F600 Precision DC Thermometry Bridge

User Manual – Issue 2.0

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This manual supersedes all previous versions – please keep for future reference

Revision history: Original version 23rd March 2007 Issue 1	
Previous releases: (Provisional copy only for internal review)	
Issue and date	**Description of change**
Issue 1.1 8th May 2007	Fuse rating changed from 2A to 3A. USB and PC command information added. Analogue output information added. Minor typographical changes.
Issue 2.0 6th June 2007	Added information on modified editing keys. Minor typographical changes. Revised channel menu and shift keys described.

Contents

Conventions used in this manual

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 F600DC Precision Bridge, precision bridge, bridge, F600, F600DC and instrument are used interchangeably in this manual.

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 F600DC is a precision DC bridge. 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.

- × Do NOT clean the instrument with solvents
- × Do NOT insert objects into openings
- × Do NOT place the instrument onto a hot or cold surface
- × Do NOT place any weight on top of the instrument

- ✓ Do use the correct USB lead supplied

Warning

The outer conductor of the BNC connectors and the cable braid are not at earth potential and should not be earthed.

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 Li clock battery must be disposed of in accordance with local regulations.

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

- ✓ 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 probes used with the instrument. The following safety information must be observed.

- × Do NOT attempt to lift the F600 by any of the leads
- ✓ Do ensure that long probe-leads are kept away from areas where people could trip over them or become tangled in them
- ✓ Do ensure the probe-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.

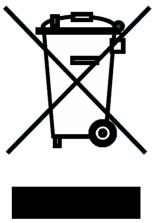
Warning

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.

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.

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1.0 Introduction

1.1 Overview

The F600 Precision Thermometry Bridge is a high precision instrument designed for laboratory, commercial and industrial temperature measurement and calibration applications.

The F600 operates with all 4-wire Platinum Resistance Thermometers (PRTs) and with virtually all thermistors.

Features include –

- Internal or external reference resistors
- A large graphic VFD display for excellent viewing of measurement values and instrument settings
- USB communication interface as standard for automated monitoring and calibration applications
- Calibration against traceable external standards
- User selectable units –- ratio, resistance or temperature display (Ω, °C, °F or K)
- Wide operational range to include all 4-wire thermometers with R_0 values from 0.25 ohms to 1000 ohms
- Rack-mount option
- Expandable to allow multi-channel input multiplexing
- Up to 99 probe calibration configurations
- Up to 99 channels (instrument setup configuration)

Overall system accuracy depends on the reference resistor quality and calibration - see the specification section. Resistance ratio measurement accuracy is better than ±3ppm (at 20°C ±2°C), equivalent to a temperature measurement precision of ±1mK.

1.2 Definitions and terminology

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 α) 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 Ω resistance at 0 °C)

RTD (Resistance Temperature Device)

vii. Abbreviations for thermistor thermometers include -

therm

viii. System accuracy refers to the overall, combined accuracy of the F600 and thermometer.

1.3 Principles of measurement

The F600 measures the voltage (V_t) developed across the unknown sensor resistance (R_t) and the voltage (V_s) across a stable internal (or external) 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.

The reference resistor may be either one of the internal resistors (fitted as standard) or a reference resistor connected to the external R_s ports. Either way, the resistor must have a known (calibrated) value for an accurate determination of the thermometer resistance R_t.

In the same way that AC resistance measurement eliminates thermal EMF's, switched DC achieves a similar advantage. Switched DC works by reversing the current flow on alternate measurement cycles and taking the average value, thereby cancelling any thermal EMF offsets from the final result.

When using PRTs, the relationship between resistance and temperature varies slightly from one PRT to another. Therefore, no matter how accurately the F600 measures the PRT

resistance, if the relationship between resistance and temperature for a particular PRT is not known, accurate temperature measurement is not possible. For thermistors, the relationship depends totally on the thermistor type and specifications.

The F600 uses PRT and thermistor calibration data to overcome this problem and calculates the temperature from conversion functions using calibration data stored in the F600's internal non-volatile memory. This method enables the F600 to convert ratio to temperature, uniquely for each sensor used. Applications requiring multiple thermometers may store up to 99 sets of calibration data in the instrument.

It is very important, therefore, that a sensor is used on a properly configured input channel and that the probes' coefficients are correctly entered into the instrument.

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 resistance to reference resistance ratio and the calibration uncertainty placed on reference resistors, PRTs (or thermistors) by the calibrating laboratory.

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2. Setting up the F600

2.1 Safety information

Please read the safety information section before attempting to operate the F600.

2.2 Unpacking the instrument

When you unpack the F600 bridge, check that the following items are present before using the instrument[1] –

- F600 precision thermometry bridge
- Operator's handbook on CD
- Test certificate
- Mains lead
- USB lead

Please contact the ASL Technical Services Group 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.

2.3 Setting up temperature measurement

To enable accurate resistance to temperature conversion to be carried out by the instrument, PRT characterisation data is required for both –

- temperature conversion algorithm (DIN, CvD or ITS90), and
- temperature conversion algorithm coefficients

For Thermistors, (Steinhart & Hart) characterisation data is only required for –

- temperature conversion algorithm coefficients

[1] Thermometer probes and other accessories (if ordered) will be supplied separately.

The probe conversion algorithm and its coefficients can be stored in the instrument's internal non-volatile memory. Each probe setting stores one set of PRT/Thermistor characterisation data; up to 99 settings can be stored.

Up to 99 channels can be stored for the instrument. Each channel contains a complete set of instrument set-up conditions; this saves the user from resetting the instrumental conditions every time a different set of operating conditions is required.

Set-up for the probe channels and calibration data is covered later in the manual.

2.4 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 is cold)
- Connect a 100 ohm resistor (any type will do) to the Rt terminals as described in section 4
- Switch on, and start measuring the ratio without changing any of the settings[2]
- Change one setting at a time to familiarise yourself with each of the menus. Start with the alternative display functions described in section 5.1
- Next use the **Units** menu - and try changing to °C, K and ohms
- Follow this by systematically changing the other instrument settings. Remember to reset each change until you are familiar with the F600

[2] As supplied, the F600 will be set for this measurement using the internal 100 ohm reference resistor.

3. About the F600DC Precision Bridge

This section introduces the features and functions of the F600DC Precision Thermometry Bridge. Each of the F600 Bridge's features is explained in turn. Once the F600 has been set to your particular requirements, all the commonly used functions are available using single key-strokes.

3.1 The front panel

The front panel is shown below (figure 3.1) with the various controls and connections -

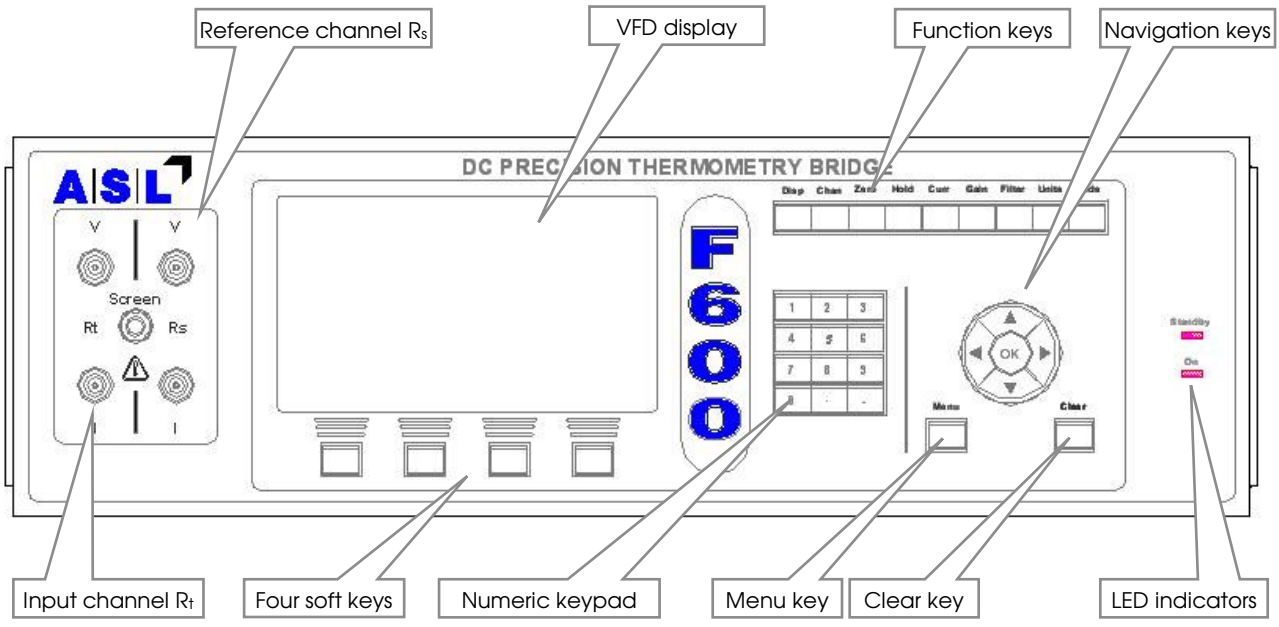

Figure 3.1- front panel

The graphical display is situated roughly in the centre off the instrument. The electrical input connections are situated to the left of the front panel. The two indicator LEDs to the right are used to indicate that electrical power is applied and to indicate that the bridge is in standby mode (graphical display in low power mode).

The various controls, connectors, displays and keys are described in detail in each of the following sections. The four keys under the display are 'soft-keys' so their function varies with the instrument operating mode (whenever these keys can be used, their current function is be displayed above each key).

3.2 About the VFD display screen

The large graphic VFD (Vacuum Fluorescent Display) screen is your direct link to the instrument, presenting you with the measurement results (and information relating to them) and also to the menus to set and control the instrument.

The VFD screen is designed for ant-reflective-viewing under normal ambient lighting. The VFD brightness may be set from the menu options (see section 5.3.7).

3.3 LED indicators

Two LEDs are situated to the right-hand side of the instrument.

3.3.1 Power LED

The lower (green) LED is illuminated when power is applied to the bridge and the bridge is switched on. The bridge should be switched off if it is not to be used for a long period of time.

3.3.2 Standby LED

The upper (orange) LED is lit whenever the bridge is in standby mode. In this mode, the VFD display is turned off, saving power and prolonging the display's life; the remainder of the electronics is powered normally during standby to ensure the instrument is stable and ready to use at a moments notice. See the section on the **Disp** function key for further details.

3.4 The keypad

The instrument's keys are grouped by type and consist of nine **Function** keys, a twelve key **Numerical** keypad, a **Navigation** and **OK** cluster of keys, four **Soft-keys**, and separate **Menu** and **Clear** keys. The combination of **Function** and **Soft-keys** lets you choose how to access data and/or functions within the instrument.

The F600 keypad is shown in figure 3.1 and in more detail in figure 3.3. The keys are used to select the various menu options and to control the instrument. Generally, no more than one menu level is required for the commonly used settings. A few (infrequently used options) require two or three menu levels. Operation is very simple and straightforward once you are familiar with instrument. Alternative shift key operation, which may be preferred, is available via the **Presets Menu** (see section 5.3.12).

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.

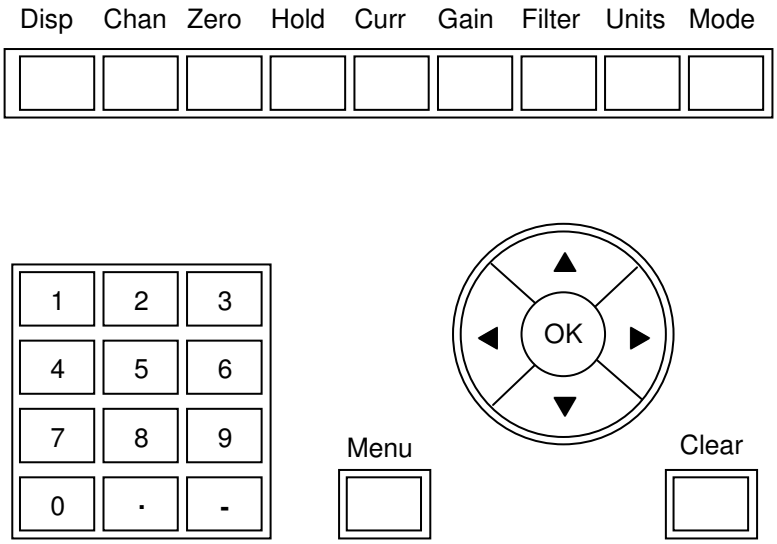

Figure 3.3- keypad detail

The keypad is used to select the various menu options and to set the operating modes. The commonly used keys are collected together in the top row. The numeric keypad used to enter numerical values (and may also be used to select sub-menu options when these are shown on the screen). The Menu key is used to select the remainder of the less frequently used options. The circular buttons are used to navigate through the menus.

A summary of the keys and their function is shown on the next page in table 3.1.

Instrument functions keys		
Key symbol	**Description**	**Function**
Disp	Select display type	Alternates numerical display and graphical display
Chan	Select Input Channel	Opens and closes the R_t /R_s channel select menu
Zero	Zero display measurement	Opens and closes the display zero (null) menu
Hold	Hold display measurement	Starts and stops display (measurement continues)
Curr	Select operating current	Opens and closes the sensor-current menu
Gain	Select instrument gain	Opens and closes the instrument-gain menu
Filter	Select filter value	Opens and closes measurement-bandwidth menu
Units	Select display units	Opens and closes the display-units menu
Mode	Select operation mode	Opens and closes operational-mode menu[3]

Menu function keys		
Key symbol	**Description**	**Function**
Clear	Clear data entry	Clears any data entry errors or returns from a menu
Menu	Menu selection	Displays other sub-menus
▲ ▼ ◄ ►	Arrow keys	Used to navigate through the menus
OK	Save entry	Saves data entry and returns to previous menu

Numeric keypad		
Key symbol	**Description**	**Function**
0 to 9	Numerical data entry	Enters a numerical digit or selects a numeric menu
-	Minus key	Used during numerical data entry
.	Decimal point	Used during numerical data entry

Table 3.1 - summary of front panel key functions

[3] Acts as the shift key when the alternative function menu is selected

3.5 Input connectors

The BNC input connectors are located to the left of the display. The central connector is used when a screen connection is required. The two right-hand connections are only used when an external reference resistor is selected; they are not required when one of the internal reference resistors is used. The unknown resistance or probe is connected to the left-hand BNCs. Connections are described in detail in section 4.

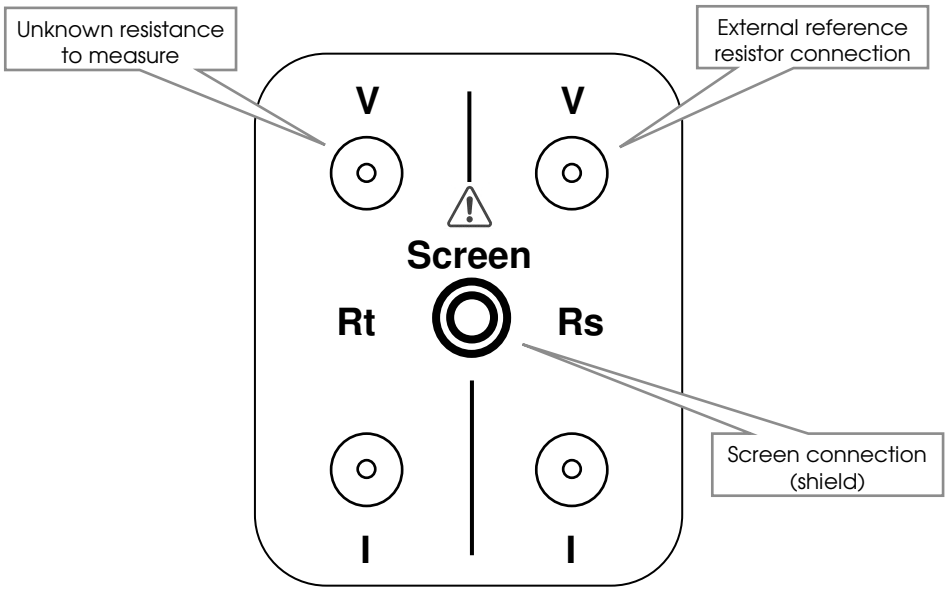

Figure 3.4- input connections

The inputs accept Passive probes. Passive probes do not contain calibration information and the F600 must be set-up with calibration information for each probe used (unless the calibration calculations are done externally). Up to 99 sets of probe information can be stored simultaneously in the F600 Bridge.

3.6 Rear panel

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

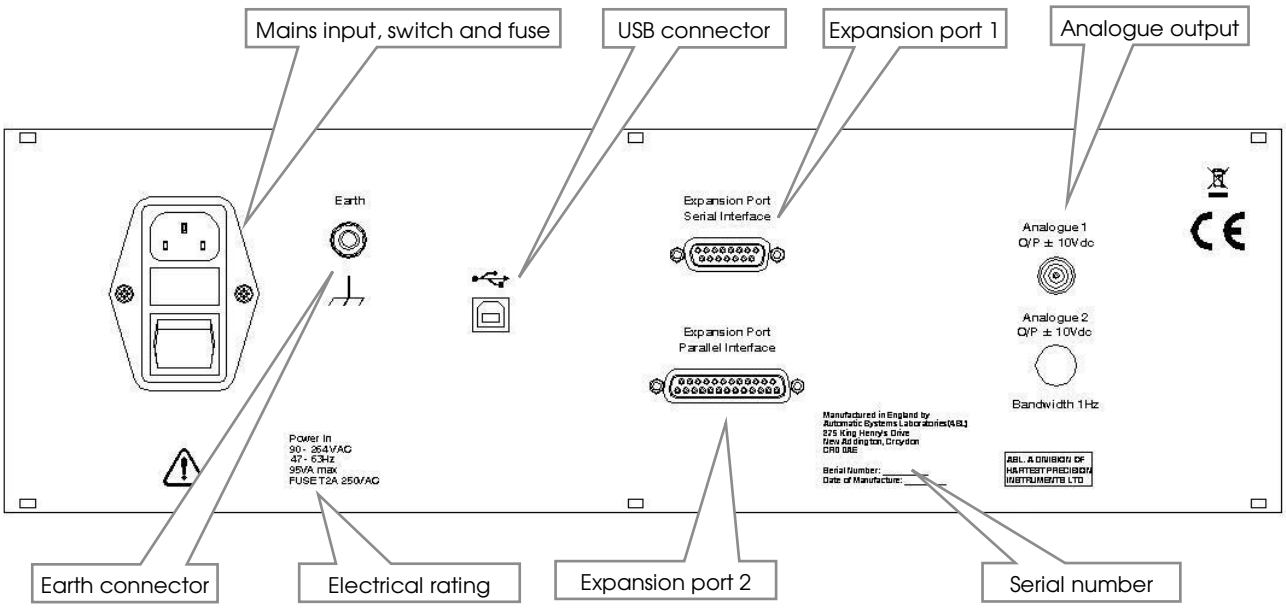

Figure 3.4 - rear panel

3.6.1 Name plate and serial number

The instrument's serial number is positioned here.

3.6.2 Electrical rating plate

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

3.6.3 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. The fuse(s) are located within the body of the connector.

3.6.4 Expansion ports

There are two expansion port connectors provided on the rear panel. These connectors enable a multiplexer (purchased separately) to be used to expand the number of input connections.

3.6.5 Analogue output

The analogue output (Output 1) provides a scaled measurement[4] voltage (±10V) that may be used with a chart recorder. The output can be scaled and offset to provide a voltage proportional to the current reading over the range of interest.

3.6.6 USB Communication interface connector

The USB connector is fitted as standard (see figure 3.4). Communication requires the installation of the USB driver on a PC. See the separate information supplied on the CD. A standard USB cable is supplied with the instrument.

The instrument can be controlled through simple ASCII commands (see later section) and can transmit ASCII result-data, which may be recorded using a simple terminal program.

3.6.7 Earth connector

The earth connector on the rear of instrument is joined to the instrument's chassis and may be conveniently used to connect to other equipment (particularly if the instrument is rack-mounted).

[4] Units are selectable

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4. Sensor and reference resistor connections

The F600 Bridge is designed to operate with four terminal resistors or four terminal resistance thermometers and includes comprehensive guarding circuits.

Probe connection information for both PRTs and thermistors is shown below. Two wire PRTs or thermistors must be connected similarly to four-wire devices either at the sensor (preferred for accuracy) or at the input connector.

Since the measurement method relies on accurately measuring the ratio of two resistors, and since the bridge is limited to a 5:1 ratio, the measured resistor must not be greater than 5 times the value of the reference resistor.

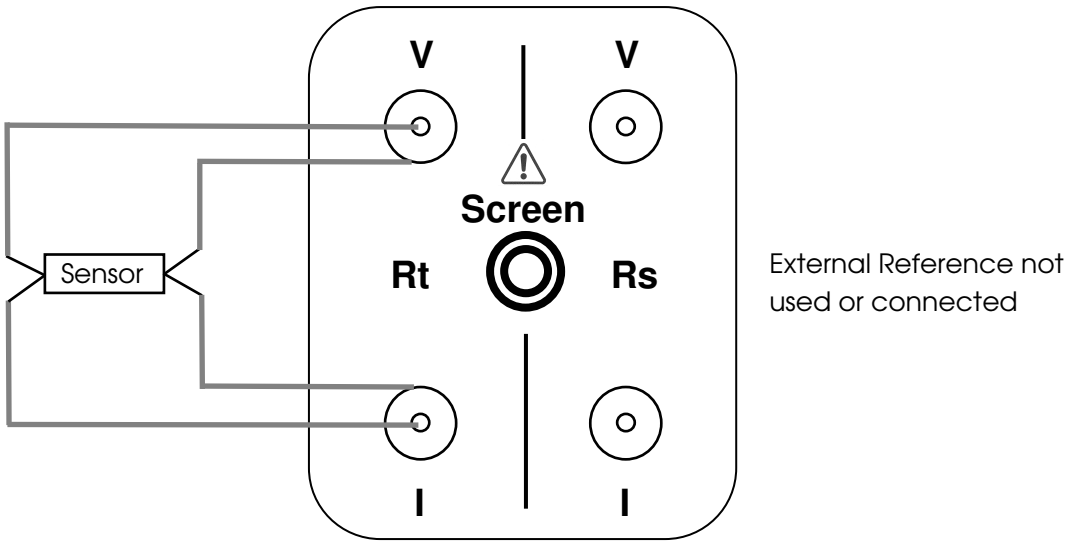


Figure 4.1 - connections when using an internal reference resistor

The screen connection may be used when noise is an issue. In this case, both connections to the BNC must be screened (together) and this outer-screen is connected to the **Screen** connection.

Note
The outer conductor of the BNC connectors is not at earth potential and should not be earthed.

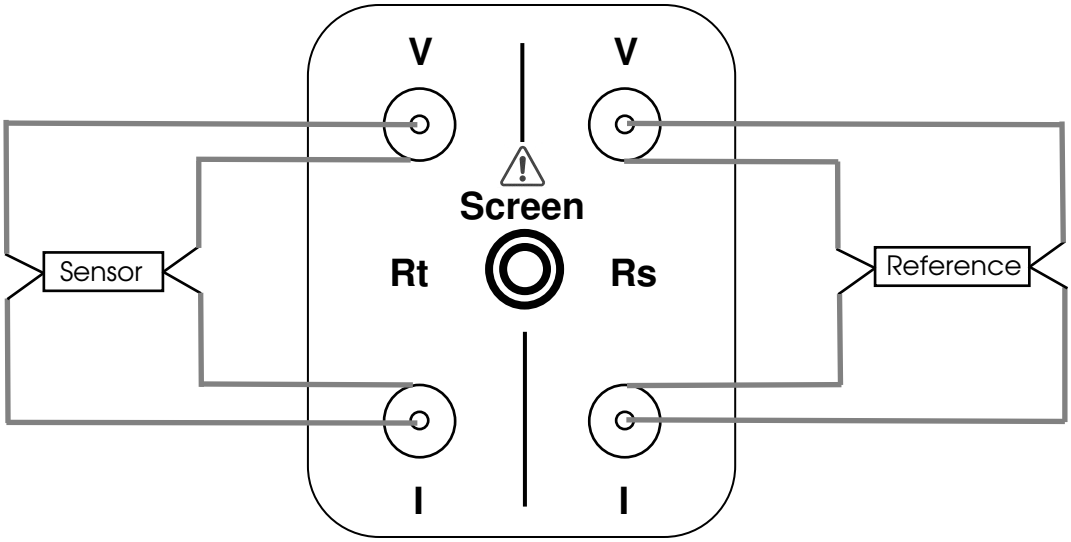


Figure 4.2 - connections when using an external reference resistor

4.1.1 Connection and guarding

Two coaxial BNCs are provided for connections to each resistor. The normal four terminal connection arrangement is shown in Figure 4.2. The lower coaxial connector of the R_t and R_S connector pairs is the current drive and should be connected to the resistors as shown. A single braided, outer conductor is driven from a low impedance source and effectively screens the returning current on the inner coaxial conductor.

The upper coaxial connectors in Figure 4.2 are the voltage sense lines and should be connected to the resistors as shown. The inner conductor is connected to the 'low' point and the outer to the 'high' point of the resistor, i.e. the screen connects to the voltage terminal on the same side of the four terminal resistor as the screen of the current drive cable. This point is the driven, 'high' point of the resistor. The inner conductor is connected to the 'low' point of the resistor and is at the same end as the inner conductor from the current drive cable. In this way, the outer cable screens are driven and provide screening for the low side of the resistor and cable inner conductors.

Additional guarding is provided by the guard circuit. This drives the "tail" of the bridge so that the common point of R_S and R_t is held at virtual ground potential. This common point is the low point of each resistor. Hence the high points are at opposite ends of the bridge and are each driven, but with opposite polarity. Although the low point of the resistors are held near earth potential by the guard amplifier, this is not a true earth and electrical connection other

than the two bridge cables should be avoided. Where connections cannot be made directly to the resistor assemblies it is recommended that the join between the resistor leads and the coaxial cables is made with the FA-3 adaptor box. Flying leads from the resistor assemblies should be twisted in two pairs, the current **I** leads together and the voltage **V** leads together.

4.1.2 Two terminal resistors

Two terminal resistors can be used with the Model F600 Bridge. Two terminal resistors must be converted to four terminal devices to take full advantage of the instrument's performance. The connector leads should be soldered on to each lead of the two terminal resistor[5], as shown in Figure 4.3. Standard coaxial cables should be used for connection to the F600 Bridge. In the case of a two terminal thermometer the FA-3 adaptor box should be used. The thermometer leads should be connected so as to link the two high terminals together and likewise for the two low terminals.

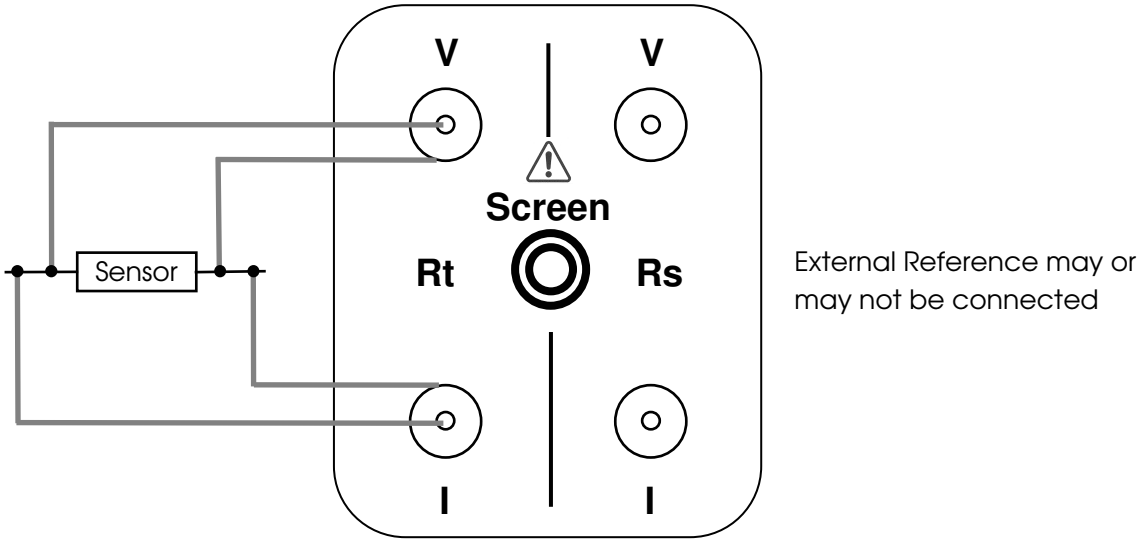


Figure 4.3 - modification for a two terminal resistor

4.1.3 Resistor current selection

The normal resistor current setting is 1mA; higher and lower settings can be used. To maintain the bridge within operating limits the IR voltage drop on the standard resistor should not

[5] Note that the voltage sense connections should be soldered nearer to the resistor (or sensor) body than the current drive connections.

exceed about ±0.4 volts (on minimum gain setting). This limits the R_S resistor to about 400 ohms when using the 1mA current setting so that the √2 multiplier is still effective. High value resistors must be operated with a lower current setting. The R_f resistor value is limited to about 5 times the R_S resistor value.

Conversely, low value resistors (below 10 ohms) may develop too small a voltage to give an adequate signal to noise ratio and a higher current settings may be required. Inevitably, for a given resistor, higher currents lead to higher self heating effects. The √2 current multiplier will cause a doubling of the power developed across each resistor and can be used with the other current settings to estimate the effect of self heating on the sensor or resistor being measured.

5. Operating the F600

5.1 Instrument operating modes

The instrument has two operating modes -

- **Measurement Mode** which displays the measurement and the instrument status
- **Menu Mode** which allows selection of operating conditions and its settings[6]

5.1.1 Measurement mode (normal)

In Measurement Mode, the screen displays the current reading (and its units - ratio, resistance or temperature), reference resistor (value and type) the current channel and probe selected and the instrument's gain; statistics and the time of day are also shown. This is the normal operating display for the F600. The display will look similar to the one shown below[7] –

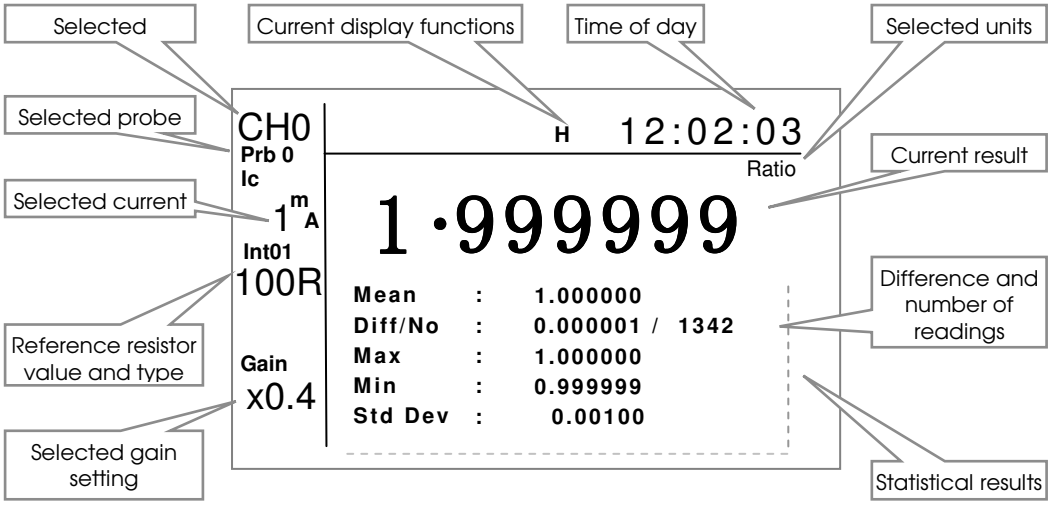


Figure 4.1 – F600 display screen

The currently selected channel and probe (here 0 is the default for both) are always shown at the top left of the display.

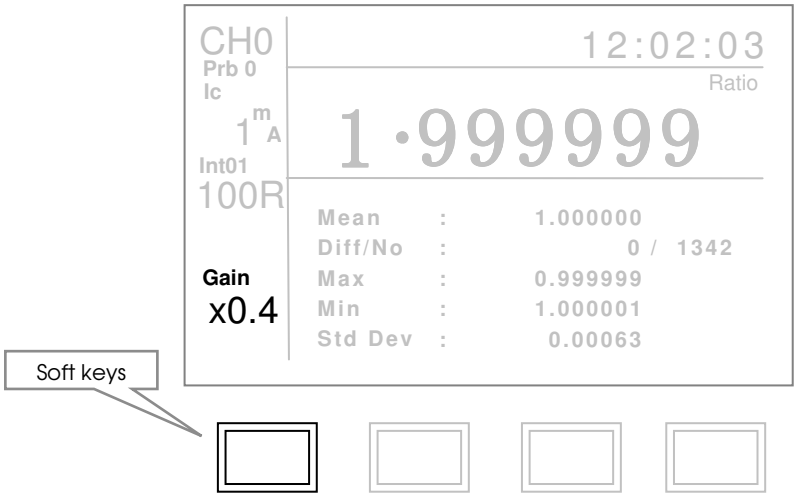
[6] However, measurements are still displayed in menu mode whenever possible.

[7] The display may be toggled between this view and a graphical display using the **Disp** key.

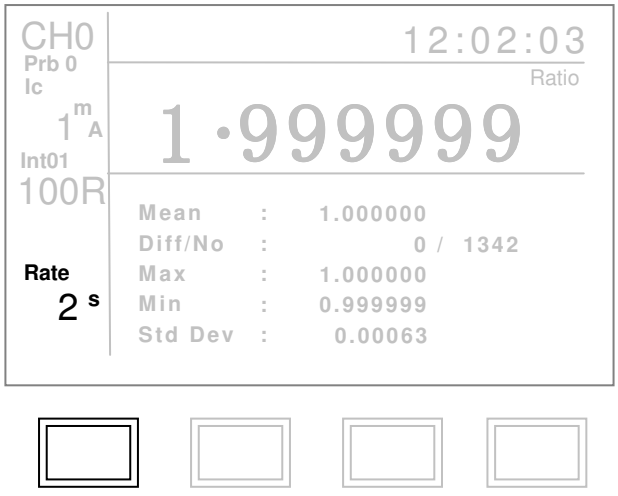
This display always reflects the operation of the instrument, showing the current reading and settings. Readings are updated at the selected conversion rate of once every second to once every 20 seconds[8].

5.1.2 Measurement mode (alternative display)

There are four **soft-keys** are under the display. The action of these keys is context sensitive – their action generally depends on the text above them on the screen. Two of these keys (left-hand side) are active when the display is in normal measurement mode.

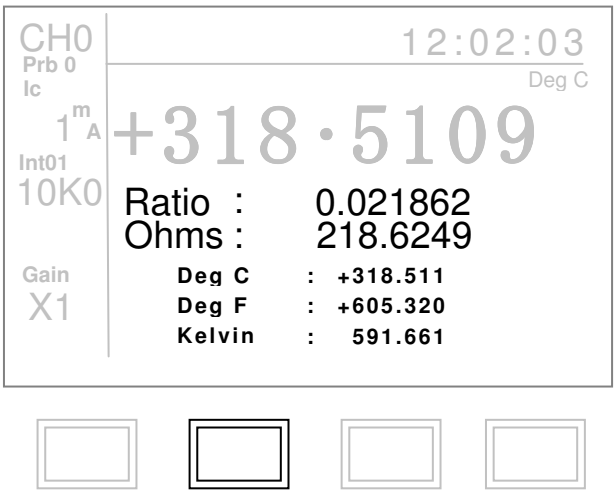


The far left soft-key toggles the screen between Gain and Filter display (see above and below).



[8] Depends on the filter value selected.

The other active soft-key (second to left in normal measurement mode) toggles between normal measurement mode and the screen showing multiple-unit conversions (see below).



5.1.3 Measurement mode (graphical - Disp function key)

Press the **Disp** key to change the display from normal measurement mode to graphical display mode (shown below).

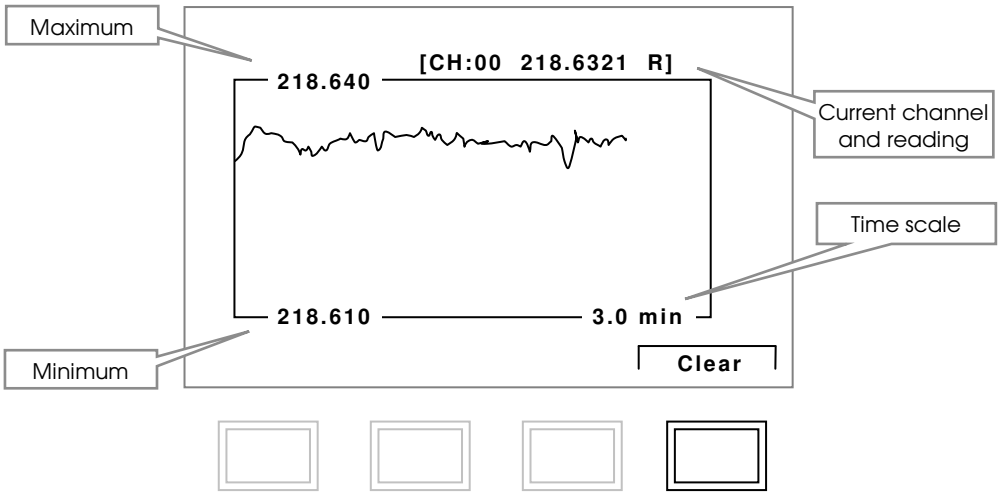


Figure 4.2 – F600 graphical display mode

The screen shows a record of measurements[9]. The display automatically scrolls to the left once the initial x-axis period has been displayed (starting from the left-hand y-axis – i.e. the

[9] The x-axis scale depends on the filter setting (time between samples – 6 minutes for a 2 second update rate).

most recent value is displayed on the right-hand side), The F600 automatically rescales the y-axis when necessary.

Pressing the **Disp** key will change from this mode to **Standby** mode. Pressing it again will change the display back to (normal) Measurement mode.

5.1.4 Measurement mode (standby - Disp function key)

Press the **Disp** key to change the display from graphical display mode to **Standby** mode (see section 3.3.2.

Press the **Disp** key once more to return to normal measurement mode.

5.2 Setting the instrument's operating conditions

The most commonly used keys are grouped together at the top of the front panel into nine **Specific Function** keys. These keys are used to select the instrument's operating mode. Function key operations are generally independent of each other[10]. As an example, press the **Units** key and the display will change to the following one –

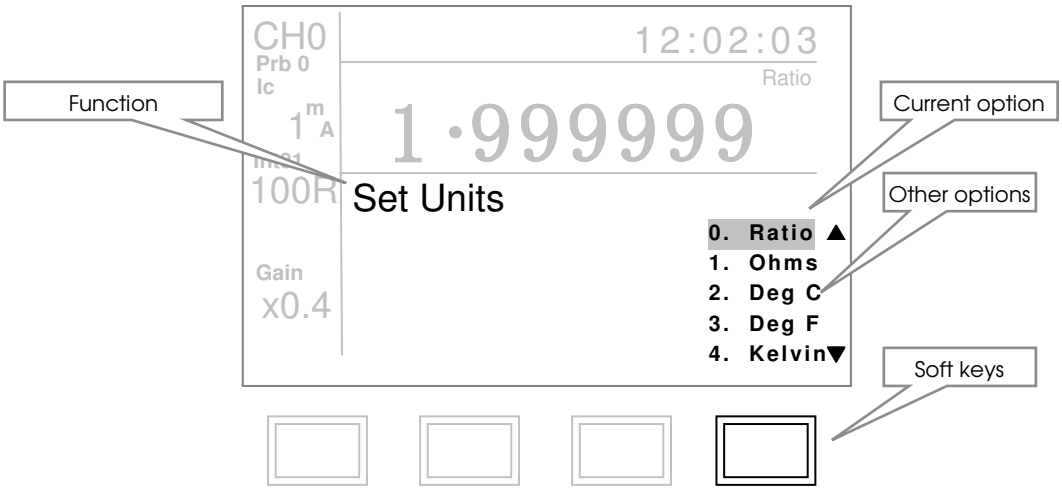


Figure 5.2 – unit selection example

There are four parts to the screen. The **function description** shows the currently selected menu – in this case **Set Units**. The currently set (selected) value is shown in reverse video (i.e. the current units); the **other options** are displayed below.

Note
The instrument continues to measure in menu mode. Selecting one of the available options will change the instrument settings immediately (with the exception of the current menu).

Four **Soft-keys** are situated below the VFD. There are three ways to change the current set value –

[10] Except in the case of the gain and current menus which are limited by instrumental considerations.

- **Method 1**

  Use the ▲ and ▼ navigation keys to scroll the selection (inverse video line) through the available options

- **Method 2**

  Use the soft key under the menu to scroll the selection (inverse video line) through the available options

- **Method 3**

  Use the numerical keypad to set one of the available options – for example, pressing the number 4 will set the units immediately to **kelvin**

Press the **Units** key, the **OK** key (in the navigation cluster) or the **Clear** to return to normal operation.

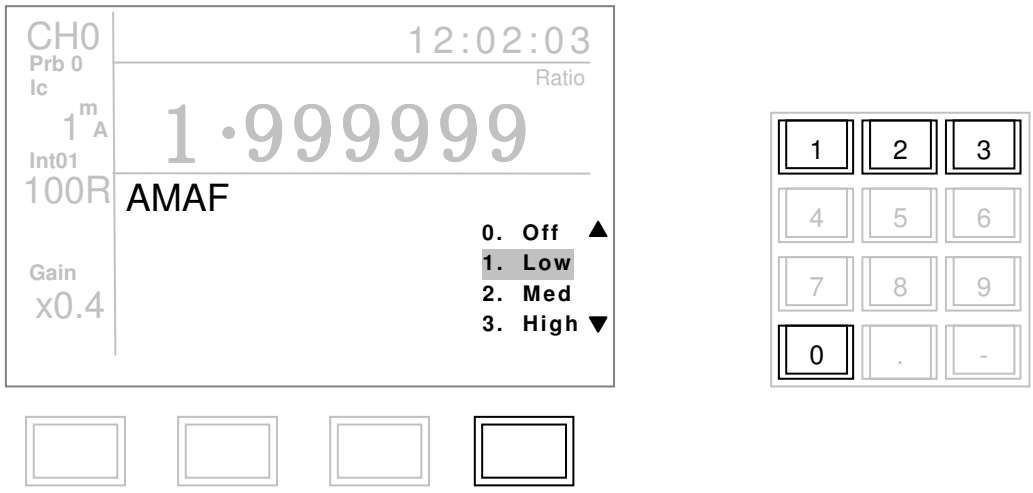
All menus operate in the same way. The **Specific function** keys are described in detail in the following sections. The default values are shown in each section.

Note that it is not necessary to press the current function key or OK key to move to another menu; simply pressing a function key will immediately move there.

5.2.1 Mode function key

Press the **Mode** function key to show the mode menu[11]. Select the data collection mode you require using the soft-key, the ▲ / ▼ navigation keys or the numerical keypad; the change to the current value is implemented immediately. Press the **OK** key, the **Mode** or the **Clear** key to return to normal measurement mode.

Four adaptive, moving average filters (AMAF) are available, as shown below. Selecting one of these will significantly reduce noise at the expense of response time. However, should the signal change significantly, the moving average will reset. Experiment a little to see which setting is best suited to your application (select the highest value possible).



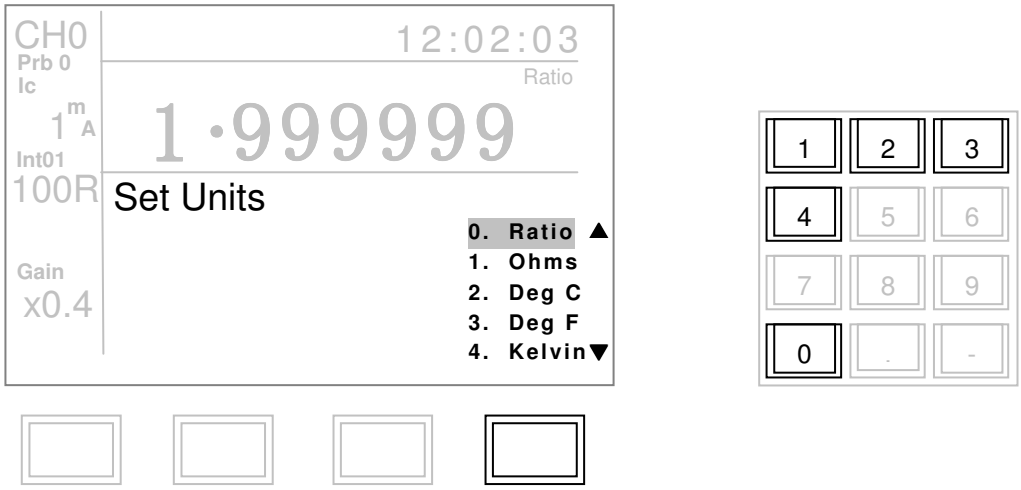
The effects of the moving-average filters are shown in the table below –

AMAF		
Filter	**Description**	**Function**
0	Off	No filter. Normal operation
1	Low filter	Default. Least filtering (4 points)
2	Medium filter	Medium filtering (8 points)
3	High filter	Most filtering (16 points)

[11] Note that the mode key acts as a shift key if the alternative menu mode is operational.

5.2.2 Units function key

Press the **Units** function key to show the units menu. Select the units you require using the soft-key, the ▲ / ▼ navigation keys or the numerical keypad; the change to the current value is implemented immediately. Press the **OK** key, the **Mode** or the **Clear** key to return to normal measurement mode.



The effects of the Units selection menu are shown in the table below —

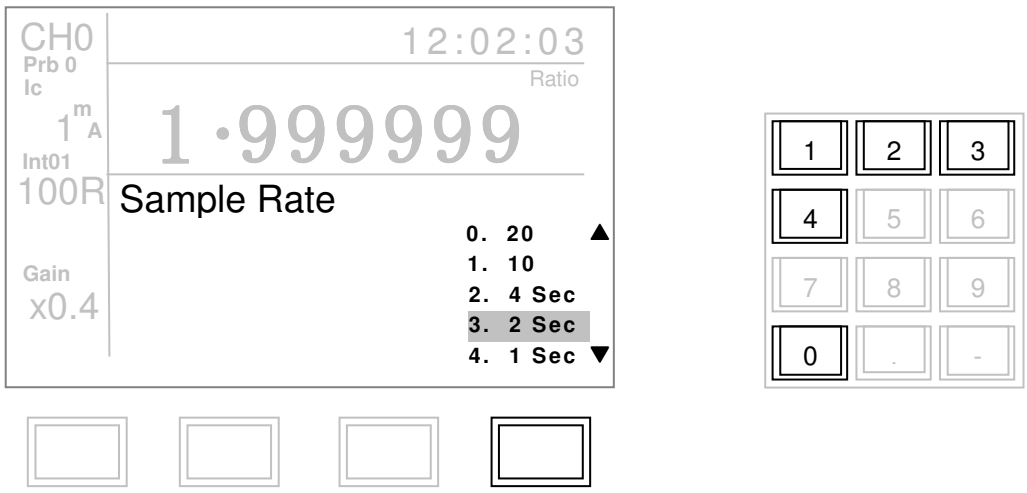
Units		
Unit	**Description**	**Function**
0	Ratio	Normal operation. Show measured ratio
1	Ohms	Convert ratio to ohms and display
2	Deg C	Convert ratio to celcius and display
3	Deg F	Convert ratio to farenheit and display
4	kelvin	Convert ratio to kelvin and display

5.2.3 Filter function key

Press the **Filter** function key to show the filter (sample rate) menu. Select the sample rate you require using the soft-key, the ▲ / ▼ navigation keys or the numerical keypad; the change to the current value is implemented immediately. Press the **OK** key, the **Mode** or the **Clear** key to return to normal measurement mode.

Five averaging sample filters are available, as shown below. Select the one that best matches and is consistent with the physical time-constant of the process you are measuring.

The longer the update interval, the better the noise reduction; however, noise reduction is achieved at the expense of response to fast-changing processes.



The effects of the **Filter** selection menu are shown in the table below –

Filtering		
Filter	**Description**	**Function**
0	20 second sample rate	20 second update rate
1	10 second sample rate	10 second update rate
2	4 second sample rate	4 second update rate
3	2 second sample rate	Default. 2 second update rate
4	1 second sample rate	1 second update rate

5.2.4 Gain function key

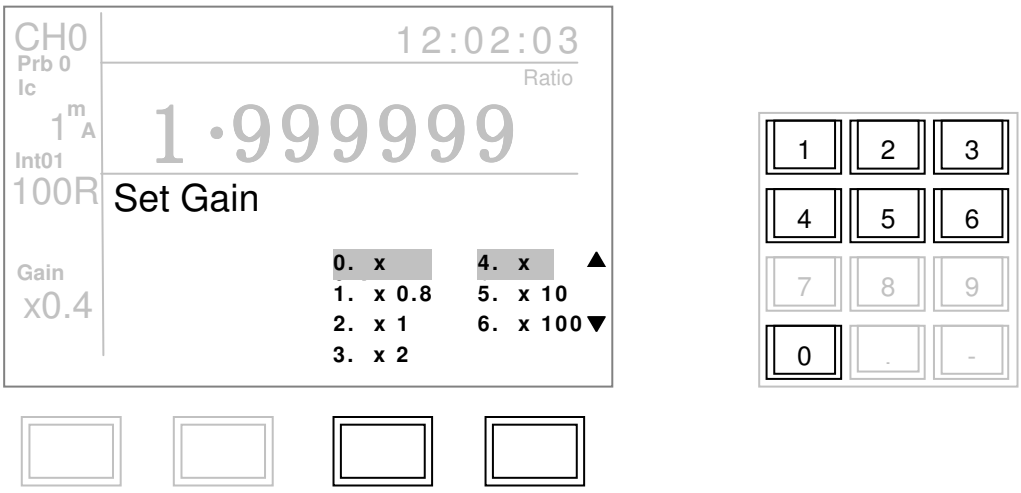
Press the **Gain** function key to show the gain menu. Select the gain settings you require using the soft-key, the ▲ / ▼ navigation keys or the numerical keypad; the change to the current value is implemented immediately. Press the **OK** key, the **Mode** or the **Clear** key to return to normal measurement mode. Use the ◀ / ▶ keys to move the navigation-key selection between the two columns.

Two gain tables are available and may be used in any combination. So, in the example shown below, a total gain of 0.4 is selected (0.4 x 1). Pressing 1 and 5 would give a total system gain of 8.0 (0.8 x 10).

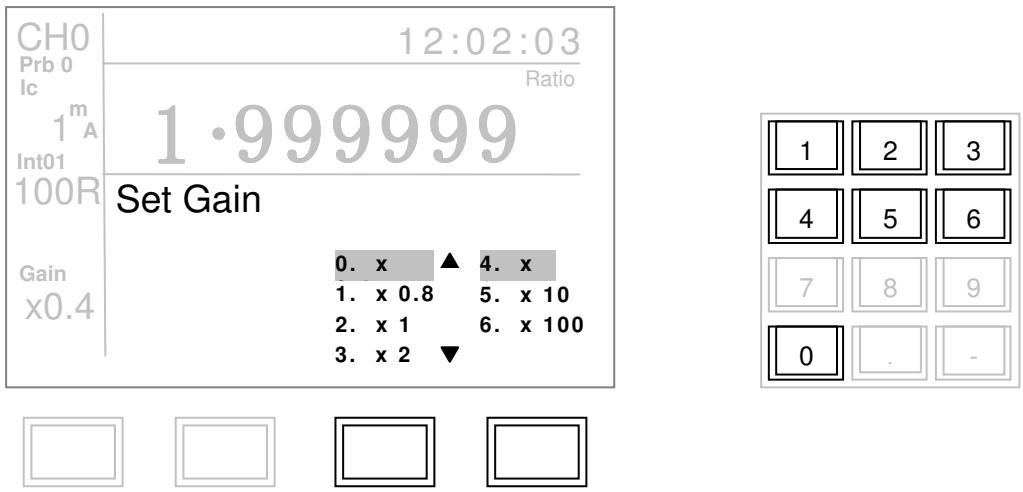
Use as high a gain as possible for your measurement, remembering that if the gain is set too high, the system may not be able to cope with the full measurement range. The gain used will also depend on the probe-current setting. Use a gain setting that gives you use of the instrument's full dynamic range –

$$Gain = \frac{2.0}{\left(i_{probe} \times R_{\max} \right)}$$

Note
The instrument's performance will not be optimised if the gain is set too low



Press the ◀ key to move the column selection to the left (see below). The ▶ key will move it back to the right-hand column.



The Bridge's gain may be set to -

0.4, 0.8, 1.0, 2.0, 4.0, 8.0, 10.0, 20.0, 40.0, 80.0, 100.0, or 200.0

5.2.5 Curr(ent) function key

Press the **Curr** function key to show the current selection menu. Select the current setting you require using the soft-key, the ▲ / ▼ navigation keys or the numerical keypad; the change to the current value is implemented immediately. Press the **OK** key, the **Mode** or the **Clear** key to return to normal measurement mode. Use the ◄ / ► keys to move the navigation-key selection between the two columns.

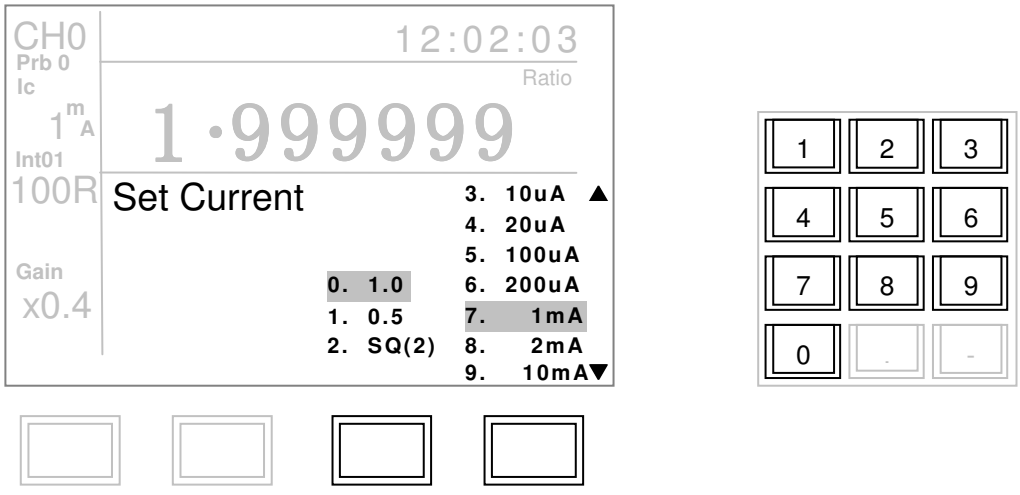
Note

The current menu is slightly different to other menus since changing the setting on this screen does not immediately change its value. This is because, for example, scrolling down from 1mA through 10mA and back to 10µA may unacceptably increase self-heating.

Two current tables are available and may be used in any combination. So, in the case shown below, a total current of 1mA is selected (1.0 x 1mA). Pressing 1 and 5 would give a new setting of 50 µA (0.5 x 100µA).

Use as high a current as possible for your measurement, remembering that if the current is set too high, self-heating effects in the probe (or resistor) may become significant.

Note that the instrument's performance will not be optimised if the current is set too low.



The F600's currents may be set to –

10 µA, 20 µA, 100 µA, 200 µA, 1 mA, 2 mA, 10 mA

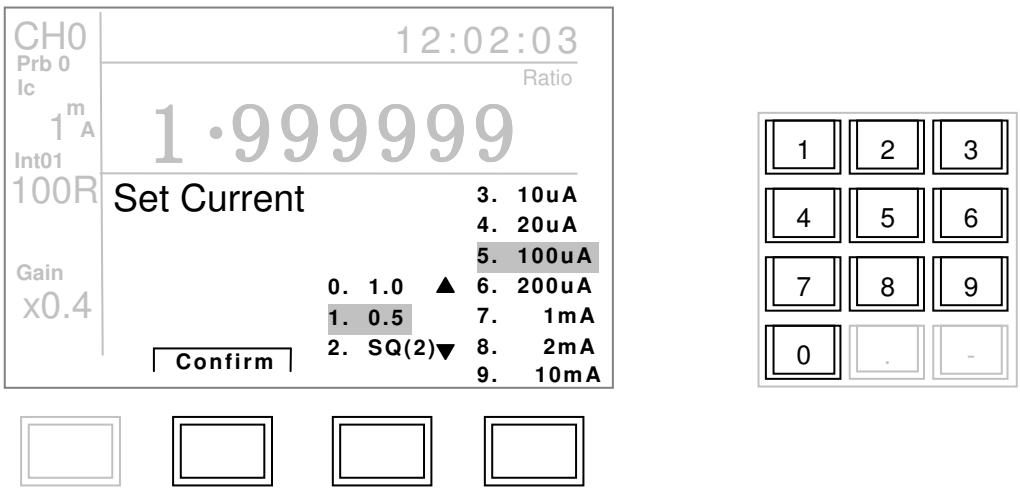
5 µA, 10 µA, 50 µA, 100 µA, 500 µA, 1 mA, 5 mA

(√2 x 10 µA), (√2 x 20 µA), (√2 x 100 µA), (√2 x 200 µA), (√2 x 1 mA), (√2 x 2 mA), (√2 x 10 mA)

The (x√2) setting doubles the power in the probe (or resistor) and is useful when checking for self-heating effects.

Pressing the 1 and 5 keys on the numeric keypad will show the display below.

Note that the **Confirm** legend has appeared above the 3rd soft-key; this is used to prevent any menu changes from taking effect immediately. Either press the **Confirm** soft-key (and note that the display will return to the one shown above) or press the **OK** key (and the display will return to the measurement mode). Pressing the **Curr** or **Clear** key will return control to the top level measurement menu <u>without</u> altering the current value.



Note

The voltage supply from the current source is limited to ± 10V and the minimum F600 gain is 0.4. This means that the maximum current (10 mA) can only be supplied to probes with resistances less than 1 kΩ.

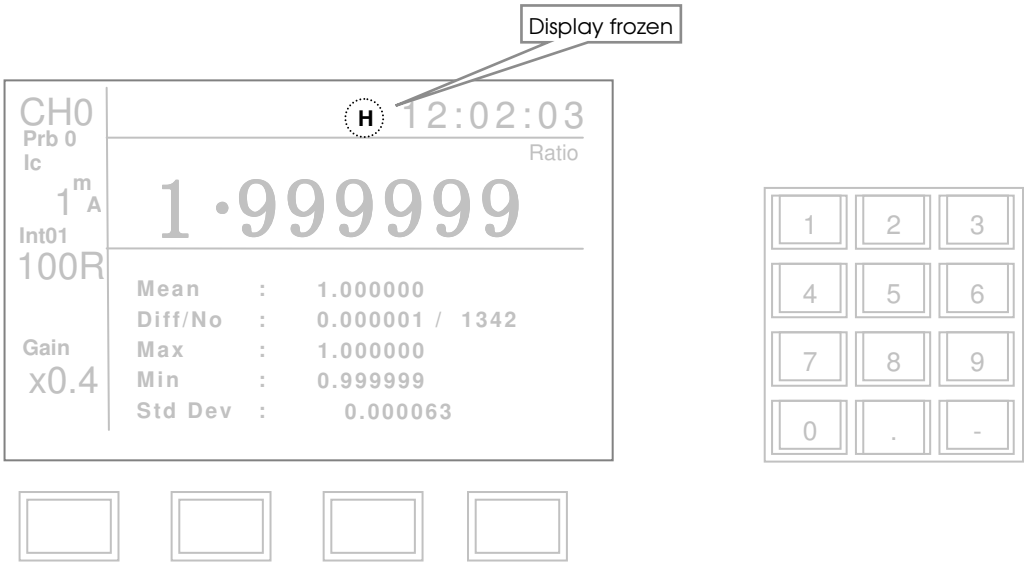
The maximum current can be calculated from –

$$i_{\max} = \frac{10.0}{R_{\max}}$$ where i_{max} is in mA and R_{max} in kΩ

R_{max} is the maximum value of the probe resistance that can be driven at a current of i_{max}. Set the current to the highest value allowed by the self-heating of the probe.

5.2.6 Hold function key

The **Hold** function key does not have a menu associated with it. Press the **Hold** key to freeze the value shown on the display; this is indicated by the letter **H** on the top line (see below). Measurements continue even if the display is frozen.

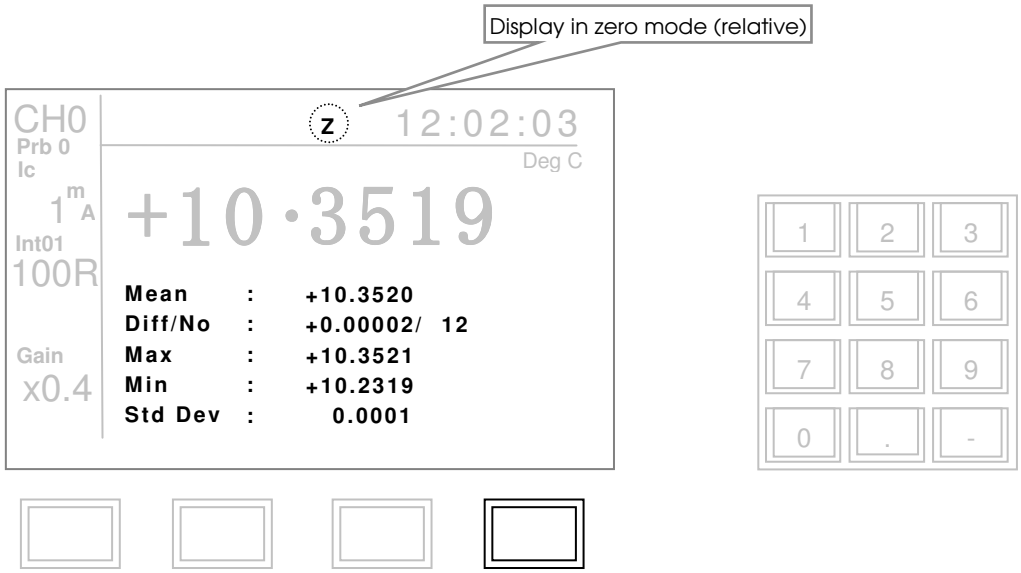


Press the **Hold** key to un-freeze the display.

5.2.7 Zero function key

The **Zero** function is useful when looking for changes. The current reading is held and then subtracted from subsequent readings.

The function key does not have a menu associated with it. Press the **Zero** key to zero the value shown on the display. This is indicated by the letter **Z** on the top line (see below).



The zero function can be used with any of the instrument's temperature units; it will not work when ratio or resistance is selected.

Note
A warning message will appear if the zero function key is pressed when ratio mode is selected.

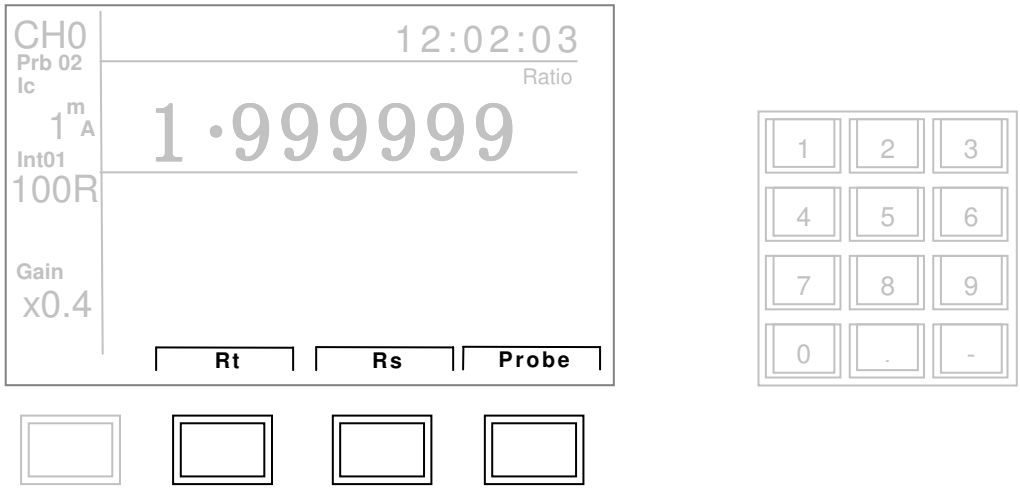
Zero mode can be turned off by pressing the **Zero** key again.

5.2.8 Chan function key

The channel function key is used to change channels, select an alternative reference resistor (internal or external) or change probes.

Channel settings are entered from the Channel Edit Menu (see section 5.3.6), probe settings from the Probe Edit Menu (section 5.3.4) and reference resistor values from the R_s Menu (section 5.3.9).

Press the **Chan** function key to display the channel menu below –



Press the soft-key to select the function you need to change or set.

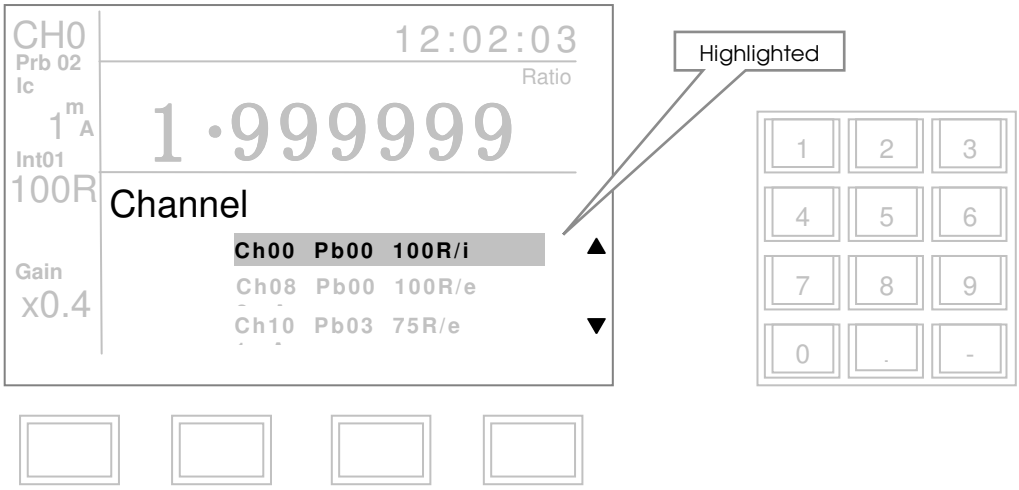
5.2.8.1 Channel selection

Up to 99 channels can be stored and edited; channel 0 is the default instrument channel.

> **Note**
>
> External channel numbering is only important when the F600 is used with a switch-box - otherwise, external channel numbering can be set as required.

Each channel contains a complete set of instrumental conditions; channels can be used to quickly and efficiently restore a previous saved setup. Alternatively, they can be set to use the instrument efficiently with an external switch-box. External channels may be set to perform either as R_t or R_s inputs.

Pressing the **R_f** soft-key will display the screen below –



A list of active channels will be shown. Use the ▲ / ▼ navigation keys to scroll the highlighted line up or down the list (up to three lines, only, are displayed on the screen due to space limitations). Press the **OK** key to select the highlighted channel or press the **Chan** key to select the highlighted line and return to measurement mode; alternatively, press the **Clear** key to return without altering the channel.

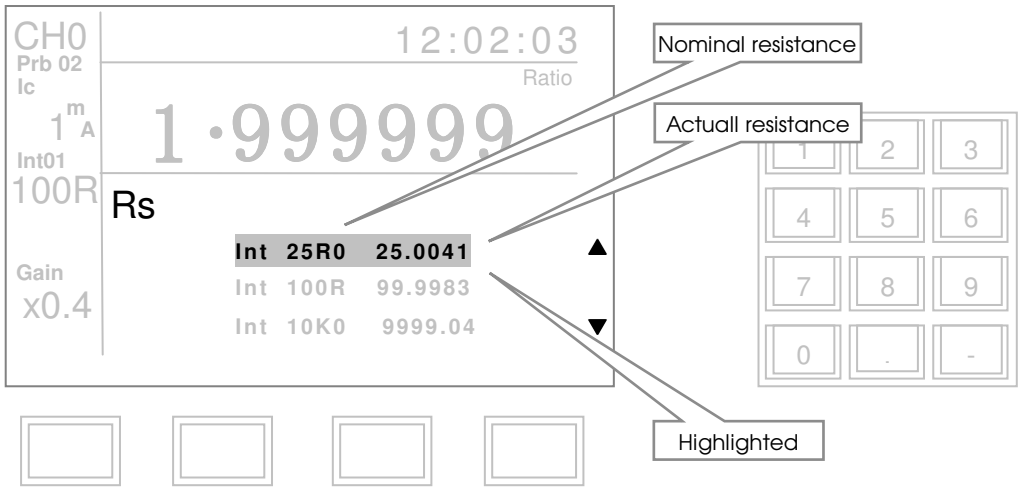
Note
Note that the **OK** key immediately selects the highlighted line (but does not return to normal measurement mode), allowing you to individually view and select other channels easily.

5.2.8.2 Reference resistor selection

One of four internal reference resistors or up to one of 99 external reference resistors may be selected.

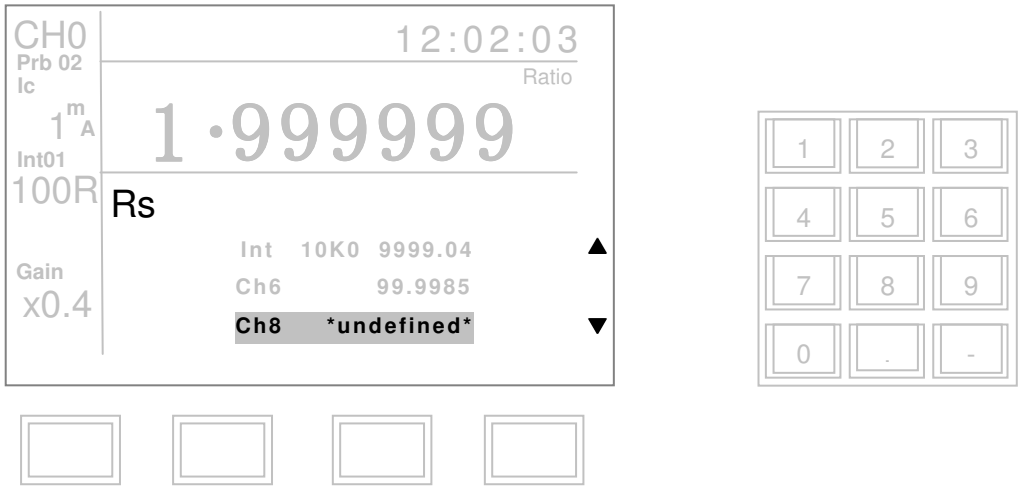
Note
External reference resistors are entered as R_s channels.

Pressing the **R_s** soft-key will display a screen similar to the one below –



A list of available reference resistors will be shown. Use the ▲ / ▼ navigation keys to scroll the highlighted line up or down the list. Press the **OK** key to select the highlighted reference resistor or press the **Chan** key to select the resistor and return to measurement mode; alternatively, press the **Clear** key to return without altering the reference resistor.

As an example, once the highlighted line has been scrolled down four times, the display will change to one similar to the screen below –



This screen shows that two external reference resistors have be added to the instrument (channels 6 and 8) but that channel 8 has not had an actual value entered for the reference resistor yet.

The four internal reference resistors[12] are predefined; their values are –

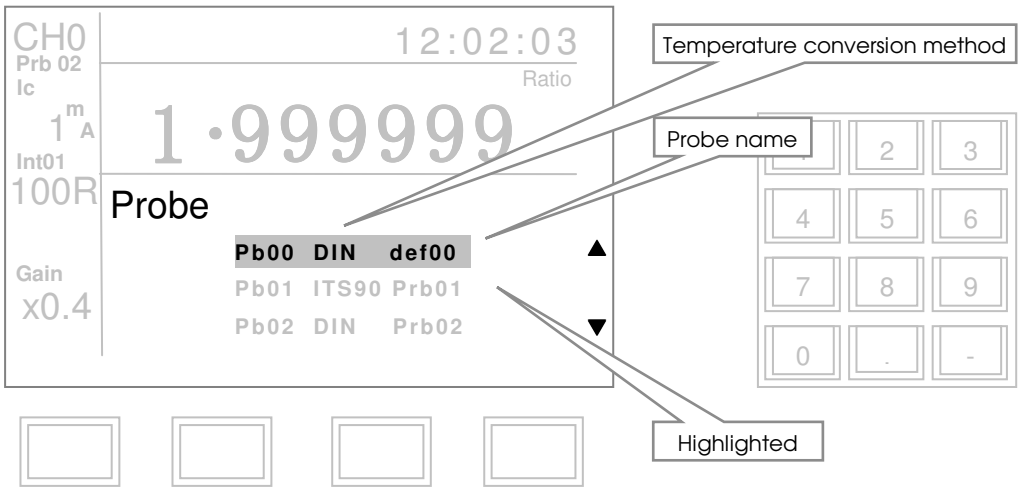
Nominal values
25 Ω
100 Ω
10,000 Ω
100,000 Ω

5.2.8.3 Probe selection

Up to 99 probe selections may be made (provided these have been entered).

Note
Probe 0 (def 00) is predefined as DIN and cannot be changed.

Pressing the **Probe** soft-key will display a screen similar to the one below –



A list of available probes will be shown. Use the ▲ / ▼ navigation keys to scroll the highlighted line up or down the list. Press the **OK** key to select the highlighted probe or press

[12] It is important to realise that the number in the field is only a reference value; the actual value is entered via the calibration menu.

the **Chan** key to select the highlighted probe and return to measurement mode; alternatively, press the **Clear** key to return without altering the probe.

5.2.9 Disp function key

The **Disp** function key does not have a menu associated with it.

The key is used to change VFD display modes. Three display modes available –

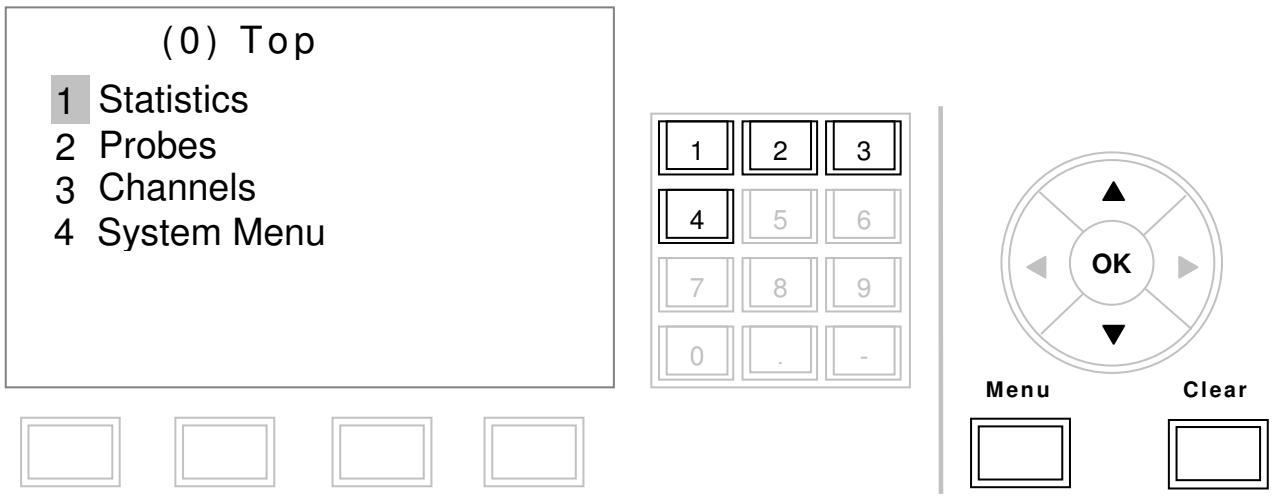
- Normal (measurement mode) display
- Graphical display
- Standby (VFD blanked)

Press the **Disp** key once to move between each of these modes (see section 5.1).

Note
The VFD display will be blanked (turned off) in Standby mode.
The orange Standby LED will be on when the Bridge is in this mode.

5.3 Menu key

The **Menu** key is used to access all other aspects of the F600. These menus are used less frequently. Press the **Menu** key to display the top level menu. The ▲ and ▼ keys can be used to navigate through these menus. The numeric keypad is also active. The **Menu** key can be used to return to measurement mode. The **Clear** key will cause the instrument to return to the previous menu (measurement mode if the top level menu is already shown).



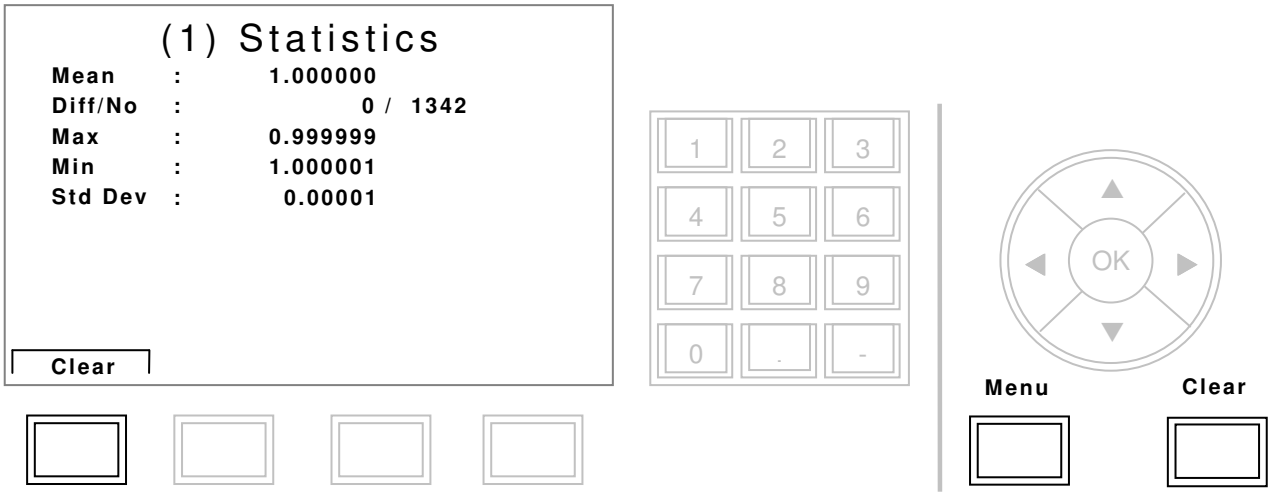
The following sections describe each of these menus - and their sub-menus where appropriate. The statistics menu is shown below as an example of sub-menu.

Note

The navigation cluster **Clear** key will return to the previous menu.

5.3.1 Statistics menu

Press the **1** key on the numeric pad (or the **OK** key) to access this menu to show –



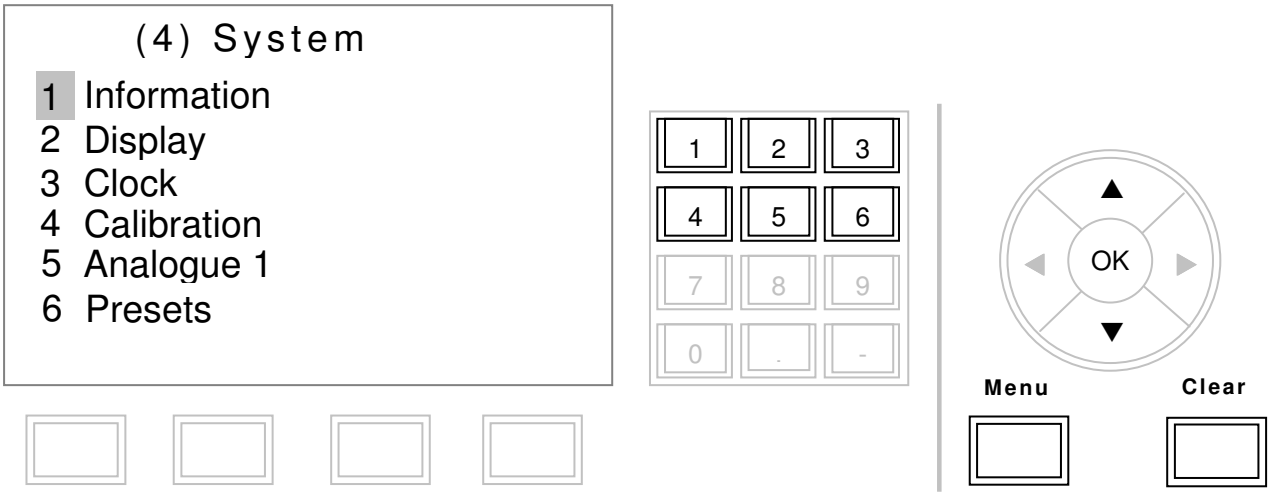
The **Clear** soft-key may be used to reset and restart statistical calculation. Press the **Menu** key to return to measurement mode or press the **Clear** key to return to top level menu.

.

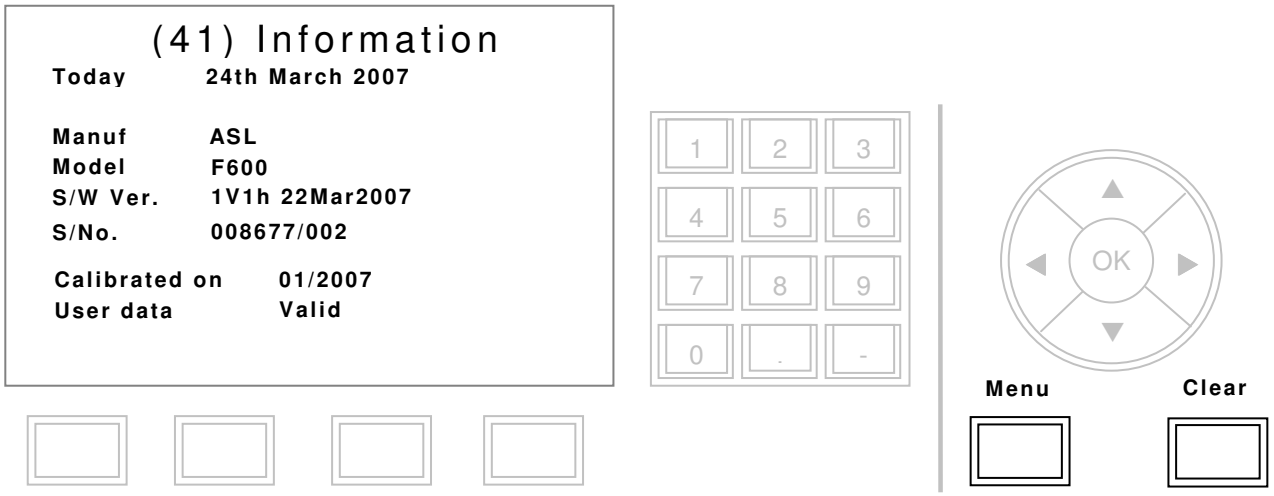
5.3.2 System menu

This menu displays useful information about dates and version numbers.

Press the **4** key on the numeric pad (or use the up and down keys to navigate to the System Menu and press the **OK** key) to access this menu. The display will change to show –



Press the **1** key or the **OK** key to display the system Information screen –

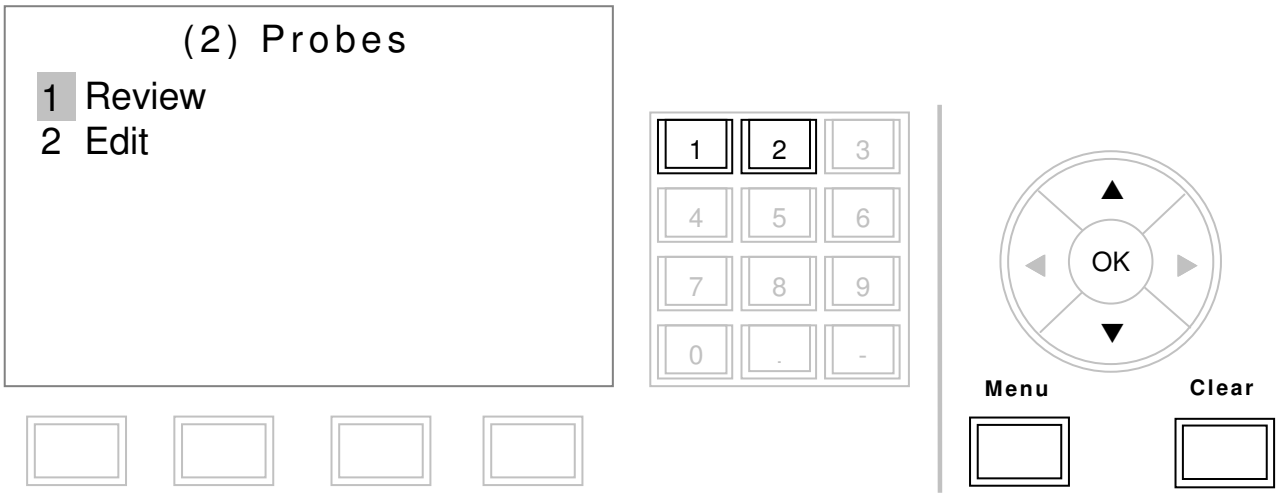


Press the **Menu** key to return to measurement mode or the **Clear** key to return to the previous menu.

5.3.3 Probe (Review) menu

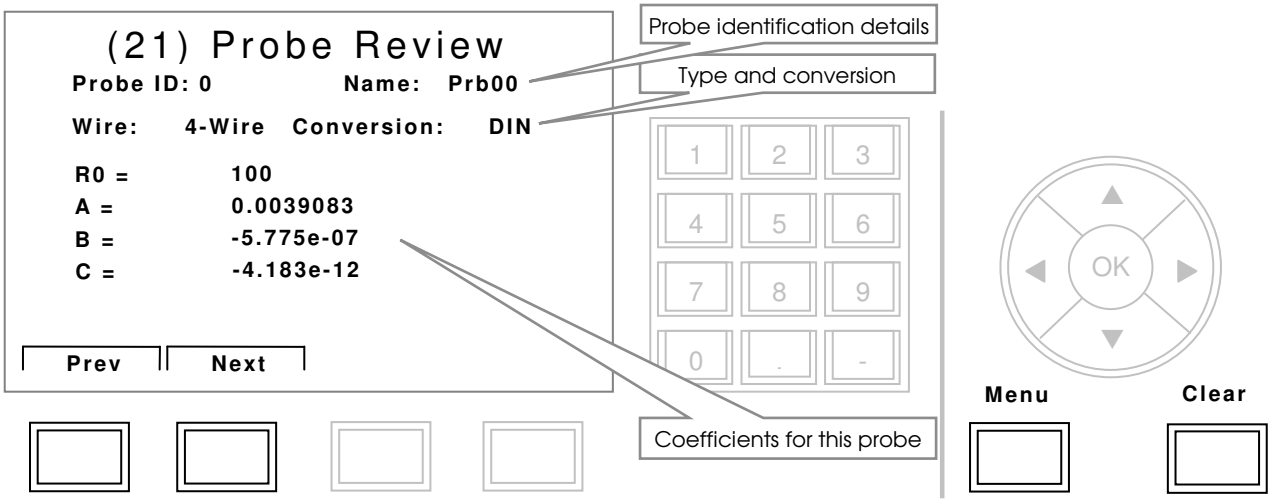
This menu is used to Review individual probe information. All probes used on the F600 must have the correct data entered to accurately perform the resistance to temperature conversion.

Press the **2** key on the numeric pad or use the up and down keys to navigate to the Probe Menu and press the **OK** key to access this menu.



Press the **1** key (or the **OK** key) to Review the previously entered probe data.

Probe identification is shown on the top line, followed by the type (4-wire)[13] and the resistance to temperature conversion method (DIN). The coefficients for the conversion method are shown below the probe type.



[13] 3-wire measurement is only available when using an external multiplexer unit.

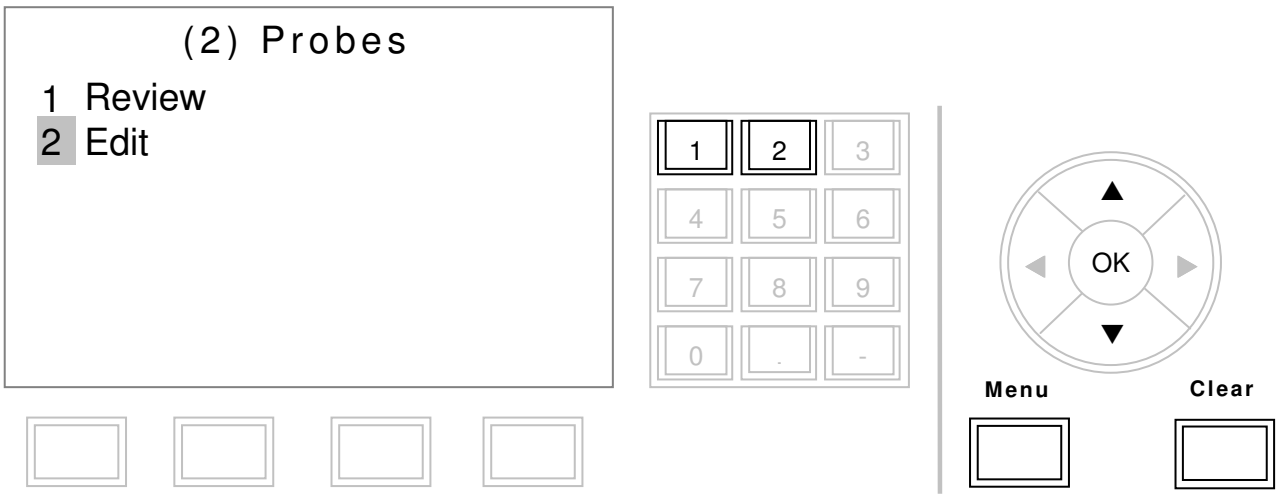
Use the **Prev** and **Next** soft-keys to move between pages to review information about all the current probes; the pages are continuous so eventually, by pressing the **Next** soft-key, you will return to the first page of information.

Press the **Menu** key to return to measurement mode or the **Clear** key to return to the previous menu.

5.3.4 Probe (Edit) menu

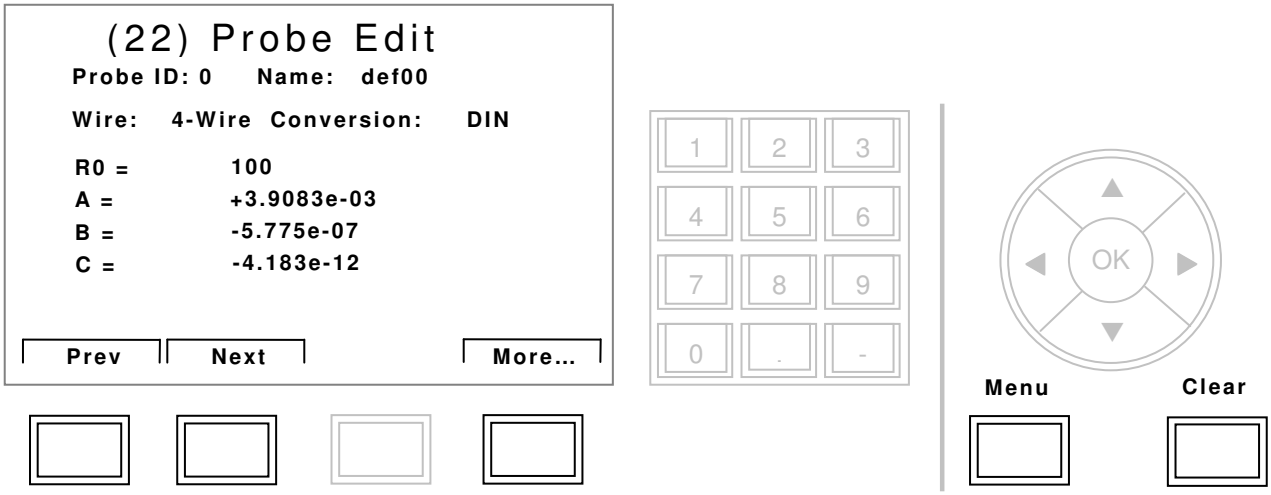
All probes used on the F600 **must** have the correct data entered to accurately perform the resistance to temperature conversion.

Press the **2** key on the numeric pad or use the up and down keys to navigate to the Probe Menu and press the **OK** key to access this menu.



Press the **2** key (or the **OK** key) to Edit the previously entered (or new) probe data. See the previous section for a detailed description of the screen. Its layout is similar except for the addition of the **More…** soft-key.

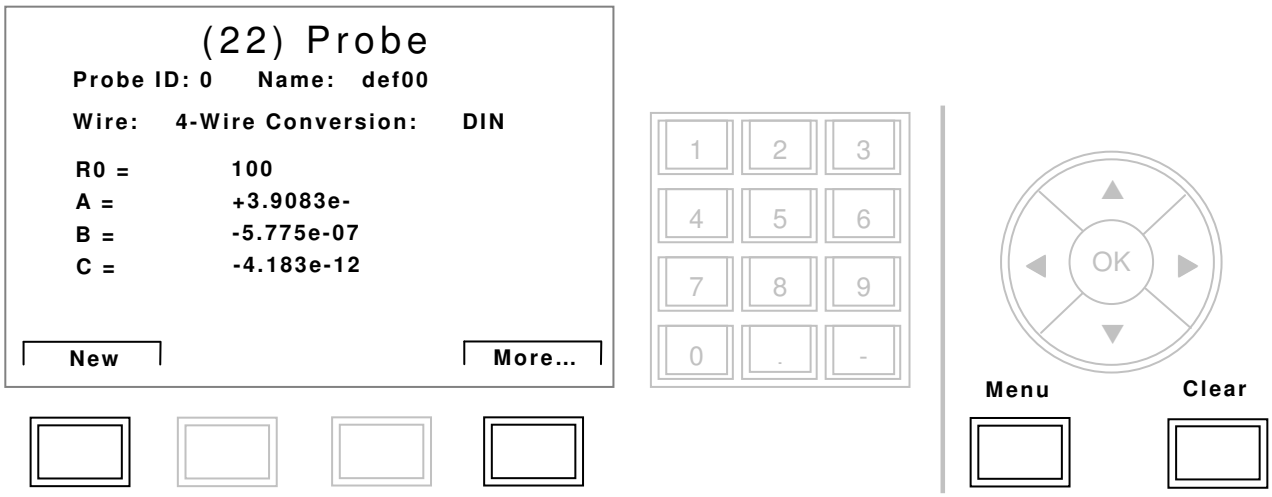
Use the **Prev** and **Next** soft-keys to move between pages to review information about all the current probes; the pages are continuous so eventually, by pressing the **Next** soft-key, you will return to the first page. Move to any probe other than **Prb00**.



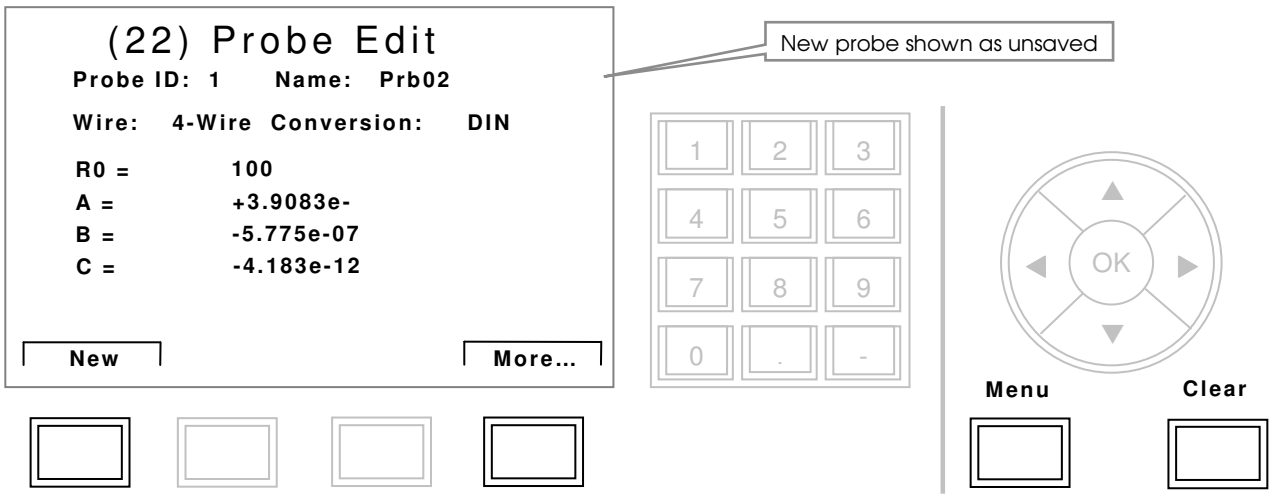
Note

Prb00 is the default F600 probe. You will not be able to edit details for this probe.

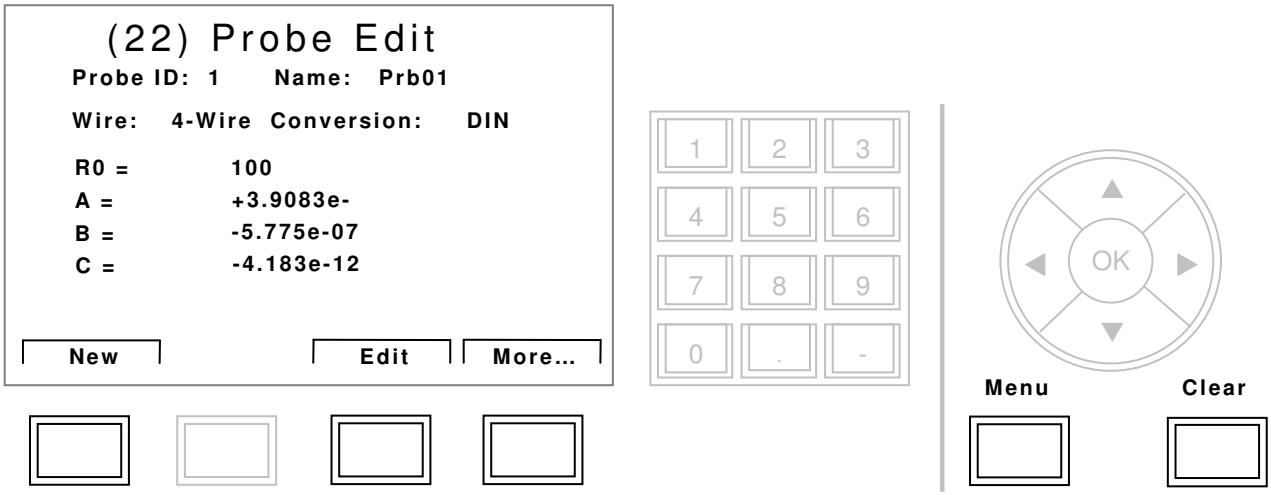
Press the **More…** soft-key to edit the displayed probe details. The display will change to -



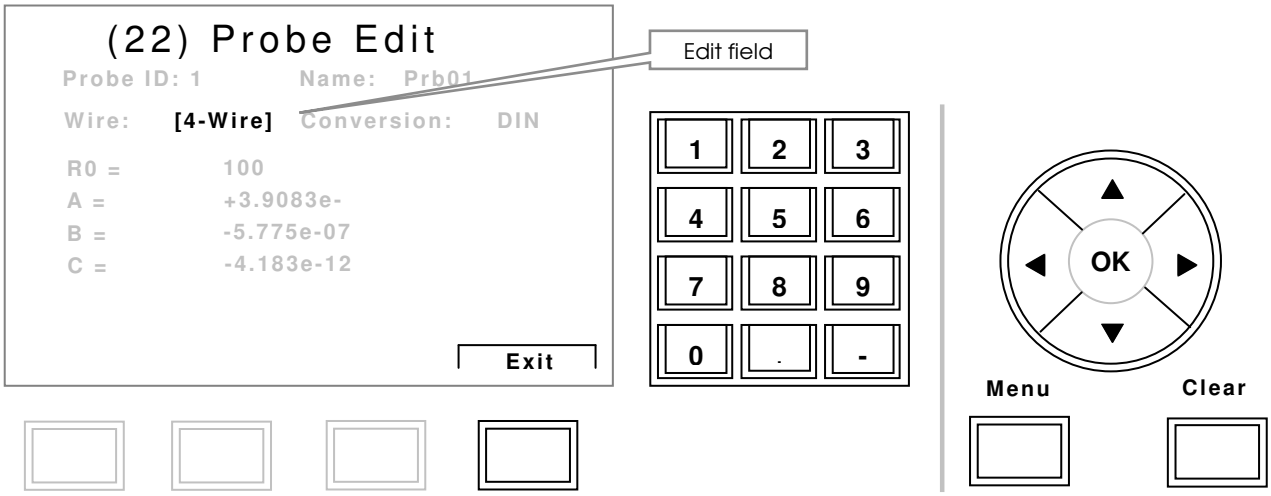
The **New** soft-key will enter a new probe (with the first unassigned number). The display will change to show a new probe with the default system probe settings. If at any time you want to exit the procedure, press the **Menu** or **Clear** key - but note that the entries will not be saved.



Press the **More…** soft-key twice to get to the following screen –

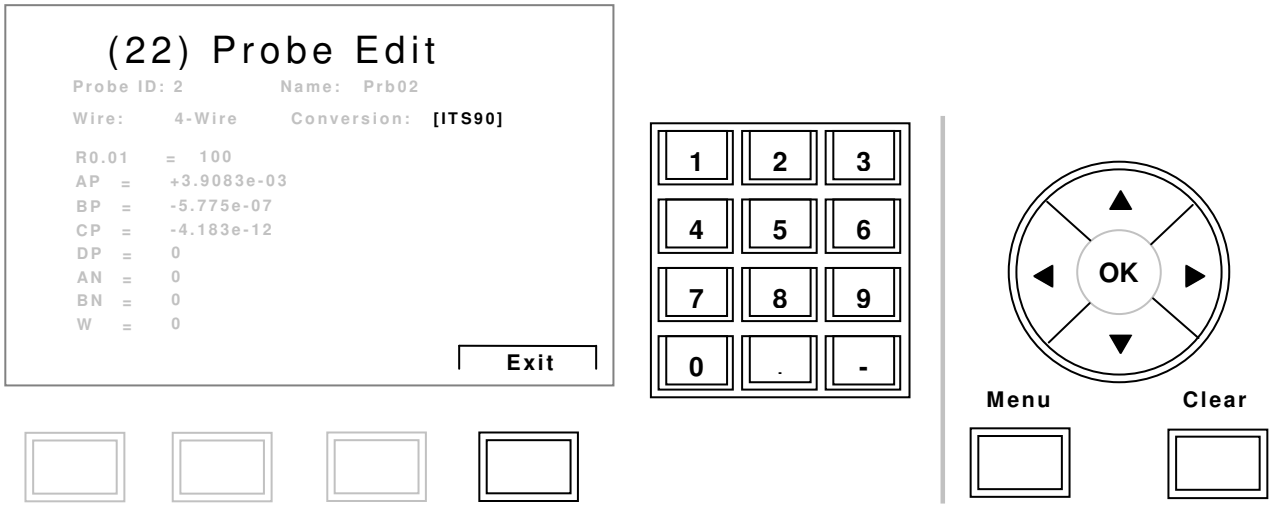


Press the **Edit** soft-key to get to the following screen –



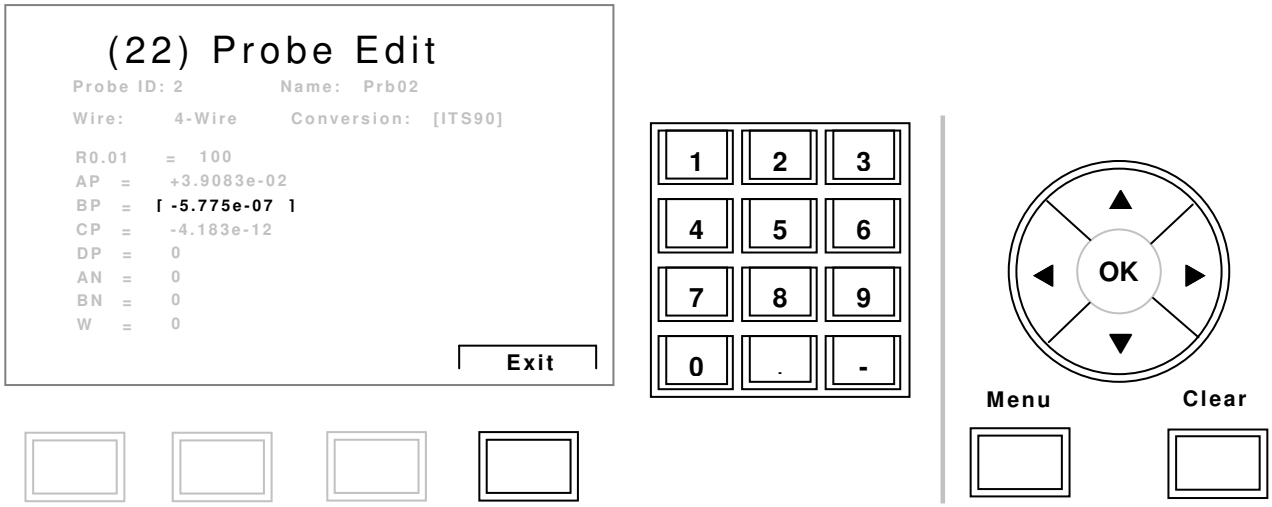
The probe data fields can now be edited. Use the ◀ and ▶ navigation keys to move the edit field (the field with the `(` and `)` brackets). When the **Wire** and **Conversion** fields are current, use the ▲ and ▼ navigation keys to select the number of wires and conversion type. For example, using the ▶ key to move the edit field to the conversion entry and then using the ▲ key twice will result in the display[14] –

[14] Note that DIN is the default method and will be set if the clear function is used.

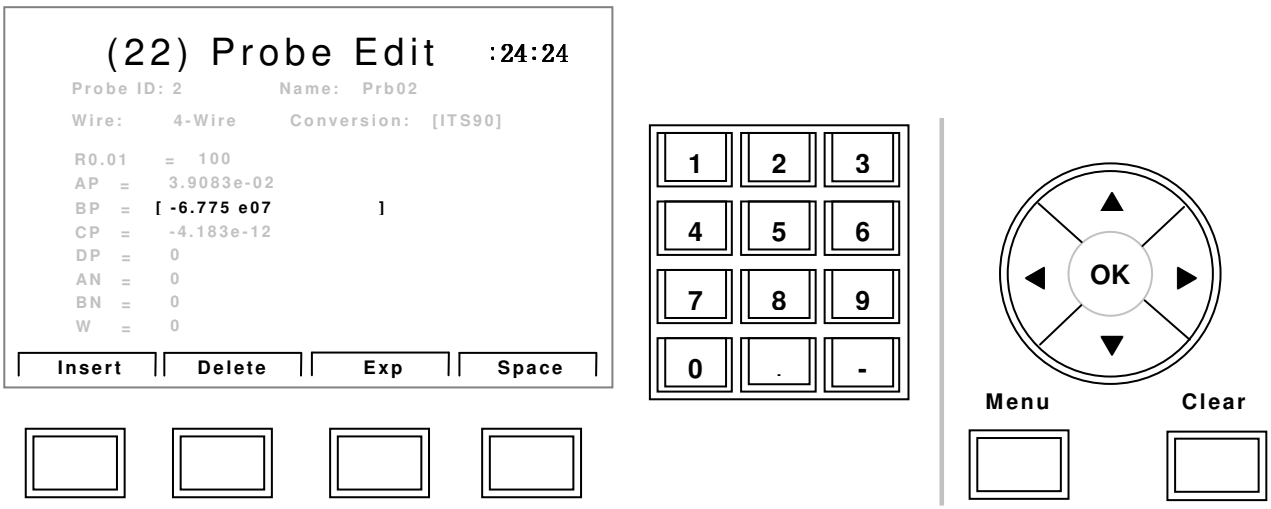


Similar displays are shown for CvD and S&H.

Now press the ▶ navigation key three times to move to the Bp field -



The Bp field can now be changed using the numeric keypad. Pressing the **–** key followed by the **6** key will result in the following display –



The remaining digits may be edited/added or changed as required.

The function of the various editing soft-keys is fairly obvious (described by their legends). If pressed, the **Insert** soft-key will change to **Overtype** (and **Delete** will change to **Backspace**). If **Insert** is then pressed it will revert to **Overtype** (and **Delete** will change to **Backspace)**. The **Insert** key allows you to inset a digit and the **Delete** key to erase a digit. The **Space** key inserts a blank digit. The **Overtype** key changes the selected digit and the **Backspace** key moves one digit to the left (if possible). The **Exp** key is used to insert an exponent. In edit mode, the ◀ and ▶ keys move the cursor between digits.

Press the **OK** key after the edited value is correct; this returns the action of the ◀ and ▶ keys to moving between fields.

Press the **Exit** soft-key once all the probe data has been entered and then press the **Save** key to save the probe data (the **Clear** soft-key will reset the current probe's fields to their default values).

Data entry is similar for the other temperature conversion methods.

Press the **Menu** key once you have entered all the data.

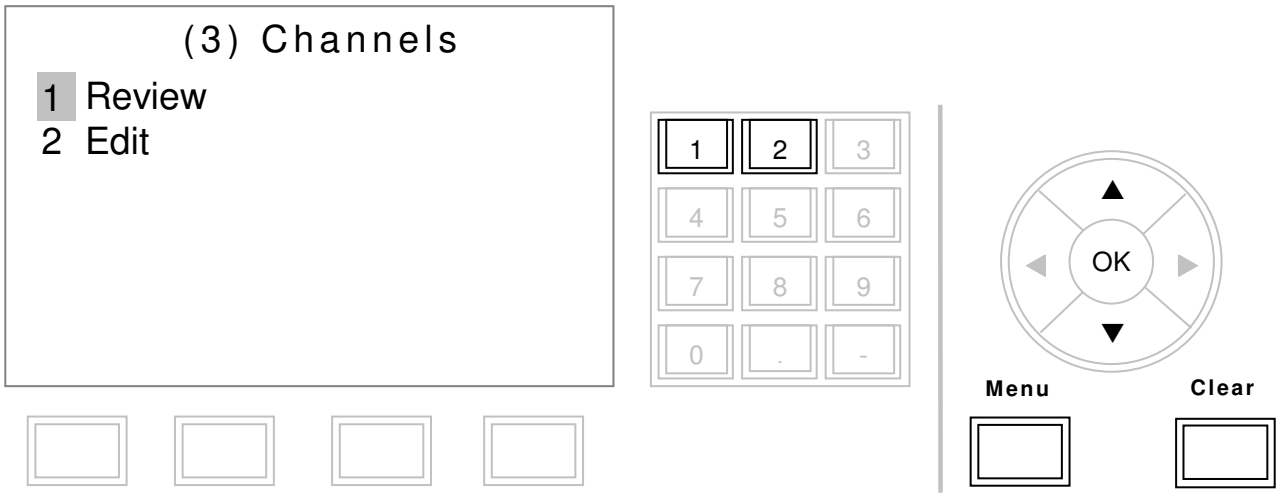
Note

Failure to accurately enter the correct probe-type and its associated calibration data will lead to inaccurate (or wrong) resistance to temperature conversion calculations.

5.3.5 Channels (Review) menu

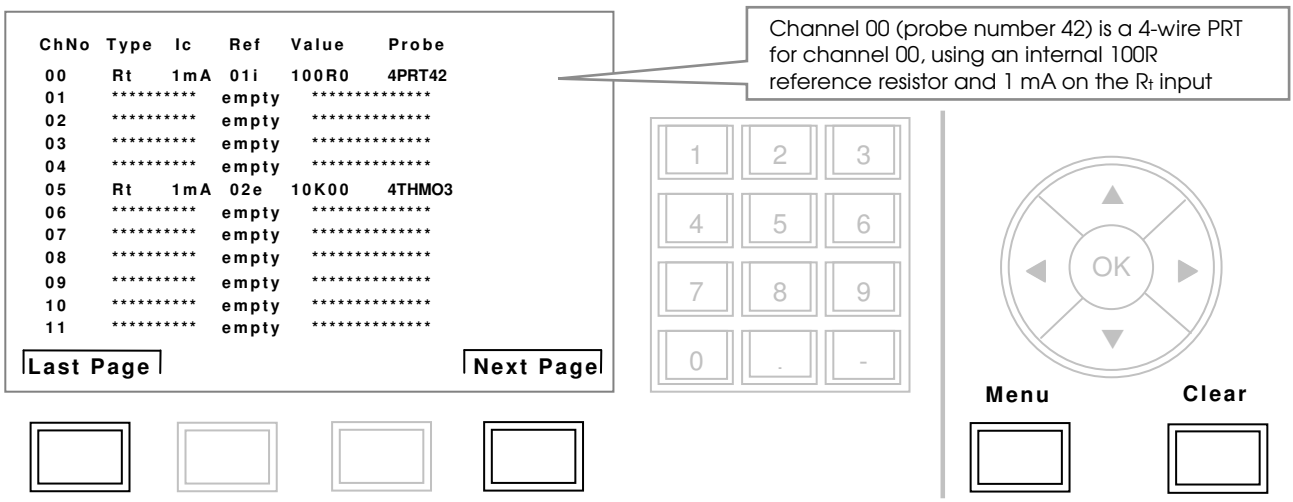
A channel holds a complete instrumental setup under its identification number. This menu may be used to Review individual channel information.

Press the **3** key on the numeric pad or use the up and down keys to navigate to the Channel Menu and press the **OK** key to access this menu.



Press the **1** key (or the **OK** key) to Review the previously entered channel data.

Use the **Prev Page** (not visible on the first page) and **Next Page** soft-keys to move between pages to review channel information. The screen below shows that channel 00 (system default) and channel 05 have been set (and their associated values).



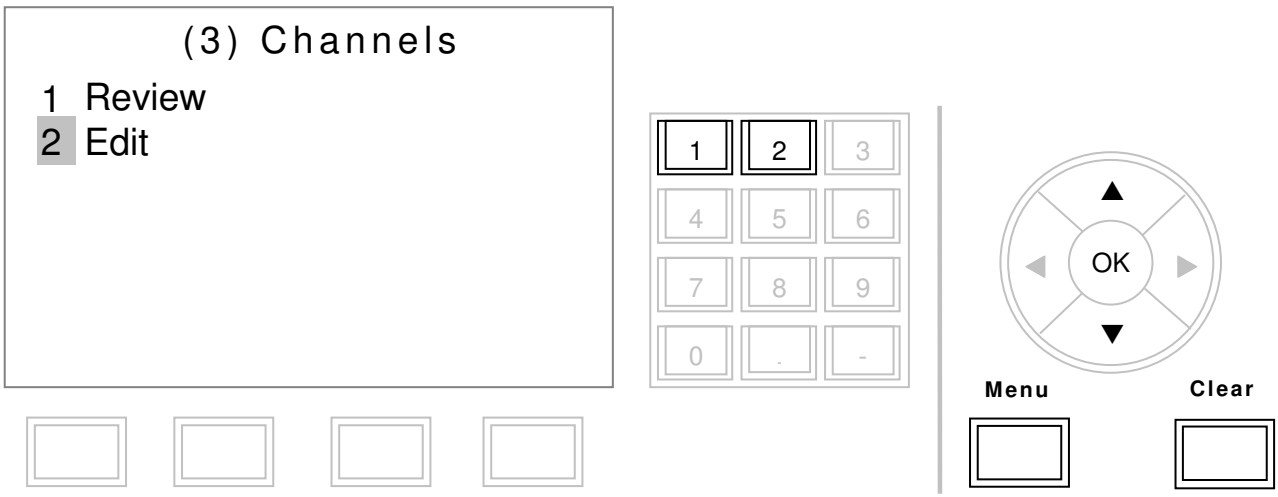
Press the **Menu** key to return to measurement mode or the **Clear** key to return to the previous menu.

5.3.6 Channels (Edit) menu

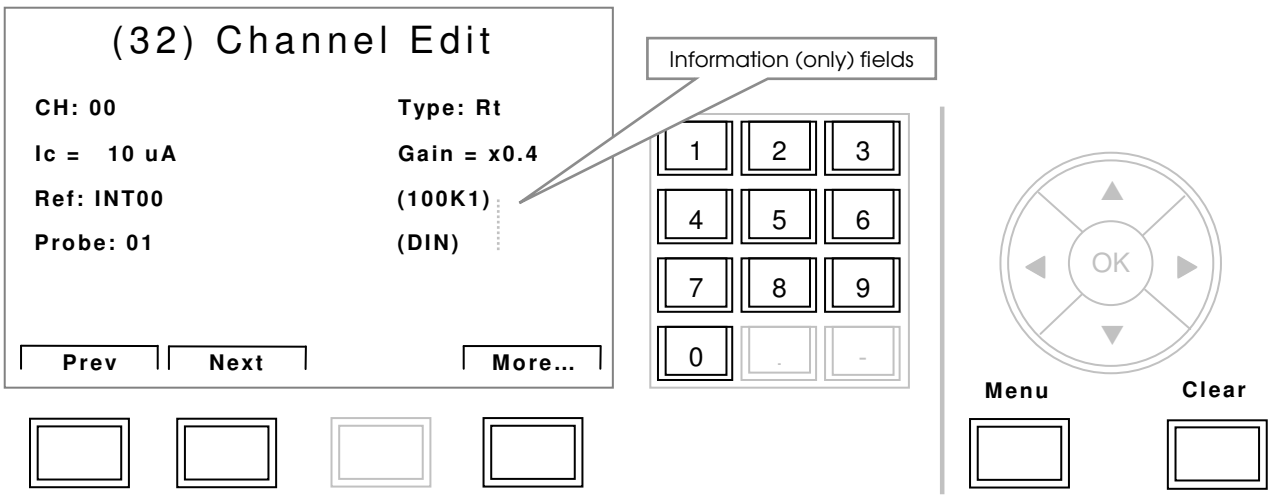
A channel holds a complete instrument's setup under its identification number. This menu may be used to Edit individual channel information.

Channels may be set to either measurement (R_t) or reference (R_s) types.

Press the **3** key on the numeric pad or use the up and down keys to navigate to the Channel Menu and press the **OK** key to access this menu.



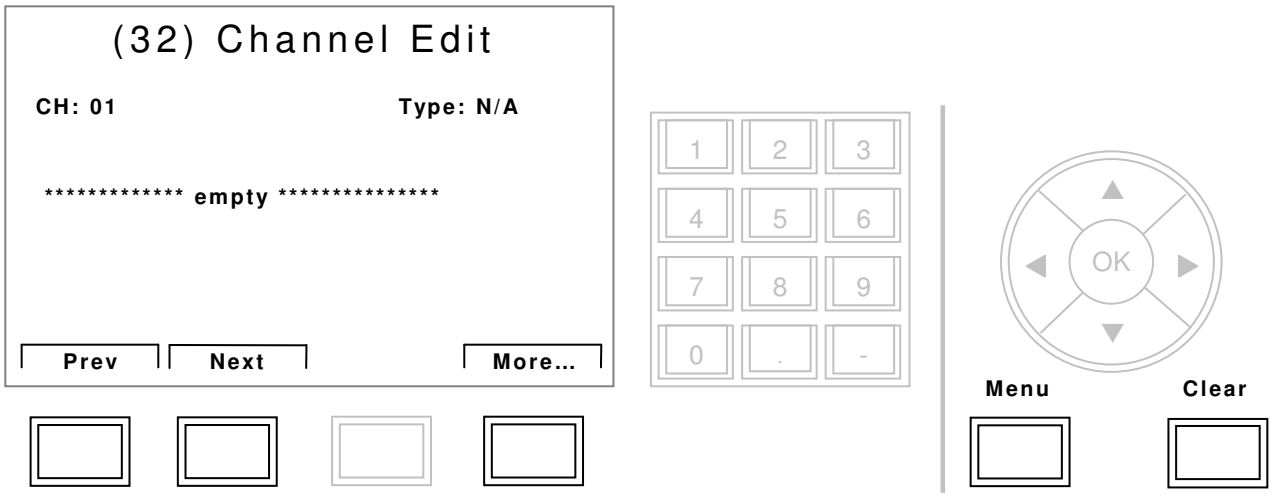
Press the **2** key (or the ▼ navigation and **OK** key) to Edit the previously entered channel information.



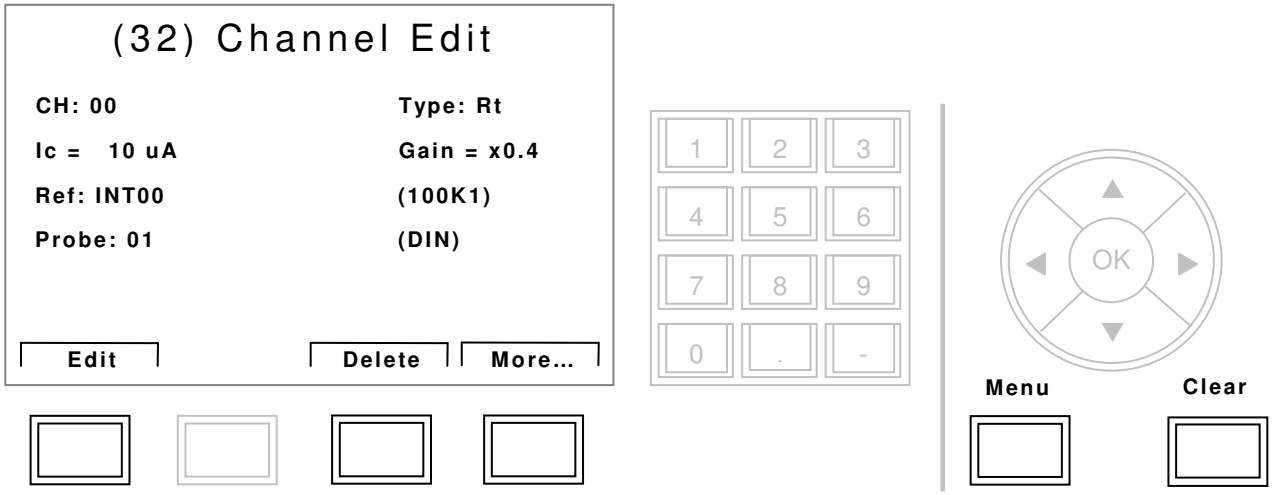
The screen will look similar (but with less information) when the channel type is set to Rs.

The two fields in rounded brackets are for information only (they cannot be edited here). Use the **Prev** and **Next** soft-keys to move through the pages for all 99 channels[15]. Channels that have been entered will look similar to the example above.

Unused channels will look similar to the one below –

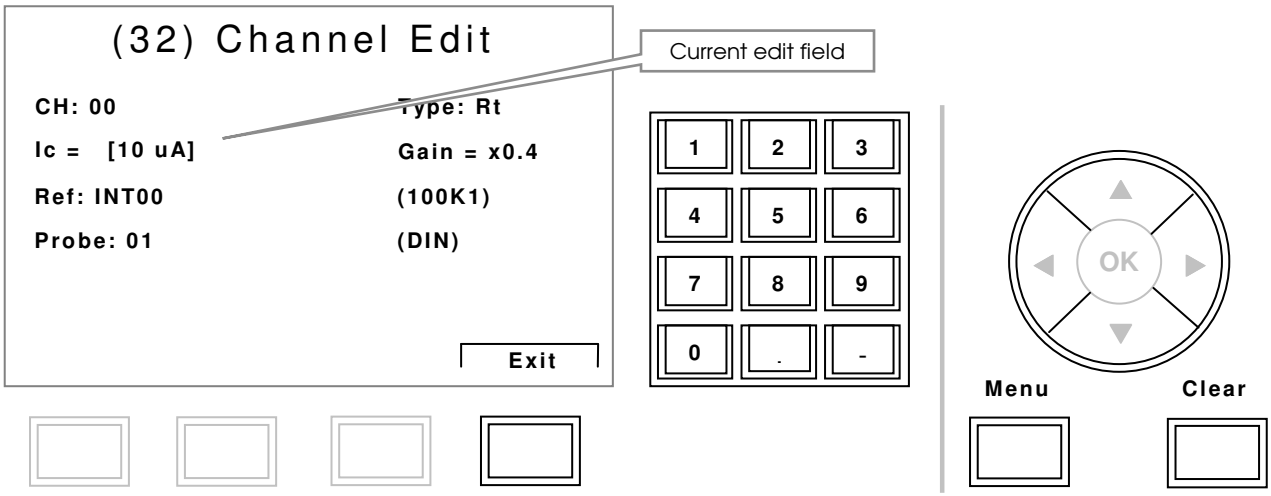


Used channels may be edited. Press the **More…** soft-key to see the screen below –



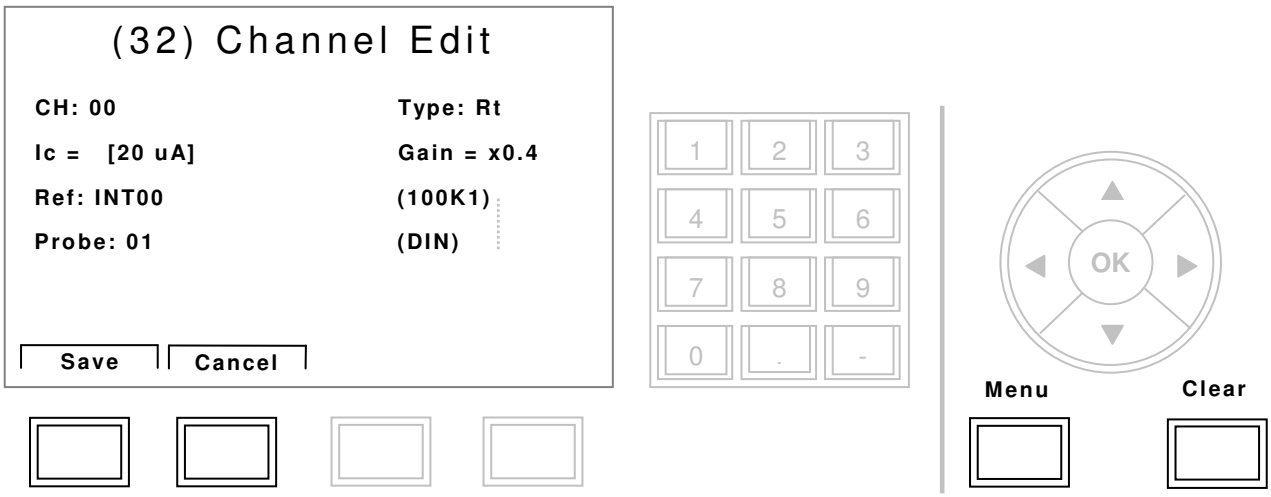
Now press the **Edit** soft-key to get to the following display –

[15] Alternatively, type in the channel number using the numeric keypad.



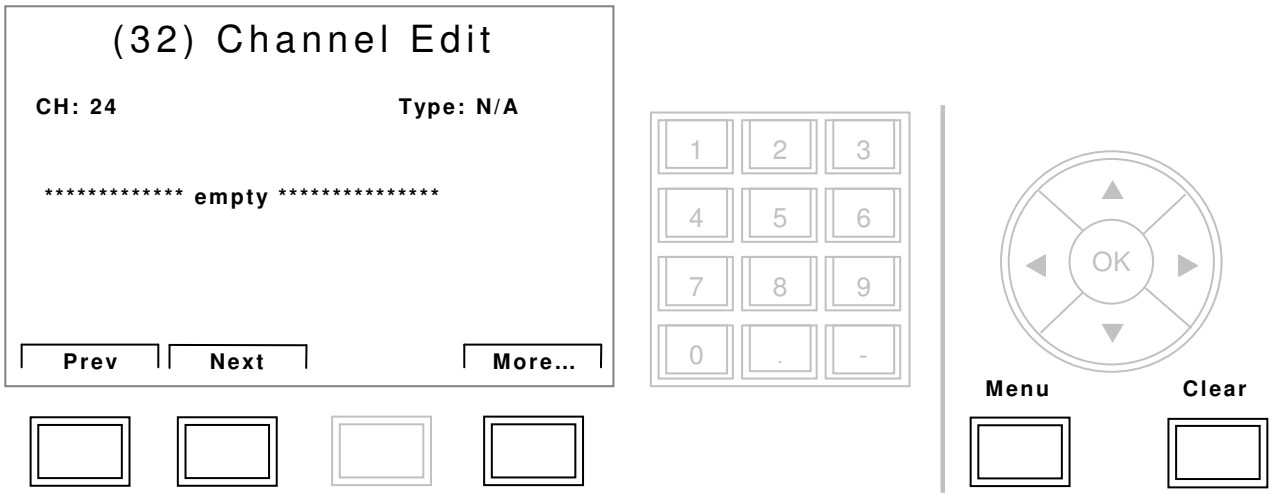
The square brackets are shown around the first editable field. The editing functions and procedures are now identical to those associated with probe editing – see section 5.3.4 for complete details on changing and entering data. Use the **More…** soft-key to return to the previous screen, if necessary.

Edit the fields, as required, before pressing the **Exit** soft. The screen, for example, will change to –

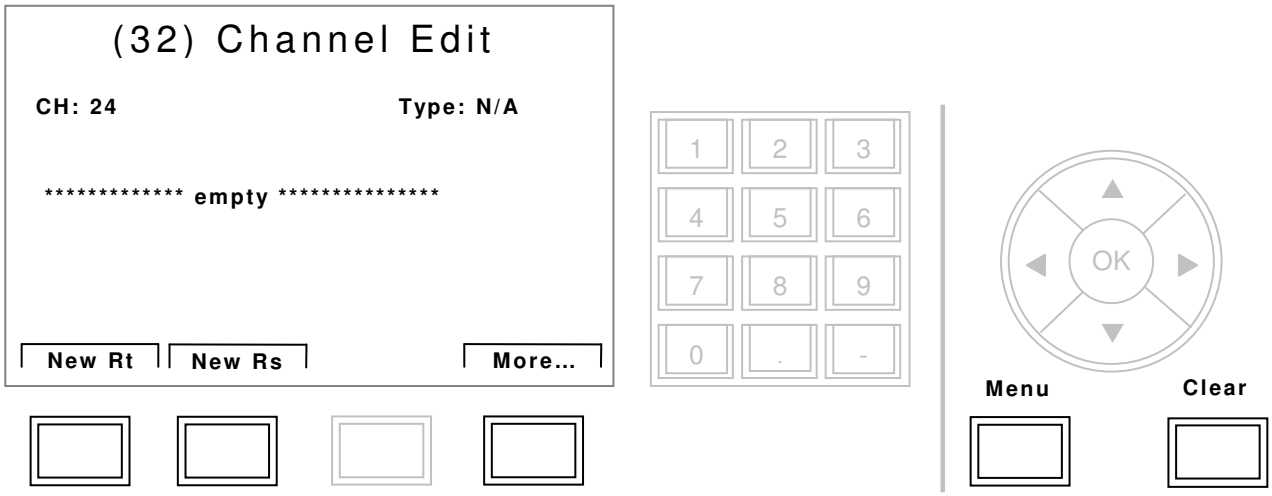


Select **Save** or **Cancel**, as required, and the screen will change back to the one allowing you to select another channel for editing.

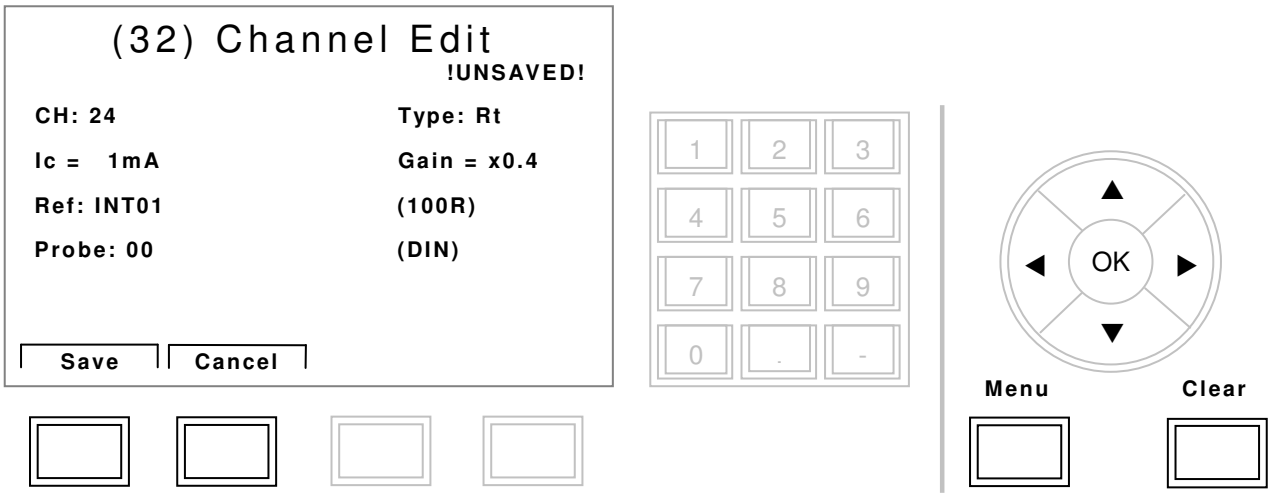
New channels may be entered (used ones may only be edit or deleted). Select an unused channel using the **Prev** and **Next** soft-keys. The display will look similar to –



Press **More...** to see a screen similar to the following one –

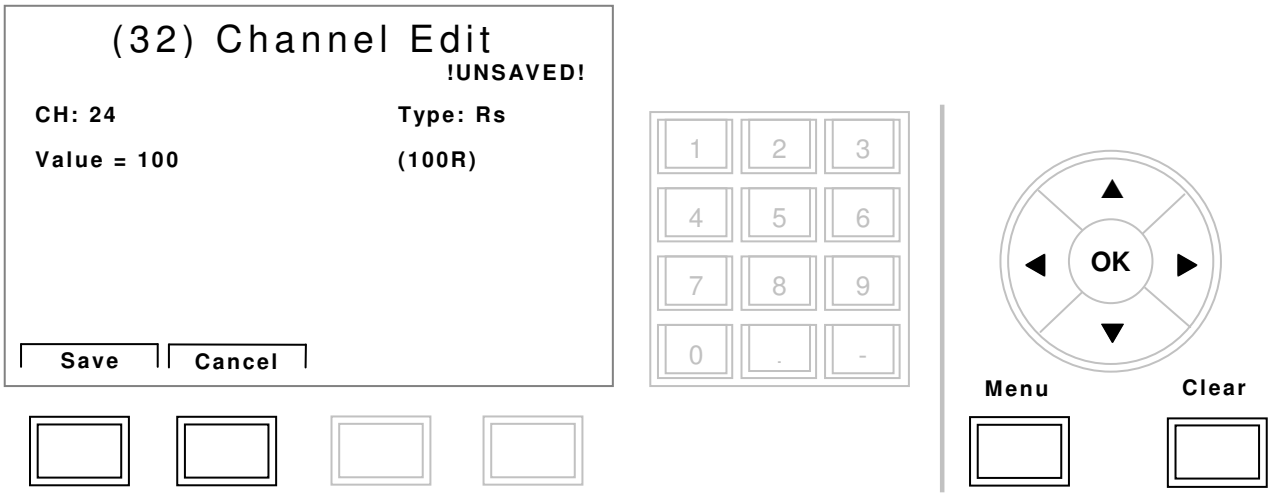


Press **New Rt** to create a new Rt channel; a default set of parameters will be entered. Alternatively, if **New Rs** is pressed, a default set of parameters for the Rs channel will be entered. For example, if the **New Rt** soft-key is pressed, the screen will change to –



Press either the **Save** or **Cancel** soft-keys, as required. Pressing **Save** soft-key will enter a new Rt channel; the default values can then be edited.

The display will look like the following if **New Rs** is pressed –



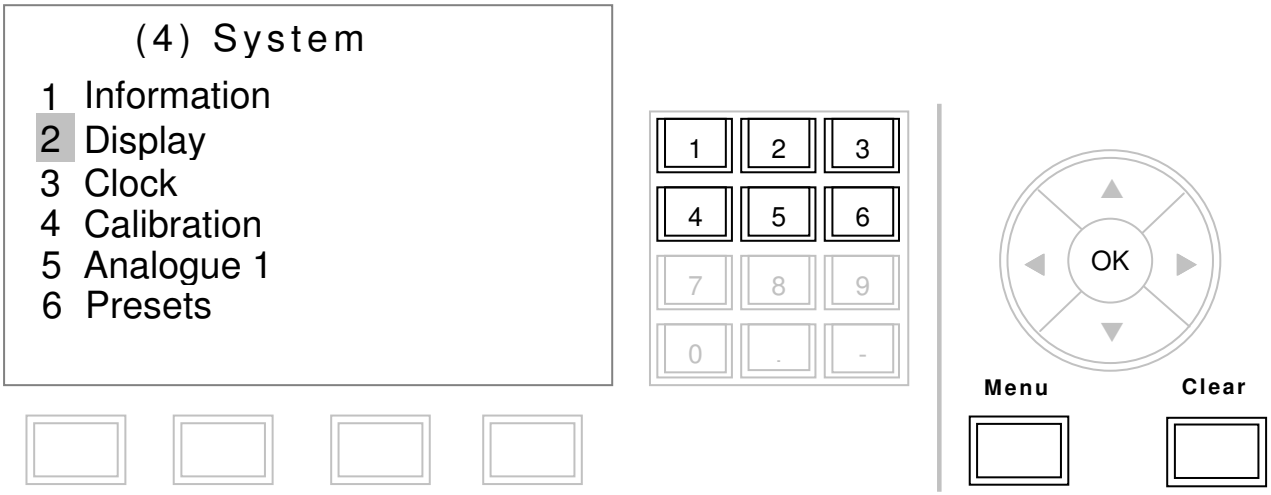
Press either the **Save** or the **Cancel** soft-keys, as required. Pressing **Save** soft-key will enter a new Rs channel; the default values can then be edited.

Press the **Menu** key to return to measurement mode or the **Clear** key to return to the previous menu.

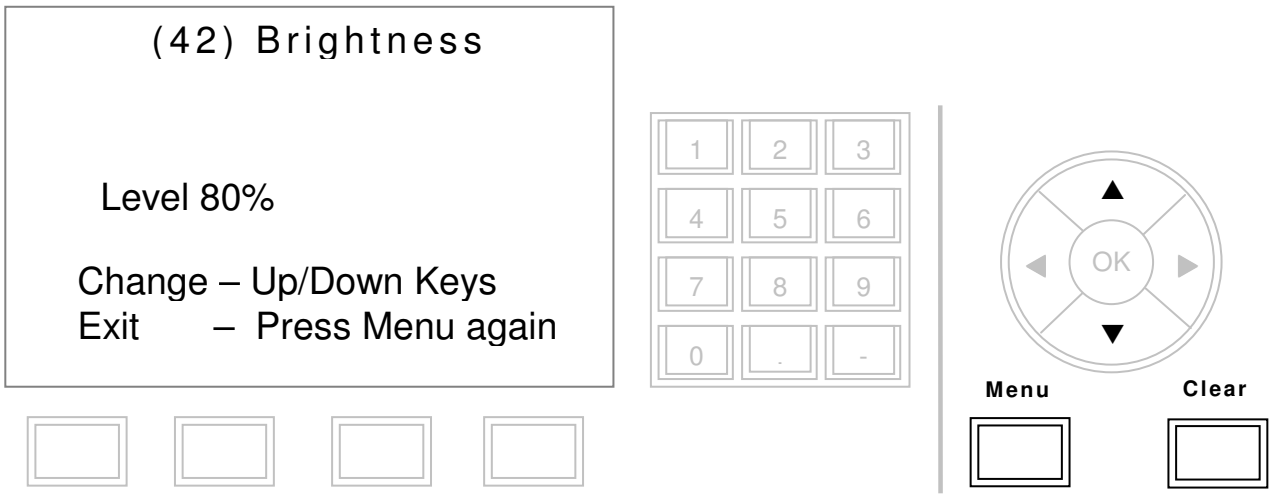
5.3.7 Display menu

This menu is used to set the desired display brightness level.

Press the **4** key on the numeric pad and use the up and down keys to navigate to the System Menu and press the **OK** key to access this menu. Use the navigation key to move to the Display menu as shown below.



Press the **2** key or the **OK** key to get to this screen –

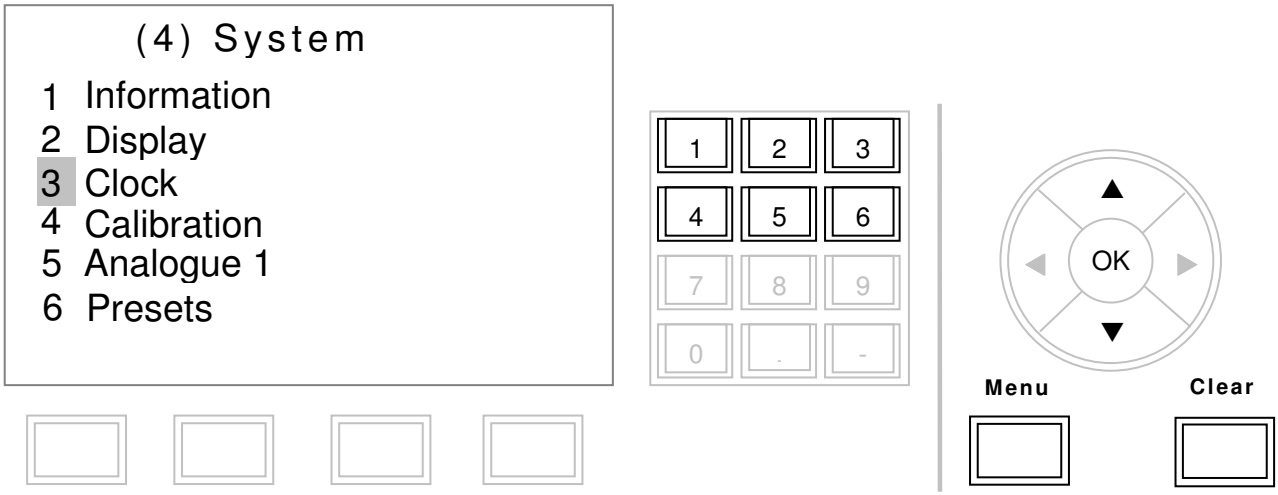


Use the ▲ and ▼ navigation keys to set the brightness to the desired value. Press the **Menu** key to accept the value and return to measurement mode or the **Clear** key to return to the previous menu.

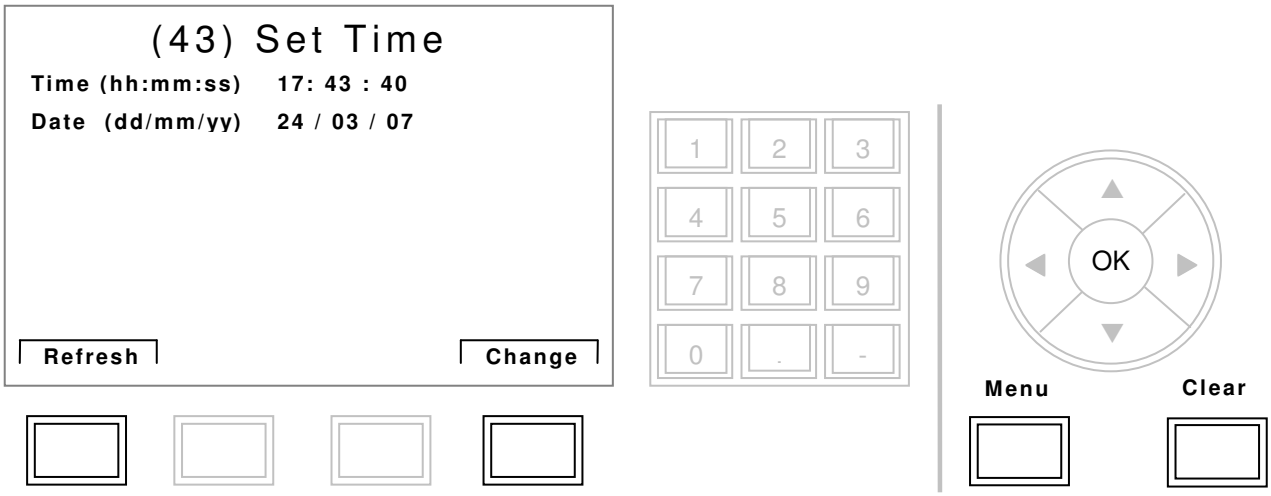
5.3.8 Clock menu

This menu is used to set the current date and time.

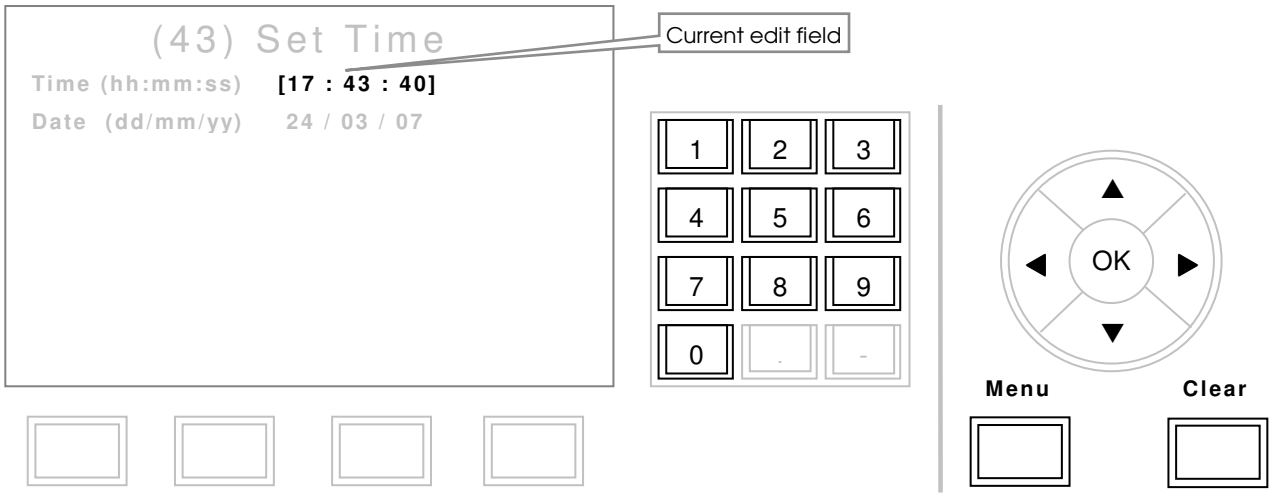
Press the **4** key on the numeric pad and use the up and down keys to navigate to the System Menu and press the **OK** key to access this menu. Use the navigation key to move to the Clock menu as shown below.



Press the **3** key or the **OK** key to set the time and/or date –

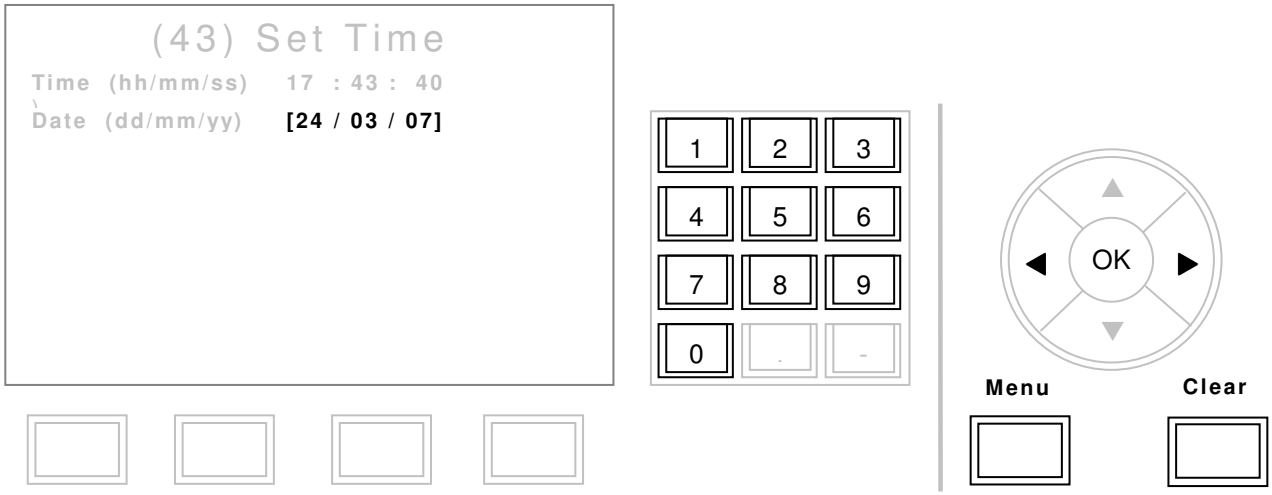


The **Refresh** soft-key is used to show the current time and date (time and date are frozen on entry so that they can be easily edited). Press the **Change** soft-key to alter the settings. The display will change to show –



The display has changed to show the `**(**' and **')**' brackets around the current edit field (the time). The ◀ and ▶ keys are used to move the cursor to the left or right; edit the time and press **OK** (press the **Clear** to exit without changing the time). Use the numeric keypad to change the current edit field values. The ▲ and ▼ keys swap between time and date fields.

Press the **OK** key once the entry within the currently selected field is correct; this returns the action of the ◀ and ▶ keys to moving between fields.

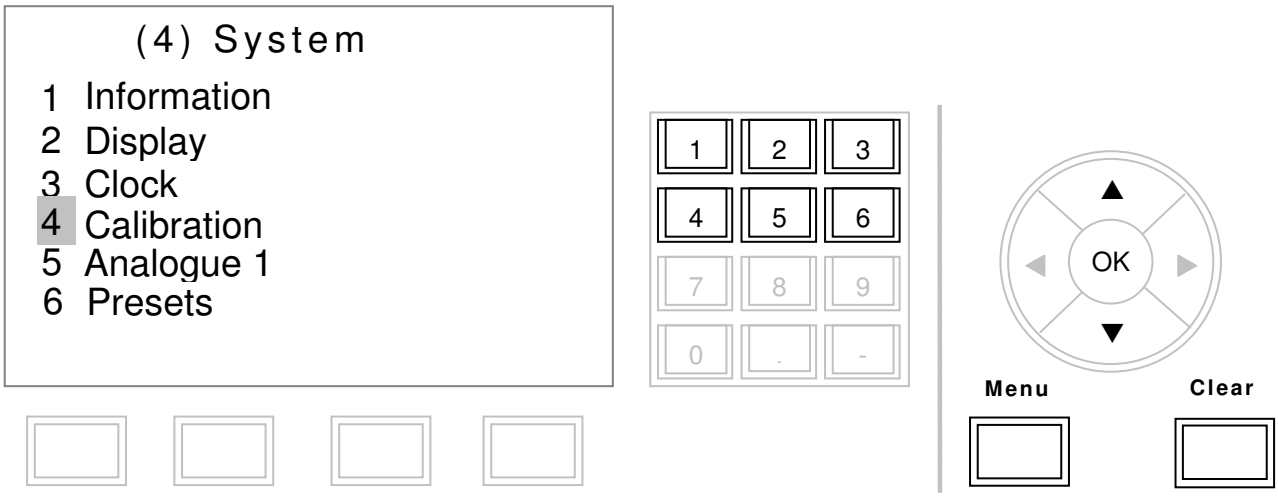


Once you are happy with all the field-entries, press the **Menu** key to accept the value and return to measurement mode or press the **Clear** key to return to the previous menu without setting the clock.

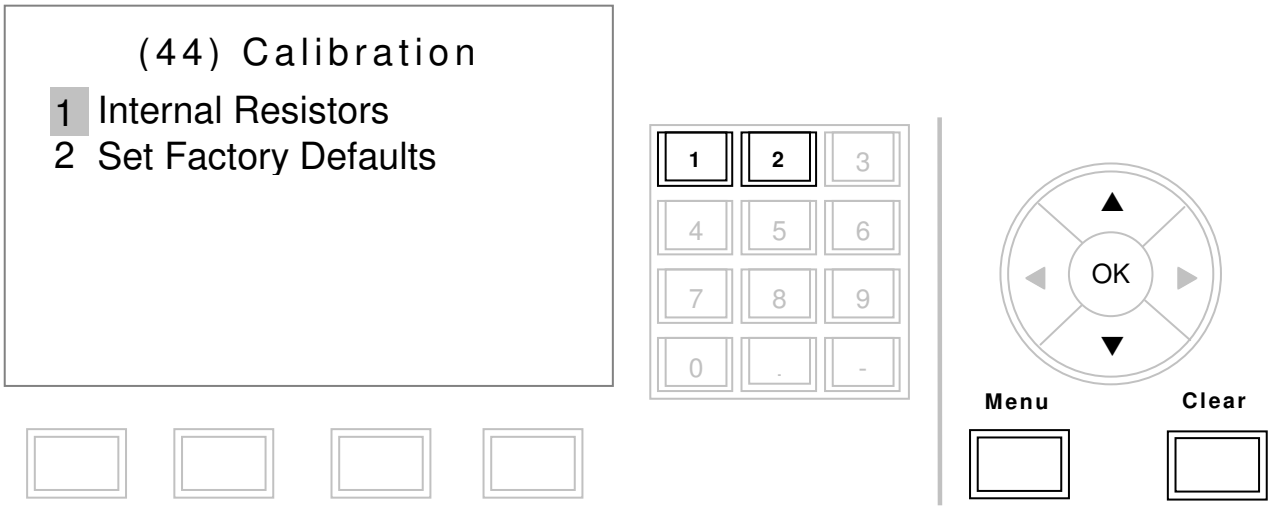
5.3.9 Calibration (Internal Rs) menu

This menu is used to set the calibrated values of the internal reference resistors and to reset the F600 to its factory default setting.

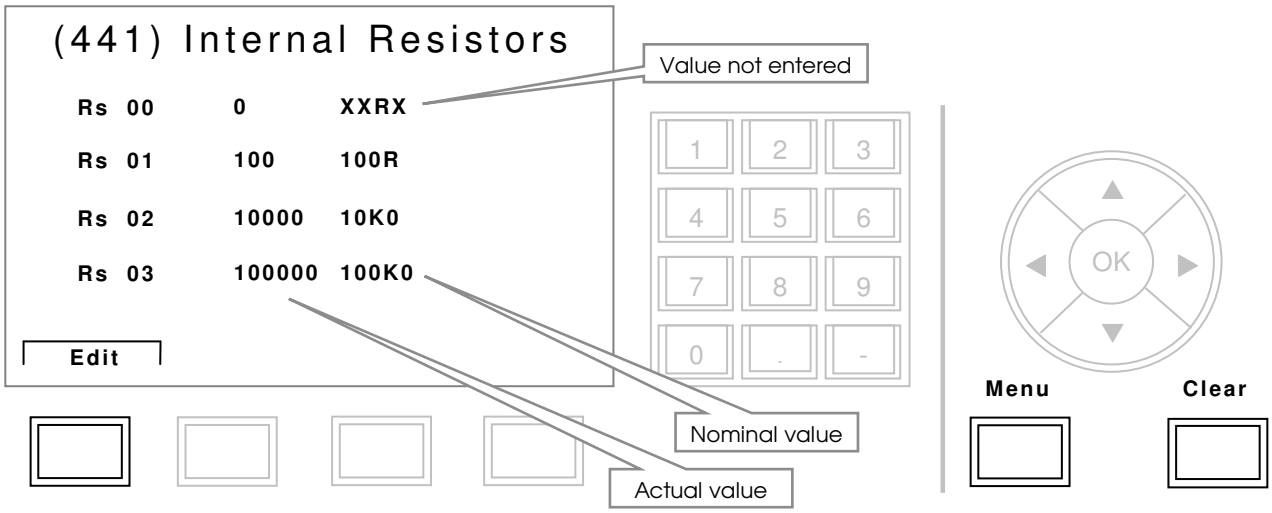
Press the **4** key on the numeric pad and use the up and down keys to navigate to the System Menu and press the **OK** key to access this menu. Use the navigation key to move to the Calibration menu as shown below.



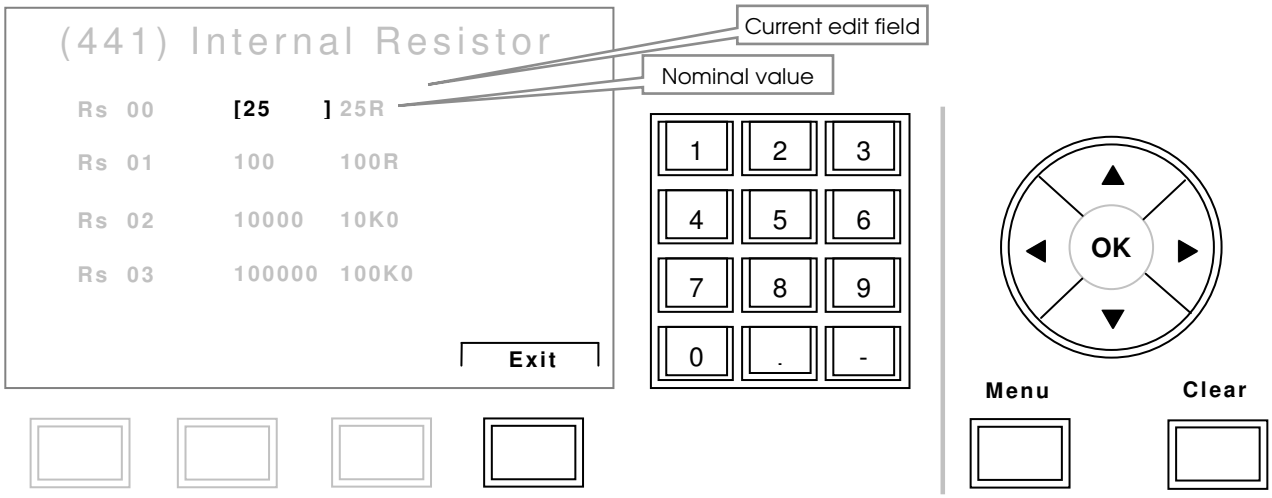
Press the **4** key or the **OK** key to see the menu –



Press the **1** key or the **OK** key to see the calibration menu for the internal resistors -



Press the **Edit** soft-key to adjust the internal calibration resistance values[16]. The screen will change to show -



Work out the adjusted resistance value that must be entered, based on the actual calibration resistor value. This is most easily done by first setting the internal calibration value (R_{Int}) to the nominal resistor value (R_{Nom}), measuring the value (R_{Obs}) and then entering the calibration resistance value calculated from –

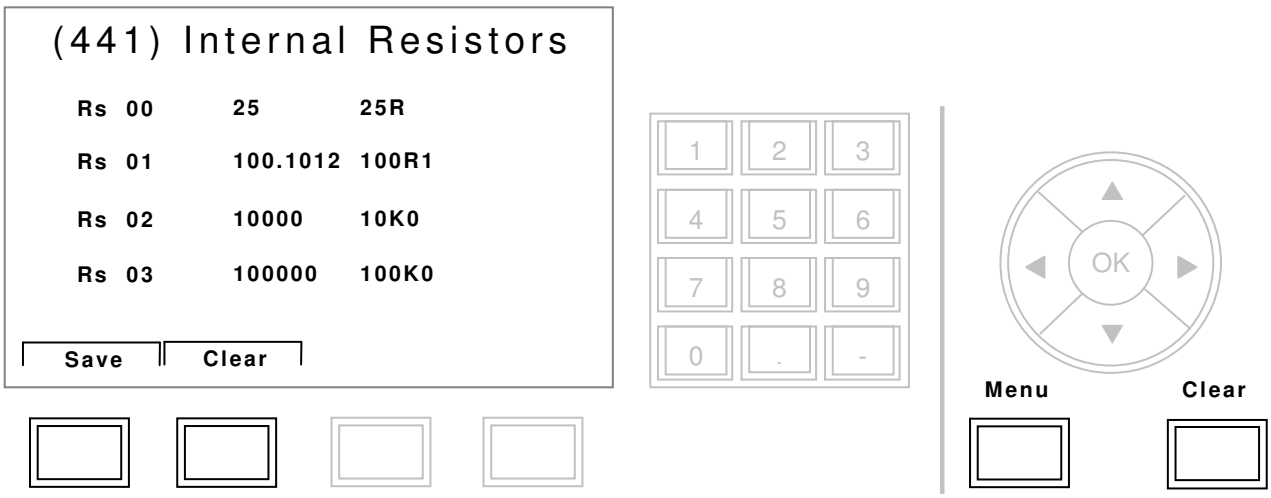
$$R_{Internal} = \left(\frac{R_{Ref}}{R_{Obs}} * R_{Nom} \right)$$

[16] Note that these will be recorded on the test certificate that comes with the instrument.

The editing process is identical to the one used in section 5.3.4. Edit the current field and note that the nominal field will automatically be adjusted to follow it (3 significant digits shown).

Press the **OK** key once you are happy with the new value. Edit the remaining values, as required before pressing the **Exit** soft-key.

The screen, for example, will change to show –



Press the **Save** soft-key to keep the change(s) or press the **Clear** soft-key to prevent any changes from being applied. Press the **Menu** key to end editing (or the **Cancel** to return to the previous menu).

The nominal internal resistors values (fitted as standard) are 25 ohms, 100 ohms, 10 kohms and 100 kohms.

Note

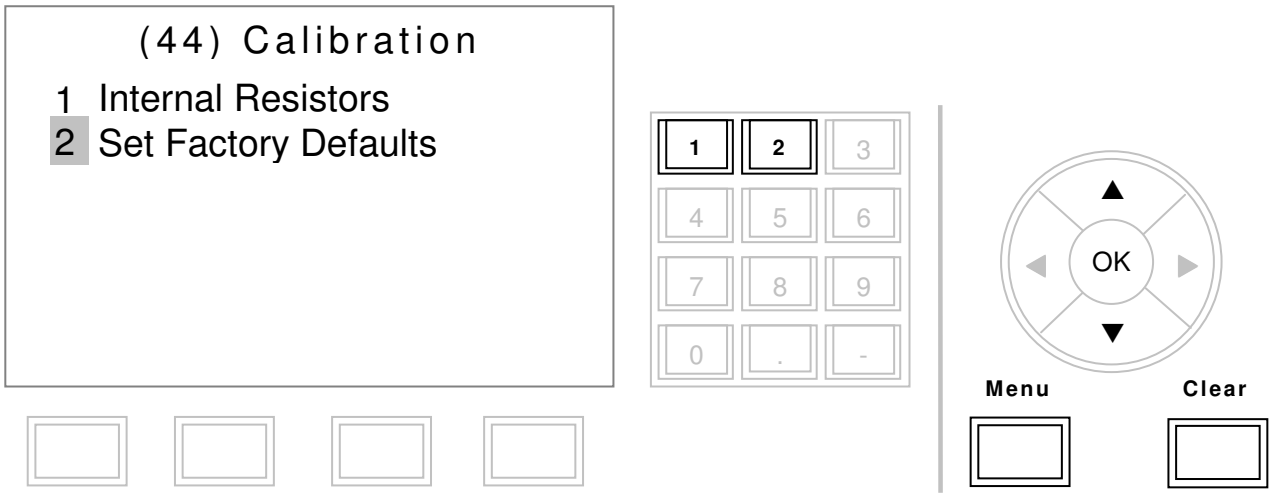
The calibration values are held in non-volatile memory inside the F100. The instrument MUST be switched off and on again for the new calibration values to take effect.

5.3.10 Calibration (Factory Defaults) menu

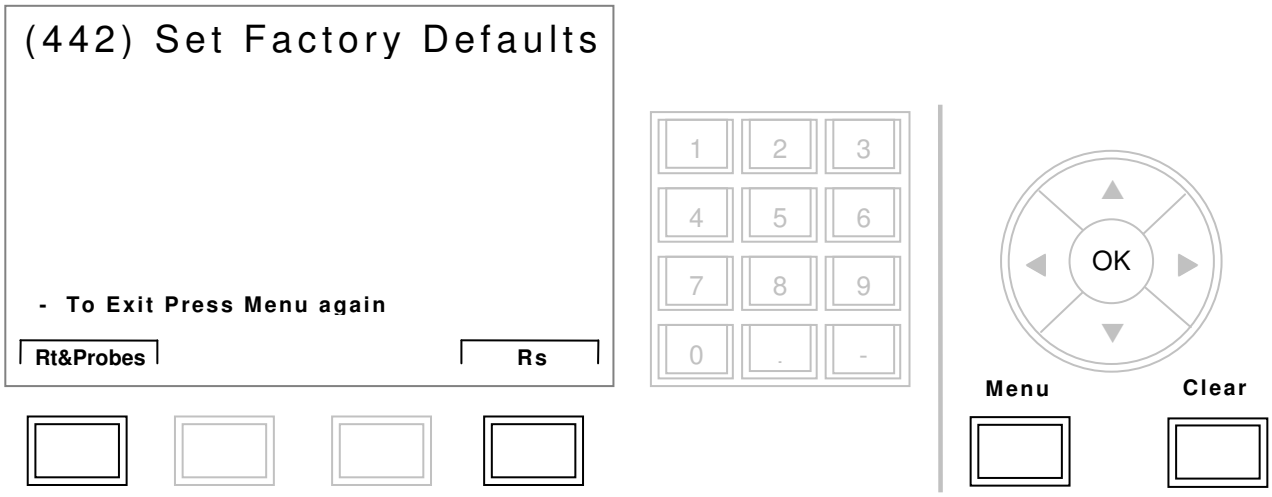
This menu clears the factory default settings for the internal resistors and probes and also for the external references.

Note
Use this menu with care.
ALL values entered into the F600 will be cleared.

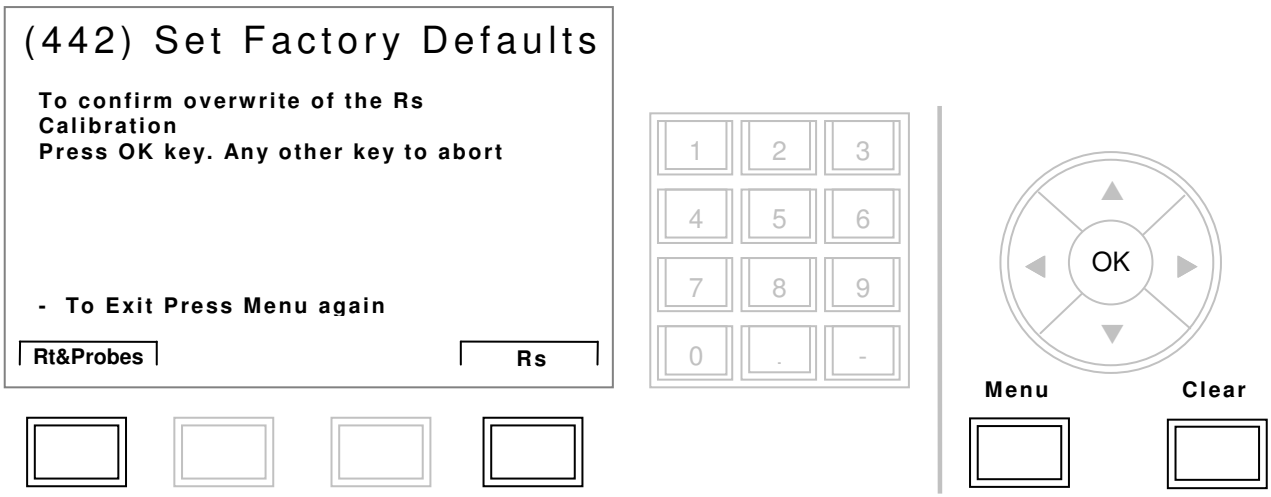
Press the **4** key or the **OK** key to see the calibration menu –-



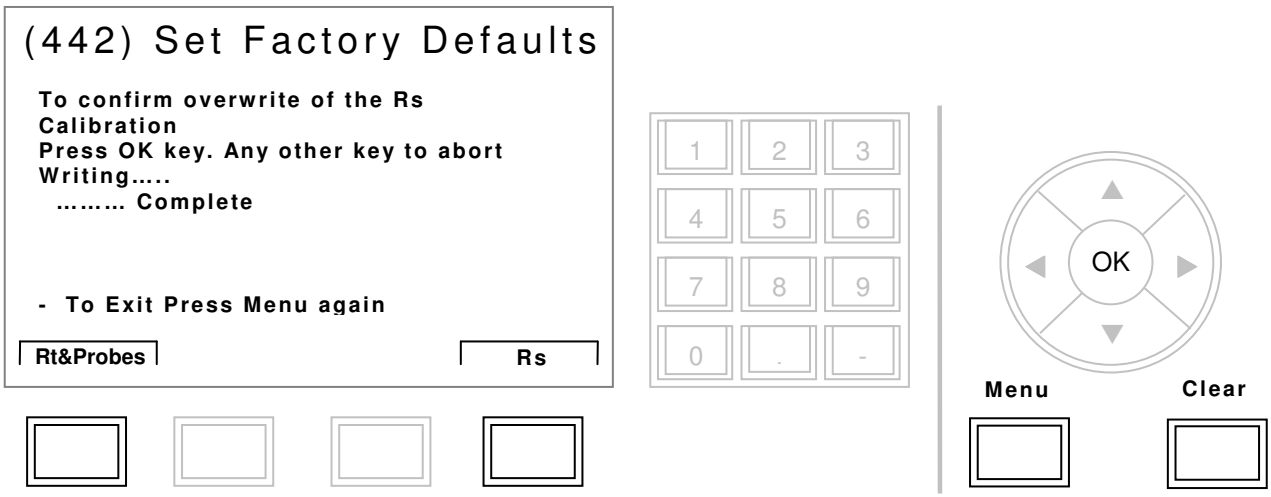
Press the **2** key (or use the navigation keys) and press the **OK** key to select the Set Factory Defaults menu.



Either press the **Rt&Probes** soft-key or the **Rs** soft-key. For example, pressing the **Rt** key will show –



Either press the **OK** (or any other key) to prevent overwriting. If the **OK** key is pressed then the following screen will be seen after a few seconds.

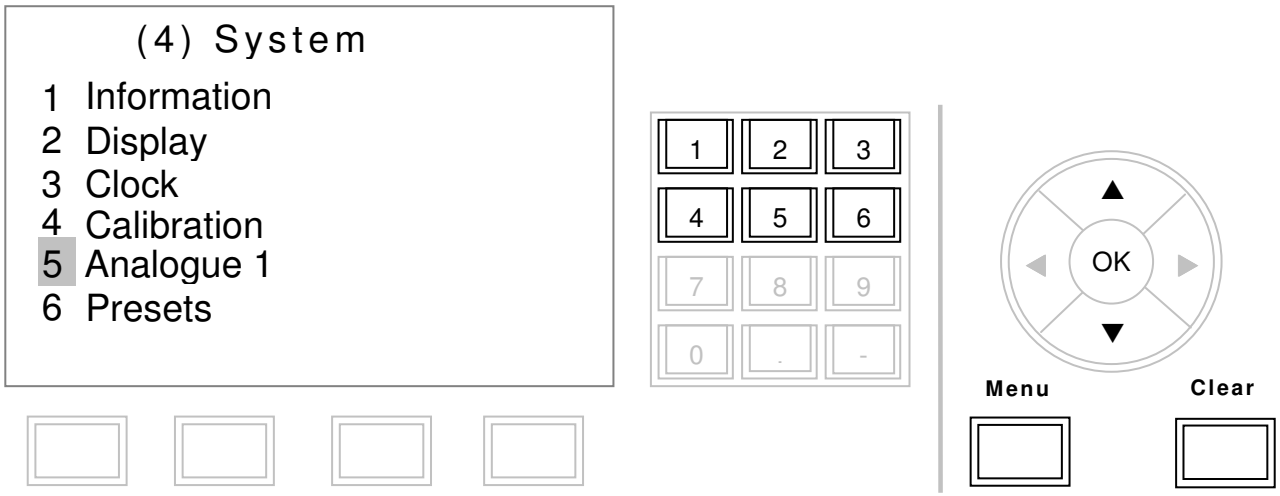


Press the **Menu** to exit or press the **Cancel** key to return to the previous menu.

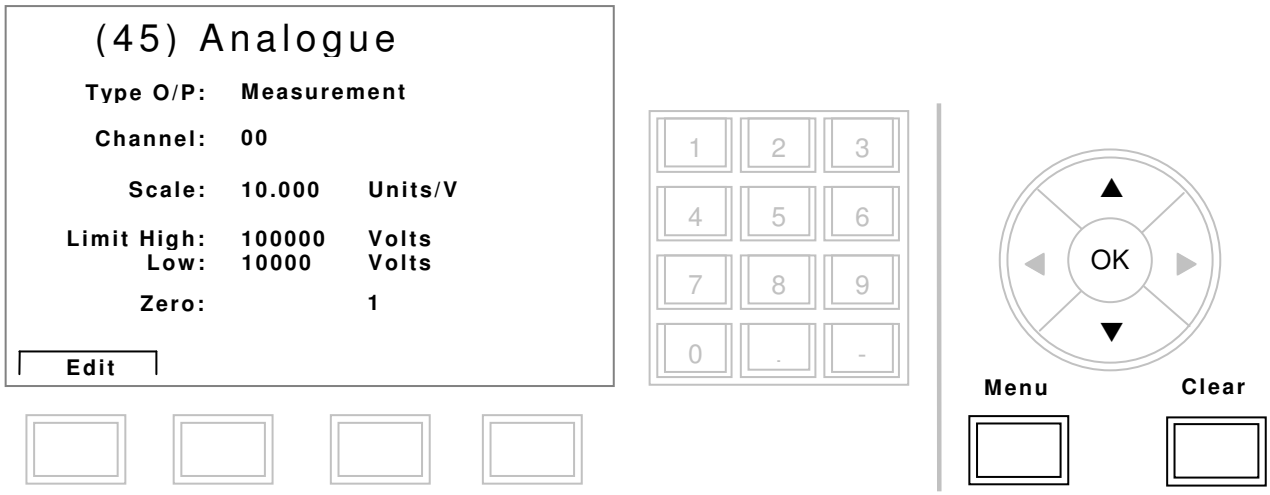
5.3.11 Analogue output menu

This menu is used to set the analogue output scaling and offset values for the F600 Bridge.

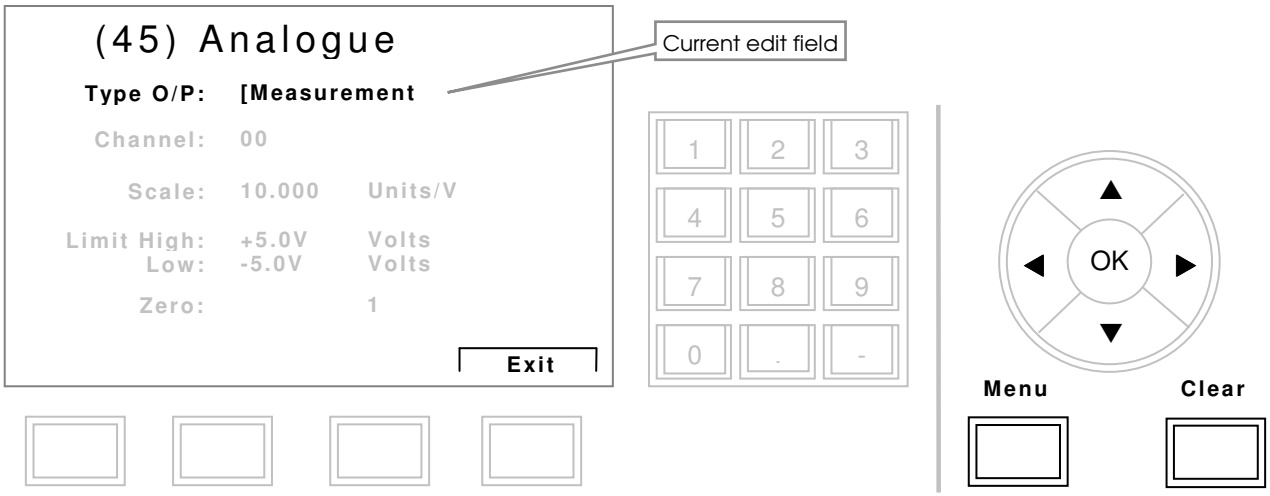
Press the **4** key on the numeric pad and use the up and down keys to navigate to the System Menu and press the **OK** key to access this menu. Use the navigation key to move to the Analogue 1 output menu as shown below.



Press the **5** key or the **OK** key to see the current values –



Press the **Edit** soft-key to alter the analogue output values. The screen will change to show -



The display has changed to show the `**(**' and **')**' brackets around the current edit field (the measurement type in this case). The ◀ and ▶ navigation keys are used to move the active edit field. Move to the field that you want to change and press **OK**. The ◀ and ▶ keys will change to moving the cursor within the field. The numeric keypad may be used to change numeric field values. Editing is similar to the Probe Edit screen (see section 5.3.4). Use the ▲ and ▼ navigation keys to change the Measurement field.

Type O/P

This field is fixed to **Measurement** as the output value for the F600DC Bridge. The output is based on the current units –

Output(V) = (Measurement - Zero) * Scale

Channel

Selects channel for which to set the analogue parameters to (0 to 99)

Scale

Scale factor for the selected channel in units/volt (+/-1000 to 0.01)

Limit High

Sets the maximum output in volts for the selected channel (+10.0 to -10.0V)

Limit Low

Sets the minimum output in volts for the selected channel (+10.0 to -10.0V)

Zero

Sets the offset value (from 0V) for the selected channel (real or exponential number)

Note that the values of **Zero** and **Scale** are unit-less and will apply to the active channel's units.

For example, to set channel 19 to give ±5V full-scale output based around +1V (i.e. a full-scale output between +6V and -4V), set the values to –

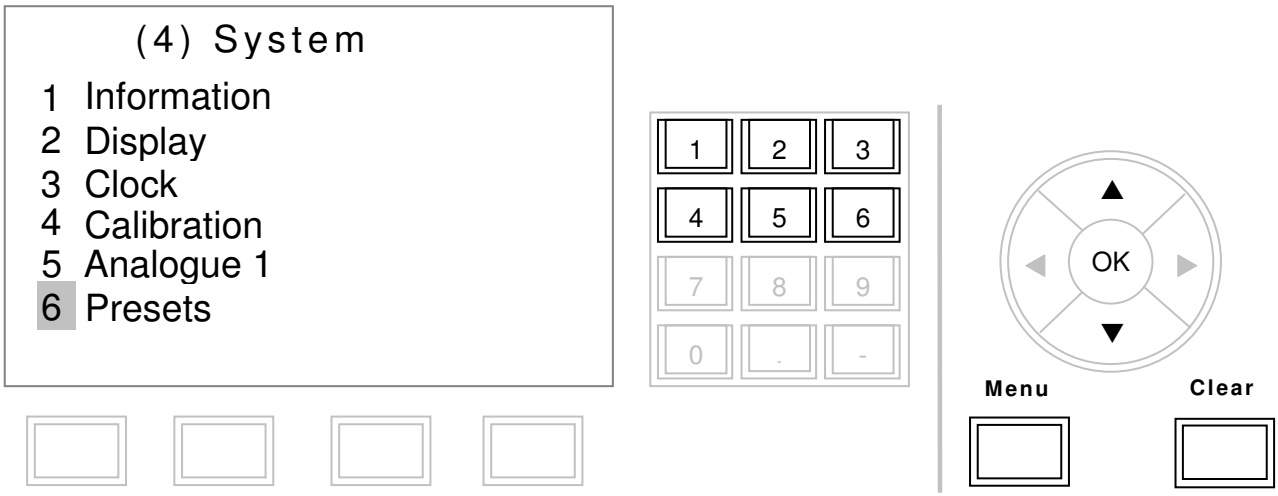
Channel = 19
Scale = 0.5
Limit High = +6V
Limit Low = -4V
Zero = +1V

Once you are happy with all the field-entries, press the **Menu** key to accept the value and return to measurement mode or press the **Clear** key to return to the previous menu.

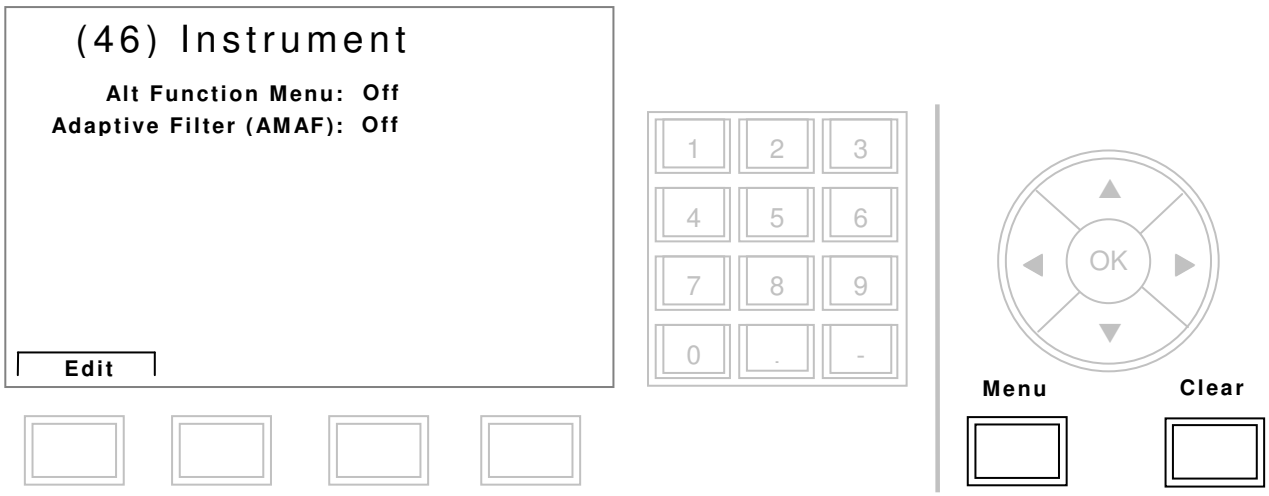
5.3.12 Presets menu

This menu is used to set alternative operation for the keypad (shift key functions) and may be used to set the adaptive (AMAF) filter when shift key operation is active.

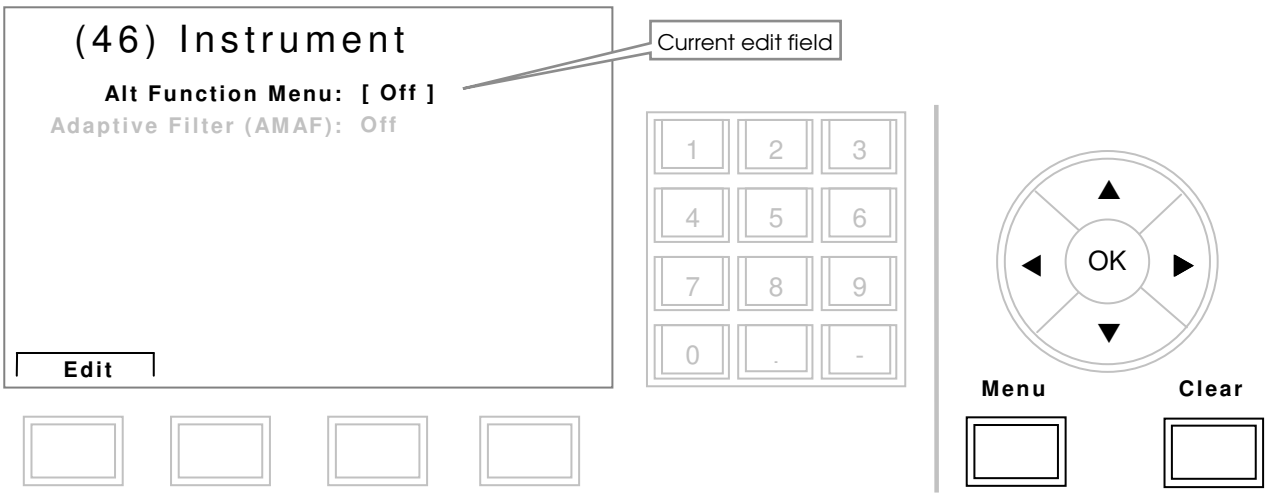
Press the **4** key on the numeric pad and use the up and down keys to navigate to the System Menu and press the **OK** key to access this menu. Use the navigation key to move to the Presets menu as shown below.



Press the **6** key or the **OK** key to see the current values –



Press the **Edit** soft-key to alter the values. The screen will change to show -

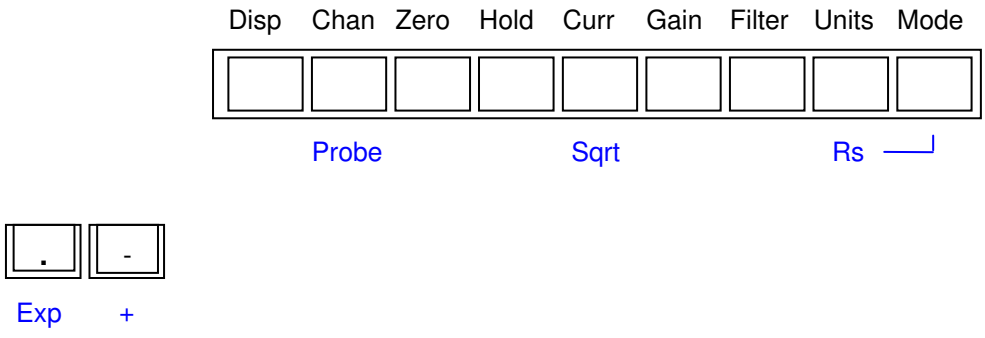


Editing is similar to the previous menus. Use the ▲ and ▼ navigation keys to move the active edit field. Move to the field that you want to change and press the ◀ and ▶ keys to alter the values within the field.

Once you are happy with the entries, press the **Menu** key to return to measurement mode or press the **Clear** key to return to the previous menu.

Adaptive filter (AMAF) setting is described in section 5.2.1.

The **Alt Function Menu** option allows some of the more frequently used functions to be accessed at the top level using a shift key(and the decimal and minus keys gain additional functionality). There are only two values for this field (Off and On). Once the option has been enabled (On), the **Mode** key will act as a shift key with the some of the function keys producing alternative operation[17]. Alternative (shift) key functions are shown below in blue. Press the Shift key followed by the required function key to access alternative key operation.



[17] The alternative function list is briefly displayed when the **Mode** key is pressed.

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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 by a message on the display.

6.2 Measurement ranges

Measurement Units Thermistor	Conversion	Under Range	Over Range	Units
Resistance	None	0	500,000	ohms
Temperature	S & H	Thermistor dependent		°C, °F, K

Measurement Units PRT	Conversion	Under Range	Over Range	Units
Resistance	None	0	400	ohms
Temperature	Din90	-201	+851	°C, °F, K
	CvD	-201	+850	°C, °F, K
	ITS90	-201	+963	°C, °F, K

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7. Calibrating the F600

7.1 F600DC instrument calibration

The F600DC bridge measurement technique used in the F600 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°C ±2°C.

Set of stable, calibrated (0.01ppm) resistors (3 ranges, 6 resistors).

7.3 Calibration procedure

See section 5.3.9.

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8. Obtaining the best from the F600DC bridge

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 40 minutes for the instrument to fully stabilise if switching on from cold (less time is required if using external reference resistors).
- ✓ 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.
- ✓ Do ensure that you use an external, regularly calibrated reference resistance for your most accurate measurements[18].
- ✓ 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.
- ✓ Select a suitable moving average filter (medium or high values are suitable for most situations when the measurements are taken on thermally stable systems.
- ✓ Set the maximum current that your probe will stand without self-heating becoming an issue.
- ✓ Set the maximum gain consistent with the probe current and maximum temperature (resistance) that you need to measure.

- × Do NOT locate the instrument near a source of heat or in draughts.
- × Do NOT locate the instrument near sources of electrical interference – e.g. electric motors.

[18] The F600DC Bridge contains high-quality and stable internal reference resistors, however these are only specified to an accuracy of ±0.01% with a thermal stability ±0.5 ppm/°C.

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9. Communications - Interface and PC commands

9.1 Introduction

The F600 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).

The USB PC interface will be installed as a virtual COM port driver (simulated serial port). The communication protocol is –

Bits per second	9600
Data bits	8
Stop bits	1
Parity	none
Flow control	none

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

The commands are buffered by the F600 (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, it is normally easier to wait for the expected response before issuing the next one.

9.2 USB device driver

Run the program **CDM_Setup.exe** from the directory **D:\Downloader** on the CD supplied with the instrument[19]. This will install the USB drivers. You will see the following message once this is complete.

[19] Replace the '**D**' with the name of your CD device as necessary

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[20], through some programming interface, from Excel™ (or similar program) or interactively with a dedicated program (such as ULOG – supplied by ASL).

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 F600'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[21] <parameter list>	Parameters list separated by commas
Terminator <cr> or <cr><lf>	Terminates the line and the command

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

[20] A number of these are available free on the Web.

[21] The `<' and `>' symbols in the text are used to help with clarity; they do not form part of the command sequence.

CONF:CURR 2,3<cr><lf>

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

It is important to remember the space between the end of 'CURR' and the '2'.

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 Startring with PC commands

Experiment with the ***IDN?** commands when first starting and do not use the **SYSTEM:REMOTE** command until you are happy with the instrument's operation[22].

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

[22] The SYSTEM:REMOTE command is cancelled once the instrument's power is switched off and on again.

9.4 USB interface commands

All F600 commands are described in detail in the follow sections. Each command description follows a common layout.

9.4.1 SYSTem:REMote

Command SYST:REM
SYSTEM:REMOTE

Returns None

Function Places the instrument in remote mode for USB interface control
Displays 'Remote' on the F600
Aborts the current measurement cycle
Clears the last reading from the display
Clears the output buffer
Locks out the instrument's front panel keys

Example SYST:REM

9.4.2 SYSTem:LOCal

Command SYST:LOC
SYSTEM:LOCAL

Returns None

Function Returns the instrument to local mode
Removes 'Remote' from the instrument display
Enables the instrument's front panel keys

Example SYST:LOC

9.4.3 *IDN?

Command *IDN?

Returns <manufacturer>,<model no>,<serial no>,<firmware version>

Parameters

<manufacture>	ASL
<model no>	F600DC
<serial no>	Serial number of the instrument
<firmware version>	Current firmware version and date

Function Reads the instrument's identification code consisting of the manufacturer name, instrument model number, instrument serial number, firmware version and date

Example

*IDN?<cr><lf>	(command)
ASL,F600DC,00001003,1V0,30March2007	(response)

9.4.4 CONFigure:CURRent <multi>,<base>

Command CONF:CURR <multiplier>,<base>
CONFIGURE:CURRENT < multiplier >,<base>

Returns None

Parameters

< multiplier >	0	Multiply by	1
	1	Multiply by	0.5
	2	Multiply by	✓2
<base>	0	Current set to	-
	1	Current set to	-
	2	Current set to	100µA
	3	Current set to	200µA
	4	Current set to	-
	5	Current set to	1.0mA
	6	Current set to	2.0mA
	7	Current set to	-
	8	Current set to	10mA

Function Selects the specified current without initiating a measurement

Aborts the current measurement cycle

Clears the last measurement from the display

Clears the output buffer

Example CONF:CURR<space>2,3<cr><lf>
(sets the active channel's current to ✓2 x 200µA)

9.4.5 CONFigure:CURRent ?

Command CONF:CURR?
CONFIGURE:CURRENT?

Returns < multiplier >,<base> formatted to 2 significant digits

Function Returns the active channel's current setting

Example CONF:CURR?<cr><lf> (command)
02,03<cr><lf> (response)
(returns the active channel's setting of ✓2 x 200µA)

9.4.6 CONFigure:GAIN <multiplier>,<base>

Command CONF:GAIN <multiplier>,<base>

CONFIGURE:GAIN <multiplier>,<base>

Returns None

Parameters

< multiplier >	0	Multiply by	0.4
	1	Multiply by	0.8
	2	Multiply by	1
	3	Multiply by	2
<base>	0	Gain set to	$1x10^0$
	1	Gain set to	$1x10^1$
	2	Gain set to	$1x10^2$
	3	Gain set to	$1x10^3$
	4	Gain set to	$1x10^3$
	5	Gain set to	$1x10^4$
	6	Gain set to	$1x10^5$
	7	Gain set to	$1x10^6$
	8	Gain set to	$1x10^7$

Function Sets the active channel's gain

Example CONF:GAIN<space>3,1<cr><lf>
(sets the active channel's gain to 20)

9.4.7 CONFigure:GAIN?

Command CONF:GAIN?
CONFIGURE:GAIN?

Returns < multiplier >,<base><cr><lf> formatted to 2 significant digits

Function Returns the active channel's gain setting

Example
CONF:GAIN?<cr><lf> (command)
03,01<cr><lf> (response)
(returns the active channel's gain settings of 20)

9.4.8 CONFigure:FILTer <filter>

Command CONF:FILT <filter>
CONFIGURE:FILTER <filter>

Returns None

Parameters

<filter>	0	1 sec
	1	2 sec
	2	4 sec
	3	10 sec
	4	20 sec

Example CONF:FILT 1<space><cr><lf>
(sets the sample rate to 2 seconds)

9.4.9 CONFigure:FILTer?

Command CONF:FILT?
CONFIGURE:FILTER?

Returns <filter>

Function Returns the currently active channel's filter setting

Example CONF:FILT?<cr><lf> (command)
01<cr><lf> (response)
(returns the active channel's filter setting of 2 sec)

9.4.10 CONFigure:AOUT <type>,<channel>,<scale>,<high>,<low>,<zero>

Command CONF:AOUT <type>,<channel>,<scale>,<high>,<low>,<zero>
CONFIGURE:AOUT <type>,<channel>,<scale>,<high>,<low>,<zero>

Returns None

Parameters

<type>	0	Measurement (fixed)
<channel>	0 to 99	Which channel to apply to
<scale>	+/-1000 to 0.01	Scale factor in units/volt
<high>	+10.0 to –10.0	Maximum output in volts
<low>	+10.0 to –10.0	Minimum output in volts
<zero>	Real or exp number	Value to offset the output in units

Function Sets the analogue output parameters. The output is based on the current units –

Output(V) = (Measurement - Zero) * Scale

Note that the values of zero and scale are unit-less and will apply to the active channel's units - e.g. zero = 10.0, scale =100 will adopt the units of the instrument

Example CONF:AOUT<space>0,02,-10.0,+5.0,-5.0,1.0<cr><lf>
Sets the analogue output voltage on channel 2 with a gain of x –10 symmetrically about 1.0 and limiting the output to +/-5V of full scale.

So if CH2 = 1.1, the analogue 1 output = -1.0V, and if CH2 = 0.75, the analogue 1 output = +2.5V

9.4.11 CONFigure:AOUT?

Command CONF:AOUT?
CONF:AOUT?

Returns <type>,<channel>,<scale>,<high>,<low>,<zero> formatted to 2 places

Function Returns the active channel's AOUT settings

Example
CONF: AOUT?<cr><lf> (command)
0,02,-10.00,+5.00,-5.00,1E01<cr><lf> (response)
(returns the active channels AOUT setting)

9.4.12 CONFigure:REFerence <source>,<channel>

Command CONF:REF <source>,<channel>
CONFIGURE:REFERENCE <source>,<channel>

Returns None

Parameters

<channel>	0 to 99	single channel measurement
<source>	INT	Internal
	EXT	External

Function Sets the channel to use this reference type
Aborts the current measurement cycle
Clears the last measurement from the display
Clears the output buffer

Example CONF:REF<space>INT,01<cr><lf>
(sets the selected channel's reference to internal 01 standard)

9.4.13 CONFigure:REFerence?

Command CONF:REF?
CONFIGURE:REFERENCE?

Returns <source>,<channel>

Function Returns the active channel's reference setting

Example
CONF:FILT?<cr><lf> (command)
I,01<cr><lf> (response)
(returns the reference for the active channel as Internal Ch01)

9.4.14 CONFigure:MODE <mode>,<test>

Command CONF:MODE <mode>,<test>

CONFIGURE:MODE <channel>,<test>

Returns None

Parameters

<mode>	0	Reserved
	1	Reserved
<test>	0	Reserved

Function Selects the specified instrument measurement mode
Aborts the current measurement cycle
Clears the output buffer

Example CONF:MODE<space>1,0<cr><lf>
(puts the instrument into the normal mode of operation)

9.4.15 CONFigure:MODE?

Command CONF:MODE?
CONFIGURE:MODE?

Returns <mode>,<test><cr><lf>

Function Select the specified instrument measurement mode

Example CONF:MODE<space>1,0<cr><lf>
Put instrument into auto with no test mode (i.e. normal operation)

CONF:MODE?<cr><lf> (command)
0,0<cr><lf> (response)
(returns with the instrument's setting of manual & manual)

Command MEAS:CHANNEL <channel>
MEASURE:CHAN <channel>

Returns None

Function Sets the instrument to the active channel specified
Aborts the current measurement cycle
Clears the last measurement from the display
Clears the output buffer
Continues measuring with this channel's settings

Example MEAS:CHAN<space>23<cr><lf>
(makes channel 23 the currently active channel)

9.4.16 MEASure:CHANnel?

Command MEAS:CHANNEL
MEASURE:CHAN

Returns Currently selected channel

Function Returns the currently selected channel

Example MEAS:CHAN?<cr><lf> (command)
23<cr><lf> (response)
(returns with the active channel of 23)

9.4.17 MEASure:READ?

Command MEAS:READ?
MEASURE:READ?

Returns <measurement>,<units>,<flag>

Parameters

<measurement>	last measurement value
<units>	current units for the active channel (see below)

C	Degrees Celcius
F	Degrees Fahrenheit
K	Kelvin
R	Resistance ohm's
W	Ratio

<flag>	B Balanced (reading OK)
	L too Low
	H too High
	Exx error state (see below)

Exx	Description
E01	Invalid reading
E02	Open probe
E03	Reserved
E04	Ratio over-range (exceeds maximum value of 9.999999)
E05	Ratio under-range (less than minimum value of <0.0000000)
E06	Ratio not a real value (i.e. divide by zero)
E07	Reserved
E08	Resistance over-range
E09	Resistance under-range
E10	Resistance does not compute to a real value

E11	Reserved
E12	Probe error
E13	Invalid temperature calculation
E14	Temperature above Limit
E15	Temperature below Limit

Function Returns the active channel's next measurement and settings

Example
MEAS:READ? <cr><lf> (command)
0.999993, W,B<cr><lf> (response)
(returns the balanced ratio of 0.999993 for the active channel)

9.4.18 MEASure:FETCH?

Command MEAS:FETCH?
MEASURE: FETCH?

Returns <measurement>,<units>,<flag>

Parameters See MEASURE_READ?

Function Returns the active channel's current measurement and settings with the currently selected units. May be used to reread with different units

Example
UNIT:TEMP<space>CEL<cr><lf> (command to set units to celcius)
MEAS: FETCH? <cr><lf> (command)
203.456, C,B<cr><lf> (response)
(returns the balanced value of 203.456 °C for the active channel)

9.4.19 UNIT:TEMPerature <units>

Command
UNIT:TEMP <units>
UNIT:TEMPERATURE <units>

Returns None

Parameters

<units>	C or CEL	Degrees Celcius
	F or FAR	Degrees Fahrenheit
	K	Kelvin
	R	Resistance ohm's
	W	Ratio

Function Sets the active channel's units.

Example
UNIT:TEMP<space>CEL<cr><lf>
(sets the active channel's units to celcius)

9.4.20 UNIT:TEMPerature?

Command UNIT:TEMP?
UNIT:TEMPERATURE?

Returns <units><cr><lf>

Function Returns the active channel measurement units
Change current display unit.

Example UNIT:TEMP?<cr><lf> (command)
C<cr><lf> (response)
(returns the active channel's units as celcius)

9.4.21 CONFigure:AMAF <value>

Command CONF:AMAF < value>
CONFIGURE:AMAF < value>

Returns None

Parameters

<value>	0	Off
	1	Low
	2	Med
	3	High

Function Selects the specified filter without initiating a measurement
Aborts the current measurement cycle
Clears the last measurement from the display
Clears the output buffer

Example CONF:AMAF<space>2<cr><lf>
(sets the digital filter to medium)

9.4.22 CONFigure:AMAF?

Command CONF: AMAF?
CONFIGURE: AMAF?

Returns < value>

Function Returns the digital filter setting

Example CONF: AMAF?<cr><lf> (command)
01<cr><lf> (response)
(returns medium as the digital filter's setting)

10. Options and Accessories

10.1 Accessories

The following options are available for the F600 –

Part Number	Description
FA-1	1 pair coaxial leads, BNC to BNC, 3 metres long
FA-2	1 pair coaxial leads BNC to open end, 3 metres long
FA-3	1 adaptor box (BNC to terminal and BNC)
FA-4	2 Terminal Binding Post to BNC (2 off)
T25-650-1	Standard reference PRT R_O = 25.5 ohms (nominal). 2 metre cable 4 wire plus screen with spade terminal connections. Stem length 450mm, quartz. R100/R_O 1.3925 (minimum). Reproducibility 0.01K or better. Range -189 °C to +650 °C.
T100-650-1	Physically similar to T25-650-1, but with R_O = 100 + 0.05 ohms. Suitable for use in laboratory environments, but not for general industrial applications. Range -189 °C to +650 °C
T25-660-1	Secondary transfer standard PRT 25.5 ohm 4 wire with 4 metres connecting cable to spade terminals. Range 0 °C to +650 °C.
T100-450-2	Working reference PRT R_O = 100 ohms, 2 meter cable with spade terminals. Stem length 450mm stainless steel with quartz liner. Range -100 °C to +450 °C. Alpha = 0.00385.
T100-450-3	As T100-450-2 except Alpha = 0.00392.
T100-600	Working reference PRT R_O = 100 ohms, 2 meter cable with spade terminals. Stem length 460mm quartz. Range -50 °C to +600 °C. Alpha = 0.00385.
T0.25-962-1	High Temperature standards PRT. R_O= 0.25 ohms. Range up to 962 °C
SB148	10 channel automatic/remote scanner. Current source for unselected PRTs.
FR4	Four, oven controlled reference resistors for systems applications. 1, 10, 25 & 100 ohms.
RW	Oil filled Standards resistors. 1, 10, 25, 100 & 1000 ohms
RR	Laboratory Reference Resistors. 1, 10, 25, 100 & 1000 ohms
RTE	Thermal enclosure for RW & RR resistors.

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11. Specifications

11.1 Resistance thermometer measurement[23]

PRT characterisation	ITS90, Din90 BS EN60751:1996, IEC60751:1983 CvD BSEN1904:1984, IEC751:1983
Thermistor characterisation	Steinhart and Hart (NTC)
Resistance measurement range	0 to 500,000 ohm
Temperature measurement range	ITS90 -200 to +962ºC Din90 -200 to +850ºC CvD -150 to +850ºC Thermistor – type dependent
Display resolution	0.1 mK
Accuracy (ratio)[24]	±3ppm (+20°C ±5°C)
Accuracy (resistance)	± 0.3mΩ (+20°C ±5°C)
Accuracy (temperature)	± 1mK (+20°C ±5°C)
Sense current	10µA, 20µA, 100µA, 200µA, 1mA, 2mA, 10 mA
Sense current multipliers	0.5 and √2
User selectable measurement display	Ratio, ºC, ºF, K or ohms
Internal reference resistors	25Ω , 100Ω , 10KΩ , 100KΩ
Internal reference resistors thermal stability	± 0.5ppm/°C
Internal reference resistors accuracy	± 0.01% (uncalibrated)
Input channels	1 PRT or 1 thermistor + 1 reference resistor
Input connection	4 x BNC + shield
Expansion port (optional)	1 x SB148

[23] Mesurements do not include uncertainties to the sensor.

[24] Using 100Ω, 1mA current, x4 gain, external reference, medium adaptive filter and a 2 second update rate.

11.2 Display

Vacuum Fluorescent Display (VFD)	256 x 128 (adjustable brightness)

11.3 Analogue outputs

Output 1	±10V dc, 10 mA. Function is range dependent

11.4 Power supply

Mains charger supply voltage range	90Vac – 264Vac
Power consumption	95VA max
Supply frequency range	47Hz - 63Hz
Fuse	T3A 250 Vac (slow blow)

11.5 Environmental

Storage temperature range	-20ºC to +50ºC
Service temperature range	+15ºC to +35ºC
Specified operating temperature range	+15ºC to +25ºC
Operating relative humidity conditions	< 80% RH, non-condensing

11.6 Dimensions and weight

Dimensions	150 x 455 x 450 (h x w x d)
Weight	7 kg

The F600 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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12. Cleaning and Maintenance

12.1 Cleaning

Make sure the F600 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.

12.2 Maintenance

Keep the instrument and its leads clean with occasional calibration checks. In particular the connectors to the R_t and R_s terminals should be kept clean to prevent leakage currents flowing. Damaged cable and connectors are a common cause of poor and intermittent operation.

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13. Service and Warranty

F600 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.

13.1 Technical Support

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

Isotech North America
158 Brentwood Dr., Unit 4
Colchester, VT 05446

Phone: 802-863-8050
Fax: 802-863-8125

sales@isotechna.com
www.isotechna.com

14. Appendix 1 – 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. The procedure for updating the F600 is described in detail below. A PC, downloader software[25] 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

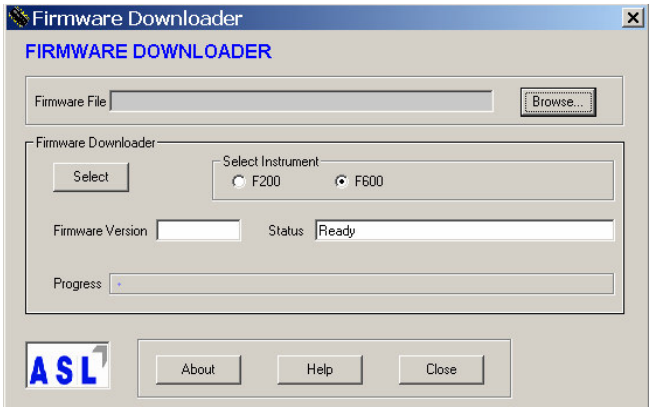
- Obtain a copy of the latest firmware from the ASL website www.aslltd.co.uk and copy the file into the directory indicated by the instructions on the website.
- Run the program **CDM_Setup.exe** from the directory **D:\Downloader** (replace the '**D**' with the name of your CD device if necessary). 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[26].

[25] Provided on the CD with the instrument.

[26] 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 F600 Instrument option
- Click on the Help button.



- Read the instructions and follow the instructions provided to update the instrument's firmware.

15. Appendix 2 – 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 –

$$R_t = R_o\left[1 + At + Bt^2 + C(t-100)t^3\right]$$

Where 'R_t' is the resistance at temperature 't' and 'R_0' 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 F600 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 F600.

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

Standard	α	A	B	C
DIN 43760	0.003850	3.9080×10^{-3}	-5.8019×10^{-7}	-4.2735×10^{-12}
ASTM	0.003911	3.9692×10^{-3}	-5.8495×10^{-7}	-4.2325×10^{-12}
ITS-90	0.003926	3.9848×10^{-3}	-5.870×10^{-7}	-4.0000×10^{-12}
				C= 0 if t > 0°C

16. Appendix 3 - ITS-90

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[27].

- 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,

[27] Note that each of these fixed points has an uncertainty associated with it.

and 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 F600 before the instrument can accurately convert resistance to temperature for a particular PRT.

The constants are conventionally called $R_{0.01}$, *Ap, Bp, Cp, Dp, An, Bn* and *W.*

17. Appendix 4 - DIN standard

17.1 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 ohms

A = 3.90802×10^{-3}

B = -5.802×10^{-7}

C = -4.2735×10^{-12}

The F600 will provide accurate resistance to temperature conversion based on these values when DIN conversion is selected for a probe.

18. Appendix 5 – Steinhart & Hart

18.1 Steinhart & Hart thermistor conversion algorithm

Nowadays, thermistors provide inexpensive and sensitive temperature sensors for suitable many applications. Thermistors may be closely matched and may be interchanged; the matching tolerance depends on the thermistor supplier.

There are many ways to convert the resistance of Negative Temperature Coefficient (NTC) thermistors into an equivalent temperature reading. The most popular of these is the Steinhart & Hart (S&H) equation.

The S&H equation uses a three term polynomial to curve-fit the thermistor's resistance to obtain an equivalent temperature value[28].

The S&H equation is –

$$\frac{1}{t} = C_1 + C_2 * \ln(R_t) + C_3 * \ln(R_t)^3$$

Where *'R_t'* is the thermistor's resistance (in ohms) and *'t'* is the absolute temperature in kelvin. The constants *C_1, C_2 and C_3* are the S&H values for the thermistor; these will be provided on a calibration certificate.

Once these coefficients have been entered into the F600, the Bridge will provide accurate resistance to temperature conversion for the probe based on these values.

[28] Higher-degree polynomials may be used, but usually the S&H three term polynomial is accurate to ±0.01°C.

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