Diagnostics

**Several diagnostics are available for the CTR5000. Their use is specialised. Access is restricted and various passwords are required to use them.**

## 5. Data Pairs

---

### 5.1 Introduction

The CTR5000 measures a resistance value by comparing the probe's resistance to a known calibrated resistor inside the instrument. Mathematical equations are used to convert this resistance measurement to a temperature (commonly to the DIN90, CvD or ITS-90 standards). The equations use (polynomial) coefficients to convert from resistance to temperature. The more accurately the coefficients reflect the probe characteristics over a range of temperatures, the more accurate the temperature conversion will be.

The CTR5000 can provide (calculate) the coefficients from measurements of resistance at accurately known temperatures. These measurements are called data pairs – consisting of one resistance measurement and its corresponding temperature measurement.

One data pair is not sufficient to calculate all the coefficients. The number of pairs required depends on the temperature conversion method and also the range that the temperature conversion is to cover – for example four data pairs are required for CvD conversion method.

### 5.2 Procedure

Pairs of measurements are required. The probe must be placed in a stable, temperature controlled environment during the measurement. The CTR5000 will provide the probe's resistance at the stable temperature - and also the temperature if a calibrated probe is used to measure the stable environment.

The CTR5000 menus will help with the measurement. The procedure, in order, is –

- 1 Place the probe to be calibrated in a stable temperature-controlled environment
- 2 Measure the environment's temperature with the calibrated probe connected to channel B and the probe to be calibrated to channel A<sup>41</sup>
- 3 Allow the system to temperature-stabilise
- 4 Enter the resistance and the corresponding temperature
- 5 Repeat the procedure for all the pairs required

---

<sup>41</sup> Other channels may be used, but for a single probe this can simplify data entry

- 6 Use the CTR5000 to calculate and transfer the coefficients to the probe
- 7 Confirm correct calculation by measuring the calibration temperature with the probe
- 8 Record or output the probe coefficients values

Generally, CvD data-pairs are entered for –

- One negative temperature
- A temperature at 0°C
- A temperature near 100 °C
- A temperature well above 100 °C

More pairs are required for ITS-90 entry.

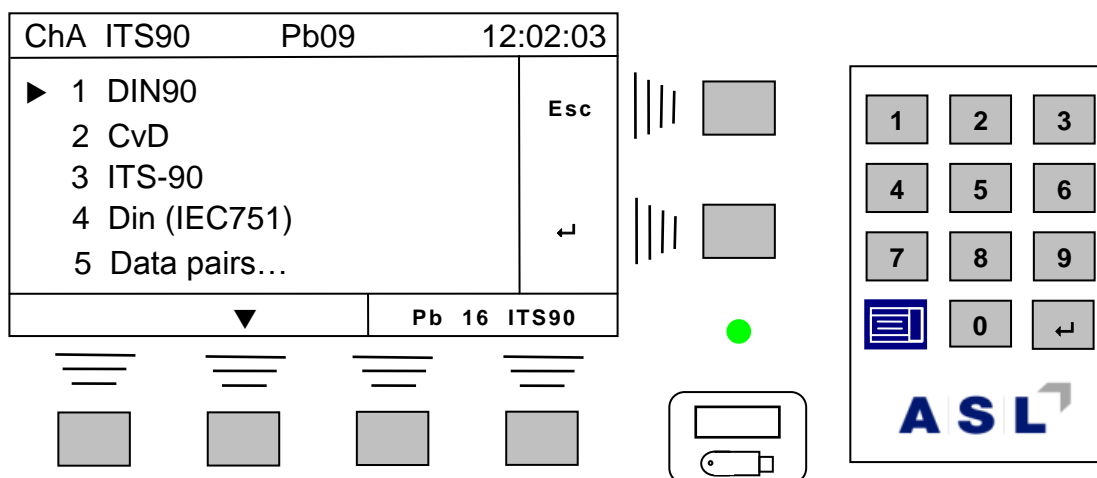
**Note**

It is not always necessary to enter all data-pairs. For example, it is unnecessary to enter the negative pair values if negative temperatures will not be measured.

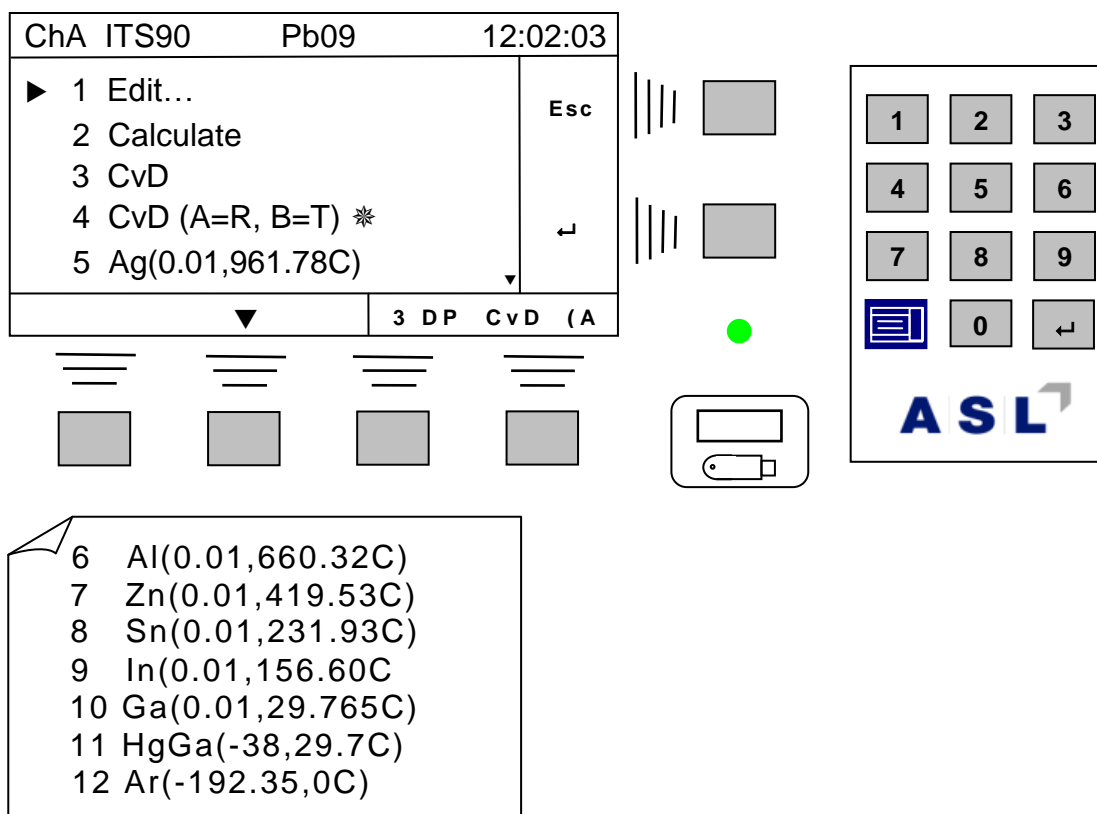
The full procedure will be covered in detail in the following sections.

### 5.3 Data Pair menu

The data-pair menu is called by selecting this as the conversion method for the currently selected probe. Once a probe has been selected, choose its conversion method as data-pairs from the Conversion... menu –



This will allow data-pair entry, calculation and transfer<sup>42</sup>. Display the Data pairs menu –



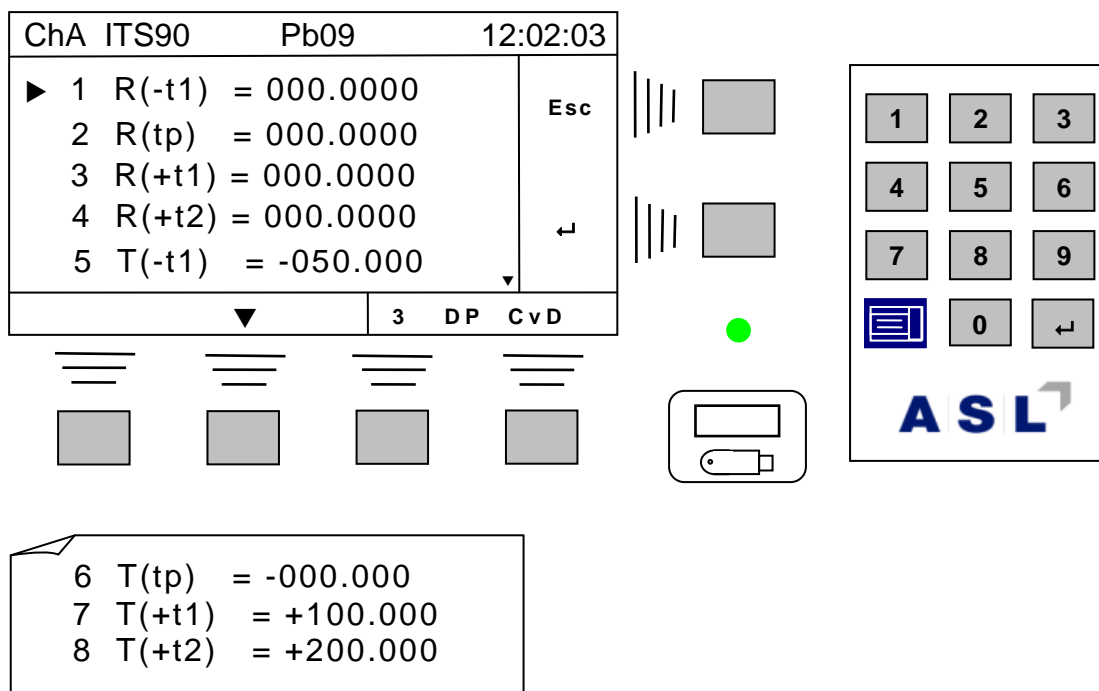
The menu items are described below –

### 5.3.1 Edit...

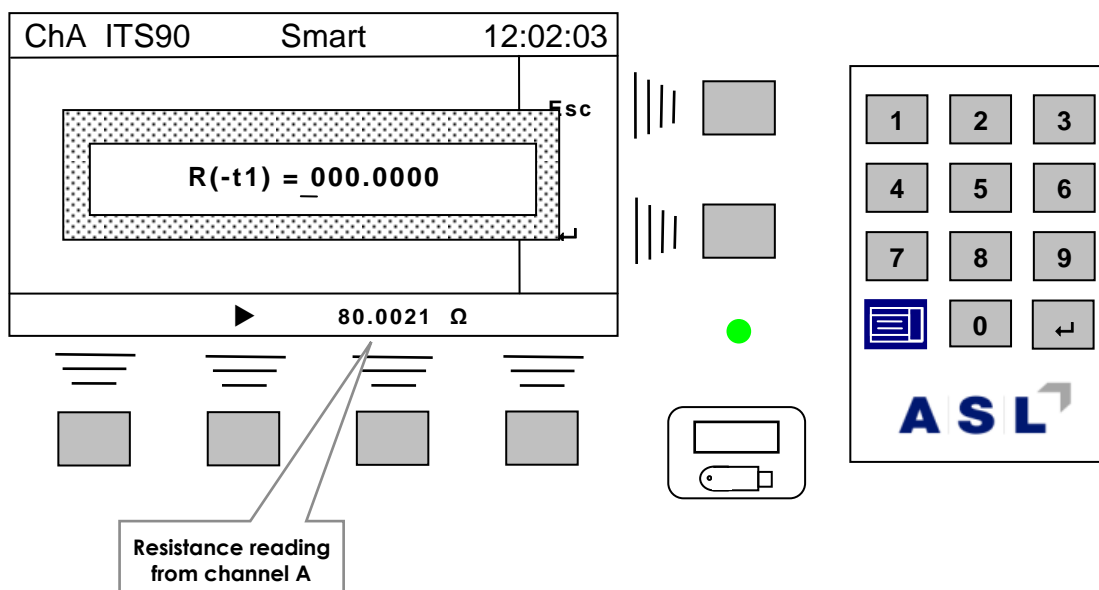
This menu is used to edit (or enter) the resistance and temperature data pairs. The exact form of the Edit... menu will depend on the selected conversion method. The screen above shows that CvD (A=R, B=T) (menu item 4) is the currently selected conversion method for data-pair entry (the \* symbol and bottom right of the LCD show this as the currently selected method). The examples described will use the CvD (A=R, B=T) method; other conversion methods are very similar. The CTR5000 will present only the correct menus for the selected conversion method.

Selecting Edit... (for CvD) will show –

<sup>42</sup> Once the pairs have been entered and calculated, they may be transferred to the currently selected probe's coefficients for review.



Selecting, for example, menu item 2 will display the edit screen for the resistance part of the data-pair<sup>43</sup>. Selecting item 1 (R(-t1)) will display –



The resistance value for R(-t1) can be entered (or edited). Alternative, the resistance (read from channel A) is shown above soft-key 3; pressing the key will enter this reading into the R(-t1) value. Similarly, when editing temperature readings, the value above the soft-key will show the currently temperature reading from channel B.

<sup>43</sup> Note that resistances are entered to 4 decimal places and temperatures to 3.

Pressing the soft\_key will enter 80.002 into the edit field. Pressing the ↵ key will return to the previous screen and change the text on the top line to read 1 R(-t1) = 80.002.

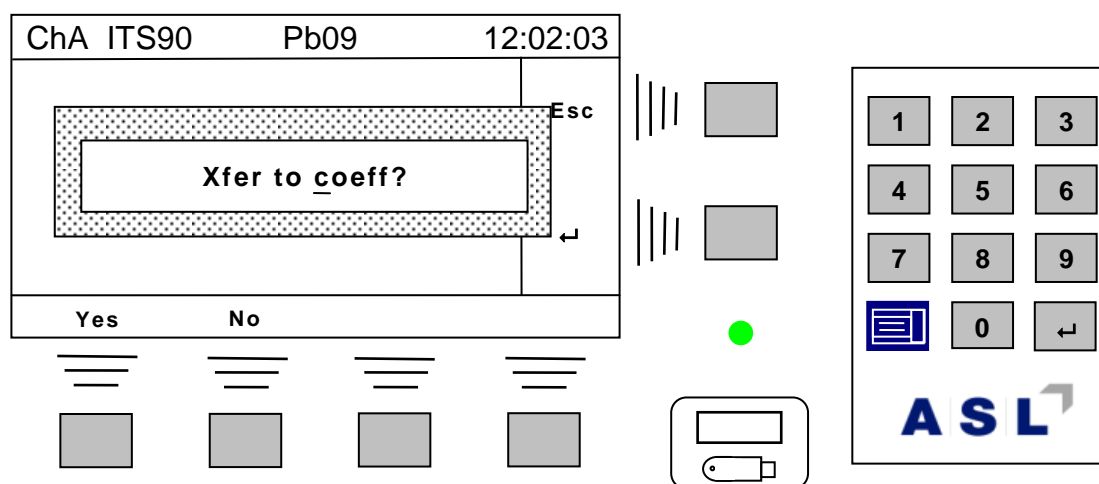
**Note**

Soft-key 3 is only available for this for resistance readings on other conversion methods. The value shown next to the key then comes from the currently selected channel.

The value will only be displayed next to the key when valid.

### 5.3.2 Calculate...

This is used to calculate the coefficients (if possible) from the entered data. Selecting this will calculate the coefficients and then display –



Pressing the Yes soft-key will transfer the coefficients to the currently selected probe (Pb09 in the example above). Pressing the No soft-key (or Esc key) will leave the coefficients unchanged.

**Note**

The CTR5000 will show an error if it cannot use one or more of the data-pair values



Once calculated and transferred, the coefficients can be reviewed as normal from the Probes... menu. After transfer, these coefficients will be used for the probe.

Its temperature conversion can be checked by returning to measurement mode.

**Note**

Once calculated, there is no error checking on the coefficients.

Incorrectly entered data will result in incorrect coefficients.

### 5.3.3 CvD

Used for CvD data entry. Temperatures must be entered manually.

### 5.3.4 CvD (A=R, B= T)

Used for CvD data entry from channel A (resistance) and channel B (temperature).

### 5.3.5 Ag(0.01,961.78C) to 12 Ar(-192.35,0C)


Used for data entry for standard methods. Temperatures must be entered manually. Select the menu that covers the range of interest.

## 6. Instrument Measurement Range

### 6.1 Instrument measurement working range

The instrument can detect the following conditions Open Circuit Probe, Over Range measurement and Under Range measurement. These conditions are shown on the display as

-

Condition	Display
Open probe	
Over range	$R > R_{\max}$
Over temperature	$T > T_{\max}$
Under temperature	$T < T_{\min}$

### 6.2 Measurement ranges

Measurement units PRT	Conversion	Under range	Over range	Units
Resistance	None	-	500	ohms
Temperature	Din90	-201	+851	°C (°F, K)
	CvD	-201	+850	°C (°F, K)
	ITS90	-201	+962	°C (°F, K)

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## 7. Calibrating the CTR5000

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### 7.1 CTR5000 reference calibration

The CTR5000 bridge measurement technique used is inherently very stable and linear. However a small drift of the internal reference resistor may occur with time, making periodic re-calibration advisable.

Check calibration daily before and after use with known, regularly-calibrated, reference resistors.

### 7.2 Equipment

Temperature controlled environment at  $+20^{\circ}\text{C} \pm 2^{\circ}\text{C}$ .

Stable, calibrated (1ppm) resistors (0 $\Omega$ , 25  $\Omega$  and 100  $\Omega$ ).

### 7.3 Calibration procedure

See the section on calibration for the full procedure.

### 7.4 Full instrument calibration procedure

Special equipment is required for this. Refer to the supplier or agent for details.

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## 8. Obtaining the best from the CTR5000 bridge

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### 8.1 Procedure

Please observe the following to obtain the best results from your instrument –

- ✓ Do ensure there are no draughts or forced air flow around the instrument (e.g. from an air conditioning unit).
- ✓ Allow at least 20 minutes for the instrument to fully stabilise, or longer if switching on from cold.
- ✓ Do keep the operating environment stable.
- ✓ Do ensure the sensor leads and input connectors are free from dirt as leakage current will affect the results.
- ✓ In common with best practice, use a known stable, calibrated resistor to take a measurement at the start and end of the day; log the results.
  
- × Do NOT locate the instrument near a source of vibration, heat, or draughts.
- × Do NOT locate the instrument near sources of electrical interference – e.g. electric motors.

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## 9. Communications - Interface and PC commands

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### 9.1 Introduction

The CTR5000 is fitted with a USB communication interface as standard. The connected PC must have the correct USB driver installed to use the interface (see section 9.2). Alternatively, the CTR5000 may be fitted with an RS232 or LAN or IEEE interface.

The commands are buffered by the CTR5000 (saved in order of arrival) so more than one command can be sent to the instrument without waiting for the previous one to complete. However, to prevent unpredictable results, it is normally easier to wait for the expected response before issuing the next one.

When an additional interface is fitted, it is possible to use both simultaneously. However, unpredictable results may occur, depending on the exact timing and order of any input commands.

### 9.2 Interfaces

The USB interface is fitted a standard. The (optional) IEEE or RS232 or LAN interfaces, while using a completely different means of transporting data, work in the same way as far as the command structure is concerned.

The specific difference between the data-transport methods are covered in the sections below.

#### 9.2.1 USB device driver

The USB PC interface will normally be installed as a virtual COM port driver (simulated serial port).

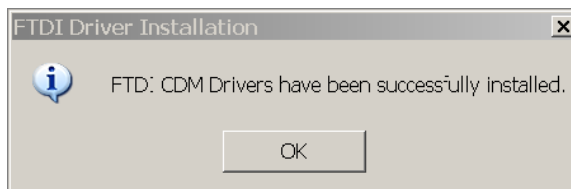
An interval of 1ms to 2 ms should be allowed between transmitted characters.

The communication protocol is –

Bits per second	19200
Data bits	8
Stop bits	2
Parity	none
Flow control	none



Use the menu system on the CD to load the device driver; alternatively, run the program CDM\_Setup.exe from the directory D:\USB Drivers\ on the CD supplied with the instrument<sup>44</sup>. This will install the USB drivers. You will see the following message once this is complete.



When writing a control program for the instrument, it may be easier to use the API commands provided by FTDI<sup>TM</sup>. See their web-site for more details –

<http://www.ftdichip.com/>

### 9.2.2 IEEE-488.2 interface (optional)

The IEEE-488.2 interface<sup>45</sup> requires the instrument's bus address to correspond to the address used by the controller (normally a PC).

The IEEE interface uses an 8-bit data bus and software protocol to transfer data in parallel. Each instrument connected to the bus must have a unique address. This address may be changed at any time using the Comms menu. The CTR5000 slave bus address has a default address of 3.

The software driver for the IEEE interface will be supplied by the PC interface card's vendor. A popular text based console program is supplied by National Instruments<sup>TM</sup> and an example of the use of this is shown below –

Win32 Interactive Control

Copyright 1996 National Instruments Corporation

All rights reserved.

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<sup>44</sup> Replace the 'D' with the name of your CD device as necessary

<sup>45</sup> Also known as a GPIB interface

Type 'help' for help or 'q' to quit.

: ibdev

enter board index: 0

enter primary address: 3

<<= Default for CTR5000!!!

enter secondary address: 0

enter timeout: 13

enter 'EOI on last byte' flag: 1

enter end-of-string mode/byte: 10

ud0: ibwrt "Q\_"

<<= <CR> required i.e. \x0D

[0900] ( rqs cmpl )

<<= rqs also

count: 11

ud0: ibrd

enter byte count: 6

<<= line added unless you specify the  
<<= number of byte top read it requests

[0900] ( rqs cmpl )

<<= Actual flags

count: 6

30 33 2c 30 31 0d

03,01.

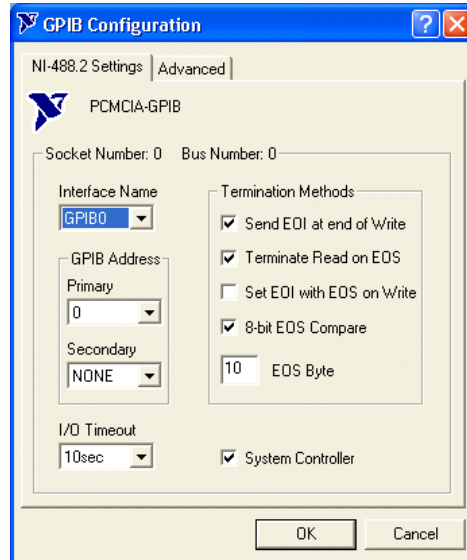
<<= <CR> appears as a dot & is 0D hex

<<= plus ascii in lower case

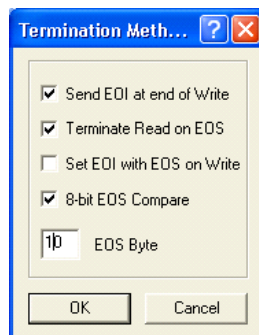
#### Note

When the IEEE address is changed (via the Comms Options menu), the instrument must be switched off and on to reset and use the new address.

The more recent version of the National Instrument interface GPIB configuration for the PC interface card is shown below –

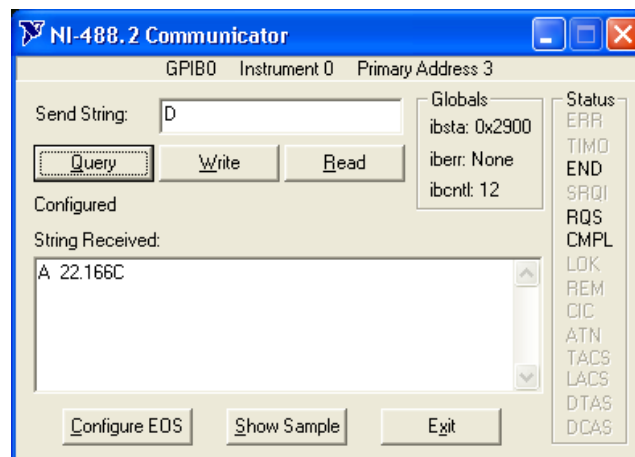


The device EOS settings for the ASL IEEE Interfaces are –



Using the NI Communicator and the Instrument PC Command set (below), enter the required command parameters into the 'send string' box and select 'write'.

Select 'query' for a command that returns data from the CTR5000 –



The following error may be seen in NI communicator if 'write' and then 'read' is used

**lberr = EABO**

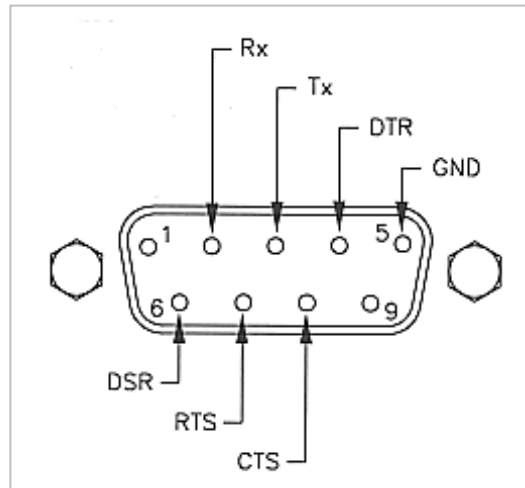
EABO indicates that an I/O operation has been cancelled - usually due to a timeout condition after a GPIB read. Before reading from the instrument, verify that the GPIB commands you send are understood by your interface and that it instructs it to place data in its output buffer. For information on your interface's command syntax, consult the instrument manufacturer's user documentation.

9.2.3 RS232 interface (optional)

The RS232 interface uses a standard data lead to connect to a PC. The connections are the same as those used for the F250. The default parameters are –

19200 baud, 8 bits, hardware handshaking, 2 stop bits and no parity

Connections are –



Computer	Instrument	
9-pin connector	Function	9-pin connector
2	Rx	2
3	Tx	3
4	DTR	4
5	GND	5
6	DSR	6
7	RTS	7
8	CTS	8


The instrument has a male gender connector. The number of wires required for the connection will depend on the exact RS232 settings.

Baud rate and other parameters are selectable (via the Comms... menu).

#### 9.2.4 LAN interface (optional)

The LAN symbol  will be permanently displayed when this interface is connected. There are no LAN options.

### 9.3 Instrument PC commands

The following sections cover use of the remote PC commands. These may be sent to the instrument via a simple terminal program<sup>46</sup>, through some programming interface, from Excel™ (or similar program) or interactively with a dedicated program (such as ULOG – supplied by ASL). The PC symbol (  ) will be displayed briefly when communicating (depends on timings).

#### 9.3.1 Remote mode (local lockout)

The instrument may be set into Remote mode to prevent problems with simultaneous control from a PC and from someone using the front panel keys. In Remote mode, the instrument can only be controlled over the interface since the CTR5000's front panel keys are locked out. To enable Remote mode, the instrument must be sent a Remote mode command (see section 9.4.1).

It is not necessary to be in remote mode to use any of the PC commands, but care must be taken not to inadvertently change settings.

#### 9.3.2 Programming command syntax

The programming command language is based on the SCPI command format. Commands consist of one or more command strings containing some or all of the following –

Colon ':'	Separates command words
Question mark '?'	Command requiring a response
Space ' '	Separates the command word from the first parameter (shown as <space> in the examples)
Comma ','	Separates the parameters list
Parameter <sup>47</sup> <parameter list>	Parameters list separated by commas

---

<sup>46</sup> A number of these are available free on the Web.

<sup>47</sup> The '<' and '>' symbols in the text are used to help with clarity; they do not form part of the command sequence.

Terminator <cr> or <cr><lf> Terminates the line and the command

For example, the units may be set by sending the string –

UNIT:TEMP CEL<cr><lf>

i.e. <command><:><command><space><parameter><,><parameter><terminator(s)>

It is important to remember the space between the end of TEMP and CEL.

Additional or extra arguments after a valid command will be ignored.

### 9.3.3 Case sensitivity

Command words are not case sensitive; you can use upper or lower case characters or any combination. For example, the following are all valid –

SYSTEM:REMOTE

system:remote

SyStEm:rEmOtE

### 9.3.4 Long form short form commands

Command words can have a long form and short form. The short form version is indicated by upper case characters in subsequent sections. Either form may be used. The following are identical –

SYSTEM:REMOte (long form)

SYST:REM (short form)

### 9.3.5 Command terminators <cr> or <cr><lf>

All commands sent to the instrument must be terminated with a carriage return <cr> character. The terminating character pair <cr><lf> may be used, since the <lf> character is ignored.



### 9.3.6 Error responses

A list of error responses follows the command descriptions. Two common error responses are -

The E4 error (unrecognised command) will be sent in response to all incorrect commands.

The E5 error (unrecognised parameter/argument) will be sent in response to all incorrect commands with an incorrect parameter.

### 9.3.7 CTR5000 0.005 K and CTR5000 0.01 K commands

The CTR5000 0.01 K commands are also included in an Appendix. These commands can be mixed with the CTR5000 0.005 K commands<sup>48</sup>. However care should be taken to ensure correct operation.

Commands are very similar to those used by the F200/F201, but have been simplified in a few instances.

### 9.3.8 Starting with PC commands

Experiment with the \*IDN? command when first starting and do not use the SYSTEM:REMOTE command until you are happy with the instrument's operation<sup>49</sup>.

Use each of the commands in turn to confirm that they produce the response you expect from them.

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<sup>48</sup> All CTR5000 0.01 K commands are available to the CTR5000 except for the 'C' command.

<sup>49</sup> The SYSTEM:REMOTE command is cancelled once the instrument's power is switched off and on again.


## 9.4 Interface commands

All CTR5000 commands are described in detail in the follow sections. Each command description follows a common layout.

### 9.4.1 \*IDN?

<b>Command</b>	<b>*IDN?</b>	
<b>Returns</b>	<b>&lt;manufacturer&gt;,&lt;model no&gt;,&lt;serial no&gt;,&lt;firmware version&gt;&lt;date&gt;</b>	
<b>Parameters</b>	<b>&lt;manufacture&gt;</b>	<b>ASL</b>
	<b>&lt;model no&gt;</b>	<b>CTR5000AC</b>
	<b>&lt;serial no&gt;</b>	<b>Serial number of the instrument</b>
	<b>&lt;firmware version&gt;</b>	<b>Current firmware version and date</b>
<b>Function</b>	<b>Reads the instrument's identification code consisting of the manufacturer name, instrument model number, instrument serial number, firmware version and date</b>	
<b>Example</b>	<b>*IDN?&lt;cr&gt;&lt;lf&gt;</b>	<b>(command)</b>
	<b>ASL,CTR5000,123456/003,V1.00,22/01/10&lt;cr&gt;&lt;lf&gt;</b>	<b>(response)</b>

### 9.4.2 SYSTem:REMOte

<b>Command</b>	<b>SYST:REMO</b>
	<b>SYSTEM:REMOTE</b>
<b>Returns</b>	<b>None (or ACK if set on)</b>
<b>Function</b>	<b>Places the instrument in remote mode for interface control Displays 'PC icon on the CTR5000. The PC symbol (  ) will be displayed permanently when the CTR5000 is in remote mode.  Locks out the instrument's front panel keys</b>
<b>Example</b>	<b>SYST:REM</b>

### 9.4.3 SYSTem:LOCAL

<b>Command</b>	<b>SYST:LOCA</b>
	<b>SYSTEM:LOCAL</b>
<b>Returns</b>	<b>None (or ACK if set on)</b>

<b>Function</b>	Returns the instrument to local mode  Enables the instrument's front panel keys
<b>Example</b>	SYST:LOC

9.4.4 *SYSTem:ACKnowledge* <state>

<b>Command</b>	SYST:ACKN <state>  SYSTEM:ACKNOWLEDGE <state>
<b>Parameters</b>	0 Turn acknowledge response OFF  1 Turn acknowledge response ON
<b>Returns</b>	ACK
<b>Function</b>	Sets or clears the acknowledge command response. Commands that do not have a response may use this command to force a positive response by the CTR5000
<b>Example</b>	SYST:ACK 1  (Sets acknowledge response ON)

9.4.5 *SYSTem:CALibrated?*

<b>Command</b>	SYST:CALI?  SYSTEM:CALIBRATED?
<b>Returns</b>	System calibrated status
<b>Function</b>	Returns the calibration status
<b>Example</b>	SYST:CALI?<cr><lf> (command)  1<cr><lf> (response)  (the system is calibrated)

9.4.6 *SYSTem:DISPlay:RESOlution* <argument>

<b>Command</b>	SYST:DISPL:RESO <argument>  SYSTEM:DISPLAY:RESOLUTION <argument>>
<b>Returns</b>	None (or ACK if enabled)
<b>Parameters</b>	<argument> 0 to 3 Number of decimal places

4

For resistance only

<b>Function</b>	Sets the number of decimal places used
<b>Example</b>	SYST:DISP:RESO<space>2<cr><lf> (sets 2 decimal places)

## 9.4.7 SYSTem:DISPlay:RESOLution?

<b>Command</b>	SYST:DISPL:RESO? SYSTEM:DISPLAY:RESOLUTION?
<b>Returns</b>	Current resolution
<b>Parameters</b>	See above
<b>Function</b>	Returns the number of decimal places used
<b>Example</b>	SYST:DISPLAY:RESO?<cr><lf> (command) 2<cr><lf> (response) (returns the resolution as 2 decimal places)

## 9.4.8 SYSTem:DATE &lt;date&gt;

<b>Command</b>	SYST:DATE <date> SYSTEM: DATE <date>
<b>Returns</b>	None (or ACK if set on)
<b>Function</b>	Sets the instrument's date
<b>Format</b>	yy,mm,dd
<b>Example</b>	SYST:DATE <space>10,07,23<cr><lf> (set instrument date to 23/07/10)

## 9.4.9 SYSTem:DATE?

<b>Command</b>	SYST:DATE? SYSTEM: DATE?
<b>Returns</b>	Date
<b>Function</b>	Returns the instrument's date

<b>Example</b>	<b>SYST:DATE?&lt;cr&gt;&lt;lf&gt;</b>	<b>(command)</b>
	<b>10,07,23&lt;cr&gt;&lt;lf&gt;</b>	<b>(response)</b>
	<b>(instrument date is set to 23/07/10)</b>	

#### 9.4.10 SYSTem:PASSword <password>,<enable>

<b>Command</b>	<b>SYST: PASS &lt;password&gt;&lt;enable&gt;</b>		
	<b>SYSTEM: PASSWORD &lt;password&gt;&lt;enable&gt;</b>		
<b>Returns</b>	<b>None (or ACK if set on)</b>		
<b>Parameters</b>	<b>&lt;password&gt;</b>	<b>9900</b>	<b>System password</b>
	<b>&lt;enable&gt;</b>	<b>0 enable</b>	<b>Enable flag</b>
		<b>1 disable</b>	
<b>Function</b>	<b>Enables or disables the password</b>		
<b>Example</b>	<b>SYST: PASS &lt;space&gt;9900,0&lt;cr&gt;&lt;lf&gt;</b>		
	<b>(disables the password check)</b>		

#### 9.4.11 SYSTem:PASSword?

<b>Command</b>	<b>SYST: PASS?</b>	
	<b>SYSTEM: PASSWORD?</b>	
<b>Returns</b>	<b>System password status</b>	
<b>Function</b>	<b>Returns the password status</b>	
<b>Example</b>	<b>SYST: PASS?&lt;cr&gt;&lt;lf&gt;</b>	<b>(command)</b>
	<b>1&lt;cr&gt;&lt;lf&gt;</b>	<b>(response)</b>
	<b>(the system password is disabled)</b>	

#### 9.4.12 SYSTem:TIME <time>

<b>Command</b>	<b>SYST: TIME &lt;time&gt;</b>
	<b>SYSTEM: TIME &lt;time&gt;</b>
<b>Returns</b>	<b>None (or ACK if set on)</b>
<b>Function</b>	<b>Sets the instrument's time</b>

<b>Format</b>	hh,mm,ss
<b>Example</b>	SYST: TIME <space>9,14,23<cr><lf> (set instrument time to 9:14:23)

## 9.4.13 SYSTem:TIME?

<b>Command</b>	SYST: TIME? SYSTEM: TIME?
<b>Returns</b>	Time
<b>Function</b>	Returns the instrument's time
<b>Example</b>	SYST: TIME?<cr><lf> (command) 9,14,23<cr><lf> (response) (instrument time is to 9:14:23)

## 9.4.14 SYSTEM:ECHO: &lt;argument&gt;

<b>Command</b>	ECHO <argument>
<b>Returns</b>	None
<b>Parameters</b>	<argument> 0 Turn echo OFF 1 Turn echo ON
<b>Function</b>	Turns the echo command ON or OFF. Useful when debugging.

## 9.4.15 SYSTem:DISPLay:TIME &lt;state&gt;

<b>Command</b>	SYST:DISP:TIME <state> SYSTEM:DISPLAY:TIME <state>
<b>Parameters</b>	0 Display the reference resistor 1 Display the time
<b>Returns</b>	None (or ACK if set on)
<b>Function</b>	Determines the top right-hand display setting
<b>Example</b>	SYST:DISP:TIME <space>0 (Sets the display to show the reference resistor)

9.4.16 *SYSTem:BEEPer* <note>,<length>

<b>Command</b>	<b>SYST:BEEP &lt;note&gt;&lt;length&gt;</b>		
	<b>SYSTEM:BEEPER &lt;note&gt;&lt;length&gt;</b>		
<b>Parameters</b>	<b>&lt;note&gt;</b>	<b>200 to 4000</b>	<b>Set pitch</b>
	<b>&lt;length&gt;</b>	<b>0 to 3000</b>	<b>Set time in ms</b>
<b>Returns</b>	<b>None (or ACK if set on)</b>		
<b>Function</b>	<b>Sound a note. Setting a time of 0 will disable the beeper. The CTR5000 will continue operation while the note sounds.</b>		
<b>Example</b>	<b>SYST: BEEP: &lt;space&gt;2000,1000</b>		
	<b>(Sounds note for 1 second; pitch 2000)</b>		

9.4.17 *SYSTem:MESSage* <message>

<b>Command</b>	<b>SYST:MESS &lt;message&gt;</b>	
	<b>SYSTEM:MESSAGE &lt;message.</b>	
<b>Returns</b>	<b>None</b>	
<b>Parameters</b>	<b>&lt;message&gt;</b>	<b>Text (maximum of 18 characters)</b>
<b>Function</b>	<b>Displays the message and waits for a key press</b>	

9.4.18 *SYSTem:SNUMber?*

<b>Command</b>	<b>SYST: SNUM?</b>	
	<b>SYSTEM: SNUMBER?</b>	
<b>Function</b>	<b>Returns the instrument's serial number (10 characters)</b>	
<b>Example</b>	<b>SYST: SNUM?&lt;cr&gt;&lt;lf&gt;</b>	<b>(command)</b>
	<b>123456/123cr&gt;&lt;lf&gt;</b>	<b>(response)</b>
	<b>(instrument's serial number is 123456/123)</b>	

9.4.19 *SYSTem:PCB?*

<b>Command</b>	<b>SYST: PCB?</b>
	<b>SYSTEM: PCB?</b>

<b>Function</b>	<b>Returns the PCB serial number (10 characters)</b>	
<b>Example</b>	<b>SYST: PCB?&lt;cr&gt;&lt;lf&gt;</b>	<b>(command)</b>
	<b>789012/123cr&gt;&lt;lf&gt;</b>	<b>(response)</b>
	<b>(instrument's PCB serial number is 789012/123)</b>	



## 9.4.20 MEASure:CURRent?

<b>Command</b>	<b>MEAS:CURR?</b> <b>MEASURE:CURRENT?</b>
<b>Returns</b>	Last reading on currently selected channel with units
<b>Function</b>	Returns the last reading on currently selected channel
<b>Example</b>	<b>MEAS: CURR?&lt;cr&gt;&lt;lf&gt;</b> (command) <b>30.431,K&lt;cr&gt;&lt;lf&gt;</b> (response) (returns with 30.431K as the latest reading on the current channel)

9.4.21 *CONFigure:CHANnel* <channel>

<b>Command</b>	<b>CONF:CHAN &lt;channel&gt;</b> <b>CONFIGURE:CHANNEL &lt;channel&gt;</b>
<b>Returns</b>	<b>None (or ACK if set on)</b>
<b>Function</b>	<b>Sets the instrument to the channel specified</b>
<b>Example</b>	<b>CONF:CHAN&lt;space&gt;03&lt;cr&gt;&lt;lf&gt;</b> <b>(makes channel 03 (C) the currently active channel)</b>

9.4.22 *CONFigure:CHANnel?*

<b>Command</b>	<b>CONF:CHAN?</b> <b>CONFIGURE:CHANNEL?</b>
<b>Returns</b>	<b>Currently selected channel</b>
<b>Function</b>	<b>Returns the currently selected channel</b>
<b>Example</b>	<b>CONF:CHAN?&lt;cr&gt;&lt;lf&gt;</b> (command) <b>03&lt;cr&gt;&lt;lf&gt;</b> (response) <b>(returns with the active channel of 03)</b>

9.4.23 *CONFigure:CHANnel:FITted?* <channel>

<b>Command</b>	<b>CONF:CHAN:FIT? &lt;channel&gt;</b> <b>CONFIGURE:CHANNEL:FITTED? &lt;channel&gt;</b>
<b>Returns</b>	<b>0 = Not fitted</b> <b>1 = Fitted</b>
<b>Function</b>	<b>Returns the channel fitted status</b>
<b>Example</b>	<b>CONF:CHAN:FIT?&lt;space&gt;,3&lt;cr&gt;&lt;lf&gt;</b> (command) <b>0&lt;cr&gt;&lt;lf&gt;</b> (response) <b>(channel 3 is not fitted)</b>

#### 9.4.24 CONFigure:SERIal?

<b>Command</b>	<b>CONF:SERI?</b> <b>CONFIGURE: SERIAL?</b>	
<b>Returns</b>	<b>0 = Not fitted</b> <b>1 = Fitted</b>	
<b>Function</b>	<b>Returns the RS232 fitted status</b>	
<b>Example</b>	<b>CONF: SERI &lt;cr&gt;&lt;lf&gt;</b> (command) <b>0&lt;cr&gt;&lt;lf&gt;</b> (response) <b>(RS232 interface is not fitted)</b>	

#### 9.4.25 CONFigure:IEEE?

<b>Command</b>	<b>CONF:IEEE?</b> <b>CONFIGURE: IEEE?</b>	
<b>Returns</b>	<b>0 = Not fitted</b> <b>1 = Fitted</b>	
<b>Function</b>	<b>Returns the IEEE fitted status</b>	
<b>Example</b>	<b>CONF: IEEE &lt;cr&gt;&lt;lf&gt;</b> (command) <b>0&lt;cr&gt;&lt;lf&gt;</b> (response) <b>(IEEE interface is not fitted)</b>	

#### 9.4.26 CONFigure:LAN?

<b>Command</b>	<b>CONF:LAN?</b> <b>CONFIGURE: LAN?</b>	
<b>Returns</b>	<b>0 = Not fitted</b> <b>1 = Fitted</b>	
<b>Function</b>	<b>Returns the LAN fitted status</b>	
<b>Example</b>	<b>CONF: LAN &lt;cr&gt;&lt;lf&gt;</b> (command)	

0<cr><lf> (response)

(LAN interface is not fitted)

#### 9.4.27 CONFigure:REFErence <argument>

<b>Command</b>	CONF:REFE <argument>		
	CONFIGURE:REFERENCE <argument>		
<b>Returns</b>	None (or ACK if set on)		
<b>Parameters</b>	<argument>	1	Automatic selection
		2	25 ohm reference
		3	100 ohm reference
<b>Function</b>	Sets the current channel to use this reference		
<b>Example</b>	CONF:REF<space>2<cr><lf>		
	(sets current channel to use 25 ohms reference)		

#### 9.4.28 CONFigure:REFErence?

<b>Command</b>	CONF:REFE?		
	CONFIGURE:REFERENCE?		
<b>Returns</b>	Reference used on current channel		
<b>Function</b>	Returns the current reference resistor and channel		
<b>Example</b>	CONF:REFE?<cr><lf>	(command)	
	2,1<cr><lf>	(response)	
	(25 ohms reference is in use on channel 1 (A))		

#### 9.4.29 CONFigure:CHANnel:SMARt?

<b>Command</b>	CONF:CHAN:SMAR?		
	CONFIGURE:CHANNEL:SMART?		
<b>Returns</b>	0 = No Smart Probe		
	1 = Smart Probe		
<b>Function</b>	Returns the Smart Probe status for the current channel		

Example

CONF:CHAN:SMAR?<cr><lf> (command)

1<cr><lf> (response)

(a Smart Probe is attached to the current channel)

9.4.30 *PROBe:ASSIgn* <probe>,<channel>

<b>Command</b>	<b>PROB: ASSI</b> <probe>,<channel> <b>PROBE: ASSIGN</b> <probe>,<channel>
<b>Returns</b>	None (or ACK if set on)
<b>Parameters</b>	<probe>      1 to 72 Probe number  <channel>    1 to 80 Channel number
<b>Function</b>	Assigns the probe to the specified channel. To un-assign a probe, assign it to channel 0.
<b>Example</b>	CONF: ASSI <space>2,1<cr><lf>  (assign probe 2 to channel 1)

9.4.31 *PROBe:ASSIgn?* <probe>

<b>Command</b>	<b>PROB:ASSI?</b> <probe> <b>PROBE:ASSIGN?</b> <probe>
<b>Returns</b>	Probe assignment status
<b>Parameters</b>	<probe>      1 to 72      Probe number
<b>Function</b>	Returns the probe assignment status for the specified channel. Returns 0 if the probe is unassigned.
<b>Example</b>	PROB:ASSI? 5<cr><lf>      (command)  2<cr><lf>      (response)  (Probe 5 is assigned to channel 2)
<b>Errors</b>	E9      Probe does not exist

9.4.32 *PROBe:IDENtifier* <probe>,<type>

<b>Command</b>	<b>PROB: IDEN</b> <probe>,<identification> <b>PROBE: IDENTIFIER</b> <probe>,<identification>
<b>Returns</b>	None (or ACK if set on)
<b>Parameters</b>	<probe>      1 to 72 Probe number

	<b>&lt;type&gt;</b>	0 to 10 long string. Identifiers less than 10 characters will be padded with trailing spaces
<b>Function</b>		Sets the probe identifier to the specified string
<b>Example</b>		PROB: IDEN <space>2,abcDEFG1<cr><lf> (sets probe 2 identifier to abcDEFG1)

#### 9.4.33 PROBe: IDENtifier? <probe>

<b>Command</b>	PROB: IDEN? <probe> PROBE: IDENTIFIER? <probe>
<b>Returns</b>	Probe Identifier string
<b>Parameters</b>	<probe>      1 to 72      Probe number
<b>Function</b>	Returns the probe Identifier string
<b>Example</b>	PROB: IDEN? 5<cr><lf>      (command) abbbb12343<cr><lf>      (response) (Probe 5 is identifier is abbbb12343)

#### 9.4.34 PROBe:TMAX <probe>,<temperature>

<b>Command</b>	PROB: TMAX <probe><temperature> PROBE: TMAX <probe>,<temperature>
<b>Returns</b>	None (or ACK if set on)
<b>Parameters</b>	<probe>      1 to 72 Probe number  <temperature>      valid floating point temperature (°C)
<b>Function</b>	Sets the probe Tmax to the specified temperature in degrees Celsius. The temperature must be a value between -201.0 °C and 961.78 °C.
<b>Example</b>	PROB: TMAX <space>2,501.5<cr><lf> (sets probe 5 Tmax to 501.5 °C)

#### 9.4.35 PROBe: TMAX? <probe>

<b>Command</b>	PROB: TMAX? <probe> PROBE: TMAX? <probe>
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Returns	Probe Identifier string	
Parameters	<temperature> 1 to 72	Probe number
Function	Returns the probe Tmax setting in degrees C	
Example	PROB: TMAX? 5<cr><lf>	(command)
	501.5<cr><lf>	(response)
	(Probe 5 is Tmax is set to 501.5 °C)	

#### 9.4.36 PROBe: TMIN <probe>,<temperature>

Command	PROB: TMIN <probe><temperature>	
	PROBE: TMIN <probe>,<temperature>	
Returns	None (or ACK if set on)	
Parameters	<probe>	1 to 72 Probe number
	<temperature>	valid floating point temperature (°C)
Function	Sets the probe Tmin to the specified temperature in degrees Celsius. The temperature must be a value between -201.0 °C and 961.78 °C.	
Example	PROB: TMIN <space>2,-102.0<cr><lf>	
	(sets probe 2 Tmin to -102.0 °C)	

#### 9.4.37 PROBe: TMIN? <probe>

Command	PROB: TMIN? <probe>	
	PROBE: TMIN? <probe>	
Returns	Probe Identifier string	
Parameters	<temperature> 1 to 72	Probe number
Function	Returns the probe Tmin setting in degrees C	
Example	PROB: TMIN? 5<cr><lf>	(command)
	-102.0<cr><lf>	(response)
	(Probe 5 is Tmin is set to -102.0 °C)	



9.4.38 *PROBe:STANdard* <probe>,<type>

<b>Command</b>	<b>PROB: STAN&lt;probe&gt;,&lt;type&gt;</b>		
	<b>PROBE: STANDARD&lt;probe&gt;,&lt;type&gt;</b>		
<b>Returns</b>	<b>None (or ACK if set on)</b>		
<b>Parameters</b>	<b>&lt;probe&gt;</b>	<b>1 to 72</b>	<b>Probe number</b>
	<b>&lt;type&gt;</b>	<b>1 to 4</b>	<b>Probe type (see below)</b>
<b>Function</b>	<b>Sets the probe to the specified type</b>		
<b>Example</b>	<b>PROB: STAN &lt;space&gt;2,1&lt;cr&gt;&lt;lf&gt;</b>		
	<b>(sets probe 2 to DIN90)</b>		
<b>Type</b>	<b>1</b>	<b>DIN90</b>	
	<b>2</b>	<b>CVD</b>	
	<b>3</b>	<b>ITS90</b>	
	<b>4</b>	<b>DIN</b>	

9.4.39 *PROBe: STANdard?* <probe>

<b>Command</b>	<b>PROB: STAN? &lt;probe&gt;</b>		
	<b>PROBE: STANDARD? &lt;probe&gt;</b>		
<b>Returns</b>	<b>Probe type</b>		
<b>Parameters</b>	<b>&lt;probe&gt;</b>	<b>1 to 72</b>	<b>Probe number</b>
<b>Function</b>	<b>Returns the probe type</b>		
<b>Example</b>	<b>PROB: STAN? 5&lt;cr&gt;&lt;lf&gt;</b>		
			<b>(command)</b>
	<b>3&lt;cr&gt;&lt;lf&gt;</b>		
			<b>(response)</b>
	<b>(Probe 5 is type ITS90)</b>		

9.4.40 *PROBe:UNIT* <probe>,<units>

<b>Command</b>	<b>PROB: UNIT &lt;probe&gt;,&lt;units&gt;</b>		
	<b>PROBE: UNIT &lt;probe&gt;,&lt;units&gt;</b>		
<b>Returns</b>	<b>None (or ACK if set on)</b>		

Parameters	<probe>	1 to 72 Probe number
	<type>	1 to 5 Units (see below)
Function	Sets the probe to the specified type	
Example	PROB: UNIT<space>2,5<cr><lf> (sets probe 2 units to Kelvin)	
Type	1	Instrument Units
	2	Ohms
	3	Celsius
	4	Fahrenheit
	5	Kelvin

#### 9.4.41 PROBe: UNIT? <probe>

Command	PROB:UNIT? <probe>		
	PROBE: UNIT? <probe>		
Returns	Probe units		
Parameters	<probe>	1 to 72	Probe number
Function	Returns the probe units (see above)		
Example	PROB: UNIT? 3<cr><lf>		(command)
	5<cr><lf>		(response)
(Probe 3 is set to Kelvin)			

#### 9.4.42 PROBe:COEFFicient <probe>,<identifier>,<value>

Command	PROB: COEF <probe>,<identifier><value>		
	PROBE: COEFFICIENT <probe>,<identifier>,<value>		
Returns	None (or ACK if set on)		
Parameters	<probe>	1 to 72 Probe number	
	<identifier>	1 to 8, or R0, Ap, Bp, Cp, Dp, An, Bn, Wt (see next)	

	<b>&lt;value&gt;</b>	Scientific notation, five decimal places eg 3.90830e-03 R0 as a decimal, four decimal places eg 100.1234
<b>Function</b>		Set the specified probe's coefficient to the number supplied. Only valid coefficients for the probe type can be set.
<b>Example</b>		PROB:COEF<space>3,2, +3.90730e-03<cr><lf>  (sets probe 3's A <sub>p</sub> coefficient to +3.90730x10 <sup>-03</sup> )
<b>Errors</b>	<b>E9</b>	Probe does not exist

#### 9.4.43 PROBe:COEFFicient? <probe>,<identifier>

<b>Command</b>	PROB:COEF? <probe>,<identifier>  PROBE:COEFFICIENT? <probe>,<identifier>																
<b>Returns</b>	Coefficient for specified probe and coefficient number																
<b>Parameters</b>	<b>&lt;probe&gt;</b> 1 to 72 Probe number  <b>&lt;identifier&gt;</b> 1 to 8, or  R0, Ap, Bp, Cp, Dp, An, Bn, Wt																
<b>Function</b>	Returns the probe coefficient for the specified probe. Only valid coefficients for the probe type will be returned.																
<b>Example</b>	PROB:COEF? 3, 2<cr><lf> (command)  +3.90830e-03<cr><lf> (response)  (Probe 3's A <sub>p</sub> coefficient is +3.90830x10 <sup>-03</sup> )																
<b>Coefficient codes</b>	<table> <tr><td>1</td><td>R<sub>0</sub></td></tr> <tr><td>2</td><td>A<sub>p</sub></td></tr> <tr><td>3</td><td>B<sub>p</sub></td></tr> <tr><td>4</td><td>C<sub>p</sub></td></tr> <tr><td>5</td><td>D<sub>p</sub></td></tr> <tr><td>6</td><td>A<sub>n</sub></td></tr> <tr><td>7</td><td>B<sub>n</sub></td></tr> <tr><td>8</td><td>W<sub>t</sub></td></tr> </table>	1	R <sub>0</sub>	2	A <sub>p</sub>	3	B <sub>p</sub>	4	C <sub>p</sub>	5	D <sub>p</sub>	6	A <sub>n</sub>	7	B <sub>n</sub>	8	W <sub>t</sub>
1	R <sub>0</sub>																
2	A <sub>p</sub>																
3	B <sub>p</sub>																
4	C <sub>p</sub>																
5	D <sub>p</sub>																
6	A <sub>n</sub>																
7	B <sub>n</sub>																
8	W <sub>t</sub>																

9.4.44 *UNIT:TEMPerature* <units>

<b>Command</b>	<b>UNIT:TEMP &lt;units&gt;</b> <b>UNIT:TEMPERATURE &lt;units&gt;</b>
<b>Returns</b>	<b>None</b>
<b>Parameters</b>	<b>&lt;units&gt;</b>  1 <b>Instrument Units</b>  2 <b>Ohms</b>  3 <b>Celsius</b>  4 <b>Fahrenheit</b>  5 <b>Kelvin</b>
<b>Function</b>	<b>Sets the active channel's units</b>
<b>Example</b>	<b>UNIT:TEMP&lt;space&gt;CEL&lt;cr&gt;&lt;lf&gt;</b>  <b>(sets the active channel's units to Celsius)</b>

9.4.45 *UNIT:TEMPerature?*

<b>Command</b>	<b>UNIT:TEMP?</b> <b>UNIT:TEMPERATURE?</b>
<b>Returns</b>	<b>&lt;units&gt;&lt;cr&gt;&lt;lf&gt;</b>
<b>Function</b>	<b>Returns the active channel measurement units (see above)s</b>
<b>Example</b>	<b>UNIT:TEMP?&lt;cr&gt;&lt;lf&gt;</b> <b>(command)</b>  <b>3&lt;cr&gt;&lt;lf&gt;</b> <b>(response)</b>  <b>(returns the active channel's units as Celsius)</b>

<p><b>Note</b> To update a Smart probe, Smart probes must be enabled, the probe must be unlocked and the system password active.</p>
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9.4.46 *SENSe:FRTD:CAL:DATE* <year>, <month>, <day><sup>50</sup>

<b>Command</b>	<b>SENS:FRTD:CAL:DATE</b> <year>, <month>, <day> <b>SENSE:FRTD:CALIBRATION:DATE</b> <year>, <month>, <day>	
<b>Returns</b>	None (or ACK if enabled)	
<b>Parameters</b>	<year>	4 digit numerical string
	<month>	01 to 12 for month
	<day>	01 to 31 for day
<b>Protection</b>	Password protected command.	
<b>Function</b>	Enter the calibration date to the selected smart probe, save the old calibration date in history. Clear the max and min recorded values outside working range since last cal.	

9.4.47 *SENSe:FRTD:CAL:DATE?*

<b>Command</b>	<b>SENS:FRTD:CAL:DATE?</b> <b>SENSE:FRTD:CALIBRATION:DATE?</b>	
<b>Return</b>	<year>, <month>, <day>	
<b>Parameters</b>	<year>	4 digit numerical string
	<month>	01 to 12 for month
	<day>	01 to 31 for day
<b>Function</b>	Query the calibration date for the selected smart probe.	

9.4.48 *SENSe:FRTD:CAL:NEXT* <year>, <month>, <day>

<b>Command</b>	<b>SENS:FRTD:CAL:NEXT</b> <year>, <month>, <day> <b>SENSE:FRTD:CALIBRATION:NEXT</b> <year>, <month>, <day>	
<b>Parameters</b>	<year>	4 digit numerical string
	<month>	01 to 12 for month
	<day>	01 to 31 for day
<b>Returns</b>	None (or ACK if enabled)	
<b>Protection</b>	Password protected command.	
<b>Function</b>	Enter the next calibration date to the selected smart probe.	

9.4.49 *SENSe:FRTD:CAL:NEXT?*

<b>Command</b>	<b>SENS:FRTD:CAL:NEXT?</b> <b>SENSE:FRTD:CALIBRATION:NEXT?</b>	
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<sup>50</sup> Use 2 digits for day and month when less than 10 - e.g. 06. Maximum year is 2099.

<b>Return</b>	<year>,<month>,<day> -222	No smart probe detected
<b>Parameters</b>	<year> <month> <day>	4 digit numerical string 01 to 12 for month 01 to 31 for day
<b>Function</b>	Query the next calibration date for the selected smart probe.	

9.4.50 *SENSe:FRTD:CAL:SOURce* <source>

<b>Command</b>	SENS:FRTD:CAL:SOUR <source> SENSE:FRTD:CALIBRATION:SOURCE <source>	
<b>Parameters</b>	<source>	17 byte maximum ASCII string (10 displayed on CTR5000)
<b>Returns</b>	None (or ACK if enabled)	
<b>Protection</b>	Password protected command.	
<b>Function</b>	Save the calibration source reference code to the selected smart probe.	

9.4.51 *SENSe:FRTD:CAL:SOURce?*>

<b>Command</b>	SENS:FRTD:CAL:SOUR? SENSE:FRTD:CALIBRATION:SOURCE?	
<b>Return</b>	<source>	
<b>Parameters</b>	<source>	17 byte maximum ASCII string.
<b>Protection</b>	Password protected command.	
<b>Function</b>	Query the calibration source reference code for the selected smart probe.	

9.4.52 *SENSe:FRTD:STANdard* <standard>

<b>Command</b>	SENS:FRTD:STAN <standard> SENSE:FRTD:STANDARD <standard>		
<b>Parameters</b>	<standard>	1	Din90 (EN60751)
		2	CvD
		3	ITS90
		4	DIN
<b>Returns</b>	None (or ACK if enabled)		
<b>Protection</b>	Password protected command.		
<b>Function</b>	Set the selected temperature conversion method. Smart probe input save to smart probe.		

None smart probe input save to instrument internal channel configuration.

This command does not work on passive probes.

#### 9.4.53 *SENSe:FRTD:STANdard?*

<b>Command</b>	<b>SENS:FRTD:STAN?</b> <b>SENSE:FRTD:STANDARD?</b>		
<b>Return</b>	<standard>		
<b>Parameters</b>	<standard>	1	Din90 (EN60751)
		2	CvD
		3	ITS90
		4	DIN
<b>Function</b>	Query the selected temperature conversion method. Smart probe input query the smart probe. None smart probe input query the instrument internal channel configuration.		

#### 9.4.54 *SENSe:FRTD:REFErence <reference>*

<b>Command</b>	<b>SENS:FRTD:REFE &lt;reference&gt;</b> <b>SENSE:FRTD:REFERENCE &lt;reference&gt;</b>		
<b>Parameters</b>	<reference>	3	25 ohms
		5	100 ohms
<b>Returns</b>	None (or ACK if enabled)		
<b>Protection</b>	Password protected command.		
<b>Function</b>	Set the selected reference resistor. Smart probe input save to smart probe. This command does not work on passive probes.		

#### 9.4.55 *SENSe:FRTD:REFErence?*

<b>Command</b>	<b>SENS:FRTD:REFE?</b> <b>SENSE:FRTD:REFERENCE?</b>		
<b>Return</b>	Reference for Smart probe (current selected channel)		
		3	25 ohms
		5	100 ohms
<b>Function</b>	Query the selected channel reference resistor.		

#### 9.4.56 *SENSe:FRTD:COEFFicient <coefficient>,<value>*

<b>Command</b>	<b>SENS:FRTD:COEF &lt;coefficient&gt;,&lt;value&gt;</b> <b>SENSE:FRTD:COEFFICIENT &lt;coefficient&gt;,&lt;value&gt;</b>		
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<b>Parameters</b>	<b>&lt;identifier&gt;</b> 1 to 8, or R0, Ap, Bp, Cp, Dp, An, Bn, Wt or all <b>&lt;value&gt;</b> Scientific notation, five decimal places eg 3.90830e-03 R0 as a decimal, four decimal places eg 100.1234
<b>Returns</b>	None (or ACK if enabled)
<b>Protection</b>	Password protected command.
<b>Function</b>	Set the selected input channel specified coefficient value. Smart probe input save to smart probe. None smart probe input save to instrument internal channel configuration.

#### 9.4.57 *SENSe:FRTD:COEFFicient? <coefficient>*

<b>Command</b>	<b>SENS:FRTD:COEF? &lt;coefficient&gt;</b> <b>SENSe:FRTD:COEFFICIENT? &lt;coefficient&gt;</b>
<b>Parameters</b>	<b>&lt;identifier&gt;</b> 1 to 8, or R0, Ap, Bp, Cp, Dp, An, Bn, Wt or all
<b>Return</b>	<b>&lt;value&gt;</b> Scientific notation, five decimal places eg 3.90830e-03 R0 as a decimal to four decimal places eg 100.1234
<b>Function</b>	Query the selected input channel specified coefficient value. Smart probe input query the smart probe. None smart probe input query the instrument internal channel configuration.

#### 9.4.58 *SENSe:FRTD:IDENtification <identification>*

<b>Command</b>	<b>SENS:FRTD:IDEN &lt;identification&gt;</b> <b>SENSe:FRTD:IDENTIFICATION &lt;identification&gt;</b>
<b>Parameters</b>	<b>&lt;identification&gt;</b> 19 byte maximum ASCII string
<b>Returns</b>	None (or ACK if enabled)
<b>Protection</b>	Password protected command.
<b>Function</b>	Enter the identification number to the selected smart probe.

#### 9.4.59 *SENSe:FRTD:IDENtification?*

<b>Command</b>	<b>SENS:FRTD:IDEN?</b> <b>SENSe:FRTD:IDENTIFICATION?</b>
<b>Return</b>	<b>&lt;identification&gt;</b>
<b>Parameters</b>	<b>&lt;identification&gt;</b> 19 byte maximum ASCII string (10 displayed on CTR5000)



**Function** Query the identification number for the selected smart probe.

#### 9.4.60 *SENSe:FRTD:RANGe* <rmax>,<rmin>

<b>Command</b>	<b>SENS:FRTD:RANG</b> <rmax>,<rmin> <b>SENSE:FRTD:RANGE</b> <rmax>,<rmin>	
<b>Parameters</b>	<rmax>	0 to 500 ohm's
	<rmin>	0 to 500 ohm's
<b>Returns</b>	None (or ACK if enabled)	
<b>Protection</b>	Password protected command.	
<b>Function</b>	Enter the working range of the selected smart probe.	

#### 9.4.61 *SENSe:FRTD:RANGe?*

<b>Command</b>	<b>SENS:FRTD:RANG?</b> <b>SENSE:FRTD:RANGE?</b>	
<b>Return</b>	<rmax>,<rmin> <rmax>,<rmin>  <rmax>,<rmin>	smart probe working range recorded value outside working range since last cal  recorded value outside working range ever
<b>Parameters</b>	<rmax> <rmin>	0 to 500 ohms 0 to 500 ohms
<b>Protection</b>	Password protected command.	
<b>Function</b>	Query the working range and working history of the smart probe.	

#### 9.4.62 *SENSe:FRTD:LOCK* <state>

<b>Command</b>	<b>SENS:FRTD:LOCK</b> <state> <b>SENSE:FRTD:LOCK</b> <state>	
<b>Parameters</b>	<state>0	Smart probe data unlocked
	1	Smart probe data locked
<b>Returns</b>	None (or ACK if enabled)	
<b>Protection</b>	Password protected command.	
<b>Function</b>	Set the smart probe data protection state, before any smart probe data can be changed it must first be unlocked.	

9.4.63 *SENSe:FRTD:LOCK?*

<b>Command</b>	<b>SENS:FRTD:LOCK?</b> <b>SENSE:FRTD:LOCK?</b>
<b>Return</b>	<b>&lt;state&gt;</b>
<b>Parameters</b>	<b>&lt;state&gt;0</b> <b>Smart probe data unlocked</b> <b>1</b> <b>Smart probe data locked</b>
<b>Function</b>	<b>Query the smart probe data protection lock state.</b>

9.4.64 *SENSe:FRTD:ENABle <parameter>*

<b>Command</b>	<b>SENS:FRTD:ENAB &lt;parameter&gt;</b> <b>SENSE:FRTD:ENABLE &lt;parameter&gt;</b>
<b>Returns</b>	<b>None (or ACK if enabled)</b>
<b>Parameters</b>	<b>&lt;parameter&gt; 0</b> <b>Set Smart Probes OFF</b> <b>1</b> <b>Set Smart Probes ON</b>
<b>Function</b>	<b>Sets the CTR5000 Smart Probe enable mode</b>
<b>Example</b>	<b>SENSE:FRTD:ENAB&lt;space&gt;0&lt;cr&gt;&lt;lf&gt;</b> <b>(sets Smart Probes OFF)</b>

9.4.65 *SENSe:FRTD:ENABle?*

<b>Command</b>	<b>SENS:FRTD:ENAB?</b> <b>SENSE:FRTD:ENABLE?</b>
<b>Returns</b>	<b>&lt;parameter&gt;&lt;cr&gt;&lt;lf&gt;</b>
<b>Function</b>	<b>Returns the CTR5000 Smart Probe enable setting</b>
<b>Example</b>	<b>SENSE:FRTD:ENAB?&lt;cr&gt;&lt;lf&gt;</b> <b>(command)</b> <b>0&lt;cr&gt;&lt;lf&gt;</b> <b>(response)</b> <b>(Smart Probes disabled)</b>

9.4.66 *SENSe:ZERO <parameter>*

<b>Command</b>	<b>SENS:ZERO &lt;parameter&gt;</b> <b>SENSE:ZERO &lt;parameter&gt;</b>
----------------	---

<b>Returns</b>	None (or ACK if enabled)	
<b>Parameters</b>	<parameter> 0	Set Zero mode OFF
	1	Set Zero mode ON
<b>Function</b>	Sets the CTR5000 zero mode	
<b>Example</b>	SENSE:ZERO<space>0<cr><lf> (sets zero mode OFF)	

#### 9.4.67 SENSE:ZERO?

<b>Command</b>	SENS:ZERO? SENSE:ZERO?	
<b>Returns</b>	<parameter><cr><lf>	
<b>Function</b>	Returns the CTR5000 zero mode setting	
<b>Example</b>	SENSE:ZERO?<cr><lf>	(command)
	0<cr><lf>	(response)
	(Zero mode is OFF)	

## 10. Error codes

Error codes can be generated by the instrument for a variety of reasons –

Error code	Meaning / Cause
E1	Balance error / No PRT, PRT open circuit / Ratio over range.
E2	Temperature over range
E3	Not used
E4	IEEE or RS232 error / Unrecognized instruction sent
E5	IEEE or RS232 error / Illegal argument sent
E6	RAM failure
E7	Not used
E8	Unable to track temperature change or change too large
E9	Invalid password
E10	Coefficient not available
E11	Probe already assigned to a channel
E12	Unable to communicate while logging
E13	Remote enable is OFF (communications disabled)
E14	Channel or probe not available
E15	Locked out
E203	Password protected
E222	No Smart probe detected
E223	Smart probe disabled
E224	Smart probe locked

When in remote mode, for F250 compatibility, the error codes are –

Error code	Meaning / Cause
E1	Balance error/no PRT, PRT open circuit/ratio over range
E2	Temperature over range
E4	Unrecognized instruction sent
E5	Illegal argument sent

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## 11. Cleaning and Maintenance

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### 11.1 Cleaning

Make sure the CTR5000 is disconnected from any leads and from the mains supply before cleaning.

Clean the outside of the instrument with a soft, clean cloth, slightly dampened with mild detergent. Do not allow water to enter the instrument.

**Warning**

**Never use alcohol or thinners as these will damage the instrument.**

**Never use a hard or abrasive cloth or brush.**

**Always disconnect from the mains supply before cleaning.**

**Warning**

**Regularly inspect the mains cable and plug for damage.**

### 11.2 Maintenance

Keep the instrument and its leads clean with occasional calibration checks. In particular the connectors to input terminals should be kept clean to prevent leakage currents flowing.

Damaged cable and connectors are a common cause of poor and intermittent operation.

## 12. Service and Warranty

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CTR5000 instruments and accessories, (unless stated otherwise), are covered by a 12 month warranty on parts and labour from the date of dispatch from ASL (provided the instrument has not been damaged in use or tampered with). This warranty does not include costs incurred in returning the equipment to the factory for repair.

### 12.1 Technical Support

For all technical support, repair, warranty and service inquiries please contact:

**Technical Services**  
**WIKA UK**  
**4 Gatton Park Business Centre**  
**Wells Place**  
**Merstham, Redhill**  
**RH1 3LG**  
**ENGLAND**  
**United Kingdom**

**Telephone:** +44 (0) 1737 644 008

**Fax:** +44 (0) 1737 644 403

**E-Mail:** [service@asltd.co.uk](mailto:service@asltd.co.uk)

**Web:** [www.wika.co.uk](http://www.wika.co.uk)

### 13. Appendix 1 – Definitions and terminology

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- i. **0 °C = 273.15 K**
- ii. **1 mK (milli-Kelvin) = 0.001 °C (one milli-degree Celsius)**
- iii. **1 milli-degree C = 0.001°C = 1m °C = 1mK = 1.8m °F**
- iv. **1 milli-degree F = 0.001°F = 1m °F = 0.56mK = 0.56m °C**
- v. **Alpha (or  $\alpha$ ) is the temperature coefficient, or temperature sensitivity, of the platinum wire used in PRTs. In general, the higher the alpha value, the better the PRT thermometer measurement reproducibility, stability and performance'**
- vi. **Abbreviations for platinum resistance thermometers include –**
  - PRT (Platinum Resistance Thermometer)**
  - Pt100 (PRT with nominally 100  $\Omega$  resistance at 0 °C)**
  - RTD (Resistance Temperature Device)**
- vii. **System accuracy refers to the overall, combined accuracy of the CTR5000 and PRT in use.**



## 14. Appendix 2 – Firmware update

---

### 14.1 Firmware updates

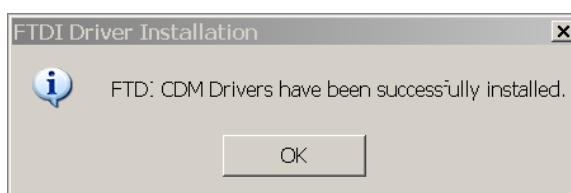
ASL may decide to provide firmware updates from time to time. These can be downloaded from the ASL website [www.aslltd.co.uk](http://www.aslltd.co.uk). The procedure for updating the CTR5000 is described in detail below. A PC, downloader software<sup>51</sup> and USB cable are required.

### 14.2 Firmware update disclaimer

It is entirely your choice whether you choose to apply these firmware updates to your instrument. ASL, whilst taking the utmost care to thoroughly test both the firmware and the update procedure, can not accept any responsibility for any problem or loss resulting from the procedure.

### 14.3 Firmware update procedure

- Obtain a copy of the latest firmware from the ASL website [www.aslltd.co.uk](http://www.aslltd.co.uk) and copy the file into the directory indicated by the instructions on the website.
- Run the program CDM\_Setup.exe from the directory D:\Downloader (replace the 'D' with the name of your CD device if necessary). This will install the USB drivers. You will see the following message once this is complete.



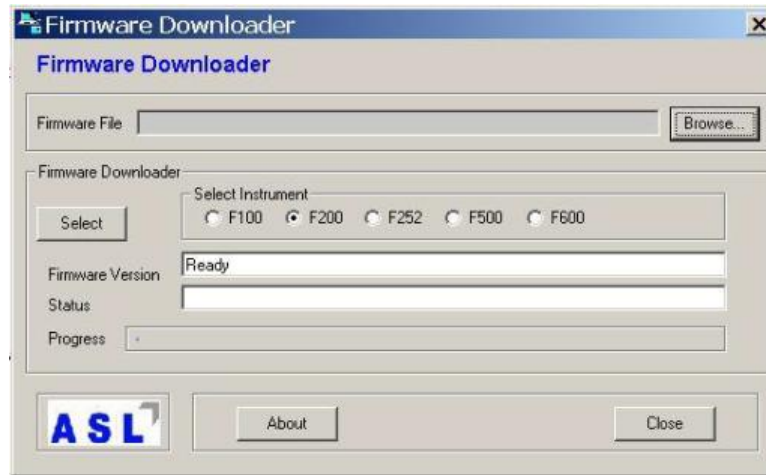
- Install the downloader software on your PC by running the program INSTALL.EXE from the directory D:\Downloader (replace the 'D' with the name of your CD device if necessary). Follow the installation procedure instructions which require you to enter your name and the name of your company<sup>52</sup>.

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<sup>51</sup> Provided on the CD with the instrument.

<sup>52</sup> The same download program can be used to update F200 firmware.

- This will create a shortcut icon on the desktop called ASL Downloader. Click on the ASL downloader icon to run the downloader program. Select the CTR5000 Instrument option
- Click on the Help button.



- Select the CTR5000 option and choose Select. This will display a form with specific instructions for the download process.
- Read and follow the instructions provided to update the instrument's firmware.
- The whole process will take about 15 minutes.

## 15. Appendix 3 – Callendar van Dusen

### 15.1 Callendar van Dusen equation (CvD)

Platinum Resistance Thermometers (PRTs) are one of the most linear temperature sensors that we have. Even so, the relationship between resistance and temperature is not entirely linear and so it is necessary for the conversion from resistance to temperature to allow for this.

The IEC751 standard provides an equation that can be used to convert resistance to temperature taking into account the small non-linearities of the PRT –

$$R_t = R_0 [1 + At + Bt^2 + C(t-100)t^3]$$

Where 'R<sub>t</sub>' is the resistance at temperature 't' and 'R<sub>0</sub>' is the resistance at 0°C. The coefficients A, B and C (C = 0, if t > 0 °C) are defined in IEC751 for standard PRTs. However, the coefficients must be measured individually (by regression) for a particular PRT when greater accuracy is required.

An alternative (and easier) method exists via the Callendar van Dusen (CvD) equation, based on measurement of four accurately known temperatures. The CTR5000 allows these coefficients to be entered for each probe used. The resistance to temperature conversion calculation is then carried out automatically within the instrument. However, this does rely on the user knowing the coefficients A, B and C accurately and entering these into the CTR5000.

It is worth noting that the coefficients vary between standards. Typical values (PRT dependent) are –

Standard	$\alpha$	A	B	C
DIN 43760	0.003850	3.9080 x 10 <sup>-3</sup>	-5.8019 x 10 <sup>-7</sup>	-4.2735 x 10 <sup>-12</sup>
ASTM	0.003911	3.9692 x 10 <sup>-3</sup>	-5.8495 x 10 <sup>-7</sup>	-4.2325 x 10 <sup>-12</sup>
ITS-90	0.003926	3.9848 x 10 <sup>-3</sup>	-5.870 x 10 <sup>-7</sup>	-4.0000 x 10 <sup>-12</sup>
				C = 0 if t > 0°C

## 16. Appendix 4 - ITS-90

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### 16.1 International Temperature Scale (ITS-90)

The purpose of this scale is to define procedures by which certain specified practical PRTs of the required quality can be calibrated in such a way that the values of temperature obtained from them can be precise and reproducible; at the same time matching the corresponding thermodynamic values as closely as current technology permits. Since 1968 when the IPTS68 was adopted, there have been significant advances in the techniques employed in establishing temperature standards and in the measurement of thermodynamic temperature.

The ITS-90 scale has much improved continuity, precision and reproducibility compared with IPTS68. The implementation of the ITS-90 scale according to its definition calls for significant changes in equipment and procedure compared with IPTS68, but lower uncertainties of calibration are achievable in all parts of the range. However, the instruments and equipment needed to implement the ITS-90 scale in calibration laboratories will be substantially the same. Particular features are –

ITS-90 specifies the use of the PRT up to the freezing point of silver, 961.78 °C. The platinum 10% rhodium/platinum thermocouple is no longer specified for use in the scale, though it and other noble metal thermocouples will continue to be used as secondary standards<sup>53</sup>.

- New, more precise, fixed points have been introduced and mathematical procedures for calculating resistance/temperature equivalents have been revised so as to reduce the 'non-uniqueness' of the scale: that is, to reduce the differences which occur between different, identically calibrated PRTs. In particular, the calibration of a PRT can no longer be extrapolated beyond the freezing point of zinc, 419.527 °C, but requires a measurement at the freezing point of aluminium, 660.323 °C.
- Alternative definitions are permitted in certain sub-ranges, so that the calibration of a PRT can be terminated at almost any fixed point. This provision allows primary calibrations to be carried out with suitable PRTs over reduced ranges, and

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<sup>53</sup> Note that each of these fixed points has an uncertainty associated with it.

will be of special importance to metrology standards departments which need to make precise measurements at ambient temperatures.

- The part of the ITS-90 scale which may be measured by PRTs extends from 83.8058 K (-189.3442 °C) to 961.78 °C. The actual range of temperatures which may be measured depends on the type and range of the PRT used.

The ITS-90 scale requires the entry of 6 constants into the CTR5000 before the instrument can accurately convert resistance to temperature for a particular PRT.

The constants are conventionally called  $R_{0.01}$ ,  $A_p$ ,  $B_p$ ,  $C_p$ ,  $D_p$ ,  $A_n$ ,  $B_n$  and  $W$ .

## 17. Appendix 5 - DIN standard

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### 17.1 DIN 90 1980 (EN 60751)

The DIN90 standard uses defined values for the conversion of resistance to temperature using the Callendar van Dusen equation. No data entry for the probe is required since the coefficients are predefined. The DIN coefficients are defined as –

$$R_0 = 100 \text{ ohms}$$

$$A = 3.90823 \times 10^{-3}$$

$$B = -5.7750 \times 10^{-7}$$

$$C = -4.1830 \times 10^{-12}$$

The CTR5000 will provide accurate resistance to temperature conversion based on these values when DIN90 conversion is selected for a probe.

### 17.2 DIN 43760 1980 (IEC 751)

The DIN standard uses defined values for the conversion of resistance to temperature using the Callendar van Dusen equation. No data entry for the probe is required since the coefficients are predefined. The DIN coefficients are defined as –

$$R_0 = 100 \text{ ohms}$$

$$A = 3.90802 \times 10^{-3}$$

$$B = -5.8020 \times 10^{-7}$$

$$C = -4.2735 \times 10^{-12}$$

The CTR5000 will provide accurate resistance to temperature conversion based on these values when DIN68 conversion is selected for a probe.

## 18. Appendix 6– AC Bridge operation

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### 18.1 AC Bridge basics

The CTR5000 Bridge measures the voltage ( $V_t$ ) developed across the unknown sensor resistance ( $R_t$ ) and the voltage ( $V_s$ ) across a stable internal reference resistance ( $R_s$ ). The voltages are proportional to the resistances so the thermometer resistance is derived from –

$$R_t = R_s \times \frac{V_t}{V_s}$$

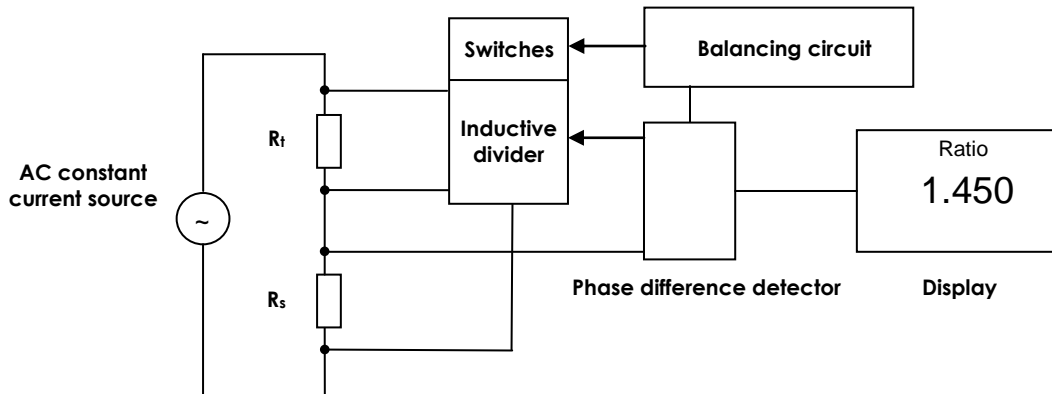
This technique achieves immunity from slow moving time and temperature drifts in the electronics as it is not affected by voltage measurement gain variations or current source fluctuations. In addition, the AC Bridge technique used achieves superior stability performance (over DC Bridges) by eliminating all other sources of thermally generated EMF's (voltages) and sources of drift

The internal reference resistor must have a known (calibrated) value for an accurate determination of the thermometer resistance  $R_t$ .

Although the principle of measuring the ratio of two resistors (see introduction) is identical between AC and DC bridges, the bridges operate very differently in the way they perform this ratio measurement.

DC bridges require very stable and accurate electronics to achieve their performance; AC bridges do not require such high-stability. Since they are based on an AC measurement, these bridges are also immune to all thermal problems associated with DC bridges.

The basic bridge arrangement is shown below –



The AC constant current source generates a sine-wave that supplies  $R_f$  and  $R_s$  in series - so both resistors see identical currents.

The inductive divider consists of numerous turns of wires round transformer cores. The turns are arranged so that they form a series of ratio dividers that can be individually switched in and out by the balancing circuit.

The bridge works by balancing the inductive dividers (using the phase difference detector) so that the ratio of currents in the two series resistors is precisely known and equal to their ratio. Since the balance point depends only on the ratio of the transformer turns to the unknown resistance, the measurement is precise and unaffected by drift.



## 19. Appendix 7– Report examples

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### 19.1 Channel report

**CTR5000**

Serial number,123/456789

Date,23/01/10,Time,13:22:31

\*

Channel,01,Type,Internal,A

Conversion,ITS90

Probe Undefined,Smart s/no,ABCD

Tmax,+851.0,Tmin,-201.0

Units,ohms

Ref R,100

Channel,02,Type,Internal,B

Conversion,DIN90

Probe Undefined,Passive probe,DIN90

Tmax,+851.0,Tmin,-201.0

Units,None Set

Ref R,100

Channel,03,Type,Internal,C

Conversion,DIN90

Probe Undefined,Passive probe,DIN90

Tmax,+851.0,Tmin,-201.0

Units,None Set

Ref R,100

Channel,16,Type,S252,16,Serial number,123/456789

Conversion,DIN90

Probe Undefined,Passive probe,DIN90

Tmax,+851.0,Tmin,-201.0

Units,None Set

Ref R,100

.  
.

**Report continues to end of connected channels**

19.2 Assigned probes report

CTR5000

Serial number,123/456789

Date,23/01/10,Time,13:34:10

\*

Probe no,41

Probe id,

Conversion,DIN90

Assigned to channel,03,Tmax,323.1,Tmin,-200.1,

Units,None Set,R0=+100.0000,A=+3.90830x10-03,B=-5.77500x10-07,C=-4.18300x10-12,

All other probes are unassigned

## 19.3 All probes report

CTR5000

Serial number,123/456789

Date,23/01/10,Time,13:35:40

\*

Probe no,01

Probe id,

Conversion,DIN90

Unassigned,Tmax,555.2,Tmin,-200.1

Units,None Set,R0=+100.0000,A=+3.90830x10-03,B=-5.77500x10-07,C=-4.18300x10-12,

Probe no,02

Probe id,

Conversion,DIN90

Unassigned,Tmax,555.2,Tmin,-200.1

Units,None Set,R0=+100.0000,A=+3.90830x10-03,B=-5.77500x10-07,C=-4.18300x10-12,

.

.

.

.

Probe no,41

Probe id,

Conversion,DIN90

Assigned to channel,03,Tmax,123.4,Tmin,-20.2,

Units,None Set,R0=+100.0000,A=+3.90830x10-03,B=-5.77500x10-07,C=-4.18300x10-12,

.

.

.

.

Probe no,72

Probe id,

Conversion,DIN90

Unassigned,Tmax,533.1,Tmin,-200.1

Units,None Set,R0=+100.0000,A=+3.90830x10-03,B=-5.77500x10-07,C=-4.18300x10-12,

All other probes are unassigned

19.4 Instrument report

CTR5000

Serial number,123/456789

Date,23/01/10,Time,13:39:45

\*

S/W version,V0.1

Date format,dd/mm/yy

100R reference,99.998

200R reference,199.992,400R reference,399.999

Channels available,A,B,C,D

S252's present,1

S252,1,S/W version,0.00,Channels,16-31,Serial number,123/45678,PCB,123/45678,Built, 23/01/10,Used,4

Interfaces

USB

RS232

### 19.5 Smart probe report

CTR5000

Serial number,123/456789

Date,23/01/10,Time,14:34:14

\*

Smart probe data for channel,01

Version,1

Locked,0

Serial no,ABCD

Cal date,01/01/10

Next cal date,01/01/11

Cal type,2,ITS90

Probe type,0,PRT

Wire type,0

Source,ASL-CTR5000

R\_max,-1

R\_min,0

R\_max since,-1

R\_min since,0

R\_max ever,-1

R\_min ever,0

Units,1,R

Reference R,0,100R

T conversion,0,DIN90

R0.01,+100.0000

Ap,3.90830e-03

Bp,-5.77500e-07

Cp,-4.18300e-12

Dp,0.00000e+00

An,0.00000e+00

Bn,0.00000e+00

WT90,0.00000e+00

Cal log count,00

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## Appendix 8 – CTR5000 0.01 K PC commands


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### 19.6 CTR5000 0.01 K PC commands

The following sections cover use of PC commands. These may be sent to the instrument via a simple terminal program<sup>54</sup>, through some programming interface, from Excel™ (or similar program) or interactively with a dedicated program (such as ULOG – supplied by ASL).

The PC symbol  will be briefly displayed when a command is received.

#### 19.6.1 CTR5000 0.01 K Remote mode (local lockout)

The instrument may be set into Remote mode to prevent problems with simultaneous control from a PC and from someone using the front panel keys. In Remote mode, the instrument can only be controlled over the interface since the CTR5000's front panel keys are locked out. To enable Remote mode, the instrument must be sent a Local lockout command. The PC symbol  will be permanently displayed in remote mode. Remote mode is cleared when the instrument is switched on.

It is not necessary to be in remote mode to use any of the PC commands, but care must be taken not to inadvertently change settings.

#### 19.6.2 CTR5000 0.01 K Commands and Syntax

The following commands can be sent to the instrument - all commands are composed of single letters, followed by none, one or two single digit parameters or letters (except the switchbox commands, which have 2 alphabetical characters followed by 2 digits).

Commands are terminated by a carriage return character <CR> and/or a line feed <LF> character.

Response data are always terminated by a carriage return and line feed character <CR><LF>.

The instrument responds to all illegal or unrecognized commands with error 5.

A PC icon will flash briefly on the CTR5000 display when data are received. The icon will be continuously present when the instrument is in remote mode.

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<sup>54</sup> A number of these are available free on the Web.

For ease of use, new commands, new details and additional information, not present with the F250, are coloured blue.

A full list of commands follow –



## 19.6.3 A command

**Function:** Requests the instrument to return the PRT reading (temperature or resistance) and display units every time the display is updated. Any valid channel may be selected (see below), and units may be C, F, K or W (when units are set to W (ohms), data readings are returned followed by the letter R).

**Examples:** "A 100.000C", "B 273.150K", "D 20.1501R" (quotes and comma are for clarity only)

**Note:** The returned data is 10 characters long +CR+LF. Leading spaces are inserted before the value, when necessary - i.e. " 1.233C", not "00001.233C". The first character after the channel character is either a space or a minus sign, or a numerical digit (when over 1000 °).

Channels prefixes are return as A, B, C, D, E, F H (channel 8), I, J, K, L or M (channel 13). Switchbox channels are return as two numerical digits - i.e. 16, 17, etc followed by a S. Therefore, the string length is increased by two characters for a switchbox channel.

The returned channel is variable in A B mode.

The command is cancelled when the instrument is changed to logging mode.

**Syntax:** An, where n = 0 to 8 or Ann (see below)

**Parameters An:**

n = 0 selects PRT A

n = 1 selects PRT B

n = 2 selects PRT A - B (differential)

n = 3 selects alternate mode (A then B)

n = 4 cancels continuous output

n = 5 selects PRT C

n = 6 selects PRT D

n = 7 selects PRT E

n = 8 selects PRT F

**Initial State:** n = 4

**Parameters Ann:**

nn = any valid channel (new numbering)

**nn = 00 cancels continuous output**

**Initial State:** n = 4

#### 19.6.4 C command (CTR5000 0.01 K only)

**Function:** Clear – immediately resets the instrument to the home state.

**Syntax:** C

**Parameters:** None

**Initial State:** Not applicable

**Note:** this command does not require the LF (line feed) delimiter and must be upper case (i.e. lower case c is ignored).

#### 19.6.5 E command

**Function:** Echo input text – useful when developing communications.

**Syntax:** En

**Parameters:** n = 1 turns echo ON  
n = any other character, turns echo OFF

**Initial State:** Echo OFF

**Note:** the instrument responds to this command with “echo on” or “echo off”

#### 19.6.6 ! command

**Function:** Returns error 15 – useful when developing communications.

**Syntax:** !

**Parameters:** None

#### 19.6.7 \*I command

**Function:** Returns information string about the instrument:  
Manufacturer, Model, serial number, firmware version, date

**Syntax:** \*I

**Parameters:** None

**Example:** Returns, e.g. ASL,CTR5000,1234567/89,V1.0,22/01/10

#### 19.6.8 F command

**Function:** The analogue output is not implemented on the CTR5000.

**Note:** Always returns Error 5

### 19.6.9 *H command*

- Function:** Holds the current reading, or clears the hold command if already set.
- Syntax:** H
- Parameters:** None
- Initial State:** OFF
- Note:** Commands requesting a result or channel change will turn hold off

### 19.6.10 *Hn command*

- Function:** Holds the current reading, or clears the hold command according to the parameter following the H
- Syntax:** H1 or H0
- Parameters:** 1 or 0 (H1 = ON; H0 = OFF)
- Initial State:** OFF
- Note:** Commands requesting a result or channel change will turn hold off

### 19.6.11 *I command*

- Function:** Set the Probe Id string
- Syntax:** Ims--s, where  $m \geq 1$  and  $m \leq 72$  (probe number)
- Parameters:** Sets the Probe Id to s--s (10 characters maximum)
- Note:** If the first character of the string is numeric, then the probe number must be two digits long (e.g. for Probe 2, use I02s-s)

### 19.6.12 *L command*

- Function:** Local lockout - enables or disables the instrument front panel controls.
- Syntax:** Ln, where  $n = 0$  or  $1$
- Parameters:**  $n = 0$  enables front panel (lockout OFF)  
 $n = 1$  disables front panel (lockout ON)
- Initial State:**  $n = 0$ , lockout off

**Note**

To maintain F250 compatibility, global units are applied when lockout is ON (and Smart probes are also disabled).

19.6.13 *M* command

**Function:** Requests the instrument to return the PRT reading (temperature or resistance) and display units every time the display is updated.

**Examples:** "A 100.00C", "A273.150K02", "B100.1234R", "D120.1501R04".

**Note:** Similar to the A command (see A command for further details). The arguments and return values are slightly different, however.

**Syntax** Ma, where a = @, A,B,C,D,I,J,K or L, or  
Mab, where a and b specify a switchbox channel number

**Parameters** a = @ cancels continuous output  
a = A sets PRT to A and sends data when reading available.  
a = B sets PRT to B and sends data when reading available.  
a = C sets PRT to A-B and sends data when reading available.  
a = D sets PRT alternately to A then B and sends data when reading available.  
a = I sets PRT to A and sends data with channel number when reading available.,  
a = J sets PRT to B and sends data with channel number when reading available.  
a = K sets PRT to A-B and sends data with channel number when reading available.  
a = L sets PRT alternately to A then B and sends data with channel number when reading available.  
ab = 16 to 80, sets PRT to a switchbox channel number (if fitted). The CTR5000 channel number is always appended when this command is used (no leading channel character). Note that 2 digits are required – i.e. a leading 0 is required when the channel number is less than 10. Preceding channel data is not supplied.

**Initial State:** a = @

**Note:** see also command A above

#### 19.6.14 N command

**Function:** Set Smart probe serial numbers

**Syntax:** Nms--s, where m = S or m = O

**Parameters:** m = S sets the Smart probe serial number to s--s (19 chars maximum)  
m = O sets the Smart probe source to s--s (17 chars maximum)

#### 19.6.15 P command

**Function:** Set PRT input for display

**Syntax:** Pn, where n = 0 to 8, A or B

**Parameters:** n = 0 selects the A PRT input for display  
n = 1 selects the B PRT input for display  
n = 2 selects A - B (differential) for display  
n = 3 selects C PRT input for display  
n = 4 selects D PRT input for display  
n = 5 selects E PRT input for display  
n = 6 selects F PRT input for display  
n = 8 also selects A - B (differential) for display  
n = 9 selects B - A (differential) for display  
n = A selects A B mode for display  
n = B selects A/B mode for display  
n = xx, where xx = 16 upwards (switchbox channels) selects channel xx

**Initial State:** Current channel

**Note:** Error 14 will be returned if the channel is not available

Error 5 will be returned if the channel is not recognised

#### 19.6.16 Q or ? command

**Function:** Query, the instrument will return the status of the function

**Syntax:** ?a or Qa, where a is P, R, U, Z or \_

**Parameters:** a = F queries analogue setting – always returns F0 (for F250 compatibility)  
a = H queries the hold function - (0 = no zero set, 1 = zero set)  
a = L queries the remote status - (0 = OFF, 1 = ON)

**a = M** returns last command

**a = P** queries the PRT setting – returns the current channel (n) (see P command)

**a = R** queries the resolution - return setting 0 or 1 (see R command for parameters)

**a = U** queries the units - return setting 0, 1, 2 or 3 (see U command for parameters)

**a = Z** queries the zero function - (0 = no zero set, 1 = zero set)

**a = \_** queries all settings - returns reading + all settings. (26 characters +CR+LF normally, 27 characters +CR+LF in high res. with units set to Ohms).

**Example:** A 24.998RF0H0L0M@P0R1U3Z0

**Initial State:** Not applicable

### 19.6.17 R command

**Function:** Sets the instrument resolution

**Syntax:** Rn, where n = 0, 1, 2 or 3

**Parameters:** n = 0 selects 2 decimal places (3 decimal places for ohms)

n = 1 selects 3 decimal places (4 decimal places for ohms)

n = 2 selects 1 decimal places (2 decimal places for ohms)

n = 3 selects 0 decimal places (1 decimal places for ohms)

n = 4 selects 0 decimal places for ohms

**Initial State:** Current resolution

### 19.6.18 S command

**Function:** Remote control of the CTS5000-8, CTS5000 -16 switchboxes (if connected)

**Syntax:** Smn, where m = A or B (C or D) and n is a number 00 to 15.

**Parameters:** m = A, B, C or D (must be present). A selects the first switchbox, B selects the 2<sup>nd</sup>, C the 3<sup>rd</sup> and D the 4<sup>th</sup>. n = the number of the channel on the selected switchbox.

**Initial State:** No switchbox channel selected.

**Note:** 4 characters must be sent to form a valid command, for example SA02, SB13, SC03. Error 14 is returned if the channel is not available.



### 19.6.19 T or D command

- Function:** Asks the instrument to send the current channel's PRT reading and selected units.
- Examples:** "A 0.003C", or "B 75.149K".
- Note:** See note for A command
- Syntax:** T or D
- Parameters:** None
- Initial State:** Not applicable

### 19.6.20 U command

- Function:** Sets the units to °C, °F, K or W (ohms)
- Syntax:** Un, where n = 0, 1, 2 or 3
- Parameters:** n = 0 selects °C  
n = 1 selects K  
n = 2 selects °F  
n = 3 selects W (ohms)
- Initial State:** Current units
- Note:** when units are set to W (ohms), data readings are returned followed by the letter "R".
- Note:** E5 is returned when A/B or A B modes are selected

### 19.6.21 Z command

- Function:** Sets present reading to zero, or clears zero setting if already set
- Syntax:** Z
- Parameters:** None
- Initial State:** OFF

### 19.6.22 Zn command

- Function:** Sets the current reading to zero or returns to normal operation.
- Syntax:** Z1 or Z0
- Parameters:** 1 or 0 (Z1 = ON; H0 = OFF)
- Initial State:** OFF



**Note**

**Commands (when valid) that disable Hold are P, A, M, T, D and U.**

### 19.6.23 CTR5000 0.01 K Error codes

**These are the same as the CTR5000 (see section 9).**

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## 20. Specifications

### 20.1 Resistance thermometer measurement<sup>55</sup>

PRT characterisation	ITS90, Din90 BS EN60751:1996, IEC60751:1983 CvD BSEN1904:1984, IEC751:1983
Resistance measurement range	0 to 500 $\Omega$ (125 $\Omega$ with 25 ohm reference)
Temperature measurement range	ITS90 -201 to +962°C Din90 -201 to +858°C CvD -150 to +850°C
Measurement interval	0.5 seconds
Display resolution	1 mK (0.1 m $\Omega$ when in resistance mode)
Accuracy (resistance)	$\pm 2\text{m}\Omega$ (+20°C $\pm 5^\circ\text{C}$ )
Accuracy (temperature)	$\pm 5\text{mK}$ (+20°C $\pm 5^\circ\text{C}$ )
User selectable measurement display	°C, °F, K or ohms
PRT current	1 mA constant current (100 ohm reference) 2 mA constant current (25 ohm reference)
Internal reference resistors	25 $\Omega$ and 100 $\Omega$
Internal reference resistors stability (typically)	$\pm 0.1$ ppm/°C
Internal reference resistors accuracy (typically)	$\pm 0.01\%$ (uncalibrated)
Input channels	2, (4 or 6 optionally)
Input connection	5 pin DIN
Expansion port (optional)	CTS5000-8, S500-16 (4 maximum)
Internal log	8000 points (non-volatile)
External logging	65000 points to external interface
Log interval	1 sec to 99 secs or 1 minute to 99 minutes

<sup>55</sup> Measurements do not include uncertainties to the sensor. A warm-up time of 20 minutes is required to meet specification

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## 20.2 Display

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Liquid Crystal Display (LCD)	160 x 80 (adjustable contrast)
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## 20.3 Power supply

Mains charger supply voltage range	90Vac – 264Vac
Power consumption	25VA max
Supply frequency range	47Hz - 63Hz
Fuse	T1A 250 Vac (anti surge)

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## 20.4 Environmental

Storage temperature range	-20°C to +50°C
Service temperature range	+15°C to +35°C
Specified operating temperature range	+15°C to +25°C
Operating relative humidity conditions	<80% RH, non-condensing

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## 20.5 Dimensions and weight

Dimensions	80 x 260 x 240 (h x w x d)
Weight	2.6 kg

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## 20.6 Approvals

The CTR5000 has been designed to comply with current standards and safety legislation. The instrument complies with IEC61010-1 and conforms to the low-voltage and EMC directives.

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